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Additions to the Chilean phalloid mycota

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Abstract — Two species in the *Phallales* (*Agaricomycetes*), *Laternea pusilla* and *Lysurus cruciatus*, are recorded as new to Chile. We also present a discussion and a key to the phalloid species known to occur in the country.

Key words — *Clathrus*, gasteromycetes, *Ileodictyon*, *Phallus*, stinkhorns

Introduction

Phalloid fungi, commonly known as stinkhorns, may produce basidiomata with very distinct morphologies, but all are characterized by an ovoid structure during the immature stage. Most species produce an expanded basidiome when mature, but others (e.g., in *Protubera* Möller, *Claustula* K.M. Curtis, *Gelopellis* Zeller, maintain the glebal tissue enclosed by the peridium in a sequestrate structure. The gleba is usually mucilaginous and fetid, which facilitates the spores' dispersion by insects.

Phallales E. Fisch. is traditionally classified in two families, mainly based on basidiome development and morphology: *Clathraceae* Chevall. and *Phallaceae* Corda (Fischer 1898-99, Pilát 1958, Kirk et al. 2008). Recent sequence analyses support these two families as monophyletic clades, but four additional families are accepted: *Claustulaceae* G. Cunn., *Lysuraceae* Corda, *Protophallaceae* Zeller, and *Trappeaceae* P.M. Kirk (Hosaka et al. 2006, Kirk et al. 2008).

Phalloids are widespread, but most species are found in the tropics, with South East Asia being the center of diversity (Kreisel 1996, Cannon & Kirk 2007). However, despite their ample diversity and distribution, in Chile they

have been poorly studied. The first report is from the nineteenth century, when Montagne (1853–54: 497–499) recorded the occurrence of species of *Clathrus* P. Micheli ex. L., *Ileodictyon* Tul. & C. Tul., and *Laternea* Turpin. Additional species were reported by foreign naturalists (e.g., Cunningham 1868, 1871; Johow 1896; Spegazzini 1921; Zeller 1939; Santesson 1943; Singer 1969). Reports from Chilean researchers beginning in the twentieth century (Gunkel 1939, Lazo 1983, 2001; Lazo et al. 1977, Garrido 1981, 1986; Parra & Escudero 1994) have increased the number of phalloid species registered in Chile. The aim of this study is to provide descriptions of species previously unrecorded from Chile and a key to facilitate identification of all phalloid species recorded in this country.

Materials & methods

Specimens were treated according to Rossman et al. (1998) and photographed (in and ex situ) with a Nikon Coolpix P8 (Nikon, Japan). Vocabulary for morphological features follows Calonge (1998), and colors were coded following Kornerup & Wanscher (1978). Dried collections were rehydrated in 90% alcohol before examination. Anatomical characters were observed under a phase contrast microscope (Axiostar plus, Carl Zeiss, Germany) on glass slides mounts in water, 3% (w/v) KOH with phloxine, and cotton blue lactophenol. Vouchers were deposited at the herbaria of Museo Nacional de Historia Natural, Santiago, Chile (SGO), and Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil (ICN). Herbaria acronyms follow Thiers (2013).

Taxonomy

Laternea pusilla Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10: 343, 1868. Fig. 1

Immature basidiomata epigeous, ovoid to subglobose, ≤3.0 cm in diam.; exoperidium yellowish brown (5E4, 5F4), membranous, fragile, endoperidium white (5A1) to yellowish white (4A2); one or several rhizomorphs attached at the base. Mature basidiomata epigeous, up to 10 cm high; volva with the same characteristics of the immature basidioma. Receptacle long-elliptic in profile, formed by three, occasionally four columns that are free at the base and united above. Columns up to 8 cm high, 0.4–1.4 cm in diam., pastel red (8A5), reddish gray (8B2), reddish white (8A2) to orange white (6A2), fading towards the base, pale orange (5A3) when dry, with a central, longitudinal furrow; with elongated, delicate crests ≤1.5 cm high, projecting from the columns' external margins, especially near the apex; trapezoid in transversal section, multi-tubular, tubes 8–10, usually not interconnected, with the widest tubes and openings on the adaxial face. Glebifer situated beneath the arms' junction, orange red (8A8); gleba confined to the glebifer, mucilaginous, olive brown (5E7), fetid.

Basidiospores cylindrical attenuate at one side, 3.75–4.5 × 1.5–2 µm, chlorohyaline, smooth, thin-walled. Volva's exoperidium formed by

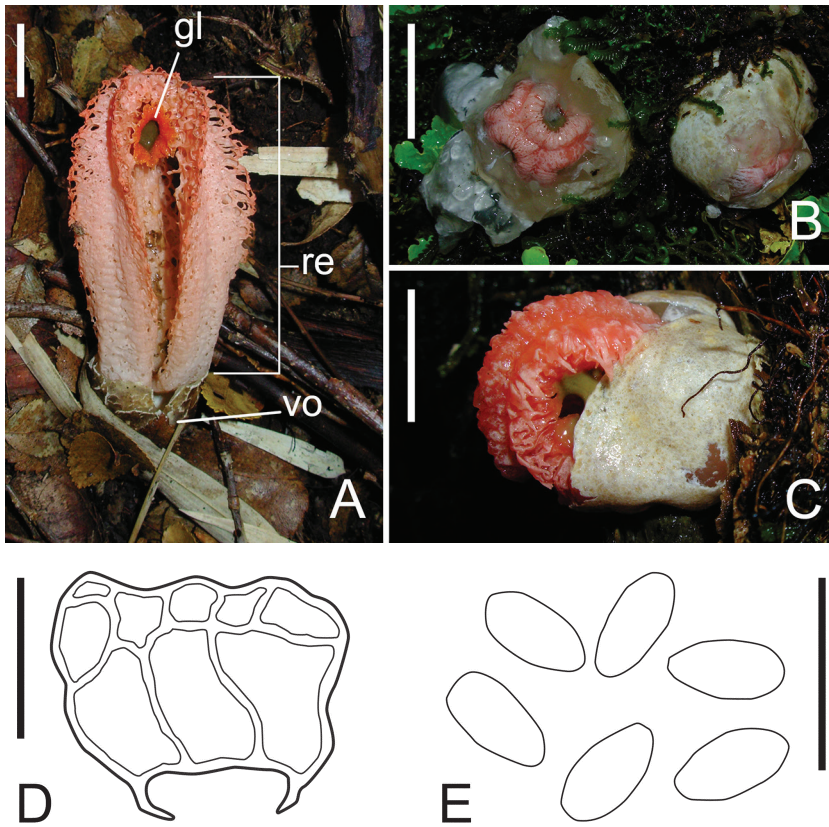

Fig. 1. *Laternea pusilla*: A. Basidiome (gl = glebifer; re = receptacle; vo = volva) (SGO 163170). B, C. Basidiomata expanding from the immature forms (SGO 163171). D. Receptacle column in transverse section. E. Basidiospores (ICN 192157). Scale bars: A–C = 2 cm; D = 2 cm; E = 5 µm.

pseudoparenchymatous hyphae, 14–39 µm in diam., with brownish content, thick-walled, walls yellowish; endoperidium formed by hyaline hyphae, simple septate, 3–7 µm wide, thin-walled. Columns formed by pseudoparenchymatous hyphae, 9–60 µm in diam., hyaline, thin to thick-walled, and walls ≤2.0 µm wide, yellowish to brownish; crests also pseudoparenchymatous.

Habit — growing on mossy barks on shady places. In southern Chile, it is commonly found within *Nothofagus* forests. It is possible that also occurs within *Nothofagus* forests from Argentina.

Specimens examined — **CHILE. Región XI**, Comuna Puerto Aysén, near Lago Yulton, 27.VI.2008, P. Sandoval-Leiva (SGO 163171); near Lago Los Palos, 14.XII.2009, P. Sandoval-Leiva (SGO 163170); **Región X**, Comuna Queilén, Isla Tranqui, 8.II.2009,

P. Sandoval-Leiva (SGO 163169); Chaitén, Parque Pumalín, Sendero de Alerces, 22.XI.2012, L. Trierveiler-Pereira et al. LTP 310 (ICN 192157). **Región XIV**, Comuna Máfil, Fundo Llao-Llao, 12.IX.2011, P. Sandoval-Leiva & J. Marquez (SGO 163168).

Remarks — The most striking feature of *L. pusilla* is the presence of crests projecting from the columns' external margins, usually found on the upper part of the receptacle. When basidiomata are not fresh, crests may appear shrunken. The receptacle morphology varies in many aspects: size, column structure (arched or more or less straight), number of columns (2–4), and color (ranging from bright red to pale pinkish). Chilean specimens are larger than those reported from the neotropics, reaching up to 10 cm high. It is also important to note that sometimes the columns are pitted. *Laternea pusilla* is a neotropical species reported from Central and South America (Dring 1980, Sáenz & Nassar 1982, Meijer 2006).

Lloyd (1909) included seven species in *Laternea*, but Dring (1980) recognized only two (*L. pusilla* and *L. triscapa*). In this study, we recognize a third species, *L. dringii* A. López et al. (López et al. 1981).

Laternea triscapa Turpin was earlier reported from Chile (Montagne 1853–54, Berkeley 1868, Philippi 1869), but we could not confirm the presence of this species in the country. Santesson (1943) suggested that the Chilean specimens identified as *L. triscapa* were misdeterminations of *Colonnaria columnata* (Bosc) E. Fisch [≡ *Clathrus columnatus*]. Dring (1980) examined Santesson's specimens and preferred to keep the name *L. triscapa*; however, he noticed that the specimens had some differences from the tropical ones. It is probable that these *Laternea* specimens from southern Chile reported by Santesson are conspecific with *L. pusilla*. Gamundí & Horak (2002) reported *L. triscapa* for the Patagonian forests in Argentina. The photograph presented by these authors depicts a pinkish receptacle with small crests (which appear shrunken) at the columns' margins. It is possible that this photograph also represents *L. pusilla*.

Lysurus cruciatus (Lepr. & Mont.) Henn., Beibl. Hedwigia 41: 172. 1902. Fig. 2

Immature basidiome subhypogeous, globose to obovoid, soft, up to 4 cm in diam.; with numerous mycelial cords attached at the base; exoperidium grayish yellow (1B3), membranous, endoperidium translucent, gelatinous and rather fluid. Mature basidiome epigeous, 6.5 cm high. Pseudostipe cylindrical, without longitudinal ribs, 6.5 cm × 1.8 cm, yellowish white (1A2), internally hollow, externally rough and consisting of one to three layers of intercommunicating tubes, surmounted by 5–8 arms; arms conical, hollow, up to 3 cm long, sometimes of different lengths in the same basidiome, initially united or not at the tips, but usually free when mature, externally brownish orange (6C6), orange white (6A2) at the center; external surface with a whitish, longitudinal, central, smooth groove; internal surface slightly concave and

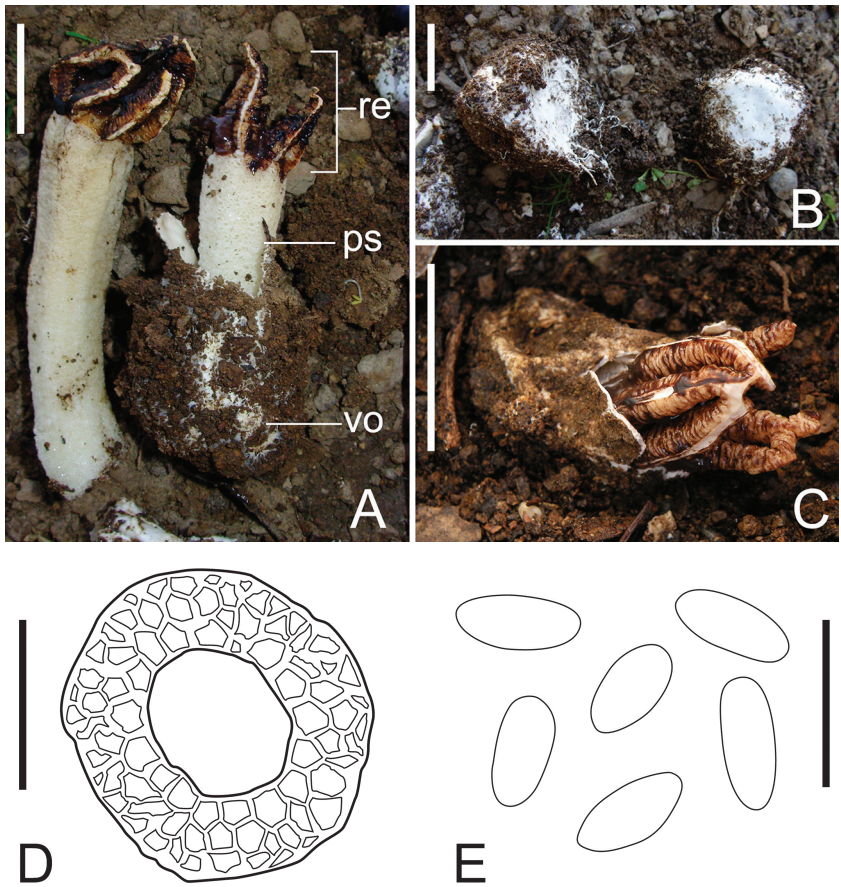

Fig. 2. *Lysurus cruciatus* (SGO 159558): A. Basidiome (re = receptacle; ps = pseudostipe; vo = volva). B. Immature forms. C. Basidiome expanding from the immature form. D. Pseudostipe in transverse section (note the hollow center). E. Basidiospores. Scale bars: A–C = 2 cm; D = 1 cm; E = 5 µm.

covered by the glebal mass. Gleba mucilaginous, yellowish brown (5F5), fetid.

Basidiospores cylindrical to ellipsoid, (3.3–)3.8–4.0(–4.5) × (1.4–)1.7–2.2 µm, chlorohyaline, smooth, thin-walled. Pseudostipe formed by pseudoparenchymatous hyphae, 29–52 µm in diam., hyaline, thick-walled, cell walls up to 5 µm.

Specimen examined — **CHILE. Región Metropolitana**, Melipilla, Cholqui, on soil under *Olea europaea* L., 28.VII.2010, Alarcón, Henríquez & P. Sandoval-Leiva (SGO 159558).

Remarks — The Chilean collection of *L. cruciatus* matches descriptions given by Domínguez (1995), Calonge (1998), and Dring (1980). *Lysurus cruciatus* is a saprobic species that grows in enriched cultivated and uncultivated soils with humus or plant debris in shady and humid places. It has also been recorded in glasshouses (Kreisel 2001). It is a typical alien species, originally described in French Guiana and actually with a wide distribution with records in Australia, Africa, North and South America, Europe, and western Asia (Dring 1980). Kreisel (2001) points out that *L. cruciatus* is unstable in temperate to Mediterranean climates, where it does not expand and disappears after one or several years.

Lysurus Fr. is a widespread genus with five species (Kirk et al. 2008). Prior to this study, there were two records of the genus in Chile: '*Lysurus*? sp.', reported by Spegazzini (1921) based on an immature basidioma; and *Lysurus periphragmoides* (Klotzsch) Dring in *Pinus radiata* plantations (Garrido 1986, as *Simblum sphaerocephalum* Schltdl.).

Discussion

Seven phalloid species are now reported from Chile. Most species have expanded basidiomata, with the exception of *Gelopellis macrospora* Zeller, a hypogeous, truffle-like species.

Phallus impudicus L. is the only species of the genus reported from the country, in the Valdivia province, observed abundantly during several years in the winter (Gunkel 1939). Gunkel does not cite voucher material, but since a good photograph of a specimen is presented, we believe that its identification is correct. Kreisel (1996) characterized *P. impudicus* by a reticulate receptaculum surface, lack of veil, and a white pseudostipe, volva, and mycelial strand. Since the species is common in Europe, Gunkel (1939) theorized that spores had arrived around the 1930's with European boats that frequently moored at the port.

Clathrus columnatus was reported only once from Chile, based on a collection by C. Gay (Montagne 1853–54). Dring (1980) also reported collections from Valdivia, probably referring to the same collection. We were able to analyze Gay's collection (Herbarium P), but as the specimen is not well preserved, it was difficult to verify its identification. As previously discussed, Santesson (1943) suggested that Chilean specimens recorded as *Laternea triscapa* might also represent this species. *Clathrus columnatus* is reported from America, Africa, and Australasia, so its occurrence in Chile is expected. The species is characterized by 2–5 robust, spongy, reddish to orange columns free at the base and fused at the apex. The gleba is spread in the internal portion of the columns and is not confined to a glebifer.

Cunningham (1868, 1871) reported a *Clathrus* or *Ileodictyon* species found on sand in Chiloé Island (Quemchi). The material was later examined by Fischer (1893) and Dring (1980), who identified it as *Ileodictyon cibarium* Tul. & C. Tul. [≡ *Clathrus cibarius* (Tul. & C. Tul.) E. Fisch.]. Cunningham's collections are probably the ones mentioned by Lloyd (1909). Spegazzini (1921) reported the species as *Clathrus cibarius* (which he considered a variety of *C. gracilis*), growing on soil under *Persea lingue* (Miers ex Bertero) Nees. *Ileodictyon cibarium* was also reported by Parra & Escudero (1994) from the Region of Valparaiso. Parra & Escudero (1994) also reported *Clathrus* sp. from Cerro Pajonal, but their descriptions and illustrations lead us to conclude that their "*Clathrus* sp." also represents *I. cibarium*. Lazo et al. (1977) reported *Clathrus* spp. in exotic plantations near Peñuelas Lake, and Lazo (1983, 2001) reported *C. cibarium* (mistakenly published as *C. gracilis,* W. Lazo, pers. comm.) in Pumanque.

Ileodictyon gracile Berk. was reported from Chile many times (Montagne 1853–54, Léveillé 1846, Johow 1896, Philippi 1869). Montagne (1853–54) clearly stated that he had no voucher of *I. gracile* in his fungal collection and that his description was based on Gay's illustration and field notes. However, Léveillé (1846) stated that in Herbarium P there was a Chilean collection of *I. gracile* made by Gay. Fischer (1891) identified this collection as *I. cibarium;* our examination of Gay's collection at P confirms Fischer's identification.

Singer (1969) recorded *I. gracile* in Juan Fernández Archipelago and southern Chile, stating that it is easily recognized and the only clathroid species native to the region. However, our observation of a single glebifer in Singer's collection (#M7200, SGO) suggests that *I. gracile* probably represents a *Laternea* species.

Ileodictyon cibarium is similar enough to *I. gracile* that many authors had difficulties in separating them (e.g., Fischer 1890). The two species can be differentiated by the morphology of the receptacle arms (Dring 1980, Cunningham 1944): in *I. cibarium* the arms are thicker, concertina-like, and not noticeably thickened where anastomosed. The difference between the two species was well illustrated by Lloyd (1909) and Dring (1980). The original description of *I. gracile* (Berkeley 1845) shows a very clear illustration of the type, which allows us to differentiate it from *I. cibarium*. Basidiomata of *I. cibarium* are usually larger and may even reach a diameter of about 40 cm (Lloyd 1910).

Due to the great similarity between the two species and erroneous interpretations of *Ileodictyon* species, many Chilean records of the genus are misidentifications. The descriptions and illustrations presented in literature lead us to conclude that *I. cibarium* is the only *Ileodictyon* species definitely known to occur in Chile.

Key to the phalloid species known to occur in Chile

1. Basidiome hypogeous, sequestrate (truffle-like); exoperidium thick, yellowish to brownish. . . . . ***Gelopellis macrospora***
1. Basidiome epigeous when mature, expanded; exoperidium thin, whitish to pale yellow. 2
2. Pseudostipe simple, cylindrical. 3
2. Pseudostipe absent; receptacle clathroid or columnar. 5
3. Receptacle conical. . . . . ***Phallus impudicus***
3. Receptacle sphaerical, clathroid or surmounted by short arms 4
4. Pseudostipe surmounted by short arms. . . . . ***Lysurus cruciatus***
4. Pseudostipe bearing an apical clathroid receptacle . . . . . ***Lysurus periphragmoides***
5. Receptacle clathroid, whitish; becoming detachable from the volva . . . . . ***Ileodictyon cibarium***
5. Receptacle ramified into columns, orange, pink to pale red; remaining attached to the volva. 6
6. Columns massive, reddish to orange, externally smooth; glebal mass spread internally in the arms; glebifer absent . . . . . ***Clathrus columnatus***
6. Columns delicate, pinkish to pale red, externally with delicate crests; glebal mass confined to a single glebifer . . . . . ***Laternea pusilla***

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