The birth and fate of new generic names

D Jean Lodge & Andrus Voitk

No student of natural history can have escaped the proliferation of new names in the last few decades, certainly evident in mycology. Of course, the most obvious need for a new name comes about when an organism is discovered whose existence was hitherto unknown, i.e. a species, genus, or larger group new to science. However, for the layman the sudden profusion of new names for seemingly old organisms or groups of organisms is causing some confusion and consternation, particularly when several names replace a former single name. In this discussion we shall use genera as an example to show how new names (new genera) come about and what happens to them after introduction.

In order to understand the organisms with which we share this world, we have tried to classify them, putting like with like in the belief that likeness indicates relatedness. It follows that when we find consistent differences between organisms, in order to keep like with like we also separate out differing groups. An example of this process was provided in a recent Omphalina article devoted to *Cystoderma*.[1] Careful study of the genus *Cystoderma* led Harri Harmaja to conclude that it contained two different groups of mushrooms, those with amyloid spores and those without.[2] To him these differences were sufficiently significant to warrant placing each in its own genus. This was done by leaving the mushrooms with amyloid spores in the original genus *Cystoderma*, and creating a new derivative or segregate genus, *Cystodermella*, for the species with inamyloid spores. Not all taxonomists agreed that this difference was sufficient to justify the rank of a new genus, and therefore some continued to use the genus name *Cystoderma* for both groups. Saar studied the molecular phylogeny of these mushrooms and discovered that phylogenetically the amyloid-spored group and the inamyloid-spored group have travelled along different evolutionary pathways from a common progenitor.[3] In other words, the two differ genetically, as well as in the ability of their spores to react to Iodine (rare exceptions aside). Phylogeny supported Harmaja's observations, lending more weight to his decision to consider them different genera. Hence, it is likely that more taxonomists will accept the derived genus *Cystodermella*. If its use becomes accepted practice, *Cystodermella* will be considered a good genus in the sense that it is generally accepted as standing apart from its original "parent" genus, *Cystoderma*.

In mycology there are no absolute criteria that must be met to designate a new genus. Every taxonomist is free to describe observed differences—macroscopic, microscopic, ecological, chemical or phylogenetic—and propose a derived genus with a new name. Phylogeny has, however, certain guidelines. Since the aim is to lump like with like, a genus should be monophyletic—that is, "pure"; it should not contain other genera within it (that would make it polyphyletic). Thus, new genera are proposed when a genus is found to be polyphyletic, i.e. contain within it one or more other genera. At the same time, new genera cannot be created within existing genera, but must stand on their own.

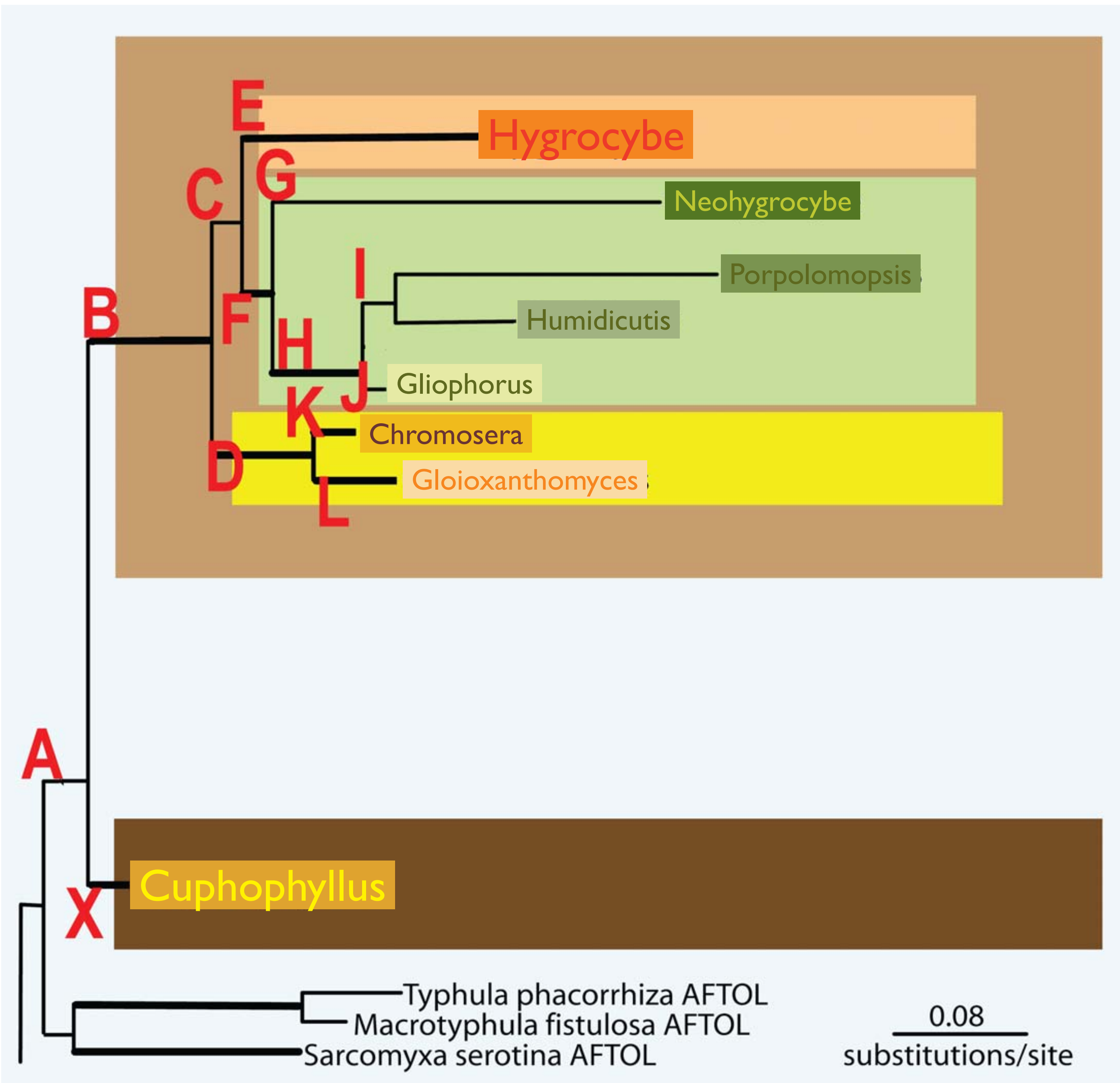
Current taxonomy is based on phylogenetics, comparative analysis of genetic regions. The results can be illustrated by clade trees that trace the likely evolutionary path and show the relation of genera to each other—snippets from the Tree of Life. When genetic differences are found within genera previously thought to be one, new branches appear. Significantly divergent new branches may be considered separate entities and given a new genus name, or they might be recognized at a lower rank such as subgenus or section. A prolific amount of molecular genetic investigation is discovering much unsuspected branching within groups, i.e. new potential derived genera. This is why so many new names are proposed.

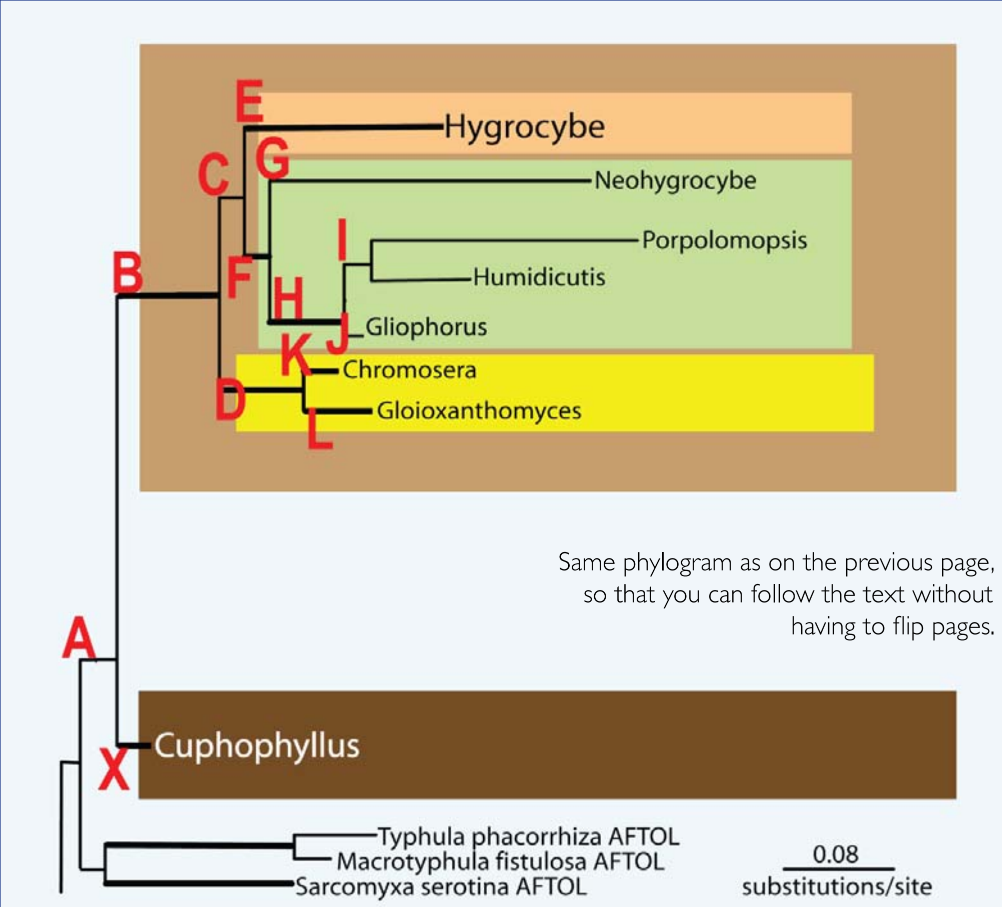
Now that we know how such names come about, let us see what their fate is. As an example, let us consider the previous article, where one of us (DJL) describes the derived genera she and her coworkers supported with molecular phylogeny in the former genus *Hygrocybe*. Excluding *Cuphophyllus*, they supported six derived genera of which only one was 'new'. Since there are no absolute criteria for naming new genera, this becomes an active decision of each taxonomist. As with all decisions, there is judgment and opinion involved, both of which may vary with different observers. This means that there are choices, first for the investigator and second for the users. To explore these choices, we chose Figure 1, adapted from that article, but pared of individual species, and trimmed of all branches not pertaining to *Hygrocybe*, as it has been known in its wide sense for the last few decades. The branch that leads us to this group is A, arising from the root.

Let us first deal with the genus

Cuphophyllus, shown on branch X. Lodge mentioned that its acceptance as a good genus apart from *Hygrocybe* was unavoidable. At one time species of *Cuphophyllus* were considered part of the larger genus *Hygrocybe*. However, Lodge's article (see the phylogeny diagram in that article) presents phylogenetic evidence that the entire genus *Hygrophorus*, as well as the smaller genera of *Chrysomphalina*, *Lichenomphalia*, *Arrhenia*, *Cantharellula* and *Pseudoarmiraliella* come between branch X and Branch B. In other words, B and X are not the only branches that rise off the B-X axis—the others have just been removed in our illustration for simplicity. As mentioned, if we wish to consider all the illustrated genera as one large genus, we need to include all the intervening genera as well and the name would have to be *Hygrophorus* rather than *Hygrocybe* as it is the oldest genus name in that group. That would create a very large genus, containing very many discrete groups that differ significantly in appearance, lifestyle and genetic make-up. For most people this is not a useful grouping of like with like. Therefore, with the current information the only reasonable option seems to be to accept *Cuphophyllus* as a good genus.

Now, let us turn to Branch B. It splits into branches C and D. To our knowledge, there are no other intervening branches, so that one valid option is to consider everything on these branches as one genus. This produces a genus not too dissimilar from one earlier version of *Hygrocybe*, when most of what is now known as *Cuphophyllus* was considered a separate genus, at that time called *Camarophyllus*. This concept of *Hygrocybe* has worked





Same phylogram as on the previous page, so that you can follow the text without having to flip pages.

in the past, and may continue to do so. However, Lodge and coworkers have demonstrated a split of branch B into C and D. Branch D has good statistical support (indicated by a thick line), which means that the likelihood is over 70% that this genetic separation is a consistent or "true" finding. Because we can also identify other consistent differences between the genera on branch D and those on branch C, you may decide to acknowledge this difference, in order to keep like with like.

If you opt to accept the split, your next choice is to decide what to do with the genera on branches C and D. Both are independent branches, so that a decision on one does not affect the decision on the other. The choice on branch D is simple: accept both genera, or reject *Gloioxanthomyces* (which was derived from *Hygrocybe* on branch C—either on the *Hygrocybe* branch E or the *Gliophorus* branch J, depending on the author) and transfer *Gloioxanthomyces* species to *Chromosera*. Branches K and L, leading to these genera, both enjoy high statistical support, so that if you put a lot of value on such findings, you would likely support distinguishing between the two genera. You could summon support in the different habitat and looks of the two genera. *Gloioxanthomyces* has a gelatinized gill edge, similar to *Hygrocybe laeta* (*Gliophorus laetus*), but the cells that make up the flesh are distinctive. Or you may opt to continue considering differences in species of *Gloioxanthomyces* and *Chromosera* as minor, concluding that such differences are reasonable between otherwise similar species within one somewhat diverse genus. Note that branch D is a sister to C, containing all the other genera. Therefore, you can lump branches K and L or choose both, but not select only one.

If you chose to recognize branches C and D as valid splits, then regardless of what you chose to do with branch D, branch C presents you with several options. First, you may elect to lump all genera emanating from branch C as one genus, *Hygrocybe*. But both of its branches, E and F, have high statistical support, and the pigments that give these branches are chemically unrelated and give the species in branches E and F very different appearances. These considerations may influence you to separate genetically unlike groups. If you decide to separate E and F, you are automatically accepting *Neohygrocybe* as a valid genus. Your decision then is what to do with branch H. You may lump all into one genus (*Gliophorus*, named in 1958, which has priority over *Humidicutis* named the following year in 1959, and the limits of the genus would have to be expanded to absorb *Gliophorus* species). If not, you automatically accept *Gliophorus* as valid. Your last decision is whether to lump *Porpolomopsis* and *Humidicutis*, or accept both as valid genera. Each branch is well supported but the split that separates the two branches is not statistically significant, and they are morphologically similar. If you have come this far, why not go for broke and accept these as valid genera as well? Should you reject this split, you would join several mycologists who previously placed species of the younger genus, *Porpolomopsis*, in the older of the two named genera, *Humidicutis*. The type species of *Porpolomopsis* (*Hygrocybe calyptriformis*) has never been placed in *Humidicutis* but was thought to belong to *Hygrocybe* in branch E because it's conical pileus with a splitting margin resembles that of *Hygrocybe conica* (the type species of *Hygrocybe*). *H./P. calyptriformis* would need to be transferred to *Humidicutis* in order to recognize the entire branch I as a single genus.

Among this confusing profusion of permutations and combinations, three valid choices stand out. One option is to lump all derived genera (excluding *Cuphophyllus*) into one large *Hygrocybe*. Another is to decide, as did Lodge and her coworkers, to accept all proposed derived genera. A compromise is to accept three bigger genera: the "parent" *Hygrocybe*, one large genus flowing from branch F (needs descriptions and naming), and the small *Chromosera*, transferring into it species of the new genus *Gloioxanthomyces*.

What happens now? How are the decisions made? Who "accepts" or "rejects" the proposed new derived genera? After all, if they were found to exist genetically, is that not the end of the discussion: they are there and therefore must be accepted?

Well, not exactly. The fate of these new genera now rests in the hands of the community of users, primarily taxonomists and mycologists, but also all others interested in fungi. Anybody wishing to talk about them with others must find a common language, including what to call them. Remember, there are no fixed rules, so incorporation of new proposals is left to usage. We already saw some of the decisions guiding such usage: an overly large and overly diverse genus, such as the super-*Hygrophoprus*, containing *Cuphphyllus*, *Hygrophorus*, *Arrhenia*, basidiolichens and other genera, seemed to be undesirable. Why? Well, mostly because it did not seem helpful. It had in it so many species with distinctive characters that they would be difficult to organize in the mind without breaking them down into subgroups. At the same time, some of these organisms were so different, that this large genus did not seem to lump like with like, either in appearance or ecology. Much as overly large genera are not perceived to be helpful, overly small genera are also not helpful. If genera become very small, they offer very little advantage to the user over species, and a larger group would seem more desirable.

As we see, the size of the group influences the likelihood of its acceptance. Some 50 species split off the large genus *Cortinarius* likely will be perceived as helpful. Small genera of one to two species split off a large genus like *Entoloma* will not be equally helpful. Neither will the splitting of a small 12-species genus into ten little genera most with only one species, even if scientifically correct. Of course, the nature of the species may override these considerations. For example, there really is no other mushroom remotely like *Polyozellus multiplex*, so placing it in a genus by itself will likely be accepted. Sometimes a new discovery creates an epiphany: "Aha! I always knew there was something different about this group! Now I know." Well, in that case the acceptance will be viewed as helpful to placing like with like, and its acceptance likely. Splitting in half a manageable genus of mushrooms that look alike and have the same lifestyle may be far less likely to gain acceptance. But if two similar genera are shown to have different genetic make-up on two different continents, the names are more likely to be accepted. Why? Because in this case it is perceived to provide some insight into their evolution, once the opportunity of exchanging genetic material is removed. In other words, the split is seen as helpful to our understanding of fungi.


Polyozellus multiplex

These are the main factors that influence the usage and acceptance of proposed names. Of course, there are many others, because we human beings are moved in many and mysterious ways. For example, petty things like pronunciation no doubt influence decisions. "Polyozellus" is a foreign word, but seems to roll off the tongue smoothly, with an appealing aftertaste of chocolate and a hint of tobacco, so it is likely to be used. "Gloioxanthomyces" may find it has a tougher row to hoe. You may be surprised, but even the tongues of scientists have limits.

But what about science, where is its place in this, you ask. Surely it should determine what is accepted or not. Of course, science does play a role, but it is not the final arbiter. If scientific evidence for a separation is overwhelming, it is accepted, even when morphologically incongruous. For example, when *Rickenella* was shown to be related to *Hymenochaete*, together with genera like *Phellinus*, *Trichaptum* and *Inonotus*, and far away from lookalikes *Hygrocybe* or *Mycena*, this was readily accepted as an example of parallel evolution. By the way, at the same time *Phellinus*, *Trichaptum* and *Inonotus* proved to be far away from their lookalikes *Fomitopsis* or *Trametes*. These splits were very helpful to lump genetically like with genetically like as an attempt to indicate relatedness.

This makes it clear that whether a proposed new name is accepted or not, the science behind its proposal remains equally valid. In the absence of absolute criteria for designating a genus, proposing a new genus on the basis of scientific evidence always involves some degree of judgement or opinion about the significance of the findings. Opinions differ, without altering the underlying facts.

Just as some may accept a genus with

Non-intuitive or incongruous groupings. The two in the middle are not related. The two on the edges are not related. The two on the left are related. The two on the right are not related. Parallel evolution is the term used for the ability of an evolutionary line to (re)invent a shape or function when it proves advantageous. The Hymenochateoid clade (two on the left), the Euagaric clade (3rd from left) and the Polyporoid clade (on the right) have all developed a gilled hymenium or a poroid conk fruiting body, as suited the occasion. Because this discovery gave new insights into evolution, these new larger groupings were readily accepted.

both slimy and viscid species while some may prefer to place each in a genus of its own, so some may accept a genus with some phylogenetic divergence, while others would prefer to place each branch in a genus of its own. Whichever decision becomes accepted custom, the slimy ones remain slimy and the ones on one evolutionary branch remain there. The system we have for ranking organisms is a tool, designed to help us place like with like, in our effort to understand nature around us. We strive for a perfectly balanced tool, not too bulky for use in fine situations, not too fine for a bigger job, and not too complicated to handle comfortably. Taxonomy is for us, not the mushrooms. This is why the word "helpful" appeared so many times in the discussion of why some new genera may be accepted or not. Not every perceived difference needs to be named, or if named, it may not require incorporation into taxonomy (or it may be recognized at a lower rank, a subgroup within a genus). It is the job of the scientist to discover new things, including differences, and present them to both peers, and eventually us at large. It will then be up to collective usage over time, to determine what will be helpful if incorporated into the tool we use to understand nature.

Lodge and coworkers have done a large amount of work, dissecting out the phylogeny of the Hygrophoraceae and correlating the branches with previously named genera and subgroups within genera—all based on appearance and ecology. Most of the work was in sifting through the multiple names that have been applied to each group and applying the rules of nomenclature to determine which were the names that could be used (i.e., correct, validly published, and legitimate). Both the 'lumper' and 'splitter' naming approaches to *Hygrocybe* classification were presented by Lodge and co-workers in parallel so that users could decide for themselves which system is most useful to them. Science is perceived to deal with absolutes, but certain aspects are democratic. It will be interesting to follow the fate of these segregate genera that were supported by molecular phylogeny, ecology, pigment chemistry and morphology. As an experiment, we shall adopt them all in our Foray Newfoundland & Labrador lists. Those of us with a distant best-before-date can then see which remain in general usage 10, 20, 25 or more years from now.

References

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