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PALAEOBOTANY IN THE DIGITAL AGE: UNEARTHING THE FUTURE OF TAXONOMY

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Palaeontologica Electronica (PE) is at the forefront of electronic publication of palaeontological articles in the age of burgeoning digital scientific communication. In its nine-year history, PE has established a paradigm for the universal dissemination of palaeontological information through electronic media. Currently, the editorial staff is making every effort to accommodate all forms of palaeontological publications, particularly works of a taxonomic nature. This has been no easy feat, as the nomenclatural codes are particularly rigorous with regard to their requirements for valid publication. However, the rewards of providing an electronic format for publishing new taxonomy are profound and immediate.

As palaeontologists, we know that accurate and accessible taxonomic work forms the basis of nearly all aspects of palaeobiology. We cannot discuss diversity, extinction, origination, or evolution without a sound taxonomic foundation. Despite being a pillar of our science, large taxonomic efforts are rarely undertaken and then often with apprehension because of publication costs and time, and lack of impact or distribution of the work. In our eat-or-be-eaten business, particularly for early career scientists, large, expensive, and slow-to-publish taxonomic works are often not feasible. Imagine a venue for taxonomic work that is cost-free, rapidly published, universally distributed with an open access policy, and where unlimited pages, illustrations and colour plates are available to describe a new species accurately—enter electronic publication.

In 1999, a single phrase changed the face of taxonomic publication in the zoological community. Article 8.6 of the most recent edition of the International Code for Zoological Nomenclature (ICZN), states the following: 'For a work produced after 1999 by a method other than printing on paper to be accepted as published within the meaning of the Code, it must contain a statement that copies (in the form in which it is published) have been deposited in at least 5 major publicly accessible libraries which are identified by name in the work itself.'

Tucked away shyly between parentheses, the seemingly inconsequential phrase "in the form in which it is published" opened a door condoning the publication of zoological names in an entirely electronic format (see PE Nomenclature). This was a highly significant move for natural scientists around the world, as it gave them the freedom to publish taxonomy in the economic, conducive and innovative realm of peer-reviewed, electronic journals.

Despite the many benefits offered by publication on the Internet, there is a great deal of reluctance among members of the palaeontological community to entrust posterity to digital media. Even the technologically emboldened ICZN voices these concerns in no uncertain terms. Recommendation 8B of the Code states that 'Authors and publishers are strongly urged to ensure that a new scientific name or nomenclatural act is first published in a work printed on paper.' The current version of the International Code for Botanical Nomenclature (ICBN) categorically precludes publication of nomenclatural changes in purely electronic media. According to Article 29.1 of the St. Louis Code (Vienna Code, which is soon to be released maintains this position), legitimate publi-

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cation is not effected '...by publication online, or by dissemination of distributable electronic media.' For publication of new names or for nomenclatural changes to be valid, at least two paper copies must be lodged at recognized repositories accessible to at least the general botanical community.

The concerns regarding electronic publication of botanical and palaeobotanical taxonomy no doubt stem from a mistrust of digital media as a long-term storage option. Such concerns are not entirely unfounded. The digital age is rapidly sweeping aside centuries of nomenclatural tradition, with a fast-paced technology that terrifies many of us. Deep down we fear the worst—what if this precarious tower grows beyond the strength of its foundations? Data storage technology and software packages are in a constant state of flux, and computer equipment must be replaced every few years just to keep up. All data storage media have a limited life span, and even though PE is archived on CD-ROMs with expected lifetimes of more than a hundred years, it is possible that the technology to read this media may be obsolete or abandoned long before then. Digital files are prone to 'bit rot', the gradual and unpredictable accumulation of irreversible errors at the bit level, and the regular backup of data is time-consuming and can accelerate attritional corruption of the data. There are other potential hazards to stored digital information that cannot be ignored, such as disk crashes, power cuts, corruption by viruses or subversive elements, human error (e.g. accidental deletion) and, not least, our reliance on potentially ephemeral host sources.

These issues are being debated in many forums—there are entire conferences devoted to the subject of electronic publication in the sciences—and have been the subject of numerous, interdisciplinary publications in recent years. The fact is, there are many ways of countering all of the envisioned problems that feed our fears. Library administrators are deeply invested in their role as custodians of world knowledge in the digital age, and many are taking a proactive stance toward finding effective long-term methods of electronic data storage and preservation. For instance, one of the most successful and widely supported initiatives is the LOCKSS (Lots of Copies Keeps Stuff Safe) Program (see http://www.lockss.org), developed by Stanford University Libraries. LOCKSS provides a means for libraries to collect, protect and provide access to web-based journals. The system allows libraries to take custody of data from the journals to which they subscribe, and to preserve it, irrespective of the status of the source journal. Long-term preservation of archived data on hard disk is effected though a self-regulating, cooperative, peer-to-peer process of damage detection and repair across a global network of computers.

So in the face of all these challenges, what exactly is the allure of electronic publication to the botanical and palaeobotanical community?

One of the positive outcomes of globalisation has been the free exchange of ideas that has become possible with the advent of the Internet and email. Open-access publication takes us one step closer to creating a synergistic community of palaeontologists able to freely exchange ideas, without discriminating against those unable to afford costly subscriptions or access limited distribution documents. Electronic publishing reduces the cost of publication dramatically while providing unlimited, universal access, making the 'open access' philosophy truly practical. Aside from sparing the consumer the monetary cost of paper and printing, the environmental costs of paper production, transport, and disposal are also negated.

The freedom provided to palaeobotanists and botanists alike by an electronic journal format is limited only by the imaginations of the author and editor, and the available technology. A publication need not only contain text and photographs, but video clips, interactive images, and 3D models—all in full colour. Moreover, the length of papers will become a matter of what's needed for the most effective and complete communication of scientific material rather than a question of expense. And at the touch of a button, this wealth of information is available across the world to all who are interested. Without typesetting and printers to worry about, the turnover time of articles submitted electronically is vastly reduced. Combined with an open access policy, this allows taxonomic works to garner a rapid response from a broad readership. This is particularly important in botany and zoology, where biodiversity decline may be faster than article turnaround.

Finally, electronic publication, where page and graphic limits are no longer insurmountable monetary hurdles, provides the ideal venue to start addressing the surplus of unpublished fossil floras in museum coffers. Many leading museums are already providing electronic access to these collections. Though these floras are excellent reference sources for both amateurs and professionals, without formal taxonomy their full value cannot be realized. If validly published, the taxonomy of these floras will greatly increase our knowledge base,

facilitating and expediting ‘big picture’ research projects in palaeoecology, palaeoclimate, and trends in floral evolution and diversity. Open-access availability of this information will also greatly enhance biogeographical comparisons across the world.

Fortunately, PE has been able to meet the requirements for legitimate publication outlined by the ICBN and ICZN, and is now fully compliant with both codes. A printed copy of each issue of PE, as well as an archival CD-ROM containing the full version of the journal in its original format, are to be archived at ten recognized institutions, starting with this issue. Furthermore, the Index Nominum Genericorum (Plantarum) will be notified of all new genera described in PE. Although PE will be producing paper copies, our goal in this regard is not to fill the shelves of libraries across the globe but simply to fulfill the requirements of the ICBN. This will empower contributing authors to set a precedent for the valid, effective electronic publication of botanical and palaeobotanical taxonomic works.

The dynamic nature of digital media is what makes it exciting, accessible, cutting edge—and yes, a bit scary at first. The problems of digital permanence are being and will continue to be addressed, as we adapt to and evolve with new technologies. We are already fully immersed within a new culture of digital freedom, and we should be prepared to exploit it to the fullest. We are not destined to suffer the fate of the Library of Alexandria; rather, electronic publication will be for taxonomy—and for all science for that matter—what Gutenberg was to the Bible. The question we need to ask is, are we going to become the fossils we study or will we plant palaeobotany firmly in the digital age?