



***Limacella brunneovenosa*, a new species of *Limacella* sect. *Amanitellae* from Brazilian Atlantic Forest**

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Abstract

A new species of *Limacella* sect. *Amanitellae*, namely *L. brunneovenosa*, is described based on morphological and anatomical evidence. It is compared with similar species and illustrated with line drawings and photographs. This species was found in “Floresta Nacional Restinga de Cabedelo”, an Atlantic Forest protected area located in the municipality of Cabedelo, State of Paraíba, Brazil. In addition, we present a list and some remarks about Central and South American species of *Limacella*.

Key words – Agaricales – Agaricomycetes – Amanitaceae – Neotropics – taxonomy

Introduction

Limacella Earle is an uncommon genus of Agaricales, probably worldwide (Kirk et al. 2008). It comprises ca. 50 named taxa, although most of them involve inconsistent and poorly described reports, placing therefore the current state of knowledge of the genus in a chaotic situation (Tulloss & Yang 2018). The noteworthy papers about morpho-taxonomy and molecular phylogeny involving *Limacella* species have been useful for its macroscopical recognition and support inside the family Amanitaceae (Reijnders 1979, Komorowska 1984, Singer 1986, Ridley 1993, Gminder 1994, Moncalvo et al. 2000, 2002, Yang & Chou 2002, Kibby 2004, Bhatt et al. 2003, Neville & Poumarat 2004, Smith 2007, Ferreira et al. 2013).

Traditionally, the genus has been recognized by the following combination of characters: pileus slightly viscid or glutinous, without universal veil remnants; epicutis consisting of variously transformed or unchanged terminal members of hyphae which are ascendant or erect in a gelatinous mass; lamellae free or nearly so; lamellar-edge fertile; hymenophoral trama bilateral with divergent lateral strata; spore print white to cream; basidiospores globose to short ellipsoid, inamyloid, rarely dextrinoid, acyanophilous; stipe dry or viscid; partial veil present either as a glutinous layer or as a membranous annulus; not ectomycorrhizal (Singer 1986, Neville & Poumarat 2004). However, Tulloss & Yang (2018) emphasizes that in the most noteworthy characterizations for *Limacella* some characters are stated in vague ways, while others are based on probable misunderstandings of

tissue ontogeny and the analogous relationships between tissues in *Amanita* and *Limacella* or are mentioned, but ignored in the taxonomy of the genus.

In order to diminish the use and influence of the diffuse, confusing characterizations that have been common up to the present, Tulloss et al. (2016) provide a concise characterization for *Limacella*. In this sense, a species of the Amanitaceae is a member of the genus *Limacella* if and only if it has both (1) an agaricoid basidiome not produced by schizohymenial ontogeny and (2) a fertile lamella margin and a gluten bearing cap with gluten held in place by anticlinally oriented elements.

The infrageneric arrangement proposed by Singer (1986) divided *Limacella* into two sections based mainly on the viscosity of the stipe: sect. *Lubricae* and sect. *Limacella* [= *Viscidae* (Smith 1945)]. Sect. *Lubricae* includes taxa with a viscid or glutinous stipe, whereas taxa in sect. *Limacella* have a dry stipe. Later, studying the morphological and ecological characters of European species of *Limacella*, Gminder (1994) described sect. *Amanitellae* to accommodate *L. guttata* (Pers.) Konrad & Maubl and its allies. This is the most clearly defined of the three sections, including those species of the genus that (1) have many terminal cells of gluten-supporting hyphae which are conic or subconic, and (2) with such terminal cells frequently having a subtending cell, or subtending short chain of cells, that is/are inflated (globose, subglobose, broadly ellipsoid, or other) (Gminder 1994, Tulloss & Yang 2018).

The genus has been mainly recorded in Europe and North America, with little information for the Southern Hemisphere, especially from the Neotropics (Neville & Poumarat 2004, Ferreira et al. 2013). Murrill (1911) was the first author to describe a species of *Limacella* from Central and South America. Since then, few publications (see Table 1) have contributed to our knowledge of this genus in this region.

The aim of the present contribution is to propose a new species within section *Amanitellae*, named *Limacella brunneovenosa*. It was found in a remnant area of Atlantic Forest in Brazilian Northeast, and represents the first new species of *Limacella* described from South America. In addition, we present a list and some remarks about Central and South America species of *Limacella*.

Materials & Methods

The new species was collected at the “Floresta Nacional Restinga de Cabedelo”, an Atlantic Forest protected area of about 100 ha, located in the municipality of Cabedelo, State of Paraíba, Brazil. The area comprises a ‘restinga’ forest, with 160 species of angiosperms belonging to 61 families, of which the most diverse are Myrtaceae, Leguminosae (all subfamilies), Rubiaceae, Poaceae and Euphorbiaceae (Pontes & Barbosa 2008).

Macromorphological descriptions are based on field notes and color photographs of basidiomata taken in the field. Color codes are according to Kelly (1965) and Online Auction Color Chart-OAC (2004). Observations and measurements reported for micromorphological features were from dried material rehydrated and mounted in distilled water, 3% KOH and Congo red or Melzer's reagent. Biometric values and notation follow Tulloss et al. (1992), Tulloss (1993, 1994, 1998, 2000), which is summarized below.

At the beginning of a set of spore data, the abbreviation [*a/b/c*] signifies "*a*" basidiospores measured from "*b*" basidiomata of "*c*" collections. Dimensions of basidiospores are presented in the following form (*m*--*n*--*o* (--*p*), in which "*m*" is the smallest value observed or calculated and "*p*" is the largest value observed or calculated. In the range of values observed or calculated, the 5th percentile is "*n*"; and the 95th percentile is "*o*". A summary of definitions of biometric variables follows:

w_{cs} = breadth of central stratum of lamella;

$w_{st-near}$ = distance from one side of central stratum to nearest base of basidium;

w_{st-far} = distance from one side of central stratum to the most distant base of basidium on the same side of central stratum;

$L, (W)$ = the range of average lengths (widths) of spores of each basidioma examined;

L' , (W') = the average of all lengths (widths) of spores measured;

Q = the ratio of length to width of a spore or the range of such ratios for all spores measured;

\bar{Q} = the average of Q computed for all basidiomata examined;

\bar{Q}' = the average of all Q values computed for all spores measured.

The type has been lodged in the mycological collection of JPB (Thiers, continuously updated).

Results

Limacella brunneovenosa C.C. Nascimento & Wartchow, sp. nov.

Figs 1–7

Mycobank: MB819451; Facesoffungi: FoF04688

Etymology – From Latin: '*brunneo*' (= brown) and '*venosa*' (= veins); referring to the brownish veins embossing the pileus surface of the new species.

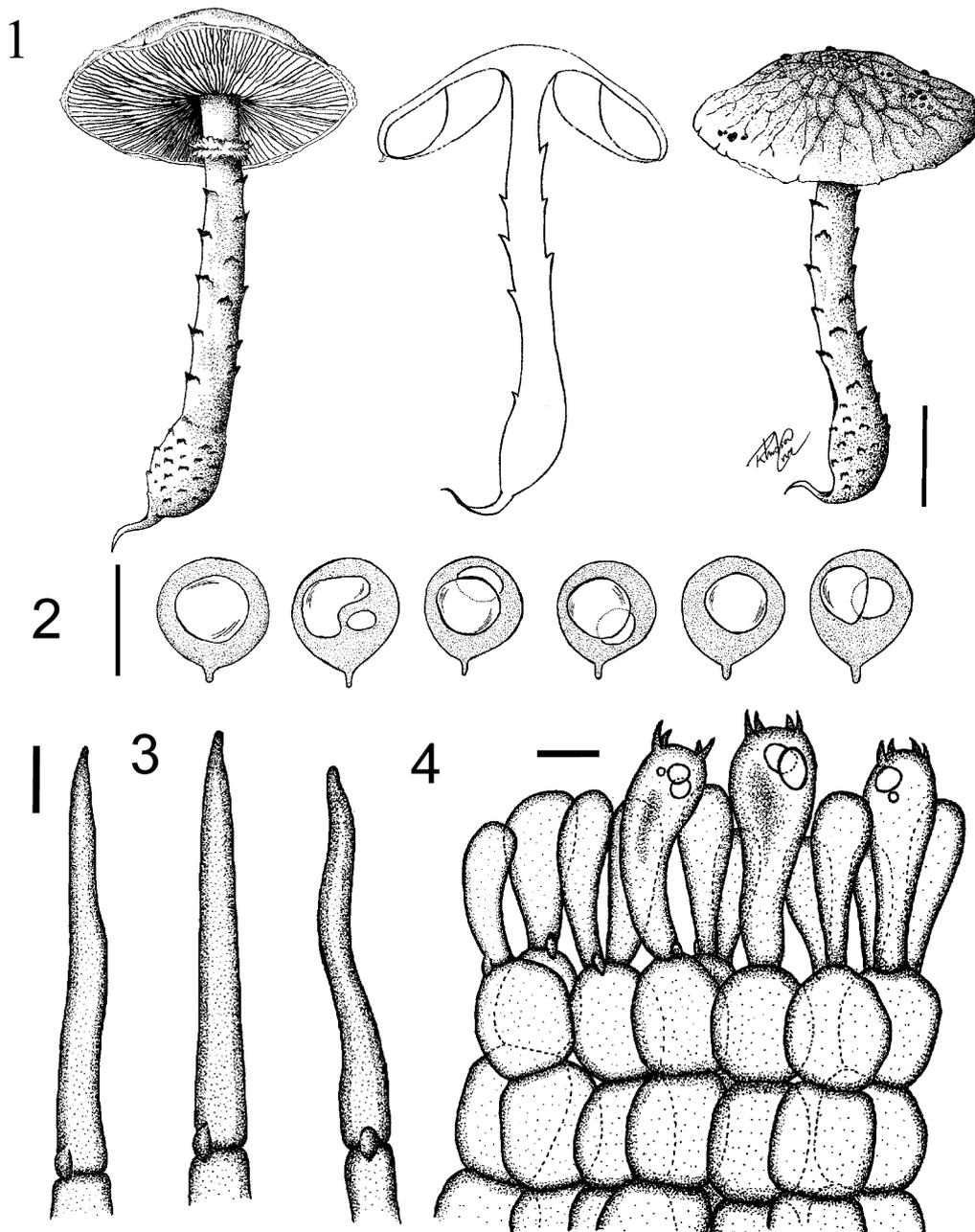
Type – Brazil, Paraíba, Cabedelo, Floresta Nacional Restinga de Cabedelo, Mata da AMEM, 12 July 2012, *F. Wartchow 119/2012* (JPB 62772, holotype).

Basidiomes small, growing in pairs adhered by the stipe base. Pileus 26–39 mm diam., cream buff (K 73.p.oy; OAC 759), with radial brownish (K 72.d.oy; OAC 748) veins, which are paler (K 73.p.oy; OAC 759) at spotted margin, sub-globose to hemispherical, becoming convex; surface smooth, somewhat glutinous, becoming dry, with adhering soil particles; margin entire, non-striate, non-appendiculate and exceeding lamellae; context stuffed, whitish, unchanging, to 8 mm thick above stem. Lamellae free to slightly adnexed, pale cream (K 89.p.y; OAC 815), subclose to subdistant, ventricose to subventricose, to 5 mm broad; lamellulae attenuate, fairly abundant, with several lengths, evenly distributed; edge entire, concolorous with lamellae. Stipe 30–38 × 3.5–5 mm, solid, subcylindrical, slightly tapering upwards, dry, rather fragile, central to slightly excentric; base slightly inflated and curved to one side (within substrate), with white rhizomorphs; surface white to whitish, with scattered, easily detached, cream buff (K 76.I.yBr) squamules over almost all length; context fibrous, whitish, to 4.0 mm thick, unchanging. Partial veil fragile, easily broken, superior or apical, cream buff (K 76.I.yBr). Odour sweet fruit. Taste not recorded. Spore print not obtained.

Basidiospores [60/2/1] (4.0–)4.3–6.0(–6.5) × (3.9–)4.3–5.5(–6.5) μm [$L = 4.9–5.5$ μm; $L' = 5.2$ μm; $W = 4.6–5.1$ μm; $W' = 4.9$ μm; $Q = (1.00–) 1.02–1.15(–1.17)$; $\bar{Q} = 1.06–1.07$; $\bar{Q}' = 1.06$], globose to subglobose, rarely broadly ellipsoid, hyaline, inamyloid, smooth, thin-walled, contents granular to multiguttulate; apiculus sublateral to subapical, cylindrical, often proportionately long-cylindrical. Basidia 15–25 × 4.5–7 μm, clavate with abundant contents, 4-spored, occasionally 2- or 3-spored, with sterigmata to 2–3 μm. Lamellar trama bilateral, slightly divergent, hyaline, with a prominent mediostratum, with sparse oleiferous hyphae, up to 8 μm wide; mediostratum of dominant thin-walled inflated elements, up to 60 × 18 μm, filamentous hyphae infrequent 3–6 μm wide; $w_{cs} = 30–35$ μm; lateral stratum composed of divergent inflated, somewhat clavate elements (to 27 μm wide) and filamentous hyphae, 4–7 μm wide. Subhymenium cellular, to 30 μm thick, of 2–3 layers of more or less isodiametric to slightly irregular cells, 8.5–15(–18) × 7.5–12.5(–16) μm; $w_{st-near} = 17.5–34$, $w_{st-far} = 36.5–45.5$. Cheilocystidia and pleurocystidia absent. Lamellar edge fertile. Hyphae supporting voval gluten erect (or almost so), hyaline, with tapering (sometimes sinuous) terminal elements, 50–80 × 4–11.5 μm, embedded in a gelatinous matrix, arising from subtending chains of more or less isodiametric cells, 34–43.7 (–50) × 28.5–40.5 μm. Pileus context of hyaline, undifferentiated filamentous hyphae, to 7 μm wide, sometimes inflating to 16–19 μm wide. Stipitipellis not differentiated. Stipe context longitudinally acrophysalidic; acrophysalides 120–190 × 9.5–15 μm very slender clavate; filamentous hyphae 2–6.5 μm wide, abundant, hyaline, septa often clamped; oleiferous hyphae up to 7 μm wide, locally conspicuous to abundant. Clamp connections common in all tissues examined.

Habit and habitat – Growing in pairs connate at the base, on sandy soil in 'restinga' vegetation Atlantic Forest.

Known distribution – Presently known only from type locality (South America: Brazil).



Figs 1–4 – *Limacella brunneovenosa*. 1 Basidiomes (bar 10 mm). 2 Basidiospores (bar 5 μm). 3 Terminal elements of gluten-supporting hyphae (bar 10 μm). 4 Subhymenium, basidia and basidioles (bar 5 μm).

Notes – *Limacella brunneovenosa* is well circumscribed in the field by the cream buff, somewhat glutinous but soon drying pileus with radially arranged brownish veins, pale cream hymenophore, a dry stipe with scattered squamules, and presence of a fragile and easily broken annulus. Its main microscopic features can be summarized by (1) globose to subglobose, rarely broadly ellipsoid, smooth, thin-walled, inamyloid basidiospores [(4–4.3–6(–6.5) \times (3.9–)4.3–5.5(–6.5) μm], (2) cellular subhymenium, composed of 2–3 layers of more or less isodiametric to slightly irregular cells [8.5–15(–18) \times 7.5–12.5(–16) μm]; and (3) hyphae supporting the vovel gluten erect (or almost so), hyaline, with conic to subconic (sometimes sinuous) terminal elements (50–80 \times 4–11.5 μm), arising from conspicuous subtending chains of more or less isodiametric cells and (6) common presence of clamps at the basal septa of basidia.

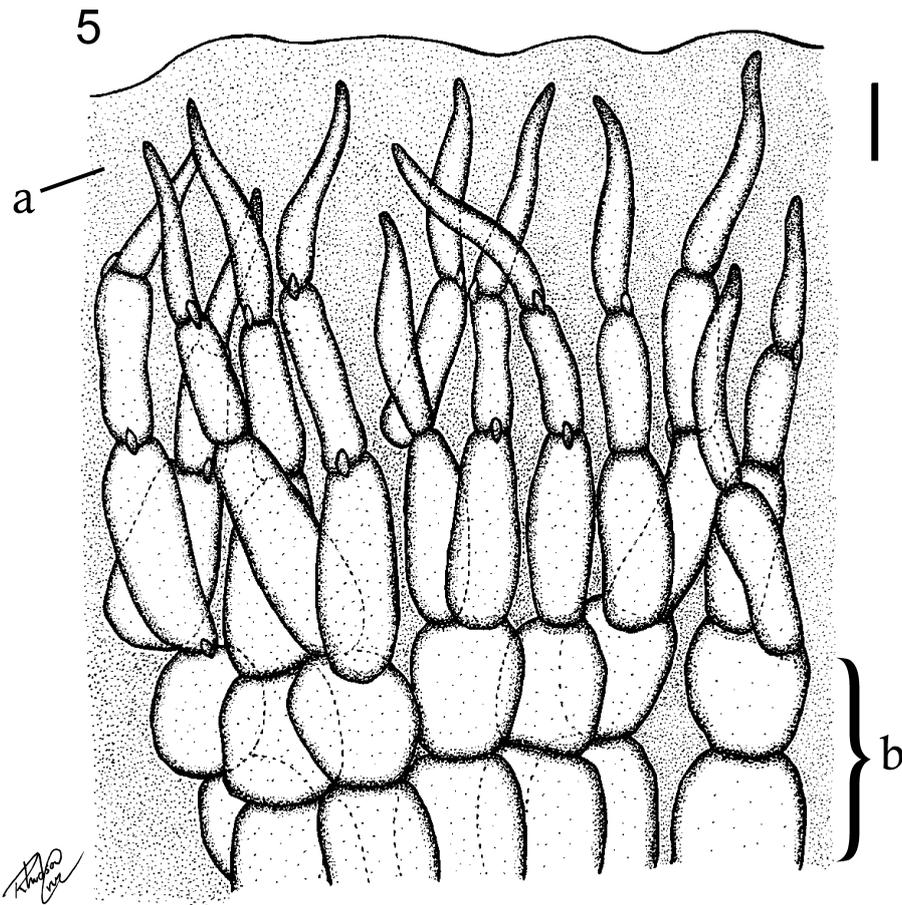
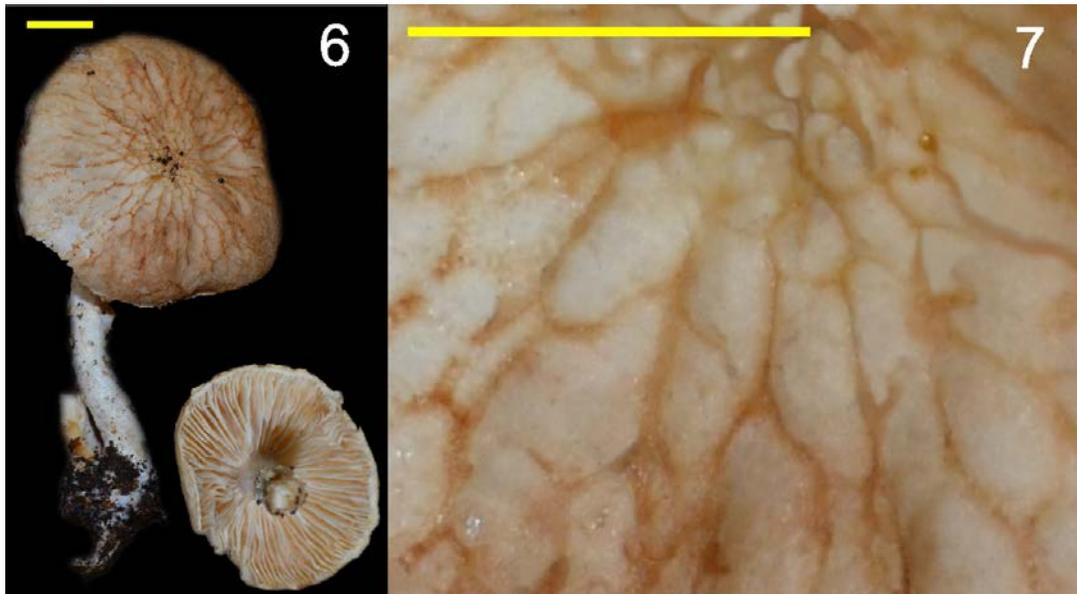


Fig. 5 – *Limacella brunneovenosa*. a Gluten-supporting hyphae (bar 20 μ m): a gelatinized matrix. b subtending cells.

On account of the overall features in the gluten-supporting layer, which includes conic to subconic terminal cells and subtending chains of more or less isodiametric elements, this new species is best placed in sect. *Amanitellae* (Gminder 1994, Tulloss & Yang 2018). Within this section, the type species *Limacella guttata* (Pers.) Konrad & Maubl. represents an uncommon agaric with a widespread distribution throughout the Europe and North America (Smith 1945, Gminder 1994, Kibby 2004, Neville & Poumarat 2004). It differs from *L. brunneovenosa* by its larger sized basidiomata [pileus (40–)70–120(–150) mm wide, stipe 70–150 \times 10–25 mm]; ochraceous cream to pinkish beige, umbonate pileus; lack of veins on pileus surface; fibrillose to finely fibrillose stipe surface; bulb clavate or with rather distinct knob and a membranous, ample, persistent partial veil, often covered above with small viscid exuded droplets (Gminder 1994, Neville & Poumarat 2004). Although there are no detailed descriptions of the microanatomy from the descriptions provided by Gminder (1994) and Neville & Poumarat (2004), *L. guttata* can be distinguished from *L. brunneovenosa* by its shorter/narrower terminal cells of gluten-supporting hyphae [17–43 \times 3.5–6 μ m (at base) \times 1.5–3 (at apex)].

Limacella myochroa Pegler and *Limacella solidipes* (Peck) H.V. Sm. are other species in sect. *Amanitellae* that can be compared to *L. brunneovenosa*. *Limacella myochroa* described from Martinique (Pegler 1983) has similar globose to subglobose basidiospores (5–6 \times 4–5 μ m; $Q' = 1.16$), but has a gray-brown (or brown-gray) pileus with a slightly striate margin and a persistent, membranous partial veil. *Limacella solidipes* described from New York – USA (Smith 1945) is most similar to *L. brunneovenosa*. Both taxa have globose to subglobose, sometimes broadly ellipsoid basidiospores (4–5 \times 4–5 μ m, $Q = 1.00$ –1.25) and erect hyphae of the gluten-supporting layer, which have a distinctive rather blunt-pointed end cells. However, *L. solidipes* has small to medium-sized basidiomata (cap 30–70 mm broad, stipe 80–100 \times 6–10 mm) with a "pale pinkish buff" (very pale alutaceous) pileus surface; crowded lamellae; never scaly stipe and a persistent,

ample, pendulous partial veil (Smith 1945). In *Limacella brunneovenosa* basidiomata are smaller, with a cream buff pileus; subclose to subdistant lamellae; scaly stipe and an inconspicuous, evanescent partial veil.



Figs 6–7 – *Limacella brunneovenosa*. 6 Basidiomes (bar 10 mm). 7 Venous pattern on pileus surface (bar 5 mm).

Discussion on distribution of *Limacella* from Central and South America

To date, including *L. brunneovenosa*, only nine species of *Limacella* are known from Central and South America (Table 1).

Amongst these, *L. agricola* and *L. alachuana* are problematic taxa. The first remain as an ‘insufficiently known’ species according Tulloss & Yang (2018). It was only recorded from the type locality in Jamaica by Murrill (1911), and no information is available on the important anatomical features, which are mandatory in order to determine its relationships. The latter species was described originally from Florida, USA (Murrill 1938), and subsequently reported from Martinique by Pegler (1983) as a new combined taxon (within *Limacella* sect. *Lubricae*). However, Pegler’s determination has been questioned (Tulloss & Yang 2018), since it did not involve a revision of the type collection and even overall features described by him, such as pigments from pileus and lamellae, differ from those in the Murrill’s protologue (Murrill 1938).

Four taxa of *Limacella* are believed to occur in Brazil (Table 1). Three, namely *L. illinita*, *L. glischra* and *L. guttata*, are known only from checklists of agarics (Bononi 1984, Pegler 1997, Meijer 2006). So, their status cannot be verified as there are no comments on macro- and microcharacters, and no mentions about available specimens in herbarium. The only reliable species of *Limacella* so far reported from Brazilian territory seems to be *L. ochraceolutea*, occurring on woodland soil among fallen leaves of palm *Syagrus romanzoffianum* in Paraná State, South Brazil (Ferreira et al. 2013). It is the only fully described *Limacella* species for Central and South America using methodology that benefits from the advances in Amanitaceae studies since Corner & Bas (1962) and Bas (1969), therefore it represents an important source of comparison for subsequent studies (morphological comparison and/or molecular analysis) for *Limacella* species in Neotropical Brazil.

In conclusion, the listed species of *Limacella* for Central and South America should be regarded with caution, since most of them are incomplete or unsubstantiated reports. Moreover, the results of this paper strongly support the necessity of collecting and studying *Limacella* especially in Central and South America because very little is known about its Neotropical species.

Table 1 Taxa of *Limacella* recorded from Central and South America, country distribution and Reference list.

Species	Country	References
<i>Limacella agricola</i> Murrill	Jamaica	Murrill (1911), Smith (1945)
<i>Limacella alachuana</i> (Murrill) Pegler	Martinique	Pegler (1983)
<i>Limacella glischra</i> (Morgan) Murrill	Brazil	Bononi (1984)
<i>Limacella guttata</i> (Pers.) Konrad & Maubl.	Brazil, Martinique	Pegler (1983, 1997), Meijer (2006)
<i>Limacella illinita</i> (Fr.) Maire	Antigua, Brazil, Martinique	Pegler (1983), Meijer (2006)
<i>Limacella laeviceps</i> (Speg.) Raithelh.	Argentina, Uruguay	Spegazzini (1899, 1926), Farr (1973), Raithelhuber (1974, 1987, 1991, 2004)
<i>Limacella myochroa</i> Pegler	Martinique	Pegler (1983)
<i>Limacella ochraceolutea</i> P.D. Orton	Brazil	Ferreira et al. (2013)
<i>Limacella brunneovenosa</i> C.C. Nascimento & Wartchow	Brazil	This paper

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