

Mycena margarita (Murrill) Murrill, 1916 (Basidiomycota: Agaricales: Mycenaceae): A bioluminescent agaric first recorded in Brazil

Maria Helena Alves* and Cristiano Coelho do Nascimento

Universidade Federal do Piauí, Campus Parnaíba. Avenida São Sebastião, 2819, CEP 64202-020, Parnaíba, PI, Brazil.
* Corresponding author. E-mail: malves@ufpi.edu.br

ABSTRACT: *Mycena margarita*, a widespread agaric in the Caribbean region and recently recognized as frequently bioluminescent, is reported for the first time in Brazil, occurring on decaying wood in the Araripe National Forest, municipality of Crato, Ceará state. This species is fully described and illustrated and accompanied by color photographs of fresh basidiomata. Comments on the taxonomy and ecology of the species are presented.

Mycena (Pers.) Roussel is a large polyphyletic genus and has been classified in the euagaric family Mycenaceae Overeem (Moncalvo *et al.* 2002; Matheny *et al.* 2006; Kirk *et al.* 2008). This genus is composed of saprophytic, non-symbionts, cosmopolitan species, which grow mainly on decaying plant material such as twigs, leaves, pine cones and trunks, but also on soil, with a worldwide distribution (Pegler 1986; Piovano *et al.* 2005; Webster and Weber 2007).

Morphologically, species of *Mycena* can be recognized by the following combination of characters: basidiome small to medium, mycenoid, omphalinoid or collybioid, typically fragile and thin; pileus conical to campanulate, pellucid-striate; lamellae free to decurrent, mostly adnexed, ascendant, horizontal or descendent; spore print white to pale cream; stipe well developed, mostly long, central, slender, hollow, veil absent. Pileipellis an epicutis of repent hyphae, either undifferentiated or variable; hymenophoral trama sub-regular to regular; basidia 1-4-spored; basidiospore ellipsoid to oblong, hyaline, thin walled, smooth, amyloid, rarely inamyloid; cheilocystidia nearly always present; pleurocystidia present or absent (Pegler 1986; Singer 1986).

Kirk *et al.* (2008) recognize approximately 500 *Mycena* species of which, according to Desjardin *et al.* (2007), at least 33 taxa belonging to 16 sections form luminescent mycelium and/or basidiomes. These authors reported six bioluminescent species of *Mycena* for a single site in primary Atlantic Forest habitat in the state of São Paulo, Brazil; two of them represent new species (*M. asterina* Desjardin, Capelari & Stevani and *M. lucentipes* Desjardin, Capelari & Stevani), three represent new reports of luminescence in previously described species (*M. fera* Maas Geest. & de Meijer, *M. singeri* Lodge and *M. discobasis* Métrod) and an additional indeterminate luminescent *Mycena* species was described.

Mycena lacrimans Singer appears as the only luminescent taxon of the genus known in the Brazilian Amazon; it has been collected in the municipality of Careiro, state of Amazonas (Desjardin and Braga-Neto 2007). The

species was previously described by Singer (1989) for the Amazon region; however, this author did not emphasize the occurrence of luminescence in his description.

Recently Desjardin *et al.* (2010) provided a complete description of four new luminescent *Mycena* species. These include *M. luxaeterna* Desjardin, BA Stevani & Perry and *M. luxarboricicola* Desjardin, BA Perry & Stevani that were collected in Brazil in the states of São Paulo and Paraná, respectively. In addition, the authors reported luminescence for the first time in *M. aff. abieticola* Singer, collected in the state of São Paulo, emphasizing that the species was erroneously reported as *M. fera* by Desjardin *et al.* (2007).

In the last decade, the relative progress of the descriptions and records of luminescent *Mycena* species in Brazil is evident, especially in the Southeastern Region of that country. However, many areas of the country with a fantastic biodiversity remain unexplored and their mycobiota unknown. Therefore, in order to expand knowledge of the aforementioned genus, this paper presents detailed descriptions and illustrations, as well as comments on the taxonomy and ecology of *M. margarita*, an agaric frequently luminescent and widespread in the Caribbean region, herein recorded for the first time in Brazil. This also constitutes a first record of a luminescent *Mycena* for the Brazilian northeastern.

The specimen considered was collected during forays in the area of Araripe National Forest (ANF) (07°11'42" – 07°28'38" S and 39°13'28" – 39°36'33" W), located in the municipality of Crato, 'Chapada do Araripe', Ceará state. The ANF comprises elevations between 840 and 960 m.a.s.l, with an average annual rainfall about 1,100 mm and rainy season occurring between the months of January and April. In terms of physiognomic attributes, the region is an area of vegetation types associated with the wet dry tropical climate, within which the highest percentage of coverage is represented by the montane ombrophilous dense forest (humid forest), savanna (cerrado), savanna woodland (cerradão) and carrasco, comprising transition vegetation types (Austregesilo-Filho *et al.* 2001).

Field collections took place in January 2011. The material was collected, documented and preserved using standard methods (Largent *et al.* 1986). The specimen was photographed in the field using a digital camera and extensive notes on the basidiome were made before drying. Microscopic analysis of the material was performed using an Olympus microscope BX41.

All measurements and colors reported for microscopic features were made from dried material rehydrated in 96% ethanol followed by distilled water, distilled water + cotton blue, 3% KOH, or Melzer's reagent. At least 25 measurements were made of each microstructure. Spore statistics include: arithmetic means (\bar{x}_m) of basidiospore lengths and widths \pm standard deviation measured for n objects; quotient of basidiospore length by spore width (E) indicated as a range variation in n objects measured; the mean of E-values (Q) \pm standard deviations. The sample size (n) = total number of basidiospores measured (x) divided by the number of basidiomata studied (y), as shown in the formula $n = x/y$ (Largent and Abell-Davis 2011).

The study followed the taxonomic constructs adopted by Matheny *et al.* (2006) at the family rank and the terminology was based on Kirk *et al.* (2008). The documented material has been deposited at the Herbarium Delta (HDELTA), Department of Biology, Federal University of Piauí, *Campus Parnaíba*.

Description of material collected - *Mycena margarita* (Murrill) Murrill, *Mycologia* 8: 220. 1916. [= *Prunulus margarita* Murrill, *North American Flora* 9(5): 340. 1916]. Figures 1 and 2.

Pileus 15–38 mm diam., at first conical to campanulate soon becoming convex-hemispherical, than plano-convex with a flattened umbo that becomes slightly depressed in the center, surface white to pale grayish, pale brown on the disc, glabrous, subviscid to viscid, strongly hygrophanous, opalescent, translucent striate-sulcate with pale brown striae extending radially from the disc toward the edge, margin thin. **Lamellae** adnexed to adnate, subdistant, slightly broad with lamellulae of two lengths. **Stipe** 10–22 \times 2–3 mm, cylindrical, central, hollow, equal, hygrophanous, with a cupulate basal disc in the **substrate interface**;



FIGURE 1. *Mycena margarita*. A. Basidiomes. B. Pileal detail. C. Stipe. Bars= 10 mm. Photos: Maria Helena Alves.

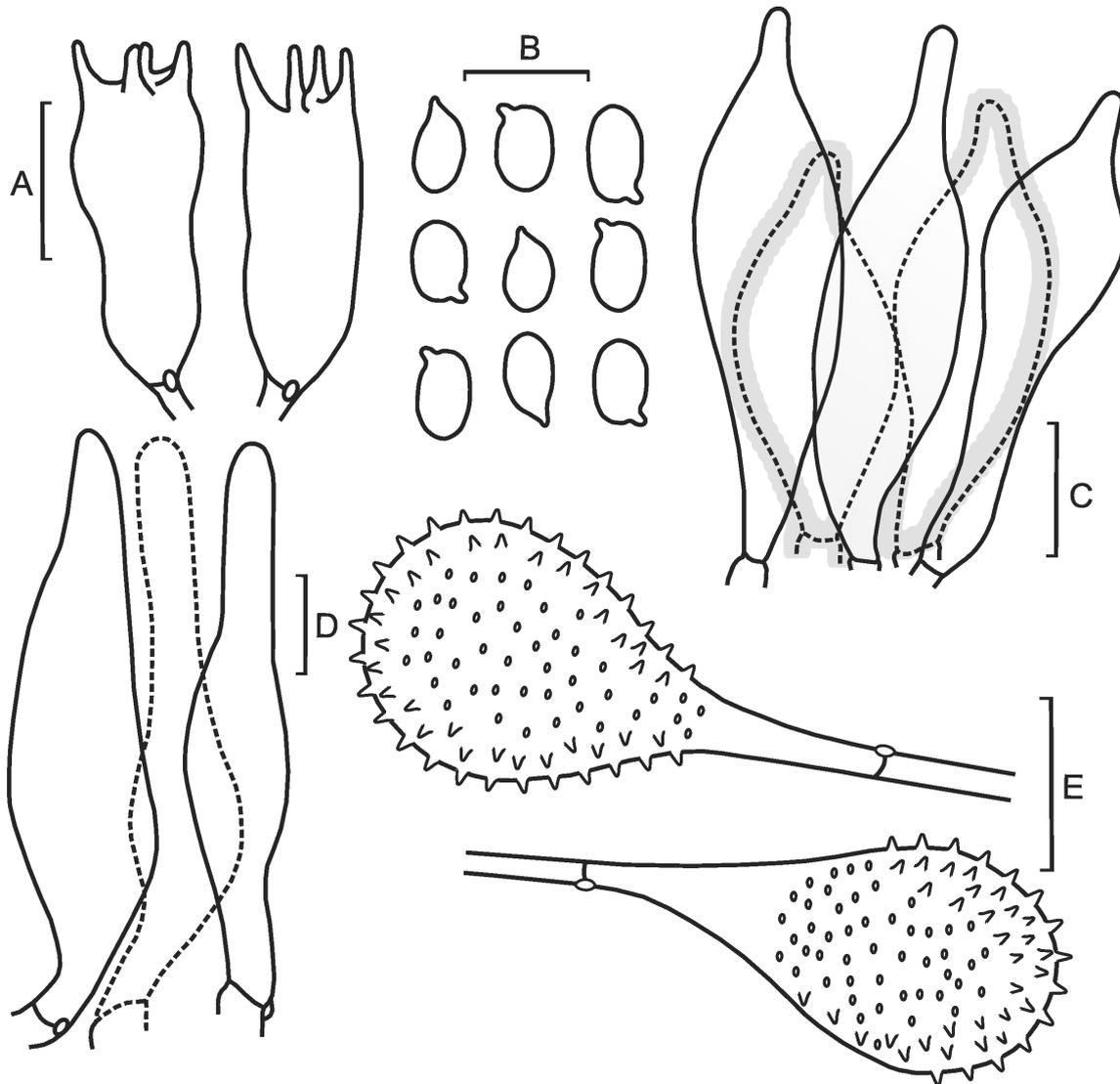


FIGURE 2. *Mycena margarita*. A. Basidia. B. Basidiospores. C. Cheilocystidia. D. Caulocystidia. E. Pileipellis terminal cells. Bars= 10 μ m. Drawings: Cristiano Coelho do Nascimento.

surface white to slightly grayish becoming yellowish brown at the base; context thin, aqueous, concolorous with the pileal surface, unchanging. **Odor** weakly fungoid or not distinctive. **Taste** not recorded. **Luminescence** weakly greenish in all parts of the basidiome, almost imperceptible to the naked eye or unobserved.

Basidiospores 6–7.7 \times 3.2–5 μ m ($x_m = 6.9 \pm 0.54 \times 4.2 \pm 0.58$; E = 1.3–2.3; Q = 1.66 \pm 0.136; n = 30/3, ellipsoid, hyaline, smooth, thin-walled, strongly amyloid. **Basidia** 13–19.5 \times 5.5–9 μ m, 4-spored, clavate to subcylindrical, thin-walled, clamped. **Lamellar edge** sterile, with abundant cheilocystidia. **Cheilocystidia** 22–47.5 \times 10–20 μ m, fusoid-ventricose with a rounded apex or with a papillate rarely forked tip, irregular projection, hyaline, thin-walled. **Pleurocystidia** none. **Hymenophoral trama** regular, hyaline, dextrinoid, consisting of cylindrical, thin-walled, inflated hyphae 4–18 μ m diam. **Pileus context** consisting of very thin-walled, interwoven, hyaline, dextrinoid, inflated hyphae (3–16 μ m diam.). **Pileipellis** a gelatinized ixocutis (187–250 μ m thick) composed of narrow, hyaline, branched, thin-walled, inamyloid, clamped hyphae (1–4 μ m diam.), allocated in a gelatinous-matrix, containing cylindro-clavate, spinulose, terminal elements (20–43 \times 7–15 μ m). **Hipodermium** of hyaline, thin-walled,

inflated hyphae (10–22 μ m diam.) containing brown vacuolar content. **Caulocystidia** numerous, scattered, rarely in fascicles, hyaline, thin-walled, fusoid-ventricose (50–80 \times 7–14 μ m), sometimes with a semi-bulbous base.

Habit and habitat: Solitary or gregarious growing in place of high humidity on decaying logs; collected in humid forest zone in the Araripe National Forest in the rainy season.

Material examined: **BRASIL. Ceará:** Crato, Araripe National Forest, Belmonte trail, 07°14'56" S and 39°29'42" W, 958 m a.s.l., 24 and 26-I-2011, leg. Alves M. H. and Nascimento C. C. 019/11 (HDELTA 72).

Distribution in America: Murril (1916a; 1916b; 1940); Dennis (1951); Pegler (1983); Desjardin *et al.* (2010).

Comments - *Mycena margarita* is a widespread agaric in the Caribbean region, occurring in Dominica, Dominican Republic, Jamaica, Puerto Rico and Trinidad, with additional records for Belize, Florida (USA) and Venezuela (Figure 3A). This is a solitary or gregarious fungus that grows mainly on decaying logs and has recently been registered as a bioluminescent species by Desjardin *et al.* (2010). However, based on the study in populations of different geographical areas, they showed that luminescence in

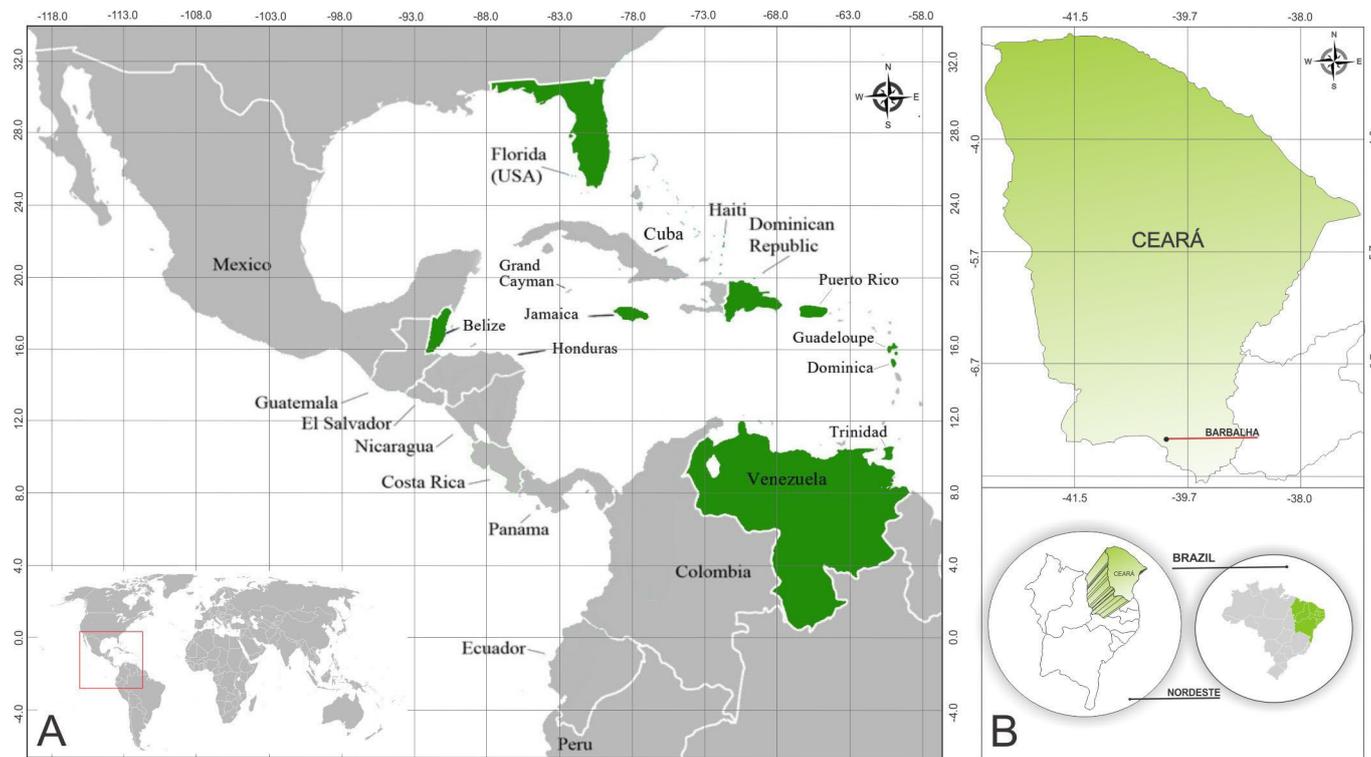


FIGURE 3A-B. Geographical distribution of *M. margarita*. A. The shaded areas represent previous reports of the species according to the literature. B. Represents the local of the new record of the species for the northeastern region of the Brazil (Barbalha, State of Ceará).

Mycena margarita might be a variable character, including nonluminescent specimens or luminescence strongly weak, not easily observed by the naked eye.

In the protologue of *Prunulus margarita* (= *Mycena margarita*) in Murril (1916a), it was described as a lignicolous species, solitary, with a widely convex-umbonate pileus, lamellae attached to a collarium and a cylindrical stipe. However, our northeastern Brazilian collection presents some differences when compared to the description in the protologue of the type from Morce's Gap, Jamaica. Although presenting the same convex-umbonate pileus, our collection shows adnexed to adnate lamellae lacking a collarium, and stipe with a cupulate basal disc. The latter feature is diagnostic of the material herein recognized as *M. margarita*; however, this structure has not been described in the protologue of *Prunulus margarita*. Examination of the holotype by Desjardin *et al.* (2010) revealed the presence of subfree lamellae lacking a collarium, and a stipe that arises from a cup-like basal disc, agreeing with the description of our material. However they reported slightly broader basidiospores $6.7\text{--}8.5 \times 4.3\text{--}5.5 \mu\text{m}$ ($3.2\text{--}5 \mu\text{m}$ diam. in our material) and longer cheilocystidia $37\text{--}54 \times 12.5\text{--}18 \mu\text{m}$ ($22\text{--}47.5 \times 10\text{--}20 \mu\text{m}$ in our material).

Pegler (1983) reported the occurrence of *Mycena margarita* in areas of Dominica, Guadeloupe and Trinidad (Figure 3A), being the first author to place this species in an infrageneric group, considering it together with *M. junquillina* Dennis and *M. translucitipes* (Murrill) Kühner in sect. *Fragilipedes* (Fr.) Quél. The description of *M. margarita* provided by him matches our specimen in macromorphology, basidiospores size, 4-spored basidia, cheilocystidia shape, presence of clamp connections and gelatinized pileipellis. However he did not report accounts about caulocystidia, pileipellis terminal cells, and

luminescence, which were strongly evident in analysis of our specimen.

Mycena margarita was described by Pegler (1983) as a gregarious species found in large numbers on both stumps and trunks of living trees; however, in our records, it was found exclusively on rotten logs, corroborating with Desjardin *et al.* (2010), that records exclusively decaying trunks as substrate. Therefore, it appears that basidiomes of *M. margarita* are formed typically on wood (lignicolous), playing an important role in the ecosystem as a wood-rotting fungi. With respect to habit, *Mycena margarita* can be both solitary and gregarious, matching with descriptions of Pegler (1989) and Desjardin *et al.* (2010).

In studies about luminescence on *Mycena*, Desjardin *et al.* (2010) reported seven new cases for the genus, presenting a detailed description of *M. margarita*, based on the analysis of collections from Belize, Dominican Republic, Jamaica (Holotype) and Puerto Rico. The examination of the referred species revealed pileus convex-umbonate, opalescent, radially streaked, basidiospores ellipsoid measuring $6\text{--}8.5 \times 4\text{--}5.5 \mu\text{m}$; cheilocystidia fusoid-ventricose to clavate-rostrate with $30\text{--}60 \mu\text{m}$ in length and pileipellis an ixocutis composed of spaced hyphae with repent to suberect terminal cells. In our analyzes the dimensions observed for basidiospores ($6\text{--}7.75 \times 3.25\text{--}5 \mu\text{m}$) and cheilocystidia ($22\text{--}47.5 \mu\text{m}$) were slightly smaller. Thus, all those features are congruent with our findings; however, Desjardin *et al.* (2010) describe the occurrence of pileal marginal cells (similar to the cheilocystidia), which were not observed in our collection.

Murril (1916b), Smith (1947) and Pegler (1983) recognized only *Prunulus margarita* as a synonym of *M. margarita*. On the other hand, Desjardin *et al.* (2010), based in Singer (1937), Murrill (1940) and Mass Geesteranus

(1989), accept *Prunulus subepipterygius* Murril and *Mycena subepipterygia* Murrill as a synonym of *M. margarita* and *Mycena chlorinosma* Singer as a possible synonym. Herein, we accept the synonyms aforementioned, considering the detailed taxonomic study presented by Desjardin *et al.* (2010).

Recognizing the similarity between *M. margarita* and *M. chlorophos* (Berk. & M.A. Curtis) Sacc., species previously considered in different sections, Desjardin *et al.* (2010) established both as members of the sect. *Exornatae* Maas Geest., together with the luminescent *M. discobasis*. Within this section *M. margarita* is closely related with *M. chlorophos*, which is a pantropical luminescent species, originally from Bonin Islands, Japan, with records from the old to the Neotropics. With regard to Brazil, there are citations for the states of Paraná (Maas Geesteranus and de Meijer 1997), Manaus and Rio de Janeiro (Corner 1954). On the other hand, *M. margarita*, originally from Morce's Gap, Jamaica, has records only for the new world, occurring almost exclusively in the Caribbean region, while in South America the records are scarce, being mentioned only for Venezuela by Dennis (1951).

Therefore, the first record of *M. margarita* for the Brazilian (Figure 3B) territory represents a rare occurrence for the South American region, contributing effectively for the clarification of the phytogeographical distributions in this luminescent species.

ACKNOWLEDGMENTS: This study was partly supported by Programa Biodiversidade do Semiárido – PPBio grants from Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq. The Universidade Federal do Piauí – UFPI for the technical support.

LITERATURE CITED

- Corner, E.J.H. 1954. Further descriptions of luminous agarics. *Transactions of the British Mycological Society* 37: 256–271.
- Dennis, R.W.G. 1951. Some Agaricaceae of Trinidad and Venezuela. *Leucosporae* I. *Transactions of the British Mycological Society* 34: 411–482.
- Desjardin, D.E. and R. Braga-Neto. 2007. *Mycena lacrimans*, a rare species from Amazonia, is bioluminescent. *Edinburgh Journal of Botany* 64: 275–281.
- Desjardin, D.E., M. Capelari and C.V. Stevani. 2007. Bioluminescent *Mycena* species from São Paulo, Brazil. *Mycologia* 99: 317–331.
- Desjardin, D.E., B.A., Perry, D.J., Lodge, C.V. Stevani and E. Nagasawa. 2010. Luminescent *Mycena*: new and noteworthy species. *Mycologia* 102: 459–477.
- Austregesilo-Filho, P.T., J.A.A., Silva, I.M.J., Meunier and R.L.C., Ferreira. 2001. Fisionomias da Cobertura Vegetal da Floresta Nacional do Araripe, Estado do Ceará. *Brasil Florestal* 71: 13–21.
- Kirk, P.M., P.F., Cannon, D.W. Minter and J.A. Stalpers. 2008. *Ainsworth & Bisby's dictionary of the fungi*. 10th ed. Wallingford: CAB International.
- Largent, D.L., D. Johnson and R. Watling. 1986. *How to identify mushrooms to genus III: microscopic features*. Eureka: Mad River Press Inc.
- Largent, D.L. and S.E. Abell-Davis. 2011. Observations on *Inocephalus virescens* comb. nov. and *Alboleptonia stylophora* from northeastern Queensland. *Mycotaxon* 116: 231–245.
- Matheny, P.B., J.M., Curtis, V., Hofstetter, M.C., Aime, J.M., Moncalvo, Z.W., Ge, Z.L., Yang, J.C., Slot, J.F., Ammirati, T.J., Baroni, N.L., Bougher, K.W., Hughes, D.J., Lodge, R.W., Kerrigan, M.T., Seidl, D.K., Aanen, M., DeNitis, G.M., Daniele, D.E., Desjardin, B.R., Kropp, L.L., Norvell, A., Parker, E.C., Vellinga, R. Vilgalys and D.S. Hibbett. 2006. Major clades of Agaricales: a multilocus phylogenetic overview. *Mycologia* 98: 982–995.
- Maas Geesteranus, R.A. 1989. Conspectus of the *Mycenas* of the northern hemisphere 12. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* 92: 331–365.
- Maas Geesteranus, R.A. and A.A.R. de Meijer. 1997. *Mycenae* paraenses. *Tweede Reeks* 97: 1–164.
- Moncalvo, J.M., R., Vilgalys, S.A., Redhead, J.E., Johnson, T.Y., James, M.C., Aime, V., Hofstetter, S.J.W., Verduin, E., Larsson, T.J., Baroni, R.G., Thorn S., Jacobsson, H. Cléménçon and O.K. Jr., Miller. 2002. One hundred and seventeen clades of euagarics. *Molecular Phylogenetic and Evolution* 23: 357–400.
- Murrill, W.A. 1916a. *Prunulus*. *North American Flora* 9(5): 319–344.
- Murrill, W.A. 1916b. *Pleurotus*, *Omphalia*, *Mycena* and *Collybia* published in North American Flora. *Mycologia* 8: 218–221.
- Murrill, W.A. 1940. Additions to Florida fungi IV. *Bulletin of the Torrey Botanical Club* 67: 227–235.
- Pegler, D.N. 1983. The Agaric flora of Lesser Antilles. *Kew Bulletin Additional Series* 9: 1–668.
- Pegler, D.N. 1986. Agaric flora of Sri Lanka. *Kew Bulletin Additional Series* 12: 1–519.
- Piovano, M., M., Clericuzio, S., Tabasso, M.C., Chamy, J.A., Gabarino, G. Vidari and P. Vita-Finzi. 2005. Studies on Chilean Fungi III. Free and Bound Sterols from *Mycena chlorinella* (Basidiomycetes). *Journal of the Chilean Chemical Society* 50: 459–477.
- Singer, R. 1937. Notes sur quelques Basidiomycètes. *Revue Mycologie* 2: 226–242.
- Singer, R. 1986. *The Agaricales in modern taxonomy*. 4th ed. Königstein, Koeltz Scientific Books.
- Singer, R. 1989. New taxa and new combinations of Agaricales (Diagnoses Novorum Agaricalium IV). *Fieldiana, Botanica* 21: 1–133.
- Smith, A.H. 1947. *North American species of Mycena*. Ann Arbor: University Michigan Press. XX pp.
- Webster, J. and R. Weber. 2007. *Introduction to fungi*. 3th ed. New York: Cambridge University Press. 842 pp.

RECEIVED: December 2012

ACCEPTED: January 2014

PUBLISHED ONLINE: February 2014

EDITORIAL RESPONSIBILITY: Matias J. Cafaro