Book Reviews

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The New Taxonomy.— Quentin D. Wheeler (editor). 2008. The Systematics Association Special Volume Series 76. CRC Press, New York. xi + 237 pp. ISBN 978-0-8493-9088-3 (ISBN-10 0-8493-9088-5). US$99.95 $52.99 (hardcover).

Taxonomy faces exciting challenges and opportunities to meet the demand for an ever more profound understanding of the diversity of life, how it developed, and the impact of human activity on the variety and distribution of biodiversity. Fundamental to the development of taxonomy are the rapidly expanding fields of high-throughput DNA sequencing, automated digital data gathering, and biodiversity informatics. Although an ever-expanding repertoire of theoretical and practical tools is available to taxonomists, there will have to be substantial, even radical, changes in how taxonomy is done in order to fully exploit these opportunities. It is widely acknowledged that for taxonomists "business as usual," even if scaled up, is simply not an option.

As one of the oldest scientific disciplines, taxonomy has been slow to adopt technologies that are more commonly embraced by other scientists. The reasons for this are many, but foremost is the fact that no algorithm can outdo the highly refined judgment of a taxonomic expert, who can classify from nuanced differences even the smallest organism. Fast, number-crunching computers have until recently had little to offer the taxonomist, who must wade through vast collections of diverse specimens in a myriad of institutions, and a fragmented literature spanning 250 years, in pursuit of identifying and describing new species. Thanks to the Internet and advances in information technologies, this is beginning to change. These systems, coupled with major digitization programs, are starting to bring together the vast global collections of natural history specimens, literature, and data. Together with collaborative research tools, this new approach to taxonomy, sometimes dubbed 'cybertaxonomy' by its practitioners, is the subject of a recent book edited by Quentin Wheeler: *The New Taxonomy*.

Born from a symposium of the same name held at the 2005 biennial meeting of the UK Systematics Association, this volume charts the efforts of several international groups to address the problems faced by contemporary taxonomists. In 10 essays covering techniques such as DNA barcoding, computer-aided identification, digital morphology, and E-typification, the book provides what the back cover describes as "an unapologetic look at morphology and descriptive taxonomy . . . [that] frames one of the most constructive responses to the biodiversity crisis." This is a bold claim. But perhaps we should expect nothing less from the editor who, amongst other things, is director of Arizona State University's International Institute for Species Exploration (http://www.species.asu.edu/).

Wheeler sets the tone for the book in his introductory chapter "Toward the New Taxonomy." His pitch will be familiar to anyone who has followed Wheeler's recent publications. With missionary zeal, he outlines his views on "the poverty of phylogeny," the failings' of molecular systematics, and berates what he calls the "I don't care" school of classification. Wheeler attributes the latter to Joe Felsenstein, but by implication indicts many others. This relentless barrage against much of contemporary systematics is proclaimed as an answer to *The New Systematics* (Huxley, 1940), which according to Wheeler formed "a battle cry for those who would dilute, detract, and eventually decimate taxonomy." Hyperbole aside, if Huxley's *New Systematics* was a battle cry for systematists, this response comes rather late. Few dispute the central challenges faced by modern taxonomy. These have been extensively commented on elsewhere and are selectively answered in this book's subsequent chapters; but to lay all the woes of taxonomy at the door of systematics is at best disingenuous, and at worst, dishonest. Doubtless, Wheeler's introduction will strike a chord with some sections of the taxonomic community, but it will do little to persuade most biologists about the central value of modern taxonomy.

Taxonomy is often caricatured as a cottage industry of individuals, working in isolation. Malcolm Scoble and Sandra Knapp dispute this image in their separate chapters that look at the role of networking and of collaboration in taxonomic research. Meeting global threats to biodiversity, like that of climate change, means that taxonomists frequently work as part of highly connected, interdisciplinary research teams. Their specialist knowledge and skills are central to planning fieldwork, collecting specimens, performing identifications and handling requests for information. Indeed, with a diminishing pool of specialists, taxonomists are increasingly hard pushed to balance these needs with the day-to-day demands of traditional descriptive research. Although it is true that taxonomy still requires periods of self-immersion in topics that others might find a total bore, the same is arguably true of all scientific endeavors.

In fact, it is the very parochial nature of taxonomic information and expertise that is behind the biggest transformation of the discipline. Taxonomy is fast

reinventing itself as an information science that is able to collate and publish information on the Web, rapidly and on demand. Through projects like Scoble's CATE (Creating a Taxonomic eScience; http://www.cate-project.org/) and Knapp's Solanaceae Source (http://www.nhm.ac.uk/solanaceaesource/), taxonomists working in collaboration are able to compile revisionary studies that individually would have taken a lifetime to complete. Web-based taxonomy provides the space and accessibility that traditional publications cannot afford. More importantly, Web systems and content can be developed and updated in minutes. This flexibility is a radical change from the all-or-nothing approach to traditional taxonomy, and in itself brings new challenges. For example, contributions to collaborative Web systems risk being short-lived, can be harder to cite, and do not attract the kudos of traditional publications. Addressing these problems will be a central issue if this new taxonomy is to be fit for its purpose.

Perhaps the darkest stain on the conscience of the taxonomic community is that we have no single register of animal names and descriptions. This problem is considered by Polaszek and colleagues in their chapter on ZooBank, a proposal for an open-access Web register of zoological names. Name registration is not a new idea. In fact it has existed for bacteria since 1980, was flirted with for plants from 1998 to 1999, and a voluntary scheme has been in place for fungi since 2004. So what is stopping the zoologists? Technical barriers are few, and so it is apparently the sociological problems that pose the greatest challenge. As Polaszek et al. note, tools like ZooBank could be an essential part of transforming taxonomy into a Web-based science. Such a database would improve the quality of taxonomy, validating new names and nomenclatural changes against a central registry.

ZooBank might also answer those who argue that the web is too ephemeral to be trusted with taxonomy. As a repository for descriptions, ZooBank might act as a backup, providing essential copies in the event that the original becomes unavailable. Personally, I would go further, merging all of the nomenclatural codes as part of a single registry that is integrated with the international DNA barcoding effort. Perhaps ZooBank would be a step in this direction, but given the sociological difficulties of creating ZooBank I acknowledge that this might be a step too far—at least for now.

Funding taxonomy, especially descriptive (alpha) taxonomy, is a perennial challenge for taxonomists worldwide. It has been argued that taxonomy needs to attract large-scale funds in the same way as other big programs, like the Human Genome Project, if the discipline is to survive. However, the directed, top-down approach to funding and managing taxonomy is at odds with the bottom-up, parochial activities of most taxonomists. Joining the two can be difficult, but as a model of how this can be done, Larry Page highlights experience from his Planetary Biodiversity Inventories (PBI) grant, in a chapter on the All Catfish Species Inventory (ACSI).

As one of the most diverse vertebrate orders, with a worldwide distribution and a high proportion of undescribed species, catfish are a natural choice for a PBI grant. Rather than distributing the funds to a handful of high-profile catfish taxonomists, Page and colleagues engaged the worldwide catfish community by inviting them to apply for small-scale funds to support basic taxonomic activities. With awards of US$59 to US$23,000 and averaging just under US$3000, ACSI was able to provide 118 grants in the project's first 3 years. In an initial analysis of the output from this work, Page suggests that these small grants have had a marked impact on the state of catfish taxonomy. Measuring the number of new catfish species descriptions, publications and graduate students affiliated with ACSI projects, he shows how small amounts of money distributed by taxonomists to taxonomists have made a major difference to our knowledge of catfish taxonomy. Although Page's analysis does not extend to what might have happened had these funds been spent on larger, more traditional projects, my suspicion is that their impact would have been far less.

The success of empowering grass-roots activities like ASCI does not detract from large-scale infrastructures supporting taxonomic research. In fact, better coordination of taxonomy's products (our data, publications, tools, and expertise) is perhaps the single most important activity that the taxonomic community could do to attract more funding. By making the products of taxonomy more visible and accessible and less fragmented, the value of taxonomy to the broader scientific community would be easier to demonstrate. These ideas are explored in a chapter on GBIF, the Global Biodiversity Information Facility, and to a lesser extent in a chapter on DNA barcoding.

Arguably, GBIF should be to taxonomists what GenBank (and its sisters) is to molecular biologists. In practice, GBIF is not yet so indispensable; but as a broker for all types of taxonomic data GBIF has the potential to occupy this seminal role. To date, GBIF's efforts have focused on specimen records (more than 1.5 billion) and in this chapter Speers and Edwards chart their plans to index additional data types. It is depressing to note that almost 3 years on from when this chapter was written, relatively little progress has been made in delivering these goals. The short and rather cursory nature of this chapter may provide some clues as to why this is the case, and it stands in stark contrast to Rudolf Meier's lengthy chapter on DNA barcoding.

As with GBIF, DNA barcoding is an activity that scales across all taxonomic disciplines. It has benefited from some coordination by the Consortium for the Barcode of Life (CBoL), but Meier's chapter does not focus on this aspect. Instead, he summarizes much of the debate about the potential merits of barcoding that have been played out in the recent literature. This account was more balanced than I expected, especially given the remarks by Wheeler in his introductory chapter. However, for me the barcoding debate is over. Like all character systems, barcoding genes have strengths and weaknesses. DNA barcoding is not taxonomy's magic bullet, but it has proved itself to be part of the new taxonomy. DNA-barcoding activities are already ingrained within

contemporary taxonomic research, and integrating these activities with informatics infrastructures like those of GBIF and ZooBank will be pivotal to the development of the new taxonomy.

Two chapters stand out as being misplaced in this book. The first, by Franz and colleagues, addresses the use of those taxonomic concepts that purport to circumscribe the exact meaning of a taxonomic name by documenting the context in which a name is used. This helps with data integration, and allows users to track changes in the meaning of taxon names over time. Unfortunately, my experience suggests that, in practice, the difference between taxon concepts and taxon names is sufficiently subtle that it is lost on many people, including most taxonomists! Even the believers struggle to put taxon concepts into practice, because they require meticulous documentation of every use of a taxon name, ever. Thus, the concepts scale only to small taxon groups that are worked on by a close-knit community of taxonomists. None of this negates their value—my argument is that taxon concepts, unlike more automated solutions using electronic identifiers, cannot scale to the challenges of the new taxonomy.

I make similar arguments against Norman MacLeod's chapter on morphometrics. Again, I call this chapter misplaced not because it is uninteresting or irrelevant to taxonomy—quite the contrary. As someone who has published and presented studies that have relied on morphometrics, I make this claim with some regret. However, as is perhaps unintentionally demonstrated by MacLeod, the field of morphometrics is insufficiently developed or automated to address the scale and magnitude of most taxonomic questions. In over 50 pages (more than a quarter of the entire book!), MacLeod walks the reader through a series of successively more complex techniques in order to differentiate three species of bivalve mollusc. Unfortunately, these methods struggle to do what a child (let alone a taxonomist) could do in seconds. The shells of these species are sufficiently distinct that they can be readily distinguished by eye; but their characters are subtle enough that they defeat all but the most sophisticated morphometric analyses. At the end of the chapter, MacLeod laments that "after almost 50 years of publications on morphometric approaches... it is discouraging to note that such methods remain the exception in most systematic studies." Alas, having read this chapter, I am not surprised.

Despite my reservations about the significance of taxonomic concepts and morphometrics to *The New Taxonomy*, this books greatest sin lies in its omissions. Informatics projects like the Encyclopedia of Life initiative (EOL; http://www.eol.org/) and the Biodiversity Heritage Library (BHL; http://www.biodiversitylibrary.org/) receive barely a whisper in the text, despite the fact that they are substantially changing the way taxonomists publish and access information. EOL is perhaps the most well-funded biodiversity initiative ever. This alone should qualify the project for more than the occasional passing reference.

In recent years, the very landscape of taxonomy has changed as a host of informatics projects, many of which predate the inception of this book, have become ingrained in the taxonomic process. Examples include the Tree-of-Life project, Morphbank, the Catalogue of Life, uBio, FishBase (and its relatives for other taxa), and even the electronic journal *ZooTaxa*. Add to these the acronyms of more recent projects like iSpecies, iPhylo, iNaturalist, Plazi.org, and Scratchpads, and you have the makings of an entirely new lexicon for taxonomy. It is hard to conceive how a book titled *The New Taxonomy* can claim contemporary relevance when it has taken more than 3 years to come to press and omits so many groundbreaking informatics projects. In recent years the very process of scholarly communication has changed, as scientists embrace blogging and Web publication as rapid and more effective channels of communication. Had this book used some of these new technologies, it could have been published more quickly and retained more than passing relevance to taxonomists. As a testament to the New Taxonomy, much of the book was out of date before it was published.

Wheeler closes the book with the same firebrand rhetoric and hyperbole as his introduction. In a chapter titled "Taxonomic Shock and Awe" he positions the new taxonomy as a cyberinfrastructure that underpins biological science. Although I strongly endorse this theme, his war-like tones and references obfuscate the book's overall message. The principles of this new taxonomy are issued as "The Call to Arms" for taxonomists, whose "ultimate goal should be to overwhelm the skeptics, detractors and enemies of taxonomy." Singularly, such overstatement might be forgivable. However, the chapter is replete with similar comments, which might be better suited to an election campaign than to forging a new scientific discipline. These risk demeaning the very cause that Wheeler is trying to promote.

To hope for the new taxonomy is to imply no disrespect for the old. Contrary to Wheeler's arguments, it is the very success of modern systematics that laid the foundation for the informatics development of the new taxonomy. If taxonomy is to find principles that will enable it to cope with the vast burden of its own data, it must evolve as an information science that is integrated with the demands of the wider scientific community. Scalable technologies like some of those charted in this book, coupled with informatics and digitization projects that are not even mentioned, are laying the foundation for this transition. Later generations will look back with sorrow and justified anger if we fail to make this new taxonomy work.

REFERENCE

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