

A Mycological Florilegium: A Selection of Articles Published in 2007 and 2008

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MYCOLOGY IS is a booming and blooming field of science, and mycologists are prolific writers. The result is that many fungal papers are published every year, and they range widely; recently there are biochemical studies of how a gene works in the development of a small dung denizen, inventories of the mycoflora of a hemlock forest in Ontario, the description of new species and a comprehensive phylogenetic study of the entire kingdom Fungi.

An eclectic and highly personal choice of topics is presented here to bring you some of the most recent and noteworthy literature about your favorite organisms. The selection covers all types of research, comes from all over the globe, and in several cases involves professional and amateur mycologists working together as a team.

What stands out for me, after compiling this overview, is that with molecular data adding a whole new dimension to what we knew about mushroom morphology and classification, the world of mushrooms has become more fascinating, more complex and more challenging than we could have dreamt. The number of questions to be answered just keeps growing.

Also striking is how many of these studies rely on field observations, and well-described collections, showing that field mycology is still the basis for all other types of research. Amateur mycologists can really help.

If this smorgasbord makes you hungry for more mycological information, but you do not live next door to a good mycological library, be aware that most journals post abstracts of their articles online— just use the name of the journal in a search engine to start exploring. Some journals now allow free online access to the whole article, either immediately or after a modest delay; this is indicated below when it applies to one of the articles on my list.

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Lots to Do about Fly Agarics

Geml, J., R. E. Tulloss, G. A. Laursen, N. A. Sazanova, and D. L. Taylor, 2008. Evidence for strong inter- and intracontinental phylogeographic structure in *Amanita muscaria*, a wind-dispersed ectomycorrhizal basidiomycete. *Molecular Phylogenetics and Evolution* 48: 694–701.

Geml, J., G. A. Laursen, K. O'Neill, H. C. Nusbaum, and D.L. Taylor, 2006. Beringian origins and cryptic speciation events in the fly agaric (*Amanita muscaria*). *Molecular Ecology* 15: 225–39.

Oda, T., C. Tanaka, and M. Tsuda, 2004. Molecular phylogeny and biogeography of the widely distributed *Amanita* species, *A. muscaria* and *A. pantherina*. *Mycological Research* 108: 885–96.

The fly agaric has recently been the subject of intensive study, starting with the Japanese researchers Oda, Tanaka, and Tsuda who concluded that there are two distinct taxa under the name *Amanita muscaria*, one in America, and one in Eurasia, as well as the high-latitude and high-altitude species *Amanita regalis*. The Alaska based group of Lee Taylor and Gary Laursen did a follow-up study and added Laursen's Alaska collections to those of the Japanese. Lo and behold! All three taxa occur in Alaska; could it be that this is the original birth place for all fly agarics? But this was not the last word; a recently published third study includes collections from far eastern Russia, just across the Bering Strait, and also from many other parts of the U.S.A. With more samples from more places, the picture becomes clearer and more confused at the same time. One group is found to be widespread throughout the northern hemisphere from Europe eastwards to Alaska (though sampling from northern Canada and Greenland is spotty). Another big group is represented in various parts of North America. Then, there are several really different (different in this case means different in

genes), smaller groups in the southern states, in the Pacific Northwest, and especially on the Channel Islands off the coast of southern California. Santa Cruz Island, the biggest of these islands, is rugged, hardly inhabited, and harbors at least four different types, only one of which falls within the big North American group. Such variation on such a small scale is remarkable, and makes one wonder how speciation takes place, and whether spore dispersal is very short-range. Would more sampling unearth more variation, especially in northern Canada, in Mexico and its western islands, Central America, and in the southern states?

The genetic variation and the biogeographical structure within “*Amanita muscaria*” have been presented but not yet the morphological descriptions and conclusions.

Inevitably, the studies raise questions about other well known and easily recognized species. Is there any such thing as a cosmopolitan species? And do we have more than one *Boletus edulis* and *Cantharellus cibarius* in North America?

If you are interested in further aspects of the fly agaric and the roles it has played in cultures and folk tales, check out Dugan’s article in *North American Fungi* 3 (see below).

Psathyrella and the Demise of a Genus

Padamsee, M., P. B. Matheny, B. T. M. Dentinger, and D. J. McLaughlin, 2008. The mushroom family *Psathyrellaceae*: Evidence for large-scale polyphyly of the genus *Psathyrella*. *Molecular Phylogenetics and Evolution* 46: 415–29.

Larsson, E., and L. Örstadius, 2008. Fourteen coprophilous species of *Psathyrella* identified in the Nordic countries using morphology and nuclear rDNA sequence data. *Mycological Research* 112: 1165–85.

Vašutová, M., V. Antonín, and A. Urban, 2008. Phylogenetic studies in *Psathyrella* focusing on sections *Pennatae* and *Spadiceae*—new evidence for the paraphyly of the genus. *Mycological Research* 112: 1153–64.

Much less visually appealing than the fly-agarics are members of the genus *Psathyrella*. Many grey, brown, purple, cream species with pale to dark brown spores cry out to be classified. The classic monograph by Alexander H. Smith (available

through the New York Botanical Garden) describes many species, but does not place them in a phylogenetic context, nor makes it easy to identify them.

Some progress has recently been made by several research groups tackling the genus in a wide context, examining only a few sections, or focusing on the dung-dwellers.

The first study tackles the whole family *Psathyrellaceae*, including the ink caps *Coprinellus*, *Parasola*, and *Coprinopsis*. By the time these three genera were recognized as separate from *Coprinus* in the strict sense (with shaggy mane, *C. comatus*, and *C. sterquilinus*, its sole surviving members, expelled to the *Agaricaceae*), it was clear that their relationships with *Psathyrella* had to be re-examined. It now appears, that the family *Psathyrellaceae* as a whole is monophyletic (meaning that all its members share a most recent common ancestor and all descendents of this ancestor are members of the family), but that the genus concepts have to be reconsidered. Thirteen different groups stand out; some consist only of species from one morphologically defined genus, but others are a mixed bag. For instance, *Psathyrella conopilus* forms a group together with *Parasola* species (ink caps with pleated caps, such as *P. plicatilis*) while some *Psathyrella* species, like *Ps. marcescibilis*, fall smack in the middle of *Coprinopsis* (the genus for *C. atramentarius*, *C. lagopus*, *C. radiatus*, *C. friesii*, *C. naroticus* and many others). Though this paper clearly indicates that the old genus *Psathyrella* cannot be maintained in its present form, new genera or groupings are not proposed.

The Swedish paper is a rare example of a combined approach, with descriptions of all the fourteen species encountered, including two new ones, and placement of all species in a phylogenetic context using molecular data. The ecology is also treated, and a key to the European dung-inhabiting species is given.

The third paper looks in detail at two sections, section *Spadiceae* in which the species have relatively small spores, and thick-walled cystidia, and section *Pennatae*, also with small spores, but with flask-shaped to wedge-shaped, often thick-walled pleurocystidia. A nice thing about this paper is that the morphological characters are indicated in color on the phylogenetic tree.

The general conclusions are the same as in the first paper: *Psathyrella* is a mess and needs to be

sensibly split up, with some reshuffling of species. We are waiting for a courageous person to do the carving.

Polypores in the Age of Molecular Phylogenetics

Lindner, D. L., and M. T. Banik, 2008. Molecular phylogeny of *Laetiporus* and other brown rot polypore genera in North America. *Mycologia* 100: 417–30.

Sotone, K., H. Tsutome, Y. Ota, C. To-anun, B. Salleh, and M. Kakishima, 2008. Phylogenetic relationships of *Polyporus* and morphologically allied genera. *Mycologia* 100: 603–15.

We are slowly getting used to the notion that the genus *Laetiporus*, the sulphur shelf, is represented by more than one species in North America; it is not all *L. sulphureus*. We have learned that the deep orange species growing on conifers in the West is not the same as the white-pored pinkish species on hardwoods in the Midwest, and indeed that there are at least five species in the continental USA. Mating studies, molecular data, and morphology showed this quite convincingly. Now, the genus *Laetiporus* is put in a phylogenetic context and compared with genera like *Wolfiporia*, *Phaeolus*, and *Antrodia*. The rare species *L. persicinus*, known from the Gulf states, is separate from all the other *Laetiporus* species. *Wolfiporia* is split up; *W. dilatolypha* becomes a sister to *Laetiporus*, while the well-known and sought after *W. cocos* becomes a sister to the dyer's polypore *Phaeolus schweinitzii*. Several new taxa are discovered, e.g. one sulphur shelf species growing on Koa trees in Hawaii, but none is officially named and described, nor are the non-*Laetiporus* species placed in new or other existing genera.

A similar situation appears to be true for *Polyporus* which splits up into five rather non-divergent groups. One part of the genus (*P. brumalis* and *P. arcularius*) separates from all the rest and should be considered a separate genus that is close to *Lentinus*. Some species from other genera are found in the middle of the old *Polyporus*. The authors consider making separate genera for all the new groups, but this is going beyond the data and is not a road I am ready to take. A mixed approach, combining morphology with molecular, and mating data, is necessary to clear up the confusion in this genus.

Agaricus—Names and Occurrences

Geml, J., G. A. Laursen, and D. L. Taylor, 2008. Molecular diversity assessment of arctic and boreal *Agaricus* taxa. *Mycologia* 100: 577–89.

Kerrigan, R. W., (“2007”) 2008. Lectotypification of *Agaricus brunnescens*. *Mycologia* 99: 906–15.

It is very easy to recognize a member of the genus *Agaricus* as such, but species recognition is hard. The species are not very rich in morphological characters and, on top of that, their appearance changes significantly during maturation. Microscopically, too, only a few characters, in particular spore size, are informative. This paucity of morphological characters is paralleled at the molecular level in the low differentiation of the ITS region (Internal Transcribed Spacer, a part of the DNA that does not code for the making of proteins). In many species of mushrooms, ITS is a good species recognizer, and can be used as a universal ‘bar code’, but closely related *Agaricus* species often differ only in a few base pairs in the ITS region. Perhaps other parts of the DNA might serve better for species recognition, but so far nobody has looked into it seriously. The present study focuses on the Alaskan species, which represent only a few sections. The *Arvenses* and the *Campestres*, both notoriously difficult groups, are well represented. *Agaricus bisporus* is found too but the reddening species, and the toxic phenol-smelling taxa around *Agaricus xanthodermus*, were not found despite extensive sampling in time and space. The authors refrain from naming their species, but suggest that their area contains several which are undescribed.

One name in *Agaricus* that has received a lot of scrutiny is *Agaricus bisporus* (J. E. Lange) Imbach, since it is used for the most commonly cultivated mushroom species, the button mushroom. But should we be calling it *Agaricus brunnescens* Peck? Kerrigan becomes a historical sleuth to tackle this lingering problem; he looks at Peck's letter exchanges in the late 19th century and examines Peck's collections which are still available. Just like any modern-day detective, he uses molecular forensic methods to determine what the original *Agaricus brunnescens* collection really is. It turns out that Peck packed two different species under one label. That does happen. One part of the collection (the 22 different bits and pieces were carefully split

between the two species) is chosen to represent what Peck meant by the name *A. brunnescens*, the rest is *Agaricus subrufescens*. The *Agaricus brunnescens* part is the same as what we have been calling *A. bisporus*. Because *A. brunnescens* is the earlier name, a formal proposal will be put forward to keep the well-known name *A. bisporus* instead of renaming the button *A. brunnescens*.

Paxillus—More Species Than We Thought

Hedh, J., P. Samson, S. Erland, and A. Tunlid, 2008. Multiple gene genealogies and species recognition in the ectomycorrhizal fungus *Paxillus involutus*. *Mycological Research* 112: 965–75.

Paxillus involutus is often one of the first mushrooms one learns, with its slightly ribbed cap margin, and gills that peel off the underside of the cap as easily as the tubes come off a bolete. It is distinctive and ubiquitous. European research had established the presence of more than one species, that were not mating with each other, but not all had been named. Now, data from five different gene regions in 50 collections show that four different European taxa can be distinguished: *P. involutus* sensu stricto, *P. validus*, *P. obscurusporus*, and one unnamed species. The alder associated *Paxillus rubicundulus* is totally separate from the *P. involutus* group. It still belongs in *Paxillus* though its closest relative, *Paragyrodon sphaerosporus*, has pores instead of gills. The North American species *Paxillus vernalis*, represented with one sample in this study, is found to be close to *P. validus* and *P. obscurusporus*. That is also my own conclusion, based on work on the Californian species. Here in the west of the USA we find *P. vernalis* in natural habitats associating with oaks, and aspens, the unnamed species with introduced birch, and a third, chunky, species, whose identity is not yet known, growing with introduced Cedar (*Cedrus deodara*), and with our native coastal pines. But the real *P. involutus* has been found in the mid-west and the east.

For this group at least, the single universally used mushroom bar-coding ITS region is as good at distinguishing species as five gene regions combined.

Paxillus involutus grows easily and fast, making it the perfect lab rat for ectomycorrhizal research, and causing it to be one of the few mushrooms

nominated for whole genome sequencing. Other well-known ectomycorrhizal species, such as those in *Russula* and *Tricholoma*, are very hard to grow in culture, and impossible to experiment with.

To fill out the picture, the non-mycorrhizal species of *Paxillus* were transferred earlier to *Tapinella*—you can now find *P. pannuoides* and the dye mushroom *P. atrotomentosus* in that genus.

Spore Secrets

Bruns, T. D., K. G. Peay, P. J. Boynton, L. C. Grubisha, N. A. Hynson, N. H. Nguyen, and N.P. Rosenstock, 2009. Inoculum potential of *Rhizogogon* spores increases with time over the first 4 yr of a 99-yr spore burial experiment. *New Phytologist* 181: 463–70.

Nara, K., 2009. Spores of ectomycorrhizal fungi: ecological strategies for germination and dormancy. *New Phytologist* 181: 245–48.

Ishida, T. A., K. Nara, M. Tanaka, A. Kinoshita, and T. Hogetsu, 2008. Germination and infectivity of ectomycorrhizal fungal spores in relation to their ecological traits during primary succession. *New Phytologist* 180: 491–900.

Kausserud H., J. E. Colman, and L. Ryvardeen, 2008. Relationship between basidiospore size, shape and life history characteristics: A comparison of polypores. *Fungal Ecology* 1: 19–23.

One of the big questions in mushroom ecology is what role the spores play in dispersal of individuals and in distribution of species. Mushrooms are spore factories, pumping out millions of spores, but how many actually form a new individual, how far away from the “mother” mushroom do they get and how long do they stay viable? These are all open questions.

After a disastrous wildfire on the California coast in 1995, Bishop pine seedlings sprouted in many of the burned areas. They could do so because of the presence in the soil of *Rhizogogon* (false truffle) spores that survived the heat of the fire. During the succession and the aging of the forest, the composition of the mycoflora changes, different *Rhizogogon* species, and many other species occupy and compete for the tree roots. The early colonizers are the species whose spores stay viable in the soil for extended periods. To assess

how long, very long-term studies are under way and the first results, obtained four years after the experiment began, are now reported. It is very refreshing to see a research plan with a focus that extends so far beyond the here and now that it will occupy several generations of researchers.

A grassy area where *Rhizopogons* do not occur and pine trees are not found, was selected to bury pots containing soil mixed with *Rhizopogon* spores. The pots cannot be penetrated by tree roots and one by one, over a period of 99 years, they will be dug up, and the soil they contain used to grow pine trees. After the treelets have been in the soil for several months, they will be dug up and the viability of the spores will be measured by the amount of mycorrhization of their roots. After the first four years in the soil, spores of all four *Rhizopogon* species tested in the experiment did well. In fact, they actually did better than when spores were taken from fresh fruitbodies before the burial experiment. Compare that to tropical *Marasmius* species, whose spores drop and lose their ability to germinate within 24 hours.

A different approach was taken by a Japanese group studying the shrub willows and their fungi on the dry and sparsely vegetated slopes of Mount Fuji. The first species to arrive on the roots of newly settled plants are *Inocybe lacera*, *Laccaria laccata* and *L. amethystina*, followed by *L. murina* and *Scleroderma bovista*. In the last stages of development there is a more varied mycoflora, with some *Russula*, *Hebeloma*, and *Cortinarius* species. The researchers made spore prints of all the mushrooms, and sandwiched roots of willow seedlings between bits of the spore prints. After a while they examined how the spores were doing, and whether the mushroom mycelium could establish mycorrhiza with the plants. Spores of ectomycorrhizal fungi need signals from the plant roots in order to germinate at all. The first colonists did reasonably well, in so far as both germination and colonization took place, but the later-stage fungi were more reluctant and only one *Hebeloma* species was eager to germinate—it was one of the late succession species. The spore prints were retained, and the experiment was repeated after one year, but germination then was very low and in most cases just plain absent. There was enormous variation in the number of germinating spores per species.

A different kind of study looked at the size and shape of spores of 303 species of European polypores, trying to find a correlation between size and shape of the spores and the characteristics of the fruitbodies—their size and life style (saprotrophic or parasitic), the kind of rot they produce and whether they grow on the wood of conifers or hardwoods. The conclusions were that the bigger the fruitbodies, the bigger the spores, and the bigger the spores the more globose they are. Parasites tend to have bigger spores and there is a tendency for white rot species and parasites to have more rounded spores than brown rotters and saprotrophs. Now we only need to find out what, if anything, these trends mean in nature.

Observations and Predictions about the When and Where

Gange, A. C., E. G. Gange, T. H. Sparks, and L. Boddy, 2007. Rapid and recent changes in fungal fruiting patterns. *Science* 316: 71.

Kausserud, H., L. C. Stige, J. O. Vik, R. H. Økland, K. Høiland, and N. C. Stenseth, 2008. Mushroom fruiting and climate change. *Proceedings of the National Academy of Sciences of the USA* 105: 3811–14.

Krebs, C. J., P. Carrier, S. Boutin, R. Boonstra, and E. Hofer, 2008. Mushroom crops in relation to weather in the southwestern Yukon. *Botany* 86: 1497–1502.

Wollan, A. K., V. Bakkestuen, H. Kausserud, G. Gulden, and R. Halvorsen, 2008. Modeling and predicting fungal distribution patterns using herbarium data. *Journal of Biogeography* 35: 2298–2310.

The ongoing changes in climate, especially in temperature, have wide ranging repercussions in the natural world. Plants are flowering earlier in spring, leaves are turning yellow and red later than before, and now two studies show that mushroom fruiting patterns have changed dramatically in the last 50–60 years. The first study analyzed the finds recorded by a group of mushroom hunters during the period 1950–2005, in the course of walks in and around the English city of Salisbury. The second study examined 34,500 herbarium records for collections made from 1940 onwards in Norway.

The English mushroom season has expanded in both directions, with more early and more later fruiting, whereas in Norway, the entire season has shifted since 1980, with species fruiting 13 days later than in the 1950s. As Norway is a country with huge variation in climate and vegetation, there are considerable regional differences.

A second Norwegian study again used herbarium collections to model and predict fungal distribution. Temperature was found to be a strong determinant for the presence of a certain species fruiting at a certain place. This means, of course, that changes in temperature will change the composition of the mushroom flora, which will first show in the fruiting patterns.

Studies such as these are possible in Europe since data has been painstakingly and presciently collected over long periods. Both Norwegian studies show the special relevance of herbarium data in documenting change, and in predicting distribution patterns—setting a good example for other places to follow!

The Canadian study examined above ground mushroom production in the Yukon over a period of 15 years and tried to find a correlation with weather patterns during the summer months. It turned out that there was a high correlation between the amount of rainfall in June of the present year, but even more so between the rainfall in May the preceding year, and the total weight of the mushrooms. Whether there are any correlates with the depth and length of the snow cover is still to be explored.

Unseen, but New and Exciting

Porter, T. M., C. W. Schadt, L. Rizvi, A. P. Martin, S. K. Schmidt, L. Scott-Denton, R. Vilgalys, and J. M. Moncalvo, 2008. Widespread occurrence and phylogenetic placement of a soil clone group adds a prominent new branch to the fungal tree of life. *Molecular Phylogenetics and Evolution* 46: 635–44.

Schadt, C. W., A. P. Martin, D. A. Lipson, and S. K. Schmidt, 2003. Seasonal dynamics of previously unknown fungal lineages in tundra soils. *Science* 301: 1359–61.

Nobody has yet seen this newly discovered group of soil fungi, which are known only by their DNA

fingerprints. Since the original discovery in 2003 from the Colorado Rocky Mountains, and thanks to Terry Porter, who pieced together the data, their occurrence has been established in other parts of North America, a tropical forest of Costa Rica, dry forests of Australia and various places in Europe. The new fungi are currently known under a provisional and very prosaic name—Soil Clone Group I—and they form a new branch of the phylum Ascomycetes, in between the *Taphrinomycotina* (fission yeasts, leaf curl disease) and the budding yeasts of the *Saccharomycotina* (bakers' yeast), with *Pezizomycotina* (all other ascomycetes including morels, truffles, and various moulds and mildews) constituting a fourth branch.

Inocybe—What Are the Unknowns of Which We Have Only a Genetic Footprint?

Ryberg, M., R. H. Nilsson, E. Kristiansson, M. Töpel, S. Jacobsson, and E. Larsson, 2008. Mining metadata from unidentified ITS sequences in Genbank: a case study in *Inocybe* (*Basidiomycota*). *BioMedCentral Evolutionary Biology* 8: 50 (14 pp) (open access at www.biomedcentral.com).

It is now routine to inventory mycorrhizal fungal communities below-ground, by comparing sequence data derived from mycorrhizal root tips or, increasingly, soil samples, with the corresponding data from fruitbodies. But Genbank, the public database where these sequences are deposited, has a dearth of sequences derived from correctly identified fruitbodies. Consequently, many new sequences were entered under imprecise names such as *Agaricales* sp. and *Inocybe* sp. Careful comparison of these unmatched sequences with data based on identified fruitbodies of the genus *Inocybe* took place. Now a species name can be attached to about one third of the unknown sequences, and the name of a species group to many of the others. *Inocybe* species have turned up in studies made all over the globe, including the tropics and boreal and arctic regions. Several species are widespread, and are now known from the entire temperate zone. This paper is the first to use this approach to identify the unnamed sequences in Genbank and its success shows clearly the potential for naming and placing the sequences in a genus context. The constraint is that this is only possible when sufficient sequences have already been derived from

named fruitbodies. Building up such a reference database in Genbank has enormous value for environmental sampling and providing these names is a project to which all mycologists and mushroom lovers can contribute.

Fossils

Boyce, C. K., C. L. Hotton, M. L. Fogel, G. D. Cody, R. M. Hazen, A. H. Knoll, and F. M. Hueber, 2007. Devonian landscape heterogeneity recorded by a giant fungus. *Geology* 35: 399–402.

Schmidt, A. R., H. Dörfelt, and V. Perrichot, 2007. Carnivorous fungi from Cretaceous amber. *Science* 318: 1743.

Schmidt, A. R., H. Dörfelt, and V. Perrichot, 2008. *Palaeoanellus dimorphus* gen. et sp. nov. (Deuteromycotina): a Cretaceous predatory fungus. *American Journal of Botany* 95: 1328–1334.

Today's fungi are very intriguing and in many cases we have no clue how they live. Structures preserved from the past pose an even greater challenge for interpretation and understanding. One such enigma is *Prototaxites*, which lived 400 million years ago; their fossils are known from many different places and are preserved as pillars up to 9 m high. This structure has been called a tree, a red alga, a lichen or just a fungus. Most recently, researchers who cross-sectioned the structure have compared the thick-walled cells to those of polypore hyphae. Carbon from *Prototaxites* fossils was compared with carbon from plant fossils in the same environment and of the same age. Differences were found that suggest a different lifestyle and appear to corroborate that, indeed, *Prototaxites* was a fungus. However, the organism lived at a time when there were only some small plants, and it would have towered over them. The big question is what food source did it have? Was the bacterial crust rich enough in minerals and proteins to sustain this huge fungus, or was it just very long-lived? Could the small plants furnish all the cellulose and lignin the fungus needed? Unfortunately, the evidence from carbon is not entirely convincing, as there is a big variation over time, suggesting different lifestyles at different times. Neither is it clear that carbon content and isotope ratios remained unchanged

over 400 million years. Speculations abound but we will probably never know for sure what this fossil really is. Artistic renditions of the organism and its environment have been featured widely, e.g. on the back of the April 2008 issue of *Field Mycology*.

Just as speculative are the claims that fungal remnants in amber from the Cretaceous period, some 100 million years ago, represent nematode-trapping fungi. Some hyphal remnants, some spores and a lonely nematode were the grounds for this claim, on which a new genus and species were described. The authors speculate that the species was present in a filamentous stage and in a yeast-like stage. Evidence, however, is scant and we will probably never know whether these were indeed nematode trappers.

Megacollybia

Hughes, K. W., R. H. Petersen, J. L. Mata, N. H. Psurtseva, A. E. Kovalenko, O. V. Morozova, E. B. Lickey, J. Cifuentes Blanco, D. P. Lewis, E. Nagasawa, R. E. Halling, S. Takahashi, M. C. Aime, T. Bau, and T. Henkel, 2007. *Megacollybia* (Agaricales). *Report of the Tottori Mycological Institute* 45: 1–57.

A combined molecular-phylogenetic and morphological study covering many parts of the Northern Hemisphere provides an in-depth study of *Megacollybia*. This genus was always considered to contain one species, *M. platyphylla*. The differences in morphology, though mostly qualitative, in sequence data and in distribution seem to be sufficient to distinguish six species besides *M. platyphylla*, with the latter not occurring in America. The genus splits up nicely into a Eurasian group and a New World group with the new species *M. rodmani*, *M. subfurfuracea*, *M. texensis*, and the transferred *Tricholomopsis fallax*, now *Megacollybia fallax*, in North America. The article was published in a less accessible journal, but fortunately the pdf is available on the first author's web page.

Laccaria Bicolor Genome

Martin, F. + many other authors, 2008. The genome of *Laccaria bicolor* provides insight into ectomycorrhizal symbiosis. *Nature* 452: 88–92.

The sequencing of the genome—that is, every gene—of *Laccaria bicolor* is truly a milestone in

mushroom knowledge. This is the first ectomycorrhizal species to be completely sequenced, and, also the first mushroom species of any kind for which complete data are publicly available (the first *fungus* species, however, was the bakers' yeast *Saccharomyces cerevisiae*). A finding that surprised the authors is that *Laccaria bicolor* lacks the necessary enzymes to break down lignin and cellulose. Those enzymes are necessary for fungi which live saprotrophically from wood and litter, but not for a species that receives its carbohydrates and sugars from a mycorrhizal partner. *Laccaria* has around 20,000 genes that encode for proteins—compare that to 20,000 to 25,000 for humans! There are also many pieces of DNA that are not incorporated in genes, but the function of these is not known—they are often, but perhaps wrongly, called junk DNA. New techniques are slashing the cost and more and more species are in line to have their genomes sequenced. A wealth of new data will soon illuminate the origin of different lifestyles and habitat preferences.

Edibles Named

Arora, D., 2008. California porcini: three new taxa, observations on their harvest and the tragedy of no commons. *Economic Botany* 62: 356–75.

Arora, D., and S. M. Dunham, 2008. A new, commercially valuable chanterelle species, *Cantharellus californicus* sp. nov., associated with Live Oak in California, USA. *Economic Botany* 62: 376–91.

Kuo, M., 2008. *Morchella tomentosa*, a new species from western North America, and notes on *M. rufobrunnea*. *Mycotaxon* 105: 441–46.

Three big conspicuous California mushrooms are now named: *Boletus rex-veris*, the reddish capped Sierra Nevada spring King Bolete; *Boletus regineus*, the Queen bolete, erroneously called *B. aereus*, a European species; and *Cantharellus californicus*, the big muddy chanterelle, growing under coastal live oaks. A big variant of the King Bolete with a brown to cinnamon pore surface when mature is given the name *Boletus edulis* var. *grandedulis*. It is amazing that some of our big conspicuous edible mushroom species went unnamed or under cover of European names for so long!

The issue of *Economic Botany* in which these new species are described is totally devoted to ethnomycology. The other articles treat the usage of mushrooms by indigenous people in Burkina Faso, Mexico, China, Japan, and many other countries, with attention to economic changes that are due to mushrooms.

In the western mountains, morels are found in greatest abundance after forest fires. There are definitely several species but they still go nameless; for one of them, that situation has changed, and Kuo (known from his Mushroomexpert website) named it officially *Morchella tomentosa*, because of the dark tomentose stem. Dark pigmented hairs on the stipe make up that tomentum.

Real Birds' Nest Fungi

Freymann, B. P., 2008. Physical properties of fungal rhizomorphs of marasmioid basidiomycetes used as nesting material by birds. *Ibis* 150: 395–99.

Prangle, S., and D. H. Nelson, 2006. Use of fungal rhizomorphs as nesting material by *Glaucomys volans* (Southern flying squirrels). *Southeastern Naturalist* 5: 355–60.

The Streak-backed Oriole, a bird occurring from southern Arizona to northwest Costa Rica builds hanging nests over two feet long. The outer, hanging parts of these nests are made entirely from long rhizomorphs of *Marasmius* species, whereas the lining of this hammock or basket consists only of short grassy fibers. The birds go to great lengths to gather the material for their nests, as there is a lot of grass or other vegetation around, but finding *Marasmius* rhizomorphs requires much more time and effort. What are the advantages of such a structure? First of all, the rhizomorphs take up much less water than the grass fibres and the fungal fibres carry much higher weights before snapping than the grass fibres—two huge advantages.

You don't need to go to the tropics to see fungi in nests—lichens line humming birds' nests, and several birds (Bicknell's thrush, Yellow-rumped warbler, and Blackpoll warbler to name a few) in the boreal and subalpine zones of the northeastern USA use *Marasmius androsacens* rhizomorphs, another horsehair fungus, as nest material.

Flying squirrels use mosses, lichens, feathers,

Spanish moss, and a huge variety of all kinds of (man-made) material for their nests, depending on what is available. But on top of all that, Southern flying squirrels also use *Masrasmius brevipes* rhizomorphs as nesting material.

“North American Fungi” (formerly Pacific Northwest Fungi): www.pnwfungi.org

Glawe, D. A., and J. F. Ammirati, editors. 2008. A *Festschrift* in honor of Professor Jack D. Rogers. *North American Fungi* 3(7): 1–267. A selection of the articles:

Dugan, F. M. 2008. Fungi, folkways and fairy tales: mushrooms & mildews in stories, remedies & rituals, from Oberon to the Internet. *North American Fungi* 3(7): 23–72.

Norvell, L. L., J. F. Ammirati, and S. A. Redhead. 2008. Woody desert puffballs of the Pacific Northwest. 1: *Chlamydopus meyenianus*. *North American Fungi* 3(7): 127–38.

Pfister, D. H. 2008. Early illustrations of *Xylaria* species. *North American Fungi* 3(7): 161–166.

Hemmes, D. E., and D. E. Desjardin. 2008. Annotated List of Boletes and *Amanita* in the Hawaiian Islands. *North American Fungi* 3(7): 167–76.

Burdsall, H. H., Jr., and T. J. Volk. 2008. *Armillaria solidipes*, an older name for the fungus called *Armillaria ostoyae*. *North American Fungi* 3(7): 261–67.

The completely online, Washington-based journal *North American Fungi* publishes articles on fungi (including lichens) from North America. This journal is freely accessible and anyone can download articles without cost. A special issue on the occasion of Jack D. Rogers' 45 years of service at Washington State University brings together contributions on *Xylaria* and its allies, Jack's pet fungi, and many other species and topics. A selection is listed above.

Field Mycology 2008

Field Mycology is a journal of the British Mycological Society that focuses on field studies, inventories, keys to species, and conservation issues, with a strong emphasis on the United Kingdom. The July

2008 issue carries a long article treating the British *Xerocomus* species (the velvety *Boletus* species) with many photos of the details used in the accompanying synoptic key, including the cap and stipe surfaces, and the spore shape; descriptions of the species and photos of the less common taxa are also provided. To wander off on a side-track, *Xerocomus* is not a monophyletic group, and has recently been split up into smaller genera, based on morphology; new are *Xerocomellus*, and *Hemileccinum*, whereas *Pseudoboletus* (for the parasite on *Scleroderma*) had been described earlier.

A series of articles on the genus *Hypoxylon* appeared throughout the year.

The Farlow Herbarium librarian Lisa DeCesare, together with George Hasapidis, wrote an article on the Danish 18th-century mycologist Theodor Holmskjold, whose most influential work is called *Beata ruris otia fungis Danicis impensa* (Happy rural interludes in the country studying Danish Fungi). His illustrations are beautiful, and depict the mushrooms in their natural habitats. He was the first to realize that *Cordyceps militaris* grows on dead insects buried in the soil; previously, insects were supposed to transform miraculously into fungi.

Mushrooms from Ecuador

Læssøe, T., and J. H. Petersen, 2008. Svampelivet på ækvator. Svampe 58: 1–52. [Equatorial fungi—mycological biodiversity in Ecuador] www.mycokokey.com/Ecuador.html

The last item I want to draw attention to for armchair myco-travellers is the autumn 2008 issue of the Danish journal Svampe. The main part of the issue is taken up with a lusciously illustrated article on the fungi of Ecuador. Wow! What beauties and weirdos are there! Waxcaps without gills, stink-horns with the gooey part halfway up the stalk under a lacy top, a pink telescope-shaped *Favolaschia* species, small black chanterelles with spines on their cap, and so on and so forth. Pictures of the jungle with man-high buttress roots, and some scary inhabitants complement the article. Photos of these and many other Ecuadorian fungi (over 1200 in all) are available online at the Mycokey website, to seduce the staunchest fungophobe.

