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Mycological Research News[1]

This month *Mycological Research* News features: In this issue; and Crisis in teaching future generations about fungi.

Twelve papers are included in this part, of which five concern *Peronosporomycetes*: A 400 My old Early Devonian new fossil genus; *Plasmopara* species on *Geraniaceae*; A new genus for *Bremia graminicola*; Asexual recombination in *P. halstedii*; and a Novel approach to the microarray detection of *Phytophthora* species.

Other papers address: Powdery mildews on *Catalpa*; Effects of novel antifungal pyrazoles on *Magnaporthe grisea*; dsRNA viruses in *Chalara elegans*; Population structure of *Armillaria* species at the landscape scale; Effects of hypersaline conditions on *Trimmatostroma* species; Effects of water potential on *Rhizoctonia solani* from potato; and Community structure of ectomycorrhizal fungi in wooded meadows.

The following new scientific names are introduced: *Graminivora*, and *Hassiella* gens. nov.; *G. graminicola* (syn. *Bremia graminicola*) comb. nov.; and *H. monospora*, *Plasmopara geranii*, and *P. praetermissa* spp. nov.

In this issue

This issue includes a series of papers on different aspects of *Peronosporomycetes* (syn. *Oomycetes*), the members of which are classified in the kindgom *Chromista* or *Straminipila* in modern classifications, and not in the kingdom *Fungi*. These fungus-like organisms, that have traditionally been and continue to be studied by mycologists, include some of the most destructive plant pathogens known (e.g. *Phytophthora* spp.). Little is known of their early evolutionary history, but now a new fossil has been discovered in 400 My old Early Devonian Rhynie Chert deposits from Scotland which has features suggesting it had antheridia and oogonia/oosporangia, all well-illustrated in the paper (pp. 628-632). It is therefore clear that the oomycetes did not evolve very recently, as had been hypothesized by Tom Cavalier-Smith.

Molecular phlyogenetic studies on two groups of plant pathogenic oomycetes are presented. Five species of *Plasmopara* parasitic on *Geraniaceae* are recognized, all forming highly supported monophyletic lineages, and two proved to be new; detailed descriptions, nomenclatural data, illustrations, and a key are provided (pp. 633-645). *Bremia graminicola,* which occurs on subtropical and tropical *Arthraxon* grasses, has unique features in the genus and was the only one to occur on grasses; molecular and morphological data now show that it is not related to other *Bremia* species, but is a sister group to *Viennotia,* and a new generic name is therefore introduced to accommodate it (pp. 646-656).

In *Plasmopara halstedii,* which attacks sunflower, inoculation experiments with field isolates and single sporangium lines differing in host preference and fungicide sensitivity led to the production of asexually formed zoosporangia; these produced a new phenotype combining features of the parental strains which was stable over many generations, and demonstrate the occurrence of parasexuality in this fungus (pp. 657-663). Finally, a novel method for the differentiation of *Phytophthora* species using duplex melting kinetics and microarrays is described; it is shown to be effective in the detection of individual and mixtures of species more robustly than traditional approaches (pp. 664-671).

Four papers concern other plant pathogens. A detailed study combining morphological and ITS sequence analysis revealed that three species of powdery mildews occurred on *Catalpa* in the UK in 2004; the newly reported *Neoerysiphe galeopsidis* appeared first in the year, but was soon out-competed by *Erysiphe elevata* which has recently spread into Europe from the USA (pp. 672-686). The effectivity of a range of newly synthesized pyrazoles at different doses against the causal agent of rice blast, *Magnaporthe grisea*, is assessed; a cyclohexyl or *n*-butyl group generally increased antifungal activity, the most active causing ultrastructural damage to the endomembrane system (pp. 687-697). An investigation of double-stranded RNA elements in *Chalara elegans* (synam. *Thielaviopsis basicola*), which causes black root rot in several important crops, revealed that these carried at least three groups of viruses, with two clones showing no homology to any previously known virus group (pp. 698-705). A detailed study of *Armillaria* populations in a Swiss *Pinus mugo* forest, using somatic incompatibility tests, showed that while *A. cepistipes* and *A. borealis* genets occupied modest areas (mean 0.2 ha and 0.6 ha respectively), *A. ostoyae* (mean 6.8 ha) genets could occupy as much as 37 ha (pp. 706-713).

[1] *Mycological Research* News is compiled by David L. Hawksworth, Executive Editor *Mycological Research,* The Yellow House, Calle Aguila 12, Colonia La Maliciosa, Mataelpino, ES–28492 Madrid, Spain. (tel/fax: [+34] 91 857 3640; e–mail: myconova@terra.es), to whom suggestions for inclusion and items for consideration should be sent. Unsigned items are by the Executive Editor.
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Two black yeast species from extreme environments, *Trimmatostroma salinum* (hypersaline) and *T. abietis* (from a marble monument), are compared with respect to effects of salinity at the colony and ultrastructural levels; both were able to adapt to hypersaline conditions but responded in different ways (pp. 714-725). The effects of different water potentials on *Rhizoctonia solani* anastomosis groups 2-1 and 3 from potato are investigated for the first time; growth generally and sclerotial germination was reduced with decreased osmotic potential, and differences were found between the behaviour of the different anastomosis groups (pp. 726-734).

The diversity of ectomycorrhizal fungi from managed and unmanaged wooded meadows in Estonia has been examined using a combination of the morphology of the ectomycorrhizas on root tips and direct sequencing; 172 species were detected, and there were differences between the communities present in the two woodland types (pp. 735-749).

Crisis in teaching future generations about fungi

Readers of *Mycological Research* will be well aware that mycology has never been as important as it is today, and that this is an exciting time to be studying the enormous diversity, functions, and roles of fungi. We know that fungi play essential roles in the environment, in human nutrition and health, and serve as indispensable model organisms in basic biological research. We might expect that our biological colleagues were equally aware of these facts, and that any educational presentation of ''biology'' would include a balanced description of prokaryotes (bacteria and archea), eukaryotic protists, and fungal, animal, and plant biology. After all, leave out any of these components and the story of life on Earth is incomplete and defective. But when your children walk into school, do you know what the developers of the school curriculum have decided they should be taught? What we know about school curricula in our countries implies that most children get an incomplete and defective story of life on Earth in school because fungi are simply not included in the curriculum. How can we foster an interest in fungi if generations of schoolchildren are kept in ignorance of them? The purpose of this note is to ask mycologists around the world to study their school curricula and tell us what the situation is like in their countries.

It is evident, for example, that in the UK, the academics who developed the National Curriculum do not know much about fungi. Children in the UK, from primary level onwards, are taught about bacteria, animals, and plants. No fungi. In England alone, more than one million children each year complete their statutory National Curriculum with no knowledge of kingdom *Fungi* (Moore *et al.* 2005).

The situation seems to be similar elsewhere in the world. Many of the points made by Moore *et al.* (2005) are also relevant to the education system in schools in Australia. In Austria and Germany, secondary schools have the freedom to modify their curricula and develop their own specific profiles. These schools should provide pupils with standard entry qualifications for university, but in biology, which is one of their core subjects, fungi are marginalized or totally ignored. Likewise in Argentina, in the normal certificate of education (up to 14 years old), biology is incorporated into natural sciences together with chemistry and physics, and fungi are not considered. Courses leading to a technical or agricultural bachillerato include more biology, but fungi are included to the extent they deserve in only a few schools belonging to national universities.

In the USA, individual states (and sometimes even individual school districts) dictate the content of their science curricula, and there are examples of schoolteachers who do give their students a good grounding in mycology. However, the National Science Education Standards that act as a benchmark for the whole country (http://newton.nap.edu/html/nses/) provide a search engine on their website and this finds only one line containing the string 'fung*' in the entire text. That line reads, ''Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food.'' This detail is depressingly similar to the UK National Curriculum, which also, when it mentions fungi at all, brackets bacteria and fungi together, and thereby breeds ignorante. Returns of a recent questionnaire show that over 80 % of 15-16-year olds in Manchester think that fungi are bacteria.

Also alarming is that mycological education is inadequate at most universities. At university, because of the decline of organismal biology and rise of systems biology, the best we can expect is that some yeast molecular biology will survive the narrowing focus on medical and biotechnological topics in both teaching and research. However, that hundreds of thousands of university students are not being taught enough about fungi is not the real problem. The fundamental crisis is that *many millions* of school children are not being taught anything about fungi.

It is vital that we get awareness of fungi into schools, from primary through to secondary education, to banish the cosy, comfortable notion that complex organisms are either animals or plants. If this could be accomplished, then the process of improvement would become self-driving. Sixteen-year-olds who know what fungi are and how fungi affect their daily lives, will expect to learn more in pre-university courses. University entrants who know a balanced amount of fungal biology will expect the same balance in their university courses. In time, graduates with a good education in the whole of biology will become university teachers and then the teaching of animal, plant *and fungal* biology will be a natural part of a good scientific education.

It's a heady vision that will take time to achieve. Indeed, it may require a revolution in school curriculum design; and not many mycologists are involved in school curriculum design. But mycologists can make a contribution towards turning the tide of ignorance. Experience in the UK is that schoolteachers are willing to include fungi in their teaching if they are provided with the resources to do so. The teacher's concern is to teach the curriculum specified by their national authority. Schoolteachers do not have the time, or indeed the knowledge, to devise ways to use fungi to illustrate the statutory curriculum. Yet there are many aspects of science (and not just biology) that can be illustrated with fungal examples, and who is better placed to identify these than the committed mycologist? There are already several books for the general reader that provide a good starting point, which should at least be recommended to (and maybe even gifted to) school libraries, and some more classroom-oriented resources have been produced by the British Mycological Society and the Royal Botanic Gardens Melbourne[2].

Most of the school teaching resources that are available are in English, but we doubt that limitation of statutory school biology to animals, plants and bacteria is unique to the English-speaking world. This is one reason why we want information about school curricula around the world – in how many languages should the resources be produced? The second reason we want information from you is to get you involved. Mycologists around the world *must* become involved in communicating their science to schoolchildren unless they're willing to see their science wither. So our questions to you are these: do your school curricula call for comparisons only between animals and plants? Do they offer details about animal and plant cells only? Do they only ever mention fungi (and always linked with bacteria) as 'decomposers' or 'degraders'? Do most of the 16 year-olds in your country think that fungi are some kind of bacteria? These are the symptoms of the disease afflicting the national curricula in our countries. Do you recognise them? If you do, then please contact the first or another of the authors.

Moore D , Fryer K , Quinn C , Roberts S , Townley R , 2005. How much are your children taught about fungi in school? *Mycologist* **19**: 152–158.

David MOORE[a], Reinhold PÖDER[b], H. Peter MOLITORIS[c]
Nicholas P. MONEY[d], Débora FIGLAS[e], Teresa LEBEL[f]
[a]*Faculty of Life Sciences, 1.800 Stopford Building, The University of Manchester, Manchester M13 9PT, UK*
[b]*Institute of Microbiology, Faculty of Biology, University of Innsbruck, Technikerstrasse 25, A-6020 Innsbruck, Austria*
[c]*Botanisches Institut, Fachbereich Biologie, Universität Regensburg, Universitätstrasse 40, D-90340 Regensburg, Germany*
[d]*Department of Botany, Miami University, Oxford, OH 45056, USA*
[e]*Laboratorio de Hongos Comestibles y Medicinales, Cerzos-Cribabb, Bahía Blanca, Argentina*
[f]*National Herbarium of Victoria, Royal Botanic Gardens Melbourne, Birdwood Avenue, South Yarra, 3141 Victoria, Australia*

E-mail: david.moore@manchester.ac.uk

[2] For suggested books and available teaching resources see http://www.fungi4schools.org and http://britmycolsoc.org.uk.