The botanical and zoological codes impede biodiversity research by discouraging publication of unnamed new species

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Abstract Molecular systematics is advancing rapidly, while the pool of taxonomic expertise dwindles: thus, the lag between recognising potential new species, and formally describing those species, will increase. Given the urgency of the biodiversity crisis, the existence of potential new undescribed species should be communicated as rapidly and widely as possible, thus highlighting the relevance and importance of systematics to other sciences, and to biodiversity managers, policy makers, and the general public. However, under the current botanical and zoological codes, scientists who reveal the existence of unrecognised taxa are vulnerable to having those candidate species rapidly named by unscrupulous individuals using unrefereed (and often self-published) works. This compelling argument for peer review in nomenclature has been largely overlooked in previous debates about the codes. The botanical and zoological codes need to be immediately updated to discourage such taxonomic piracy; this would encourage taxonomists to disseminate their vital biodiversity data as quickly and broadly as possible.

Keywords biodiversity; cryptic species; new species; nomenclature; *ICBN*; *ICZN*; peer review; taxonomic impediment

THE GROWING LAG BETWEEN SPECIES RECOGNITION AND SPECIES DESCRIPTION

Even before the advent of rapid, large-scale molecular sequencing, recognising the existence of new species was a much quicker process than formally describing them (e.g., Scanlon, 1981; Shea & Scanlon, 2007). This lag between species recognition and description now threatens to increase: molecular analyses can efficiently identify deeply divergent lineages or "candidate species" with increasing speed and efficiency (Hebert & Gregory, 2005; Fouquet & al., 2007), while there is a decreasing pool of taxonomic expertise that can evaluate the biological and ecological attributes of these divergent lineages to clarify their species status, and to formally diagnose, typify, and name them (e.g., Agnarsson & Kuntner, 2007). The latter endeavour remains a critical part of systematics, as most organisms are currently identified using external morphology (portable DNA barcoding "probes" are many years away, at best: iBOL, 2010). Taxonomic expertise is particularly important to species complexes that include divergent lineages with confusing and overlapping patterns of phenotypic variation, which might or might not represent species (regardless of adopted species concept). Thus, advances in molecular biology have ironically increased the magnitude of the 'taxonomic impediment' (de Carvalho & al., 2005).

In the face of this massive and increasing taxonomic backlog, science and biodiversity management are best served if knowledge of potential new species is disseminated as rapidly as possible. In science, knowledge of multiple deep lineages means ecological and evolutionary studies can exploit this information, and will not be confounded by lumping multiple lineages. In management, such knowledge helps shape our inference of biodiversity hotspots. Recognition of multiple distinct lineages also highlights distinct management units within species complexes (Evolutionarily Significant Units: Moritz, 1994), although much conservation planning and legislation remains dependent on the existence of formal names. Immediate use of informal taxonomies (e.g., species A, species B), pending lengthy preparation of formal nomenclature and exhaustive diagnoses, greatly improves our ability to rapidly communicate current biodiversity knowledge (e.g., Last & Stevens, 1994).

Finally and perhaps most importantly, highlighting new undescribed species draws both public and scientific attention to the huge gaps in our knowledge of life on Earth, and the fact that considerable work needs to be done. Public awareness of the taxonomic imperative, and support for systematics as relevant and dynamic science, is increased by high-profile research reporting extremely high levels of unrecognised biodiversity, even in charismatic and apparently well-studied groups, such as vascular plants (e.g., Gibson & al., 2007), butterflies (Hebert & al., 2004), mammals (Ceballos & Ehrlich, 2009), reptiles (Oliver & al., 2009) and frogs (Meegaskumbura & al., 2002; Fouquet & al., 2007; Vietes & al., 2009). As an extreme example, the existence of not one but two species of the largest terrestrial animals (African elephants) was only recognised within the last decade (Roca & al. 2001).

THE RISKS OF COMMUNICATING THE EXISTENCE OF UNDESCRIBED TAXA

While there are compelling reasons to rapidly disseminate information about the existence of newly-discovered biodiversity, this practice is hindered by current codes of nomenclature. The *International Code for Zoological Nomenclature* (Ride

& al., 2000; "zoological code") and the *International Code for Botanical Nomenclature* (McNeill & al., 2006; "botanical code") both make scientists publishing evidence for potential new species extremely vulnerable to acts of poor and even malicious taxonomy. The rules for naming animal and plant species are currently so liberal that it is easy for unscrupulous individuals to immediately attach names to newly-identified candidate species, not only scooping legitimate workers but creating long-term taxonomic problems through poor diagnoses and descriptions, inappropriate designation of types, complex synonymies, and obscure literature. This unfortunate situation arises because, provided certain minimal criteria are satisfied, taxonomic names erected in self-published works are valid. To make matters worse a proposal to amend the *ICZN* to recognise names published on the web has already been submitted (International Commission on Zoological Nomenclature, 2008) and proposals to amend other codes may follow. Given the ease of on-line publishing these changes may increase the scale of the problem of valid but substandard self-published taxonomic works. The lack of requirement for peer review makes it easy for "taxonomic vandals" (see Jäch, 2007a,b) to cause chaos by proposing wholesale taxonomic changes across large swathes of species, rapidly self-publishing works in order to "scoop" other people (see Borrell, 2007), and attaching names to candidate species identified by other people despite having little demonstrated expertise on the relevant group (e.g., see commentary on "*Asymbolys teriae*" and "*A. diessneri*" in Eschmeyer & Fricke, 2009). The grey literature produced is often poorly accessible (Wheeler & Krell, 2007), further hindering taxonomy.

Numerous self-published works proposing wholesale changes have had long-lasting, destabilising effects on taxonomy. The non-peer-reviewed works of Dewanand Makhan have wrought havoc on the taxonomy of the most diverse group of animals (coleopterans) for over 20 years, enough to prompt a recent protest signed by 120 scientists to his university employer, where he is a technician in wood anatomy (Jäch, 2007a). This is not a unique case: many other groups have been subject to the same destabilising effects of self-published works that do not appear to have undergone rigorous peer review (e.g., Australian Society of Herpetologists, 1987; Wüster & al., 2001; Georges & Thomson, 2010). Botany is not immune, with many unrefereed amateur contributions to orchid taxonomy being labelled by one scientist as "a disaster" (Borrell, 2007), and which may have severely distorted perceived patterns of biodiversity hotspots (Pillon & Chase, 2007). Even extinct forms cannot rest in peace, with over 40 dubious species of *Conus* shells described outside the peer-reviewed literature in the past 17 years (Hendricks, 2009).

■ A FURTHER REASON FOR MANDATORY PEER REVIEW

Introducing peer review as an essential criterion for validity of newly proposed taxonomic names would dramatically reduce these problems. All three codes were drafted before peer review became the norm: for instance, Einstein's classic 1905 papers were not externally reviewed, and he angrily withdrew a paper from *The Physical Review* when he first encountered the system in 1936 (e.g., Schweber, 2008). Also, when all three codes were originally written, self-publishing was virtually impossible except for those wealthy enough to run their own printing presses. Times have now changed. Peer review is ubiquitous, and has been demonstrated to be a most effective means of screening out poor-quality science, rejecting poor papers and improving the rigor of the acceptable manuscripts (Harnard, 1998), while virtually anyone can self-publish papers of dubious quality. Introducing a requirement for peer review in the codes would filter out most of the latter papers: works proposing gratuitous changes based on poor evidence would either be rejected, or subject to major revisions and improvements. The bacteriological code now requires elements of peer review before names are validated (see below). However, the zoological and botanical codes remain neutral on this issue, although the *ICZN* acknowledges that "current provisions for peer review of taxonomic papers are often far from ideal" (Polaszek & al., 2005), and the *ICBN* recommends (but does not insist) that new names be published in standard, readily accessible taxonomic avenues such as scientific journals (Recommendation 30A.2) rather than unorthodox outlets such as popular periodicals or ephemeral printed matter (Recommendation 30A.1).

Many reasons for and against mandatory peer review have proposed (e.g., see Eyualem-Abebe & al., 2006; Polaszek & al., 2008). However, peer review is now general for all scientific fields, and to exempt taxonomy from the standards of all other evidence-based sciences appears to be special pleading. Most recent arguments against mandatory peer review have been proposed in informal electronic communications (e.g., Taxacom: http://mailman.nhm.ku.edu/mailman/listinfo/taxacom). Common reasons, and counterarguments, are briefly listed here.

(1) Many good papers were published without peer review. The "classic" taxonomic works published without peer review were mostly written before the middle of the twentieth century, i.e., before peer-review became the scientific norm. In contrast, almost all valuable taxonomic papers today are published through peer reviewed avenues. By analogy, Einstein's landmark 1905 papers were not externally reviewed, yet few physicists have used this fact to question the need for peer review in their discipline.

(2) Peer review doesn't filter out all bad papers. While no system can totally eliminate poor research, it is indisputable that peer review greatly improves the quality of published research, by rejecting poor work and improving accepted work (Harnard, 1998). This is why peer review is universal in science today.

(3) Peer review hinders taxonomic freedom and suppresses innovation, i.e., some good papers can get rejected. Geography or financial resources no longer impede access to peer-reviewed journals; there are now many taxonomic journals accessible to virtually all scientists, all with electronic manuscript submission (and most with no publication charges). Good taxonomic work that gets rejected unfairly from any one journal will eventually be accepted for publication in another peer-reviewed journal. The only works peer review would suppress

are manuscripts so poor they get rejected from all taxonomic journals. It is difficult to imagine that such works would make a positive contribution to science if published.

(4) Peer review places an increased burden on referees. Most taxonomic papers are already being published through peer-reviewed journals and academic books, so there would be little increased burden on referees to make peer-review compulsory (Polaszek & al., 2008). Indeed, the botanical code explicitly already encourages publications in standard taxonomic outlets such as peer reviewed journals.

(5) Poor taxonomic work, more likely to be published in unrefereed outlets, will be eventually corrected by the scientific community: if someone erects 100 new species by formally naming every population variant, future workers will synonymise the names of poorly-constituted species until only the names of "good" species remain (International Commission on Zoological Nomenclature, 1991). This argument is weak because it rewards the unscrupulous practice of naming every possible variant as a new species without good evidence, in the hope that some names will stick. Such works would be unlikely to pass peer review. Taxonomic stability is maximised when species are formally named *after* there is good evidence for their reality; allowing ambit naming of species results in tangled synonymies that wastes the increasingly valuable time of ethical taxonomists.

However, as highlighted earlier, perhaps the most compelling argument for peer review in the codes has been largely overlooked. Scientists will be increasingly reluctant to publish discoveries of potential new species, for fear of "taxonomic piracy": unscrupulous workers using self-published works to rapidly attach names to these candidate species, before more rigorous nomenclatural evaluations can appear in the proper scientific literature (e.g., see Borrell, 2007). Such unethical taxonomic behaviour would be unlikely to survive peer review. However, without such a safeguard in the codes, scientists will increasingly withhold their phylogenetic and biodiversity information until they have also finalised the detailed taxonomy. Even if scientists do publish on the existence of unrecognised species, it is likely that locality and specimen information will be withheld, making it difficult to relate field records to published research. Molecular methods for discovering potential species are forging ahead of the taxonomic expertise required to describe them, so the delay between species discovery and taxonomic description grows ever greater. Any code that encourages delaying dissemination of vital information on biodiversity is doing science a disservice.

In a recent assessment of Australian turtle taxonomy, Georges & Thompson (2010) argued that the zoological code should be modified to include a list of acceptable journals and/or to require proof of peer review before a name is regarded as valid. We strongly endorse the call for an unambiguous strengthening of the rules of both the zoological and botanical codes, although there will be some debate about the details. For instance, the quality and publishing policy of a given scientific journal can change with time, and new journals (especially electronic-based) are appearing with increasing rapidity. Any list of "acceptable journals" would need to be continually updated, placing a burden on the relevant code. One simple solution might be to recognise only names published in journals that appear on at least one of the many reputable databases which rigorously screen indexed publications. For non-journal publications, a model similar to the bacteriological code could also be workable, and indeed is one of several options canvassed by the *ICZN* (Polaszek & al., 2008). The bacteriological code (Lapage & al., 1992) does not impose any restrictions on where names are initially published (permitting self-published books and journals), but the names are not formally validated until they are confirmed to satisfy rigorous standards and announced in the peer-reviewed journal *International Journal of Systematic and Evolutionary Microbiology.* However, proposed amendments to the *ICZN* to make registration mandatory (*ICZN*, 2008) do not include reference to peer review, so the problems discussed at length above will not be ameliorated. This contradicts a report from commission members that most taxonomists might support mandatory peer review (Polaszek & al., 2008). As a starting point for discussion, a relevant clause for the *ICBN* might be as follows:

Insert a new Article following Art. 37 restricting valid publication of names of new taxa to peer-reviewed publications

"*37bis.1.* On or after 1 January 2013, the name of a taxon must, in order to be validly published, appear in a publication that has demonstrably undergone formal peer review, by satisfying at least one of the following three criteria:

(i) the taxon name is published in a journal that, at the time of publication, is indexed in one of the following databases of peer-reviewed academic journals (Science Citation Index, PubMeb, Science Direct);

(ii) the taxon name is published in a journal that, at the time of publication, is indexed *as a peer-reviewed journal* in one of the following general databases (Academic Search Premier, Academic One-File);

(iii) the taxon name originally appeared in a publication that did not satisfy either of the above criteria, but which has been assessed by the organisation administering the relevant code (e.g., the nomenclature section of the IABMS) as being both peer-reviewed and meeting basic scientific standards, and accordingly the publication and included taxon name(s) have been announced in the journal *Taxon* [or some associated online database]. In such instances, the publication must be submitted to the administering organisation along with a statement from the editor that it underwent independent peer review, and any other relevant information. The administering organisation has absolute discretion whether or not to recognise any such publication, and will not necessarily provide detailed reasons for their decisions."

Insert the following new Recommendation following Art. 37bis.

"*37bisA.1* The name of a new taxon should be published in peer-reviewed, readily accessible scientific journals which are indexed in one or more of the following databases: Science Citation Index, PubMeb, Science Direct."

The above draft proposal removes the onus on the nomenclature committees to maintain a list of acceptable journals: the relevant indexing services have their own rigorous criteria. At the same time it does not cause the codes to rely exclusively on any single journal database, which could be problematic as any single database can change or disappear (e.g., Zoological Record and Biological Abstracts have been subsumed into the Science Citation Index). Further, it is not overly restrictive because any journal that does not appear on *any* of the databases listed in (i) and (ii) is likely to be so difficult to access, and of such dubious quality, that publication of taxon names in it should be discouraged. Finally, while the third clause necessarily does not remove all subjectivity about what counts as peer review, and requires the relevant nomenclature committees to "vet" publications not listed on the standard scientific journal databases, the amount of effort it takes a committee to decide that an unorthodox publication fails to meet rigorous scientific standards is far less than the amount of effort required by the entire taxonomic community to examine and refute multiple dubious taxonomic acts contained therein. This third clause is similar to the procedure adopted by the bacteriological code, but is more efficient than the latter in that it does not place a burden on the nomenclature committees to specifically ratify articles and names which appear in standard peer-reviewed journals.

The above comments are only a suggestion. The final wording of any amendments the zoological and botanical codes would have be to the topic of careful consideration; the aim here is to catalyse the relevant discussion, highlight a new argument for making peer review mandatory, and show that these changes can be readily implemented within the relevant codes. Strengthening the codes in this way would greatly reduce the disruption to taxonomists and end-users caused by unrefereed taxonomic contributions. Most importantly, it would dramatically discourage taxonomic piracy. This would encourage systematists to rapidly communicate their discoveries of hidden biodiversity, thereby underlining the continuing relevance of taxonomy to the scientific and general community.

We welcome prompt comments and suggestions so that it may still be possible to make formal proposals to the XVIII International Botanical Congress to be held in Melbourne in 2011, for which the final deadline for submission of proposals is imminent.

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