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What Old Wives (and Old Husbands) Have to Tell Us About Mushrooms

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MycoDigest: Fishing for Fungi From the Deep Sea to the High

Else Vellinga

Quite soon the traditional way of inventorying the mushroom flora in our forests may be obsolete. You won't be walking around any more with a big basket (except for pot hunting); instead you will just carry a little tube to take cores from the forest floor or the tree roots. A machine will analyze the DNA you pick up and you will be presented with a species list. Already this method has greatly expanded our knowledge of bacteria and archaea, which were only known before from the small numbers that could be grown in culture.

The advantage is of course that the mushrooms (i.e. the actual fruiting bodies) do not need to be present for a species to be spotted. A big disadvantage is that the stage in the lifestyle of the organism (Is it fruiting? Is it present just as hyphae or as spores?) is not known. Also the thrills of the hunt and the discussion of your mushroom finds are totally absent.

An edible *Thelephora species* (probably *Th. vialis*) from northern Thailand, June 2007.
Photo by Else Vellinga

One of the prerequisites for such a program is that there be enough baseline data with which to compare the records. Someone has to have found a specimen of each mushroom to get its molecular fingerprint. So, traditional morphological, systematics, paired with molecular characterization of species and taxa, will continue and remain indispensable for years to come.

It may sound simple, but in reality there are many pitfalls, which researchers are now very much aware of and are learning to avoid. Consequently, environmental sampling studies are usually more realistic today than they were a few years ago. The technology is not ready yet for wide scale use, but it is coming.

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MycoDigest is a section of *Mycena News* dedicated to the scientific review of mycological information.

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The same approach can be used to fish for fungi in the sea. You take seawater, filter it to get the organisms, extract DNA, and with a specific "bait" (in fact, a short piece of complementary DNA) you can fish the fungi out, or at least the sequences that serve as their ID-tags. There are particular tags that will distinguish fungi from other organisms, though of course you won't know their species or even, perhaps, be able to say much about who their fungal relatives are.

What about fishing with really long lines? From time to time National Geographic shows pictures of the most amazing and fantastic animals from the depth of the oceans—so what about the fungi? Alas, as yet no one has seen spectacular fungal forms in the oceanic abyss, but a few representatives in a small number of species have been found. Most are yeasts, in the ascomycetes (like such things as Brewer's and Baker's yeasts) or in the basidiomycetes (some are close to the basidio-yeast *Cryptococcus neoformans*, a ubiquitous species). An earlier study, showing that Baker's yeast can survive short periods of high hydrostatic pressure, such as what prevails deep in the ocean, makes this all the more plausible. Several of the recovered fungi might be parasites of deep-sea animals. From the species found at different depths, it looks plausible that there is occasional contact between the different sea layers, and that fungi living in shallow waters, or even on land, may occasionally end up in the depths.

On land, we thought that we had a rather good idea about the different fungi. We have been looking for a long time and have done much direct sampling; have observed fungi as pathogens on plants, animals and people; and have grown them on cultures. It came as a big surprise when a completely new type of ascomycetes was discovered in soil in the Colorado Rockies a few years ago. This new group did not just represent a species in the midst of well-known relatives—the morels, say—but a basal branch on the ascomycete tree.

It seems that several researchers, without realizing the significance, had already uncovered some evidence of these new fungi. With further sampling from Canada to Costa Rica, at treeline in the high mountains to tropical lowland forests, a tentative concept of this still nameless group has emerged. At the high altitude sites, they have only been found during the summer, never under the snow. At least 30 species have been discovered already, most of them in living roots of trees and grasses. Nobody has actually seen one of these fungi yet, but their place in the grander scheme of the ascomycetes has become clearer.

We know that they make up a new group, probably at the level of subphylum, within the ascomycetes, and fit between the Taphrinomycotina and the Saccharomycotina. The Taphrinomycotina harbor the peach leaf curl disease *Taphrina* (widespread here in the Bay Area) and *Pneumocystis carinii*, the cause of pneumonia—especially in people whose immune system is compromised. The Saccharomycotina is the group of the budding yeasts, including Baker's and Brewer's yeasts. The one other asco-subphylum known is the Pezizomycotina; it contains morels, most lichens, cup fungi, etc., and is more derived than the others. The newly discovered subphylum is prosaically and provisionally called Soil Clone Group I or "SCGI." A proper name awaits characterization of its features.

Although it is often supposed that the biggest diversity of fungi not yet described lurks inside plants, this research shows that new fungi may be present under our noses in places we thought we had explored thoroughly. All these unknown soil and marine fungi are recognized solely on account of their DNA; what they look like is still a big mystery! ❁

Further reading:

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Porter, T.M., C.W. Schadt, L. Rizvi, A.P. Martin, S.K. Schmidt, L. Scott-Denton, R. Vilgalys & J.M. Moncalvo, 2007. *Widespread occurrence and phylogenetic placement of a soil clone group adds a prominent new branch to the fungal tree of life*. Mol. phylogenetics Evolution. doi:10.1016/j.ympev.2007.10.002.

Schadt, C.W., A.P. Martin, D.A. Lipson & S.K. Schmidt, 2003. *Seasonal dynamics of previously unknown fungal lineages in tundra soils*. Science 301: 1359-1361.

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Every year at the Fair is different. This was a dry fall, and many familiar species were absent—no *A. ocreata* with which to frighten folks. Serving as a docent is fun, challenging, and a useful public service. The interactions are illuminating. We've learned that matsutakes smell different to different folks. For some it is the usual red-hots and dirty socks. Others report candied cherries or marzipan. Some hardly smell it at all. Several knew that jack-o'-lanterns glow in the dark, but on discussion we all confessed that we had never seen it. One attendee vowed she would not eat anything with white gills. There was a long discussion with a knowledgeable fellow about the benefits of drying—improves boletes, but not matsutakes, he insisted. We courted another who lives on a large plot in the Sierra foothills—an area greatly lacking in public access. "Wouldn't you like to join our Davis club?" Our 10-year-old grandson was very excited and went home to Alameda to find numerous fungi tucked away on his island. Maybe some day we'll be able to make the brown-spored display interesting. ❁