Conidial fungi

Penicillium subgenus _Penicillium_: New taxonomic schemes, mycotoxins and other extrolites. By Robert A. Samson & Jens C. Frisvad. 2004. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [Studies in Mycology No. *49.*] Pp. vi + 258. *ISBN 90 70351 53 6.* Price: € 50.

This number of *Studies in Mycology* comprises four contributions on the economically most important subgenus of *Penicillium*. The most substantive of these (173 pp.) is a predictive polyphasic taxonomy prepared by Frisvad & Samson. This and correct identifications are paramount as these are amongst the most difficult of fungi to identify accurately. Nevertheless, this new presentation is intended to be stable for many years. The paper definitely has an extrolite emphasis. 'Extrolite' is the term coined by Frisvad for externally produced compounds that previously were generally referred to as secondary metabolites, although the term does not appear to cover secondary metabolites which function internally (such as those associated with conidiation). I no doubt approached this paper with an idiolite bias.

In all 58 species are accepted, of which four are new, and some terverticillate species are intentionally excluded. Phenotypic characters used include micro- and macromorphology, physiology, and nutritional characters. All species were analysed for secondary metabolites, and the profiles were highly species-specific and "often" of high consistency. The history of the use of secondary metabolites in penicillia is discussed. Cultures were all analysed by HPLC DAD and electrospray mass spectroscopy – not facilities to be found in a typical taxonomic laboratory (unfortunately). It is noted that nucleic acid characters were not included, which is surprising in the current climate and for such a well-studied genus. Descriptions, excellent colour illustrations of colonies, and almost 3D micromorphology images of all the treated species are provided. Keys to the taxa are included and a database with further details is provided at http://www.cbs.knaw.nl/penicillium.htm. The authors confirm that identifications are difficult because the micromorphologies are all very similar. However, a synoptic key is provided for the 17 series despite this assertion. It would be interesting to express the data provided in the "box" keys, and the other information in a dendrogram.

I produced a dendrogram myself from the extrolite information presented which I entered into a database for use in ongoing (including DNA) studies on penicillia in my laboratory. Species emerged as usually distinct, however, *P. dipodomyicola*, *P. formosanum* and *P. ulaiense* clustered more on a lack of production than the reverse (all from sect. *Penicillium*). *P. dipodomyis*, *P. nalgiovense*, and *P. flavigenum* were closely related and all from series *Chrysogenum*. *P. commune* and *P. camemberti* were very similar and both belong to series *Camemberti*. Equally, *P. echinulatum* and *P. solitum* were virtually the same and both from series *Solitum*. There was a large cluster from species numbers 21-28 in my dendrogram of a mixed series origins. Another cluster was apparent from numbers 49-52, consisting of sects. *Viridicatum* and *Penicillium*. One group of species (25, 30 and 55) clustered, although otherwise unrelated. This was followed by triplet 15-18, all from series *Viridicata*. A large cluster from species 2-17 were all sect. *Viridicata* apart from one of sect. *Penicillium* (53). Finally, important individual species formed "single member clusters." In summary, there appears to be relatedness in some cases from the extrolite data alone.

The subgenus is characterised by having plastic phenotypes rendering taxonomies very unstable. Other characters are required to stabilise the taxonomy and to recognise new species. Controversially, the authors state that DNA sequencing is more suited for phylogenetic studies and less satisfactory for classification and identification than phenotypic data. Surely that depends on the available technological equipment and expertise – in many laboratories molecular facilities are routinely used by students while there may not even be an obsolete HPLC in the faculty. In fact, very few differences have been found by other workers between taxa in the sequenced ITS1 and ITS 2 regions in this subgenus, for example that of Peterson on its rDNAs. The authors conclude that rDNA has too few differences to reveal the phylogeny of the penicillia (or that they are monophyletic – my addition). However, the second paper in the issue uses partial ß-tubulin gene sequences and gives "a more resolved phylogeny". Although it is revealing that the two ochratoxin A "species" are identical. The difficulty in evaluating some other studies is mentioned, such as those of Bridge *et al.* in the 1980s.

As many isolates of each species "as possible" were examined to determine variability, but without providing the actual numbers studied. It is mentioned that cultures were occasionally not in good condition after years of maintenance in collections of fungal cultures, which sounds somewhat perverse. Many controversies exist about the use of infraspecific ranks, such as variety and subspecies. It is noticeable that all the varieties Frisvad recognized previously have now disappeared.

It is apparent that to obtain species identifications in the Frisvad & Samson scheme, data on all the chemistry, physiology and morphological methodologies is required; one must wonder as to the feasibility of so doing in busy laboratories. Most of the species are associated with the foods/feeds of terrestrial animals, or in some cases their dung (is there a difference?). The authors assert that most are associated with particular habitats, a statement which is somewhat contradicted by saying that most authors regard them as ubiquitous weed organisms!

A third paper in the issue reviews the mycotoxins and pharmaceuticals produced by the subgenus, and suggests that they are still being "bioprospected". The authors' marvel that previous schemes were in any way successful without extrolite characters. However, it is also stated that accurate identifications are possible without extrolites, again something of a contradiction. Frisvad & Samson's penicillia concepts are closer to those described by Raper & Thom in 1949 than by Pitt in 1980, so there is a sense of coming full-circle. I cannot help thinking that a simpler identification system followed by relevant biochemical analyses would be more helpful (Paterson *et al.* 2004).

The final paper of the quartet is devoted to classification by electrospray mass spectrometry. An extremely elegant and sensitive approach, but unlikely to be able to be applied in all but the most sophisticatedly equipped laboratories.

The English is uneven on occasions throughout (e.g. p. 40), and neither is it free of typographical errors. In addition, my issue disintegrated into loose leaf form upon first opening. Further, I cannot accept that aromas of cultures should ever be used as characters in case toxic or carcinogenic compounds are inhaled. Indeed a section on safety would have been appropriate. Nevertheless, I can think of no other taxonomic workers in the world who could have produced this work, because of its technical sophistication and their combined experience. This publication will be indispensable

to a wide range of mycologists because of the inclusion of mycotoxin, pharmaceutical, and ecological information, and constitutes another landmark in the series of key works on penicillia.

Paterson, R. R. M., Venâncio, A. & Lima, N. (2004) Solutions to *Penicillium* taxonomy crucial to mycotoxin research and health. *Research in Microbiology* **155**: 507-513.

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