Registration of scientific names of plants, fungi, bacteria, cultivated plants, and animals: Approaches and experiences across disciplines

David L. Hawksworth

Chair, IUBS/IUMS International Committee on Bionomenclature, Departamento de Biologia Vegetal II, Facultad de Farmacia, Universidad Complutense de Madrid, Plaza Ramón y Cajal, Ciudad Universitaria, Madrid 28040, Spain; Department of Botany, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
(e-mail: d.hawksworth@nhm.ac.uk)

Introduction

On 29 November 2007, the Linnean Society of London hosted its third systematics debate on the topic 'Should the registration of new names of organisms be compulsory?'. Immediately prior to the debate itself, five presentations were made on the approaches to, and experiences in, the registration of scientific names in different groups of organisms whose nomenclature is governed by four separate internationally mandated *Codes* of nomenclature. Summaries of these presentations are provided here, along with a synopsis of the debate itself.

The concept of some formal registration process for names of organisms is not new. It was proposed for botanical groups as far back as 1954, but rejected. After an independent *Code* for bacteria had been developed, from 1980 publication of bacterial names was effected only by publication in, or listing in, a single journal. In 1987, a special committee was established by the International Botanical Congress in Berlin to examine how registration might be implemented; the proposals made were adopted at the subsequent congress in Tokyo in 1993 and a trial system established with a view to implementation at the St. Louis congress in 1999 – but, that congress rejected the proposals. However, in the interim, registration had been included as mandatory in the 'Draft BioCode: the prospective international rules for the scientific names of organisms' prepared by representatives of all five *Codes* under the auspices of the IUBS/IUMS International Committee on Bionomenclature (ICB) in 1996. In 2004, MycoBank, a voluntary web-based system for new fungal names (and additional information) went live; proposals to make that mandatory for fungi are now in preparation for discussion at the International Mycological Congress in Edinburgh in 2010. For names of animals, the development of ZooBank was first proposed in 2005.

In considering the registration issue today for particular groups of organisms, it is prudent to be cognizant of the experiences and plans of those working with others. The reports presented here aim to provide a background to the current discussions as to the desirability of the compulsory registration of newly proposed scientific names for animals and fungi in particular.

Registration of names: the botanical experience

Werner Greuter

Chair, Editorial Committee, International Code of Botanical Nomenclature, 1987–2006, Botanischer Garten und Botanisches Museum Berlin-Dahlem, Zentraleinrichtung der Freien Universität Berlin, Königin-Luise-Strasse 6–8, D-14195 Berlin, Germany (e-mail: w.greuter@bgbm.org)

Definition

'Registration of names is the process of entering names into a register whereby they acquire a special quality (whereas indexing: the listing of names with a defined set of qualities but without adding to their status)' (Greuter, 1986). From the beginning, registration has been envisioned as being: (a) non-censorial; (b) generally available and free of cost, at the very least for the authors of names; (c) based on a reliably functioning, preferably decentralised system tested beforehand; and (d), if at all possible, financially self-supporting in the long run.

Rationale

- Any author who publishes a new name wants to make it available and generally known. The onus of doing the needful has always been placed on the author. In this process, registering a name is a small and easy supplementary step, very much in the authors' own interest.
- It is in the publishers' interest to 'pamper' their authors. Publishers may be expected to be cooperative, especially when their authorship includes significant taxonomic content.
- It is in the users' interest to be informed quickly, completely and reliably on any and all nomenclatural novelties that are published. Users are unwilling, however, to pay for that service, so it must be free of charge.
- Indexers, where they exist, will see their task alleviated by registration (the active hunt for items to be indexed being replaced by proffered data), and will see the value of their product increased (being now exhaustively complete by definition).

Concise history

1985: At the request of IUBS (International Union of Biological Sciences) and ICSEB (International Congress on Systematic and Evolutionary Biology), the General Committee on Botanical Nomenclature appointed a Committee on Registration of Plant Names, with five members, to report to the Berlin Congress.

1986: The Committee's report and proposals appeared in *Taxon*. Mandatory registration was recommended from an unspecified date later than the next subsequent Congress in Tokyo in 1993 (Greuter, 1986).

1987: At the Berlin Congress there was a long and lively debate on the independently proposed issues of registration of names and journals. A Special Committee to look into both issues was approved (Greuter et al., 1989).

1991: The Special Committee on Registration, with two subcommittees, met at Kew in February. The idea of journal registration was abandoned, and concrete steps

toward the mandatory registration of new names were supported and a set of proposals was published in *Taxon* (Faegri, 1991).

1993: Together with the NCU (Names in Current Use) proposals, registration became the principal issue at the Tokyo Congress. By a sweeping majority, the principle of mandatory registration of new names was written into the *Code*, to become effective in 2000 after a trial run and subject to approval by the subsequent congress in 1999. The IAPT (International Association for Plant Taxonomy) accepted responsibility for setting up the required structures and procedures (Greuter et al., 1994).

1998: After thorough preparations, the IAPT Registration trial started officially (Borgen et al., 1997) and went online immediately on 5 January with the first 91 entries. At a workshop on 'Removing the Taxonomic Impediment', in February, the 'Darwin Declaration' (Environment Australia, 1998) was formulated. The declaration was later approved by the Conference of Parties to the Convention on Biological Diversity. Among other things, it recommended that 'Institutions/ Individuals should support and encourage a system for the registering of newly proposed names of organisms . . .'. Proposals to implement the mandatory registration of new plant names were published in *Taxon* (Borgen et al., 1998).

1999: By mid-April, 207 journals had signed a covenant with the IAPT, by which they became accredited with the registration system (meaning that they agreed to care for the registration of new plant names published in them, on behalf of their authors). National registration centres in 38 countries had been set up (Raab-Straube, 1999). By mid-August, 10,047 (non-fungal) names had been registered (counting some duplications). In August, even though the trial run had functioned without hiccups for 19 months, the St. Louis Congress decided against registration, and exorcised all reference to it from the *Code* (Greuter et al., 2000). Registration offices (whose maintenance for two years had cost the IAPT ca. €60,000) were wound up by the end of the year.

2000 on: Registration had virtually become a non-word in botanical nomenclature. The main trace it left was maintenance of separate indexes of nomenclatural novelties in most of the accredited journals, to which they had agreed for becoming accredited. The registration database with its (eventually) 10,173 entries is still available for online searching (Greuter et al., 1999).

Registration at work

Registration was a low-cost operation. Design and implementation of the database, including screen frames for both data input and online query, cost IAPT a €2500 contract. The office was run by a half-time secretary for data input and a half-time taxonomic botanist screening the incoming literature, preparing data, and handling the correspondence with authors, publishers and registration centres. Input time for one name averaged six minutes, including optical scanning of the protologues for the purpose of archival documentation.

Input started by assigning each new name to its relevant category: new taxon or new combination or nom. nov.; fossil, algal, or other. Depending on the category, conditions for valid publication were queried and, unless confirmed, a 'caveat' or flag was generated (e.g. for a new fossil taxon: 'no Latin or English description or diagnosis'). For new combinations, the presence of a full and direct basionym

reference was checked, but not the basionym itself. Entered data included the name with standardised author citation, literature source (with stated date of publication), types (including specimen location) of names of new taxa, or basionym or replaced synonym of new names or combinations. The spelling was checked for correctable errors (this was my job), such as wrong terminations or connecting vowels.

An estimated 75% of the data came from accredited journals, the rest mostly from books and non-accredited journals. Only a tiny fraction were submitted by the authors themselves on the apposite (downloadable) forms, either directly or through a national registration centre. This proportion is bound to change if and when registration becomes mandatory.

Implementation in the *Code*

Fitting mandatory registration into the existing botanical *Code* (McNeill et al., 2006) requires remarkably little change. The proposals made to the Tokyo congress in 1993 were only four, and just two of them were essential:

- Addition of registration as a new, supplementary condition for valid publication of a name.
- Definition of the registration procedure as submission of the relevant printed matter to an accredited registration office. (Proposals to the St. Louis congress in 1999 would have modified this, permitting the submission of photocopies, under certain conditions.)
- Defining the date of a name as the date of reception at a Registration Office. This is an important point that has proved to be controversial, but is not central to the concept of Registration. Other solutions are possible.
- A clarification of what happens when someone wants to cheat by submitting not yet published names for Registration (they have to be registered anew once published) is of debatable usefulness and necessity.

Several important issues, as follows, were not explicitly mentioned, as it was felt that such details could be left for later clarification:

- Who is entitled to register a name? The implicit answer is anyone, if the author (or the publisher acting on his behalf), who are the first who can play the ball, fail to do so. Authorship is unaffected by this issue. It is assumed that, at least initially, the staff of the relevant registration centres will scan the literature for new, unregistered names and will register them on their own initiative.
- What status do registered names have? Initially it was thought by some that they would, by definition, be made valid and even perhaps legitimate by registration. This is not so. Whereas valid publication of the registered names of new taxa could, as a rule, be taken for granted, their legitimacy can not. It may, in particular, be affected by validly published, perhaps unindexed, earlier homonyms. As to new combinations, they may not even necessarily be new. Especially in groups or at ranks in which infraspecific names were not so far indexed, earlier validations of the same combination may exist.

Options for the future

Can (and should) anything be changed in a future registration system for botany with respect to what has been envisioned in the past? I can see at least one basic possible improvement, allowing for greater flexibility (and, hopefully, acceptability)

of registration. So far, registration has been seen as the last, supplementary step to be taken to achieve valid publication of a name fulfilling all other requirements. However, that chronology of events need not be mandatory. It is nowadays easily conceivable to have a name registered prior to its publication, in such a way that only the publication date must eventually be added. Authors would thus have a choice in structuring their taxonomic workflow.

It would be a minor step to turn registration into a cheap, quick, and easy alternative vector of validation. Authors could feed the data required for validation directly into an apposite online form, and these data would be promptly released in print (perhaps with a monthly of even weekly frequency) by the registration centre. This might even provide a source of income to the registration centre. Presumably, the original, rather cumbersome scheme of national Registration Centres can nowadays be dispensed with. Electronic communication has become safe, cheap and universally accessible, and while ordinary mail can and must not be ruled out as an available option, it will in practice all but disappear from the scene.

Registration will depend on the good will and full co-operation of existing indexing centres, as it did before. This can now be done without losing the unity of doctrine of the process as a whole. IPNI (International Plant Names Index) has demonstrated how well a multi-platform, shared-responsibility approach can function without the user even noticing it.

Should lists of registered names be published as hard copy? This has not so far been specified, although many may have assumed it tacitly. The option should be explored. Clearly, free online access to the information is paramount for today's user. Still, hard copy is unrivalled as a mean of safely archiving the data. Hard copy (which might include the new validations referred to above) could be generated quickly and cheaply directly from the computer, by means of an apposite formatting programme. Institutions not directly involved in the registration process may wish to support it financially by subscribing to the printed documents (or so I hope).

It would be a real boon if at least the elements required for valid publication, if not the whole protologues, could be made available on line. This will obviously depend on the agreement of copyright holders. In addition, automatic translation services (from English and perhaps other languages to Latin for authors, and conversely for users) should have become easily feasible by the time registration becomes functional.

In the medium term, once registration of names has proved its usefulness and has fully established itself in the mind of the biological community, the need will be felt to widen its scope to cover all nomenclaturally relevant acts, type designations in particular.

The way ahead

Registration is overdue. I could easily imagine that, once the present reluctance toward the registration concept is overcome by botanists, there will be a hue and cry for it to happen immediately, today better than tomorrow.

Undue haste can be detrimental, as can excessive restiveness. Should this meeting come to a positive conclusion on the desirability of registration, both in the botanical and zoological domain, then the upcoming IUBS General Assembly in Cape Town this year (2009) would, I believe, provide an ideal forum for deliberating and moving ahead. If this happens I might, hopefully, live to see registration become a reality.

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MycoBank, the virtual fungal laboratory of tomorrow

Joost A. Stalpers, Vincent Robert, Gerrit Stegehuis and Pedro W. Crous*

**President, International Mycological Association, CBS Fungal Biodiversity Centre, P.O. Box 85167, 3508 AD Utrecht, The Netherlands*
(e-mail: p.crous@cbs.knaw.nl)

MycoBank was officially launched by the CBS Fungal Biodiversity Centre towards the end of 2004, and announced in two papers published simultaneously in *Mycological Research* and *Studies in Mycology* (Crous et al., 2004a, b). It was envisaged as a freely available electronic depository system for taxonomic novelties in fungi (including lichens, oomycetes, other straminipiles, slime moulds, and yeasts). Since 2007, MycoBank has operated under the auspices of the International Mycological Association (IMA; www.IMA-mycology.org), and is directed by an international Scientific Advisory Board in regard to its terms of actions and policy. MycoBank presently contains three main elements:

A depository for nomenclatural novelties

This system allows mycologists to deposit new names, be it names of new taxa or new combinations. It also requires some basic information, both nomenclatural (for

example the basionym or type information) and taxonomical (e.g. a description). As soon as a name is deposited, the MycoBank system automatically e-mails a unique registration number to the depositor.

Before the deposit is accepted, the MycoBank software checks the uniqueness of the name: there is an automatic search for existing homonyms, and the depositor will immediately be warned if an earlier homonym exists. After the deposit, MycoBank administrators check the correctness of the name (for example for the correct termination, or typing errors) and will make suggestions when appropriate. MycoBank never applies any censorship, and a depositor may deposit anything he or she wants. The final judgement lies with the journal editors and reviewers, where it belongs. The correspondence between MycoBank and the depositor remains strictly confidential.

The deposited name is restricted until the name has actually been published; only in searches for homonyms may users be alerted to the existence of a name 'in press', but without any additional data, so neither the identity of the depositor nor the intended source of publication will be revealed. In some instances though (especially new combinations), potential authors have queried such names with MycoBank staff, who again contacted the primary depositor, leading to either cross references between two papers, or in some cases joint publications co-authored by all scientists involved.

The search for homonyms is based on the *Index Fungorum*. CBS is (with CAB International and Landcare New Zealand) one of the three custodians of *Index Fungorum*, and has contributed more than 100,000 new records, additions and corrections, including all new registrations (when published). At the moment the versions of the CAB International site and MycoBank are not completely identical, but we hope to have a working web-based system that automatically updates the respective hubs shortly.

The advantages of MycoBank over printed sources are obvious: (a) between 2004 and 2007, new names of fungi have been published in more than one hundred periodicals (excl. numerous books), and no indexing publication covers them all; (b) a time gap of up to 18 months between the publication of a new name and the listing in an index is not unusual; and (c) MycoBank allows the publication of additional data including descriptions, illustrations, DNA sequences, etc. Finally, MycoBank is a free service, and accessible from anywhere with internet access.

The acceptance of MycoBank by the mycological community is best illustrated by the following data: in 2006, 870 out of 1710 novelties were registered through MycoBank (approx. 50%). In 2007, 1445 novelties were registered, which is approx. 85% of the total for that year. Further, during 2007, 95 mycologists completed questionnaires at major mycological meetings in Baton Rouge (U.S.A.), St. Petersburg (Russia), and Léon (Spain) in August–September 2007 where 73 (85% of those voting) were in favour of registration of names in MycoBank being made compulsory for valid publication (Hawksworth, 2007).

In addition, the number of periodicals requiring MycoBank numbers as a prerequisite to acceptance for publication is increasing steadily. Judging from the sources of the total amount of newly published names in 2004, these periodicals already account for over 50% of the expected novelties, and these numbers are rapidly increasing. In fact, all leading mycological journals covering systematics in the ISI system (International Statistical Institute, Web of Knowledge) now require authors to deposit novelties in MycoBank, as does *Taxon*.

Additional taxonomic information

Depositors of nomenclatural novelties are asked to deposit, in addition to a description and type information, as much other data as they feel appropriate or have available. This includes illustrations, molecular sequences, physiological data, links to web-based data, etc. Also, data on existing taxa can be deposited, provided full information is given as to the source of the data, and a number of scientists are constantly updating MycoBank to complete the information for certain groups of fungi, or geographical regions. MycoBank at the moment contains over 25,000 descriptions and 8,000 illustrations, all with full references to either the original publication or, in case of unpublished material, to its owner. MycoBank now actively seeeks collaboration with the managers of websites that contain authoritative information on fungi by providing cross-links directly to the information. These can be descriptions, illustrations, or literature.

The species bank concept

MycoBank contains additional taxonomic information, for example heterotypic synonymy, and an opinion as to the correct name. However, this can not be done by the present curatorial staff alone. The mycological literature is simply too vast to monitor and judge all developments, and this task can only adequately be accomplished by (groups of) dedicated specialists. At the moment, MycoBank contains eight species banks, which each contains a number of species, usually belonging to a taxonomic unit such as a family or several families (*Mycosphaerellaceae*, resupinate *Russulales*), but sometimes one or several genera (*Aspergillus-Penicillium*), an ecological group (medical fungi), or morphological unit (yeasts).

A species bank contains, besides rather complete sets of descriptions and illustrations and heterotypic synonymy, structured morphological and molecular data, allowing, for example, polyphasic identification. In the near future it will be possible to curate species banks on-line, and the IMA will actively stimulate individual researchers or research groups to adopt a larger fungal taxon in MycoBank. These specialists or groups of specialists will have full rights and control, and will have the final responsibility for taxonomic decisions. Simultaneously, a Wiki-type system is also to be provided, so that different taxonomic opinions can also be viewed.

Prospects

The increasing acceptance of MycoBank by mycologists is a reason for confidence that the International Code of Botanical Nomenclature will make the deposit of new names of fungi in MycoBank a condition for valid publication at the next International Botanical Congress in Melbourne in 2011, subject to approval at the International Mycological Congress which will debate the issue in Edinburgh in 2010. As a consequence the mycological community has the prospect of names *plus* a minimum set of data available freely via the internet immediately once they are published.

It is also feasible that, when the *Index Fungorum* has reached a very good coverage of the available names, the nomenclatural past will become a closed system by giving only those names the status of availability. That would end the current situation where the literature is a black box containing numerous previously unnoticed names or ones of uncertain application that are a threat to well-established names and a

constant source of instability. This would allow a situation that the bacteriologists faced in 1980, but without the drawback of facing numerous taxa without an available name.

Finally it is hoped that the possibility to adopt groups of fungi will be attractive to scientists, and that this will enhance MycoBank as a much-used reference source. New developments under consideration, such as linking species banks to strains, and DNA Barcodes, will undoubtedly add further to the usability of the system.

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Registration of names: the bacteriological experience

Brian J. Tindall

Chairman, Judicial Commission of the International Committee on the Systematics of Prokaryotes, DSMZ, Inhoffenstrasse 7B, D-38124 Braunschweig, Germany (e-mail: bti@dsmz.de)

Prokaryote nomenclature is governed by the International Code of Nomenclature of Bacteria (Lapage et al., 1992), which like all *Codes* of nomenclature regulates nomenclature, requires the formal description of named taxa, and uses the principle of types. There are a number of similarities with the botanical *Code* (from which it was derived), but there are a number of significant and revolutionary differences that make the bacteriological *Code* one of the pioneering works that other *Codes* of nomenclature have yet to emulate or even appreciate in full.

Like all nomenclatural systems dealing with the names of organisms, the bacteriological *Code* has had to deal with an increasing number of names of dubious value and a constant source of confusion (Skerman et al., 1980; Lapage et al., 1992; Sneath, 2005). However, during the 1960s a small group of bacteriologists laid the cornerstone of a system that has revolutionised prokaryote nomenclature and put it in the enviable position of being able to trace all names in use under the *Code*, as well as indicating which names are considered to be synonyms (Lapage et al., 1992; Sneath, 2005). The present system relies on two key features that were introduced during the 1970s.

Firstly, it was decided to collect all known names of prokaryotes, and to evaluate them according to the existence of appropriate descriptions and adequate typification (Skerman et al., 1980; Lapage et al., 1992; Sneath, 2005). The goal was to draw up an accurate list of names that were to become the basis of a list of protected names (*Approved Lists of Bacterial Names*; Skerman et al., 1980), and to discard all names that did not fit the essential criteria of a modern code of nomenclature, i.e. an

adequate description and typification. All names that did not conform to these criteria lost standing in nomenclature and, unlike the names on the *Approved Lists of Bacterial Names*, were not considered to be 'validly published'. These names served as the starting point for the new nomenclature (1 January 1980), although it is important to emphasise that all names on that list make reference to the original authors and the dates of publication of those names. During the course of the compilation of the Approved Lists of Bacterial Names, some 30,000 names were examined, and less than 2,500 names at the rank of class to subspecies were retained.

Secondly, there seemed little point in creating the list of protected names if the *Code* were not to provide a mechanism by which the problems of the past were not to repeat themselves. The solution that was formulated consisted of checking that names conformed with the requirements of the bacteriological *Code*, i.e. are accompanied by a description and a type designation. Although the bacteriological *Code* refers to this process as 'valid publication of a name' it is significantly different from the equivalent term in the botanical *Code*. In order for a name to be validly published under the bacteriological *Code* it must conform to the rules of the *Code*, a formal act of registering *Code* compliant names. Contrary, to popular misinterpretations this does not include any form of censorship (Tindall et al., 2006).

Thus, modern prokaryote nomenclature is based on a list of protected names (that cannot be replaced by earlier names), serving to secure a link with the past, and a continually growing list of new names that are officially registered, i.e. confirmed as being compliant with the *Code*. This system is unique, has operated since 1 January 1980, and has created a comprehensive, valuable system that serves as a goal that botany and zoology have yet to reach.

The bacteriological *Code* has also adopted a traditional approach to the way names are registered (i.e. validly published), in the form of peer reviewed journal or monograph publication, with notification of registration being made *via* a single organ, the *International Journal of Systematic Bacteriology* (now the *International Journal of Systematic and Evolutionary Microbiology*), itself being in the hands of the International Committee on Systematic Bacteriology (now the International Committee on Systematics of Prokaryotes). However, that traditional approach does not meet the requirements of a modern global community of bacteriologists. Relying on the printed word is no longer adequate, and increasing use is being made of the advantages that internet communication has to offer. In particular, the existence of expertly curated lists of names, with accurate reference to the date and authors of valid publication of the name, indication of the location of the description (and the appropriate experimental work), the location of the material that typifies species and subspecies, as well as indicating synonymies, provides a widely distributed global network of end users with rapid access to the critical elements of the taxonomic literature. Having such information available is equally valuable to those describing new taxa, those identifying existing taxa, and those who may only be interested in the nomenclature for other reasons, such as regulatory authorities. The most comprehensive list is that available at the 'Lists of Prokaryote Names with Standing in Nomenclature (LPSN)' (www.bacterio.cict.fr), and others that can be recommended are the 'Taxonomic Outline of the Bacteria and Archaea (TOBA)' (www.taxonomicoutline.org), and 'Bacterial Nomenclature up-to-date' www.dsmz.de/microorganisms/bacterial_nomenclature.php.

The *International Journal of Systematic and Evolutionary Microbiology* (IJSEM), published by the Society for General Microbiology, also provides an open access service to the original literature published in the pages of the journal (ijs.sgmjournals.org). This policy makes all publications available free of charge two years after the date of publication. The journal also participates in the WHO HINARI and UN (FAO) AGORA (access to scientific literature) programmes, allowing access without charge, to eligible institutions in World Bank List 1 countries, immediately on posting on the internet. All back issues of the *International Journal of Systematic Bacteriology* and the *International Bulletin of Bacteriological Nomenclature and Taxonomy* (predecessors of the IJSEM) are now available online without charge. This gives access to all institutions now interested in these publications that have never subscribed to the original printed versions.

The advantages of the current system should be obvious, providing access to even the casual users who would otherwise not have access. The availability of complete and accurate lists of names is of immeasurable importance, although probably not fully appreciated. To date, only virologists have come anywhere near to achieving a similar goal. The value of both the registration of names and the availability of those names in a modern form of communication puts the bacteriological *Code* at the forefront among the traditional *Codes* of nomenclature.

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The Cultivated Plant experience

John C. David

Member of the IUBS Commission for the Nomenclature of Cultivated Plants; Royal Horticultural Society, RHS Garden Wisley, Woking, Surrey GU23 6QB, U.K. (e-mail: johndavid@rhs.org.uk)

Uniquely among organisms, cultivated plants are covered by two *Codes* of nomenclature: the International Code of Botanical Nomenclature (ICBN) which deals with the genus, species, infraspecific ranks, and hybrids; and the International Code of Nomenclature for Cultivated Plants (ICNCP) which is applied to plants selected or used by people, and uses the categories of grex, group, and cultivar. The concept of registration for cultivated plants actually predates the first ICNCP, which was drawn up in 1952, and grew out of the need to record the names of new cultivars which are often only to be found in ephemeral literature such as nursery catalogues,

seed lists and gardening magazines. Frequently these publications are imprecise in date or even undated, so there was a need to establish a system for determining priority. This was realised in a system of registration which was first proposed for cultivated plants during the International Horticultural Congress in 1930 which recommended the drawing up of lists of names for particular groups of plants. The first such lists included those for irises, tulips, delphinium, orchids, and daffodils. Many of the bodies that produced these lists are today still the official registration authorities. The first classified list of daffodil names was published by the RHS in 1908 and was 31 pages long, while in 1998 the Register was 1166 pages long and contained the names of over 26,000 cultivars.

The present system of horticultural registration operates under the International Commission for Nomenclature and Cultivar Registration, which is a body constituted by the International Society for Horticultural Science (ISHS). The Commission is responsible for appointing and monitoring the International Cultivar Registration Authorities (ICRAs) of which there are currently over 70 worldwide and which are listed on the ISHS website (www.ishs.org/sci/icra.htm). Registration is carried out by individuals (Registrars) on behalf of the ICRA, who receive applications to register new names from growers, hybridizers and nurserymen all over the world. They also scan literature (both recent and old) to build up a comprehensive listing of names in the group for which they are responsible. Such a group may be a single genus, species, or similar, but not closely related plants (such as bulbs) or a geographically defined group.

Under the ICNCP, registration is defined as 'The act of recording a new name or epithet with a registration authority.' It is not a requirement for valid publication and is not mandatory for establishment of a new name. This has to be the case as the combined coverage by ICRAs is not universal and there are many plant groups for which there is no registrar. While the concept of priority is fundamental, a registrar has the authority to set this aside in certain circumstances and can even allow the re-use of a cultivar epithet for a different plant. The registrar is required to publish a full register from time to time and this can itself be a means of validating a name. In registering a new name, the registrar must check whether a proposed name has been used before and whether it meets the requirements of the current ICNCP. If the application fails, then the registrant is invited to re-submit the registration once the reasons for its failure have been addressed. Successful applications are generally recognised by a certificate as proof of registration.

Although the system has been in place for over 50 years, the process does not enjoy the status and rigour of the scientific *Codes* of nomenclature. As pointed out earlier, it is entirely voluntary and there are no nomenclatural consequences for not registering a name; the system is not universal as there are horticulturally important groups that lack an ICRA and it is dependent upon the support of organisations to be willing to undertake registration activities. That said, some invaluable work has been carried out to document and make available comprehensive lists by some ICRAs – most notably but not exclusively for camellias, heathers, irises, syringas, and geraniums, as well as those produced by the RHS. It has been encouraging to see ICRAs starting up around the world, such as the Chinese Flower Association (Sweet Osmanthus Branch) and the American Brugmansia and Datura Society.

The cultivated plant *Code* is much more affected by commercial concerns than other *Codes*, which means both statutory and legal issues can prevail over purely

nomenclatural considerations. Its user group is diverse and not generally attuned to the niceties of rules for the correct naming of plants, especially when they get in the way of making a living. A registrar therefore has to be flexible and as helpful as possible when dealing with plant naming problems.

In registration, the commercial requirements can conflict with nomenclatural rules in relation to Plant Breeders' Rights (PBRs) and selling names, or 'Trade Designations' to give them their more formal term. PBRs provide a system for protecting new cultivated varieties of plants by an intellectual property right which is established by an International Convention and operates through an international body (UPOV). There are national statutory plant registration authorities that register PBRs, and once granted a PBR is legally enforceable. As a consequence the cultivated plant *Code* has ruled that a PBR name takes priority over any existing name. Since a statutory plant registration authority is not required to check whether a proposed name has already been registered with an ICRA, registrars must make themselves aware of any proposed PBRs. However, a PBR is geographically limited and is not permanent so can lapse if the registrant decides not to renew the application, although it will still retain its priority under the ICNCP.

'Selling names' arise when names are needed to sell the plants and the cultivar name is not thought appropriate. These can vary from country to country, and a 'selling name' may be a translation or transliteration of the correct cultivar name into the language of the country where it is being sold. 'Selling names' are not governed by the ICNCP, although a registrar does need to be aware of the application of selling names when considering the registration of cultivars. The use of trademarks to protect plant names is another complication as the rules for these vary according to national legislation and are not always well understood by nurserymen.

For horticulture, while registration by ICRAs has provided the basis for stabilisation of nomenclature for the reasons explored above, it still has some way to go before it can be said to fully address the needs of all its users. Looking ahead, future developments should include greater harmonisation between ICRA registration and UPOV (PBRs); encouragement of registration by making it easier to effect (such as registration online) and to devise a system for logging cultivar names for groups not covered by an ICRA. All these opportunities are being explored and, building on the solid work of the registrars to date, it will be possible to bring about a more comprehensive and widely supported system of registration for cultivated plants.

The vision for zoology: ZooBank

Andrew Polaszek

Executive Secretary, International Commission on Zoological Nomenclature in 2004–2007; Department of Entomology, Natural History Museum, Cromwell Road, London SW7 5BD, U.K. (e-mail: a.polaszek@nhm.ac.uk)

ZooBank was originally conceived as an open-access register for all scientific names of animals, new and retrospective, back to 1758, and formally proposed by 29 internationally acclaimed zoologists in 2005 (Polaszek et al., 2005). The first version of ZooBank, with 1.6 million animal names, was provided by Zoological Record

(Thomson Zoological Ltd) in August 2006, and provided a popular online service until late 2007. At that point in its development, discussions between ICZN (International Commission on Zoological Nomenclature, the initiators of ZooBank), Thomson Zoological, the Global Biodiversity Information Facility (GBIF), and the Taxonomic Databases Working Group (TDWG; currently Biodiversity Information Standards) resulted in the transfer of responsibility for the development of ZooBank to Commissioner Richard Pyle at the Bishop Museum, Hawaii, where it is currently based.

Registration of animal names and nomenclatural acts with ZooBank will undoubtedly increase the rate and ease of description of the planet's animal biodiversity, by facilitating access to novel and retrospective zootaxonomic data. Adopting the GenBank model, where publishers of scientific papers require authors to provide universally accessible data (molecular in the case of GenBank, nomenclatural and taxonomic in the case of ZooBank), will eventually result in a mandatory registration system for the scientific names of animals, ensuring the universal visibility of the scientific names of animals and all nomenclatural acts in zoology. The two crucial differences between GenBank and ZooBank are: (a) the eventual mandatory requirement for registration with ZooBank under the International Code of Zoological Nomenclature; and (b) that the primary stakeholders in ZooBank are expert zootaxonomists.

Why is ZooBank vital for the future of animal taxonomy, and hence all animal biodiversity studies? A primary requirement for facilitating biodiversity studies is to increase the visibility of taxonomic and nomenclatural acts. Many of these are effectively 'hidden' in thousands of journals and other publications, many extremely difficult to obtain. With ZooBank, taxonomic data will not only be freely available, but an alerting service using RSS feeds will also be provided for those taxa of interest to the user.

The idea of a mandatory registration system implemented *via* ICZN may, for some, have authoritarian overtones. However, the opposite is actually true. The universal visibility of and access to all animal names and nomenclatural acts will effectively open up, democratise and make available the fundamental and inclusive support system for biodiversity studies – animal taxonomy. In order to achieve completeness of the ZooBank resource, integrating registration of new names with retrospective registration of all animal names back to 1758, the mandatory aspect is crucial. In this way, ZooBank will become a primary source of authoritative animal names and data. To give a medically important example, the primary causative organism of the disease giardiasis is the protozoan *Giardia lamblia*. The primary database of organism names, *Zoological Record*, contains seven variant spellings of the species name: *lablia*, *lambia*, *lambila*, *lambla*, *lamblia*, *lambllia*, and *lamlia*, without any indication of which is correct. This example makes very obvious the need for a central, authoritative source of taxonomic information.

The establishment of ZooBank provides an opportunity to introduce unprecedented stability into zoological nomenclature by, among other things: automatic checking for code-compliance; prevention of homonymy; stabilisation of spelling; fixing of genders and stems; stability in gender agreement; and quality control.

The current *Code* permits certain descriptions or other taxonomic acts that actually run against its main principles, for example the description of new taxa in the absence of type specimens runs directly counter to the Principle of Typification. This provision is of course essential for endangered or otherwise illegal, unethical, or impossible to

collect species, but in its present hazy form requires some simple additional legislation by the community acting through the Commission to prevent future problems and possible abuses. There is a growing concern – to some extent connected to the previous provision – about the auctioning or otherwise selling of 'naming rights', for which some intervention by the *Code* is also required. However, the most important change needed to the present zoological *Code* concerns publication criteria. Currently, the *Code* does not permit electronic-only publication, and this is, and will increasingly become, a problem, as journals quite understandably reduce their hard-copy output and move towards online-only publication. While online only taxonomy may be highly desirable, and the logical next step, without a mandatory registration system that both facilitates and regulates the process chaos will result.

Registration in ZooBank is envisaged as a relatively straightforward task, with an online proforma requiring all the data available for code-compliance and prevention of a large proportion of future nomenclatural problems requiring Commission intervention. Both primary and third party registration will have to be permitted, and there will be important differences between pre- and post-publication registration, with a holding period in the pre-publication scenario where the as-yet unpublished names are protected. Built-in spell-checks will detect homonyms and enable the correction of gender agreement, while drop-downs will greatly facilitate the process, for example with very frequently-cited historical literature. Links to exact copies of original descriptions and figures, and no limit to the amount of data (e.g. figures, gene sequences) associated with new descriptions will be made via Morphbank, GenBank and other universally accessible free resources. This will lead in many cases to inevitable problems over authors' and publishers' copyright, heralding a radical but essential change in attitude towards copyright in animal systematics and eventually further afield. Above all, in order to succeed, registration with ZooBank must be straightforward, it must be free, and the resulting data must be freely, universally accessible.

There are still many unknown factors in the development of ZooBank. The last experience in botany was ultimately unsuccessful, but perhaps because it was premature. To date (2007) we have had 2½ years of public discussion and debate, especially facilitated by e-mail discussion lists, wikis, and emerging projects such as CATE, and EDIT. GBIF and TDWG are currently taking an active role in these activities. Through animal taxonomists working together openly we can show that mandatory name registration is neither authoritarian nor imperialistic, but is actually both authoritative and democratic. Clearly additional resources will be required, and some high-profile groups need to be showcased successfully in the very near future, but the spirit of cooperation that has led to ICZN *Code* adherence being one of the best examples of international scientific cooperation will ensure the success of ZooBank.

Reference

Polaszek, A. et al. 2005. A universal register for animal names. *Nature*, **437**: 477.

The debate

The Chairman for the evening session, Richard Fortey (Department of Palaeontology, Natural History Museum, London), reminded all of the content of the earlier presentations and explained that he would begin by asking for a preliminary vote on

the motion 'The registration of new names of organisms should be compulsory', and that there would be a final vote after the debate.

The Proposer, John McNeill (Royal Botanic Garden, Edinburgh), reviewed the afternoon's presentations and the different ways in which registration of new names was being dealt with by the different *Codes*. He stressed that the present proposal dealt only with new names, and would not replace existing systems but support them and the accompanying indexing systems. He considered the financial implications of possible cuts to funding for maintaining indexes if registration of names is not seen as mandatory, and went on to discuss some of the obstacles met by earlier schemes before the current global network was in place providing new solutions to these. He concluded by stressing that any registration system should be: (a) easy; (b) accessible; and (c) community based.

The Opposer, Alain Dubois (Muséum National d'Histoire Naturelle, Paris), considered the taxonomic impediment of naming all new organisms, the geographical distribution of papers on new taxa and their authors, stressing the differences between the contributions from the countries of the 'North' and those of the 'South', together with their differing levels of information technology (IT) access, the threats to IT, and available access to the older literature supporting taxonomy. All these create major problems for those working in such regions. He also drew attention to the present unbalance in ZooBank geographical representation. He considered that the key solutions to stabilising names were the monographic publications featuring major revisions, but these would often be traditional paper publications with low impact factors. The support provided for them by subscriptions, and exchanges within the academic community, was essential if they were to survive in the face of growing competition from consortium or package sales for access to commercial online journals. He feared that mandatory registration, assuming it could be implemented and regulated, could lead to the loss and abandoning of paper copies, divisions among the biological community, and waste of energy and time in activities such as those proposed by supporters of the PhyloCode. The 250th anniversary of the 10th edition of *Systema Naturae* should not be used as an excuse to impose new systems, but instead ICZN should just add ZooBank as an additional tier to the existing nomenclature procedures and see what happens over time.

Contributions from the floor were made by speakers from the afternoon session, together with George Garrity, Sandra Knapp, Rafael Govaerts, Suzanne Walker and others. Votes cast before and after the debate were as follows:

	Yes	No	Don't know	Total voting
Before	42	19	2	63
After	38	24	1	63

The motion was therefore passed, but not by an overwhelming majority of those present.

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