Basidiomycetes of the Greater Antilles Project

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During the four-year project on the Basidiomycetes of the Greater Antilles, approximately 20% of the taxa were found to be undescribed species or varieties, and some may represent new genera, families or orders.

KEYWORDS: Agaricales, polypores, Aphyllophorales, West Indies

The investigation of the basidiomycetes of the Greater Antilles was a four-year project initiated in 1996 with a grant from the USA National Science Foundation's (NSF) Biotic Surveys and Inventories Programme to the State University of New York at Cortland (grant DEB-95-25902). Many other institutions and non-governmental organizations provided matching funds and support which greatly facilitated the research, including the USDA Forest Service, the Royal Botanic Gardens at Kew, Geobotanical Institute ETH, University of Oslo, University of Goteborg, and Duke University. The objective of the project was to survey and inventory all basidiomycetes (except rust fungi) on the Greater Antillean islands of the Caribbean. In addition to the authors, our primary research group included Drs. Julieta Carranza, Karen Nakasone, Karl-Henrik Larsson, Roy Halling, Egon Horak, Orson K. Miller, Jr., Peter Roberts, Leif Ryvarden, and Rytas Vilgalys.

The habitats sampled included coastal sand dune communities, low elevation seasonally dry and moist forests, middle elevation non-seasonal wet forests (200-550 m above sea level), and rain and cloud forests at around 700 to 2,000 m a.s.l. In addition, repeated visits were made to the Dominican Republic to collect basidiomycetes in the native pine savannahs, which range from 550 to 3,000 m a.s.l. Most of the collecting was concentrated in Puerto Rico, the Dominican Republic, Guana and Tortola islands in the British Virgin Islands, and St. John in the US Virgin Islands. There was one expedition to Jamaica.

Basidiomycetes, except for durable *Lentinus* species and polypore fungi, were not well known in the Greater Antilles before this project began. Many botanists have collected hard polypores throughout the history of the Caribbean since it was colonized five centuries ago. The basidiomes of polypores have retained their characteristics sufficiently for later identification. Relatively few of the agarics and other ephemeral fungi had previously been recorded for the region. For example, Stevenson (1975) had summarized all of the previous records of fungi from Puerto Rico and the nearby Virgin Islands, but only listed 55 species of ephemeral basidiomycetes. Jamaica and Cuba were still poorly known despite receiving somewhat more attention than Puerto Rico from R. W. G. Dennis, W. A. Murrill and 0. P. Swartz.

Numbers of new species and varieties

We have identified at least 75 new species and varieties so far, and this number will undoubtedly increase when all of the collections have been identified. In our research proposal, we predicted that the percentage of new species in each group would remain the same as the rate of discovery in the previous 5-15 years. Our expected percentages of new species for Agaricales (21%), polypores (6%), corticioid fungi (10%) and gasteromycetes (12%) are very close to our observed values so far (21%, 4%, 12%, and 12%, respectively; Lodge *et al.,* in press). Many of the new corticioid species are cryptic species that belong to a complex of similar taxa (Nakasone, 1999). All but one of the new polypore species are ephemeral, and were therefore easily missed by previous collectors (Ryvarden 2000a,b,c, 2001). For example, we recently found an ephemeral, orange, widely effused polypore on pine logs in the Dominican Republic that is a previously unknown species of *Antrodia* (Fig 1). The deep orange pores of this species are 1-4 mm wide and sinuous, differing from those of *A. radiculosa* (Peck) Gilbn. & Ryvarden which are subround and 3-4 per mm (Lodge & Ryvarden, unpublished manuscript).

Fig. 1. A new resupinate species of *Antrodia* on pine logs from the Central Mountain Range of the Dominican Republic. It has deep orange, sinuous pores that are larger and more irregular than those of *A. radiculosa*. (Photo by D. J. Lodge.)

Fig. 2. A previously undescribed species of *Callistodermatium* which was found in the mountains of Puerto Rico and the Dominican Republic. One of the diagnostic characteristics of this genus is that the pigments of the pileus surface turn violet to purple when alkaline solutions are applied, as seen in this illustration. (Photo by T. J. Baroni.)

Fig. 3. An unusual new species in Sect. *Firmae, Hygrocybe brunneosquamosa* Lodge & S. A. Cantrell, from the Luquillo Mountains of Puerto Rico. (Photo by D. J. Lodge.)

Fig. 4. This undescribed green species of *Hygrocybe* in Sect. *Coccineae* was collected in the Central Mountain Range of Puerto Rico. (Photo by T. J. Baroni.)

The highest diversity and percentages of undescribed species are among the agaric fungi, especially in the families Amanitaceae (Miller *et al.,* 2000; Miller & Lodge, in press), Tricholomataceae, Entolomataceae (Baroni & Lodge, 1998) and Hygrophoraceae (Cantrell & Lodge, 2000, 2001). One of the more intriguing finds is a new species of *Callistodermatium* Fig 2, a previously monotypic genus described from South America. This new species has been collected in the mountain ranges of Puerto Rico and the Dominican Republic. The genus is characterized by having pileus pigments that turn purple to violet in alkaline solutions, and is thought to be related to *Cyptotrama asprata* (Berk.) Redhead & Ginns.

We expected to find about 48 species of Hygrophoraceae in the Greater Antilles, based on the number of species that were previously known and a rate of recent discoveries of 23% (Lodge & Pegler, 1990). The number of Hygrophoraceae has already exceeded our expectations by 130% (63 species). Seventeen of the additions to the mycota were previously

undescribed taxa, exceeding our prediction of ten new species. Seven of the 17 new species are in Section *Firmae,* a tropical group characterized by two sizes of spores and basidia on the same basidiome. One of our new species in this group, *H. brunneosquamosa* Lodge & S. A. Cantrell (Fig 3), is very unusual in this section for having dull brown rather than bright colors and a squamulose pileus (Cantrell & Lodge, 2001). Most species in Section *Firmae* are brightly colored (yellow, orange, red, purple or green), and have a silky-fibrillose, subviscid or viscid surface (Cantrell & Lodge, 2001). Two additional new species of Hygrophoraceae with unusual colors are shown in Figs 4 and 5. Species with green basidiomes are rare, such as the undescribed species of *Hygrocybe* in Section *Coccineae* (Fig 4). A new species with a conic rose-wine colored pileus shown in Fig 5 (see front cover)

Fig. 5. This striking new rose-wine colored *Humidicutis* has been found several times in the Luquillo Mountains of Puerto Rico, and is the first reported species of *Humidicutis* in the Caribbean. (Photo by S. A. Cantrell.)

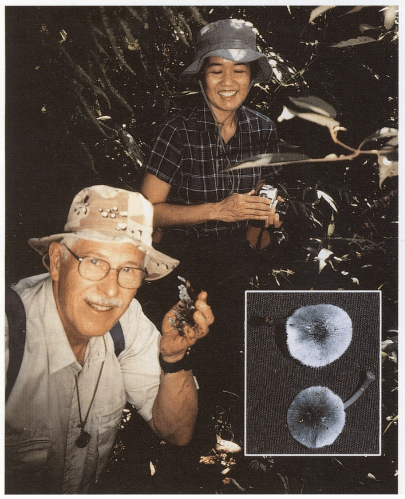

Fig. 6. Dr. Orson K. Miller, Jr. was clearly delighted with his discovery of this blue species, *Clitocybula azurae*, in the Blue Mountains of Jamaica, shown in the inset. Dr. Karen Nakasone is standing behind him. (Photo in the field by D. J. Lodge, inset by E. Horak.)

was initially mistaken for *H. calyptriformis* (Berk.) Fayod in subgenus *Hygrocybe,* but the broadly attached lamellae and short lamellar trama hyphae indicated it did not belong in subgenus *Hygrocybe.* There are several similar species described from South America (e.g., *H. rhodoleuca* Singer and *H. mutabilis* Singer), New Zealand *(H. rosella* Horak), and Africa *(H. vinosa* (Beeli) Heinem.). Horak (1990) transferred *Hygrocybe rosella* to *Humidicutis* based on the absence of clamp connections throughout the basidiome except for the presence of medallion-type connections at the bases of the basidia. These characteristics are shared by *H. mutabilis, H. vinosa,* and the undescribed species in Figure 5. This is the first report of *Humidicutis* from the Caribbean.

In terms of biogeographical patterns, most of the species in the Hygrophoraceae are restricted to the Greater Antilles or the Caribbean Basin (36% and 22%, respectively). Only one species has a pantropical distribution, *Hygrocybe hypohaemacta* (Corner) Pegler. Some of the Greater Antillean species of *Hygrocybe* in subgenus *Hygrocybe* are also found in the North Temperate zone, i.e. *H. acutoconica* (Clem.) Singer *[=H. persistens* (Britzelm.) Singer], while others are represented by new Caribbean varieties, such as *H. konradii* var. *antillana* Lodge & S. A. Cantrell and *H. calyptriformis* var. *domingensis* Lodge & S. A. Cantrell (Cantrell & Lodge, 2000).

Fig. 7. This previously undescribed species, *Amanita cruzii* O. K. Miller & Lodge, is associated with native pine in the mountains of the Dominican Republic. The orange, powdery material is the inner universal veil. (Photo by T. J. Baroni.)

Species with unknown affiliations

Some of the new species of agarics found in the Greater Antilles are easily placed in a genus, but they do not appear to have any close relatives. For example, Miller and Lodge (in press) described a striking new species, *Amanita cruzii* O.K. Miller & Lodge, that is associated with native pine in the Dominican Republic (Fig 7) for which we have been unable to locate any close relatives within Subgenus *Amanita.* This species is unusual in having a duplex universal veil in which the outer layer is fibrous and forms white pyramidal warts, while the inner veil is rusty in color and powdery in texture. The inner universal veil covers the lower side of the annulus, making it appear duplex (Fig 7). Another unusual find is a strikingly beautiful blue species, *Clitocybula azurae* Singer (Fig 6). In addition to the unusual color, this species differs from typical members of *Clitocybula* in having a dextrinoid stipe context, and veil remnants on the pileus margin and basal disc.

Some of the species we have found were previously known, but they were clearly assigned to the wrong genus. In these cases, DNA analyses have been very helpful in placing them. Legon (1999) showed illustrations of two of these i.e. *Collybia aurea* (Beeli) Pegler and *Marasmius rhyssophyllus* Mont. These two brilliant yellow species are closely related, and according to DNA analyses by Drs. Jean-Marc Moncalvo and Rytas Vilgalys (pers. comm.), they belong in the genus *Tricholomopsis,* rather than the genera in which they are currently placed. Another example is *Macrocybe praegrandis* (Berk.) Pegler & Lodge (Fig. 8), which was previously placed in the ectomycorrhizal genus, *Tricholoma* (Pegler *et al.,* 1998).

Fig. 8. Leanne Barley, project data manager, is holding a large basidiome of *Macrocybe praegrandis* from Puerto Rico. (Photo by S. A. Cantrell.)

The X-files

Some of the basidiomycetes we have found have defied or challenged classification. We refer to one of these species as the nail-head fungus because of its shape and hard texture (Fig 11). The outer surface becomes brown and powdery (from spores) as it ages. This undescribed species resembles members of the genus *Tephrocybe,* but it lacks siderophilous granulation in the basidia and therefore appears to belong in the Tribe *Tricholomatae* rather than *Lyophyllae. Two* species described by Corner (1994) from Malasia *(Tricholoma furcatifolium* and *T. umbricatum)* resemble the nail-head fungus. Although Corner (1994) placed his species in the genus *Tricholoma,* he indicated that they did not exactly fit into any genus yet described. We suspect our fungus may belong with one or both of Corner's species in the monotypic genus, *Arthrosporella* Singer.

We recently made two collections of an astipitate fungus in Puerto Rico that has a completely gelatinised context in the pileus and tube trama, and tubes up to a centimetre in length (Fig 9). Although the highly ornamented cheilocystidia suggest a possible relationship with *Fauolaschia,* the spores are inamyloid whereas *Favolaschia* spores are amyloid. With a combination of r-DNA sequencing by Dr. Maria P. Martin, advice and reference sequences from Drs. Jean-Marc Moncalvo and Rytas Vilgalys, and morphological and molecular expertise in the
Tricholomataceae of Drs. Greg Thorn and Scott Redhead, we have determined that the poroid fungus in Figure 9 represents and undescribed species of *Resupinatus.* A meruliod species, *R. merulioides* Redhead & Nagasawa, has previously been described from Japan.

Another unusual fungus (Fig 10) resembles *Dichopleuropus,* except that it lacks the dextrinoid dichophyses that help to characterize that genus. *Dichopleuropus* is thought to belong to the Lachnocladiaceae, and the undescribed species we found in Puerto Rico appears, according to DNA analyses by Karl-Henrik and Ellen Larsson (pers. comm.), to be related to species traditionally assigned to that family. The other group of *Dichopleuropus-like* fungi we found (Fig 12), however, does not belong to any of the major groups of basidiomycete fungi according to the Larsson's DNA analyses. Although they resemble species of *Thelephora* macroscopically, they have spores that are smooth, hyaline, and faintly amyloid rather than ornamented, warty, and inamyloid. We have found several species belonging to this group in the Caribbean, including Puerto Rico, the Dominican Republic, Tortola Island in the British Virgin Islands, and Venezuela. We believe they may represent a new family, and possibly a new order.

Fig. 9. This unknown species has a completely gelatinized trama in the pileus and tubes, and has tubes up to 1 cm in length (photograph by D. J. Lodge). Analysis of molecular sequences and micromorphology indicate this should be placed in the genus *Resupinatus*, which typically has lamellate basidiomes.

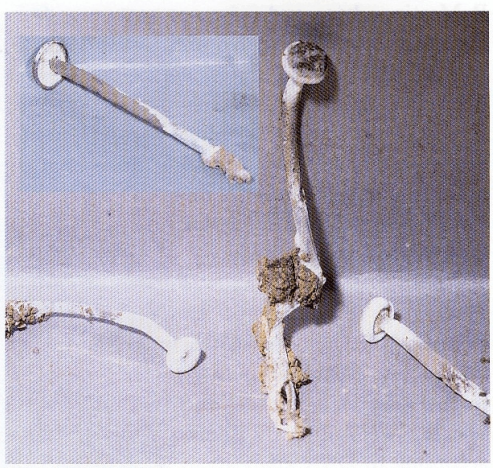

Fig. 11. This fungus, referred to as the 'nail-head fungus' for lack of another name, apparently belongs to the genus *Arthrosporella* in the Tricholomataceae. (Photograph by T. J. Baroni.)

Fig. 10. This undescribed *Dichopleuropus*-like fungus lacks dichophyses which help characterize the genus *Dichopleuropus*. (Photo by D. J. Lodge.)

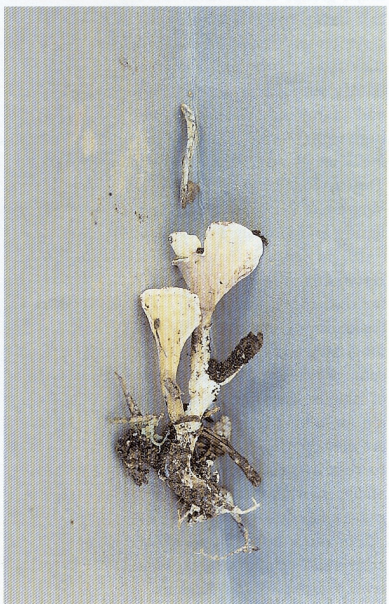

Fig. 12. This species represents a group which, although resembling the *Dichopleuropus*-like fungus in Fig. 10, does not appear to be closely related to any known basidiomycetes, according to DNA analyses. (Collected in the Dominican Republic; photo by D. J. Lodge.)

It is clear from the results of the Basidiomycetes of the Greater Antilles project so far that the Caribbean has a great diversity of basidiomycete fungi. Furthermore, many of these fungi appear to be restricted to the region, and some are only known from a single island or group of islands. Some of the recently discovered fungi are stretching the limits of known genera, a few are contributing to Vilgalys & Moncalvo's project to restructure the Agaricales using molecular analyses, while others apparently represent new genera, families, and possibly a new order.

For more information about the project and additional color images, visit our web site at www.cortland.edu/nsf/ga/html.

Acknowledgments

In addition to the individuals acknowledged above, we thank our cooperators in the Dominican Republic: A. Ferrer of the Fundacion Moscoso Puello; C. Cassanova of Fundacion Plan Sierra; Fundacion Progressio; M. Mejia and D. Rodriguez of the Jardin Botdnico; Dr. Raphael M. Moscoso, and the National Park Service. We thank T. Commock and the Institute of Jamaica for assistance in Jamaica; and the Conservation Agency and the Falconwood Foundation for support while working on Guana and Tortola Islands, BVI. We are grateful to P. Catterfeld of the Research Foundation of SUNY Cortland and L.A. Barley for taking care of a myriad of details in support of our research.

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