

CHAPTER 2

**IDENTIFICATION, NAMES AND NOMENCLATURE  
OF COMMON EDIBLE MUSHROOMS**

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**1. TAXONOMY IS FUNDAMENTAL TO MUSHROOM SCIENCE**

Taxonomy is fundamental to biological science and is the basis of information exchange. Names are the key to all knowledge about a species. Increased taxonomic knowledge of edible mushrooms benefits research on cultivation technology and breeding. For example, an awareness of current taxonomy will help to focus breeding strategy, avoiding crosses between two apparent 'species' (strains bearing different names) that are taxonomically identical.

Name changes typically derive from improved scientific knowledge of an organism in comparison with related taxa. Other reasons for changes include the existence of an earlier name which has priority, the replacement of an incorrect name (e.g. a homonym), and misidentification. The literature on systematic mycology is extensive and diverse, and is likely to be consulted infrequently by applied mushroom researchers. Taxonomists have a responsibility to transfer important information on taxonomic reassessment to relevant users in a form that can be understood and applied. Name changes of fungi of economic importance are explained in a series of papers prepared by the International Commission on the Taxonomy of Fungi, although only one mushroom species, shiitake, has been treated (Cannon, 1986).

International conferences allow a multidisciplinary approach to mushroom science in which the contributions of taxonomists can be assimilated by applied scientists. This paper considers the species concept in the basidiomycete fungi, and reviews recent clarification and current usage of names for cultivated edible mushroom species of the seven most important genera (Chang, 1991). The genera are treated in order of total production. The lack of taxonomic consensus for names of certain species, and unresolved variability in other species is discussed.

**2. THE SPECIES CONCEPT IN THE BASIDIOMYCETES**

The application of fungal names is determined by means of permanently preserved type specimens, a foundation Principle of the governing International Code of Botanical Nomenclature

(the Code) and the cornerstone of nomenclatural stability.

Morphology of the fungal fruit-body is the traditional basis for classification in fungi. Macroscopic features, in isolation, are rarely adequate to support taxonomic conclusions. Cap colour, for example, can vary considerably. Albinism has been reported in *Auricularia cornea*, *Lentinula edodes*, *Pleurotus ostreatus* and *P. salmoneostramineus*, arising spontaneously from mutation of a single recessive gene (Murakami & Takemaru, 1990). Microscopic features - in particular of spores, sterile elements of the spore-bearing region, and hyphal arrangement - provide more reliable characters.

Intercompatibility studies (Boidin, 1986) have frequently resolved questions about morphological variability within a single 'species', and apparent similarities between 'species' which carry different names. Monokaryotic strains derived from single spores or by neohaploidisation of dikaryotic strains (e.g. Petersen, 1993) are mated. In species with clamp connections at septa of dikaryotic hyphae, intercompatibility is judged by the presence of clamp connections on stable mycelia of mated colonies. True 'interfertility', however, requires successful fruiting of the mated colony and determination of the viability of progeny (Boidin, 1986). Intercompatibility is frequently sufficient to infer species relationships, though possible misinterpretations, in particular resulting from use of too few strains, have been discussed by Boidin (1986). Intercompatibility studies assist taxonomists in determining whether collections should be regarded as representing different species or grouped into a single species. Partial intercompatibility may indicate speciation in progress.

The biological species concept, based on genetic isolation between species, is widely accepted (Hallenberg, 1987). Hallenberg (1987) divided species (of corticioid basidiomycetes) into three groups: a majority of species with uniform morphology distinct from that of other species; a second group of 'species complexes' where a species circumscription suggests that more than one biological species may be present, though these entities are not easily separated by morphology; and a third group where a species is considered to be morphologically uniform but interincompatible groups (cryptic or sibling species) are discovered among strains through intercompatibility studies. Examples of the second and third groups among the edible mushrooms include the *Pleurotus ostreatus* 'complex', recently resolved, and the siblings of *Tremella fuciformis*, respectively. The nomenclatural treatment of siblings varies. Hallenberg (1987) is followed here in requiring at least some distinguishing features of morphology, biochemistry, ecology or distribution before detected sibling entities receive Latin binomials.

### 3. NAMES OF COMMONLY CULTIVATED EDIBLE MUSHROOMS

#### 3.1. *Agaricus*

The choice of name for the white button mushroom remains open to debate, following the reports of Malloch (1976) and Malloch *et al.* (1987) that *Agaricus bisporus* (Lange) Imbach, the basionym of which was described in 1926, is a synonym of the earlier name *A. brunnescens* Peck, described in 1900. Applying the principle of priority, the earlier name *A. brunnescens* is nomenclaturally correct. Neither name was originally applied to the cultivated mushroom (Malloch *et al.*, 1987). Comparison of type material of the two names is unfortunately not possible since there is no extant holotype material of *A. bisporus*.

Singer (1984) compared fresh collections with the holotype of *A. brunnescens* and with published descriptions of *A. bisporus* and *A. brunnescens*, and concluded that the names refer to two distinct species separated by fine morphological differences including colour change in context

tissue and presence of 4-spored basidia in young fruit-bodies of *A. brunnescens*. Malloch *et al.* (1987) reported that a fresh Canadian collection was both conspecific in morphology with the holotype of *A. brunnescens* and, on the evidence of mitochondrial and nuclear DNA restriction patterns, conspecific with cultivated *Agaricus* strains. While questioning the validity of Singer's distinguishing characters, Kerrigan (1987) did not emphatically support synonymy. Rather, he suggested that synonymy be accepted as a 'working hypothesis' and that the name *A. bisporus* be considered for conservation, against *A. brunnescens*, because of its long-established use. A formal proposal for conservation has not yet been made.

The other important cultivated *Agaricus* species, *A. bitorquis* (Quél.) Sacc., is clearly separated from *A. bisporus/brunnescens* (Smith, 1978; Malloch *et al.*, 1987). In addition to morphology, electrophoretic analysis of isozymes of extracellular laccases can reliably separate *Agaricus* species (Kerrigan & Ross, 1988).

#### 3.2. *Pleurotus*

*Pleurotus* production increased over four-fold between 1986 and 1989/90 (Chang, 1991). The taxonomic confusion so apparent in the genus (Rajarathnam & Bano, 1987) may be due, in part, to the rapid development of cultivation of several species and the misapplication and misinterpretation of names of newly cultivated strains. Commercial strains may carry ambiguous or incorrect names, thus perpetuating early errors in identification.

Only recently has significant taxonomic analysis brought necessary clarification. The genus is taxonomically difficult because of variability in fruit-body morphology in several species, resulting in species being described under more than one name, especially from different regions of the world. Through intercompatibility studies, a number of apparently morphologically distinct taxa have been found to belong to a common biological species. Similarly, intercompatibility studies have enabled discrimination of taxa for which distinguishing morphological characters were lacking or apparently inconsistently present in different geographic regions.

Other means of discriminating species of *Pleurotus* include electrophoretic analysis of enzymes (Magae *et al.*, 1990), and differences in nuclear DNA content correlated with different chromosome number and ploidy (Bresinsky *et al.*, 1987). Allozyme analyses of May & Royse (1988) suggest that a number of strains labelled *P. ostreatus* have been misidentified.

The following list cites epithets of commonly cultivated *Pleurotus* species, with references to synonymy and descriptions. Currently accepted names are in bold. Names followed by an asterisk are discussed further:

- abalonus*\* Han *et al.* - (Han *et al.* 1977; Hilber 1982).
- citrinopileatus*\* Singer = ***P. cornucopiae*** var. *citrinopileatus* (Singer) Ohira - (Hilber, 1982; Ohira, 1990; Petersen, 1993).
- columbinus* Quél. = ***P. ostreatus*** var. *columbinus* (Quél.) Quél. - (Hilber, 1982, 1989).
- cornucopiae*\* (Paul.) Roll. - (Hilber, 1982; Boekhout, 1990).
- cystidiosus*\* O.K. Miller - (Miller, 1969; Hilber, 1982; Guzmán *et al.*, 1991).
- djamor*\* (Fr.) Boedijn - (Corner 1981; Pegler 1986).
- eryngii* (DC.) Quél. - (Hilber, 1982; partially inter-incompatible varieties or ecotypes - Hilber, 1982; Bresinsky *et al.*, 1987; Boekhout, 1990).
- flabellatus* Berk. & Br. = ***P. djamor*** - (Corner, 1981).
- fossulatus* (Cooke) Sacc. - (Pegler, 1976).

*nebrodensis* (Inzenga) Sacc. = *P. eryngii* var. *nebrodensis* (Inzenga) Sacc. - (Hilber, 1982).  
*opuntiae* (Dur. & Lév.) Sacc. - (Hilber, 1982; Pegler, 1977).  
*ostreatoroseus* Singer =? *P. djamor* - (Petersen & Hughes, 1993).  
*ostreatus*\* (Jacq.) Kumm. - (Hilber, 1982; Boekhout, 1990).  
*pulmonarius*\* (Fr.) Quéf. - (Ohira & Matsumoto, 1980; Hilber, 1982; Boekhout, 1990).  
 sp. 'florida'\* (unpublished and ambiguous name) = *P. ostreatus* and *P. pulmonarius* -  
 (Hilber, 1989).  
*sajor-caju*\* (Fr.) Singer (misapplied name) = *Lentinus sajor-caju* (Fr.) Fr. - (Pegler, 1983;  
 Hilber, 1989).  
*salignus* (Pers.) Kumm. = *P. ostreatus* - (Hilber, 1982, 1989; Boekhout, 1990).  
*salmonostramineus* L. Vassilieva = *P. djamor* - (Corner, 1981; Neda *et al.*, 1988).  
*sapidus*\* (Schulz.) Sacc. = *P. cornucopiae* - (Hilber, 1989).  
*spodoleucus* Fr. = *P. ostreatus* - (Magaie *et al.*, 1990).  
*squarrosulus* (Mont.) Singer = *Lentinus squarrosulus* Mont. - (Pegler, 1977).

**3.2.1. *Pleurotus abalonus* and *P. cystidiosus*.** Both species have an anamorphic (asexual) fruiting phase characterised by production of coremia. Macro- and microscopic differences between the species and their geographical separation support distinction (Han *et al.*, 1977; Hilber, 1989), even though monokaryons from each showed partial intercompatibility (Hilber, 1982). Intercompatible crosses produced fertile fruit-bodies and viable spores (Bresinsky *et al.*, 1987). The two species are considered to be distinct, the partial intercompatibility suggestive of allopatric (geographically separated) speciation in progress.

**3.2.2. *Pleurotus cornucopiae*.** This species, described from Europe, is characterised by pale cream to pale brown, funnel-shaped caps. *P. citrinopileatus* Singer, from eastern Asia, was separated from *P. cornucopiae* by its bright yellow caps, an often branched stipe, and smaller basidiospores. Corner (1981) reported specimens of the former as *P. aff. cornucopiae*. Ohira (1990) and Petersen & Hughes (1993) found complete intercompatibility between monokaryotic strains of both species. Fruit-bodies produced from these crosses were yellow, and basidiospores, intermediate in size between those of the parents, were able to germinate (Ohira, 1990). In recognition of a single biological species containing morphologically and geographically separated variants, *P. citrinopileatus* was reduced to varietal status as *P. cornucopiae* var. *citrinopileatus* (Singer) Ohira.

**3.2.3. *Pleurotus djamor*.** Corner (1981) divided this variable species into six varieties reflecting differences in cap and gill colour, form of stipe, and substrate. *P. salmonostramineus* (as *P. incarnatus* Hongo) was considered to be a synonym of var. *roseus*, and this was confirmed by intercompatibility between strains of *P. djamor* and *P. salmonostramineus* (Neda *et al.*, 1988).

**3.2.4. *Pleurotus pulmonarius* and *P. ostreatus*.** *P. pulmonarius* (grey oyster mushroom, phoenix-tail mushroom) is arguably the species with the most frequently misapplied name. It has been repeatedly confused with the morphologically similar *P. ostreatus*. *P. pulmonarius* is the correct name for some strains labelled *Pleurotus* sp. 'florida' and for others misidentified as *P. sajor-caju*.

Mycologists have differing opinions on the usefulness of morphological characters for discrimination of *P. pulmonarius* from *P. ostreatus*. Discriminating characters relevant for European collections (Hilber, 1982; Bresinsky *et al.*, 1987; Boekhout, 1990) and Japanese collections (Ohira & Matsumoto, 1980) include:

*P. pulmonarius* - pale coloured cap, smaller size (laterally cap <10-13 cm), stipe typically more

eccentric than lateral, fruiting in late spring to early autumn, sweet odour like anise, under humid conditions upper surface of cap glabrous, thinner pileipellis (40-50 µm thick), and presence of sclerified hyphae.

*P. ostreatus* - dark grey-brown cap (sometimes with blue tint), larger size (laterally cap usually 12-18 cm), stipe typically more lateral than eccentric, fruiting in autumn until early spring, fungoid odour, under humid conditions upper surface of cap pubescent-tomentose, thicker pileipellis (90-120 µm thick), and usual absence of sclerified hyphae.

Petersen & Hughes (1993) reported that in North America the two species could not be separated by these characters. For example, North American *P. ostreatus* has tan to pale tan caps, and could be considered an allopatric 'morphotaxon' distinguishable morphologically from the European form.

The two species are, however, distinct genetically and are separate biological species. A complete barrier to hybridisation has been documented by several intercompatibility studies using single spore strains sourced from widely separated geographic regions, while intraspecific crosses within each species are uniformly intercompatible (Bresinsky *et al.*, 1977, 1987; Hilber, 1982; Petersen & Hughes, 1993).

Exceptions noted were two strains of *P. pulmonarius* found to be completely intersterile with all other strains of *P. pulmonarius* (Bresinsky *et al.*, 1987), possibly representative of an independent species, and partial intercompatibility between monokaryons of a strain of *P. pulmonarius* and one of *P. ostreatus* (Magaie *et al.*, 1990). A high similarity index was also reported by Magaie *et al.* (1990) from enzyme analyses between the two species. While regarding the two taxa as variants of a single species, they acknowledged that further strains of *P. pulmonarius* should be studied before their conclusion could be substantiated.

Both species lack a type specimen on which to base taxonomic decisions. For *P. pulmonarius*, Petersen & Hughes (1993) propose a 'representative specimen', to serve in the interim until a neotype can be designated. The neotype should be from the same host, *Betula*, and geographic area as was originally described for the species, and should be the source of single spore tester strains intercompatible with the *P. pulmonarius* intersterility group. Typification of *P. ostreatus* has not yet been proposed.

**3.2.5. *Pleurotus sajor-caju*.** This is a synonym of *Lentinus sajor-caju*, a very common species in tropical forests. The *Pleurotus* combination has been cited frequently in error in literature on cultivated mushrooms. Kurtzman & Zadrzil (1982) reported differences in morphology between published descriptions of the species (Corner, 1981; Pegler, 1983) and a commercially available cultivated strain labelled *P. sajor-caju* (ITCCF 1725 = ATCC 32978). Several commercial strains labelled *P. sajor-caju* have proved to be misidentified and are intercompatible with *P. pulmonarius* (Hilber, 1989). Another misidentification is suggested from the description of a synnematus anamorph from a strain of *P. sajor-caju* (Nair & Kaul 1980), probably based on either *P. cystidiosus* or *P. abalonus* or a related species.

**3.2.6. *Pleurotus sapidus*.** This is a synonym of *P. cornucopiae*. Usage of the name in North America has only recently been clarified (Hilber, 1989). Eugenio & Anderson (1968) reported a common decay fungus on hickory, sugar maple and American elm as *P. ostreatus*. Anderson *et al.* (1973), in error, redetermined this species as *P. sapidus*. Hilber (1989) found that Eugenio & Anderson's material was intercompatible with *P. ostreatus*. The fungus from aspen, which Anderson *et al.* (1973) mistakenly identified as *P. ostreatus*, is now distinguished as a new species, to be published as *P. populinus* (Hilber, 1989).

**3.2.7. *Pleurotus* sp. 'florida'**. Though never published nor intended as a binomial, the name appears frequently in literature on cultivated mushrooms. The origin and history of the name were reviewed by its originator, G. Eger, in Eger *et al.* (1979). 'Florida' strains were found to be compatible with *P. ostreatus* (Eger *et al.* 1979), while Bresinsky *et al.* (1977) had previously reported intercompatibility with *P. pulmonarius*. These results were misinterpreted by Eger *et al.* (1979) to indicate that *P. pulmonarius* and *P. ostreatus* were conspecific. Bresinsky *et al.* (1987) and Hilber (1982) concluded that strains available under the name 'florida' represent two taxa, a majority being *P. ostreatus* and at least one strain being *P. pulmonarius*. Clearly, strains should not be designated 'florida' in future scientific literature. The unfortunate confusion surrounding this name has called into question several scientific results, e.g., Yoo *et al.* (1986), where interspecific hybrids were reported between *P. ostreatus* and '*P. florida*'. Hilber (1989) noted that *P. floridanus* Singer is unrelated to the two species represented by *P. 'florida'*.

### 3.3. *Lentinula*

*Lentinula*, sensu Pegler (1975), and *Lentinus*, sensu Singer (1986), are both currently used to accommodate the shiitake mushroom, as *Lentinula edodes* (Berk.) Pegler and *Lentinus edodes* (Berk.) Singer.

According to Pegler hyphal composition and gill form separate *Lentinula* from *Lentinus* and *Pleurotus*, both genera that have formerly accommodated shiitake. Hyphal composition of the fruit-body is an important taxonomic character for classification of polypore fungi, to which *Lentinus* and *Pleurotus* are related. Hyphae are not inflated and septa are not constricted. *Lentinula*, in contrast, is considered to belong in the agaric family Tricholomataceae (Pegler, 1975), with a monomitic hyphal system (one type of hypha) of inflated, thick-walled hyphae with constricted septa. The gills of *Lentinula* species do not extend down the stipe (non-decurrent), unlike those characteristic of species in the other two genera. Pegler (1972) separates *Lentinus* from *Pleurotus* on the basis of the former being dimittic and the latter monomittic.

Singer (1986) listed *Lentinula* as a synonym of *Lentinus*. He accepted both *Lentinus* and *Pleurotus* as including species with monomittic or dimittic hyphal systems, separated by differences including the structure of gill hyphae (trama) underlying the spore-bearing layer. Hyphal systems were considered by Singer to be useful to delimit sections within these two genera, but not the genera themselves.

Corner (1981) accepted *Lentinula*, while including within *Pleurotus* species with a monomittic or a dimittic hyphal system, thus blurring Pegler's distinction between *Pleurotus* and *Lentinus*.

### 3.4. *Auricularia*

*auricula* (L.) Underwood - (Lowy, 1952).

*auricula-judae* (Bull.) Schröt. = *A. auricula* - (Lowy, 1952).

*cornea* (Ehr.) Ehr. ex Endl. - (Wong & Wells, 1987).

*fuscusuccinea* (Mont.) Farl. - (Lowy, 1952).

*polytricha* (Mont.) Sacc. = *A. cornea* - (Wong & Wells, 1987).

*tenuis* (Lév.) Farl. = *A. cornea* - (Wong & Wells, 1987).

Morphological characters of basidiocarps, especially the nature of internal, hyphal, cross-sectional zones and hairs of the upper surface, were used as discriminating characters for species of *Auricularia*, the wood ear fungi (Lowy, 1951, 1952; Cheng & Tu, 1978; Quimio & de Guzman, 1982). Duncan (1982) reported that within a sample of 7 strains of *A. polytricha*, a strain from the

U.S.A. was inter-incompatible with all others; among the latter group intercompatibility varied from complete to partial. Wong & Wells (1987) found that morphological variability in *A. cornea*, *A. polytricha* and *A. tenuis* prevented discrimination. Monokaryotic strains of these species from Hawaii were fully intercompatible, and basidiocarps arising from 'interspecific' crosses conformed to *A. polytricha* (Wong & Wells, 1987). These authors concluded that described morphological distinctions between species were environmentally induced, and that the earliest name, *A. cornea*, should be adopted for *A. polytricha* and *A. tenuis*, and for an albino form (Wong, 1989). Formal synonymy, however, awaits designation of a neotype for *A. cornea* in the absence of available type material (Wong, 1989).

### 3.5. *Volvariella*

The cultivated paddy straw mushroom is widely accepted as *Volvariella volvacea* (Bull.: Fr.) Singer (Chang, 1978; Kurtzman & Chang-Ho, 1982), with the varietal name *masseei* Singer applicable to most strains grown in southeast Asia (Samarawira & Fernando, 1973; Singer & Harris, 1987). Orton (1986) questioned whether the cultivated fungus of Asia is conspecific with *V. volvacea* from the U.K., on the basis of reported differences in spore size. The genus lacks a recent monographic treatment. Further taxonomic comparison of the temperate and tropical species of *Volvariella*, using morphological, biochemical and genetic characters, would benefit clarification of species names.

### 3.6. *Flammulina*

*Flammulina velutipes* (Curt.: Fr.) Sing. (winter mushroom, enokitake) is a variable species. Bas (1983) distinguished from within the *velutipes* complex a new, morphologically distinct European species, *F. fennae* Bas. Monokaryons of *F. velutipes* and *F. fennae* were inter-incompatible (Bas, 1983; Lamoure, 1989), and the two species have different enzyme activities (Klán & Baudisová, 1992). *F. velutipes* was itself divided into two macroscopically distinct varieties, *F. velutipes* var. *lactea* (Qué.) Bas, and var. *velutipes*. Within the latter, Bas distinguished two forms, forma *longispora* and forma *velutipes*, separated by different spore dimensions and periods of fruiting. Lamoure (1989) reported incomplete genetic isolation between monokaryons of the two forms, and inconclusive results in intercompatibility studies between var. *lactea* and var. *velutipes*, indicating that speciation may be in progress. Monokaryons from two collections of var. *lactea* were typically inter-incompatible (Lamouré 1989), supporting Bas's (1983) suggestion that var. *lactea* could also be divided into two forms.

Field strains of *F. velutipes* from Japan were reported to be intercompatible with strains from New Zealand, western and eastern U.S.A., the U.K., the Netherlands, and South Korea, but inter-incompatible with strains from boreal and Northern Hemisphere alpine regions (Yokoyama, 1991). The latter were considered to belong to a separate species, which differed from *F. velutipes* in having a lower optimal temperature for mycelial growth, a higher optimum for fructification and more rounded spores.

It is not clear from published literature available to me which of the varieties and forms of *F. velutipes* are represented among cultivated strains.

### 3.7. *Tremella*

While the name *Tremella fuciformis* Berk. is taxonomically well accepted, intraspecific

differences have been recently documented. Fox & Wong (1990) found both homothallic and heterothallic strains from different geographic locations, and incomplete intercompatibility between some geographically separated heterothallic strains. These results were interpreted by Fox & Wong to suggest that *T. fuciformis* comprises either two morphological species, or else a single species in which homothallic forms have arisen through deletion of mating factors.

#### 4. 'LISTS OF NAMES IN CURRENT USE', IMPROVING STABILITY OF NAMES?

Nomenclature of fungi is governed by the Principles, Rules and Recommendations of the Code, which provide order and stability through precise definition of requirements for valid publication of names and provisions by which names can be changed. Measures allowing for conservation and rejection of names are built into the Code to avoid name changes judged to be disadvantageous.

Criticism of the frequency of name changes and the resulting disruption and confusion caused, from both users of taxonomy and practitioners, has stimulated considerable recent debate towards improvement (Hawksworth, 1991). In 1989 the General Committee of the International Association for Plant Taxonomy established a committee to coordinate discussion and preparation of 'Lists of Names in Current Use' for all plant groups covered by the Code, beginning with the estimated 36,500 generic names. At the XVth International Botanical Congress (IBC) in Tokyo (August 1993) delegates will vote on the principle of such lists, the resulting necessary changes to the Code, and the procedure for production of lists.

Opinions among mycologists are strongly divided over the criteria for exclusion of names from the list, and the need for 'protected status' of listed names against those excluded. Protected status is a direct attack on Principle III of the Code: 'The nomenclature of a taxonomic group is based upon priority of publication'. The 'digging-up' of old and long forgotten names to replace names in current use is cited by Hawksworth (1991) as the main cause of nomenclatural change, hence justifying the diminution of the priority rules, but this view is contested by Korf (1991). In agreement with Korf, mushroom name changes discussed in this paper, with the exception in part of the debate surrounding *Agaricus bisporus/brunnescens*, have arisen from new knowledge of species enabling better discrimination and are reflected in the establishment of a more accurate and stable nomenclature. Such advances in systematic science are essential to improved understanding of fungi and their interrelationships, and should not in any way be limited by the proposed lists. It is generally agreed that the lists must cater for alternative taxonomies where such taxonomies are currently employed. Gams & Kuyper (1991) favour comprehensive computerised lists which include all typified fungal names, excluding only those names with insufficient description or lacking authentic type material. Any expectation among users that the lists will effectively freeze existing names is unwarranted (Anderson, 1991).

A draft list of the estimated 64,000 accepted fungal species names, coordinated from the International Mycological Institute, U.K., is expected to be completed during 1993, but will not be ready for formal adoption at the Tokyo IBC. Whether names on the list are given protected status or not, the list once vetted and approved will serve as a reference document to standardise spelling of names, authorship and place of publication. This will provide tangible benefits to all users.

#### 5. RECOMMENDATION

Authors in mushroom science are encouraged to obtain authoritative identification of mushroom

strains before publication, and to use validly published species names. Spawn suppliers are similarly encouraged to confirm identification of commercial strains, as use of incorrect and invalid names can enter and confuse the scientific literature. Culture strains should be deposited in an internationally recognised culture collection, ensuring long-term preservation and availability to other workers. The International Collection of Micro-organisms from Plants (ICMP), Auckland, for example, provides an international holding facility for commercial strains of edible mushrooms, with the supplier retaining security of ownership.

Accuracy in the application of mushroom names will benefit mushroom science by reducing confusion and duplication of effort, and improving the reliability and reproducibility of published results.

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#### REFERENCES

- ANDERSON, N.A., WANG, S.S. & SCHWANDT, J.W. (1973). The *Pleurotus ostreatus-sapidus* species complex. *Mycologia* **65**, 28-35.
- ANDERSON, W.R. (1991). Should we change the Code? Concerns of a working taxonomist. In *Improving the Stability of Names: Needs and Options*, pp. 95-103. Edited by D.L. Hawksworth. *Regnum Vegetabile* No. 123. Königstein: Koeltz Scientific Books.
- BAS, C. (1983). *Flammulina* in Western Europe. *Persoonia* **12**, 51-66.
- BOEKHOUT, T. (1990). 1. *Pleurotus*. *Flora Agaricina Neerlandica* **2**, 20-24.
- BOIDIN, J. (1986). Intercompatibility and the species concept in the saprobic Basidiomycotina. *Mycotaxon* **26**, 319-336.
- BRESINSKY, A., HILBER, O., & MOLITORIS, H.P. (1977). The genus *Pleurotus* as an aid to understanding the concept of species in basidiomycetes. In *The Species Concept in Hymenomycetes*, pp. 229-258. Edited by H. Cléménçon. Vaduz: J. Cramer.
- BRESINSKY, A., FISCHER, M., MEIXNER, B. & PAULUS, W. (1987). Speciation in *Pleurotus*. *Mycologia* **79**, 234-245.
- CANNON, P.F. (1986). International Commission on the Taxonomy of Fungi (ITCF): name changes in fungi of microbiological, industrial and medical importance, Part 1. *Microbiological Sciences* **3**, 168-171.
- CHANG, S.T. (1978). *Volvariella volvacea*. In *The Biology and Cultivation of Edible Mushrooms*, pp. 573-603. Edited by S.T. Chang, S.T. & W.A. Hayes. New York: Academic Press.
- CHANG, S.T. (1991). Mushroom biology and mushroom production. *Mushroom Journal of the Tropics* **11**, 45-52.
- CHENG, S. & TU, C.C. (1978). *Auricularia* spp. In *The Biology and Cultivation of Edible Mushrooms*, pp. 605-625. Edited by S.T. Chang, S.T. & W.A. Hayes. New York: Academic Press.
- CORNER, E.J.H. (1981). The agaric Genera *Lentinus*, *Panus*, and *Pleurotus* with particular reference to Malaysian species. *Beihefte zur Nova Hedwigia* **69**, 1-169.

DUNCAN, E.G. (1982). Population diversity and speciation in *Auricularia polytricha*. In *Tropical Mushrooms - Biological Nature and Cultivation Methods*, pp. 409-425. Edited by S.T. Chang, & T.H. Quimio. Hong Kong: The Chinese University Press.

EGER, G., LI, S.F. & LEAL-LARA, H. (1979). Contribution to the discussion on the species concept in the *Pleurotus ostreatus* complex. *Mycologia* **71**, 577-588.

EUGENIO, C.P. & ANDERSON, N.A. (1968). The genetics and cultivation of *Pleurotus ostreatus*. *Mycologia* **60**, 627-634.

FOX, R.D. & WONG, G.J. (1990). Homothallism and heterothallism in *Tremella fuciformis*. *Canadian Journal of Botany* **68**, 107-111.

GAMS, W. & KUYPER, T.W. (1991). Some notes of caution regarding names in current use. In *Improving the Stability of Names: Needs and Options*, pp. 257-266. Edited by D.L. Hawksworth. *Regnum Vegetabile* No. 123. Königstein: Koeltz Scientific Books.

GUZMÁN, G., BANDALA, V.M. & MONTOYA, L. (1991). A comparative study of teleomorphs and anamorphs of *Pleurotus cystidiosus* and *Pleurotus smithii*. *Mycological Research* **95**, 1264-1269.

HALLENBERG, N. (1987). On speciation in Corticiaceae (Basidiomycetes). *Windahlia* **17**, 19-25.

HAN, Y.H., CHEN, K.M. & CHENG, S. (1977). Characteristics and cultivation of new *Pleurotus* in Taiwan. *Mushroom Science* **9**, 167-173.

HAWKSWORTH, D.L. (1991). Lists of names in current use: a new initiative to address a continuing problem. *Mycotaxon* **40**, 445-458.

HILBER, O. (1982). Die Gattung *Pleurotus*. *Bibliotheca Mycologica* **87**, 1-448.

HILBER, O. (1989). Valid, invalid and confusing taxa of the genus *Pleurotus*. *Mushroom Science* **12**, 241-248.

KERRIGAN, R.W. (1987). What's in a name: the chaetaceous case of the chaste champignon. In *Developments in Crop Science 10, Cultivating Edible Fungi*, pp. 141-154. Edited by P.J. Wuest, D.J. Royse & R.B. Beelman. Amsterdam: Elsevier.

KERRIGAN, R.W. & ROSS, I.K. (1988). Extracellular laccases: biochemical markers for *Agaricus* systematics. *Mycologia* **80**, 689-695.

KLÁN, J. & BAUDIOVÁ, D. (1992). Cultural, enzyme and genetic studies in the genus *Flammulina* Karst. *Mycotaxon* **43**, 341-350.

KORF, R.P. (1991). Shall we abandon the principle of priority (and other nomenclatural caveats) for the sake of expediency? *Mycotaxon* **40**, 459-468.

KURTZMAN, R.H. JR & CHANG-HO, Y. (1982). Physiological considerations for cultivation of *Volvariella* mushrooms. In *Tropical Mushrooms - Biological Nature and Cultivation Methods*, pp. 139-166. Edited by S.T. Chang & T.H. Quimio. Hong Kong: The Chinese University Press.

KURTZMAN, R.H. JR & ZADRAZIL, F. (1982). Physiological and taxonomic considerations for cultivation of *Pleurotus* mushrooms. In *Tropical Mushrooms - Biological Nature and Cultivation Methods*, pp. 299-348. Edited by S.T. Chang, S.T. & T.H. Quimio. Hong Kong: The Chinese University Press.

LAMOURE, D. (1989). Species concept in the *Flammulina velutipes* group. *Opera Botanica* **100**, 163-167.

LOWY, B. (1951). A morphological basis for classifying the species of *Auricularia*. *Mycologia* **43**, 351-358.

LOWY, B. (1952). The genus *Auricularia*. *Mycologia* **44**, 656-692.

MAGAE, Y., HAGA, K., TANIGUCHI, H. & SASAKI, T. (1990). Enzymes of strains of *Pleurotus* species (Basidiomycetes) compared by electrophoresis. *Journal of General and Applied*

*Microbiology* **36**, 69-80.

MALLOCH, D. (1976). *Agaricus brunnescens*: the cultivated mushroom. *Mycologia* **68**, 910-919.

MALLOCH, D., CASTLE, A. & HINTZ, W. (1987). Further evidence for *Agaricus brunnescens* Peck as the preferred name for the cultivated *Agaricus*. *Mycologia* **79**, 839-846.

MAY, B. & ROYSE, D.J. (1988). Interspecific allozyme variation within the fungal genus *Pleurotus*. *Transactions of the British Mycological Society* **90**, 29-36.

MILLER, O.K. (1969). A new species of *Pleurotus* with a coremioid imperfect stage. *Mycologia* **61**, 887-893.

MURAKAMI, S. & TAKEMARU, T. (1990). Genetic studies of *Pleurotus salmoneostramineus* forming albino basidiocarps. *Reports of the Tottori Mycological Institute* **28**, 199-204.

NAIR, L.N. & KAUL, V.P. (1980). The anamorphs of *Pleurotus sajor-caju* (Fr.) Singer and *Pleurotus gemmellarii* (Inzeng.) Sacc. *Sydowia* **33**, 221-224.

NEDA, H., FURUKAWA, H. & MIGAYI, T. (1988). Two *Pleurotus* species from Okinawa. *Proceedings of the 32nd Annual Meeting, Mycological Society of Japan*. p.51.

OHIRA, I. (1990). A revision of the taxonomic status of *Pleurotus citrinopileatus*. *Reports of the Tottori Mycological Institute* **28**, 143-150.

OHIRA, I. & MATSUMOTO, T. (1980). A new record of *Pleurotus pulmonarius* Fr. in Japan. *Reports of the Tottori Mycological Institute* **18**, 129-132.

ORTON, P.D. (1986). *British Fungus Flora - Agarics and Boleti. vol. 4. Pluteaceae: Pluteus & Volvariella*. Edinburgh: Royal Botanic Garden.

PEGLER, D.N. (1972). Lentineae (Polyporaceae), Schizophyllaceae et espèces lentinoïdes et pleurotoïdes des Tricholomataceae. *Flore illustrée des champignons d'Afrique Centrale, Fasc. 1*, 1-26.

PEGLER, D.N. (1975). The classification of the genus *Lentinus* Fr. (Basidiomycota). *Kavaka* **3**, 11-20.

PEGLER, D.N. (1976). *Pleurotus* (Agaricales) in India, Neç al and Pakistan. *Kew Bulletin* **31**, 501-510.

PEGLER, D.N. (1977). A Preliminary Agaric Flora of East Africa. *Kew Bulletin Additional Series* **6**, 1-615.

PEGLER, D.N. (1983). The genus *Lentinus*. *Kew Bulletin Additional Series* **10**, 1-281.

PEGLER, D.N. (1986). Agaric Flora of Sri Lanka. *Kew Bulletin Additional Series* **12**, 1-519.

PETERSEN, R.H. (1993). Neohaploidisation and neohaplont matings as a means of identification of *Pleurotus* cultures. *Mycosystema*, in press.

PETERSEN, R.H. & HUGHES, K.W. (1993). Intercontinental interbreeding collections of *Pleurotus pulmonarius*, with notes on *P. ostreatus* and other species. *Sydowia*, in press.

QUIMIO, T.H. & DE GUZMAN, R. (1982). Taxonomy and basidiocarp development of *Auricularia* mushrooms. In *Tropical Mushrooms - Biological Nature and Cultivation Methods*, pp. 383-395. Edited by S.T. Chang & T.H. Quimio. Hong Kong: The Chinese University Press.

RAJARATHNAM, S. & BANO, Z. (1987). *Pleurotus* mushrooms. Part I A. Morphology, life cycle, taxonomy, breeding, and cultivation. *CRC Critical Reviews in Food Science and Nutrition* **26**, 157-223.

SAMARAWIRA, I. & FERNANDO, S.T. (1973). Antigen analysis of the cultivated paddy straw mushroom of Thailand, Philippines and Ceylon. *Annals of Botany* **37**, 371-374.

SINGER, R. (1984). *Agaricus brunnescens* Peck and *Agaricus bisporus* (Lange) Imbach. *Mycotaxon* **20**, 479-482.

SINGER, R. (1986). The Agaricales in Modern Taxonomy. Königstein: Koeltz Scientific Books.

- SINGER, R. & HARRIS, B. (1987). *Mushrooms and Truffles, Botany, Cultivation, and Utilisation*. Königstein: Koeltz Scientific Books.
- SMITH, A.H. (1978). Morphology and classification. In *The Biology and Cultivation of Edible Mushrooms*, pp. 3-34. Edited by S.T. Chang & W.A. Hayes. New York: Academic Press.
- WONG, G.J. (1989). Compatibility and fruiting studies of an albino form of *Auricularia cornea*. *Mycotaxon* **34**, 259-266.
- WONG, G.J. & WELLS, K. (1987). Comparative morphology, compatibility, and interfertility of *Auricularia cornea*, *A. polytricha*, and *A. tenuis*. *Mycologia* **79**, 847-856.
- YOKOYAMA, K. (1991). Distribution and speciation in *Flammulina velutipes*. Abstract. 'Ascomycete and Basidiomycete Studies Now'. *Proceedings of the International Minisymposium of the Research Center for Pathogenic Fungi and Microbial Toxicoses*, Chiba University.
- YOO, Y.-B., YOU, C.-H., PARK, Y.-H. & PEBERDY, J.F. (1986). Genetic analysis of the life cycle in interspecific hybrids of *Pleurotus ostreatus* and *Pleurotus florida* following protoplast fusion. *Korean Journal of Mycology* **14**, 9-15.