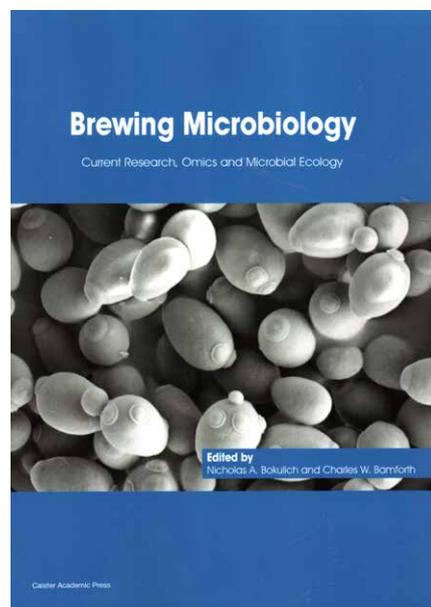


Brewing Microbiology: current research, omics and microbial ecology. Edited by Nicholas A. Bokulich and Charles W. Bamforth. 2017. Caister Academic Press, Norfolk. Pp. v + 331, figs. ISBN 978-1-910190-61-6 (pbk), 978-1-910190-62-3 (ebk). Price US\$ 319 or £ 159 (pbk or ebk).



Genomics is having an enormous impact on traditional as well as emerging fungal-based industries. Brewing had already become an increasingly scientific operation during the 20th century, but genomics is now taking it to a new level of sophistication. This book aims to provide an overview of recent advances in brewing technology and their impact, particularly in the last decade. The topics covered range from physiology and handling, through genetic modification, taxonomy and evolution, to issues of contamination and spoilage. New technology has made this an exciting and developing field, and also revealed aspects

that prove to be imperfectly understood.

Knowledge of basic physiology has improved, for example in relation to effects of nitrogen, oxygen, and sugar levels on growth, and the complex issue of factors controlling “quiescence” after cropping. The considerable stresses that yeasts undergo during brewing processes are reviewed, including changes in alcohol levels, pH, temperature, carbon dioxide and oxygen, and hyperosmotic stresses. Maintaining strain quality over time is of vital importance in production to achieve a consistent product, and best-practices for propagation, storage and rejuvenation are described.

Molecular phylogenetics has led to a clarification of species concepts, and the relationship between seven “natural” species and hybrids used in production or developed as contaminants. There is a most useful summary of how the names of 11 taxa relate to the currently accepted species (including the citation of “type strains” [*sic!*]). In the case of *Saccharomyces cerevisiae*, a whole-genome phylogeny of 114 top-fermenting beer strains is presented, including ones used in bread, sake, and wine production and some from nature in different regions of the world. The nomenclature and taxonomy of *Brettanomyces* species, also used in some beers, is also summarized. Methods of species separation are also discussed, including real-time PCR systems. A separate

chapter considers the evolution of brewing yeasts in both these two genera, especially domestication and the characters associated with that which have diverged from those found in nature. In the case of traditional beers, however, inoculations often rely on “back-slopping” or other non-critical methods. It does, however, have to be understood that the particular strains in use in major manufacturing plants are often closely guarded by the companies because that information is commercially sensitive. As a result the available laboratory strains may not always be representative of those actually used.

Also covered are the problems and potentials of genetic manipulation of brewing yeasts, and the contamination of barley and malt by a surprising variety of spoilage fungi that can lead to significant losses. Spoilage can also arise from bacteria, and omics approaches to their detection and characterization are discussed, along with the problems that can cause, whether from mycotoxins or unpleasant odours.

I learnt a great deal from this volume, and there is no doubt that this will be a valuable information source not just for those involved in the brewing industry, but for those in applied mycology and food science courses. The editors are to be congratulated on putting together such an authoritative overview of brewing yeasts and their exploitation.

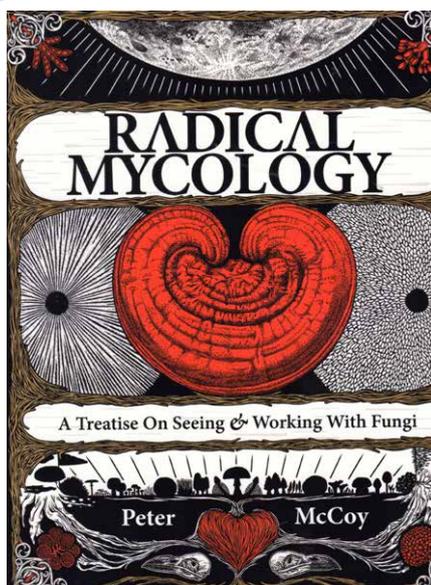
Radical Mycology: a treatise on seeing & working with fungi. By Peter McCoy. 2016. Chthaeus Press, Portland, OR. Pp. xxi + 672, illustr. (16 pp. col.). ISBN 9780986399602 (pbk). Price US\$ 49.49.

What an incredible work! The back cover states that *Radical Mycology* aims to be “an in-depth reference and resource manual for anyone interested in the growth of mycology as a people’s science”. The author has a long-standing fascination in the cultivation and collection of mushrooms, and “became deeply involved in the art and activist movement in Olympia”, and now lives in Portland (OR). In 2008 he started a “zine” when he just a few friends interested in mycology which developed

into a worldwide network of contacts, Radical Mycology Congresses, and in 2014 a Radical Mycology Collective touring North America sharing knowledge and skills. This book is the summation of his life’s work with fungi, bringing together all the information he has gleaned into a single reference work – and with almost no contact with professional mycologists or mycological societies.

He sees mycology as a “neglected megascience” (citing my use of the phrase),

crucial to the new millennium, and groups of Radical Mycologists Without Borders touring the world informing on the importance of fungi so that they are seen as having a central role in all aspects of human life. The book starts with basic information on the nature of fungi and major groups, structure, spore liberation, hyphal growth, and form, proceeding to life-styles: mycorrhizas, endophytes, relationships with animals, biotrophs, and saprobes. Sections on ethnomycology and the role of women



conclude the first part.

Part II concerns collection and examination, with a welcome chapter on lichens (by Natassja Noell) which in addition to identification and chemistry also includes uses. Part III covers mycomedicinals¹ and mycophagy, including recipes for not only food and beverages but also various medicines. Part IV has a 90-page chapter on working with fungi, including cultivation and culture techniques, and a shorter one on cultivation on waste materials, composting (including the use of *Trichodema*), fungus farming, and incorporating fungi with different biologies

into garden design. This is followed by one looking to the importance for the future, particularly in bioremediation of soil contaminants (including petrol spills), stressing the need to have a standard of care, and the range of chemical products.

Part V, Integration, unconventionally, turns to the incorporation of mycelium parallels into various activities, including searching for information, navigating human situations, decision making, building connections and support networks. There are also separately authored sections on sharing fungi with children (Maya Elson) and mushroom sex life, including sexual orientation (Willoughby Arevalo). This is followed by a 44-page chapter devoted to psychoactive fungi, covering different categories of experiences, the War on Drugs in the USA, historical uses in different regions, in religions, an assessment of Gordon Wasson's investigations, and the psychedelic movement (Peter SjoXstedt-H).

The last sections comprise species profiles, and appendices covering "id" forms, lists of endangered fungi, fungal toxins, fungal dyes and paper, healing exercises, cultivation parameters, media for cultivation, cultivation tracking forms, projects, working with psychoactive fungi, psilocin mushroom niches, facilitating events and meetings, online resources and organizations, various games, mycojokes, Latin and Greek derivations, an extensive

glossary, bibliography, and endnotes to sources used in each chapter. I was impressed by the range of sources the author has been able to put together, including many from the primary literature.

I must admit that I had not heard of the Radical Mycology movement before coming across this book. Some views expressed and slants placed on particular facts may surprise, or even shock, some professional mycologists, there can be no doubt about the enthusiasm for mycology that is evident on almost any page. Weighing 1.9 kg, this is very much a source book, a vademecum for a mycological movement. Consequently, some areas such as industrial mycology, food spoilage, genetics, genomics, pharmaceuticals, plant diseases, indoor fungi, mycoses, etc. are not or scarcely mentioned. It is a remarkable and impressive achievement by a "citizen scientist" and a few colleagues, and is indeed likely to promote the importance and knowledge of fungi amongst an audience not normally reached through conventional mycological channels. Mycology should be grateful to him.

¹Various other terms are introduced here, perhaps for the first time, including: alchemycology, mycognosis, mycoguilds, mycomemetrics, mycomimicry, mycopsychology, and mycosystematics (which has nothing to do with taxonomy as used here).

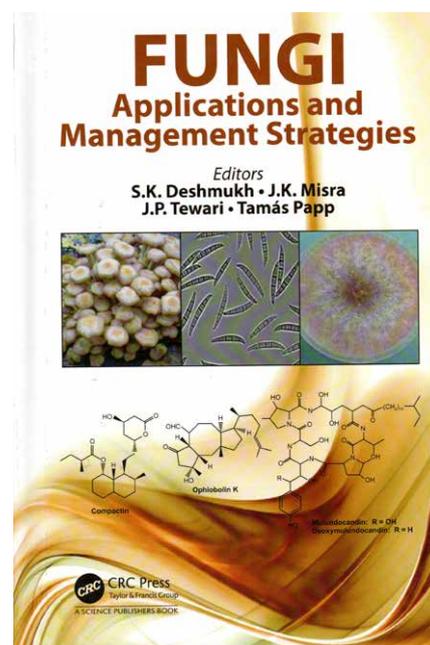
Fungi: applications and management strategies. Edited by S.K. Deshmukh, J.K. Misra, J.P. Tewari, and Tamas Papp. 2016. CRC Press, Boca Raton. Pp. ix + 486. ISBN 978-1-498-724913. Price US\$ 127, £ 88.90.

This is the fourth book in the *Progress in Mycological Research* series, and the first to focus on applied aspects; the previous one concerned fungi from different substrates (Misra *et al.* 2014). The new volume deals with "some aspects of fungi which have helped us to use them for human welfare" (p. v). The 17 chapters included represent a choice that is necessarily somewhat eclectic, and are mainly concerned with bioprospecting for, and pharmaceutical and industrial applications of, fungal products. The topics cover searching for endophytic fungi, with one a case study in Cameroon using plants used by local people as a target, antimycobacterials, antifungals, volatile organic compounds, statins, anti-plant viruses, myconanofactories, mycoremediation, mycotoxins, nutritional values of some wild edible fungi from India, and uses of thermophiles. There

is an intriguing chapter on epigenetic modification of biosynthetic pathways. Just two chapters concern management issues, fungal pathogens on rice and on soybean.

The concept of a "myconanofactory" was a new one for me, fungi that can extract metal ions (including platinum and silver) to form minute particles on their walls which promise to have applications in medicine as well as in bioremediation. Individual mycologists will have their own favourites, but I particularly valued the chapter on statins as this was the clearest exposition of their discovery I had seen.

The volume is well produced, and I was pleased to see that the so unnecessary author citations of fungal names were omitted from almost all chapters, with an unfortunate lapse in that on edible mushrooms that even has them in the abstract. The editors are to



be congratulated on a job well-done, and providing a further set of papers that will be of value to those teaching applied mycology courses. It will be interesting to speculate what a fourth volume in the series might contain!

Misra JK, Tewari JP, Deshmukh SK, Csaba Vágvölgyi C (2014) *Fungi from Different Substrates*. Boca Raton: CRC Press.

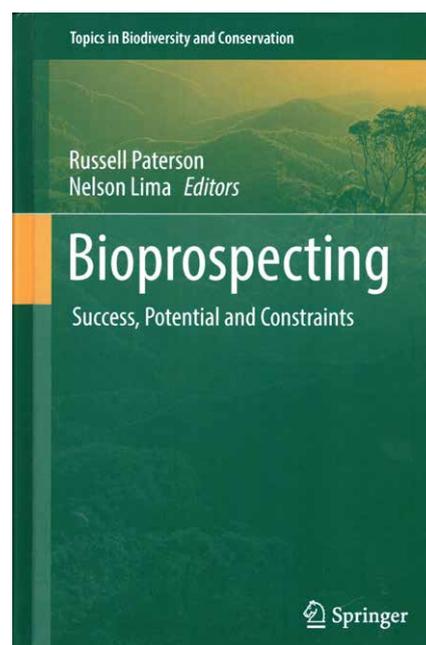
Bioprospecting: success, potential and constraints. Edited by Russell Pater-son and Nelson Lima. 2017. Springer, Cham. Pp. x + 303, illustr. (some col.). [Topics in Biodiversity and Conservation Vol. 16.] ISBN 978-3-319-47933-0 (hbk), 978-3-319-47935-4 (ebk). Price £ 117 (hbk), £ 93.50 (ebk).

Although not only concerned with mycology, this title is included here as it is edited by two mycologists and includes several chapters dealing with fungi. Bioprospecting for potentially exploitable pharmaceuticals from natural products reached its zenith in the 1990s, but has since been largely abandoned by major pharmaceutical companies, Big Pharma, in favour of combinatorial chemistry. This has come about as a result of the increasing realization that it was both long-term and expensive, compounded by increasing legal and bureaucratic constraints consequent on the adoption of the UN Convention on Biodiversity in 1992 and subsequent Protocols. These fundamental issues are addressed in the first two chapters.

Eleven chapters look at particular examples, of which four are devoted entirely or partly to fungi. These concern the role of microbial resource centres (J Overmann and D Smith), the Iwokrama fungal/plant

project (R Pingal), Brazilian fungi (J V Braga De Souza *et al.*), and mine waste fungi (A A Stierle and D B Stierle). Included in Overmann & Smith's overview, is an innovative proposed business plan designed to make well-characterized strains available to industry in a legally compliant manner; the scheme would, however, require substantial additional funding to be made available to the collections. The Iwokrama project in Guyana ran from 2000-03 and was funded by the European Commission; the outcomes are frankly analysed and may inform any future similar ventures. In Brazil, a variety of initiatives are underway, focussing on endophytic and soil fungi. Mine wastes have yielded fungi with several novel products of potential importance as inhibitors of enzymes causing inflammations associated with some cancers.

The book is well-edited and produced, but as is an increasingly common situation, it frustratingly lacks an index.



Miracle Cure: the creation of antibiotics and the birth of modern medicine. By William Rosen. 2017. Viking (Penguin Random House), New York. Pp. ix + 358, illustr. ISBN 9780525428107 (hbk), 9780698184107 (ebk). Price US\$ 28.00 (hbk), US\$ 14.99 (ebk).

This is not just yet another book on some aspect of the discovery and utilisation of penicillins, but a meticulously researched investigation with numerous notes and an extensive bibliography – and one which is also enthralling to read. The author's experience as an editor and publisher at Macmillan, Simon & Schuster for almost 25 years shows. He acknowledges it as a little ironic that its' completion was only possible through the products of the pharmaceutical industry as he developed a particularly aggressive cancer; he died in April 2016 without seeing the book published.

While much of the subject matter will be familiar to mycologists with an interest in the history of the discovery of

penicillin in particular, it also presents new insights into how Fleming's observations were transformed into a miracle drug, and the often antagonistic stances taken by some of the key players. As Fleming's accounts of his discovery vary, he favours the suspicion that the "accidental" mould contamination may have actually been a part of an experiment searching for a new source of the enzyme lysozyme he had discovered in 1922, and that it was the *Staphylococcus* that was the contaminant. The possibility that the *Penicillium* came from La Touche's laboratory on the floor below Fleming's room is surprising not mentioned; the study with that hypothesis (Hare 1970) is missing from the numerous sources and 16 page bibliography.

There had been reports of antibacterial properties of *Penicillium* by earlier authors as far back as at least the observations of John Tyndall published in 1876. What Fleming did was to realise that there was a phenomenon to explore although he did not explore possible curative effects even in mice or foresee the possible value to human health. His 1929 paper attracted almost no notice until about 1937 when it came to the attention of Ernst Chain and Howard Florey in Oxford; they later both claimed to have seen and realised its significance before each other. They planned to search for antibacterial compounds from diverse microorganisms, including some strains of *Penicillium* "notatum" already held in their lab. Methods to grow the fungus in



The Creation of Antibiotics
and the Birth of Modern Medicine

MIRACLE CURE WILLIAM ROSEN



bulk were devised by Norman Heatley, and Chain elucidated the chemical structure. In 1940 the first successful tests on diseased mice were carried out, and in 1941 it was

used to treat an Oxford policeman with amazing results. Unable to secure adequate facilities in the UK, Florey visited the USA and established links there which included Charles Thom and later Kenneth Raper. New strains were isolated by the USDA Northern Regional Laboratory; one from cantaloupe from a Peoria market giving the best yields and facilitated mass production. In 1942 interest on both sides of the Atlantic took off. Fleming's boss, Almroth Wright, published a letter in *The Times* claiming Fleming should have the credit and that has remained the case in the public media to this day.

The author goes on to describe production and arguments over patents, involvement of pharmaceutical companies, issues of supply and legal battles over pricing, and later discoveries. Amongst the latter, particular attention is given to the discovery of streptomycin by bacteriologist Selman Wakaman (who coined the term "antibiotic") and his team, chloromycetin, and the thalidomide disaster. He also points

out that it is extremely difficult to find new antibiotics, and none working by different methods have been discovered in the last 60 years. At the same time, antibiotic resistance is increasing, with some 23 000 deaths attributed to resistant bacteria each year. And the major drug companies have abandoned the search for pharmaceuticals in natural products (Borris 2017).

The style makes it a difficult book to put down, and it also includes many historic photographs I had not seen reproduced before. I enjoyed it very much, and unhesitatingly commend it as my top choice for vacation reading by all mycologists this summer.

Borris RF (2017) Bioprospecting: an industrial perspective. In: *Bioprospecting: success, potential and constraints* (Paterson R, Lima N, eds): 1–14. [Topics in Biodiversity and Conservation vol. 16.] Cham: Springer Nature.

Hare R (1970) *The Birth of Penicillin and the disarming of Microbes*. London: George Allen & Unwin.

Mycorrhiza – function, diversity, state of the art. Edited by Ajit Varma, Ram Prasad, and Narendra Tuteja. 2017. 4th edn. Pp. xv + 394, illustr. (some col.). Springer, Cham. ISBN 978-3-319-53063-5 (hbk), 978-3-319-53064-2 (ebk). Price 181.89 € (hbk), 142.79 € (ebk).

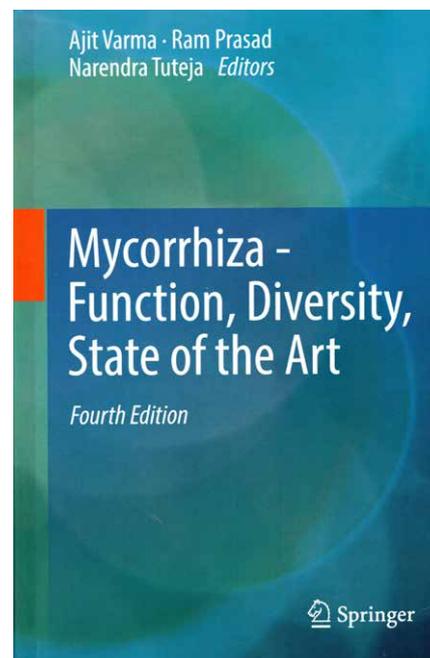
The study of mycorrhizal fungi is a field in which there is enormous interest and novel research findings arising from numerous laboratories worldwide. Periodic syntheses are essential to provide overviews of just where particular areas of research are today, and that is accomplished here in 18 chapters involving 45 authors drawn from 11 countries.

The topics covered are wide-ranging, and include the mobilization of micronutrients, improving the tolerance to Fusarium wilt of tomato plants through the use of arbuscular mycorrhizal (AM) fungi, interactions with bacteria, ectomycorrhizal (ECM) fungi and their roles, ECM fungi with *Fagaceae* in Mediterranean ecosystems, plant flavonoids in the establishment of endosymbioses, importance to tree health, importance in plant succession in glaciers and sand dunes, truffle ecology, diversity of AM fungi in symbioses, interactions with dark septate

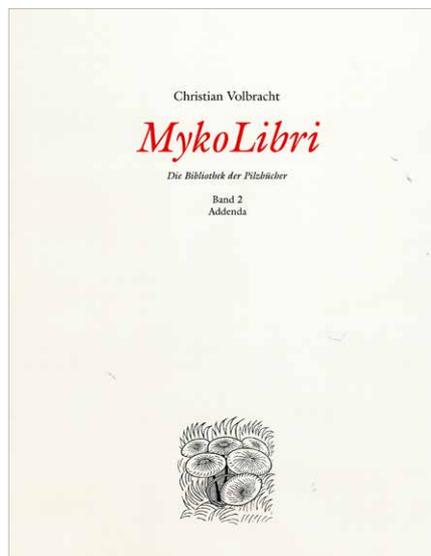
endophytes in viticulture, and mycorrhizal colonization of wetland plants. Two chapters are concerned with responses of AM fungi to climate change, and two to *Piriformospora indica* and its cultivation.

The book is nicely produced, with some coloured figures distributed though the text, and not just collected together and tipped-in as one signature. I was also pleased to see an index – something sadly missing from an increasing number of titles.

This is, however, very much a collection of mainly potentially stand-alone chapters on particular aspects of mycorrhizal research, rather than a comprehensive overview, as some exciting and rapidly advancing areas are scarcely mentioned, such as host specificity, genomics, and inter-biont signalling mechanisms. Mycorrhizal researchers will consequently use this as a source for reviews of the selected subjects covered, rather than commend it to students as a comprehensive "state of the art" review.



MykoLibri: Die Bibliothek der Pilzbücher. Vol. 2. Addenda. By Christian Volbracht. 2017. Pp. vi + 210, figs 100 (20 full page), mostly col. Christian Volbracht, Hamburg. ISBN not provided. Price 105 €.



Christian Volbracht is a dealer in mycological books, but also a mycophile and bibliographer. He published an account

of his holdings in 2006 (Volbracht 2006). He started collecting in the mid-1970s, and the 2006 volume includes information on just over 3000 titles published between 1481 and 1959, with full bibliographic details presented in 525 large-format (29.5 x 21 cm) pages, interspersed with mainly coloured copies of title pages and plates. His library has continued to swell, and this addendum volume includes an additional 600 titles published in the years up to 1959. The format is the same, and while the emphasis is on macromycetes and mycophagy, also included are some sets of plates, and even at least one work on lichenicolous fungi; works dealing exclusively with lichenized fungi are not, however, treated. The text is in German, with the short introduction given also in English and French. Unlike the original volume, the addendum comes in just one

version, hard-bound with a paper cover. It is produced to the highest standards, and will be a pleasure to own and use. I have made considerable use of the original volume when needing information on particular titles, many of which are exceedingly rare, when assisting with nomenclatural and taxonomic investigations, and the two volumes should be on the shelves of all major mycological libraries, and also those of other mycophiles. Christian has provided a great service to mycology by putting this catalogue together and making it available for sale.

I understand that some copies of the original volume are still available at 140 €, and the two can be purchased as a set for 200 €.

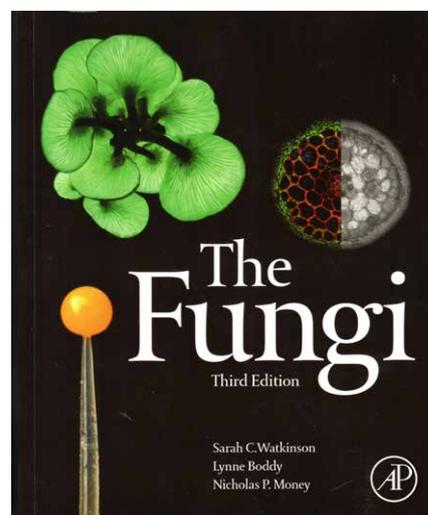
Volbracht C (2006) *MykoLibri: Die Bibliothek der Pilzbücher*. Hamburg: C. Volbracht.

The Fungi. Edited by Sarah C. Watkinson, Lynne Boddy, and Nicholas P. Money. 3rd edn. 2016. Academic Press (Elsevier), Amsterdam. Pp.xv + 449, illustrated, col. plates 27. ISBN 978-0-12-382034-1 (pbk), 978-0-12-382035-8 (ebk). Price 65.95 € (pbk), 64.95 € (ebk), 78.54 (pbk+ebk).

There are few authoritative and substantial texts endeavouring to cover the whole field of mycology, so it is pleasure to see a new edition of this familiar one. The first edition was in 1994, prepared by Michael Carlile and Sarah Watkinson, and for the second in 2001 they were joined by Graham Gooday. Unusually for a co-authored book, each of the authors is named as the single author for each of the 12 chapters they prepared. Also surprising is that it is 139 pages shorter than the second edition.

The balance of topics, and just what to include and what to omit within them, cannot be other than eclectic when contemplating production of a single volume aimed at addressing the whole field. As the primary target audience is given as “undergraduates and graduate students”, the choice is necessarily influenced by the content of the courses it is expected to be used in. It is evident that the authors had courses with an experimental “fungal biology” emphasis to the fore, “encompassing mycology from a microbiological perspective” (p. xiii). In consequence, the coverage of the structural and phylogenetic

diversity of the fungi is largely limited to the first two chapters by Nick Money, occupying 36 pages as opposed to 84 in the second edition. Amazingly for the 21st century, these two chapters lack any detailed phylogenetic classification below phylum, and dismiss the whole of the ascomycetes in just under six pages (including illustrations), without even mentioning the former practice of separately naming morphs of the same species which students are likely to encounter. I was also sorry to see the 11 page Appendix on classification giving examples of species down to order in the second edition omitted. There is something of an apologia (p. xv) for this approach on the basis of “the pace of change in phylogenetic research”, which I find somewhat anachronistic at a time when major relationships at class and order are now rather stable. It would have been helpful to at least direct users wishing to understand classifications and check current names to those accepted in *Species Fungorum*; that would have been a useful exercise for the authors to have undertaken before the work went to press as some names used are not the current ones.



On the positive side, the treatment of fungal ecology and interactions with other organisms has benefitted enormously from the involvement of Lynne Boddy. There is now a rather full treatment of genetic variation, mating systems, speciation, and evolution, and no less than five chapters on interactions with other organisms: mutualisms, autotrophs, humans and other animals, with other microbes, and role in

ecosystem and global change. Particularly topical are the treatments of the effects of climate change and pollutants, and fungal conservation; the latter includes a table showing the use of IUCN Red List categories which had merited much more exposure to mycologists in general. I also enjoyed Sarah Watkinson's chapter on molecular ecology explaining the issues that needed to be addressed, especially in relating environmental sequences to naming fungi and the issue of cryptic speciation, but also the promise of genomics.

In contrast, the coverage of industrial

uses seemed rather limited for the intended audience. Just a single chapter is devoted to fungal biotechnology and occupies just 24 pages with only five references, three relating to yeasts. I would also have expected to see much more on the uses of mushrooms, mushroom cultivation, fungal products, and biocontrol, and also sections on the biodeterioration of manufactured materials, food spoilage, and fungi in the indoor environment.

Each chapter ends with a "Further Reading" section, in most cases with general titles followed by others arranged by topic. There is also a helpful glossary and an index.

Colour was not used in the last edition, so I was also pleased to see a final 28-page signature with colour versions of some of illustrations that appeared as half-tones in the text; a second best to having them in colour where they appeared, but better than having none at all.

I am sure that the book will prove valuable in some fungal biology courses, but while particular chapters can be highly commended for further reading on topics in broader mycological ones, the uneven coverage will sadly limit its international appeal.