

International Code of Botanical Nomenclature: implications of Melbourne Convention 2011 to mycology in India

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The provisions of the International Code of Botanical Nomenclature (ICBN) are scarcely taught to Bachelor's or Master's degree life sciences students or covered in the curricula of M Phil and Ph D courses, though the ICBN comes with amendments, almost every six years. For a long time, Article 59 of ICBN permitted dual nomenclature for pleomorphic fungi (different morphs or life-cycle states), wherein the anamorph (asexual state) and teleomorph (sexual state) of the fungus can have separate names. Fungi that have both sexual and asexual morph/s in their life cycle are called holomorphs. In the case of holomorphs, the teleomorph name has priority over the anamorph name in nomenclature and typification¹. The International Botanical Congress held in Melbourne in 2011 brought in some important changes in the Rules²⁻⁹. These are (i) a 'Latin diagnosis' is no longer mandatory in the description of a new species or genus; (ii) electronic publication of new fungi is acceptable in the form of pdf files in ISSN and ISBN publications; (iii) the ICBN name has been changed to accommodate, besides plants, algae and fungi and hence the new name of the code, 'International Code of Nomenclature for Algae, Fungi and Plants'; (iv) 'One fungus = one name' has become the norm and multiple names are no longer legitimate with effect from 1 January 2013; (v) a mandatory requirement to deposit new fungal names in a recognized repository and (vi) both teleomorphs and anamorphs of non-lichenized ascomycetes could compete for legitimate names based on chronological priority for unification of the names. Since there seems to be some confusion on the latter part of this clause, the Sub-committee on Fungi has been asked to make suitable amendments to this clause. The nomenclatural correction may take some time for the existing names as this aspect is also being addressed by the Sub-committee on Fungi.

The Nomenclature Section of the ICBN in Melbourne approved a new rule in the Code whereby, on or after 1 January 2013, the publication of a new fungal name (names of new taxa, new combina-

tions, replacement names and names at new rank) must include a citation of 'an identifier issued by a recognized repository' in order to be validly published (i.e. to have any status under the Code). The mechanism for implementation of the new rule is for the Nomenclature Committee for Fungi (NCF) to appoint 'one or more localized or decentralized open and accessible electronic repositories to perform this function'. The Committee also has the power to remove such repositories at its discretion; and even to set aside the requirement should the repository mechanism cease to function⁷.

Thus, according to the new Code, a prerequisite for valid publication is deposition of new fungal names in a recognized repository along with preliminary data such as descriptions and illustrations. Article 42.3 of the International Code of Nomenclature (ICN) has empowered the NCF, a body appointed by the International Botanical Congress, with the ability to appoint and recognize one or more repositories subject to later ratification by the International Mycological Congress. The NCF has voted to support multiple official repositories over a single repository in a ballot and has accepted the following, viz. Fungal Names, Index Fungorum and MycoBank as official repositories from 1 January 2013. MycoBank is owned by the International Mycological Association and has servers in Belgium and The Netherlands; Index Fungorum is run by Landcare Research, New Zealand and Royal Botanical Gardens (RBG), Kew-Mycology, while Fungal Names is an initiative of the Institute of Microbiology, Chinese Academy of Sciences (IM-CAS), with servers in Beijing. These three repositories represented by the respective institutions have entered into an Memorandum of Cooperation (MOC) with NCF. The MOC is valid until August 2017, which also coincides with the next International Botanical Congress to be held in China¹⁰.

Hawksworth⁶ mentioned that after the adoption of the Melbourne Code 2011, the nomenclature of non-lichenized, pleomorphic fungi has entered into a phase

of transition. The issue has moved from 'One Fungus = One Name', to 'One Fungus = Which Name?'. Regardless of the life-history state represented by their types, all legitimate fungal names are now treated equally for the purposes of establishing priority. Since the special rules permitting dual nomenclature no longer apply, the correct name is now the earliest published legitimate name, i.e. the principle of priority applies to both sexual and asexual stages represented by the name-bearing type. An additional new set of rules was also accepted that will allow lists of widely used names to be protected en masse, or lists of names of uncertain application to be rejected en masse, so as to minimize the nomenclatural disruption that would otherwise be caused by strictly applying the rule of priority⁷. Hawksworth⁶ predicted that the new rules would affect around 2000–3000 genera and 10,000–12,000 species, which may require nomenclatural correction in the unification of names to get one name for one fungus in the case of pleomorphic fungi. This will undoubtedly be a herculean task before the mycologists.

To address the issue of unification of names, Hawksworth⁶ explained the procedural details of acceptance or rejection of a list of names through certain steps. A list of accepted or rejected names, following the recommendations of the Melbourne Code 2011, could be prepared by individuals or small groups, as well as formally constituted committees or sub-committees of international or national mycological organizations. However, the Code requires that the list be submitted to the General Committee on Nomenclature (GCN), which will pass it on to the NCF. The NCF, in turn will refer it to a sub-committee established in consultation with the GCN 'and appropriate international bodies' such as International Commission on the Taxonomy of Fungi (ICTF) and its sub-committees. A sub-committee would review and refine lists proposed and then submit the same to the NCF. After a detailed discussion within the NCF, a vote would be taken and 60% majority is required while considering

the names. Once the NCF approves the list, then it will be passed on to the GCN for approval and formal adoption in the next International Botanical Congress scheduled to be held in China during 2017. Hawksworth⁶ suggested an action plan and road map on time schedule, on how to reach and present the task of preparing and submitting the lists for approval before the next International Botanical Congress, where the ICN would include the accepted or rejected lists of fungi as appendices to the new Code to be adopted in 2017.

As a consequence of the Melbourne Code 2011, the need to establish connection between a teleomorph and its anamorph/s and to give one composite name, is now more apparent than ever before. The connection between a teleomorph and its related anamorphs is generally confirmed by any of the following: (i) appearance of both sexual and asexual stages in a culture; (ii) perfect co-occurrence of both morphs on natural substrata, and (iii) as practised in the recent times, use of molecular sequence data. However, certain concerns have been expressed by Hawksworth⁶ and others²⁻⁴. These are: (i) only a small percentage (16.8) of the fungi have so far been cultured; (ii) many researchers tend to consider the fungicolous or any co-occurring fungi as the anamorph of a teleomorph or vice-versa when found on natural substrata; (iii) it would sometimes be difficult to extract DNA for molecular sequence analysis from natural samples, particularly if pure cultures are not available, and (iv) many countries around the world are yet to establish needful infrastructural facilities such as precision microscopic equipment and facilities for molecular sequence analyses. Though molecular sequence analysis as being essential for valid publication has not been added in the present Code as yet, indirectly it is being insisted by most high impact factor journals^{2,11}.

The result of this important development and ground reality is that mycology journals with high impact factor are not accepting papers of new genera or new species if these are not accompanied with DNA sequence data or type cultures not deposited in international repositories. It has been suggested that those who do not have facilities for deposition of cultures and those countries under the Convention on Biological Diversity (CBD) need to collaborate with other institutions either

within their country or outside, but need to deposit cultures or herbarium specimens in a recognized international repository¹¹.

India has witnessed a golden period of taxonomic mycology between the 1930s and 1990s, when many new genera and new species of fungi were described by mycologists of international repute such as B. B. Mundkur, M. J. Thirumalachar, M. N. Kamat, K. S. Thind, C. V. Subramanian and many more. Unfortunately, in the past two decades contribution to fungal taxonomy from India has declined considerably. This is primarily because (i) 'taxonomy' has become a less attractive area of interest to the current generation of students of biology; (ii) inadequacy of government or sponsored research funds for taxonomic studies and (iii) lack of advanced research facilities such as differential interference contrast (DIC) microscope, freeze microtome, and PCRs and related high-cost consumables for molecular research in most less-endowed academic institutions in the country. However, the new ICN ratified at the International Botanical Congress held at Melbourne in 2011, has posed greater challenges to mycologists in India. The major challenge for mycologists worldwide is to provide the correct and validly published names under the new Rules for the thousands of fungi so far described. This is a herculean task.

Though line drawings still hold their charm and provide valuable support in the description of new taxa, good photomicrographs as evidence or proof of the species described are now a necessity. Many of the commonly occurring fungi have already been described in the past. That leaves us with the fact that we are now looking at rare or hitherto unknown fungi. Many ceolomycetes and ascomyces (e.g. fungi belonging to the Halosphaerales, Sordariales and Loculoascomycetes) have spores with elaborate appendages or mucilaginous sheaths. These special structures are discernible accurately only in a DIC microscope¹². But how many institutions have a DIC microscope? Taxonomy in general is currently a neglected area of science. At the higher taxonomic hierarchical level, the ascomycetes are delineated largely on the basis of fruit body structure, centrum features and other tissue structures present within the fruit bodies, including the type of wall layers¹³. Recognition of these characters is important, in addition

to the understanding of association of fruit bodies on different substrata and the spore morphology (asci and ascospores or basidia and basidiospores). Vegetative structures can be discerned with clarity only when ultra-thin sections are taken using a freeze microtome and observed under a high-powered microscope. Without such thin sections and associated high-precision photomicrographs as supportive evidence, high impact factor mycology journals do not accept manuscripts for publication.

Though several laboratories have PCRs, most morpho-taxonomists in India have not yet commenced routine use of DNA sequence analysis data as support for description of a new genus or species. Equally true is that it would be difficult for a full-fledged molecular taxonomist to gain expertise in morpho-taxonomy at once. One possible avenue of bridging this gap is research collaboration. When research collaborations have become the order of the day all over the world, Indian researchers cannot remain aloof whether it be collaboration within India or overseas. Alternatively, one has to be well-versed in both morpho-taxonomy and molecular-based phylogeny to describe new genera and species of fungi. Early from the time of the Tulasne brothers' magnificent *Selecta Fungorum Carpologia* (1861-65)¹⁴, mycologists have been at the unification of anamorph and teleomorph names. The terms anamorph, teleomorph and holomorph came up in the pursuit of such unification. Molecular systematists are further extending assistance in removing the dual names of anamorphic and connected teleomorphic fungi¹⁵, besides providing phylogenetic bases for fungal classifications^{16,17} and model descriptions of new species of fungi with molecular sequence data¹⁸.

At this juncture, India cannot and should not remain an end-user of the research carried out overseas in phylogenetic studies or descriptions of new genera and species of fungi. India needs to participate seriously in global efforts of documentation of fungi and this exercise calls for more support to research in the universities and institutes where fungal taxonomy is pursued with earnestness. There is an urgent need for laboratories being well equipped with good and high-precision microscopes, freeze microtome, PCRs and required consumables for morphological and molecular studies and trained manpower with advanced

knowledge in morpho-molecular taxonomy of fungi, so that India becomes an active participant in meeting these challenges. China is way ahead of us in planning, initiating and executing molecular work on taxonomy and inventory of fungi^{19,20}.

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