Towards a polynomial system of zoological nomenclature? A response to the proposals of D.S. Yu (1993)

Earle E. Spamer

Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103–1195, U.S.A.

Arthur E. Bogan

Freshwater Molluscan Research, 36 Venus Way, Sewell, New Jersey 08080, U.S.A.

Introduction

Yu's 'proposed system for stabilizing the names of species' (BZN **50**: 7–12) was introduced to mitigate the proliferation of 'extra names' for species-group taxa that originate largely from the reassignment of species to genera in which they were not originally named. He proposed an extension of the Linnean system of binomial nomenclature, to accommodate a polynomial name constructed from an immutable original binomen prefixed or interleaved with the name of the genus (and when relevant subgenus and subspecies) in which the organism is now classed. In this way, Yu argued, the taxon's original identity is always recognized and never lost even if there is an error in, or an omission of, the author and date.

In his proposal, Yu used examples from the entomological literature. The particular cases of a taxon with 75 names, including 36 junior synonyms, the 62 identical subspecies names erected by one author over a period of 23 years, or the 13 identical species names erected by one author in one year, are particularly enlightening examples of the potential for taxonomic confusion when organisms are reidentified or synonymized.

It would be a simple matter just to say that complete synonymies provide the information that Yu seeks to preserve. Synonymical lists are not always complete, nor are they always accurate. It would be simple also to suggest that a table be included in all appropriate papers, in which the taxa cited therein are listed with their original binomens. But the publication of Yu's proposal has brought to our minds several points of discussion.

Remarks on the present system

Since 1758, the system of binomial nomenclature in zoology has functioned in the manner it was intended — to provide a name for an organism, within an artificially derived hierarchy. Over more than 230 years biologists have worked within the arbitrary confines of Linné's binomial system. As the result of these centuries' work, synonymies have sometimes become unwieldly, but proper attention to them is a requisite for every revisionary work in biology.

Biologists have always dealt with the inherent problems of reidentification and synonymization in the guidelines of a binomial system. This is not to admit that the system is wholly adequate; Yu's observations on the limitations of binomial nomenclature are valid. The problems are not unique to zoology; the botanical community has developed the *International Code of Botanical Nomenclature* (Greuter

et al., 1988), and the bacteriologists have devised the *International Code of Nomenclature of Bacteria* (Lapage et al., 1975) which rigidly controls its nomenclature with an approved list of bacteriological names and which places controls on valid publication. Nonetheless, all communities practice their different rules within the basic framework of binomial nomenclature. Focusing here on zoology, attention had been drawn by the beginning of the 20th century to the problems of instability in inconsistent uses of nomenclature. The *Règles Internationales de la Nomenclature Zoologique* (1905) were followed by the editions of the *International Code of Zoological Nomenclature* (see the Introduction by W.D.L. Ride in the current *Code* (ICZN, 1985, pp. xiii–xix)).

Remarks on Yu's proposal

1. Yu (p. 7) intended that his proposal was 'to make nomenclature more stable and more applicable to computer-oriented technology without diminishing the very important taxonomic function of the system'. There Yu raised a point which our forebears in biology could not have imagined — computerization. A technology now exists which permits us rapidly to organize data into logically divided categories that can be manipulated by mechanical devices and programmed directions. Here, as with the proliferation of systematic hierarchies, there are potentially as many ways of approaching a problem and manipulating its data as there are people doing the work. Yu has developed one means of dealing with the data he uses — his TAXA program. Here we enter a dangerous area, that of reorganizing the system of taxonomic nomenclature to accommodate a current, but perhaps transient, technology.

The clerical burden of binomial nomenclature, exacerbated by extraordinary situations like those cited by Yu, is amplified by the construction of a computerized database. The problems of correlating reidentified and synonymized binomens with their original binomens become more apparent when these data are divided into the arbitrary categories of a computerized database. In a less than sophisticated computer program, minor aspects such as parentheses become more complex than they should be. Solutions to these problems do exist now through more sophisticated programming, and no doubt procedures will become simpler. Both of us have worked with specialized databases for molluscan taxonomy, and we each have organized our own databases for different subject areas of biological taxonomy. These databases have been customized to accommodate special needs. The data in them are taxonomic and bibliographical; when more advanced computer programs become available we will take advantage of that technology. At this time the problems are those of the operators.

2. Recent years have witnessed the development of 'standard' lists of organisms. These often are the work of committees of biologists who are working within their special disciplines, or who are working at the behest of a governmental or other agency on some aspect of biological monitoring and conservation. Heywood (1991) has discussed the special needs for a stable nomenclature of organisms especially with regard to issues of conservation. His points have become even more well directed in light of the growing number of keys and lists of both biological groups and regional biotas.

Standard lists are not designed to usurp systematic thinking — for there are many different systematic schemes in use at any given time — but they are designed to

provide recognized names for organisms for specific non-taxonomic purposes. They often arbitrarily accept one name instead of another, and for this reason they are inadequate for most works of systematic revision. Many of them also serve as compendia of common names. But the purpose of these lists is similar to the objective of Yu's proposal; the binomial nomenclature is unambiguous. These and other standard lists would be effectively outmoded with the introduction of a polynomial system.

North American workers have devised standard lists of the names of fishes and aquatic invertebrates, coordinated by the American Fisheries Society. These lists are devised to provide stability. It is clear that the scientific details of synonymy and systematic relationships can be relegated to such professionals working on revisions within their respective fields; for most workers, who are under the pragmatic constraints of production schedules and legislative due dates, there is some coordination provided by a standardized — and revisable — nomenclature. Thus far, volumes have been produced for the fishes (Robins et al., 1991), Mollusca (Turgeon et al., 1988; second edition is in review), Decapoda (Williams et al., 1989), and Ctenophora and Cnidaria (Cairns et al., 1991). Volumes on Crustacea (Isopoda, Copepoda, Amphipoda, Cirripedia, Euphausiia), Annelida, Insecta (Plecoptera, Heteroptera, Odonata, Coleoptera), Echinodermata, Porifera, Bryozoa, and other 'miscellaneous' groups are currently in review or in preparation.

To illustrate the widespread availability of what often are prodigeous compilations of Linnean taxonomic names, we cite the standard lists of birds of the world (Sibley & Monroe, 1990), North American butterflies (Miller, 1992), coleopterids of North America north of Mexico (Leng, 1920, and supplements), and the voluminous checklists of coleopterids, organized by family, issued by the U.S. Department of Agriculture. Linnean taxonomy pervades publicly accessible computerized databases, such as those reached through the Internet consortium of computers; e.g. the *Mammal Species of the World* checklist on the Smithsonian Institution's 'Gopher' (nmnhgoph.si.edu 70), extracted from Wilson & Reeder (1993). Each reader probably can add many to our examples.

3. Latin grammar is seen by some workers as an unfortunate aspect of the Linnean system. Changing the spelling of species-group names to agree in gender with the genus name is inconvenient for many workers, and mistakes are often made. An unsophisticated computer program, too, will see a re-spelled species-group name as different, where to a taxonomist it is the same. This is a shortcoming of technology, not one of taxonomy, and should have no bearing upon the construction of a full scientific name.

4. What Yu seeks is a universal language, but such efforts have always failed. Numerical schemes independent of (or in parallel with) names have already been proposed (see Heppell, 1991). Numerical codes have been in use in standard lists (e.g., Leng, 1920, and Sibley & Monroe, 1990), but they supplement the Linnean taxonomic names. Some databases also employ 'serial numbers' which link specific groups of taxonomic data in various ways, but here too they supplement the taxonomic names. Zoologists are not alone in standardizing and numerically coding species; see, for example, the lengthy list of plants of southern Africa edited by Arnold & de Wet (1993). We express concern that computerized databases which incorporate zoological and botanical data will encounter unnecessary procedural

difficulties if they combine the binomial nomenclature of botany with a polynomial one of zoology.

5. Yu (p. 10) brings up the key point of non-taxonomists working with taxonomic names. Such people are the majority in biological work, and Yu validly emphasizes that points of ambiguity which 'may sound trivial to a taxonomist ... are real problems to non-taxonomists'; for example, the use of different genera, the use of parentheses, and the differences of gender endings of specific names. Yu does not mention that even established systematic researchers, especially in the years before the *Règles* and the *Code*, often faltered on these points, so that synonymies are littered with 'sic', 'errore', '(?)', 'non', 'nec', and so on.

In Yu's proposed system, every worker will be required to verify the original binomen if that information is not readily available to them. This will be necessary in order to construct the polynomial scientific name for an organism. These workers, including the non-taxonomists who Yu strives to assist, will have to pore through the literature of previous nomenclature. In most cases they will accept the original binomen as published by someone later than the original author, for example in a later synonymy. Most workers do not have ready access to comprehensive libraries of natural history; they will probably not have a copy of Linné's (1758) *Systema Naturae*, much less Gmelin's (1788–[1792]) revised 13th edition of that work.

Conclusions

Every few years a new system is proposed, or there are discussions on the need for improved stability in taxonomic nomenclature; one has simply to browse through the text and references of Hawksworth (1991) for many examples. Savage (1990) has called for an Official List of Names in Current Use which, if it were to be implemented, would negate the need for Yu's polynomial taxonomy. To our knowledge no one before Yu has proposed a new system of nomenclature which scrambles original and subsequent binomens.

We consider that confusion would result from an implementation of Yu's proposed system of nomenclature. In addition to the binomial system that has been in place since 1758, the literature would (after some arbitrary date set by a future edition of the *Code*) have a second nomenclatural system to take into consideration. Future biological workers would have to decide whether a published binomen was a mere relic of the present system or a non-reclassified species in the polynomial nomenclature of Yu. Every existing database would have to either retrofit to a polynomial taxonomy all of the existing binomial data or it would have to accommodate them in parallel with the new taxonomy. This difficulty erodes the purpose of Yu's proposed system.

Yu has proposed that the original binomen become a part of the full scientific name. He has illustrated (p. 11) his proposed taxonomy with the example (in the binomial taxonomy) of *Togea formosana* Uchida, 1926, which has been reclassified as *Benyllus formosanus* (Uchida, 1926) and as *Stirexephanes signatus formosanus* (Uchida, 1926). In the proposed system, the new polynomens would be, respectively, *Benyllus Togea formosana* Uchida, 1926, and *Stirexephanes signatus Togea formosana* Uchida, 1926. Once the structure of the names is understood, in each case the original binomen is unambiguous. But in each case the original genus takes up a different position in the chain of names, and the subspecific name becomes separated from that

of the species. To put these names into a database requires disassembling the scientific name into both the original binomen and the later classification that is a bi- or trinomen — in the style of Linnean taxonomy!

To change the binomial architecture of nomenclature to provide for more convenient computerization is short-sighted. This technology has been available to biologists for a couple of decades only. We are led by Yu to suppose that restructuring nomenclature to accommodate both current technology and those who do not have need to attend to the details of taxonomy will provide for a less ambiguous taxonomic environment. When the problems addressed in Yu's proposals can be automatically dealt with by more sophisticated (but easy to use) database programming, would biologists then be bound, through some future edition of the *Code*, to Yu's then-unnecessary polynomial nomenclature?

Taxonomy provides the stabilizing nomenclatural hierarchy for systematic research throughout biology. The scientific literature, particularly in recent years, is full of papers that decry the erosion of the importance given to basic systematics in biology. To meddle with nomenclature particularly at this critical time is an additional aspect which should generate concern. Even though we disagree with the specific proposal advanced by Yu, we believe that nomenclatural revision of any kind at this time is unwise. Bisby & Hawksworth (1991) have explored the reasons for the decline of systematics and have come out in clear support of stability through the adoption of a definitive List of Names in Current Usage, and called for 'user-orientated information services for all known organisms'. However, what really is needed is a database of synonymies from all of zoological literature — its core would be Sherborn's *Index Animalium*, Neave's *Nomenclator Zoologicus*, and the *Zoological Record* to date, to which can be added synonymical lists from the literature. The technology exists now to make this aid available, and it permits illustrations to be incorporated. Unfortunately, the funding to bring such a resource into being is not likely to be made available.

References

Arnold, T.H. & Wet, B.C. de. (Eds.). 1993. Plants of southern Africa: names and distribution. *Memoirs of the Botanical Survey of South Africa*, **62**: 1–825.

Bisby, F.A. & Hawskworth, D.L. 1991. What must be done to save systematics? Pp. 323–336 *in* Hawksworth, D.L. (Ed.), 1991.

Cairns, S.D., Calder, D.R., Brinckmann-Voss, A., Castro, C.B., Pugh, P.R., Cutress, C.E., Jaap, W.C., Fautin, D.G., Larson, R.J., Harbison, G.R., Arai, M.N. & Opresko, D.M. 1991. Common and scientific names of aquatic invertebrates from the United States and Canada: Cnidaria and Ctenophora. *American Fisheries Society Special Publications*, **22**: 1–75.

Gmelin, J.F. 1788–[1792]. *Caroli a Linné ... Systema Naturae per regna tria naturae ...* (Tomus I) *Editio decima tertia, aucta, reformata*. Lipsiae.

Greuter, W., Burdet, H.M., Chaloner, W.G., Demoulin, V., Grolle, R., Hawksworth, D.L., Nicolson, D.H., Silva, P.C., Stafleu, F.A., Voss, E.G. & McNeill, J. (Eds.). 1988. *International Code of Botanical Nomenclature* (Regnum Vegetabile, vol. 118). xiv, 328 pp. Koeltz Scientific Books, Königstein, Germany.

Hawksworth, D.L. (Ed.). 1991. *Improving the stability of names: needs and options; proceedings of an international symposium, Kew, 20–23 February 1991*. (Regnum Vegetabile, no. 123). 358 pp. Koeltz Scientific Books, Königstein, Germany.

Heppell, D. 1991. Names without number? Pp. 191–196 *in* Hawksworth, D.L. (Ed.), 1991.

Heywood, V.H. 1991. Needs for stability of nomenclature in conservation. Pp. 53–58 *in* Hawksworth, D.L. (Ed.), 1991.

International Commission on Zoological Nomenclature. 1985. *International code of zoological nomenclature*, 3rd Ed. xx, 338 pp. International Trust for Zoological Nomenclature, London, and University of California Press, Berkeley.

Lapage, S.P., Sneath, P.H.A., Lessel, E.F., Skerman, V.B.D., Seeliger, H.P.R. & Clark, W.A. 1975. *International code of nomenclature of bacteria*, 1975 revision. American Society of Microbiology, Washington, D.C.

Leng, C.W. 1920. *Catalogue of the Coleoptera of America north of Mexico*. 470 pp. Sherman, Mount Vernon, New York. (and supplements, 1927, 1933 (Leng, C.W. & Motchler, A.J.); 1939 (Blackwelder, R.E.); 1948 (Blackwelder, R.E. & Blackwelder, R.M.)).

Linné, C. 1758. *Systema naturae per regna tria natureae . . . .* Tomus I. Editio decima, reformata. 824 pp. Salvii, Holmiae.

Miller, J.Y. 1992. *The common names of North American butterflies*. 192 pp. Smithsonian Institution Press, Washington, D.C.

Neave, S.A. (Ed.). 1939–1993. *Nomenclator zoologicus*, 8 vols. Zoological Society of London, London.

Robins, C.R., Bailey, R.M., Bond, C.E., Brooker, J.R., Lachner, E.A., Lea, R.N. & Scott, W.B. 1991. Common and scientific names of fishes from the United States and Canada. Ed. 5. *American Fisheries Society Special Publications*, **20**: 1–183.

Savage, J.M. 1990. Meetings of the International Commission on Zoological Nomenclature. *Systematic Zoology*, **39**: 424–425.

Sherborn, C.D. 1902–1933. *Index animalium*, 10 vols. British Museum, London.

Sibley, C.G. & Monroe, B.L., Jr. 1990. *Distribution and taxonomy of birds of the world*. 1111 pp. Yale University Press, New Haven.

Turgeon, D.D., Bogan, A.E., Coan, E.V., Emerson, W.K., Lyons, G., Pratt, W.L., Roper, C.F.E., Scheltema, A., Thompson, F.G. & Williams, J.D. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. *American Fisheries Society Special Publications*, **16**: 1–277.

Williams, A.B., Abele, L.G., Felder, D.L., Hobbs, H.H. Jr., Mannin, R.B., McLaughlin, P.A. &. Farfante, I.P. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *American Fisheries Society Special Publications*, **17**: 1–77.

Wilson, D.E. & Reeder, D.M. (Eds.). 1993. *Mammal species of the world*. Ed. 2. 1206 pp. Smithsonian Institution Press, Washington, D.C.

Yu, D.S. 1993. A proposed system for stabilizing the names of species, illustrated with reference to the ICHNEUMONIDAE (Hymenoptera). *Bulletin of Zoological Nomenclature*, **50**: 7–12.