

NOTES ON THE LICHEN GENUS *OCHROLECHIA* IN BOLIVIA

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**Abstract.** The paper presents new records for four taxa of *Ochrolechia* A. Massal. from Bolivia, of which three, *O. austroamericana* (Räsänen) Räsänen, *O. subpallescens* f. *Verseghy uruguayensis* Verseghy and *O. upsaliensis* (L.) A. Massal., are new for the country. *Ochrolechia subpallescens* f. *uruguayensis* is shown to differ chemically from *O. subpallescens* s.str., but its taxonomic rank needs to be clarified with molecular studies. *Ochrolechia africana* Vain. is also reported for the first time for Tanzania and Uruguay, and *O. austroamericana* for Ecuador.

**Key words:** biogeography, lichenized fungi, Neotropics, South America

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## INTRODUCTION

Despite intensive studies of lichens in tropical and temperate regions of South America, numerous genera are still poorly investigated. One of those is *Ochrolechia* A. Massal. Some records, including newly described taxa, were published by Verseghy (1962) in her world monograph, but these are not reliable due to numerous misidentifications of secondary metabolites and overestimation of morphological characters (e.g., Brodo 1991). More recent reports by Messuti and Lumbsch (2000) and Messuti and Vobis (2002) refer to species from southern South America. Occasionally they are given as additional material in taxonomic treatments of species from other continents (e.g., Brodo 1991; Kukwa 2011). The occurrence of *Ochrolechia* in many countries on the continent is still very poorly known, and Bolivia is no exception. Only two species were known from Bolivia: *O. africana* Vain. and *O. parella* (L.) A. Massal. The first was recently reported as host of the lichenicolous fungus *Cornutispora lichenicola* D. Hawksw. & B. Sutton from a single locality (Flakus & Kukwa 2012),

and the second was recorded as *Lecanora parella* (L.) Ach. by Nylander (1861) from tree bark. *Ochrolechia parella*, as presently circumscribed, represents a saxicolous lichen confirmed only from Eurasia and North Africa (Kukwa 2011), so we consider the Bolivian record to be a misidentification. The specimen published by Nylander (1861) may represent the superficially similar *O. africana* but this cannot be confirmed as no reference material was found in H-Nyl.

In this paper we report four taxa of *Ochrolechia*, three of which are new for Bolivia.

## MATERIAL AND METHODS

The study is based on samples we collected (deposited in KRAM, LPB and UGDA) and other collections deposited in B, BP, BM, H, LINN, PRA, W and the private herbarium of Professor Mark Seaward. Specimens were examined using standard microscopic techniques. Secondary metabolites were determined by thin-layer chromatography (TLC) in solvents A, B (or B') and C (methods according to Culbertson and Kristinsson 1970, and Orange *et al.* 2001). The reactions

with C (commercial bleach) of the thallus and apothecial structures were also checked.

The following abbreviations are used: *AF* – A. Flakus, *JQ* – J. Quisbert, *MK* – M. Kukwa, *OP* – O. Plata, *PR* – P. Rodriguez Flakus, *PN* – Parque Nacional, *PNANMI* – Parque Nacional Área Natural de Manejo Integrado, *ANMIN* – Área Natural de Manejo Integrado Nacional.

## THE SPECIES

### *Ochrolechia africana* Vain.

Annal. Univ. Fenn. Aboensis Ser. A 2(3): 3. 1926. – TYPE: SOUTH AFRICA, Durban. Trunk of tree. 1921, *van der Bijl 136* (TUR-V 34315, HOLOTYPE).

The species can be recognized by its small, often pruinose apothecia with smooth margins, rugose to verruculose thallus, and apothecial margin with C+ red medulla and C– cortex (Brodo 1991). Its chemistry is very diverse; Brodo (1991) distinguished eight chemotypes, all of which contain gyrophoric acid (always together with lecanoric acid), but they vary by the presence or absence of lichexanthone, 5-*O*-methylhiassic acid and 4,5-di-*O*-methylhiassic acid. We found three chemotypes in our Bolivian material: chemotype 3 with lichexanthone and 4,5-di-*O*-methylhiassic acid, chemotype 4 containing lichexanthone, and chemotype 6 with 5-*O*-methylhiassic acid.

The saxicolous specimens cited below could be considered to be *O. peruensis* Verseghy, but according to Lumbsch *et al.* (2003) that species lacks lichexanthone. However, *O. peruensis* may represent a saxicolous morph of *O. africana* lacking lichexanthone, as morphologically and chemically (the holotype contains gyrophoric, 4,5-di-*O*-methylhiassic and 5-*O*-methylhiassic acids) it is very similar to *O. africana*, but this needs to be checked by molecular analyses.

*Ochrolechia africana* was reported from tropical to subtropical areas of Australia, Asia (Bhutan, India, Taiwan), Central and North America (e.g., Costa Rica, Cuba, Mexico, USA), South Africa and South America (e.g., Argentina, Bolivia, Brazil, Paraguay) (Brodo 1991; Allen *et al.* 2001; Aptroot & Feijen 2002; Aptroot & Sparriss 2003; Singh & Sinha 2010; Flakus & Kukwa 2012). In

Bolivia it was known from a single locality up to now (Flakus & Kukwa 2012). In this paper it is reported for the first time from Tanzania and Uruguay.

SELECTED SPECIMENS EXAMINED. BOLIVIA. DEPT. LA PAZ. Prov. Franz Tamayo, between Apolo and Mapiiri villages, 14°50'51"S, 68°21'38"W, 1490 m, artificial savannah with scattered trees, on twig, 23 Nov. 2011, *MK 10268* (LPB, UGDA; chemotype 6); Prov. Nor Yungas, Coroico village, 16°11'10"S, 67°43'16"W, 1550 m, Yungas montane forest, on bark, 6 June 2010, *AF 16423.1* & *PR* (KRAM, LPB; chemotype 3); near Pongo village, 16°19'28"S, 67°57'21"W, 3822 m, Páramo Yungueño, on twigs, 26 Nov. 2011, *MK 10456a* (LPB, UGDA; chemotype 6); DEPT. SANTA CRUZ. Prov. Cordillera, *PNANMI* Kaa-Iya del Gran Chaco, 18°28'05"S, 62°05'43"W, 307 m, Chaqueño forest, Charrata village, on bark, 2 Dec. 2010, *AF 20185, 20194* & *JQ* (KRAM, LPB; chemotype 4); between Tucavaca and Roboré, 18°37'56"S, 59°36'50"W, 370 m, transition Chiquitano-Eachqueño forest, on twig, 04 Dec. 2011, *MK 10552* (LPB; chemotype 6); Prov. Florida, *PNANMI* Ámoro, La Yunga village, 18°05'59"S, 63°56'55"W, 1648 m, transition Yungas-Chiquitano forests, on rock, 8 June 2011, *AF 22576, MK 9957* & *OP* (KRAM, LPB, UGDA; chemotype 4). TANZANIA. TANGA PROV. Usambara Mts, Amani, road towards SW, 800–900 m, 5°08'S, 38°37'E, on bark, 11 Jan. 1971, *O. Vitikainen 9431* (H, chemistry not tested by TLC). URUGUAY. DEPT. CANELONES. PN 'F. D. Roosevelt', by artificial lake, on *Eucalyptus* sp., 4 Jan. 1986, *H. S. Osorio 8594* (herb. Seaward 105288; chemotype 6). A total of 10 Bolivian specimens seen.

SPECIMENS OF *OCHROLECHIA PERUENSIS* EXAMINED. PERU. Lima, 1868-1871, *Wawra* (W, holotype).

### *Ochrolechia austroamericana* (Räsänen) Räsänen

Anal. Soc. Cient. Argent. **131**: 100. 1941. – *Ochrolechia pallescens* var. *austroamericana* Räsänen, Anal. Soc. Cient. Argent. **128**: 138. 1939. – TYPE: [Argentina, Patagonia, Prov. Neuquén] Parque de N. H. [Nahuel Huapi], Valle Limay, 5 km austr. Lipela, en rocas. ca. 750 m. 12.X.1936. D. [A. Donat] (H!, HOLOTYPE).

According to Messuti and Lumbsch (2000) *O. austroamericana* is distinguished by its verrucose to areolate, brownish grey to brown thallus,

pruinose discs, mostly 8-spored asci, rather small ascospores,  $17\text{--}25 \times 10\text{--}20 \mu\text{m}$ , and gyrophoric acid as the main secondary substance.

In the studied material we observed additional features not reported before. In some Bolivian specimens the ascospores were larger than reported before, reaching up to  $31\text{--}(35) \mu\text{m}$  in length. The algal layer in the apothecia is always present in the amphithecium, but below the hypothecium it is often absent. We also observed considerable variation in hypothecium color; in some specimens it was very pale and in others distinctly orange-yellow to orange. The species may rarely form soralia, and up to now one such specimen has been reported (Messuti & Lumbsch 2000). In Bolivia we discovered sorediate morphs of *O. austroamericana* on three localities.

The species is known only from South America, where it has been reported from Argentina, Chile and Uruguay (Messuti & Lumbsch 2000; Kukwa 2011). In this paper it is reported from numerous localities in Bolivia and one in Ecuador. These records extend the known distribution of the species much northward.

SELECTED SPECIMENS EXAMINED (all saxicolous). BOLIVIA. DEPT. LA PAZ. Prov. Bautista Saavedra, ANMIN Apolobamba, near Villa Amarca village,  $15^{\circ}16'47''\text{S}$ ,  $69^{\circ}01'47''\text{W}$ , 4643 m, Puna Húmeda, 3 July 2010, *AF 17367* & *PR* (KRAM, LPB); Prov. Camacho, near Villa Cala village,  $15^{\circ}25'53''\text{S}$ ,  $69^{\circ}05'07''\text{W}$ , 4250 m, high Andean vegetation, on rock, 19 May 2011, *AF 21197* (KRAM, LPB); Pacoamba near Wila Kala,  $15^{\circ}24'40''\text{S}$ ,  $69^{\circ}04'24''\text{W}$ , 4283 m, Puna Húmeda, 6 July 2010, *AF 17698* & *PR* (KRAM, LPB, UGDA-L); Prov. Franz Tamayo, Pelechucomita hill by Puyo Puyo village,  $15^{\circ}01'18.94''\text{S}$ ,  $69^{\circ}08'48.07''\text{W}$ , 5050 m, high Andean vegetation, 25 Apr. 2008, *PR 554* (LPB); ANMIN Apolobamba, Socondori Chico near Ulla Ulla village,  $15^{\circ}00'38''\text{S}$ ,  $69^{\circ}13'48''\text{W}$ , 4479 m, high Andean open vegetation, 4 July 2010, *AF 17440*, *17442* & *PR* (KRAM, LPB); Prov. Manco Kapac, near Copacabana village, Mt. Horca del Inca,  $16^{\circ}10'15''\text{S}$ ,  $69^{\circ}05'05''\text{W}$ , 3974 m, high Andean Puna, on rock, 18 June 2006, *AF 8669* (KRAM, LPB); Prov. Murillo, PN Tuni Condoriri, Tuni village, Mt. Condor Pustaña,  $16^{\circ}13'27.70''\text{S}$ ,  $68^{\circ}16'03.40''\text{W}$ , 4862 m, high Andean vegetation, 17 March 2009, *PR 974* (LPB); Prov. Nor Yungas, near Pongo village,  $16^{\circ}19'28''\text{S}$ ,  $67^{\circ}57'21''\text{W}$ , 3820 m, Páramo Yungueño, 25 May 2011 *MK 9407*

(LPB, UGDA); Prov. Omasuyos, El Dragon hill near Chahualla,  $15^{\circ}51'17''\text{S}$ ,  $69^{\circ}00'40''\text{W}$ , 3850 m, Puna Húmeda, 06 July 2010, *AF 17839* & *PR* (KRAM, LPB); DEPT. ORURO. Prov. Sajama, PN Sajama, near Sajama village,  $18^{\circ}07'49''\text{S}$ ,  $68^{\circ}56'54''\text{W}$ , 4437 m, Puna Sureña, 18 June 2010, *AF 16455* & *PR* (KRAM, LPB). ECUADOR. PICHINCHA PROV. Guamaní (Páramo de la Virgen), moist Páramo N of road between Pifo and Papallacta, ca 25 km WSW of Quito,  $00^{\circ}18'\text{S}$ ,  $78^{\circ}12'\text{W}$ , 4200 m, 19 June 1999, *Z. Palice 2280* (PRA). A total of 29 Bolivian specimens seen.

SOREDIAE SPECIMENS EXAMINED (all saxicolous). BOLIVIA. DEPT. LA PAZ. Prov. Murillo, PN Tuni Condoriri, Tuni village, Mt. Paco Thojo,  $16^{\circ}12'31.30''\text{S}$ ,  $68^{\circ}16'12.30''\text{W}$ , 5014 m, high Andean vegetation, 18 March 2009, *PR 1030*, *1038*, *1056* (LPB); below Potosí, on road between La Paz and Valle del Zongo,  $16^{\circ}17'43''\text{S}$ ,  $68^{\circ}07'42''\text{W}$ , 4720 m, high Andean vegetation, 28 May 2011, *MK 9493* (LPB, UGDA); DEPT. ORURO. Prov. Sajama, PN Sajama, near Sajama village,  $18^{\circ}07'49''\text{S}$ ,  $68^{\circ}56'54''\text{W}$ , 4437 m, Puna Sureña, tholares vegetation, 18 June 2010, *AF 16502* & *PR* (KRAM, LPB).

*Ochrolechia subpallescens* Versegly  
f. *uruguayensis* Versegly

Beih. Nova Hedwigia 1: 119. 1962. – TYPE: URUGUAY: Flores-Ruta 3 km. 241. Sobre Melia azedarach a 1/4 km. al oeste de la escuela Marincho, *H.S. Osorio*. Herbario Hector Osorio No 3585 (B 32260!, BP 20054!, herb. Seaward 108721!, ISOTYPES).

Versegly (1962) characterized *O. subpallescens* f. *uruguayensis* as differing from the morphologically and anatomically similar *O. subpallescens* s.str. by its chemistry and distribution. Versegly's chemical data have been questioned (Brodo 1991), however, so we re-examined the type material and some additional specimens of both names. The samples of the two taxa are almost identical morphologically, with thick, rugose or verruculose thalli, a prominent, smooth apothecial margin, and epruinose apothecial discs. They differ in secondary chemistry: *O. subpallescens* s.str. almost always contains olivetoric and 3-*O*-demethylmicrophyllinic acids (see also Brodo 1991), whereas all examined specimens of *O. subpallescens* f. *uruguayensis* lack these substances. They also differ in the C reaction of apothecial

structures: in both taxa the margin cortex and disc are C+ red, but the margin medulla reacts red with C only in *O. subpallescens* f. *uruguayensis*. Since chemical features, especially the placement of secondary metabolites in the margin medulla and cortex, have been found to be taxonomically important in at least some *Ochrolechia* groups (Brodo 1991), we keep the two taxa separate, but a macromolecular analysis is needed to determine whether *O. subpallescens* f. *uruguayensis* deserves species rank.

The reactions of the apothecial margin of *O. subpallescens* f. *uruguayensis* are identical to those of *O. mexicana* Vain. The two taxa are also similar in general habit, as both have thick thalli and epruinose apothecial discs. The main difference is in their chemistry: *O. mexicana* contains lichexanthone and 4,5-di-*O*-methylhiassic acid. A rare chemical race of this species may lack 4,5-di-*O*-methylhiassic acid, but then the margin medulla is C negative (Brodo 1991).

*Ochrolechia subpallescens* f. *uruguayensis* has been reported so far only from Uruguay (e.g., Verseghe 1962; Osorio 2007). The Bolivian locality is the northernmost record of the species.

SPECIMENS EXAMINED. BOLIVIA. DEPT. COCHABAMBA. Prov. Carrasco, PN Carrasco, near Sehuencas village, 17°30'12"S, 65°16'30"W, 2220 m, along the road in Yungas cloud forest, on tree, 21 July 2008, *MK 6313, 6369* (LPB, UGDA). URUGUAY. DEPT. ROCHA. Sierra de San Miguel, Cerro de la Guardia Perdida, 33°42'S, 53°34'W, meadow, on rock, 11 June 1989, *H. S. Osorio 9168* (herb. Seaward).

### *Ochrolechia upsaliensis* (L.) A. Massal.

Ric. Auton. Lich. Crost.: 31. 1852. – *Lichen upsaliensis* L., Sp. Pl. 2: 1142. 1753. – TYPE: unlocalized specimen, but according to the protologue ‘Upsalia’ (LINN-1273.44!, upper right-hand specimen, LECTOTYPE).

This terricolous lichen is characterized by its often yellow apothecia with thick, scabrose to coarsely pruinose discs, not or partly expanded and never hyaline basal margin cortex, and the production of variolaric acid, which is often accompanied by the murolic acid complex and two unidentified substances named “microstictoides

unknowns” (Kukwa 2011). All these substances were detected in our Bolivian material. One specimen also contained two unidentified fatty acids in Rf classes A1 and A1-2 (not found in other solvents), apparently similar to those found by Kukwa (2011) in European samples.

*Ochrolechia upsaliensis* is known from numerous localities in Europe and North America, and a few records from Asia, Africa (Canary Islands) and South America (Argentina) (e.g., Hafellner 1995; Calvello & Liberatore 2002; Kukwa 2011). In South America it was also reported from Colombia (Verseghe 1962), but this record is considered erroneous (Sipman *et al.* 2008). In Bolivia it was found at only a single locality so far. This is also the first record from South America confirmed by TLC.

SPECIMENS EXAMINED. BOLIVIA. DEPT. LA PAZ. Prov. Franz Tamayo, ANMIN Apolobamba, Puntani hill, by guards’ office of ANMIN Apolobamba, 15°01'50.26"S, 69°11'08.89"W, 4770 m, high Andean vegetation, 23 Apr. 2008, *PR 578* (LPB), Pelechucomita hill near Puyo Puyo village, 15°01'18.94"S, 69°08'48.07"W, 5050 m, high Andean vegetation, on plant remains, 25 Apr. 2008, *PR 618* (LPB, UGDA).

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