
Mycological Research News¹

This issue of Mycological Research News features: In this issue; A century of rhizosphere research: fungal interactions with plant's hidden half; Two major changes in fungal nomenclature enacted in Vienna; UNITE: molecular identification of ectomycorrhizal fungi; and Sex and natural selection in yeast populations.

A review article details the 1244 descriptions of ectomycorrhizal fungi published since 1961, covering 814 morphotypes. Seven research papers are included in this part. The first addresses ectomycorrhizal mycobionts of *Pisonia grandis* in Australia.

Five focus on the characterization of ophiostomatoid fungi, combining morphological and molecular approaches: optional mitochondrial introns/insertions are analyzed in the *Ophiostoma ulmi* s. lat. complex, focussing on three genes (*rns*, *rnl* and *cox1*). A new *Ophiostoma* species is described from oak in Europe which has a *Sporothrix* anamorph. The *Ceratocystis polonica* complex is found to contain three species. A re-appraisal of the *Leptographium lundbergii* complex shows that also to comprise three species. The *Leptographium* species associated with the mountain pine beetle and a devastating lodgepole pine disease is described as new.

Finally, the manganese superoxide dismutases in *Phytophthora nicotianae* have been analysed and compared with those in other members of the genus.

The following new scientific names are introduced: *Ceratocystis fujiensis*, *Hyalorhinocladiella pinicola*, *Leptographium longiclavatum*, and *Ophiostoma dentifidum* spp. nov.

IN THIS ISSUE

The lead contribution in this issue is a revision of the morphological descriptions of ectomycorrhizas, the actual forms of the mutualistic association between the fungi and the roots, to have been published since 1961 (pp. 1063-1104). The 1244 descriptions published in this period, gleaned from 479 publications, are analyzed and found to represent 814 morphotypes. These are listed along with the names of their plant partners, and arranged alphabetically. The listing covers both the scientific names of the fungi where these were known, and the innovative system of descriptive association names formed by adding the suffix '-rhiza' to the plant genus name developed by Rheinold Agerer in 1986-87 for morphotypes where the identity of the fungal partner was unknown (e.g. *Fagirhiza arachnoidea*, *Quercirhiza alboviolacea*). The breakdown includes 345 identified to ectomycorrhizal species, 132 to genera, and 99 under morphotype names. Most descriptions are of material collected in Europe (862) or North America (271), but those published from Africa, Asia, Australasia, and South America are also included in the compilation. Gymnosperm tree associated species predominate (510 descriptions), followed by those in *Fagaceae* (339). Molecular diagnosis is increasingly being used in ectomycorrhizal research and can be expected to eventually enable many of the unidentified fungal partners in the different morphotypes to be identified. However, that this may not always be easy as indicated by the study of ectomycorrhizal fungi associated with *Pisonia grandis* (*Nyctaginaceae*) on the Great Barrier Reef area in Australia published here, where two morphotypes were found, but molecular methods could only suggest that both were *Tomentella* species but did not match any currently represented in GenBank (pp. 1105-1111).

Five papers focus on ophiostomatoid fungi. In the September issue it was reported that the mating *MAT-B* (*MAT-2*) genes supported the current taxonomy which recognizes three species and two subspecies in the Dutch Elm disease *Ophiostoma ulmi* s. lat. complex (M. Paoletti, K. W. Buck & C. M. Brasier, *Mycological Research* **109** (9): 983-991, September

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2005). Now, additional support for this taxonomy is provided by a study of the optional mitochondrial introns/insertions focussing on three genes (*rns*, *rnl* and *cox1*) (pp. 1112-1126). Further, a new *Ophiostoma* species is described from oak in Hungary and Poland; it has a *Sporothrix* anamorph which ITS rDNA data suggests is phylogenetically most closely allied to *S. inflata* (pp. 1127-1136). A combination of morphological and molecular studies involving ITS rRNA, β -tubulin, and the HMG box of the *MAT-2* gene in the *Ceratocystis polonica* complex established that it included three species, associated with *Ips* bark beetles on different host trees, one from *Larix* in Japan being new (pp. 1137-1148). The typification and relationships of the *Leptographium lundbergii* complex have been reanalyzed using morphological and molecular data using three genes or geneic regions; *L. truncatum* proved to be distinct, *L. lundbergii* is re-neotypified, and a clade with a *Hyalorhinochlaetia* synanamorph is recognized as new (pp. 1149-1161). A further new species of *Leptographium* is described associated with the mountain pine beetle, *Dendroctonus ponderosae*, currently devastating lodgepole pine forests in British Columbia (pp. 1162-1170).

Three polypeptides with manganese superoxide dismutase (MnSOD) are reported from *Phytophthora nicotianae*, and two different genes are characterized and named; one was highly homologous with a similar gene known in *P. infestans*, *P. ramorum* and *P. sojae*, and the other substantially different but similar to another targeting sequences both in *Phytophthora* species and other eukaryotes (pp. 1171-1183).

TWO MAJOR CHANGES IN FUNGAL NOMENCLATURE ENACTED IN VIENNA

The International Botanical Congress meets every six years, and an integral part of this is the Nomenclature Section meeting which is mandated to consider proposals to amend the *International Code of Botanical Nomenclature* which regulates the procedures to be used in the naming of fungi. The current *Code* (Greuter *et al.* 2000) was prepared after the XVI Congress in St Louis, MO, USA in 1999, and the Nomenclature Section of the XVII Congress in Vienna convened on 12-16 July 2005 to debate and vote on changes proposed in those procedures. Changes made at a Congress are effective immediately unless date-restricted, and two enacted in Vienna are of particular relevance to mycologists.

Fungi described as animals

The *Code* has long had a provision to permit the names of organisms that prove to be algae to be accepted as validly published under the botanical *Code* even if they were originally described under the *International Code of Zoological Nomenclature* (Ride *et al.* 1999) and so do not meet all requirements of the botanical *Code*. Stimulated by problems occasioned by the realization that microsporidia are clearly part of the kingdom *Fungi*, the Section agreed to add "and fungi" at the appropriate places in Art. 45.4. In addition to solving at a stroke the problems of 1000 or more names of microsporidia, this change also means that the status of names in *Pneumocystis*, *Trichomyces*, anaerobic chytrids, slime moulds, and straminipiles, for example, that were first published in the belief that they were animals has to be revisited. It was anticipated that while this may cause some changes in author citations and dates of valid publication, there will be minimal impact on the names themselves.

Fungi with pleomorphic life-cycles

The need to revise the current system of dual nomenclature for fungi with pleomorphic life-cycles has become evident as more and more molecular work accrue. How to progress to an ideal one-name = one fungus situation with minimal disruption of familiar and much-used names is an extremely complex issue and different scenarios have been proposed (Hawksworth 2004, Rossman & Samuels 2005). The Section decided to appoint a Special Committee on Names of Pleomorphic Fungi to report to the next Congress in 2011, but in the

interim did agree to take a significant step towards minimizing future name changes by authorizing an extension of the situations under which epitypification could be effected. The changes made (which are subject to fine-tuning by the Editorial Committee appointed by the Section) are as follows:

Art. 59.1: Insert "or epitypified under Art. 59.4" after "typified" in line 5.

Art. 59.2: Add "or its epitype specimen under Art. 59.4" at the end of the paragraph.

Art. 59.4: Insert "or epitype" after "type" in line 1, "only" after "names in line 2, replace "both" with "the" in line 2, and add the following new sentence at the end: " Priority of competing teleomorph typified or epitypified names follows Principle III [i.e. that or priority of publication] except that teleomorph typified names published before 1 Jan. 2006 take precedence over anamorphic typified names subsequently typified or epitypified after 1 Jan. 2006 by teleomorphs."

Other provisions

No changes were made with respect to electronic publication of scientific names despite extensive debates, Latin continues as a requirement for valid publication, and illustrations can continue to be used as types for microfungi and microalgae though this option is to become more restricted in future for plants and other macroorganisms. A summary of decisions is scheduled to appear in the November issue of *Taxon* along with the results of the mail ballot held prior to the Section meetings. The Vienna Code itself is expected to be published in mid-2006.

Greuter, W., McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Filgueras, T. S., Nicholson, D. H., Silva, P. C., Skog, J. E., Trehane, P., Turland, N. J. & Hawksworth, D. L. (eds) (2000) *International Code of Botanical Nomenclature (Saint Louis Code)*. [Regnum Vegetabile No. 138.] Koeltz Scientific Books, Königstein.

Hawksworth, D. L. (2004) Limitation of dual nomenclature for pleomorphic fungi. *Taxon* **53**: 596-598.

Ride, W. D. L., Cogger, H. G., Dupuis, C., Karus, O., Minelli, A., Thompson, F. C. & Tubbs, P. K. (eds) (1999) *International Code of Zoological Nomenclature*. International Trust for Zoological Nomenclature, London.

Rossmann, A. Y. & Samuels, G. J. (2005) Towards a single scientific name for species of fungi. *Inoculum* **56**(3): 3-6.

UNITE: MOLECULAR IDENTIFICATION OF ECTOMYCORRHIZAL FUNGI

The move towards specialist-backed databases as aids to molecular identification, already established in *Fusarium* as FUSARIUM-ID (Geiser *et al.* 2004) and in *Trichoderma* as TRICHOBLAST (Kopchinskiy *et al.* 2005), is now extended to ectomycorrhizal fungi in UNITE (Köljalg *et al.* 2005). These moves have all been stimulated by problems over the reliability of the identification of fungi from which sequence data has been obtained and incorporated into GenBank.

UNITE (<http://unite.zbi.ee>) is an open access database developed by 16 specialists in seven European countries and includes ITS sequence data on 67 genera and 455 species of ectomycorrhizal fungi. Each sequence is backed by a dried reference collection preserved in an herbarium, museum or other institution which has full collection and ecological details. The database can be searched either by the name of a fungus or sequence similarities using a form of BLAST, but further perform a phylogenetic analysis using a query sequence submitted and Galaxie packages.

While many more fungi should ideally be included, especially from the Americas, Africa and Asia, release of this authoritative database is a major step in the facilitation of meaningful molecular-ecological studies involving ectomycorrhizal fungi.

- Geiser, D. M., Jiménez-Gasco, M. d. M., Kang, S., Makalowska, I., Veeraraghavan, N., Ward, T.J., Kulda, G. A. & O'Donnell, K. (2004) FUSARIUM-ID v. 1.0: a DNA sequence database for identifying *Fusarium*. *European Journal of Plant Pathology* **110**: 473-2004.
- Köljal, U., Larsson, K.-L., Abarenkov, K., Nilsson, R. H., Alexander, I. J., Ebergardt, U., Erkand, S., Høiland, K., Kjøiland, K., Kjøller, R., Larsson, E., Pannanen, T., Sen, R., Taylor, A. F. S., Tedersoo, L., Vrålstad, T & Ursing, B. M. (2005) UNITE: a database providing web-based methods for the identification of ectomycorrhizal fungi. *New Phytologist* **166**: 1063-1068.
- Kopchinskiy, A., Konmon, M., Kubicek, C. P. & Druzhinina, I. S. (2005) TRICHOBLAST: a multilocus database for *Trichoderma* and *Hypocrea* identifications. *Mycological Research* **109**: 658-660.

SEX AND NATURAL SELECTION IN YEAST POPULATIONS

The justification of the evolutionary value of sex has long been considered as providing new favourable gene combinations, despite the disruption to currently favourable ones and the time and energy the process entails. In order to put theory to the test, genetic manipulation was used by Goddard, Godfray & Burt (2005) at the NERC Centre for Population Biology of Imperial College at Silwood Park, Ascot, UK, to produce yeast strains² only differing in their capacity for sexual reproduction as a result of manipulations involving *SOP11* (which encodes an endonuclease initiating cross-over events) and *SOP13* (which determines whether a cell goes through one or two meiotic divisions). Wild type and engineered strains were subjected to benign and harsh environments in a chemostat. No differences in behaviour were apparent in the benign environment, but in the harsh one the fitness of the sexual line, judged by increases in population size, rose by 94 % as opposed to 80 % in the unengineered line.

- Goddard, M. R., Godfray, C. J. & Burt, A. (2005) Sex increases the efficacy of natural selection in experimental yeast populations. *Nature* **434**: 636-670.
- Hoekstra, R. F. (2005) Why sex is good. *Nature* **434**: 571-572.

Book Reviews¹

FUNGAL BIOTECHNOLOGY

Handbook of Industrial Mycology. Edited by Zhiqiang An. 24 Sept. 2004 ['2005']. Pp. xvi + 763. ISBN 0 8247 5655 X. [Mycology Series No. 22.] Marcel Dekker, New York. Price: US \$ 169.95.

Advances in Fungal Biotechnology for Industry, Agriculture, and Medicine. Edited by Jan S. Tkacz & Lene Lange. 2004. Pp. xvii + 445. ISBN 0 306 47866 8. Kluwer Academic & Plenum Publishers, New York. Price: €157.50, US \$ 175, £ 108.50.

Hard on the heels of three other major multi-authored volumes on aspects of fungal biotechnology published in 2004 (Arora, 2004a, b, Cole, Kück 2004; reviewed in *Mycological*

² Surprisingly, the scientific name of the yeast involved is not mentioned either in the original paper or the commentary by Hoekstra (2005).

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Research **108** (6): 719-721, June 2004) two more major texts in the same general area have been released.

An's book is in the same series of the two edited by Arora and is very much one of a triumvirate, largely complementary rather than duplicatory in content. It involves 89 authors, many based in industry, and including 24 from the Merck Research Laboratories in Rathway, New Jersey (USA) or Merck, Sharp & Dohme de España in Madrid (Spain). The book is divided into eight sections: Mycology, Industrial Mycology, and Fungal Biology (5 chapters); Fungal Secondary Metabolite Discovery (6); Biosynthesis of Fungal Secondary Metabolites (7); Fermentation, Strain Improvement, and Bioconversion (3); Metabolic Engineering (2); Heterologous Protein and Enzyme Expression in Fungi (1); Mycotoxin [*sic!*] (1); and Fungi in Biological Control (1). The chapters have been produced to the highest standards, and it is only possible here to highlight some which I personally found of especial interest or value; the selection is consequently unavoidably eclectic.

The introductory chapter 'Industrial mycology: past, present, and future' (Demain, Velasco & Adrio), is a particularly skilful overview looking at usages from the ancient to the modern and hinting at the promise of functional genomics; I am sure this be much-used by lecturers in preparing basic classes on industrial mycology. Especially well-researched, comprehensive, and authoritative, is the review of 'Biological activities of fungal metabolites' (Peláez). This is arranged not by kinds of compounds but by activities, with subheadings such as 'antifungals', 'antitumor', 'antibacterial', 'atherosclerosis', 'antiparasitic', 'neurological disorders', 'inflammation', 'immunosuppression', and 'hypertension', includes structural formulae, and has a particularly extensive bibliography. It made me acutely aware as to how many millions of people owe their continuing health to fungal products, and will be excellent to direct anyone to who asks 'What use are fungi anyway?' The chapter on 'Fungal germplasm for drug discovery and industrial applications' (Okuda, Ando & Bills) is especially pragmatic dealing with the requirements of the Convention on Biological Diversity, types of material that serve as sources, direct and indirect isolation techniques, and even with recipes for media. Particularly illuminating for me were the detailed chapters on 'Sordarins: inhibitors of fungal elongation factor-2' (Domínguez & Martín), 'The *Aspergillus nidulans* polyketide synthase WA' (Fujii, Watanabe & Ebizuka), 'Metabolic engineering of fungal secondary metabolite pathways' (Wand, Laidlaw, Marshall & Keasing), and 'Metabolomics' (Arnold & 17 others). In contrast to the coverage accorded to some very specific topics, three sections only included a single chapter (see above) which while hardly providing a comparable depth of treatment at least 'flag up' key topics such as mycotoxins and biocontrol. Irritatingly, the book has '2005' printed inside it as its year of publication, although it was actually published on 24 Sept. 2004 (the review copy was dispatched even earlier, on 25 Aug. 2004).

Tkacz & Lange's book adopts a different approach, taking selected topics related to advances in the field in filamentous fungi; yeasts were excluded as a matter of policy according to the Preface, and the word 'filamentous' perhaps should have been incorporated into the title. This has 39 contributors and 16 chapters arranged in four sections: Genetic Technology (4 chapters); Special (Secondary) Metabolism (4); Enzymes and Green Chemistry (5); and Host-Fungal Interactions (3). I found the first section rather disappointing as three of the chapters were really too short to do justice to the really exciting and rapidly growing areas of molecular taxonomy, genomics, and molecular tools. In contrast, the second section was impressive! In the Preface the editors explain that the term 'secondary' is inappropriate when applied to fungal metabolites as it is misleading to consider them as secondary or dispensable (p. xxi). But is 'special' so much better? The editors evidently did not convince the authors of the lead chapter in the section on polyketide synthases in the information age (Cox & Glod); Frisvad's term 'extrolite' (*Mycological Research* **108** (6): 596, June 2004), which was probably not published when the work was being finalized, may be preferable for those seeking a more appropriate name for 'secondary metabolites'. Also in

this section are major considerations of 'Peptide synthesis without ribosomes (Walton, Panaccione & Hallen) and 'Isoprenoids: gene clusters and chemical puzzles' (Scott, Jameson & Parker); an amazing 23 000 isoprenoid substances are now recorded. The third section includes two chapters which are especially detailed reviews, 'Biocatalysis and biotransformation' (Schauer & Borriss) and 'Organic acid production by filamentous fungi' (Magnuson & Lasure). The final part is rather a mixed bag and suffers like the first from the chapters being too short for the tasks, dealing with molecular biology in human mycoses, molecular interactions of phytopathogens and their hosts, and structural and functional genomics in arbuscular mycorrhizal fungi.

Faced with this suite of five overlapping and expensive books, what should a library order? I fear the answer is 'ideally all' as all have some gems not treated or treated as well in the others. If a choice is unavoidable, however, my recommendation has to be the three superb and largely complementary Marcel Dekker volumes, carefully put together under the keen eye of the series editor, Joan W. Bennett.

Arora, D. K. (ed.) (2004a) *Handbook of Fungal Biotechnology*. [Mycology Series No. 20.] Marcel Dekker, New York.

Arora, D. K. (ed.) (2004b) *Fungal Biotechnology in Agricultural, Food, and Environmental Applications*. [Mycology Series No. 21.] Marcel Dekker, New York.

Kück, U. (ed.) (2004) *Genetics and Biotechnology*. [The Mycota Vol. 2.] 2nd edn. Springer-Verlag, Berlin.