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The genus *Itajahya* (*Phallales*, *Basidiomycota*) in northeastern Argentina: macroscopic and microscopic characterisation of *Itajahya galericulata* and *Itajahya rosea*

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Lozano Rojas J.A., Sena D., Ramirez N.A., Popoff O., Niveiro N. (2024): The genus *Itajahya* (*Phallales*, *Basidiomycota*) in northeastern Argentina: macroscopic and microscopic characterisation of *Itajahya galericulata* and *Itajahya rosea*. – Czech Mycol. 76(2): 157–174.

Itajahya is a phalloid genus characterised by the presence of a calyptra, a sterile slightly wavy tissue which remains attached to the pseudostipe by a thin membrane. This paper presents macroscopic and microscopic features of immature and mature basidiomes of two species collected in northeastern Argentina, *I. galericulata* and *I. rosea*. Furthermore, we emphasise the contrast between the two species and also provide a comparative morphological analysis. Photographs of their development and illustrations of the basidia and basidiospores are included. This study reports the first record of *Itajahya rosea* for Argentina.

Key words: phalloid, diversity, stinkhorns, taxonomy, calyptra.

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Lozano Rojas J.A., Sena D., Ramirez N.A., Popoff O., Niveiro N. (2024): Rod *Itajahya* (*Phallales*, *Basidiomycota*) v severovýchodní Argentině: makroskopická a mikroskopická charakteristika *Itajahya galericulata* a *Itajahya rosea*. – Czech Mycol. 76(2): 157–174.

Itajahya je rod hadovkovitých hub, který se vyznačuje přítomností kalyptry, tvořené jemně zvlněným sterilním pletivem, jež zůstává tenkou membránou připojeno k nosiči. Článek představuje makroskopické a mikroskopické znaky nezralých a zralých plodnic dvou druhů sbíraných v severovýchodní Argentině, *I. galericulata* a *I. rosea*. Mimoto zdůrazňuje kontrast mezi oběma druhy a poskytuje srovnávací morfologickou analýzu. Obsahuje též fotografie jejich vývoje a ilustrace bazidií a bazidiospor. Tato studie uvádí první nález druhu *Itajahya rosea* pro Argentinu.

Introduction

The genus *Itajahya* Möller (1895) belongs to the family *Phallaceae*, order *Phallales*, in subclass *Phallomycetidae*, together with *Geastrales*, *Gomphales* and *Hysterangiales* (Hosaka et al. 2006, Trierveiler-Pereira et al. 2014, He et al. 2019, Wijayawardene et al. 2020, Melanda et al. 2021). This genus is morphologically characterised by having a foot or pseudostipe which can be white or pink, carrying a cylindrical and hollow receptacle (skirt-shaped), covered by lamellar and tuberculate membranes where the gleba is attached, at the apex of which a pseudoparenchymatous disc, the calyptra, is located. The development is of the unipileate type, which in the immature or primordium stage has a single pseudostipe, surrounded by the gleba in the form of a cylinder, formed by numerous labyrinthiform to lamelliform cavities, maintaining this external position at maturity (Dring 1973, Miller et Miller 1988).

Itajahya includes four species: *I. hornseyi* Hansf., *I. argentina* (Speg.) Speg., *I. rosea* (Delile) E. Fisch., and *I. galericulata* Möller. *Itajahya argentina* was described for Argentina, while *I. hornseyi* was recorded for Australia; both species are only known from the locations of their original descriptions (Spegazzini 1899, 1927, Hansford 1954). On the other hand, *I. galericulata* and *I. rosea* are two well-known species with a wide distribution, having been recorded on most continents, e.g. North and South America, Africa, and Asia.

The taxonomic position of *I. galericulata* and *I. rosea* within the genus has long been debated with regard to the phylogenetic relationship between the two species. *Itajahya galericulata* (type species of the genus) was described from Blumenau, Brazil. For some years, this species was questioned to be a synonym of *Alboffiella argentina* Speg. Wright (1949), analysing the type of *Alboffiella* and collected specimens of *I. galericulata*, did not find enough similarities to consider them synonyms. In addition, he managed to notice the variable occurrence of certain characters (size of pileus, thickness of pseudostipe, height) in some basidiomes of *I. galericulata*, which resulted in intermediate forms, therefore he considered the existence of two forms, called *typica* and *atypica*.

On the other hand, *Phallus roseus* was described from Egypt by Delile in 1813, but Fischer (1929) proposed combining the species into the genus *Itajahya*, based on morphological characteristics. Subsequently, Malençon (1984) and Kreisel (1996) considered *Itajahya* to be a subgenus of *Phallus* based on several common features (the shape and configuration of the pileus – granular, rough, wig-like – as well as certain pigments present in the receptacle and the variable odour of the mature gleba). This reassignment eventually affected *Itajahya galericulata* when the latter author adopted the name *Phallus galericulatus* (Möller) Kreisel. Ottoni et al. (2010), including *Itajahya* as a subgenus of *Phallus*, proposed to re-evaluate its taxonomic status with further molecular analysis of

the group, considering the presence of the calyptra at the apex of the receptacle. Following the DNA sequences generated by Cabral et al. (2012), it was found that *I. rosea* does not group with any *Phallus* species, and was therefore proposed for incorporating it in *Itajahya*, which was elevated to the status of genus. Finally, based on the first DNA sequence data for *I. galericulata*, Marincowitz et al. (2015) concluded that it is also phylogenetically separate from *Phallus* and *Dictyophora* species, thus supporting the phylogenetic relationship of *I. rosea* and *I. galericulata*, and placing both in the same genus.

The morphological similarity of mature basidiomata of *I. galericulata* and *I. rosea* complicates a precise differentiation using characters as height, spore size and calyptra shape only, omitting the pink colour of the stipe. Campi Gaona et al. (2017) complemented the differences by considering the peridium of the immature basidiome, consisting of three layers in *I. rosea* and four layers in *I. galericulata*, to be an important character separating both species. In addition, the *Phallales* have a particular life cycle which is completed in the 'egg' stage, where all cells are formed, leading to an increase in size and volume of these for the event of 'hatching' or maturation.

The aim of the present study is to provide knowledge of the macroscopic and microscopic characteristics of specimens identified as *I. galericulata* and *I. rosea* found in the northeastern region of Argentina, to clarify the differences between the two species and expanding the distribution of *I. rosea* in Argentina.

MATERIAL AND METHODS

The specimens were collected in the Chaco and Corrientes Provinces, Argentina, during the autumn, winter, and spring seasons. They were photographed in situ, and the characteristics of their natural habitat and the surrounding vegetation were noted. For taxonomic identification and description of the specimens, the criteria and terminology by Demoulin et Marriott (1981), Miller et Miller (1988), Domínguez de Toledo (1989), and Trierveiler-Pereira (2014) were followed. Basidiospore terminology follows Domínguez de Toledo (1994). The colour terminology is based on Kornerup et Wanscher (1978). Authors of scientific names are according to Index Fungorum, Authors of Fungal Names (on-line).

Two stages were considered, mature basidiomes and immature basidiomes. Measurements of mature basidiomes were taken from specimens collected in situ. Changes during the development and growth of the basidiomes at different stages were recorded by performing maturation of the basidiomes in the laboratory. For this, the collected immature material, both closed and cut in a longitudinal section, were deposited in a container with the substrate of the habitat where they were found (up to half of the volume), with the aim of stimulating the development of 'eggs'.

For analysis of microscopic structures, freehand cuts were made with a Schönfeld stereoscopic magnifier, and mounted in potassium hydroxide (5%), a solution with aqueous phloxin (1%) and Melzer's reagent (Wright et Albertó 2002). Microscopic structures were measured on photographs taken with a Leica DM 500 optical microscope with built-in camera using the ImageJ software (Schneider et al. 2012). For the spores, data are provided using the following abbreviations; x = mean value of spore length and width, Q = quotient of length and width indicated as a range of variation,

Qx = mean value of Q, n = number of spores measured, and N = number of basidiomes from which spores were measured.

The collected material was dehydrated, part of it kept in a freezer and the rest preserved in small screw-capped jars with soft-FAA, a solution composed of acetic acid (3%), formalin (5%), glycerine (20%), and distilled water (72%) as a permanent preservative, and all deposited as reference material in the BAH collection of the CTES herbarium.

RESULTS

Itajahya galericulata Möller, Bot. Mitt. Trop. 7: 79, 148, 1895 Figs 1, 2, 5, 7

Synonym: *Phallus galericulatus* (Möller) Kreisel, Czech Mycology 48(4): 275, 1996

Macroscopic features. Immature basidiomata. Eggs globose to subglobose, semihypogeal, obpyriform, 35 (height) × 37 mm (upper diameter) to 20 mm (lower diameter). Peridium light brown (5D4–5D5), composed of 4 well-defined layers organised in two strata, an exoperidium and an endoperidium, each one consisting of two layers: a firm exoperidium layer 1.5–1.7 mm thick and a mucilaginous layer 0.6–0.8 mm thick; a firm endoperidium layer 0.8–1.0 mm thick and a continuous mucilaginous layer 2.0–2.5 mm thick. Dehiscence by transverse cracking (into halves), observed more frequently than an irregular type occurring by rupture of the apical portion of the exoperidium. Gleba compact, olive green (2E4), arranged in vertical rows on the sides of the developing stipe, 5.4–5.8 mm wide, hyphae immersed, white, elongated, spread across the width of the gleba.

Mature basidiomata phalloid, unipileate. Pseudostipe simple, cylindrical, hollow, expanding up to 125–143 mm high × 28–30 mm outer diameter, thickness 5.0–6.0 mm, yellowish white (2A2), spongy with irregular pores. Pseudostipe margin with warty protruding tissues in apical zone; with subeccentric scar of pseudostipe-volva junction at base. Receptacle cylindrical, with reticulated surface, fertile portion consisting of a lamellar tissue attached to the apex at one end like a skirt, 21–25 × 30–32 mm. Gleba mucilaginous, deliquescent at maturity, dark olive (2F4), with petrichor odour and bitter taste. Calyptra yellowish white (2A2), elliptical to discoid, 30–40 mm diam., flattened, covering the central orifice of the apical portion, consisting of two layers which are joined at the margins and internally form several pseudo-chambers with the region towards the corrugated margins and horizontal and irregular margins. 'Fundamental tissue remnant' between stipe apex and the calyptra fragile, very tenuous, hyaline. Internal volva white, papyraceous.

Microscopic features. Basidia grouped in clusters, forming a hymenium, 11.4–17.8 × 3.2–4.7 µm, clavate, 8-spored, with very short sterigmata. Basidiospores hyaline, smooth, ellipsoid in equatorial view, 3.4–4.6 ×

Fig. 1. Macroscopic features of *Itajahya galericulata* (JALR 62 CTES: a–d, h, k; JALR 59 CTES: e–g, i–j): **a–b** – mature basidiomes in situ, **c–d** – immature basidiomes in situ, **e** – subeccentric pseudostipe-volva junction scar, **f** – internal volva, **g** – mature gleba on receptacle, **h** – longitudinal section of the 'egg' showing four peridial layers, **i** – external volva, **j** – fundamental tissue at receptacle apex, **k** – immature stage in longitudinal section. Bars: a, b, c, d, e, f, g, i, j, k = 2 cm; h = 1 mm. Photo J. Lozano.

1.7–2.3 µm, x = 4.1 × 2.0 µm, Q = 1.7–2.4, Qx = 2.1 (n = 20, N = 1), inamyloid, globose in polar view. Cystidia not observed. Subhymenium composed of filamentous, thin-walled, slender, non-septate, 3.2–4.9 (x = 4.2) µm wide hyphae. Pseudostipe pseudoparenchymatous, hyphae formed by subglobose, hyaline, thin-walled cells 19–35 × 16.1–26.2 µm in size. Calyptra pseudoparenchymatous, hyphae formed by globose to subglobose hyaline cells, 19–27 × 15–26 µm in size, cells oblong near the inner margin. Peridium up to 6.0 mm thick, composed of 4 layers: outer firm layer formed by filamentous, septate, thin-walled,

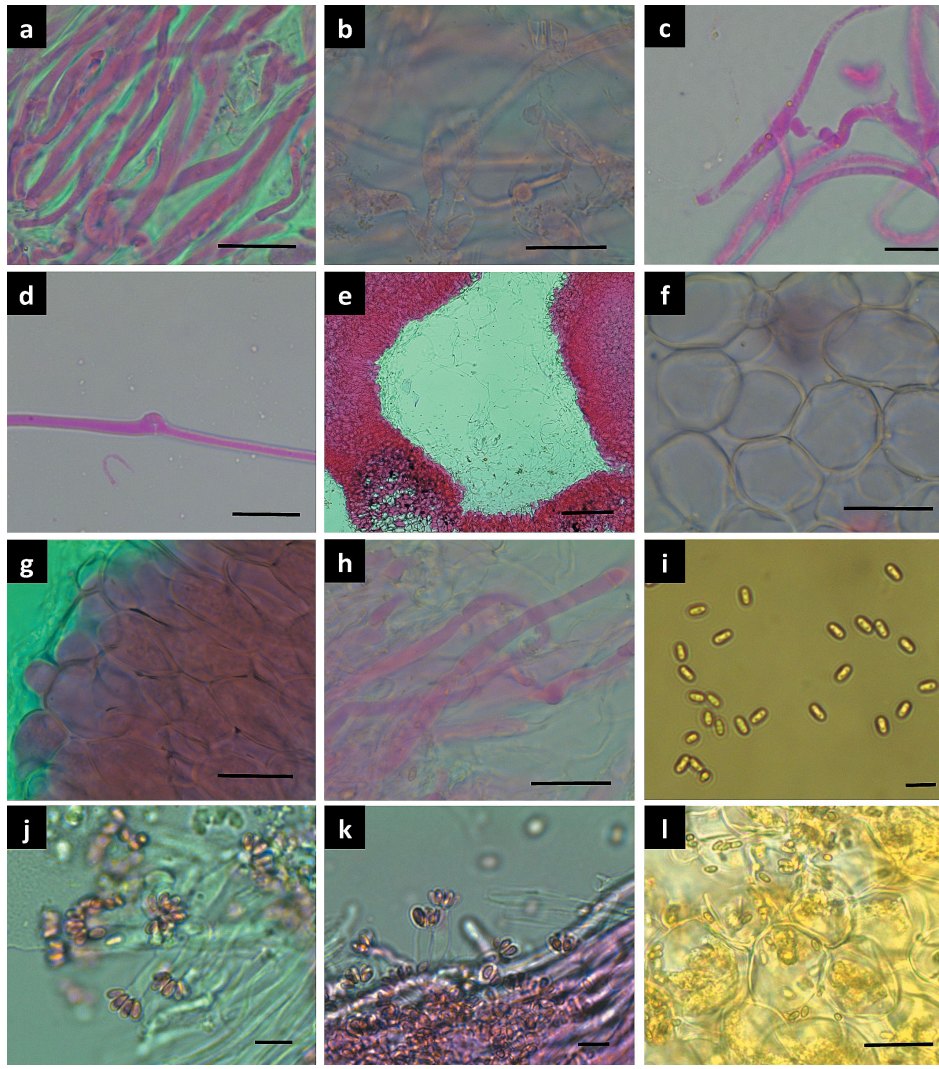

Fig. 2. Microscopic features of *Itajahya galericulata* (JALR 62 CTES): **a** – outer firm peridial layer, **b** – inner firm peridial layer, **c** – mucilaginous layer with paired nuclei, **d** – clamp-connection of mucilaginous layer, **e** – calyptra, **f–g** – pseudoparenchymatous tissue from calyptra, **h** – hyphae of internal volva, **i** – basidiospores in Melzer's reagent, **j–k** – clustered basidia and hymenium, **l** – pseudoparenchymatous tissue from pseudostipe in Melzer's reagent. Bars: a, b, c, d, h = 10 µm; i, j, k = 5 µm; e = 200 µm; f, g, l = 20 µm. Photo J. Lozano.

hyaline, 2.3–4.9 (x = 3.6) µm wide hyphae; inner firm layer formed by filamentous, hyaline, 2.3–4.1 (x = 3.2) µm wide hyphae, regions near septa moderately flared, with clamp connections; hyphae of the two mucilaginous layers located

between the firm layers and the gleba, thin-walled, long, containing a pair of yellowish nuclei, with clamp connections.

Habitat and distribution. Solitary or growing in pairs. *Itajahya galericulata* has developed a wide distribution being also recorded in Brazil (Lloyd 1907, Oliveira et al. 2023), Bolivia (Fries 1909, Rocabado et al. 2007), Argentina (Fries 1909, Spegazzini 1927, Wright 1949, Ruíz Leal 1954, Domínguez de Toledo 1995, Hernández Caffot et al. 2015), Paraguay (Campi Gaona et al. 2017). It was further reported from the states of Arizona and New Mexico in the USA (Long et Stouffer 1943), South Africa (Marincowitz et al. 2015), and India (Patel et al. 2018).

Notes. Fresh material of *Itajahya galericulata* with overripe basidiomes exhibited a formation of very distinct longitudinal striations on the pseudostipe, which are preserved in dried material. This characteristic was not observed in the youngest specimen which had the gleba partly excised.

Specimens examined

Argentina. Province of Corrientes, Corrientes city, corner of Santa Fe and Bolívar Sts, 27°28'17'' S, 58°49'51'' W, growing on soil moderately covered by vegetation, anthropised environment, at the base of *Handroanthus impetiginosus* (Mart. ex DC.) Mattos, 31 May 2023, leg. J. Lozano (JALR 59 CTES); ibid., mature and immature basidiome, 8 Jul 2023, leg. J. Lozano (JALR 62 CTES); ibid., two immature basidiomes, 9 Oct 2023, leg. J. Lozano (JALR 86 CTES).

Itajahya rosea (Delile) E. Fisch., Ber. Deutsch. Bot. Ges. 47: 294, 1929

Figs 3, 4, 6, 8

Basionym: *Phallus roseus* Delile. Flore d'Egypte 2: 300, 1813
Synonym: *Phallus impudicus* var. *roseus* (Delile) Quél. C. r. Assoc. Franç. Avancem. Sci. 11: 402, 1883

Macroscopic features. Immature basidiomata. Egg subepigeal, subglobose to ovoid, 25–35 mm wide × 32–40 mm high. Peridium orange white to pale orange (5A2–5A3). Peridium composed of three layers in longitudinal section: outer layer (exoperidium) of firm consistency, whitish, 1.5–2.0 mm thick; middle layer (mesoperidium) mucilaginous, ochre or olive brown (4D3), up to 2.5 mm thick, consumed during maturation; inner layer (endoperidium) thin, whitish, less than 1 mm thick, in contact with the gleba, at maturity persisting as an internal volva. Dehiscence by transverse cracking (into halves) or by an irregular rupture occurring in the upper part of the exoperidium. Gleba dull green to dark green (29E4–29F4), arranged in vertical rows on the sides of the developing pseudostipe, not reaching the base, with whitish, faint and delicate hyphae, grouped in circular, semicircular, and elongated conglomerations.

Mature basidiomata phalloid, unipileate. Pseudostipe simple, cylindrical, reddish white to pinkish (11A2), spongy, hollow in the centre, expanding up to 95–100 mm high × 15–16 mm outer diameter, 4–5 mm thick, covered with white membranaceous remnants from the endoperidium, becoming fainter with

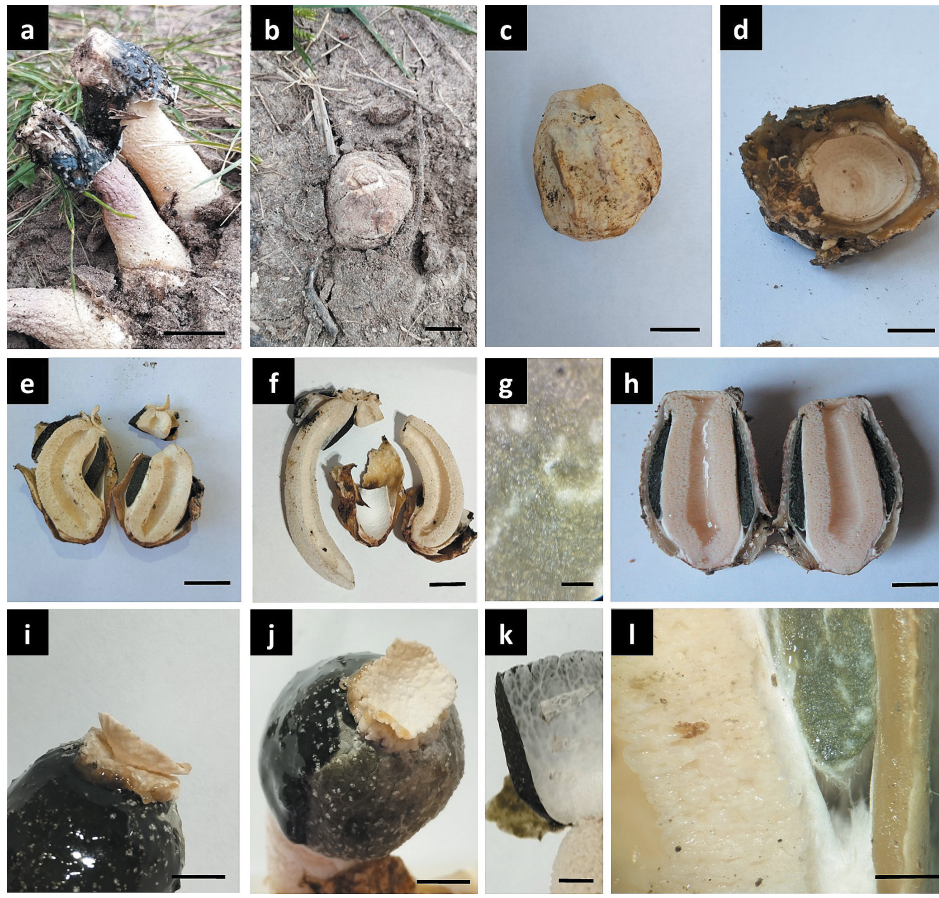

Fig. 3. Macroscopic features of *Itajahya rosea* (JALR 60 CTES): **a** – mature basidiomes in situ, **b** – immature basidiome in situ, **c** – general aspect of the 'egg' stage, **d** – internal volva, **e–f** – growth from a transversely cut immature basidiome, **g** – hyphae immersed in gleba, **h** – basidiomes compressed inside the egg, **i–j** – detail of calyptra on receptacle apex, **k** – surface of receptacle, **l** – peridial layers under magnification. Bars: a, e, f = 1.5 cm; b, c, d, h, i, j = 1 cm; g = 1 mm; k = 5 mm; l = 2 mm. Photo J. Lozano.

age; eccentric pseudostipe-volva junction scar at base. Apical margin of stipe with elongated protruding tissues. Receptacle thin and soft, 30–35 mm wide × 25–27 mm high, cylindrical in shape, attached to the stipe by the apical margin. Dorsal surface (carrying the gleba) reticulate with branched membranes. Ventral surface smooth. Remnants of 'ground tissue' between stipe apex and calyptra, very faint and fragile, hyaline. Gleba deliquescent at maturity, strong smell of leaf litter or humus, dark green (29F3), taste slightly bitter, sweet, and astringent. Calyptra pinkish (11A2), caducous, discoid, 18–20 mm diam., forming a sterile platform at the apex of the receptacle covering the hollow centre, becoming

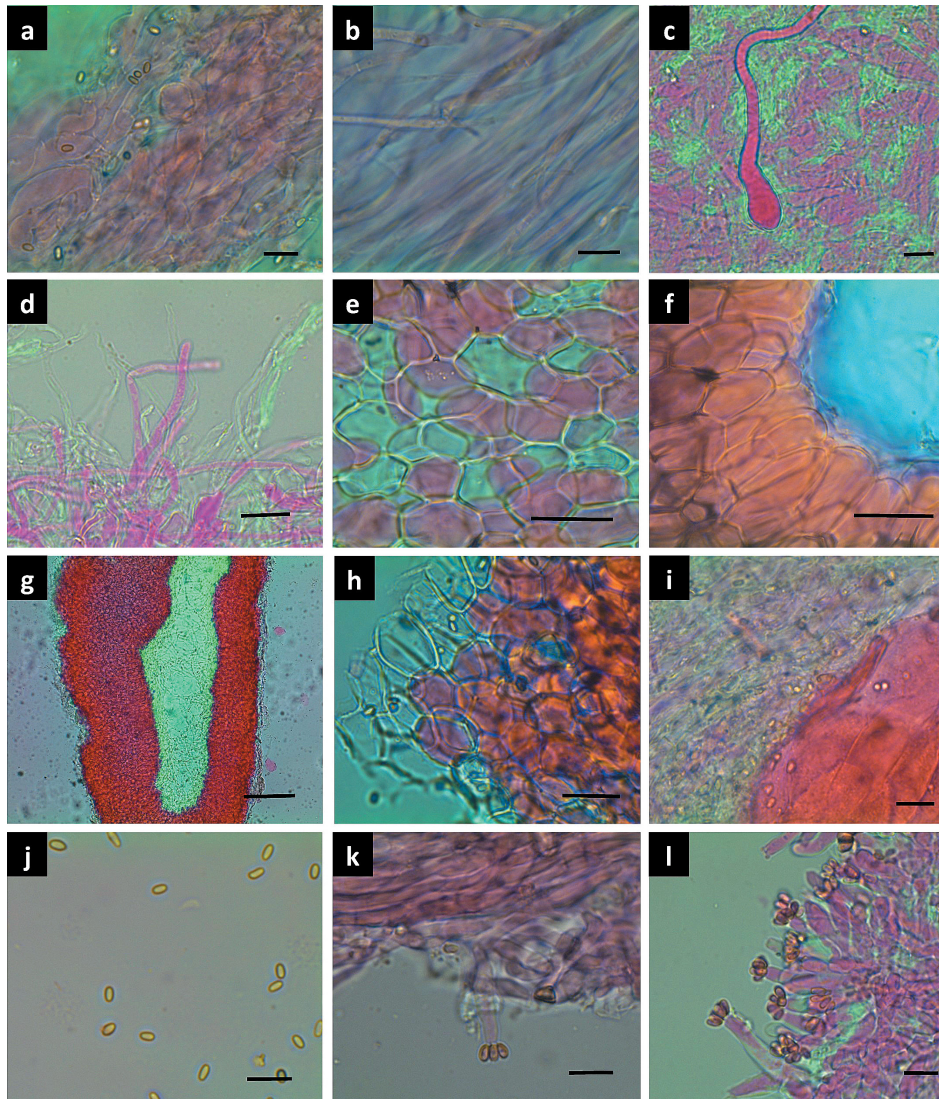

Fig. 4. Microscopic features of *Itajahya rosea* (JALR 60 CTES: a–i; NN 3554–3555 CTES: j; JALR 61 CTES: k–l): **a** – outer peridial layer, **b** – middle layer, **c** – inner layer with conductive hyphae, **d** – inner peridial layer, **e** – pseudoparenchymatous tissue from pseudostipe, **f** – central portion of pseudostipe, **g** – transversal section of calyptra, **h** – pseudoparenchymatous tissue from calyptra, **i** – internal volva, **j** – basidiospores, **k** – basidia, **l** – grouped basidia and hymenium. Bars: a, b, c, d, i, j, k, l = 10 µm; g = 200 µm; e, f, h = 20 µm. Photo J. Lozano.

subconcave at maturity, formed by two layers united at the ends, at certain points of its extension forming pseudo-chambers. Internal volva yellowish white (1A2).

Microscopic features. Basidia grouped in clusters, forming a hymenium, 24.3–31.6 × 4.5–6.3 µm in size, clavate to cylindrical, 8-spored, sterigmata very short. Basidiospores cylindrical in equatorial view, hyaline, smooth, 3.5–4.3 × 1.5–2.0 µm, x = 3.8 × 1.7 µm, Q = 1.9–2.8, Qx = 2.3 (n = 20, N = 1), globose in polar view. Cystidia not observed. Subhymenium formed by filamentous hyphae, thin-walled, without septa, 2.6–4.2 (x = 3.3) µm wide. Pseudostipe pseudoparenchymatous, hyphae formed by subglobose cells, 17.2–38.1 × 14.0–22.2 µm. Calyptra pseudoparenchymatous, hyphae formed by globose to subglobose, thin-walled cells, 18.3–33.1 × 13.2–19.0 µm, cells close to the inner margin more elongated. Peridium: firm outer layer (exoperidium) formed by filamentous hyphae, septate with widened ends, 5.0–9.5 (x = 7.7) µm wide, thin-walled. Mucilaginous layer (mesoperidium) formed by long, hyaline, filamentous hyphae, 4.1–6.5 (x = 5.3) µm wide. Hyphae of inner layer (endoperidium) located near gleba, thin-walled, 2.0–3.5 (x = 2.4) µm wide, conductive hyphae with globose end, 11.5–14.4 µm.

Habitat and distribution. Growing on compact sandy soil, with little vegetation and low humidity, near base of *Ceiba* Mill. Numerous, forming groups of 2–4 basidiomes. *Itajahya rosea* has been reported from Yemen (Kreisel et Al-Fatimi 2008), Pakistan (Moreno et al. 2013), India (Borde et al. 2021), Brazil (Ottoni et al. 2010, Cabral et al. 2012, Oliveira et al. 2023), and Paraguay (Campi Gaona et al. 2017). This is the first record from Argentina.

Notes. *Itajahya rosea* was found growing during autumn and winter after rainy days. The pinkish hue of the pseudostipe was a homogeneous character in later collections, even when the immature basidiomes were cut in longitudinal section. Moreover, the height and width of the mature basidiomes after stimulated hatching were observed to be similar to measurements of mature basidiomes collected in situ. Basidia differed in size and shape from *Itajahya galericulata*.

Specimens examined

Argentina. Corrientes, Corrientes city. Parque Mitre, 27°27'40'' S, 58°49'39'' W, 28 Jun 2023, leg. J. Lozano (JALR 60 CTES); ibid., developing immature basidiomes, 8 Jul 2023, leg. J. Lozano (JALR 61 CTES). – Chaco, General Güemes, El Impenetrable National Park, 25°00'34'' S, 60°59'45'' W, on soil in xerophytic forest, 11 Jun 2023, leg. N. Niveiro (NN 3554–3555 CTES).

DISCUSSION

Species of the genus *Itajahya* have been shown to have a cosmopolitan distribution, influenced by the fact that their spores, arranged in a mucilaginous gleba with a characteristic odour, are dispersed by dipterans, keeping their original natural location and physiological requirements unknown (Nouhra et Domínguez de Toledo 1994). An interesting aspect of many fungi is that they have an ephemeral basidiome, which often makes them difficult to find in nature. In addition, the

Phallales are a group of fungi which produce basidiomes in an accelerated and conspicuous development, maiknng it difficult to observe several taxonomically important processes, such as the development of peridial layers, basidia, or even changes during the maturation process, which in many cases can complicate the identification of some species (Sáenz et Gómez 1981).

Variability of morphological features

A concrete example of a variable feature is the 'remnants of the fundamental tissue', a structure located between the apex of the pseudostipe and the calyptra, which allows it to maintain its attachment to the rest of the basidiome. Wright (1949) mentions that the mechanism of attachment of the calyptra to the apex of the (pseudo-)stipe is not well defined, and that such a membrane may work by means of suction or simply pressure. Spegazzini (1898) and Möller (1895) also mention its presence. This membrane was observed in both species, only distinguishable when the calyptra has fallen off. Although an attempt was made to remove the calyptra before the basidiome acquired the maximum height and the gleba began its deliquescence process, it remained intact. In *I. galericulata*, it was almost intact when collected and completely intact when its development was stimulated. It also maintained some tension and was evidently attached to the pseudostipe by the margins only, except for the central region. In *I. rosea*, the material fixed in soft FAA preserved the tissue on and along the hollow region of the stipe. In addition, in the fresh material examined, remains of this very tenuous membrane were apparent after performing cuts.

Regarding the calyptra, its size was in both species directly proportional to the diameter of the receptacle when the basidiome is expanded, and had a cylindrical-flattened shape. Another detail to highlight is that in the tissue immersed in the gleba of the 'egg' phase, when examined under the microscope, basidia and spores of both species could be observed in the case of fresh specimens. However, when working with dried specimens, only the spores could be distinguished.

Dring (1973) stated that the presence or absence of a hymenium is a fundamental character for the subdivision of the former Gasteromycetes class, classifying them into those which have a well-developed hymenium at some point in their ontogeny and those which lack a hymenium entirely. Similarly, Domínguez de Toledo (1995) mentioned that the immature gleba of gasteromycetes can be classified in two groups: those without cavities (*Scleroderma* spp.) and those with cavities and a hymenium of the following types: simple (*Cyathus* spp.), lamelliform (*Montagnea* spp.), and labyrinthiform (*Phallales* and *Podaxales*). In addition, she stated that the latter group has tramal plates composed of a hymenium, a subhymenium, and the actual trama. The hypothesis that the gasteromycetes consist of two large phyla was confirmed by Malençon (1955),

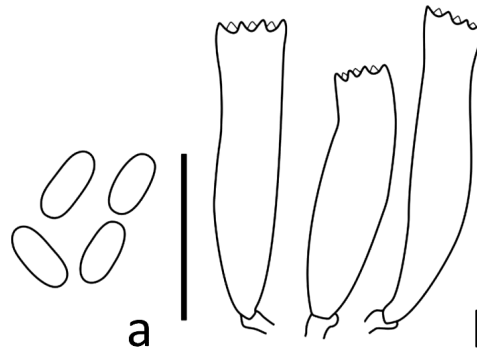

Fig. 5. Microstructures of *Itajahya galericulata* (JALR 62 CTES): **a** – basidiospores, **b** – basidia. Bar = 10 µm. Drawing J. Lozano.

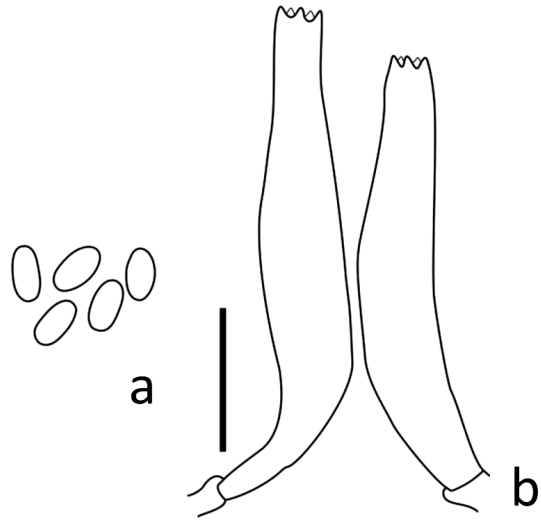

Fig. 6. Microstructures of *Itajahya rosea* (JALR 60 CTES): **a** – basidiospores, **b** – basidia. Bar = 10 µm. Drawing J. Lozano.

Heim (1971), and Dring (1973). However, several authors expressed their doubts concerning such a taxonomic classification. Reijnders (2000) considered that this criterion lacks great value in taxonomy, and also disagreed with the assumption that gasteromycetes should be divided into two well-limited taxonomic groups, because the hymenial arrangement may arise for various reasons, such as a combination of hymenial elements or a fragmentation of these. Subsequently, this idea was accepted by Gube et Dörfelt (2011), who mention that although progress has been made in the knowledge of the morphological diversity of gasteromycetes and their relationships with hymenial taxa, a much deeper

knowledge of morphological features to confirm the hymenial configuration of some groups (Kuhar et al. 2023) and their ontogeny is needed. Even so, Reijnders (2000) accepted the possibility of hymenium being formed in the gleba of gasteromycetes, especially in young stages of development. He described the formation of this hymenium from corymboid tufts of hyphae which unite sideways in a loose arrangement but remain separate, and called the lower portion of the corymb a subhymenium. Furthermore, he accepts that there are differences between species with a complete hymenium at the beginning and those with isolated basidia. Regarding the genus *Itajahya*, developing basidia are arranged in a continuous tissue, although very disheveled but recognisable. Therefore, we consider this tissue in this work to be a hymenium and we also distinguish a subhymenium.

The basidiospores of *I. galericulata* and *I. rosea* did not show strong differences in shape and size to be considered as a diagnostic character which helps to separate them: both were smooth, ellipsoidal to cylindrical in equatorial view and globose in polar view. Basidiospores of immature basidiomes, attached to the sterigmas, were compared with those of mature basidiomes from the excurrent gleba (basidiome fully expanded). Basidiospores of *I. galericulata* were more ovoid than elongated, whereas spores of *I. rosea* were clearly cylindrical to ellipsoidal. On the other hand, neither the basidia nor the subhymenium were observed in the receptacle cuts of the developed specimens. This could be attributed to the fact that one of the characteristics of the *Phallaceae* family is that the hymenium and hymenophore are autolysed at maturity, leaving only a gleba formed by spores suspended in a glutinous and homogeneous matrix.

The basidia of both species were found in clusters of approx. 20–50 basidia, with short sterigmata each carrying 5 to 8 basidiospores of a clavate to cylindrical shape. Domínguez de Toledo (1995) described and illustrated the basidia of *I. galericulata*, including their development to maturation and basidiospore formation, carrying 4 to 8 basidiospores with short sterigmata, which is consistent with our observations. Although the shape of the basidia of the two species is very similar, the species can be differentiated by the size of the basidia, being smaller in *I. galericulata* (11.4–17.8 × 3.2–4.7 µm), and also more elongated in *I. rosea* (24.3–31.6 × 4.5–6.3 µm).

Development of the basidiome

As regards the development of the basidiome, it was recorded that it took 2 to 3 days to develop the rupture of the peridium in both species, and once this point was reached, it took between 2 to 4 hours for the basidiome to expand at considerable speed, a reason to regard these species as ephemeral. The basidiome remained intact for 24 to 48 h, then the cells lost turgor, and finally the basidiome

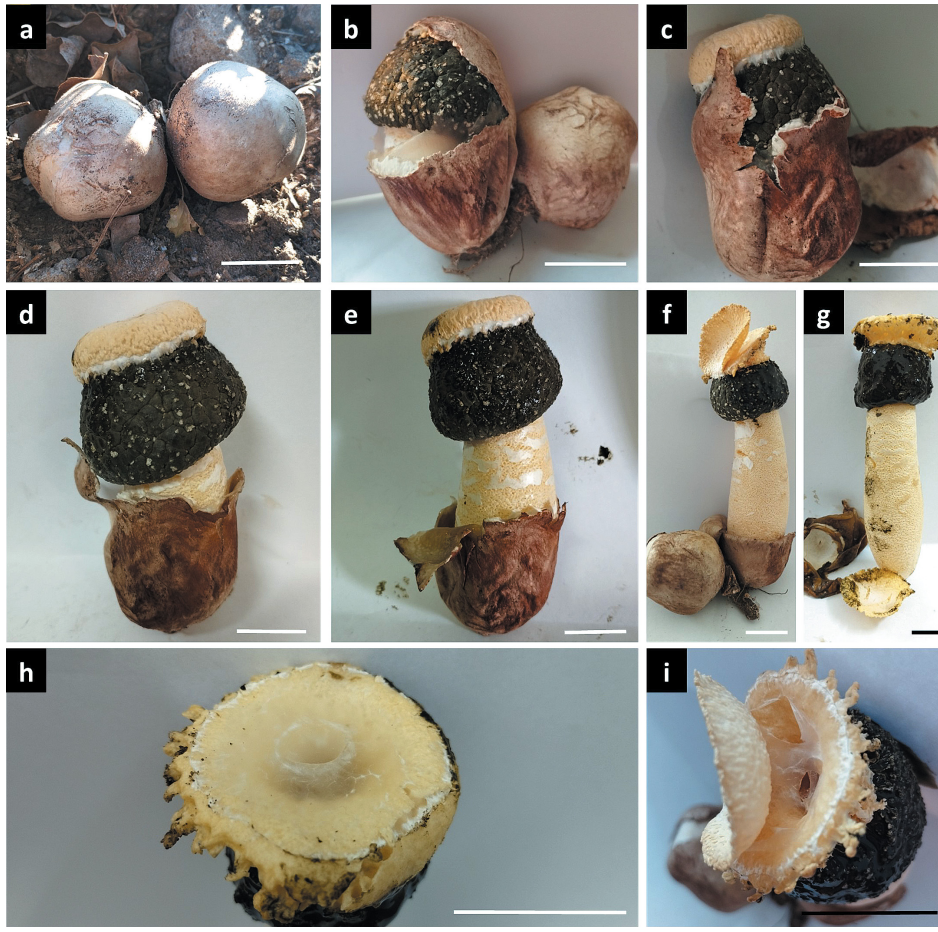

Fig. 7. Development of *Itajahya galericulata* (JALR 86 CTES): **a** – immature basidiomes in situ, **b** – peridium rupture with emerging basidiomes, **c–e** – elongation of mature basidiomes, **f–g** – final height and beginnings of deliquescence on gleba, **h–i** – remnants of fundamental tissue. Bars: 2 cm. Photo J. Lozano.

passed into an overripe state, beginning its process of decomposition. The time interval to obtain a well-extended basidiome from an 'egg' semi-submerged in the soil was significantly shorter than that reported by Wright (1949), who indicates about a week for this phase.

The number of peridial layers and their changes during the growth proved to be different in *I. galericulata* and *I. rosea*. In the former one, the exoperidium was creamy brown during the immature stage, but during the development of the receptacle and pseudostipe, it becomes darker in colour and gets a papyraceous consistency (similar to a newspaper). In *I. rosea*, the exoperidium has a whitish

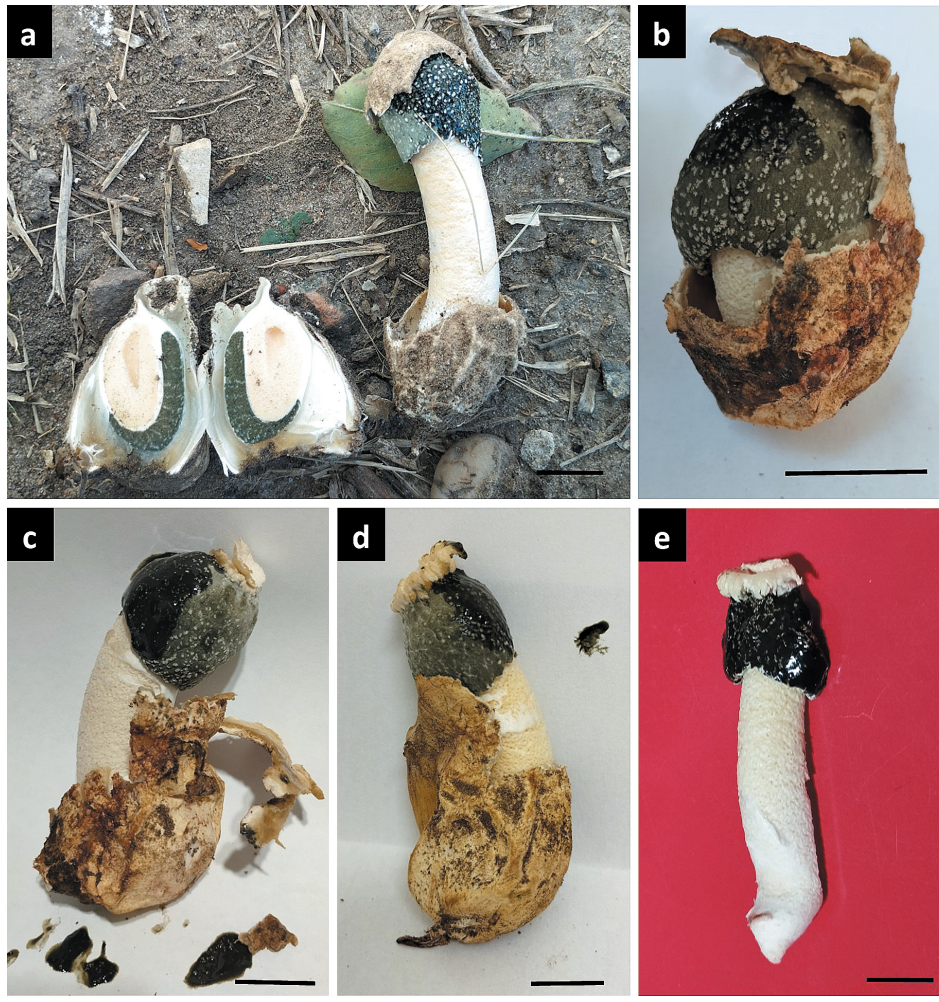

Fig. 8. Development of *Itajahya rosea* (JALR 61 CTES): **a** – mature and immature basidiomes in situ, **b** – peridium rupture and stipe elongation, **c** – maximum height of mature basidiome, **d** – deliquescent gleba, **e** – fully liquefied gleba with colour change. Bars: 1.5 cm. Photo J. Lozano.

tone which darkens slightly during maturation, maintaining a corky consistency. Campi Gaona et al. (2017) consider the layers of the peridium a reliable characteristic to differentiate the two species, *I. galericulata* having 4 layers and *I. rosea* 3 layers. Therefore, this detail is highlighted in our descriptions (Fig. 1h, Fig. 3l), This is observable when a longitudinal cut of an immature basidiome is made. Furthermore, the tone of the gleba in a fresh cut in our specimens was lighter green (2E4) in *I. galericulata*, but dull green to dark green (29E4–29F4) in *I. rosea*.

Ecology and phenology

Both species were collected in natural and anthropised habitats, with differences in date of collection and season. Möller (1895) mentions that *I. galericulata* does apparently not show seasonal preferences for fruiting. However, Domínguez de Toledo (1995) explains that this species shows an inclination for cool and cold climates and also autumn and winter seasons, which is consistent with our observations. Several of the collected basidiomes developed after heavy rains. The studies by Marincowitz et al. (2015) showed that *I. galericulata* possibly forms a mutualistic association with *Jacaranda mimosifolia* trees, typically growing in dry sandy soils. The form of relationship remains unknown. On the other hand, the specimens of *I. galericulata* were found growing at the base of a lapacho tree, *Handroanthus impetiginosus*, of the family *Bignoniaceae*, while in the case of *I. rosea* at the base of *Ceiba* sp. Nevertheless, inferences about the associations with higher plants, their as yet unknown mechanisms, and their possible invasive role require further study (Miller Jr. 1983, Wood 2017).

CONCLUSIONS

The morphological similarity of mature basidiomata of *I. galericulata* and *I. rosea* makes a precise differentiation of the two complicated. This study provides additional details of the micro- and macroscopic characters and their development, improving our knowledge of the morphological features and distribution of phalloid fungi. This is also the first record of *I. rosea* for Argentina.

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