TROPICAL CONNECTIONS: SISTER SPECIES AND SPECIES IN COMMON BETWEEN THE CARIBBEAN AND THE EASTERN UNITED STATES

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The evolutionary lineages of mushrooms on the Caribbean islands can be traced to North America, South America, and even Africa. We are currently coordinating a project funded by the National Science Foundation to inventory the basidiomycetes of the Greater Antilles with the ultimate goal of elucidating biogeographic and evolutionary connections. A few mushrooms in the Caribbean are the same species as those found in the eastern United States or only show minor differences, while many other Caribbean species are distinct from but most closely related to sister species in the eastern USA. Some of the most striking examples of these biogeographic connections are in the genus *Mycena* and the families *Entolomataceae* and *Hygrophoraceae.* In this paper, we discuss some of the links between eastern North America and the Caribbean for these primarily saprophytic agarics. We have also included here new records from the Dominican Republic for typically temperate ascomycetes in the genera *Morchella, Helvella, Gyromitra, Lachnum* and *Leotia.* These same themes for ectomycorrhizal fungi will be discussed in a later paper.

Geologic history of the Caribbean islands

To understand when sister taxa in North America and the Caribbean parted company, we need to examine the geologic history of the region, which was summarized by Hedges *et al.* in 1992. The origin and exact geologic history of the Caribbean islands are debated, but it is agreed that they originated further west than they are now, perhaps where Central America is currently or further west in the Pacific. Based on the few species of animals common to North America and South America at that time, it is believed that the islands did not form a continuous land bridge between the continents. Life on the developing islands was largely wiped out around 64 million years ago when a large asteroid-like bolide landed in the Gulf of Mexico, creating a tidal wave estimated at 2 km in height at the point of impact and over 500m by the time it reached Cuba. However, some living Caribbean amphibian and reptile lineages are thought to have been separated from their mainland relatives 80-90 million years ago and therefore may have survived the impact (Hedges *et al.,* 1992).

As the incipient island chain drifted east relative to the continents, some may have collided with each other and broke apart into new configurations. About 25 to 30 million years ago, many reconstructions suggest that Puerto Rico was joined to the southeastern part of Hispaniola (Dominican Republic on the eastern end and Haiti in the west), and was located approximately south of Florida. The sea level rose and fell by hundreds of feet over the geologic ages, joining islands above sea level as the ice ages waxed, and partially or completely inundating the islands as the ice ages waned. The last major inundation lasted for 10 to 15 million years and ended around 25 million years ago (Hedges *et al.*, 1992). Cuba, Puerto Rico and the Dominican Republic are thought to have had some parts that remained above water, based on the presence of endemic amphibians and reptiles and the large evolutionary differences separating them from mainland relatives. Despite some recent controversy, Jamaica and the Lesser Antilles are thought to have been completely submerged before 25 million years ago (Hedges *et al.*, 1992).

Description of the study areas

The highest mountain in the Caribbean is Pico Duarte in the Central Mountain Range of the Dominican Republic, standing at 3087 m. The high mountains have frosts at night and forests of an endemic pine, *Pinus occidentalis.* The pines in the Dominican Republic and Haiti represent the easternmost extent of native pine in the Caribbean; no pines are native to Puerto Rico or the Lesser Antilles. The mountain ranges in Puerto Rico are much lower than in the Dominican Republic, with the highest peak, Cerro Punto, reaching 1338 m above sea level. Dwarf cloud forests often occur on the peaks in the 850-1550 m elevation range (temperatures from the upper 40's to 60's F) in Puerto Rico and the Dominican Republic (Figure 1). Cloud forests occur at higher elevations in the Dominican Republic than in Puerto Rico because the mountain ranges are surrounded by a greater land mass. For the same reason, climates at a given elevation are cooler on the Caribbean islands than at sites with a comparable elevation and latitude on the mainland. Lower elevations in our study areas (350-850 m) have temperatures from about 60-87 F and generally have tall, wet, broadleaved forests that retain their leaves all year. These are what are popularly thought of as rain forests, but the higher elevation cloud forests are the true rain forests.

Fig. 1: Dwarf cloud forest at *ca.* 1,550 m elevation in the Ebano Verde forest reserve of Fundación Progressio. Sharon A. Cantrell is shown with Rildes Sanchez, the reserve manager, and Rafael Peralta, one of the forest guards, who served as our guides. (Lodge)*

*In each case the photographer is given in parentheses

Discomycete connections between Caribbean and temperate forests

While collecting agarics in high elevation pine forest in the Dominican Republic last January, we were surprised to find several discomycete species that are common in north temperate regions **(Table 1).** Two collections of a Morchella species in the *M. data* Fr. complex (Figure 2) were found in the pine forest in Valle Nuevo **(Table 2).** Other species of Morchella have been reported in the neotropics at high elevations in Mexico, Guatemala, Costa Rica, Argentina and Cuba (Gomez, 1971; Guzman *et al.,* 1985). Two species of *Gyromitra, G. esculenta* (Pers.) Fr. and *G. cf. infula* (Schaeff.:Fr.) Quél. were also collected in the same habitat as the morels. This is the first report of this genus in the Caribbean basin. *Leotia viscosa* Fr. was also collected in the pine forest. The genus Leotia is very common in northeastern North America, where *L. lubrica* is the most frequently observed species. Our collections of *L. viscosa* are the first report of this genus in the tropics. A *Helvella* species, *H. cf. atra* Fr., was collected at somewhat lower elevation (900 m) in tall, wet broadleaved forest. A very common species of *Luchnum, L. virgineum* (Batsch:Fr.) P. Karsten, that grows on stems of Rubus in north temperate areas was collected at high elevation in the Dominican Republic. The collection of *L. virgineum* from the Dominican Republic was also growing on a species of Rubus.

Fig. 2: Sharon A. Cantrell with the first record of morels in the Dominican Republic. The morels, *Morchella* sp. aff. *elata,* were discovered in a virgin pine forest that is owned by our cooperating non-governmental agency, Fundación Moscoso Puello, in the Valle Nuevo National Park. (Lodge)

Mushrooms in common between Eastern North America and the Caribbean

Many North American mushroom species that are also found in Puerto Rico and the Dominican Republic are primarily or exclusively found in cool wet forests at high elevation **(Table 1).** For example, *Cuphophyllus pratensis* (Pers.:Fr) Bon (=*Hygrocybe pratensis* (Pers.:Fr.) Kummer) is found above 350 m in the Luquillo Mts. of Puerto Rico. Puerto Rican *C. pratensis* is indistinguishable from north temperate collections such as the one shown in **Figure 3** (Lodge & Pegler, 1990). *Hygrophorus speciosus* Pk. was found in native pine forests between 1,550 and 2,300 m elevation in the Dominican Republic. The only morphological difference found between North American and Caribbean *H. speciosus* was the slightly larger spore size of the Dominican collections (8-11.5 x 5.2-7.2 µm versus 8-10 x 4.5-6 µm). North American *H. speciosus* var. *kauffmanii* is shown in **Figure 4.** However, *H. speciosus* was apparently ectomycorrhizal with native *Pinus occidentalis* in

Fig 3: *Cuphophyllus pratensis* in eastern Northern America. (Baroni)

Fig. 4: *Hygrophorus speciosus* var. *kauffmanni* from eastern North America. (Baroni)

Fig. 5: *Hygrophorus microsporus* is found in eastern North America and the Caribbean. This collection was from the Luquillo Mountains of Puerto Rico. (Cantrell)

Fig 6. *Mycena adonis* from cloud forest in the Ebano Verde Reserve in the Central Mountain Range of the Dominican Republic. (Lodge)

the Dominican Republic, unlike *H. speciosus* in North America and Europe that is reportedly associated with larch (Hesler & Smith, 1963). During the summer of 1997 our group made several collections of a species of *Camarophyllopsis* (= *Hygrotrama*), *Hygrophorus microsporus* Smith & Hesler in the Luquillo Mountains of Puerto Rico (Figure 5). It may represent the same species as *H. deceptivus* Smith & Hesler from the southeastern USA and France, and *H. schulzeri* Bres. in Europe (Arnolds, 1990). Hesler & Smith (1963) noted that *H. schulzeri* was originally described as being reddish brown whereas Bresadola's illustration was more gray brown. Our collections vary from reddish to grayish brown but are otherwise identical. This is the first report of this species in the Caribbean.

We found *Mycena adonis* (Bull.:Fr.) S.F. Gray, a lovely red species with a white stipe, in cloud forests from 850-1550 m elevation in the Central Mountain Range of Puerto Rico as well as in the Ebano Verde Reserve in the Central Mountain Range of the Dominican Republic (Figure 6). It was macroscopically and microscopically indistinguishable from North American and European material. *Mycena epipterygia* (Scop.:Fr.) S.F. Gray **(Figure 7)** was found in native pine forests between 1,550 and 2,300 m elevation in the Dominican Republic. The Dominican collections had larger spores than north temperate collections, but this was attributable to the basidia which had only a single sterigma bearing one large spore versus the 2-, 3- and 4-spored basidia bearing commensurately smaller spores found in N. America and Europe (Maas Geesteranus, 1992). In addition to the *Mycena spp.*, we also found *Baeospora myosura* (Fr.) Singer in the Dominican Republic growing on cones of *Pinus occidentalis. Baeospora myosura* is typically found on cones of white pine and spruce in North America.

Fig. 7: *Mycena epipterygia is* a species found in forests with temperate climates around the world. This collection was photographed at high elevation in the Dominican Republic. (O. Paino Perdomo)

Almost none of the North American species in the family Entolomataceae have been found in the Caribbean and *vice versa.* A few notable exceptions are the beautiful yellow *Entoloma murraii* (Berk. & Curt.) Sacc. and *Leptonia incana* (Fr.) Gill. *E. murraii* was originally described from New England and can be found throughout the eastern USA and into the Gulf Coast states, while *L. incana* was originally described from Sweden and can be found throughout eastern North America and Europe, especially in areas with limestone bedrock. We have collected the bright yellow *E. murraii* several times between 500 and 800 m elevation in Puerto Rico and the

Fig. 8: *Entoloma murraii* at high elevation in Parque Nacional Armando Bermudez in the Dominican Republic. (Lodge)

Fig. 9: *Entoloma murraii* in eastern North America. (Baroni)

Dominican Republic. **Figures 8** and **9** show *E. murraii* in the Dominican Republic and the eastern USA, respectively. *Leptonia incana,* a striking delicate species with a greenish-yellow pileus and bright yellow stipe which stains dark bluish-green upon handling, has been collected once so far by us in the limestone karst forest of Jamaica. Some people say it smells like a mouse cage while others say it smells like popcorn; in any case, it does have a rather distinctive odor in most collections.

Sister species

Several Caribbean mushroom species in the genus Entoloma appear to be closely related to species in Eastern North America **(Table 2).** An undescribed species we found in Puerto Rico is related to *E. velutina* from the eastern USA, but it differs from *E. velutina* Hesler in having blue colored lamellae when young, larger spores with consistently more angles (Figures **10 & 11)** and several other differences in the pileipellis and hymenium.

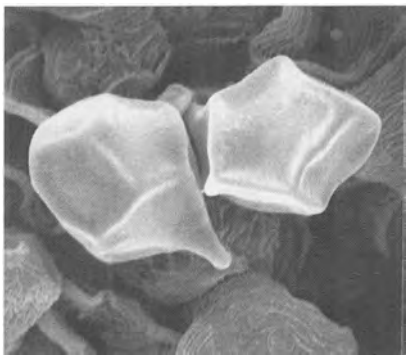

Fig. 10: Scanning electron micrograph of spores of North American *Entoloma velutina.* Spores of *E. velutina* have fewer angles than spores of its Caribbean sister species, shown in Figure 11. (Baroni)

Fig. 11: Scanning electron micrograph of spores of an undescribed species related to *Entoloma velutina* from Puerto Rico. (Baroni)

Entoloma lactifluus (Heim) Baroni comb. nov. (Basonym: *Rhodophyllus lactifluus* Heim, Rev. Myc. 1:223. 1936) has now been collected several times from above 250 m elevation in Puerto Rico. *Entoloma lactifluus,* shown in **Figure 12,** was originally described from Madagascar and it is very similar to eastern North American *E. quadraturn* (Berk. & Curt.) Horak (=*Entoloma salmoneum* (Pk.) Sacc.) shown in **Figure 13.** *Entoloma lactifluus* differs most notably in producing copious orange latex when injured and by having a densely appressed fibrillose rather than a silky, smooth pileus surface. In addition, the basal mycelioid stipe covering in *E. quadratum* is white, but in our fresh collections of E. lactifluus this mycelioid covering is bright pinkish orange. These species are very closely related, but clearly different.

Fig. 12: *Entoloma lactifluus*, a species originally described from Madagascar, was found and photographed in Puerto Rico. This species is closely related to *Entoloma quadratum* from eastern North America, which is shown in Figure 13. (Baroni)

Fig. 13: *Entoloma quadratum* from eastern North America has a smoother pileus than Caribbean/African *E. lactifluus.* (Baroni)

In addition to the sister species in the family Entolomataceae noted above, we have discovered a complex group of interrelated species in the genus *Alboleptonia,* some of which resemble *A. sericella* (Fr.) Largent & Benedict which is frequently found in the eastern USA, and related taxa such as *A. ochracea* Largent & Benedict and *A. infundibuliforma* Largent which are only found in the western USA (Largent, 1994). These small, mostly white, delicate mushrooms are distinguished by several features, most notably the size and shape of the spores, the presence and type of cheilocystidia, and the presence or absence of clamp connections on the hyphae. Shape of the pileus, color of the lamellae, color changes of bruised flesh, odor, and in some cases ecology are all helpful in recognizing the eight different species which can be found in the Caribbean. A strong garlic odor is diagnostic for the Cuban *A. eadei* (Murr.) Largent & Benedict, which we have also collected in Costa Rica. We have documented six different species of *Alboleptonia* for the Greater Antilles, of which four are new, *viz. A largentii* **(Figures 14 & 15),** *A. flaviphylla, A. subrosea,* and *A. sulcata)* (Baroni & Lodge, in review).

Beatriz Ortiz Santana recently discovered at 1,176 m elevation in the Guillarte Commonwealth Forest of Puerto Rico an undescribed orange-red species of *Mycena* that is most closely related to M. adonis. This species has yellow rather than pink to white lamellae and smaller spores (6.8-7.5 x 4.1-5.3 µm versus 8.1-10.8 x 5.4-7.2 µm for two-spored basidia; Ortiz Santana,

Fig. 14: *Alboleptonia largentii* is a new species being described from Puerto Rico. (Baroni)

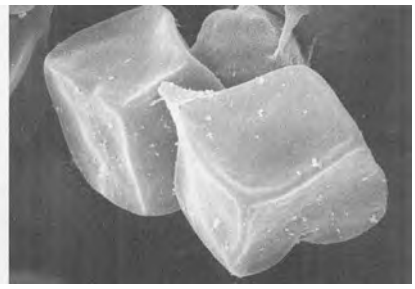

Fig. 15: Scanning electron micrograph of spores of a new *Alboleptonia* species from Puerto Rico, *A. largentii.* (Baroni)

1997; Maas Geesteranus, 1992). *Mycena gelatinomarginata* Lodge was described from Puerto Rico (Lodge, 1988) and has also been found in the Andes in Colombia (Figure 16). It is closely related to *M. carolinensis* Smith & Hasler from the southern Appalachian Mountains and *M. xanthopoda* Dennis from the mountains of Venezuela. *Mycena gelatinomarginata* differs from *M. carolinensis* in having a pileus that is depressed in the center and orange to orange-yellow rather than yellow, and in having an additional gelatinous zone in the gill margin. *Mycena xanthopoda* from Venezuela primarily differs from both of the above species in lacking a gelatinized zone in the pileus and having simpler ornamentation on the cystidia, and from *M. gelatinomarginata* in lacking a gelatinized gill edge. Another

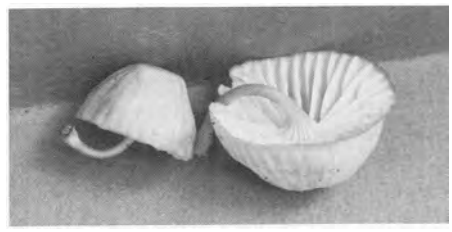

Fig. 16: *Mycena gelatinomarginata* was described from Puerto Rico, and has also been found in Colombia. It is most closely related to *M. carolinensis* in the southern Appalachian Mountains of the USA. This collection was growing from the underside of a branch and does not have the typical tall, slender aspect of this species. Except for having white rather than yellow lamellae and the presence of a gelatinized gill margin, it closely resembles an undescribed species from Puerto Rico and Trinidad and various other sister species from South America. (Lodge)

species belonging to *Mycena* Section *Carolinenses* Maas G. has been found in Puerto Rico and Trinidad. It is related to several species from the Andes previously described by Rolf Singer. All of the species in Section *Carolinenses* grow on twigs, have a lampshade-shaped orange to yellow pileus, arcuate-decurrent lamellae, a brown staining reaction to bruising and age, amyloid spores, fusiform pseudocystidia, and other distinctive microscopic features (Lodge, 1988; Maas Geesteranus, 1992).

In the family Hygrophoraceae, we have discovered a new species of *Cuphophyllus* (=*Camarophyllus)* in the Central Mountain range of Puerto Rico, characterized by a darkly colored, infundibuliform pileus and pale pinkish buff cantharelloid gills. The new *Cuphophyllus* species is related to the North American species, *Hygrophorus fumosellus* Smith & Hesler and *Camarophyllus recurvatus* (Pk.) Murr. **(Figure 17).** *Hygrophorus bakeri*

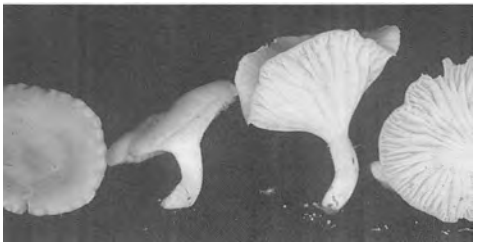

Fig. 17: Camarophyllus recurvatus from eastern North America is closely related to an undescribed species from Puerto Rico. (Baroni)

Dennis from Trinidad is yet another distinct species belonging to this tight cluster of closely related species **(Table 2).** *Hygrocybe miniata* (Fr.: Fr.) P. Kumm. from North America and Europe is very closely related to *Hygrocybe subcaespitosa* (Mum.) Lodge & Pegler which was described from Jamaica and is found throughout the Greater and northern Lesser Antilles. These species are so similar that Caribbean collections were previously identified as *H. miniata* (Lodge & Pegler, 1990). *Hygrocybe subcaespitosa* differs from *H. miniata* in having lamellae which are persistently white to pale yellow rather than red like the pileus and fading with age, the color of the stipe which is much paler than the pileus rather than the same color or darker, and consistently narrower hyphae in the gills.

Hygrocybe Section *Neohygrocybe* has several connections between eastern North America and the Caribbean **(Table 2).** For example, the honey to fuscous colored *Hygrocybe melleofusca* Lodge & Pegler **(Figure 18)** is most closely related to the North American species, *Hygrophorus caespitosus* (Murr.) Mum. *Hygrocybe melleofusca* differs from *H. caespitosus* in having a thin pileus flesh which is usually perforated in the center, larger spores,

Fig. 18: *Hygrocybe melleofusca,* found and photographed in Puerto Rico and also found in Lesser Antilles, is most closely related to *Hygrophorus caespitosus* from North America. (Baroni)

and conspicuous conducting elements below the pileus surface. *Hygrocybe melleofusca* is found in Puerto Rico and the Lesser Antilles. However, two other distinct but closely related species in Section *Neohygrocybe* from the northernmost Lesser Antilles, *H. mellita* Pegler and *H. lepidopellis* Pegler, have not been found in the Greater Antilles **(Table 2).**

The most confusing cluster of species in Section *Neohygrocybe* involves north temperate *Hygrocybe ovina* (Bull.:Fr.) Kühner. A taxon related to *H. ovina* **(Figure 19)** was found at around 650 m elevation in the Luquillo Mts. of Puerto Rico. It differs from North American and European *H. ouina* in having true cheilocystidia, encrusting pigments as well as intracellular pigments in the pileus hyphae, and lacking red staining reactions and nitrous odors. The Puerto Rican collection has pseudocystidia with brown contents extending far beyond the basidia, a character that is variable in European collections of *H. ovina* (Arnolds) but apparently lacking in North American collections (Hesler and Smith, 1963). The presence of a nitrous odor is also reportedly variable in *H. ovina. Hygrophorus subovinus* Hesler & Smith is a closely related species described from the Southern Appalachian Mountains which has cheilocystidia, pseudocystidia, and a fragrant odor, but it differs from the Puerto Rican collection in having lamellae that stain pinkish to reddish brown, much smaller spores (5-7 x 5-6 µm versus 6.6-10 x 5.3-8 µm), and lacking encrusting pigments. Yet another undescribed species related to *H. ovina* was found at the same elevation in the Luquillo Mountains of Puerto Rico, but it differs in having a pale pileus margin, grayer coloration, narrower spores (6.4-8 x 4.8 µm versus 6.6-10 x 5.3-8 µm), and in lacking red staining reactions, cheilocystidia and encrusting pigments.

Fig. 19: *Hygrocybe* aff. *ovina* in Puerto Rico is a sister species to *H. ovina* from North America and Europe, and *Hygrophorus subovinus* from the Appalachian Mountains. (Baroni)

Geographic origins

It is relatively easy to find closely related species pairs and clusters, but it is often difficult to determine what species or geographic area was the source based on taxonomic information alone. In some cases, it is difficult to know which variation of a particular characteristic such as 'cap color' is 'primitive' and which was derived from the other. In addition, some characteristics such as the number of spores per basidium can change and then revert back to the original state, while other characteristics such as gelatinized zones, certain types of veils (Watling, 1996), and the false truffle habit (Kendrick, 1994; Mueller & Pine, 1994) have arisen several times independently within a group.

It is sometimes possible to deduce the origin of a genus, family or order based on where the highest diversity of the group is centered. For example, Donald Pfister (1974) surmised that among the operculate discomycetes (Pezizales), the suborder Pezizineae diversified evolutionarily in temperate regions while the Sarcoscyphineae diversified in the tropics. Our own obser-

vations seem to support this view, since despite the presence of morels, gyromitras and helvellas in the Caribbean, they are not as common nor do they have as many species as in North America. In addition, members in the suborder Sarcoscyphineae are more abundant and diverse in the Caribbean. The highest diversity of species in *Mycena* Section *Carolinenses* is found in the Andes. Considered together with the simpler tramal structure and ornamentation of the cystidia of these Andean *Mycena* species, this may indicate a South American origin for Section *Carolinenses.* If so, then *M. carolinensis* from the Southern Appalachian Mountains represents either a geologically recent colonization via the Lesser Antilles (i.e., less than 25 million years), or a more ancient colonization from South America occurring when the Greater Antilles were located much further west, and before the Lesser Antilles had emerged from the ocean.

The controversial geology of the Greater Antilles (Cuba, Hispaniola, and Puerto Rico) prevents any firm conclusions about the connections between their fungi and those of North America. On the other hand, the Lesser Antilles present a clearer geological history. We have found a lower overlap of species in the Hygrophoraceae and Entolomataceae than we initially expected between the Greater and Lesser Antilles. Part of this difference can be attributed to the presence of species in the Greater Antilles that appear to belong to North American lineages whereas some species in the Lesser Antilles apparently belong to South American lineages. Except for a few pantropical Alboleptonia species, many of the species in the Entolomataceae that are found in both the Greater and Lesser Antilles are either the same as species found in South America, or the Antillean species have strong affinities to South American species. In these cases, the Lesser Antilles have served as a bridge between South America and the Greater Antilles in geologically recent times. Species in the Hygrophoraceae that are found in both the Greater and Lesser Antilles appear to have either a South American origin (e.g., members of Section *Firmae,* which are characterized by having two very different sizes of basidia and spores on the same fruit body) or a North American origin *(e.g., Hygrophorus caespitosus* and *Hygrocybe melleofusca, H. miniata* and *H. subcaespitosa,* and *Hygrophorus recurvatus* and the Antillean sister species).

Speciation

The striking similarity between certain species in North America and the Caribbean suggests an evolutionary relationship between them. It is likely that one of the sister species gave rise to the other, or that they shared a common ancestor. Some species pairs in **Table 2** have accumulated numerous differences and are thus easily distinguished, such as *Hygrophorus caespitosus* and *Hygrocybe melleofusca,* and *Entoloma velutina* and its Caribbean sister species, whereas other species pairs differ by only a few characters, such as *Mycena carolinensis* and *M. gelatinomarginata, M. adonis* and its Puerto Rican sister species, *Entoloma quadratum* and *E. lactifluus,* and *Hygrocybe miniata* and *H. subcaespitosa.* Although species in Section *Neohygrocybe* that are related to *Hygrophorus caespitosus* represent a closely related cluster of species in the Caribbean, they have generally

diverged from each other enough to allow easy identification using a combination of three or more macroscopic and microscopic characters. However, the separation of species in the same Section that are related to *Hygrocybe ovina* is murky at best, a situation that can be described as a species complex.

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Literature Cited

Arnolds, E. 1990. *Truibus Hygrocybeae* (Kühner) Bas & Arnolds. Pages 70-133 In: **Flora Agaricina Neerlandica, Vol. 2. Critical Monographs on Families of Agarics and Boleti Occurring in the Netherlands,** C. Bas, Th.W. Kuyper, M.E. Noordeloos & E.C. Vellinga, eds. A.A. Balkema, Rotterdam, Brookfield.

Baroni, T.J. and D.J. Lodge. Basidiomycetes of the Greater Antilles: new species and new records of *Alboleptonia* from Puerto Rico and St. John, USVI. Submitted to **Mycologia,** in review.

Boertmann, D. 1995. **The genus *Hygrocybe*. Fungi of Northern Europe – vol. 1.** David Boertmann and the Danish Mycological Society.

Führer, B. & R. Robinson 1992. **Rainforest Fungi of Tasmania and South-East Australia.** CSIRO, Editorial Services Section, Information Services Branch, East Melbourne, Australia.

Gomez, L.D. 1971. Un nuevo Discomycete operculado de America Central: *Morchella herediana,* nov. sp. **Darwinia** 16: 417-426.

Guzmán, G., M.F. Torres, H. Logemann, J. Argueta & I. Sommerkamp. 1985. Fungi from Guatemala, I. A new species of *Morchella.* **Mycologia Helvetica** 1: 451-459.

Hedges, S.B., C.A. Hass, and L.R. Maxson. 1992. Caribbean biogeography: Molecular evidence for dispersal in West Indian terrestrial vertebrates. **Proceedings of the National Academy of Science USA.** 89: 1909-1913.

Hesler, L.R. & A.H. Smith. 1963. **North American Species of *Hygrophorus.*** The University of Tennessee Press, Knoxville.

Kendrick, B. 1994. Evolution in action: from mushrooms to truffles? Parts 1 and 2. **McIlvainea** 11(2): 34-47.

Largent, D.L. 1994. **Entolomatoid fungi of the western United States and Alaska.** Mad River Press, Eureka, CA. 516 pages.

Lodge, D.J. 1988. Three new *Mycena* species (Basidiomycota: Tricholomataceae) from Puerto Rico. **Transactions of the British Mycological Society** 91: 109-116.

Lodge, D.J. & D.N. Pegler. 1990. Hygrophoraceae of the Luquillo Mountains of Puerto Rico. **Mycological Research** 94: 443-456.

Maas Geesteranus, R.A. 1992. **Mycenas of the Northern Hemisphere. Vol. 11. Conspectus of the Mycenas of the Northern Hemisphere.** Koninklijke Nederlandse Akademie van Wetenschappen Verhandelingen, Afd. Natuurkunde, Tweede Reeks, deel 90, North-Holland, Amsterdam, Oxford, New York and Tokyo.

Mueller, G.M. and E.M. Pine. 1994. DNA data provide evidence on the evolutionary relationships between mushrooms and false truffles. **McIlvainea** 11(2): 61-74.

Ortiz Santana, B. 1997. **Agaricales (Basidiomycota: Holobasidiomycetes) del Bosque Estatal Monte Guilarte en Adjuntas, Puerto Rico.** Master of Science Dissertation in Biology, University of Puerto Rico-Mayaguez., Puerto Rico.

Pegler, D.N. & J.P. Fiard. 1978. **Agaric Flora of the Lesser Antilles.** Kew Bulletin Additional Series 9: 1-668.

Pfister, D.H. 1974. Notes on Caribbean discomycetes. V. A preliminary annotated checklist of Caribbean Pezizales. **J. Agriculture U. Puerto Rico** 58(3):358-78.

Watling, R. 1996. Patterns in fungal development – fruiting patterns in nature. Pages 182-222 In: **Patterns in Fungal Development** (S-W Chiu and D. Moore, eds.). Cambridge University Press, Cambridge, UK.

Table 1. Species of mushrooms and discomycetes that are found in both eastern North America and the Caribbean basin.

Fungus	Locations in the Caribbean basin
Operculate discomycetes: Pezizales	
Gyromitra esculenta (Pers.) Fr.	Dominican Republic
Gyromitra cf. *infula* (Schaeff.:Fr.) Quél.	Dominican Republic
Helvella cf. *atra* Fr.	Dominican Republic, Jamaica & South America
Morchella esculenta Fr.	Cuba & Mexico
Inoperculate discomycetes: Helotiales & Leotiales	
Chlorociboria aeruginascens (Nyl.) P. Karsten	Mexico, West Indies & S. America
Lachnum virgineum (Batsch:Fr.) P. Karsten	Dominican Republic
Leotia viscosa Fr.	Dominican Republic
Basidiomycetes:	
Entolomataceae	
Entoloma murraii (Berk. & Curt.) Sacc.	Costa Rica, Dominican Republic & Puerto Rico
Leptonia incana (Fr.) Gill.	Jamaica
Hygrophoraceae	
Cuphophyllus pratensis (Pers.:Fr.) Bon	Puerto Rico
'Hygrophorus' microsporus Smith & Hesler	Puerto Rico
Hygrophorus speciosus Pk.	Dominican Republic
Tricholomataceae	
Baeospora myosura (Fr.) Singer	Dominican Republic
Mycena adonis (Bull.:Fr.) S.F. Gray	Dominican Republic & Puerto Rico
Mycena epipterygia (Scop.:Fr.) S.F. Gray	Dominican Republic

Table 2. North American and Caribbean sister species and taxa.

Species in eastern North America	Species in Caribbean	Location in Caribbean basin
Operculate discomycetes: Pezizales		
Morchella elata Fr.	*Morchella* sp., *M. elata* complex	Dominican Republic, Cuba
	Seven *Morchella* spp., mostly endemic	Costa Rica, Guatemala & Mexico
Basidiomycetes: Agaricales		
Entolomataceae		
Alboleptonia sericella (Fr.) Largent & Benedict	Four new *Alboleptonia* spp., Baroni & Lodge	Puerto Rico & St. John, USVI
Entoloma velutina Hesler	*Entoloma* sp. nov., aff. E. velutina	Puerto Rico
Entoloma quadratum (Berk. & Curt.) Horak	*Entoloma lactifluus* (Heim) Baroni comb. nov.	Costa Rica & Puerto Rico
Hygrophoraceae		
'Hygrophorus' fumosellus Smith & Hesler & *'Camarophyllus' recurvatus* (Pk.) Murr.	*Cuphophyllus* sp. nov. & *Hygrophorus bakeri* Dennis	Puerto Rico Trinidad
Hygrocybe miniata (Fr.:Fr.) P. Kumm	*Hygrocybe subcaespitosa* (Murr.) Lodge & Pegler	Dominica, Guadeloupe, Jamaica, Martinique & Puerto Rico

Table 2, continued. North American and Caribbean sister species and taxa.

Species in eastern North America	Species in Caribbean	Location in Caribbean basin
Hygrophoraceae: Section *Neohygrocybe*		
Hygrocybe, ovina (Bull.:Fr.) Kühner and *'Hygrophorus' subovinus* Hesler & Smith	Two undescribed taxa aff. *H. ovina* and *H. subovinus*	Puerto Rico
'Hygrophorus' caespitosus (Murr.) Murr.	*Hygrocybe melleofusca* Lodge & Pegler	Puerto Rico, Martinique & Trinidad
	Hygrocybe lepidopellis Pegler	Guadeloupe & Martinique
	Hygrocybe mellita Pegler	Guadeloupe
Tricholomataceae		
Mycena adonis (Bull.:Fr.) S.F. Gray	*Mycena* sp. nov. aff. *M. adonis* Ortiz & Betancourt	Puerto Rico
Mycena carolinensis Smith & Hesler	*Mycena gelatinomarginata* Lodge	Puerto Rico & Colombia
	& *Mycena* sp. nov., Sect. Carolinenses Maas G.	Puerto Rico & Trinidad
	& *Mycena xanthopoda* Dennis	Venezuela

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