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Molecules, morphology and classification: Towards monophyletic genera in the Ascomycetes

Introduction

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In 1979, in the proceedings of the second Kananaskis conference, published under the title, 'The Whole Fungus', Weresub and Pirozynski wrote, 'The time will come when our grasp of the morphology, biochemistry and genetics of all fungi will enable us to classify all anamorphic fungi botanically...'.

The last ten years of fungal taxonomy have seen amazing progress towards this goal. Fostered by the invention of the polymerase chain reaction and the automation of DNA sequencing chemistry, molecular techniques have changed the way that fungal taxonomy is done. Phylogenetic relationships between kingdoms, phyla and divisions of organisms have been inferred by the generation of gene trees using a variety of genetic loci, in particular subunits and spacers of ribosomal RNA genes. This volume of papers concern itself with finer taxonomic distinctions, in particular generic classifications, and one of the puzzling logistic problems of fungal taxonomy... the occurrence of pleomorphic sporulation and the historical practise of giving separate names to the asexual and sexual morphologies of a single life cycle.

Coincident with the development of molecular methodologies, cladistic taxonomy has also had a revolutionary effect on the way that taxonomies are constructed. These ideas originated with Hennig in the 1960's, but were employed by only a minority of morphological systematists. These theories are ideally suited for discrete molecular data, and now practically any issue of any mycological journal will include phylogenetic trees generated by computer programs applying cladistic concepts and algorithms. Cladistics has its own terminology. We have added a short glossary at the end of this introduction to give the reader some familiarity with some terms used by authors in this volume.

These new approaches and the rapid pace of change have given fungal taxonomy a new vitality, even as the number of taxonomic specialists has declined. Culture collections have received new recognition as virtual DNA depositories, an extension to their original responsibilities as keepers of ex-type cultures and metabolically active strains. Symposia and congresses are filled with images of phylogenetic trees and discussions of monophyletic, paraphyletic and polyphyletic groups. Large international meetings present data covering an immense breadth of taxa, often limiting the amount of time for discussion of individual data sets. In this whirlwind of activity, it is easy to lose sight of the details in the mountain of data.

Symposia at two international meetings held in August 1999 attempted to address information overload by focussing on a small number of Ascomycete orders that are particularly anamorph rich. At the heart of these meetings were several simple questions:

(i) Why are some ascomycete genera associated with such a large number of anamorph genera?

(ii) Why are some anamorph genera apparently so

widely distributed across orders or families of Ascomycetes?

(iii) Is it logical to expect a concordance of anamorph and teleomorph taxonomies?

(iv) How can mycologists effectively combine morphological and molecular data to produce reliable classifications and identification regimes?

(v) How can we best delimit monophyletic genera in the Ascomycetes without losing the information accumulated during 200 years of taxonomic study?

At the XVIth International Botanical Congress held in St. Louis, Missouri, USA, a symposium entitled 'The genus for genus concept' was organized by Pedro Crous and Gary Samuels. It included six presentations discussing theoretical concepts and data, with the underlying idea that fungal taxonomy should move towards a 1:1 correlation of teleomorph and anamorph generic concepts. At the IXth International Congress of Mycology of the International Union of Microbiological Sciences, in Sydney, Australia, a two day workshop called, 'Molecules, Morphology and Classification: Towards Monophyletic Genera in the Ascomycetes', was organized by Keith Seifert, Pedro Crous, Walter Gams and Gary Samuels.

Papers from both meetings are included here, as well as one paper on *Chalara* that was presented as a poster at the IUMS meeting in Sydney. The reader may wish to reflect on the questions listed above while reading the deliberations herein. The simple questions do not have simple answers, and conclusions in one group of fungi may be contradicted in another.

One of the recommendations to emerge from the Sydney meeting was an acknowledgment that while anamorph names often have an intrinsic information value, it is sometimes not necessary, or even desirable, to use them in the formal, Latinized sense. For that reason, we have adopted an editorial convention in this volume whereby some anamorph generic names are used as unitalicized nouns when they are being used in a strictly monomorphic, form sense. We have provided definitions for some of these terms in the appendix to this introduction.

The title of this volume is an homage to the classic paper 'Conidiophores, conidia and classification', published by our friend and colleague Stanley J. Hughes nearly 50 years ago.

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A glossary of some terms used in this volume

apomorphy A recently derived character state

clade A monophyletic group

monophyletic Pertaining to a group with a unique origin from one ancestral species, including all the descendants and the common ancestor

monothetic Pertaining to a taxon described by a collection of characters, each one of which must be present to allow membership in that taxon

paraphyletic Pertaining to a group with a unique origin from one ancestral species, from which some descendants are excluded

plesiomorphy A primitive or ancestral character state

polyphyletic Pertaining to a group originating from more than one ancestral species, ie. lacking a unique common ancestor

polythetic Pertaining to a taxon described by a collection of characters, of which a member must express a subset, with no specific characters considered essential for inclusion (a term from numerical taxonomy)

synapomorphy An apomorphy shared by all members of a terminal or subterminal clade

Appendix:

Examples of anamorph generic names known to be phylogenetically paraphyletic or polyphyletic, but that can be used as descriptive nouns.

acremonium hyaline anamorph with single or paired phialides emerging directly from hyphae, bearing hyaline conidia in slime

chalara mononematous anamorph with phialides with long, tubular collarettes, with the conidiogenous locus near the base of the collarette

cladobotryum mononematous hyaline anamorph with highly branched conidiophores, producing multiple hyaline 0–1-many septate conidia that are dry or tacky

cryptococcus unicellular polysaccharide-encapsulated holoblastically or sympodially budding yeast assimilating inositol, producing strach like compounds extracellularly, degrading urea, staining red in diazonium blue B

cylindrotrichum mononematous, dematiaceous anamorph with terminal polyphialides and slimy septate conidia

dendrodochium sporodochial, lightly pigmented anamorph with phialidic conidiogenous cells and slimy conidia that are not dark green

fusarium sporodochial or synnematous conidiomatal anamorph, with phialides and multiseptate, falcate conidia with a notched basal cell, borne in slime

gliocladium mononematous, hyaline or brightly coloured anamorph, with conidiophores terminating in a branched apex, with each level giving rise to a whorl of structures, producing slimy, unicellular conidia

graphium determinate synnema with dark stipe and bearing hyaline conidia in slime

myrothecium sporodochial or synnematous lightly pigmented anamorph with phialidic conidiogenous cells and dark green, slimy conidia

papulaspora dematiaceous bulbil-like or microsclerotium-like propagule composed of equal-sized, isodiametric cells

penicillium mononematous conidiophore terminating in a branched apex, with each level giving rise to a whorl of structures, terminating in phialides producing dry conidia connected in chains

phialophora single, variously pigmented phialides with clearly visible collarettes, emerging directly from hyphae, or on sparsely branched conidiophores, bearing hyaline or lightly pigmented conidia in slime

selenosporella	mononematous hyaline anamorph with sympodially proliferating conidiogenous cell lacking denticles, with dry sickle-shaped conidia
sesquicillium	mononematous, highly branched, hyaline anamorph with terminal monophialides subtended by intercalary phialides with lateral phialidic apertures
sporothrix	mononematous, hyaline anamorph, with sparsely branched conidiophores, distinctly denticulate, sympodially proliferating conidiogenous cells and dry conidia
stigmina	sporodochia with thick-walled, brown, verruculose conidiophores and irregular annellations that give rise to pigmented conidia that are transverse or muriformly septate
stilbella	determinate synnema with an unpigmented or nondematiaceous stipe bearing hyaline or brightly coloured conidia in slime
verticillium	mononematous anamorph with erect hyaline conidiophores bearing 2 or more whorls of hyaline, phialidic conidiogenous cells, producing conidia in slime