

## New and interesting ectomycorrhizal fungi from Puerto Rico, Mona, and Guana Islands

Orson K. Miller, Jr.<sup>1</sup>

Department of Biology, Virginia Polytechnic Institute  
and State University, Blacksburg, VA 24061

D. Jean Lodge<sup>2</sup>

Center for Forest Mycology Research, United States  
Department of Agriculture, Forest Service, Forest  
Products Lab., PO Box 1377 Luquillo,  
PR 00773-1377

Timothy J. Baroni

Department of Biological Sciences, SUNY-College at  
Cortland, Cortland, NY 13054

**Abstract:** A report of putative ectomycorrhizal fungi from Puerto Rico, Mona, and Guana Island in the Greater Antilles includes four species of *Amanita*, three of which are new species; two *Lactarius*, one is new, and two species of *Boletus*, one new. In addition, new distribution records of *Phlebopus beniensis*, *Russula littoralis*, *Lactarius ferrugineus*, a new small spored *Phylloporus*, and *Suillus brevipes* with *Pinus caribaea* are reported. Ectomycorrhizal hosts for all but the *Suillus* include *Coccoloba uvifera* (Polygonaceae) and putative hosts *Hymenaea courbaril* (Caesalpinaceae) and *Andira inermis* (Papilionaceae).

**Key Words:** *Amanita*, Basidiomycetes, *Boletus*, Greater Antilles, *Lactarius*, *Phlebopus*, *Phylloporus*, *Russula*, *Suillus*, systematics

### INTRODUCTION

Guana Island (British Virgin Islands) and Puerto Rico are part of the Puerto Rican Bank in the eastern Greater Antilles. The areas surveyed range from sea level to 1000 m, but the collections reported here were from 1–500 m. The forest types have tropical to subtropical climates and include coastal sand dune communities and subtropical dry, subtropical moist,

and subtropical wet forests according to the Holdridge Lifezone system (Ewel and Whitmore 1973).

The most intensively sampled area was the tabonuco forest type, from 100–500 m elev in the Luquillo Mountains of NE Puerto Rico. This forest type has a mean annual rainfall of 250–400 cm/yr and mean monthly temperatures from 22–26 °C. Although there are 152 tree species reported for the tabonuco forest type (Brown et al 1983), almost all of them are associated with arbuscular mycorrhizal fungi, although about 5% are also associated with basidiomycetes (Lodge 1996). The presence of the agarics reported here, which are only known to be ectomycorrhizal associates of tree hosts, leaves little doubt about the presence of ectomycorrhizal symbioses. Lodge (1996) reported the presence of thick mantles of basidiomycete hyphae with clamp connections on the roots of *Pisonia subcordata* Awhguly (Nyctaginaceae), *Coccoloba swartzii* Moiss., and *C. pyrifolia* Desf. (Polygonaceae), and ectomycorrhizae in *Andira inermis* (W. Wright) DC (Papilionaceae). Kreisel (1971) demonstrated the presence of ectomycorrhizae in the sea grape, *Coccoloba uvifera* (L.) L., which occurs extensively along the coast of Puerto Rico, often in pure stands. The fungi reported in this paper are most likely associated with these hosts, *Coccoloba rugosa* Desf. (a rare and endangered species), and possibly also with *Hymenaea courbaril* L. in the Caesalpinaceae. Although there are undoubtedly other ectomycorrhizal hosts in these forests the species reported in this paper occur near or under the putative host described above. However, some of the putative hosts reported by Pegler (1983) for the Lesser Antilles are dubious and need to be confirmed.

### MATERIAL AND METHODS

Color comparisons were made using Kornerup and Wanscher (1967) and designated Met 6E-4 which indicates the plate, row, and color block. In some cases the pileus color was recorded using Cailleux (1948), noted as Caill. T73 which indicates row T, color block 73. A few others were recorded as Ridgway color names as reproduced by Smithe (1975) and are given in capitalized form, e.g., Drab Gray (0.1Y 6.8/2.1) and accompanied by Munsell color notations in parentheses. Collection numbers preceded by PR- or GUA- refer to a unique number in the database for the Basidiomycetes of the Greater Antilles project; ledger

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<sup>1</sup> Email: ormiller@vt.edu

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numbers are also presented, if assigned. Chemical reagents including Melzer's solution, gum-guaiac, 2% phenol, and  $\text{FeSO}_4$  were used for spot testing tissue samples when appropriate and the reactions recorded. Drawings of the illustrated taxa were made from mounts in Melzer's solution. Smell and taste were recorded when possible from fresh material.  $E$  value is length/width ratio of the basidiospore and  $E_m$  is the mean  $E$  of  $n = 31$  spores. For color images of several of the taxa described here see <http://www.cortland.edu/NSF/ga.html>.

## RESULTS

Eleven putative ectomycorrhizal taxa are described, five of which are new species. The other six species represent new range extensions. The genus *Amanita* has most of these new taxa, therefore, we present a dichotomous key to those species. These are the only species now known in the area covered in this study and are all in the subgenus *Amanita*. The descriptions are presented in three groups corresponding to their taxonomic relatedness.

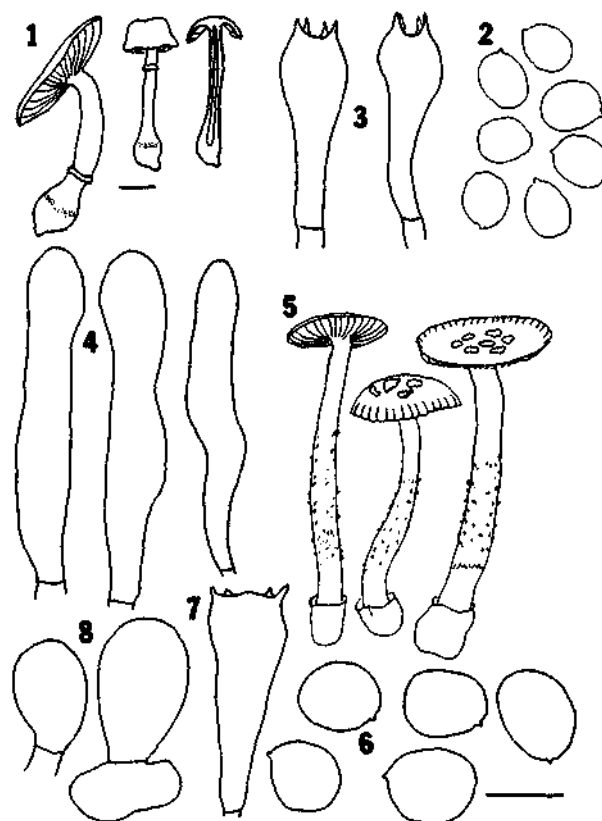
### KEY TO THE SPECIES OF *AMANITA* OF PUERTO RICO, AND THE US AND BRITISH VIRGIN ISLANDS

Subgenus *Amanita*; nonamyloid spores, and only associated with species of *Coccoloba*.

1. Annulus cothurnate, persistent; pileus yellow with a white universal veil; cheilocystidia clavate to subfusiform; spores  $7\text{--}10.5 \times 4.8\text{--}6.0\ \mu\text{m}$  . . . . . *A. cystidiosa*
1. Not annulate or partial veil evanescent and other characters not as above . . . . . 2
2. Pileus pale drab-gray; stipe with a small white, fragile volva cup; spores  $9\text{--}12.5 \times 7\text{--}10\ \mu\text{m}$ , subglobose; cheilocystidia pyriform to subglobose . . . . . *A. arenicola*
2. Pileus orange or yellow, spores smaller or  $<7\ \mu\text{m}$  wide . . . . . 3
3. Pileus orange-yellow in center, paler over margin; spores  $5\text{--}7 \times 4.5\text{--}6.7\ \mu\text{m}$ , subglobose  $E_m = 1.12$  . . . . . *A. microspora*
3. Pileus chrome yellow; spores  $7\text{--}10.5 \times 5\text{--}7\ \mu\text{m}$ , broadly elliptical  $E_m = 1.31$  . . . . . *A. chrysoleuca*

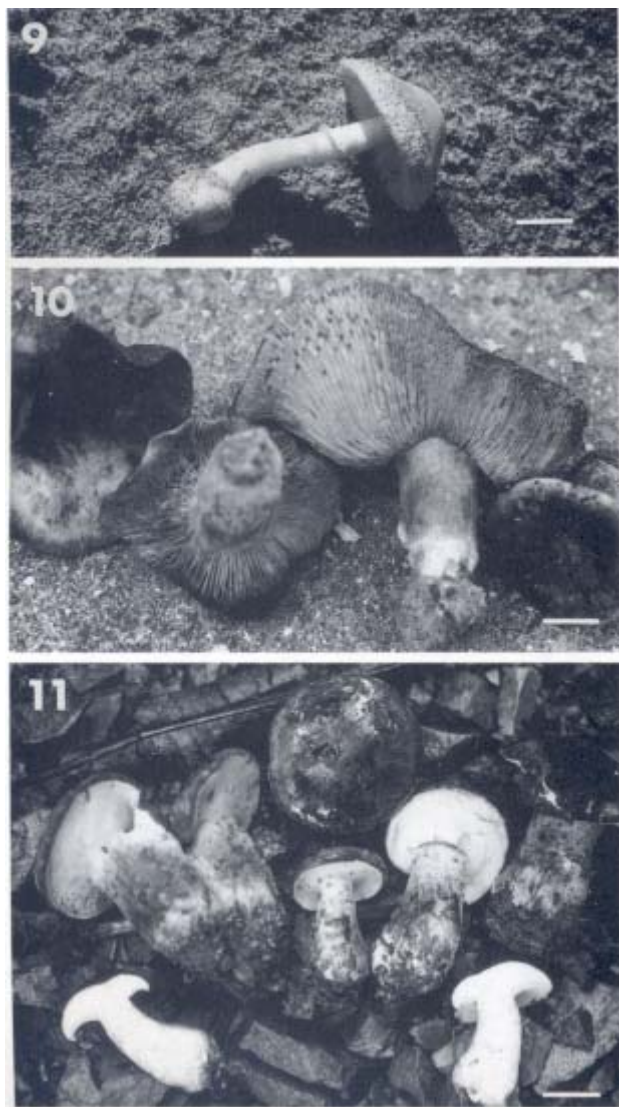
***Amanita cystidiosa*** O. K. Miller et D. J. Lodge, sp. nov. FIGS. 1–4, 9

Pileus 2.0–4.7 cm latus, primo convexus sub vetustate planus, in statu madido subviscidus, in superficie reliquias volvae universalis tenui-farinosas retinens, pallide stramineus, in margine tenuiter sulcato-striatus. Lamellae liberae, subdistantes, ventricosae, 2-seriebus lamellarum praeditae, sub vetustate pallide flavae vel flavae. Stipes 1.9–5.2 cm longus, 0.4–0.7 cm latus, aequus bulbo basali abrupte rotundato praeditus, siccus, albus praeter flavescens in bulbo per reliquias volvae universalis. Volva partialis persistens, annulum cothurnatum formans. Contextus solidus, albus. Odor non distinctus. Pileipellis e hyphis intertextis latis tenuitunicatis  $4.2\text{--}20\ \mu\text{m}$  in diametro composita. Volva partialis e hyphis filamentosis tenuitunicatis  $5\text{--}9\ \mu\text{m}$  in diametro composita. Volva universalis e hyphis intertextis tenuitunicatis  $4.0\text{--}13.0\ \mu\text{m}$  in diametro cellularum clavatas distinctas  $15\text{--}27\ \mu\text{m}$  in diametro habentibus composita. Fibulae absentes. Cheilocystidia  $45\text{--}55 \times 7\text{--}11\ \mu\text{m}$ , clavata vel subfusiformia, tenuitunicata,  $\frac{1}{2}$  vel  $\frac{1}{3}$  longitudinis eorum protrudentia. Basidia  $25\text{--}30 \times 8\text{--}9.5\ \mu\text{m}$ , clavata, tenuitunicata, 4–sterigmatiphora. Basidiosporae  $7\text{--}9\text{--}(10.5) \times (4.8\text{--})5.5\text{--}6.0\ \mu\text{m}$  ( $E_m = 1.34$ ;  $E = 1.15\text{--}1.53$ ) brevilipticae, tenues vel leniter crassitunicatae, in solutione Melzeri inamyloideae. Holotypus in thiniis arenarum sub *Coccoloba uvifera*, silva Piñones, prope Loiza, Puerto Rico, 14 Jan 1998 lectus. Leg. Lodge & Miller (NY, OKM 27232).



FIGS. 1–8. *Amanita cystidiosa* and *A. arenicola*. 1–4. *A. cystidiosa*. 1. Fruiting bodies. 2. Basidiospores. 3. Basidia. 4. Cheilocystidia. 5–8. *A. arenicola*. 5. Fruiting bodies. 6. Basidiospores. 7. Basidium. 8. Cheilocystidia. Bars: 1, 5 = 1 cm (upper bar); 2–4, 6–8 = 10  $\mu\text{m}$  (lower bar).

Pileus 2.0–4.7 cm broad, convex, becoming nearly plane in age, subviscid when wet, covered with a very fine mealy, white remains of the universal veil, pale straw yellow (Met 2A2, Met 1A2) ground color, margin finely sulcate-striate. Lamellae free, ventricose, 2 tiers of lamellulae ( $L = 2$ ), subdistant, yellow (Met 4A3–4), young light yellow (Met 4A2). Stipe 1.9–5.2 cm long, 0.4–0.7 cm wide equal with an abrupt round basal bulb, white except for the bulb which is covered with the appressed remains of the universal veil and



FIGS. 9–11. 9. *Amanita cystidiosa*. 10. *Lactarius coccolobae*. 11. *Phlebopus beniensis*. Bar = 1 cm.

is yellowish (near Met 4A2), fine white rhizomorphs emanate from the base. Partial veil leaves a persistent cothurnate, white annulus which flares upwards but may vary from inferior to superior. Context firm, white, unchanging in cap, stipe white and solid outside with a soft center. Smell not distinctive. Pileipellis of interwoven, broad, thin-walled hyphae 4.2–20  $\mu\text{m}$  diam, hyaline in 3% KOH, yellowish in Melzer's solution. Pileitrama of interwoven broad hyphae 4.2–24  $\mu\text{m}$  diam, hyaline in 3% KOH, yellowish in upper trama to dextrinoid in the lower trama in Melzer's solution. Lamellar trama of thin-walled, hyaline hyphae, yellowish with a hue of deep reddish color [dextrinoid] in Melzer's solution. Partial veil of filamentous, thin-walled hyphae 5–9  $\mu\text{m}$  diam, mostly of short, frequently branched cells. Universal veil of tightly interwoven cells 4.2–13  $\mu\text{m}$  diam, thin-walled,

hyaline with frequent, enlarged, distinctive clavate cells 15–27  $\mu\text{m}$  diam, thin-walled, and hyaline. No clamps seen on any tissue. Cheilocystidia 45–55  $\times$  7–11  $\mu\text{m}$  clavate, narrowly clavate to subfusiform, thin-walled, protruding one-third to one-half, numerous. Basidia 25–30  $\times$  8–9.5  $\mu\text{m}$  clavate, thin-walled, 4-spored hyaline in 3% KOH and Melzer's solution. Basidiospores 7–9(–10.5)  $\times$  (4.8–)5.5–6  $\mu\text{m}$  ( $E_m$  = 1.34;  $E$  = 1.15–1.53), short ellipsoidal, thin to slightly thick-walled, nonamyloid in Melzer's solution. Spore print pure white.

**Habit, habitat, and distribution.** Solitary to scattered in sand in the dunes or fore dunes among or close to *Coccoloba uvifera* and a wide spread decumbent shrub, coco plum, *Chrysobalanus icaco* L. (Rosaceae); fruiting in Jan.

**Etymology.** *cystidiosa* refers to the cheilocystidia.

**Material examined.** USA. PUERTO RICO: Piñones Commonwealth Forest, beach near Loiza, 14 Jan 1998, Coll. D. J. Lodge, O. K. & H. Miller OKM 27232 (PR-5462) (HOLOTYPE, W, ISOTYPE, CFMR); OKM 27234 (PR-5463) (PARATYPE, VPI; ISOPARATYPE, UPRRP).

**Observations.** A taxon meeting this description has not been collected before on Puerto Rico. The species is in the subgenus *Amanita* sect. *Amanita*. In the area where the holotype (OKM 27232) was found, a second collection, (OKM 27234) was made and both were in sand close to *Coccoloba uvifera* on the open beach. The persistent, membranous white annulus that flares; subviscid straw yellow pileus; clavate to subfusiform, thin-walled, protruding, cheilocystidia; filamentous partial veil and filamentous universal veil with clavate end-cells are a combination of unique characters in the genus *Amanita*. The spores are nonamyloid, short elliptic with a thickened wall. The presence of clavate to subfusiform cheilocystidia is the first demonstration of true cystidia for *Amanita* section *Amanita*. Jenkins' (1977) study of the North American taxa in the section *Amanita* reports that the gill edge is "frequently covered with inflated cells or hyphae being remnants of tissue between gills and partial veil." The cystidia in *A. cystidiosa* are derived from the lamellar trama and not remnants of a tissue differentiated during primordial development. Recently described species of *Amanita*, including reports from the Caribbean region by Tulloss (1989, 1990, 1995), Tulloss et al (1992), and Pegler (1983), do not include a taxon phenotypically similar to *A. cystidiosa*.

***Amanita arenicola*** O. K. Miller et D. J. Lodge, sp. nov. FIGS. 5–8

Pileus 3.5–5.5 cm latus, depressus vel infundibuliformis, madidus, laevis, sublutescenti-canus sed in centro maculis volvae universalis pallide bubalinis ornatus, in margine striis

plicatis praeditus. Lamellae liberae, angustae, approximatæ, albae, lamellulis inserie unica dispositis praeditae. Stipes 9.5–10 cm longus, 0.5–1.0 cm latus, subaequalis basi anguste clavatus, laevis, madidus, obscurus albus, cupula volvali fragili alba praeditus. Volva universalis e hyphis filamentosis hyalinis, in partibus subaequis inter cellulas globosas, subglobosas vel pyriformes hyalinas tenuitunicatas mixtis composita. Pileipellis ex sene unica repenti hypharum hyalinarum, cylindracearum 2.5–5.0 µm diametro composita. Fibulae absentes. Cheilocystidia sparsa hyalina pyriformia subglobosa vel globosa 18–30 × 13–17 µm. Basidia 35–55 × 12–14 µm clavata tenuitunicata hyalina, 4-sterigmatophora. Basidiosporae 9–12.5 × 7–10 µm ( $E_m = 1.25$ ;  $E = 1.11$ –1.43), subglobosae vel late ellipticae tenuitunicatae hyalinae, in 3% KOH guttula oleosa ampla flava praeditae, in solutione Melzeri inamyloideae. Holotypes in solo arenoso sub *Coccoloba uvifera* in White Bay Rd., Guana Island, British Virgin Islands, 27 Oct 1997 lectus. Leg. Lodge (NY, GUA 109).

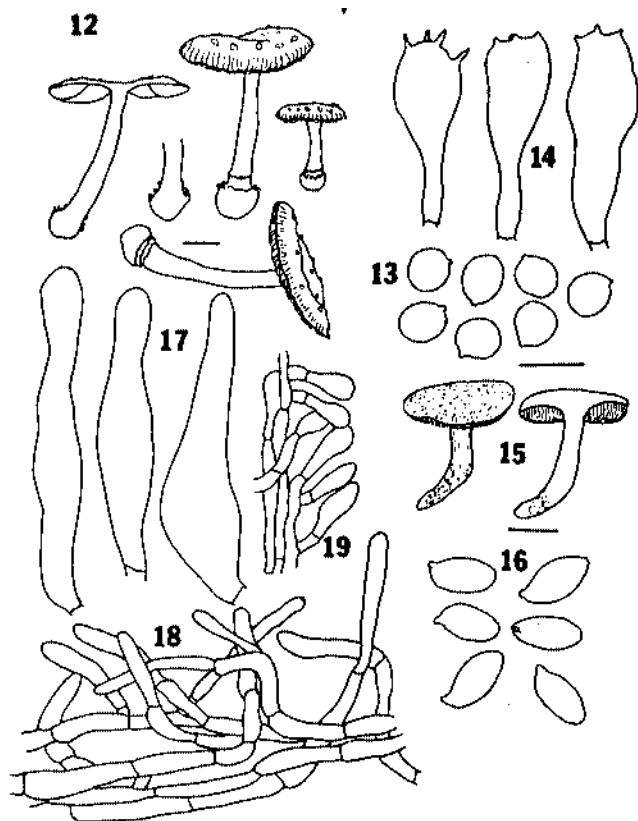
Pileus 3.5–5.5 cm broad, strongly depressed to infundibuliform, moist to sticky, sand covered, smooth, Drab Gray, with flat pale buff (124) (0.9Y 7.77/5.5) detersile patches of universal veil in the center, margin evenly pale Drab Gray (5.64, 6.82, 2.4) and plicate-striate. Lamellae free, narrow (5 mm broad), close, white, one tier of lamellulae, edges even. Stipe 9.5–10 cm long, 0.5–1.0 cm wide, nearly equal with a narrowly clavate base, smooth, moist, dull white with a small, fragile, white, volval cup, often appressed but one half or more free, often with the ragged remains of the veil in the sand or adhering to the lower stipe. Context soft, fragile, white. Pileipellis of hyphae 2.5–5.0 µm diam, thin-walled, filamentous, hyaline in 3% KOH, yellowish in Melzer's solution. Pileitrama of interwoven, broad, thin-walled, hyaline hyphae (3.6) 6–25 µm diam, mostly filamentous, sometimes swollen. Lamellar trama of filamentous to broad and swollen, thin-walled hyphae 4.2–21 µm diam. Subhymenium of short, isodiametric cells, thin-walled, hyaline. Universal veil of filamentous, hyaline hyphae intermixed with a nearly equal proportion of globose, subglobose to pyriform, hyaline, thin-walled cells. Clamp connections absent. Cheilocystidia infrequent to frequent, of pyriform to subglobose or globose cells 18–30 × 13–17 µm thin-walled, hyaline. Basidia 35–55 × 12–14 µm clavate, thin-walled, 4-spored, hyaline. Basidiospores 9–12.5 × 7–10 µm ( $E_m = 1.25$ ;  $E = 1.11$ –1.43) subglobose to broadly elliptic, thin-walled, hyaline with a large yellow oil body in 3% KOH, nonamyloid in Melzer's solution.

**Habit, habitat, and distribution.** In sandy soil under *Coccoloba uvifera* usually on beaches in Puerto Rico, and the Islands of Anguila and Guana in the Virgin Islands, fruiting in wet cool weather from July to December,

**Etymology.** arena = sand; cola = dweller.

**Material examined.** BRITISH VIRGIN ISLANDS. ANGUILLA: The Mariners Hotel, 8 Jul 1993, ANG-2, Coll. D. J. Lodge (CFMR). GUANA ISLAND: White Bay, beach road, 1 m elev, 180° 28' 39" N, 640° 34' 41" W (all of the following collections), 19 Oct 1997, GUA-38, Coll. D. J. Lodge (VPI); 27 Oct 1997, GUA-109, Coll. D. J. Lodge (HOLOTYPE, NY; ISOTYPE, CFMR); 2 Oct 1998, GUA-179, Coll. D. J. Lodge & N. Clum (CFMR NY); 2 Oct 1998, GUA-180, Coll. D. J. Lodge & N. Clum (CFMR NY); 2 Oct 1998, GUA-181, Coll. D. J. Lodge & N. Clum (NY); 2 Oct 1998, GUA-190, Coll. D. J. Lodge & N. Clum (CFMR); 2 Oct 1998, GUA-191, Coll. D. J. Lodge & N. Clum (NY); 2 Oct 1998, GUA-192, Coll. D. J. Lodge & N. Clum (CFMR, NY); 2 Oct 1998, GUA-193, Coll. D. J. Lodge & N. Clum (NY); 2 Oct 1998, GUA-196, Coll. D. J. Lodge & N. Clum (CFMR); 2 Oct 1998, GUA-195, Coll. D. J. Lodge & N. Clum (CFMR); 2 Oct 1998, GUA-196, Coll. D. J. Lodge & N. Clum (CFMR); 2 Oct 1998, GUA-197, Coll. D. J. Lodge & N. Clum (CFMR); 5 Oct 1998, GUA-198, Coll. D. J. Lodge & N. Clum (PARATYPE, NY, ISOPARATYPE, CFMR); 5 Oct 1998, GUA-199, Coll. D. J. Lodge & N. Clum (CFMR, NY); 6 Oct 1998, North Bay Woods near beach, GUA-215, Coll. D. J. Lodge (K). USA. PUERTO RICO: Munucipio Fajardo, near Luquillo, La Selva (Governor's) beach, 1 m. elev, 21 Dec 1997, PR-4716, Coll. L. Barley & E. Garcia (VPI); 21 Jul 1998, same location, PR-4908, Coll. D. J. Lodge & N. Perez (CFMR); 21 Jul 1998, PR-4909, Coll. D. J. Lodge & N. Perez; Munucipio Río Grande, Piñones Commonwealth Forest, beach near Loiza, 1 m elev, 23 Dec 1997, PR-4717, Coll. J. Trappe, D. J. Lodge & M. Cartellano (UPRRP).

**Observations.** The nonamyloid spores, type of volva, lack of a partial veil, and the plicate-striate pileus margin are all characters of the subgenus *Amanita* sect. *Vaginatae*. The characteristic drab gray cap coloration; very small, fragile, white, saccate volva; buff volval patches at the cap center and the distinctive type of universal veil tissue are characteristics of the species. The growth in beach sand, often in foredunes, associated with *Coccoloba uvifera* is a distinctive habitat. *Amanita sinicoflava* Tulloss is similar (Tulloss 1988) but has some obvious differences. In *A. sinicoflava* the volva is deeply saccate and the stipe has characteristic chevron-like rows of fibrils, often grayish in color, and a saccate volva with the "interior pale orangish or pinkish becoming gray" which are all phenotypic characters not present in *A. arenicola*. The pileus coloration and anatomical details of the universal veil combined with differences in spore size are different from the two taxa in sect. *Vaginatae* with a membranous universal veil described by Tulloss et al (1992). Pegler (1983) described *A. antillana* Dennis from the Lesser Antillies. This taxon is found in forests associated with *Coccoloba diversifolia* Jacq. and is in the sect. *Vaginatae* but differs in some respects. The pileus is brown to olive-brown, but the nonamyloid spores, measuring 10–13.5 × 7.5–11.5 µm with  $E_m = 1.26$ , are somewhat similar. Dennis (1952)



FIGS. 12–19. *Amanita microspora* and *Boletus ruborculus*. 12–14. *A. microspora*. 12. Fruiting bodies. 13. Basidiospores. 14. Basidia. 15–19. *B. ruborculus*. 15. Fruiting bodies. 16. Basidiospores. 17. Pleurocystidia. 18. Pileipellis. 19. Stipitipellis. Bars: 12, 15 = 1 cm (upper bar); 13–14, 16–19 = 10  $\mu$ m (lower bar).

stated that the volva was missing on the type collection from Trinidad, even though the fruiting body was carefully excavated. Pegler (1983) states that subsequent collections of *A. antillana* from Guadeloupe and Martinique in the Lesser Antilles have an ochraceous brown volva, unlike the white volva in *A. arenicola*. Examination of the holotype was carried out and the spores are larger than those of our taxon along with the differences in the volva noted above.

***Amanita microspora*** O.K. Miller, sp. nov. FIGS. 12–14

Pileus 3–5 cm latus convexus, vetustate subdepressus primo immaculate albus dein cito super discum flavidus vel ochraceus, margine lata alba striata ornatus, madido viscidus, in superficie areis parvis agglutinis deterisilibus albis atque reliquiis floccosis volvae universalis irregulariter dispersis instructus. Lamellae liberae subdistantes ventricosae, lamellulis cirtis infrequentibusque praeditae, primo albae vetustate pallide ochraceae. Stipes 3.5–6 cm longus, 0.3–0.5 cm latus, risque ad bulbum ovalem album abruptum in base usque ad 1.5 cm latum aequalis, albus, siccus, in omni superficie subtiliter granularis, super medium annulis concentricis pallide flavidis atque proxime super et super bulbum

basalem squamulis grossis albis ornatus. Contextus firmus albus. Volva partialis nulla. Et odor et sapor non distinctus. Pileipellis cutem e hyphis cylindricis 4.2–13  $\mu$ m diametro compositam formans. Trama lamellaris e hyphis divergentibus 4–13  $\mu$ m diam composita. Volva universalis e hyphis filamentosis 2–10  $\mu$ m diametro inter cellulas pytiformes vel clavatas mixtis composita. Fibulae absentes. Cheilocystidia absentia. Basidia 18–29  $\times$  69.5  $\mu$ m clavata, tenuitunicata, 4-sterigmatophora. Basidiosporae 5–7  $\times$  4.5–6.7  $\mu$ m ( $E_m$  = 1.12;  $E$  = 1.0–1.34), globosae vel subglobosae, tenuitunicatae, in solutio Melzeri inamyloideae. Holotypus in solo arenaceo inter thinia littoralia, *Coccoloba uviferae* consociata, prope Pitones, Loiza, Puerto Rico, 19 Nov 1996 lectus. Leg E. Horak (ZT 6125).

Pileus 3–5 cm broad, convex becoming slightly depressed in age, pure white at first, soon pale yellow to ochre over the disc with a broad, white, striate margin, viscid when moist with deterisile, agglutinated, white patches and the floccose remains of the universal veil unevenly scattered over the surface. Lamellae free, subdistant, ventricose, lamellulae short and infrequent, white at first soon becoming pale ochre in age. Stipe 3.5–6 cm long, 3–5 mm wide, equal with an abrupt oval bulb to 15 mm wide at the base, white, dry, with a fine granular surface and light yellowish tinted belts over the mid surface, coarse white squamules just above and over the basal bulb. Context firm, white. Partial veil absent. Odor and taste not distinctive. Pileipellis of loosely arranged hyphae 4.2–13  $\mu$ m diam, thin-walled, hyaline to light yellowish in 3% KOH. Pileitrama interwoven, thin-walled hyaline. hyphae 4.2–13  $\mu$ m diam. Lamellar trama of divergent hyphae 4–13 pin diam, thin-walled, hyaline to light yellowish in 3% KOH and Melzer's reagent, clamp Connections absent on all tissues. Universal veil of filamentous hyphae 2–10  $\mu$ m diam with about 30% ovoid, pyriform to clavate cells 15–32  $\mu$ m wide and 30–71  $\mu$ m long, thin-walled, hyaline, clamp connections absent. Cheilocystidia not seen. Basidia 18–29  $\times$  6–9.5  $\mu$ m diam, clavate, thin-walled, 4 spored. Spores 5–7  $\times$  4.5–6.7  $\mu$ m, [ $E_m$  = 1.12;  $E$  = 1.0–1.34] ovoid globose to subglobose, thin-walled, hyaline in 3% KOH, nonamyloid in Melzer's solution.

**Habit, habitat, and distribution.** On sandy soil in coastal sand dunes with *Coccoloba uvifera*; fruiting in Nov.

**Etymology.** *microspora* = small spores.

**Material examined.** USA. PUERTO RICO: Municipio Río Grande, Piñones Commonwealth Forest, beach near Loiza, 1 m elev, 19 Nov 1996. ZT-6125. Coll. E. Horak (HOLOTYPE, CFMR ISOTYPE, UPRRP).

**Observations.** This taxon resembles *Amanita gemmata* (Fr.) Bertillon, which is a nonannulate species that has nonamyloid spores 8.5–11  $\times$  5.5–8.5  $\mu$ m diam with  $E_m$  = 1.38. Our taxon has much smaller,

nonamyloid spores ( $5-7 \times 4.5-6.7 \mu\text{m}$ ) with  $E_m = 1.12$ . *Amanita cystidiosa* and *A. chrysoleuca* have larger nonamyloid spores.

*Amanita chrysoleuca* Pegler, Kew Bull. Addit. Ser. IX: 285. 1983.

Pileus 14-62 mm broad, broadly convex, becoming plane to slightly depressed or umbonate, smooth, shiny, moist, deep chrome yellow to orange-yellow, sulcate and translucent striate at the margin, occasionally with pale pinkish buff veil remnants. Lamellae free or narrowly adnexed, 1-6 mm wide, edge even, wavy or slightly serrated, white to cream color. Stipe 50-80 mm long, 4-8 mm wide, equal or tapering somewhat toward apex, dry, base with a small oval marginate bulb. Pileipellis of thin-walled, hyaline hyphae 7-8  $\mu\text{m}$  diam. Pileitrama a textura angularis of thin-walled, hyaline cells 7.622  $\mu\text{m}$  diam, lower trama a mixture of filamentous, hyaline hyphae 4.5-6.8  $\mu\text{m}$  diam and ovoid, elliptical to irregular, swollen cells up to 30  $\mu\text{m}$  diam. Lamellar trama narrowly divergent, broad, thin-walled hyphae 9-19  $\mu\text{m}$  diam, hyaline in 3% KOH and Melzer's solution. Cheilocystidia 17-39  $\times$  11-25  $\mu\text{m}$  ovoid, clavate, sphaeropedunculate, thin-walled, hyaline, scarce to absent at times. Basidia 30-40  $\times$  7-11  $\mu\text{m}$  broadly clavate to clavate, thin-walled, hyaline, 4-spored. Basidiospores 7-10(-10.5)  $\times$  5-7  $\mu\text{m}$  ( $E_m = 1.31$ ;  $E = 1.0-1.7$ ) subglobose, ellipsoidal, occasionally globose, thin-walled, nonamyloid in Melzer's solution, hyaline in 3% KOH with oil bodies in some.

*Habit, habitat, and distribution.* Gregarious in a subtropical moist forest, on ground; fruiting in Nov.

*Material examined.* US VIRGIN ISLANDS. STJOHN: Bordeaux Mtn., 350-400 m elev, 15 Nov 1996, St. J. 280, coll. E. Horak (NY); same loc. and date, St. J. 318, coll. S. A. Cantrell and B. Ortiz (NY); near Bordeaux Mtn. Peak, 17 Nov 1996, St. J. 276, coll. E. Horak (NY).

*Observations.* The chrome yellow pileus, stature, lack of a membranous volva, and the nonamyloid spores fit the species as described by Pegler (1983). The spores are globose and differ somewhat from the shape described by Pegler. Our spores have  $E_m = 1.31$  while those described by Pegler are 1.56.

**Boletus ruborculus** Baroni, sp. nov. FIGS. 15-19

Pileus 2.2 cm latus convexus tomentosus rubellus, super discum brunneo-tinctus. Contextus albus vel juxta tubos subcitrinus, in areis flavis immutans vel inordinate caerulescens. Tubi aurei, dente curto decurrenti adnati, 2 mm profundi. Pori concolores angulares 1 mm, ubi contusi immutati vel interdum tarde subcaeruleofusci. Stipes super basem atrovinosus, alibi pallide cremeus vel pallide lutescens, 2.5 cm longus, in apice 0.4 cm latus, aequus laevis sed velamine dense fibrilloso obtectus, solidus, contextu sordide

olivaceo-luteo in basi atrovinoso praeditus. Pileipellis trichodermium pallide lutescenti-brunneum e hyphis cylindricis laevibus 4-7  $\mu\text{m}$  diametro compositum formans. Et pleurocystidia et cheilocystidia conformia, hyalina, tenuitunicata, fusioidea vel ventricosa, aliquot cylindrica 40-60  $\times$  6.5-12  $\mu\text{m}$ . Basidia clavata, 4-sterigmatophora, 26-35  $\times$  11-12  $\mu\text{m}$ . Fibulae nullae. Basidiosporae 9-12.4  $\times$  4.8-6.4  $\mu\text{m}$  ( $E_m = 1.97$ ;  $E = 1.77-2.27$ ), brevi-subfusiformes. Holotypus in basi arboris viventis in summo collis calcarei, Saeptis Primitis Mata de Platano, Barrio Dominguito, Arecibo, Puerto Rico, 8 Nov 1996 lectus. Leg. Baroni, Cantrell et Bird (NY, Baroni 8253).

Pileus 2.2 cm broad, convex, matted tomentose, dull brick red (Met 7B4 grayish red, or Met 8C4 dull red), with more brownish hues over the disc (Met 6E4 brown). Context lemon yellow over tubes, sordid whitish elsewhere, unchanging or erratically bluing in yellow areas adjacent to the tubes when exposed. Tubes adnate with short decurrent tooth, 2 mm deep, chancelleries with pores. Pores sordid golden yellow (Met 4C5 chamois), angular, approx. 1/mm, some compound, unchanging when bruised or after a long period becoming slightly bluish fuscous. Stipe 2.5 cm long, 0.4 cm wide at apex, equal, terete, not reticulate, smooth, rhubarb red over the lower  $\frac{1}{3}$  (Met 10E5-6 violet brown), pallid elsewhere with a cream to yellowish appressed dense fibrillose covering, solid, context rhubarb red in base, dingy olivaceous yellow to apex, not changing color when exposed. Smell and taste not distinctive. Pileipellis a loosely entangled lax trichodermium of cylindric, nonencrusted hyphae in 3% KOH, 47  $\mu\text{m}$  diam; in  $\text{H}_2\text{O}$  the end cells possess brownish olivaceous globular intracellular pigments which dissolve in 3% KOH producing a diffuse pale yellowish brown color. Pileitrama a hyaline layer of intricately interwoven, cylindrical hyphae, 5-12  $\mu\text{m}$  diam. Tube trama divergent, with a distinct mediostratum of cylindric to mostly inflated hyphae, 6-16  $\mu\text{m}$  diam, and a diverging laterostratum of cylindric hyphae, 4-6  $\mu\text{m}$  diam. Pleuro- and cheilocystidia similar, hyaline, thin-walled, mostly rounded fusoid, ventricose or some cylindric, 40-60  $\times$  6.5-12  $\mu\text{m}$ . Stipitipellis over the apex a hyaline layer of repent, loosely interwoven, cylindric hyphae, 68  $\mu\text{m}$  diam, producing scattered clusters of hyaline, thin-walled, clavate or cylindric caulocystidia, 14-26  $\times$  6-8  $\mu\text{m}$ . Basidia clavate, 4-sterigmate, 26-35  $\times$  11-12  $\mu\text{m}$ . Clamp connections absent. Basidiospores 9-12.4  $\times$  4.8-6.4  $\mu\text{m}$  ( $= 10.6 \times 5.4 \mu\text{m}$ ;  $E_m = 1.97$ ;  $E = 1.77-2.27$ ), short subfusiform with pronounced suprahilar depression, smooth, slightly thick-walled, olive brown in 3% KOH. Spore deposit color not known.

*Habit, habitat, and distribution.* On the side of a living tree, near *Coccoloba* sp., Nov.

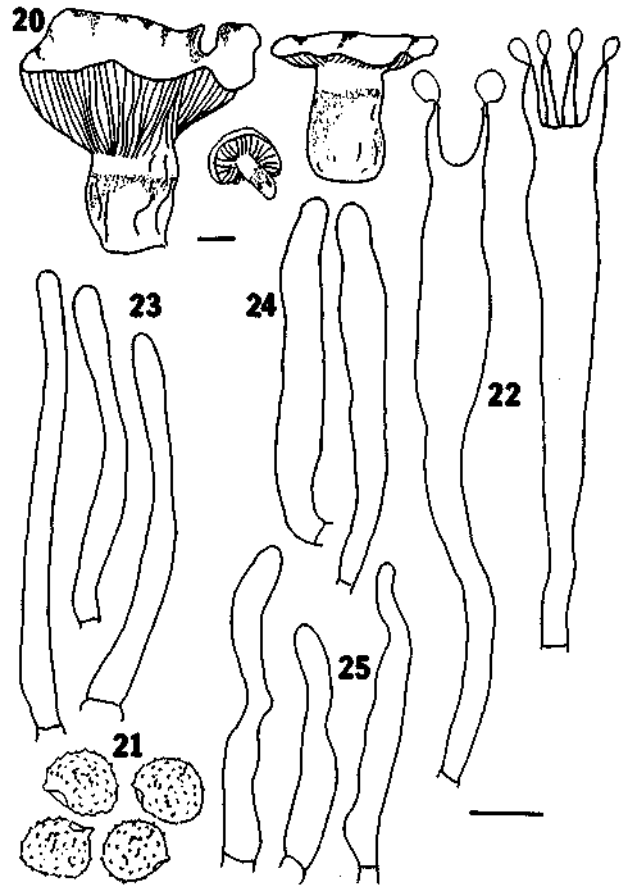
*Etymology.* rubor = redness; culus = little.

**Material examined.** USA. PUERTO RICO: Arecibo, Barrio Dominguito, Mata de Platano Private Reserve, N 18° 24' 49.6". W 66° 43' 33.1", approx. 940 m elev, on top of a limestone hill (a mogote) above bat-inhabited caves, on the side of a living tree, 8 Nov 1996, Coll. T. J. Baroni, S. A. Cantrell & F. Bird, PR-4926, ledger 8253 T. J. Baroni (NY, HOLOTYPE).

**Observations.** *Boletus ruborculus* is somewhat reminiscent of *B. rubellus* Kromb. and related taxa such as *B. campestris* Smith & Thiers; however, several features may be used to clearly distinguish these taxa. Most importantly both *B. rubellus* and *B. campestris* have distinctly yellowish flesh in the pileus and stipe that becomes obviously blue or bluish green when exposed (Both 1993, Breitenbach and Kränzlin 1991, Smith and Thiers 1971). In the case of *B. rubellus* the surface of the stipe also turns bluish green after bruising. *Boletus ruborculus* has a whitish pileus context that does not turn blue or does so only erratically at the junction with the tubes. The stipe context remains completely unchanged in *B. ruborculus* when exposed, and the stipe surface does not change color when handled or bruised intentionally. The size of the basidiospores also distinguishes *B. campestris* from *B. ruborculus* because they are clearly shorter in *B. ruborculus*, i.e., basidiospores of *B. campestris* measure  $11\text{--}14\text{--}(15) \times 4.5\text{--}6\text{--}(7) \mu\text{m}$  (Smith and Thiers 1971) whereas those of *B. ruborculus* measure  $9\text{--}12.5 \times 4.8\text{--}6.4 \mu\text{m}$ .

Corner (1972) and Singer (1947) discuss several tropical and subtropical taxa that are superficially similar to *B. ruborculus*, but these taxa are clearly different when compared to *B. ruborculus*. For instance Corner (1972) describes *B. rubellus* subsp. *borneensis* Corner, which has yellow flesh that becomes rapidly and intensely cyanescent on exposure. *Boletus monfiaseri* Corner is similar to *B. ruborculus* by its white unchanging context, but differs markedly by the inflated cells in the pileipellis. *Boletus phoeniculus* Corner has a pileipellis composed of cylindric septate hyphae, but the context is yellow and not cyanescent. *Boletus rubellus* ssp. *consobrinus* Singer is a taxon from limestone soils like *B. ruborculus*, but the context of *B. rubellus* ssp. *consobrinus* is yellow with erratic bluing when exposed, there is a striking pale greenish yellow mycelium at the base of the stipe, and the fresh basidiomata have a disagreeable odor "of old, dirty clothing" (Singer 1947). This group of small red capped boletes, centered around *B. rubellus*, is obviously quite diverse in their combinations of morphological characters.

***Lactarius coccolobae*** O. K. Miller et D. J. Lodge, sp. nov. FIGS. 10, 20–25  
Pileus (1.8)5–11 cm latus, robustus planus, sub vetustate



FIGS. 20–25. *Lactarius coccolobae*. 20. Fruiting bodies. 21. Basidiospores. 22. Basidia. 23. Dermatocystidia. 24. Caulocystidia. 25. Cheilocystidia. Bars: 20 = 1 cm (upper bar); 21–25 = 10  $\mu\text{m}$  (lower bar).

elevatus, siccus, primo obscure cremeus deinde mox per discolorationes variegatas brunneas vel atro-brunneas tinctus. Lamellae adnatae, congestae, primo albae sub vetustate brunneae, laticem album producentes, areis superficies ubi contusis vel sectis tarde atrobrunnescentibus reagentibus praeditae. Stipes 2–4 cm longus, 1.2–2.2 cm latus, siccus, apice laevis, in parte inferiore minute hirsutus, obscure albus, brunnescent vel atrobrunnescent ubicumque contusus. Contextus solidus vel tenax, primo albus, ubi sectus vel contusus per colorem obscure brunneum tinctus. Pileipellis velamen e pileocystidiis cylindricis vel fusiformibus  $24\text{--}65\text{--}(122) \times 3.6\text{--}5.4 \mu\text{m}$  compositum formans. Subpellis e hyphis implexitis gelatinosis  $2.7\text{--}4.5 \mu\text{m}$  diametro composita. Basidia  $60\text{--}79\text{--}(85) \times 8.1\text{--}9.5 \mu\text{m}$ , clavata, tenuitunicata, 2-vel 4-sterigmatophora. Basidiosporae  $7.2\text{--}9\text{--}(10) \times 5.8\text{--}8.4 \mu\text{m}$ , ( $E_m = 1.26$ ;  $E = 1.13\text{--}1.55$ ) subgloboae, in parte subapicali et verrucis humilibus ( $<0.3 \mu\text{m}$  altis) amyloideis et reticulis infirmis partialibus praeditae. Holotypus in thiniis arenarum sub *Coccoloba uvifera*, silva Piñones, prope Loiza, Puerto Rico, 14 Jan 1998 lectus. Leg. Lodge and Miller (CFMR, OKM 27240).

Pileus (1.8–)5–11 cm broad, robust, plane, repand or upturned in age, dry, dull cream but soon staining



a mottled brown, light brown (Met 6E-F 4-6) to dingy blackish brown, inrolled margin in buttons becoming plane in age. Lamellae adnate, crowded, white at first, with a white whey-like latex that stains the gill tissue dark brown where cut or bruised, in age generally mottled brown and subdistant (Met 5E-F 4-7). Stipe 2–4 cm long, 1.2–2.2 cm wide, equal, with dingy mottled light brown (Met 5D4) to dark brown (Met 5F 5-6), minutely hairy (use lens), smooth just at the apex. Context very firm to tough, white at first but soon staining on exposure to air a dull mottled brown (Met 5E5), when bruised with the knife darkening to dingy brown to black-brown at the base. Taste sweet and mild. Smell strongly of fish or herring, like *L. volemus* (Fr.) Fr., and is a room-filling odor persisting in dried material. Pileipellis an irregular turf of pileocystidia  $24\text{--}65\text{--}(122) \times 3.6\text{--}5.4 \mu\text{m}$  cylindrical or tapering toward apex, thin-walled, hyaline or with light brown slightly thick-walled, arising from a narrow layer of interwoven, gelatinized hyphae  $2.7\text{--}4.5 \mu\text{m}$  diam, with deep yellow-brown incrustated material in Melzer's solution and 3% KOH. Pileitrama of broader, filamentous, rectangular to irregular thin-walled, interwoven hyphae  $4.5\text{--}10.5 \mu\text{m}$  diam, hyaline in Melzer's solution and 3% KOH, with frequent dark yellow brown lactiferous hyphae  $7.2\text{--}9 \mu\text{m}$  diam, especially in the lower trama. Lamellar trama of tightly packed, interwoven, thin-walled, hyaline hyphae  $3.69 \mu\text{m}$  diam with frequent deep yellow-brown, laticiferous hyphae. Caulocystidia  $39\text{--}45 \times 3.6\text{--}5.4 \mu\text{m}$  cylindrical to narrowly fusiform, occasionally subcapitate, thin-walled, hyaline or with a light brownish hue in 3% KOH, numerous. Cheilocystidia  $35\text{--}65 \times 2.5\text{--}5 \mu\text{m}$ , hyphalike, fusiform with an apical projection to narrowly clavate, thin-walled, hyaline, protruding only slightly if at all, scattered not frequent. Basidia  $60\text{--}79\text{--}(85) \times 8.1\text{--}9.5 \mu\text{m}$  clavate, thin-walled, 2 to mostly 4-spored, sterigmata  $5.5\text{--}7 \mu\text{m}$  long. Basidiospores  $7.2\text{--}9\text{--}(10.8) \times 5.8\text{--}8.4 \mu\text{m}$ , ( $E_m = 1.26$ ;  $E = 1.13\text{--}1.55$ ) subglobose with a subapical plage, and a short hyaline apiculus, fine very low ( $<0.3 \mu\text{m}$ ) amyloid often irregular warts and few to frequent weak amyloid partial reticulations.

**Habit, habitat, and distribution.** Scattered in sand on dunes under *Coccoloba uvifera*; fruiting in November on Guana Island but in January at the Piñones Commonwealth Forest in Puerto Rico.

**Material examined.** BRITISH VIRGIN ISLANDS. GUANA ISLAND: North Bay Beach, 2 m elev, N  $18^\circ 29' 42''$ , W  $64^\circ 33' 40''$ , 21 Oct 1998, GUA-186, coll. N. Clum (PARATYPE, NY, ISOPARATYPE, VPI). USA. PUERTO RICO: Municipio Loiza, Piñones Commonwealth Forest, beach near Loiza, 2 m elev, 14 Jan 1998, OKM-27240, coll. D. J. Lodge and O. K. & H. Miller (HOLOTYPE, CFMR ISOTYPE, UPRRP).

**Observations.** The fruiting bodies of this species

are very robust, with adnate, close to crowded lamellae and a short stipe and sporophores which are very close to or buried in the sand. The flesh of the fruiting bodies stain brown when bruised, immediately yielding a whey-like white latex in buttons but often the latex can only be observed in age by cutting the specimens in half and observing the latex at the margin of the gills and tramal tissue. The pungent fishy odor persists in the dried specimens, which are very tough. Material soaked in 95% ethanol and water yields a wine colored extract and softens very slowly. In addition, the pileipellis has a turf of pileocystidia best seen in the young specimens arising from a layer of interwoven gelatinized hyphae, the spores have very low ornamentation (mostly  $>0.2 \mu\text{m}$  high) and the cheilocystidia are hyphalike to narrowly clavate. It also has numerous caulocystidia. It is a member of the subgen. *Lactifluus* sect. *Lactifluus* (Hesler and Smith 1979). It does appear to be closely related to *L. caribaeus* Pegler (Pegler 1983). Both have similar microscopic anatomy, especially the low individual warts that form the spore ornamentation, and spore size. However, the basidia of *L. coccolobae* are distinctly shorter and the pileipellis is gelatinized. There are distinctive macroscopic differences. The lamellae of *L. caribaeus* are deeply decurrent, subdistant with numerous lamellulae of two lengths, as illustrated by Pegler (1983, Fig. 123A and color Plate 20C), and are not adnate and crowded. In addition, the odor is reminiscent of urine rather than rotting fish. The stipe surface of *L. caribaeus* is described as pure white at first and glabrous. It is found associated with *Coccoloba pubescens* L. and *C. diversifolia* in degraded xerophytic forests and not in a dune habitat. Both of these taxa are distinctly different from any taxon now placed in the section but they have several characters in common with *L. luteolus* Peck. Fruiting bodies of *Lactarius luteolus* are not robust, have a different but similar pileipellis, smaller basidia and higher ornamentation on the spores. In addition, the cystidia are thin-walled in our material and the taste is mild. The holotype of *L. luteolus* was studied and also does not have the extractable wine colored pigment, which is so obvious when sections of *L. coccolobae* are soaked in 95% ethanol.

*Lactarius ferrugineus* Pegler, Kew Bull. 33: 626. 1979.

This species is widespread in the mountain ranges of Puerto Rico. It has been collected on various soil types under *Coccoloba* spp. and *Pisonia* spp. In the Central Mountain Range, it was found on serpentine soil in the Maricao Municipio Recreation area and on nonserpentine soils in the Municipio of Orocovis in the Toro Negro Commonwealth Forest. In the Lu-



quillo Mts, Caribbean National Forest, *L. ferrugineus* has been collected under *Coccoloba swartzii* in the Municipio of Río Grande, Palo Hueco area.

**Material examined.** USA. PUERTO RICO: Maricao Municipio, Maricao Recreation area, 25 Jun 1996, 7950 T. J. Baroni (NY), and PR-3295, coll. D. J. Lodge (CFMR); Municipio of Orocovis, Toro Negro Commonwealth Forest, El Bolo Trail, 10 November 1996, PR-3722, leg. Cantrell PR-96150, coll. S. A. Cantrell & C. Betancourt (UPRRP); Luquillo Mts., Caribbean Natinal Forest, Municipio of Río Grande, Palo Hueco area off Rt. 186, 600 m elev, N 18° 18' 15", W 65° 49' 21" elev 500-600 m, 7 Oct 1996, PR3443, ledger Cantrell PR-96111 coll. S. A. Cantrell (CMFR) 13 Apr 1998, PR-4860 ledger Cantrell PR-9848, S. A. Cantrell & C. Laboy (CFMR); 9 Oct 1998, PR-5241, ledger Cantrell PR-9889, coll. S. A. Cantrell & N. Clum (CFMR); 12 Jan 1999, PR-5511 ledger Clum NCC-992, coll. S. A. Cantrell & D. J. Lodge (CFMR); under *C. rugosa* in the Represa Icaco & Represa Prieto, by waterfall near dam, Caribbean National Forest, Municipio Naguabo, 450 m elev, N 18° 15' 24", W 66° 46' 45", 7 Jul 1999, PR-5512, ledger Clum NCC-9958, coll. S. A. Cantrell & N. Clum (CFMR); Aguas Buenas Municipio, near Bayamoncito, on Cerro La Tiza, N 18° 14' 32.4", W 66° 10' 53.9", 23 Jun 1996, PR-3618, ledger T.J. Baroni 7930 (CORT).

**Observations.** Our specimens fit exactly the description provided by Pegler (1983) for *L. ferrugineus* described from the island of Martinique. This report serves as the first documentation of this taxon from the Greater Antilles. *Lactarius ferrugineus* is easily recognized in the field by its orange brown pileus and stipe with pinkish or buffy tan adnate lamellae. The small to medium sized pileus has a low mamillate or papillate umbo, a subtly rugulose surface, and a short strate or plicate-sulcate margin. The latex is white, unchanging and the taste is bitterish and then peppery hot. The strongly reticulate ornamented spores are also diagnostic.

*Lactarius nebulosus* Pegler Kew Bull. 33: 610. 1997.

**Material examined.** BRITISH VIRGIN ISLANDS. GUANA ISLAND: North Bay woods, in sandy soil under *Coccoloba uvifera*, N 18° 28' 42" W 64° 34' 40", 24 Oct 1997, D. J. Lodge GUA-104 (CFMR).

**Observations.** The pale to dark grayish pileus, the white lamellae that stain cinnamon-brown, the white or creamy white latex that turns cinnamon-brown the odor of fish or rotting flesh, and the acrid or peppery taste are characters that help to identify *L. nebulosus* in the field. The distinctive and abundant sphaerocysts in the lamellar trama, the dense turf of narrowly cylindrical hyphae making up the trichodermium of the pileipellis, and the ellipsoid basidiospores with isolated conical amyloid verrucae are distinctive microscopic features of this special *Lactarius nebulosus* was previously known from the

island of Martinique. This report extends its range to the Virgin Islands in the Puerto Rican Bank. We expect other collections will eventually be found on Puerto Rico and other large islands in the Greater Antilles.

*Russula littoralis* Pegler, Mycotaxon 12: 93. 1980,

Pileus 3.8–11.0 cm broad, broadly convex, becoming plane with a shallow, broadly depressed disc, surface glabrous, moist or very slightly tacky over the margin, dull yellowish to cream color over the disc (3.4Y 8.4/4.2) (Met 3A4), the margin is olive-gray (Met 3C2-3), to Drab Gray (0.64 6.82/2.4) or brownish gray Glaucus 80 (6.5Y 5.90/1.2) tinted lilac over the outer one-half of the surface. Lamellae adnate, close to crowded, narrow, white, in age yellowish, Pale Horn Color (2.5Y 8.08/3.5) paler than (Met 4A3-4), 4–5 mm broad, 1 mm at margin, with occasional long lamellulae that fork just at the stipe. Stipe 1.5–4.0 (–5) cm long, 0.8–1.6 (–2.8) cm broad, nearly equal or bulbous, clavate in one specimen, glabrous, dry, dull white. Context soft and pure white, unchanging when bruised. Taste sweet or not distinctive. Odor not distinctive. Pileipellis a turf of erect dermatocystidia, hyaline, thin-walled, hyphal-like 1.7–2.5 µm diam, often decumbent in age. Subpellis a dense, thick layer of interwoven, thin-walled hyphae 2–5 µm diam embedded in a hyaline, gelatinous layer in 3% KOH to yellowish in Melzer's reagent. Pileitrama a heteromerous tissue of thin-walled, hyaline sphaerocysts 10–29 × 7.5–20 µm diam with filamentous hyphae 3–7 µm diam, hyaline in 3% KOH, light yellow in Melzer's reagent. Lamellar trama of filamentous, inflated, to ovoid cells 3–13 µm diam, thin-walled, hyaline in 3% KOH, yellowish in Melzer's solution. No clamp connections seen. Cheilocystidia and pleurocystidia 50–78 × 8–9 µm diam, numerous, narrowly clavate with subcapitate to mucronate apices, thin-walled, yellowish contents. Basidia 36–41 × 10–12 µm diam, clavate, thin-walled, hyaline, 4 spored. Basidiospores 6.7–10 × 6–8 µm ( $E_m = 1.15$ :  $E = 1.0$ –1.33) globose, subglobose or broadly ellipsoidal, thin-walled, with a small apiculus and small oval plage, small amyloid warts <0.3 µm high, solitary or partially connected by amyloid, weak low ridges. Spore deposit cream (Met 3A2) to dark cream or pale ochre buff (Romagnesi 1967: IId "crème foncé" to IIIa "ocre pâle"). Reagents: FeSO<sub>4</sub> negative; gumguaiac faint bluish; 2% phenol negative.

**Habit, habitat, and distribution.** Puerto Rico, Mona and Virgin Islands; fruiting in coastal sand foredunes and dune slack near or under *Coccoloba uvifera* during the rainy season (Sep through Nov) often following several days of torrential rains.

*Material examined.* BRITISH VIRGIN ISLANDS. GUANA ISLAND: North Bay Woods, in sand under *C. uvifera*, 2 m elev, N 18° 29' 42" W 64° 33' 40", 2 Oct 1997, GUA-103 Coll. *D. J. Lodge* (CORT); 3 Oct 1998, GUA-183, Coll. *D. J. Lodge & N. Clum* (CFMR); 6 Oct 1998, GUA-185, Coll. *D. J. Lodge* (CFMR); White Bay Beach, 2 m elev, N 18° 28' 39" W 60° 34' 41", 2 Oct 1998, GUA-178, Coll. *D. J. Lodge & N. Clum* (NY); 3 Oct 1998, GUA-184, Coll. *D. J. Lodge & N. Clum* (NY); 1 m elev 5 Oct 1998, GUA-182, Coll. *D. J. Lodge & N. Clum* (NY), USA, Puerto Rico: Mona Island, Playa de Pajaros, near new ranch and entrance to Cueva del Caballo, 1.5 m elev, N 18° 18' 15", W 67° 43' 15", 25 Sep 1995 PR-3792 and PR-889, Coll. *A. M. Nieves-Rivera* (UPRRP); Puerto Rico Island, Loiza Municipio Piñones Commonwealth Forest, beach near Loiza, in sand behind foredunes, 2 m elev, near *C. uvifera*, 19 Nov 1996. PR-4985, ledger *T. J. Baroni* 8347, Coll. *T. J. Baroni* (CORT); same location and date, PR-3987, Coll. *D. J. Lodge & T. J. Baroni* (CFMR); same location and date, PR-3988, Coll. *D. J. Lodge* (NY); same location, 14 Jan 1998, OKM-27242, Coll. *D. J. Lodge, O. K. & H. Miller* (VPI).

*Observations.* The species was described by Pegler (1980) from Grand Macabou, Martinique in sand under the "Seagrape," *Coccoloba uvifera*. This is the identical habitat in which we have found our fungus on Puerto Rico as well as Guana and Mona Islands. The description of *R. littoralis* by Pegler from Martinique in the Lesser Antilles (Pegler 1983) is very close to the material from the same habitats in Puerto Rico, Mona Island and Guana Island. However, the spore size is somewhat larger than that which we have recorded ( $6.5\text{--}8.0 \times 5.5\text{--}6.5 \mu\text{m}$  vs  $6.7\text{--}10 \times 6\text{--}8 \mu\text{m}$ , respectively).

*Russula puiggarii* (Speg.) Singer, Lilloa 23: 239. 1950.  
= *Clitocybe puiggarii* Speg., Bol Acad. Cienc. Cordoba 9: 389. 1889.  
= *Russula brasiliensis* Singer, Pap. Mich. Acad. Sci. Arts & Letters 32:108. 1948.

As pointed out by Pegler (1983), *Russula puiggarii* is relatively common in tropical regions of the Lesser Antilles and South America. Our report of this species in Puerto Rico serves as the first for the Greater Antilles. The single collection was found on humus and soil near *Pisonia* aff. *subcordata* Sw. in the El Verde Research area of Puerto Rico; N 18° 19' 30", W 65° 49' 5" 2 Feb 1998, Coll. *T. Bruns, D. J. Lodge* and *P. Bayman*, PR-4719 (CFMR).

The brown pileus with its distinctly striate or sulcate-striate margin and exposed white context in radial lines due to radial splitting of the surface layers are distinctive field characters of this taxon. The complex, three-layered pileipellis and the strongly reticulate globose basidiospores are also characteristic for this species. Our collection displays all of the morphological features reported for *R. puiggarii* by Peg-

ler (1983) and Singer (1948) except for one minor difference. In our collection the pleurocystidia, which are pseudocystidia, frequently have strangulated or torulose apices. The pleurocystidia of *R. puiggarii* from the Lesser Antilles and South America have been described as simply ventricose. It will be interesting to see if this minor morphological difference is consistent with the northernmost collections of this taxon when further material becomes available.

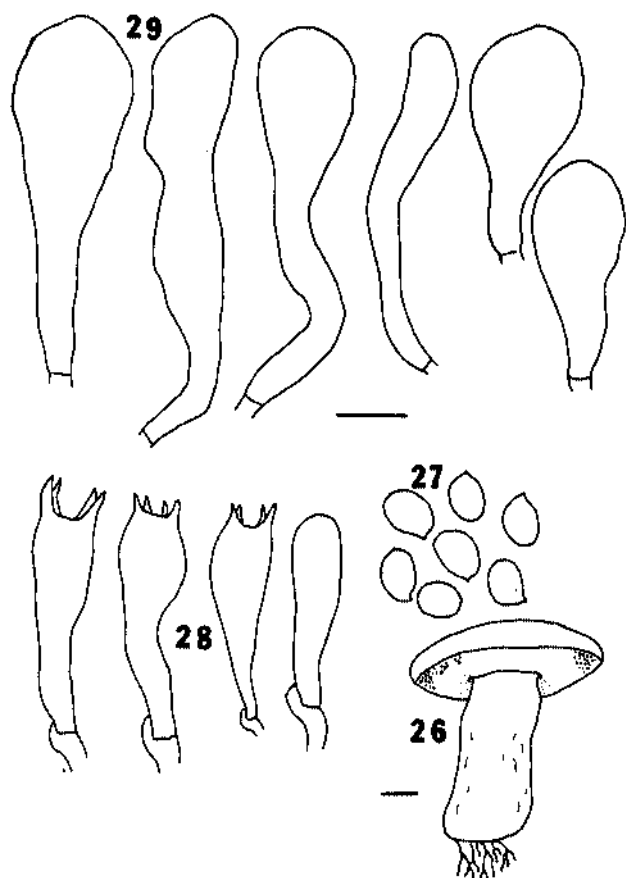
#### *Phylloporus* Quél. sp.

Pileus 22 mm broad, moist, somewhat felt-like, orange-brown. Lamellae broadly adnate, lamellate near the stipe to poroid over the margin, 2–3 mm thick, uneven and intervenose, yellow-orange, no blue staining observed when bruised. Stipe 14 × 4 mm equal, moist, smooth, yellowish. Context light buff, firm, bruising pinkish. Pileipellis a trichoderm composed of narrow, nearly cylindrical to narrowly fusiform thin-walled, hyaline cells  $34\text{--}93 \times 3.5\text{--}5.0 \mu\text{m}$  diam arising from a subpellis of interwoven hyphae  $3.4\text{--}6.5 \mu\text{m}$  diam, thin-walled, hyaline in 3% KOH and Melzer's solution. Pileitrama of interwoven, thin-walled hyphae  $2.5\text{--}10.5 \mu\text{m}$  diam, thin-walled filamentous, hyaline, hyphae on average somewhat larger than the cells of the pileipellis. Lamellar trama of large, hyaline, thin-walled cells  $7.6\text{--}19 \mu\text{m}$  diam interwoven but extending almost to the hymenium giving rise to branching subhymenial cells and basidioles, no clamps seen on any tissue. Cheilocystidia long, narrowly fusiform, thin-walled cells  $55\text{--}64 \times 7.5\text{--}9.5 \mu\text{m}$ , hyaline in 3% KOH and Melzer's solution, protruding one-third to one-half beyond the basidia. Basidia  $28\text{--}43 \times 8\text{--}9 \mu\text{m}$  narrowly clavate, thin-walled, hyaline, 4-spored, no clamp connections. Basidiospores  $6.5\text{--}8.0(9) \times 2.5\text{--}3.5(4) \mu\text{m}$  diam ( $E_m = 2.41$ ;  $E = 1.62\text{--}3.00$ ) oblong to oblong-ellipsoidal, thin-walled, light brown in Melzer's solution and 3% KOH.

*Habit, habitat, and distribution.* One very small cap was found among the *Phlebopus beniensis* collection, OKM 27200, on ground in a subtropical moist forest, on a well drained site, at 70' elev; fruiting in Jan.

*Material examined.* USA. PUERTO RICO: Between Luquillo and Sabana Field Station, off of Rt. 991 near Río Sabana, 300 m elev, above a private chicken farm in subtropical moist forest, N 18° 21' 3.4", W 65° 42' 50", 10 Jan 1998. Coll. *H. Miller*; OKM 27205 (VPI).

*Observations.* The single small specimen has spores that are distinctly smaller than found in any known species of *Phylloporus*. The spores of *P. rhodoxanthus* (Schw.) Bres. are  $11\text{--}15 \times 4.5\text{--}6 \mu\text{m}$  (Miller 1973). In addition, the specimen has a very loculate hymen-



FIGS. 26–29. *Phlebopus beniensis*. 26. Fruiting body. 27. Basidiospores. 28. Basidia. 29. Cheilocystidia. Bars: 26 = 1 cm (lower bar); 27–29 = 10  $\mu$ m (upper bar).

ophore and lacks blue staining when bruised. More material needs to be collected to provide a complete description of this new taxon. The species of *Phylloporus* are mycorrhizal fungi and this species is almost certainly ectomycorrhizal with the same host as that of *Phlebopus beniensis* (Sing & Digilio) Sing., which was fruiting all around this specimen. Additional information about the ecology is given in observations following the description of *Phlebopus beniensis*.

*Phlebopus beniensis* (Sing. & Digilio) Sing., Beih. Nova Hedw. 77:46. 1983. FIGS. 11, 26–29  
= *Paeogyroporus beniensis* Sing. & Digilio, Lilloa 30150. 1960.

Pileus 2.67.1 cm broad, broadly convex, felt-like, dry, smooth, black-brown to deep red-brown [Caill.T73; Met 7F4-6,9F3-4], margin incurved until maturity. Tubes adnate, 2–4 mm deep. Pores 3–4 per mm, stuffed and appearing pustulate at first, opening in age, uneven at maturity, yellow (Met 4A4-6) gradually staining light blue when bruised. Stipe 2.5–5 cm long, 0.9–2.1 cm wide at apex enlarging somewhat toward base to 17–28 mm wide forming a narrowly

clavate base, sometimes yellowish just at the apex, black-brown (Met 8E-F4-5) overall with a fine, sparse, evanescent network of yellow fibrils (mycelium, use lens) over the surface, copious light brown rhizomorphs at the base. Context firm, orange-yellow (Met 3A4) when first cut, darkening somewhat when bruised, on standing fading to light straw yellow. Smell stale farinaceous that persists in the dried collections. Taste mild. Pileipellis a narrow layer (40–65  $\mu$ m thick) of hyaline, gelatinized hyphae 2.5–6.0  $\mu$ m diam; subpellis of interwoven, yellow-brown, thin-walled hyphae with scattered clamp connections, wine red in 3% KOH and Melzer's solution. Pileitrama of interwoven, thin-walled to slightly thick-walled hyphae, scattered clamp connections, hyaline in 3% KOH and Melzer's solution. Tube trama of slightly divergent, hyaline, thin-walled, hyphae 3.4–5.5 (–8.5)  $\mu$ m diam, with scattered yellow-brown oleiferous hyphae, scattered clamp connections. Cheilocystidia abundant, 28–55  $\times$  615  $\mu$ m clavate, broadly clavate, thin-walled, hyaline in 3% KOH and Melzer's solution. Basidia clavate, thin-walled, with a basal clamp connection, hyaline in 3% KOH and Melzer's solution. Basidiospores 5.0–6.8  $\times$  3.8–5.5  $\mu$ m ( $E_m$  = 1.29;  $E$  = 1.09–1.52) elliptic, smooth, thin-walled to slightly thick-walled, olivaceous brown. Spore print olive-brown (Met 3E4-5).

*Habit, habitat and distribution.* On the ground on or near a dirt road at 300' elev in a dry subtropical forest, on a well drained site; fruiting in Jun.

*Material examined.* BOLIVIA. Vaca Diez, Guayaramerin, 6 Mar 1956, Singer B1613 (LIL, HOLOTYPE). USA. PUERTO RICO: Municipio Luquillo, between Luquillo and Sabana, off of Rt. 991, above Río Sabana and a private chicken farm, 70 m elev, N 18° 21' 3.4", W 65° 42' 50", 7 Jun 1997, PR-5034, ledger T. J. Baroni 8495, Coll. T. J. Baroni (NY); same location, 6 Jun 1998, PR-5452, Coll. O. Isikhue-men (DK, CFMR); same location, 10 Jun 1998, PR-5467 ledger OKM 27200, Col. D. J. Lodge, O. K. & H. Miller (CFMR); same location, 15 Jan 1998, PR-5468, ledger OKM 27252 and OKM 27254, Coll. H. & O. K. Miller (VPI).

*Observations.* *Phlebopus* species were first placed in *Phaeogyroporus* Sing. (Singer and Digilio 1960). Species now assigned to *Phlebopus* were segregated from other boletes (Singer 1936, Singer et al 1983) because of their short spores and because of the abundant clamp connections found on the hyphae of the basidiomata. *Phlebopus* is apparently allied to *Gyrodon* Opat. and is placed in the Gyrodontiae (Singer 1986). There are currently seven species known from Africa and or Australasia and three species known from the neotropics. Only one of these three species has previously been reported from the Lesser Antilles (Pegler 1983). This description serves as the first report of a *Phlebopus* for the Greater Antillian island

chain. The Puerto Rican collection comes from a dry subtropical forest of approximately 100 m elev. Although no known ectomycorrhizal symbiont was identified as an associate with this bolete, because of the existence of a *Phylloporus* species nearby, we suspect *Phlepobus* may actually form ectomycorrhizae with *Hymenaea courbaril* L. This large leguminous caesalpinoid tree, not presently known as a mycorrhizal former, was a suspect and the dominant tree near to which these two boletes were found. Another possible legume host in the vicinity was *Andira inermis*, which forms ectendomycorrhizae (Lodge 1996).

The black-brown to red-brown smooth cap and distinctive black-brown stipe with a yellow apex, fine yellow pores, and very slow blue staining even when bruised vigorously, are distinctive characters. In addition, the yellow, sparse, evanescent fine fibrils (use lens) over the surface of the stipe is most unusual for a bolete. Young specimens tend to be in the red-brown color range while older caps are black-brown fading to orange-brown. All specimens are evenly or nearly evenly colored with a conspicuously incurved margin. Note that in the same location several additional collections were found. The cap of OKM 27252 was 9.5 cm broad, the cap had faded to red-brown in the center (Met 6F5-6) the rest orange-brown (Met 5C5-6) but the rest of the fresh characteristics were the same as in the specimens described above. The additional collection, OKM 27254, was some distance from the two mentioned above but the two fruiting bodies were old and overmature.

*Suillus brevipes* (Peck) Kuntze, Rev. Gen. Pl. 3:535. 1898.

We have three collections of this ectomycorrhizal bolete from red clay soil on a bank under planted *Pinus caribaea* Morelet in the Adjuntas Municipio, Guilarte Forest Reserve, on the slopes of Silla de Calderón in Puerto Rico, N 18° E 09' 17.7" W 66° E 48' 34.9". *Suillus brevipes* is now documented from the Caribbean region. This is a plantation and the *Suillus* is not native. It was most likely introduced to Puerto Rico in pine soil/duff from North Carolina by the USDA Forest Service in 1955 in order to stimulate pine growth (see Vozzo 1971). The chocolate or vinaceous-brown, viscid pileus, lack of a thin white partial veil, and short whitish stipe that lacks prominent glandulae make this species easy to identify in the field. The subfusiform basidiospores that measure  $8-9 \times 2.4-3.2 \mu\text{m}$  diam are also typical for this species.

*Material examined.* USA. PUERTO RICO: Morelet, Adjuntas Municipio, Guilarte Commonwealth Forest, N 18° 9' 17.7" W 66° 48' 34.9", 7 Nov 1996, PR-4913, ledger T. J. Baroni 8241, Coll. T. J. Baroni (NY); same location, 24 Jan

1997, PR-4128, Coll. S. A. Cantrell & D. J. Lodge (CFMR); same location, 22 Jan 1998, PR-4904, ledger S. A. Cantrell PR-9824, coll. S. A. Cantrell, J. Trappe & M. Castellano (CFMR).

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## Systematics

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- 558-570 New and interesting ectomycorrhizal fungi from Puerto Rico, Mona and Guana Islands  
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