

## Book review

Kirk PM, Cannon PF, Minter DW, Stalpers JA 2008. *Dictionary of the Fungi*, 10<sup>th</sup> ed. Published in Australia and New Zealand by CSIRO Publishing, Collingwood. ISBN 9780643095731. AU\$175.

Tom May

Royal Botanic Gardens Melbourne

There is one word that characterises this new edition of the *Dictionary of the Fungi*—indispensable. The tenth edition (DF10), like previous editions, is a fabulous resource for all mycologists. I use it, or the on-line version of the taxonomic hierarchy (<http://www.indexfungorum.org/Names/fundic.asp>), most days and I can particularly recommend it to students, both as a dictionary for unfamiliar terms, and for the up-to-date summaries of literature under taxon and topic entries.

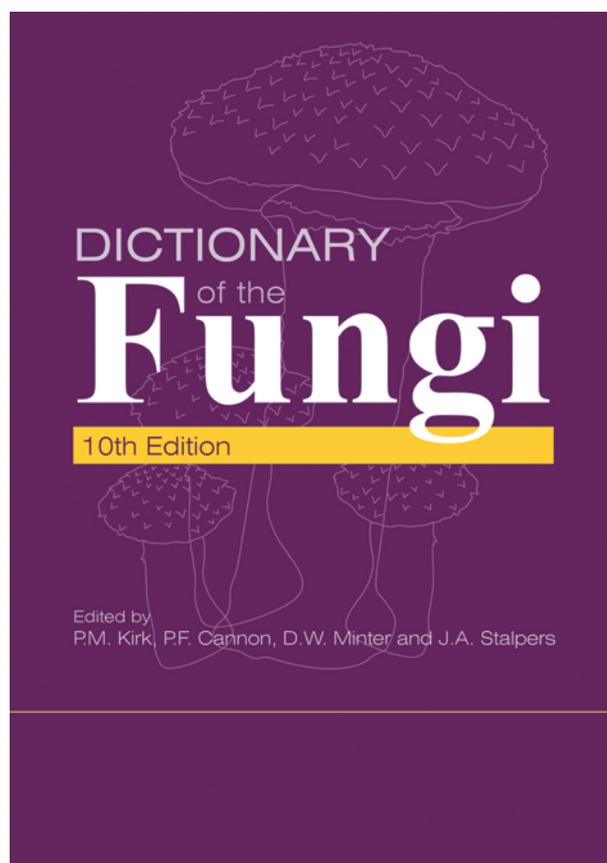
The *Dictionary*, comprising more than 21,000 entries, is actually a number of different works rolled into one. Firstly, and this is the bulk of the work, it lists all taxa of extant and fossil fungi (completely integrating lichenised fungi) from genus through the hierarchy of ranks (including families, orders, classes and phyla), including synonyms. Secondly, it is a glossary of mycological terms relating to morphology and techniques. Thirdly there are biographical entries, amongst which are mycologists with an austral connection such as **Gordon Cunningham**, **Clifford Hansford** and **Daniel McAlpine** (but not John Cleland); with a list of the included mycologists under **Author's names**. Fourthly there are entries for mycological societies, such as the **Australasian Mycological Society** and major reference collections (such as **K** and **NY**, but omitting **PDD**). Fifthly, there are longer entries on topics and techniques.

There are a few typos and occasional irregular indenting, which is not unexpected in such a massive compilation where many entries would have needed updating from the previous edition. In the literature listed under **Macromycetes**, *Field Companion to Australian Fungi* and *A Field Guide to Australian Fungi* have unfortunately been attributed to Aberdeen rather than Fuhrer. However, on the whole the work is very clearly laid out, especially where there are long lists of literature.

Unfortunately, there is no list of figures (with page numbers), which can make locating the figures very difficult, since they can be referred to on pages quite distant from their location. In addition, figures after fig. 18 (p. 330) are inconsistently numbered, with fig. 20 (p. 486), fig. 31 (p. 530), fig. 25 (p. 579), fig. 34 (p. 632), fig. 23 (p. 636), fig. 24 (p. 690), fig. 26 (p. 729), fig. 27 (p. 745). Also, cystidia shapes such as **lecythiform** are referred to fig. 23 (where general shapes are depicted) but not to fig. 14 (which is specifically of cystidia).

### Taxon entries

Each genus entry includes: author, date of publication, assignment to family, estimate of the number of species, geographical distribution and a list of selected literature. This extremely comprehensive compilation of generic names on its own would make the *Dictionary* invaluable.



In addition, there are entries on higher level taxa from family, through order, subclass, class, subphylum, phylum to kingdom, each referred to the next highest taxon, and with a list of the taxa included within (except for families, where only the number of genera is indicated). One feature of the 9<sup>th</sup> edition of the *Dictionary* was a systematic arrangement (at the end of the volume) where genera were listed under families, families under orders and so on (including superseded generic names, referred to their correct genus). This section is no longer included which makes assembling a list of genera within a family impossible, although this can be done on the on-line version.

A significant change to the organisation of the *Dictionary* (described by the editors as ‘radical’, but not before time) is that there are three parts; the main part dealing with the formal taxon **Fungi**, and two separate sections for the fungi-like organisms in the **Chromista** and **Protozoa**, respectively. The useful running heads of the starting and finishing entries on facing pages are bolded for the main **Fungi** section, but there is nothing to distinguish the sections on Chromista and Protozoa.

Another significant change to the organization is the revision of the higher classification of Fungi, largely based on the results of the AFTOL (Assembling the Fungal Tree of Life) project. Indeed, from comments in the Preface, this seems to have been the focus in revising entries for the 10<sup>th</sup> edition. It is excellent to have the classification updated, and also to have families disposed into the new arrangement (which was not the focus of the AFTOL project). However, the changes were obviously rushed, and this has led to a few serious errors.

The entry for the kingdom **Fungi** lists six phyla: **Ascomycota**, **Basidiomycota**, **Chytridiomycota**, **Glomeromycota**, **Microsporidia** and **Zygomycota**. Drastic omissions from this list are the **Blastocladiomycota** and **Neocallimastigomycota**, segregates from the Chytridiomycota, recognised at phylum level by AFTOL (Blackwell *et al.* 2007) which do have their own entry in DF10 at this rank, but are not otherwise referred to in the entry on Fungi (and nor under the Chytridiomycota), although they are included under Fungi in the on-line version. Another sign of how quickly classifications were changing during the preparation of the edition is that, in Table 4, the phyla under which numbers of fungi are reported are not in accord with the classification adopted, in only including Ascomycota, Basidiomycota, Chytridiomycota and Zygomycota. The replacement of subphylum **Ascomycotina** by **Pezizomycotina** seems to have been another late change; the entry for the former refers to the latter, but under **Pezizomycotina** there is only a reference to the **Pezizomycetes**, and not to any of the other nine classes that belong within the subphylum (and hence there is no ready means of establishing what are the constituent classes). However, the entries for each of the included classes, such as **Sordariomycetes**, do refer to the **Pezizomycotina**.

While the implication from the Preface is that the classification has been aligned with that of the AFTOL project, there are some departures that are included without comment. Examples in the Agaricales are the lumping (not in accord with AFTOL; Matheny *et al.* 2006) of Crepidotaceae under **Inocybaceae**, Hymenogastraceae under **Strophariaceae** and Omphalotaceae under **Marasmiaceae**. For each of these situations, the pairs of families are sister taxa, so at least the arrangement remains consistent with phylogeny (although in the first two cases the name adopted is not the earliest). However, placement of **Macrocytidiaceae** under Marasmiaceae is not in accord with AFTOL phylogeny (Matheny *et al.* 2006). A number of genera, such as **Cotyldia**, **Cyphellostereum** and **Rickenella**, are indicated in DF10 as belonging either in 'Hymenochaetales or Agaricales (Rickenella clade)'. The AFTOL classification recognises **Hymenochaetales**, and within this there is an informally named 'Rickenella clade' (Larsson *et al.* 2007), but there is no suggestion that this could belong in the Agaricales. In the Basidiomycota, **Wallemiomycetes** is not indicated as unplaced as far as subphylum (as in the AFTOL classification; Blackwell *et al.* 2007), and nor is there reference to that the fact that it belongs in the Basidiomycota in the main entry on that phylum. **Entorrhizomycetes** (similarly unplaced to subphylum in

AFTOL; Blackwell *et al.* 2007) is placed in DF10 in the **Ustilaginomycotina**. The AFTOL classification (Blackwell *et al.* 2007) excludes from the Zygomycota the subphyla **Entomophthoromycotina**, **Kickxelliomycotina** and **Zoopagomycotina** (which are all unplaced within the Fungi), whereas DF10 includes these subphyla within Zygomycota (albeit with a statement that the phylum is polyphyletic or paraphyletic). In the Ascomycota, the AFTOL classification (Blackwell *et al.* 2007) has **Calosphaeriales** as unplaced within the **Sordariomycetes**, but DF10 has under **Sordariomycetidae**. There may well be good reasons for some of these departures from the AFTOL classification, but in the absence of justification, and with the stated intention of bringing the classification in line with the results of the AFTOL project, the discrepancies can only be confusing.

Given the many novel features of the classification, it would have been most useful to include a table of orders within subclasses, classes, subphyla and phyla, along the lines of the phylogenetic tree in Blackwell *et al.* (2007), which could also show the unplaced taxa. The table in DF10 of orders of Ascomycota is in alphabetical order, and does not provide a clear picture of which orders belong in which classes (and subphyla are not indicated, and some taxa are placed in classes and some in subclasses). In this table (and in the main entry for the order), **Hypocreales** is listed in the **Sordariomycetidae**, when it belongs in the **Hypocreomycetidae**. In the *Dictionary* there are entries for taxa at subclass level, but these taxa sometimes seem to fall between the cracks as far as being interpolated in the classification. In the Basidiomycota, the entry for the class **Agaricomycetes** lists 17 orders, but there is no mention of the two subclasses **Agaricomycetidae** and **Phallomycetidae** (which have their own entries, under which are also listed the constituent orders) and nor is there mention of the fact that 11 of the orders of the Agaricomycetes are unplaced as to subclass.

The fact that some taxa do not have well-supported dispositions within all the ranks of the hierarchy is indeed a complication, but it does reflect the current state of knowledge and should be explicitly addressed. The inconclusive position of taxa due to unresolved phylogenetic reconstructions is likely in many cases to be rectified by additional taxon or gene sampling, but some taxa may remain hard to place. Previous editions of the *Dictionary* coped well enough with, for example, assigning genera to orders but not to families within these orders. There is an understandable tendency to want to pigeonhole all taxa, but it is better to be realistic about the uncertainty in disposition. One of the strengths of a phylogenetic classification is the predictive value in terms of trophic mode, secondary metabolites, ultrastructure and so on, and this is diluted when genera are slotted into families against current evidence. Flagging that genera are unplaced at lower taxonomic levels also will encourage further exploration of their relationships. Examples of genera that are assigned in DF10 to families in contradiction to published phylogenies (such as Matheny *et al.* 2006) are: **Descolea** in **Cortinariaceae** (rather than **Bolbitiaceae**),

*Gymnopilus* in ? **Strophariaceae** (when the genus belongs outside of this family, and also is not a member of the Cortinariaceae), *Infundibulicybe* in **Tricholomataceae** (when it is placed well outside of this family) and *Tricholomopsis* in Tricholomataceae (when it is not within this family, but is sister to **Amanitaceae**). *Panaeolus* is indicated as either belonging in the **Inocybaceae** or Strophariaceae, but molecular data place it outside of either family (and also is not in the **Psathyrellaceae**).

In migrating the classification of Fungi to one based on recent analyses, a challenge additional to unresolved phylogenies is where current data (morphological or molecular) are lacking entirely. Designation (by a simple typographical device such as a dagger) of genera where molecular data, in particular, are lacking would be useful, and serve as a stimulus for accumulating such data. Genera traditionally assigned to the Agaricales for which there are no molecular data include *Dennisomyces* and *Pegleromyces*. Such genera are all placed in families alongside other genera for which there is good phylogenetic information. Given the surprises that have already arisen from molecular phylogenies (such as *Coprinus sens. strict.* belonging in the **Agaricaceae**), the difference between genera with and without molecular data should be flagged.

An excellent feature of DF10, following the process started in previous editions, is the integration of genera of **anamorphic fungi** (formerly classified in the artificial Deuteromycetes) into the higher taxa based originally on teleomorph genera. These assignments may be to specific genera or be as general as to subphyla. The authors estimate that two thirds of the 3000-odd anamorph genera cannot be placed even to the level of class. Connections between anamorphs and teleomorphs have been long-known, such as from experiments on cultures, but many recent assignments of anamorphs into the phylogenetic classification of the Fungi have been based on molecular data. It would be useful to know what is the basis of the disposition of anamorphs, especially where molecular data are lacking (and again such as situation could be flagged by a dagger).

While the entries on genera are on the whole very up-to-date (with literature as recent as 2007 cited), some of the common names need updating as to their correct genus. **Ghost fungus** is still listed as *Pleurotus nidiformis*, rather than *Omphalotus*. **Native bread** (under the obsolete term **Blackfellow's bread**) is still listed as *Polyporus mylittae* rather than *Laccocephalum*, as is *Polyporus tumulosus*. The latter is under the common name **Giant stone-fungus**, which is the first I have seen of this term, and a reference, such as Reid *et al.* (*W. Austral. Naturalist*. 14: 120, 1979), would be useful to give context to the entry.

Distribution information for each genus is one of the very useful features of the *Dictionary*, but in some cases readily available on-line checklists for Australia and New Zealand have not been consulted: *Claustula* occurs not only in New Zealand, but also Australia; *Porpoloma* is not only in South America but also New Zealand (and for that matter occurs in North America and Europe); and *Auritella* is not only in Australia but also in Africa (as can be ascertained from literature actually cited in the

entry). In addition, references to austral species originally described in *Paxillus* that properly belong in *Austropaxillus* are still listed under the former genus. The User's Guide to DF10 does point out that the 'distributions given are approximate ... and should be regarded as indicative', but it is a shame that the necessary updating has not been carried out.

While the literature sources for synonymy are usually given (but not always, as for *Macowanites* under *Russula*); for quite a number of the synonymous genera of the Basidiomycota there is merely an indication to Kuyper or Stalpers 'in litt.' (such as *Cauloglossum* under *Podaxis*, *Copelandia* under *Panaeolus*, and *Dermocybe* under *Cortinarius*). These dispositions are correct, but it would be very useful to refer directly to the original source of the synonymy, since this is more difficult to track down than the place of new publication of genera. One recent synonymy that has been overlooked is *Pyrhoglossum* under *Gymnopilus* (Rees *et al.* 2002).

### Longer entries

The longer entries cover topics such as **climate change, conservation, forensic mycology, mycotoxins, phylogeny and weathering**; techniques such as **phylogenetic techniques, slide making** (squash mounts, slide culture etc.) and **stains** (all the technique topics are listed under **methods**); and informal groups of fungi such as **discomycetes, macromycetes and truffles**. Some entries are not where one might expect and a few more cross references would assist, such as from the short definition of **mycophagy** to the longer entry on **animal mycophagy**, and from the short entry for **community** to the longer entry on **mycosociology**. In the entry on **mycorrhiza**, the original distinction between **ectotrophic** and **endotrophic** mycorrhizas is explained, but the current categories (**ectomycorrhiza, vesicular-arbuscular, ericoid, orchid, arbutoid and monotropoid**) are listed, but not defined. The scope and depth of the long entries varies, but on the whole they all provide a good entry into the topic, especially as far as the comprehensive lists of literature cited. It is disappointing that the comprehensive treatments in the introductory volumes of the *Fungi of Australia* series of topics such as freshwater fungi, marine fungi, wood decay fungi, arthropod fungi, mycoses and mycophagy are rarely referred to.

### Glossary entries

The glossary-type entries cover a wide variety of descriptive terms that can be applied to fungi, from **abaxial** to **zymurgy** (the practice of fermentation). I checked DF10 against a glossary that I have prepared of nearly 300 morphological terms applied to agarics, and there were some surprising omissions. Some were ordinary words that don't really need defining (like *conical*), but others are commonly enough utilised, such as *amygdaliform*, *capitulate* (although **capitellum** is included), *caput* (although **capitate** is included), *citriniform* (although **limoniform** is included), *criniform* (as applied to the sterile stipe-like organs of *Mycena cystidiosa*), *gloeosphex* (as applied to the hour-glass tipped cystidia of *Hohenbuehelia*), *inamyloid* (although **amyloid** is included), *phaseoliform*, *pseudostipe* (a dorsal extension of the **pileus** attaching it to the

substratum), *sphaeropedunculate* and *tibiform*. In addition, some terms, such as **calyptra** (defined as ‘a cap or hood’) are more generally defined than their particular use in mycology; *calyprate* spores specifically having a partial envelope around the spore formed by the perispore, closely applied at the spore apex, but loose around the exposed edge.

Terms for **pellis** structure are not well covered—although **hymeniderm** and **trichoderm** are correctly defined. Confusingly, **cutis** is defined as a synonym for **cuticle**, whereas in fact cuticle is synonymous with **pellis** but a cutis is a particular type of **pellis** (composed of more or less cylindrical hyphae that are parallel to the surface). The entry for **epithelium** is ‘see cutis’, but an epithelium is a distinctive type of **pellis** consisting of inflated elements more than one layer deep. Given that the variety of ascomycete **tissue types** is illustrated, similar detail for basidiomycete tissues should have been included. In addition, terms for the arrangement of the *lamellar trama* should have been illustrated, and definitions included for *bilateral* (=divergent), *descending*, *inverse* (=convergent), *interwoven*, *mediostratum* and *regular*.

### Conclusion

For those wondering about the publication by CSIRO Publishing, this version appears to be a direct reprint for sale in Australasia of the original edition published by CABI (with ISBN 9780851998268). Given the gravity of the errors at phyla level discussed above, consideration should be given to correcting these errors in the reprint, or at least including an errata sheet.

In the authors’ introduction they state that the 10<sup>th</sup> edition ‘may well be the last ‘ink-on-paper’ version of the *Dictionary of the Fungi*. At least part of *Dictionary*, in the form of the taxonomic hierarchy, is already available on line, although only the names and original publication details are provided, but not distribution and other literature. It would be wonderful if the geography could be included in a searchable version, so that taxa present in particular regions could be selected. It would be much easier in an on-line version to include further

information, such as the basis for anamorph-teleomorph connections, and whether molecular data are available. It would also be useful if other components, such as the glossary, were made available on-line, particularly with addition of illustrations.

The **internet** merits an entry, but the list of web sites is not very comprehensive (and nor are websites cited very often throughout DF10). It is stated at the end of the entry for **macromycetes** that the quality of information on the internet is variable. This is no doubt true, but it would benefit users if the *Dictionary* highlighted the best of what is available on the internet, among which is an increasing number of very useful sites, especially those showcasing high quality colour photographs. In time, the challenge for a fully on-line *Dictionary* will be to retain the authoritativeness and comprehensiveness of the printed version, while creating opportunities for users to correct and add information.

I have spent some detail in this review on areas that need correction, in the spirit of improving future editions; but when perusing the review copy, I was always impressed and grateful for the massive effort that has gone into preparing and updating the *Dictionary*. The range of bolded terms above demonstrates the variety of taxa and topics that are covered. The authors refer to the work as ‘marvellously imperfect’, and this perfectly sums it up.

### References

- Blackwell M, Hibbett DS, Taylor JW, Spatafora JW 2007. Research Coordination Networks: a phylogeny for kingdom Fungi (Deep Hypha). *Mycologia* **98**, 829–837.
- Larsson K-H, Parmasto E, Fischer M, Langer E, Nakasone KK, Redhead SA 2007. Hymenochaetales, a molecular phylogeny for the hymenochaetoid clade. *Mycologia* **98**, 926–936.
- Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo J-M, Ge Z-W, Yang Z-L, Slot JC, Ammirati JF, Baroni TJ *et al.* 2006. Major clades of Agaricales: a multilocus phylogenetic overview. *Mycologia* **98**, 982–995.
- Rees BJ, Zuccarello GC, Orlovich DA 2002. Relationships between Australian and northern hemisphere *Gymnopilus* species II. A preliminary phylogeny of species of *Gymnopilus* and related genera based on internal transcribed spacer (ITS) region of ribosomal DNA. *Mycotaxon* **84**, 93–110.