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Open Letter to the scientific community of mycologists. Inputs from referees requested.

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To help minimise invalid publication of newly proposed scientific names of fungi, Korf (1995) provided advice on how to guarantee valid publication, and offered a few simple guidelines for authors, reviewers, and editors. He regretted that 'unfortunately many of the errors are committed by highly respected mycologists, and published in thoroughly respectable journals' and emphasised that 'although the ultimate responsibility for publishing correct names lies with authors, clearly reviewers and editors are shirking their duties to advise authors of such errors prior to publication'.

In order to be published validly, names must be introduced according to requirements of the International Code of Botanical Nomenclature (ICBN; Greuter et al. 1994, 2000). Since 1990 it has been compulsory to deposit the vouchers for new species and infraspecific taxa, the name-bearing types, in an herbarium or other collection. It is generally accepted that such voucher specimens should be deposited in publicly accessible reference collections such as herbaria.

However, voucher collections are invariably necessary not only when new fungi are described, but also in connection with any scientific study, whether by taxonomists, systematists, physiologists, chemists, molecular biologists, pathologists, ecologists, clinicians, etc., dealing with organisms. It is essential to preserve voucher specimens as dried material or, where possible, in addition as permanently preserved living cultures. When none of the investigated material is preserved, it is impossible to confirm the identity of the investigated taxa. If species concepts have changed, it is particularly crucial to be able to re-identify the organism at a later time. There are several examples of entities once thought to be species but now revealed as species complexes, where the species concept has been or will be changed, including *Pisolithus tinctorius* (Burgess et al. 1995) and *Paxillus involutus* (Fries 1985, Hahn and Agerer 1999). In such cases, re-identification of the original material is indispensable in order to know which organism was studied so that previous work will continue to be relevant. In recent years molecular biological studies have a tremendous impact on systematics, taxonomy, and ecology. DNA sequences are frequently obtained from fungal cultures. Too often there is no record either of an exact citation of the fungal material used, such as an unequivocal number referring to collection accession data and the voucher culture, or reference to the institution where the material has been deposited. Frequently, only personal or laboratory strain numbers are given, which make it hard to trace the origin of the fungal material. Only accession numbers allocated by permanent public or other open institutional collections can ensure the retrieval of voucher material over the long-term. It is not yet common practice to publish complete collection or isolation data, or to deposit vouchers, except in taxonomic articles.

Conservation of dried fruit-bodies from which cultures are made is also indispensable in order to allow checking of anatomical and morphological features that

cannot be reproduced in culture. The cultures also can be checked using molecular methods after prolonged preservation, in order to exclude the possibility of contamination. While it is rarely possible to culture fungi from dried specimens, the associated collection details are indispensable not only to clarify the geographical and ecological source, but also to facilitate the possibility of recollecting the fungus in the same site. This requires as detailed and exact a description of the sampling locality as possible, preferably including geographic co-ordinates something now facilitated by hand-held or wrist-band global positioning devices.

Voucher specimens are equally important for a wide range of other investigations. Dennis' (1960: xxii) remark that "records that cannot be verified are mere waste paper" applies to numerous aspects of our discipline. Studies of the species composition of any habitat depend on properly determined fungi, and so will require dried vouchers deposited in publically accessible collections. This applies, for example, not only to fruit-bodies, but indeed to any other form of fungal structure, such as sclerotia, or ectomycorrhizas (Agerer 1991) used in scientific work. Ecological, chemical, applied, and physiological studies quite often rely on ecotypes of species, which could later be considered, depending upon the species concepts applied, as separate species. In the seventies, Hawksworth (1974), Yocum and Simons (1977) and Ammirati (1979) were among the first to point out the importance of voucher material particularly in chemical, but also other physiological and ecological studies. In ecological studies on ectomycorrhizas, the increasing use made of RFLP patterns or DNA sequences for the detection of the symbionts requires comparison with those of identified fruit-bodies. In many studies, the identified ectomycorrhizas are completely consumed by the extraction and amplification methods. Instead, voucher specimens should be stored, when individual tips of a larger hyphal system have been used. Even more important is the citation and preservation of the fruit-body specimen from which DNA was extracted for comparison with that that obtained from ectomycorrhizae.

Voucher cultures are urgently needed when clinically relevant fungi are investigated and their etiologic data and their impact on human beings have to be evaluated (de Hoog and Guého 1985). Further, where cultural or chemical features are crucial for the evaluation of newly described fungi such as yeasts, the non-availability of cultures can make interpretation impossible and frustrate other researchers (Banno *et al.* 1993, Hawksworth 1984). Sufficient information on clinical direct microscopy or histopathology results to determine whether an isolate was medically significant or a biomedical contaminant is essential for later evaluations. In cases of apparently exotic fungi, a brief notation of relevant patient travel history is strongly recommended.

Additional documentation requirements apply to strains deposited in the major service collections of fungal cultures, such as ATCC (American Type Culture Collection, Manassas, Virginia, USA), CBS (Centraalbureau voor Schimmelcultures,

Baarn/Utrecht, The Netherlands), or IMI (CABI Bioscience (UK Centre), Egham, Surrey, UK); these and other culture collections often provide forms for depositors to simplify the documentation process. In such major culture collections, the cultures are safely stored with cryo-preservation methods, and may be revived at any time. For sporulating fungi, the citation of the allocated accession number is generally enough to meet the goal of reproducibility of scientific results, i. e. to confirm the identity of the species studied. But a comparison with naturally grown material is only possible when the original collection or isolation details have been cited. A completely different situation arises in cultures which are sterile and thus cannot be identified by normal methods. For such cultures, preservation of vouchers is particularly important together with exact collection data of the fruit-bodies and the herbarium or other collection where they have been deposited. Misidentifications can then be detected, new species concepts applied to the material, and recollection of new living material from the site of the original fruit-body might still be possible.

The addresses of public and open institutional dried reference collections and herbaria can be found in *Index Herbariorum* (Holmgren, Holmgren and Barnett 1990), and of microbial culture collections in the *World Directory* (Sugawara et al. 1993); these works both contain generally applied acronyms, which are convenient and informative enough for citation. Public and institutional collections ensure that the material in their care is well-curated and preserved in a proper way for centuries, and they usually loan dried material free of charge, subject to certain requirements. Whilst the long-term maintenance of private herbaria is often uncertain and the mailing expenses exceed a private budget, nearly all of the international herbaria and other institutions that house fungi will warmly accept properly dried and documented fungal material. Living cultures are normally supplied for a charge to cover the post of preparation and carriage, again subject to particular regulations that may apply; details vary and are available from the collections' catalogues and web sites.

Particularly in recent years, the behaviour of the scientific community has set tongues wagging, especially in relation to falsified data in publications concerning human cancer. It is a fundamental principle of science that research work must be reproducible. Reproducibility requires that studies can be made using the same dried material or cultures as the original study used. As a consequence, publications lacking unambiguous reference to the locations where the critical study material can be accessed by later researchers should not be accepted for publication. They are of no or limited scientific value in that they cannot be reproduced. Editors and referees in all aspects of mycology are often confronted with such situations and it is therefore necessary to include advice for the deposition of voucher material in instructions for authors (e. g. Hawksworth 2000) and to regard this as a prerequisite for publication.

All scientists are responsible for their results. This responsibility lies not only in relation to the scientific community, but also in relation to those who support their research - the taxpayer, charities or other funding agencies, and ultimately society at large. The general public expects integrity from the scientific community. It is the responsibility of individual scientists, referees, and editors to rigorously apply the highest standards and make every effort to ensure that published research will be reproducible. Reproducibility in mycology is irrevocably and inextricably connected to the unequivocal citation of voucher specimens and cultures.

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