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The rust fungi of *Luzuriaga* (Luzuriagaceae) with description of a new species, *Puccinia luzuriagae-polyphyllae*

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Abstract Three species of rust fungi (Uredinales), *Puccinia perforans*, *P. fuegiana* (= *Uromyces skottsbergii*), and *Aecidium callixenis* have been described on members of *Luzuriaga* (Luzuriagaceae). *Puccinia luzuriagae-polyphyllae* is added as a new species on *Luzuriaga polyphylla* from Chile. The rust had been confused hitherto with *P. perforans* occurring on *L. radicans*. Both species differ from *P. fuegiana* on *L. marginata* by the absence of a uredinal state and several telial characters. The investigated collections of *Puccinia* species on *Luzuriaga* indicate that each is restricted to a single host species. A determination key is presented.

Keywords Chile · Host specificity · Rust fungi · Uredinales · *Uromyces*

Introduction

The monocot genus *Luzuriaga* consists of three species occurring in the temperate and cool rain forests of southern South America and a fourth one in New Zealand (Jara-Seguel and Zúñiga 2005). The genus has been placed in the families Liliaceae, Philesiaceae or Smilacaceae but is nowadays accommodated in Luzuriagaceae of Liliales (Arroyo and Leuenberger 1988; Jara-Seguel and Zúñiga 2005). *Drymophila* is the only other member of Luzuriagaceae and occurs with two species in rain forests of south-eastern Australia. Luzuriagaceae is probably the sister group

of Alstroemeriaceae which is restricted to the New World with its two genera *Alstroemeria* and *Bomarea* (Fay et al. 2006, <http://www.mobot.org/MOBOT/Research/Apiweb/orders/lilialesweb.htm>; retrieved 16 March 2009).

Three rust fungi are known on members of *Luzuriaga*: *Puccinia perforans* Mont., *P. fuegiana* Lindq. (= *Uromyces skottsbergii* Jørst.) and *Aecidium callixenis* Berk. ex Syd. & P. Syd. Jørstad (1957) noted that the latter anamorph may belong to the life cycle of *U. skottsbergii*. The original description of *P. perforans* on *L. radicans* Ruiz & Pavon from Chile (comp. Saccardo 1888, p. 728) was completed by Hariot (1891), Sydow and Sydow (1904) and later supplemented by Sydow (1928), Oehrens Bertossi (1962) and Lindquist (1982). The rust fungus was distributed in ‘Sydow, Uredineen’ no. 1024, ‘Sydow, Fungi exotici exsiccati’ no. 726 and in ‘Plantae chilenses’ no. 2994 issued by the Botanical Museum of the University of Helsinki.

Recently, two clearly different species of *Puccinia* were collected on *Luzuriaga* in the Valdivian rain forest of southern Chile. Both species revealed characters, however, that matched the available descriptions of *P. perforans*. In the present paper, it is shown that reports and descriptions of *P. perforans* are based on two distinct rust species, the actual *P. perforans* and *P. luzuriagae-polyphyllae* which is described as new.

Materials and methods

The studied specimens are listed with the respective rust species. Infected plant organs were observed with a Zeiss Stemi SV8 stereo microscope. Spores and hand sections obtained from herbarium material were mounted in lactophenol on microscopic slides and gently heated to facilitate

Taxonomical novelties *Puccinia luzuriagae-polyphyllae* R. Berndt

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soaking of the fungal structures and host tissue. The preparations were examined with an Olympus 'BX51' compound microscope equipped with a 'ColorView IIIu' camera. The 'Cell^B' software package (Software Imaging System) was used to capture and edit micrographs. Photographs of rust sori were taken with the 'ColorView IIIu' mounted on a Olympus SZX2 stereo microscope.

Normally 40–50 but at least 30 spores were measured for each preparation. The arithmetic means are given in parentheses.

The names of herbaria are abbreviated by their acronyms according to Index Herbariorum (Holmgren et al. 1990). 'HerB'-numbers refer to the author's herbarium located at ZT.

Taxonomy

Puccinia perforans and *P. luzuriagae-polyphyllae*
spec. nov.

Luzuriaga specimens recently collected in the Chilean 'Región de los Lagos' bore two *Puccinia* species. One of them, found on *L. radicans*, showed rather large, crust-like, semi-compact telia (see Fig. 4, below) that were loculate by firmly coherent cylindrical paraphyses (see Fig. 5c, below). The other species occurred on *L. polyphylla* (Hook.) J.F. Macbr. and was distinguished by the presence of numerous one-celled mesospores (Figs. 1 and 2b) and by different looking telia without paraphyses (Fig. 2a). While both species were different from *P. fuegiana* in lacking a *Uredo* anamorph and in a number of teliospore traits, each of them revealed some characters that tallied with *P. perforans* according to existing descriptions. In the original description of *P. perforans*, the presence of paraphyses or mesospores was not mentioned, and Hariot (1891), who re-studied the type, did not describe these characters either. Sydow and Sydow (1904) were the first to describe that the telia were paraphysate in *P. perforans*, and Sydow (1928) claimed that numerous mesospores were present as well. Study of the recently collected specimens and the available exsiccata of *P. perforans* showed, however, that the characters 'telia paraphysate' and 'mesospores abundant' were mutually exclusive: *Puccinia perforans* issued in 'Uredineen' no. 1024 and 'Plantae chilenses' no. 2994 represented the *Puccinia* species with paraphysate telia on the host *L. radicans*, while *P. perforans* from 'Fungi exotici exsiccati' no. 726 occurred on *L. polyphylla* and revealed aparaphysate telia with numerous mesospores. In all investigated specimens, the host twigs were non-flowering, but the species could be identified or verified by their leaf morphology according to Arroyo and Leuenberger (1988).

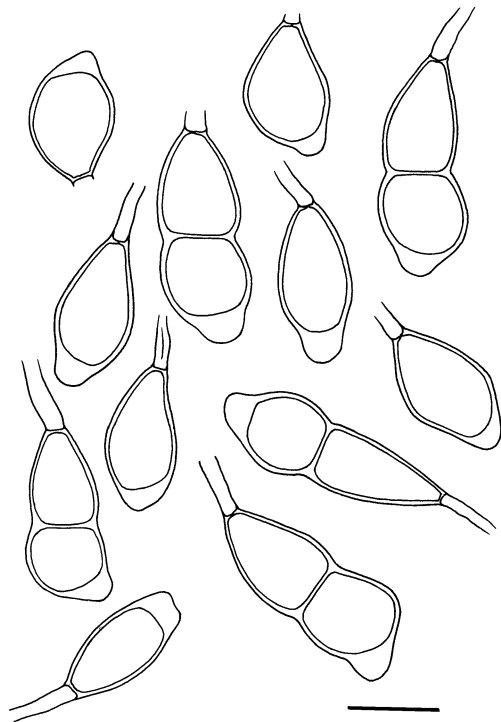


Fig. 1 *Puccinia luzuriagae-polyphyllae*, two- and one-celled teliospores (ZT Myc 1354). Bar 20 μ m

The type of *P. perforans* is kept in PC. Unfortunately, it was unavailable for microscopic study as types collected by Montagne are not sent on loan. However, through the courtesy of the curator Dr. Bart Buyck, I received a high resolution scan of the infected leaves present in the type specimen. On this, the host determination as *L. radicans* could be confirmed and it could be seen that the telia had the same gross morphology as the loculate telia present on other specimens of *L. radicans*. The *Puccinia* species with aparaphysate telia occurring on *L. polyphylla* is therefore recognized as new and described as *P. luzuriagae-polyphyllae*.

Puccinia luzuriagae-polyphyllae R. Berndt, spec. nov.
(Figs. 1 and 2)

Etymology: Named after the host species.

Spermogonia, aecia et uredinia absentia; telia adsunt. Ab *Puccinia perforanti* differt telii aparaphysatis, teliosporis unicellularibus copiosis et *Luzuriaga polyphylla* hospite. Ab *Puccinia fuegiana* praecipue vita microcyclica differt.

In foliis *Luzuriagae polyphyllae* (Luzuriagaceae).

Spermogonia, aecia and uredinia absent. Telia abaxial on leaves, subepidermal, on bleached, straw-coloured leaf spots, soon open and surrounded by the torn white epidermis, first singly but very densely aggregated, rapidly



Fig. 2 *Puccinia luzuriagae-polyphyllae*. **a** Telia on leaves of *Luzuriaga polyphylla* (ZT Myc 1352, holotype). The subpulvinate telia open irregularly and have an almost dendritic or cerebriiform appearance. Bar 1 mm. **b** Two- and one-celled teliospores. The spores are markedly constricted at the septa and show a pronounced apical thickening that may be mammilla-like (HeRB 5830). Bar 20 μm

confluent to more or less round, almost dendritic or cerebriiform, ferruginous to dull dark-brown compound sori. Teliospores two-celled or one-celled; two-celled spores subclavate, clavate or ellipsoid, moderately to pronouncedly constricted at the septum, $(35)37\text{--}55(57) \times (15)18\text{--}23 \mu\text{m}$ (mean $46.2 \times 19.0 \mu\text{m}$), distal cell more or less globose to broadly ellipsoid, as long as proximal cell or shorter, apex rounded or conical, sometimes mammilla-like, proximal cell tapering towards pedicel; spore wall smooth (sometimes very inconspicuously rough), light chestnut brown, ca. $1 \mu\text{m}$ thick, at apex $3\text{--}8 \mu\text{m}$, thickened moderately as well at germ pore of proximal cell, germ pores obscure, apical and close to the septum; pedicel subhyaline to pale brown, thin-walled and fragile, up to $30 \mu\text{m}$ long but generally breaking off close to hilum; one-celled spores numerous, rhomboid, broadly ellipsoid or subpyriform, $(25)27\text{--}43 \times 13\text{--}22 \mu\text{m}$ (mean

$33.3 \times 15.6 \mu\text{m}$), germ pore apical, spore wall as in two-celled spores.

On leaves of *Luzuriaga polyphylla* (Luzuriagaceae).

Holotype. Chile, Región de los Lagos, Puyehue Natl. Park, on *Luzuriaga polyphylla*, leg. C. Rothenbühler, 28 Jan 2009 (ZT Myc 1352). Paratypes. Chile, Región de los Lagos, Termas de Puyehue, along hiking trail ‘El Pionero’, on *L. polyphylla*, leg. R. Berndt & V. Faust-Berndt, 4 Mar 2000 (HeRB 8722, located at ZT). - Chile, Región de los Lagos, Puyehue Natl. Park, along hiking trail ‘Sendero de los Indios’, on *L. polyphylla*, leg. R. Berndt & V. Faust-Berndt, 5 Mar 2000 (HeRB 5830, located at ZT).

Additional material studied: Chile, Isla Chiloë, Castro-Pirruquina, on the leaves of *L. erecta* [revised as *L. polyphylla* by the author], leg. E. Werdermann, Feb 1924 (Sydow, Fungi exotici exsiccati no. 726, sub *P. perforans*. ZT Myc 1504 and ZT Myc 1354). *Puccinia fuegiana*. Argentina, Tierra del Fuego, Río Trucha, on *L. marginata* (Gaertner) Benth., leg. A. Ruiz Leal & F.A. Roig (no. 15198), 22 Feb 1953 (LPS 22389, type).

Puccinia luzuriagae-polyphyllae is easily distinguishable from *P. perforans* in the dendritic or cerebriiform and subpulvinate appearance of the telia, the absence of telial paraphyses, the occurrence of numerous one-celled teliospores and in the different host species.

Uromyces skottsbergii and *P. fuegiana* were published in the same year by Jørstad (1957) and Lindquist (1957), respectively. While *P. fuegiana* contained *Puccinia*-like two-celled teliospores together with one-celled mesospores, only one-celled teliospores were observed in *U. skottsbergii*. Lindquist (1958) reported that Jørstad had compared the types of both rusts and found them to be identical. *P. fuegiana* is the correct name for this rust species though it was published a few days later than *U. skottsbergii*. The reason is that *U. skottsbergii* could not be combined into *Puccinia* as the name *P. skottsbergii* Jørst. already existed for a rust on *Colobanthus*. *P. fuegiana* differs from *P. luzuriagae-polyphyllae* mainly by the presence of a *Uredo* anamorph, fusiform two-celled teliospores with longer pedicels and its occurrence on *L. marginata*. It should be noted that *P. fuegiana* had first been recognized by Cummins (1952) as *Puccinia* sp. but was not formally described due to the scarcity of the telial stage. Jørstad (1957) suggested that *Aecidium callixenis* could belong into the life cycle of *U. skottsbergii*. This might well be possible as both fungi were collected on the same host on the Falkland Islands/ Islas Malvinas.

As Luzuriagaceae are closely related to Alstroemeriaceae *P. luzuriagae-polyphyllae* was compared with the rusts known on *Alstroemeria* and *Bomarea*. It is different from *P. alstroemeriae* Syd. & P. Syd. and *P. bomareae* Henn. in the telia lacking paraphyses, and from the macrocyclic *P. pallor* Arth. & Holw. by the presence of abundant mesospores and

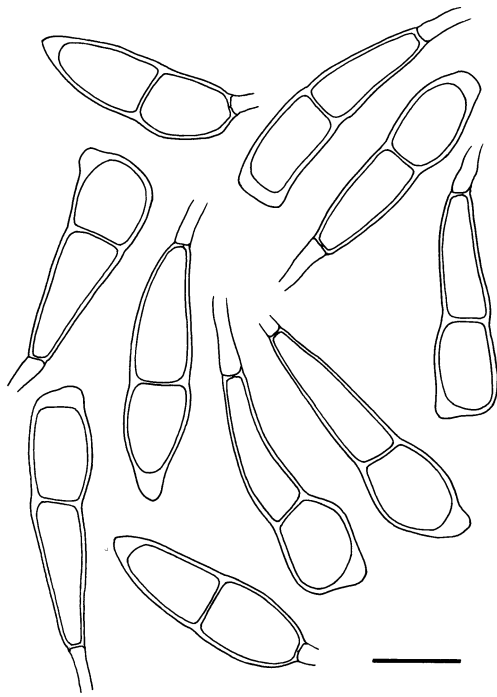


Fig. 3 *Puccinia perforans*, teliospores (HeRB 5829). Bar 20 μm

its microcyclic life cycle. It also differs from *Uromyces alstroemeriae* Henn. and *U. bomareae* Henn. which have ‘semi-stromatic’ or stromatic telia, respectively, and a uredinial stage (Laundon 1965). *Uromyces tehuelches* Speg. has teliospores with a reticulate wall and an *Aecidium* anamorph.

All investigated specimens were found on *L. polyphylla* and one can assume that the rust occurs specifically on this host species. A report of *P. luzuriagae-polyphyllae* on *L.*

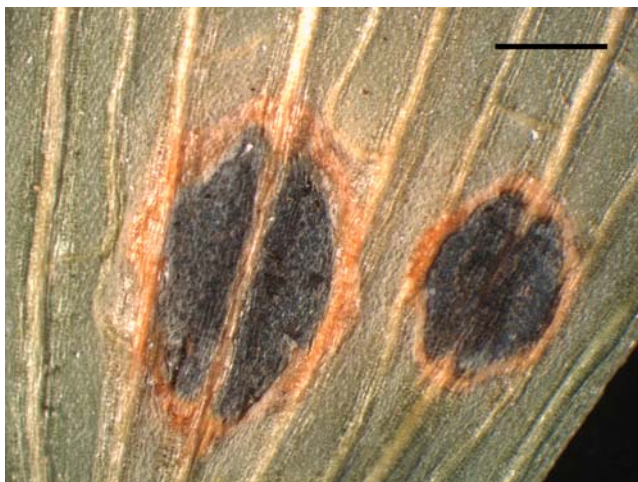


Fig. 4 *Puccinia perforans* on leaves of *Luzuriaga radicans* (HeRB 5829). The telia form uniform, blackish, only slightly raised crust-like patches. Bar 1 mm

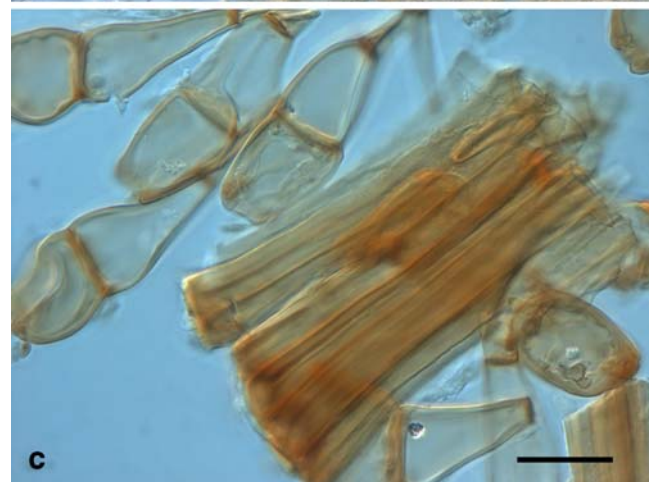
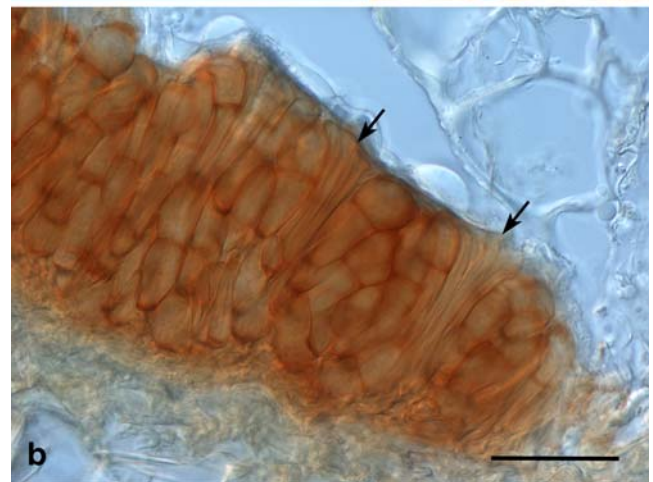


Fig. 5 *Puccinia perforans*. **a** Teliospores (HeRB 5829). **b** Section through telium (HeRB 5829). The teliospores are confined to locules separated by firmly adherent slender paraphyses (arrows). **c** Bundle of telial paraphyses among some old teliospores (ZT Myc 1353). Bars (a,c) 20 μm , (b) 50 μm

radicans by Oehrens Bertossi (1962) is in contradiction, however. The rust was listed under *P. perforans* but the provided description clearly shows that *P. luzuriagae-polyphyllae* is involved. As I did not see this specimen, the host identity could not be confirmed.

Puccinia perforans Mont. (Figs. 3, 4 and 5)

Material examined: Chile, on *L. radicans*, leg. Gay, without date (PC, holotype); only scan of leaves available. Additional material studied: Chile, Región de los Lagos, Termas de Puyehue, along hiking trail ‘El Pionero’, on *L. radicans*, leg. R. Berndt & V. Faust-Berndt, 4 Mar 2000 (HerB 5829, located at ZT). - Chile, Región de los Lagos, Puyehue Natl. Park, on *L. radicans*, leg. C. Rothenbühler, 28 Jan 2009 (ZT Myc 1506). - Chile, Concepción, on *L. radicans*, leg. F. Neger, Aug 1896 (Sydow, Uredineen no. 1024. ZT Myc 1505). - Chile, Prov. de Cautín, Temuco, Cierro Ñielol, on *L. radicans* in shady native forest, alt. 250 m a.s.l., leg. H. Rovainen, 25 Mar 1970 (Plantae Chilenses no. 2994, issued by the Botanical Museum of the Univ. of Helsinki. ZT Myc 1353).

Spermogonia, aecia and uredinia absent. Telia on abaxial leaf surface on bleached, ebony or straw-coloured leaf spots, that may break out of the leaves together with older sori; sori subepidermal, irregularly rounded or elliptic, uniformly crust-like, up to 2.5 mm diam., first covered by the whitish epidermis, later exposed by epidermis flaking off, blackish brown, subcompact, loculate by bundled and firmly adherent, narrowly cylindrical to subclavate paraphyses with moderately thick, brown walls. Teliospores two-celled, clavate to ellipsoid, more rarely fusiform or broadly ellipsoid, not or hardly constricted at septum, 35.5–71.5 × 13.5–22 µm (mean 52.8 × 17.7 µm), distal cell shorter or as long as proximal cell, with subtruncate, conical or, rarely, rounded apex, proximal cell generally tapering towards pedicel; spore wall smooth, rarely with delicate longitudinal ridges, (pale) golden-brown, light chestnut-brown in the apical thickening and at septum, ca. 1 µm thick, apex thickened to 3–7 µm, germ pores obscure, apparently apical and close to septum; pedicels slender, fragile, pallid brown, up to 30 µm long but usually breaking off shorter. One-celled and three-celled spores very rare.

Puccinia perforans resembles *P. alstroemeriae* by loculate telia but has longer teliospores with thinner walls. Differences from *P. luzuriagae-polyphyllae* are listed under the latter species.

All investigated specimens of *P. perforans* grew on *L. radicans*, and one can hypothesize that the rust is host species specific. As already mentioned, the same may hold true for *P. luzuriagae-polyphyllae* of which all but one specimen stem from *L. polyphylla*. The exceptional

specimen on *L. radicans* was reported in the literature and could not be studied. *Puccinia fuegiana* is only known from *L. marginata*. The available data thus indicate that the *Puccinia* species of *Luzuriaga* are specific to single host species. This hypothesis is supported by the observation that *P. perforans* and *P. luzuriagae-polyphyllae* were collected several times in close vicinity on their respective hosts in the Valdivian rain forest. In any such case, the rusts were only found on a single host species despite the availability of a congener.

Key to *Puccinia* species on members of *Luzuriaga*

- 1 Microcyclic, only telia formed.....2
 1* Not microcyclic, with uredinia, perhaps also *Aecidium*-like aecia; teliospores two- or one-celled, the latter may be prevalent; probably restricted to *Luzuriaga marginata* *P. fuegiana*
 2 Telia with ± dendritic or cerebriform pattern, not divided/loculate by paraphyses; teliospores two- or one-celled, the latter always numerous; probably restricted to *Luzuriaga polyphylla* *P. luzuriagae-polyphyllae*
 2* Telia not dendritic or cerebriform, divided/loculate by firmly adherent, narrowly cylindrical, brown paraphyses; teliospores two-celled, very rarely one-celled; probably restricted to *Luzuriaga radicans* *P. perforans*

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