II. Taxonomy and Phylogeny of Fungi

By WALTER GAMS and WALTER JÜLICH

1. General Considerations, Phylogeny, and Ecology

We welcome the publication of the 7th edition of AINSWORTH and BISBY's Dictionary of Fungi (HAWKSWORTH et al. 1983) which reflects the considerable progress achieved in mycology over the past 12 years. We also wish to mention the much improved 4th edition of MÜLLER and LOEFLER'S Mykologie (1982) which now presents a strongly modernized classification of the fungi. In order to provide a pragmatic framework, we adopt here a compromise between these two works (for ascomycetes also ERIKSSON 1982 and M. BARR 1983 and for basidiomycetes KHAN and KIMBROUGH 1982) as basis for the systematic arrangement. The full integration of lichens in the fungal system cannot, however, be adopted for the present report.

Speciation in fungi was the topic of BURNETT's (1983) presidential address to the British Mycological Society. Numerous examples of genetic differentiation at or below species level were reviewed. Genetic separation need not be allopatric, and sympatric sibling species are drawing more and more attention. Recent examples are the separation of Armillaria mellea (MARC-MÜLLER 1982; ROMAGNESI and MARX-MÜLLER 1983) and Heterobasidion annosum into several host-specific microspecies (CHASE and ULLRICH 1983, WORRALL et al. 1983). (See also Uredinales).

Studying haploid mitotic fruiting in Polyporus ciliatus, PRILLINGER and SIX (1983) emphasized that the sexual cycle is controlled genetically by mating type factors on the one hand, and by a multitude of different genes determining fruitbody formation on the other. Similar conclusions were reached by MEINHARDT and ESSER (1983) while surveying genetic aspects of sexual differentiation in fungi. PRILLINGER (1982a) reviewed the occurrence of haploid apomixis and amphithallism among basidiomycetes, which lead to fruiting without previous sexual reaction. Forcibly discharged meiotic basidiospores are regarded as derived from mitotic ballistospores, and haploid apomixis as a primitive character. Heterothallism is believed to have evolved from homothallism along different lines within the fungal kingdom (PRILLINGER 1982b) as suggested by KNIJP in the 1920's. Some cases of homothallism are, however, derived from a heterothallic condition. JAHRMANN and PRILLINGER (1983) found a yeast phase in the homobasidiomycete Asterophora lycoperdoides; in order to interpret this surprising observation, they reviewed various old and new ideas of fungal phylogeny; if it has a phylogenetic implication at all, this yeast phase would be a sign of atavism. Chitinous fungi may have been derived from primarily heterotrophic unicellular organisms; primitive fungi might have adapted to terrestrial life in a coccoid phase.

As in our previous contribution, the second author deals with the taxonomy of basidiomycetes and the senior author with remaining groups.
Nomenclature. The problems caused by the changes in Art. 13 ICBN (VOSS et al. 1983) noted in our previous report were discussed by KORF (1982 a, b), PETERSEN (1983b) and RAUSCHERT (1983); GAMS and KUYPER (1984) tried to solve problems encountered by GAMS (1984) who compiled an index to the sanctioned names. The fate of names adopted by FRIES before the "Systema" was traced by PETERSEN (1983a).


Chemotaxonomy. 5S rRNA was sequenced for a few basidiomycetes by WALKER and DOOLITTLE (1982) and the results were recalculated by TEMPLETON (1983); the findings support a fundamental separation in doliporous and non-doliporous basidiomycetes but do not object against a monophyletic origin of the basidiomycetes. Digestion of DNA by restriction enzymes and analysis of the resulting fragments by gel electrophoresis or hybridization with radioactively labeled RNA was applied for the first time to fungi but with species of Aspergillus it did not yield plausible results (KOZLOWSKI and STEPIEN 1982). Coenzyme-Q systems showed considerable heterogeneity in yeasts and yeast-like fungi (YAMADA et al. 1982, 1983). Consistent results were obtained at the genus level, with exceptions in Trichosporon (YAMADA et al. 1982).

The study of cytochrome absorption spectra is another approach which supports previous conclusions on the existence of two distinct groups of species within Kluyveromyces (FIOL and CLAISSE 1982). Analysis of glucuronic acid content in cold-water extracts of fruitbodies of diverse asco- and basidiomycetes showed unusually high percentages in the Phallales and relatively low levels in the ascomycetes examined (TSUCHIHASHI et al. 1982). Sterols were analyzed in some species of Oomycota and Hyphochytridomycota (WARNER et al. 1983); the preferential utilization of cycloartenol over lanosterol in all taxa studied may indicate an ancestral affinity to photosynthetic organisms. The abundant production of ergosterol by Zoophagus (Pythiaceae) is unusual, casting doubts on its classification (WARNER et al. 1982). Sterol content in two species of Endogonales differs from that of other Zygomycetes (BEILBY 1980, BEILBY and KIDLEY 1980). An unusual sterol, brassicasterol, was found in Taphrina and Protomycetes, in addition to ergosterol in some species of Taphrina (VAN EIJK and ROEIJMANS, 1982). Large quantitative differences in composition of cellular fatty acids allowed four groups of yeasts to be distinguished (MOSS et al. 1982). TLC analysis of secondary metabolite profiles (some pigments, some mycotoxins) in Penicillium yielded taxonomic criteria that may be useful in deciding about delimitation of critical species (FRISVAD and FILLENBORG 1983). The levels of the naphthoquinone pigments (toxins) xanthomegnin and viomellein allowed two groups of isolates of Penicillium viridicatum to be distinguished (CIEGLER et al. 1981). In contrast with previous unsatisfactory results using isoenzyme analysis for fungal taxonomy, JONES and NOBLE (1982) obtained a good correlation with morphological classification in some Dermatophytes. Pectic zymograms seem to be particularly promising as a taxonomic tool in Sclerotinia (CRUIKSHANK 1983a) and Botrytis (CRUIKSHANK 1983b). BERNIER et al. (1983) succeeded in differentiating between aggressive and nonaggressive isolates of Ceratocystis ulmi, using five particular enzymes. The highest specificity of serological techniques is achieved by means of monoclonal antibodies; IANNELLI et al. (1982, 1983) even were able to differentiate between formae speciales of Fusarium oxysporum by applying at least five hybridomas in one analysis. Analysis of amino acids in total fungal protein of some yeasts and yeast-like fungi led to the crude distinction of eight somewhat heterogeneous groups (KOCKOVÁ-KRATOCHVÍLOVÁ et al. (1981). (More work on DNA and serology is cited under "Endomycetales").