books? Applications outside of science may explain the popularity of some topics, such as the potential for behavioural economics to illuminate the decisions of investors. Brain-scan images themselves may also have amplified interest in neuroscience. Both the public and the media are drawn to the powerful and persuasive visual message of such images. Fundamentally, however, people remain interested in neuroscience and psychology because understanding our brains helps us to understand ourselves. ■

Sandra Aamodt is former editor of *Nature Neuroscience* and author of *Welcome to Your Brain: Why You Lose Your Car Keys But Never Forget How to Drive and Other Puzzles of Everyday Life*.

Technological twist on taxonomy

Systematics as Cyberscience: Computers, Change, and Continuity in Science
by Christine Hine
MIT Press: 2008. 320 pp. $35.00, £22.95

Kevin Kelly

Taxonomy, the science of identification and classification of new species, has been one of the slowest disciplines to adopt computers. When most other scientists routinely use these number crunchers to detect patterns within large sets of data, why have taxonomists only recently started to use them?

The reasons are many. Foremost has been the subtle variation among closely related species, which makes quantification of their traits difficult. No computer program can outdo the highly refined judgements of a taxonomic expert who can classify from nuanced alterations even the smallest organism. Consequently, new species are identified and described in a manner that would have been familiar to Charles Darwin 150 years ago.

Second, much taxonomic information has been, and remains, parochial. The expertise required for classifying fly parasites has little in common with that for fungal species or whales. Taxonomic information occupies niches — niche being the exact biological term for these narrow confines. Specialized niches of information with their own protocols challenge computerization.

Third, the low priority given to taxonomy has meant it is perennially underfunded. High-powered computation and software come low on the list after the meagre needs of traditional taxonomy are (barely) met.

Despite these hurdles, the related field of systematics (exploring relationships between organisms over time) is rapidly transforming itself as computation becomes integral. In *Systematics as Cyberscience*, sociologist Christine Hine investigates the effects of computers and communication technology on the taxonomic community.

Hine's subjects are primarily the practising taxonomists and systematists in the United Kingdom, but this community is representative of that in the rest of the world. Her concern is the sociology of change, how these tradition-bound disciplines imagine, place and incorporate computers into their identity.

The Encyclopedia of Life will log facts for all species on Earth.

D. BACKLUND/WILD PHOTOS PHOTOGRAPHY; J. SULLIVAN/WILD HERPS; IMAGES COURTESY OF EOL

For instance, she notices that "the Web and the Internet are seen … as evocative objects which bring a certain glamour and an image of modernity and accessibility to systematics". Computer technology is not only an aid to getting work done, and to getting new kinds of work done, but also to securing the respect and funding needed to do any work at all. This strategy plays into a misperception that you are not doing real science unless you are doing it on computers.

As a consequence of digitalization, classical taxonomy is put under different strains as it adjusts to its new tools. Hine notes that: "Traditionally, systematics has worked on long time scales, with taxonomists focusing on grand life works, and major flora projects taking maybe 30 years to complete." Now, by contrast, taxonomy projects based on Internet databases are offered up in minutes, and are never viewed as finished. Instead they remain in the 'perpetual beta' state of most digital content.

Cheap, ubiquitous genetic sequencing is further accelerating taxonomy's rush into computation. Classifications based on gene sequences are hugely disruptive to the established order of doing things. The focus of *Systematics as Cyberscience* is not rapid genetic taxonomy, which could fill its own book, but these recent advances only heighten the identity shift now under way in taxonomy.

As taxonomy evolves into the cyber age, it is reappearing in the public eye. In February 2008, systematists launched the first digital version of the Encyclopedia of Life (www.eol.org), wherein many of the approximately 1.8 million known species on Earth will be represented, each on its own web page. The fact that most of these pages are still blank does not dilute the mythical power of this embryonic encyclopaedia. We can see its promise in the 30,000 populated pages now in operation. Each species page includes photographs of the organism in its various life stages, the original taxonomic description, updatable geographical maps of its range, classification charts, links to ecological niches, popular knowledge of the organism, and many other attributes needed to understand its biology.

The most important aspect of this emerging cyber library is the way in which it facilitates the completion of the great taxonomic imperative: to identify all of the living species on Earth. There is doubt as to how long this will take, but it will surely happen only with the help of vast communication webs and computer technology.

The future of systematics will involve advances in computational photography, innovations in creating identification keys, pattern-recognition software, expert-knowledge systems and, eventually, genetic identification gadgets. Soon, the practice of taxonomy will be unthinkable without the Internet. Yet, as Hine notes, at the moment "systematics has been able to portray itself as fundamentally unchanged by its experience with these technologies, stressing instead the way it is pursuing its established goals and preserving its heritage."

The long sweep of evolution breeds in those who try to untangle it a great appreciation of the winnowing process of time. Taxonomists are wary of tossing away any highly evolved method of knowledge that has proven itself. It is remarkable then to see the speed at which these refined practices are being reimagined for this digital century.

Systematics as Cyberscience reminds us that change generates strain, conflicting views, fear of the new and concern for integrity. But we cannot stop this shift that is being played out by experts in their respective museums and natural history collections. ■

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