Towards a strategy to enhance access to microbial diversity

The decision of the International Committee on Systematics of Prokaryotes [ICSP, an IUMS COMCOF (Committees, Commissions and Federations)] to enforce the mandatory deposit of nomenclatural types of archaea and bacteria in two publicly accessible services was considered necessary to ensure that type strains are available to the international scientific community for the purpose of systematic research. A comparable deposition policy does not exist for non-type strains. Journal editors’ prompts to authors to make novel organisms, viruses and vectors available to all qualified members of the scientific community are nothing more than weak ineffective recommendations and are not enforceable. Not only editors, but also reviewers and authors, fail to follow a fundamental foundation regarding the publication of scientific data, which is the potential for other researchers to verify the published data. Obviously, the plea for voluntary deposition is insufficient to convince authors to share strains among their peers and to ensure that microbial diversity is archived in the long-term for confirmation, repetition and extension of scientific data.

How can data in scientific literature be verified and how can strains included in publications be used as future reference strains when they are not available to the scientific community and provision is left at the discretion of the authors? Compared with the small number of about 9800 nomenclatural type strains of prokaryotes that are available from public collections, the fate of an inestimable number of additional strains of these species remains unknown, as they are generally not deposited in public collections (Stackebrandt, 2010). It goes without saying that the uncritical deposition of each microbial strain isolated is not practical and is even nonsensical in the true meaning of the word. In times of prudent handling of resources and public awareness of biodiversity, a coordinated strategy should be put in place which would increase and facilitate access to valuable and irretrievable microbial resources.

In order to enhance the public availability of reference strains, researchers and authors must be aware that the deposition of strains isolated in the course of ‘their’ investigations with mainly public funding is in the general public interest. At a given point of the publication process, editors, authors and culture collection staff should find a way to collaborate over which strains should be transferred into which public collection. The deposit of a small number of selected key strains should not be optional but mandatory. Historically this practice was followed but it has lapsed in recent decades.

The situation is different with research collections, i.e. non-public collections created at academic institutes as the result of diversity studies. Without doubt, the quality of such holdings must be improved. This should be done for two purposes: (i) to facilitate the transfer of endangered collections into the hands of professionals, i.e. curators of public collections, and (ii) to increase the chance of the long-term maintenance of recalcitrant, rare and extremophilic strains, as well as strains of species which are under-represented in public collections. Deposition of selected strains in research collections should not be enforced but is recommended.

In recent communications (Emerson & Wilson, 2009; Stackebrandt, 2010), the primary role of public culture collections in sharing microbial resources and information that promotes scientific discovery has been highlighted. It has also been stressed that, at present, culture collections maintain and provide only a fraction of the diversity of isolated microorganisms due to financial constraints and lack of recognition of the importance of safeguarding resources for future generations. The number of government-funded public collections is marginal; most public collections are linked to universities and research centres with insecure support and no long-term perspective. However, as mentioned by Emerson & Wilson (2009), continued support and development of collections to carry out these tasks are essential to meet the future demands of environmental microbial collections and their associated data.

Microbial collections have never been in a position to cope with even a glimpse of microbial diversity. Even today, internationally, less than a handful of public collections are in a position to accept, maintain and preserve for the long term the less than thousand type strains of novel species described annually for which deposition is mandatory. Most of the remaining collections can and will accept only those type strains and a few additional strains that fit into their portfolio and into the expertise of current curators. As a consequence, at present, almost no public collections are in a position to accept taxonomically under-characterized collections of strains of potential scientific and biotechnological value from academia and research laboratories unless they receive additional support for the future tasks they are asked to perform. If adequate support was provided, a network of cooperating public collections could achieve more than the sum of its members. Except for some type and reference strains in high demand, overlap rarely exists among collections internationally. Most collections concentrate on a distinct section of the diversity spectrum, providing expert skills for both identification and long-term maintenance. This know-how must be made available to the scientists who are willing to deposit their biological assets.

In order to interact fully with stakeholders, public collections need to be organized so that they can be easily identified and can demonstrate their strength and expertise to strain providers. It is envisaged that at the beginning of such an initiative, only a small number of public collections would be in a position to receive large numbers of additional
strains, but deposition should not be restricted to them. Rather than scientists and authors having to search for themselves to find a home for their strains, the collections should have a central entry port to offer expertise and to facilitate discussions on which strains should be deposited and which would be the most appropriate collection for deposition. Here, the newly initiated Global Biological Resource Centre Network (GBRCN; http://www.gbrcn.org/) has a key role. With one of its mandates to collaborate with existing networks plus stakeholders and users, the GBRCN could serve as the portal to a catalogue of collections that had agreed to accept such resources and as a forum for subsequent discussions between authors, editors and collections.

For most public collections, the main obstacle for expansion is the inveterate degree of underfunding that prevents collections from increasing holdings, from introducing new technologies and from hiring scientific expertise. The role of repositories for microbial strains must be re-evaluated. Non-governmental host organizations should reconsider their hesitant attitude towards supporting their intramural ex-situ collection centres as the keepers and providers of authenticated value-added biological resources. The lack of commitment to the value of collections and insecure career prospects can result in the demotivation of staff and can discourage young scientists from joining collections. **Collections need additional support to fulfil governmental commitments to the Convention on Biological Diversity (CBD) to place a higher fraction of microbial diversity into the custody of collections and resource centres.** Unfortunately, the number of collection curators is too small for them to be able to lobby for their interests on their own, but if all stakeholders agree to support and champion this science policy innovation, successful investments in the expansion of collections can be envisaged. However, before any level of funding can be discussed bilaterally with their national funding bodies and host organizations, each collection must make its own decisions about the magnitude of support needed for expansion based upon the numbers of strains that could be accepted, the degree of difficulty of their maintenance, as well as on the recruitment of the necessary expertise and possible increases in laboratory and storage space.

Research funding organizations will have to play a major role in a strategy for improved accessions as they are in the driving position to be able to implement the compulsory steps. Not only are they the main research sponsoring bodies, but they are also in a powerful position to monitor and enforce these guidelines. Both the grant guidelines for applicants and research contracts should make it very clear that: (i) biological material collected during the course of a successful project must be identified according to a minimal (yet to identified) taxonomic standard, and (ii) selected strains included in the scientific literature or reports resulting from the research must be deposited. The first recommendation is the basis for the future transfer of research collections into public collections, while the second recommendation improves the credibility of published studies and allows the inclusion of such reference strains in future studies. **A fraction of the research grant budget should be reserved for strain identification, deposition and shipping.**

The public availability of non-type strains included in the scientific literature is not obligatory. This makes practical but not scientific sense as the compulsory deposition of all strains investigated would be beyond the financial and practical capabilities of both collections and research facilities. However, rather than stating in the ‘Instructions for Authors’ for journal submissions that these strains, e.g. ‘should be made available in a timely fashion’, a stronger phrase such as ‘authors are advised to contact public collections for requisite depositions of selected reference strains’ would reinforce their scientific obligations. **The optimal case would follow a strategy similar to the compulsory deposition of sequences in public databases – a manuscript would only be accepted after written confirmation that the strains selected had been accepted by a culture collection.** Provided that consensus among chief editors could be achieved, a paragraph with text along this line, together with a link to the GBRCN website and a link to public collections accepting such strains, should be included in any ‘Instructions for Authors’. Such a strategy would demonstrate the international consensus on this matter. During the course of the peer-review process for manuscripts, it will be important to find a confidential mechanism by which the editor, author(s) and collection(s) discuss the selection of the taxon and the number of strains to be deposited. Considering the number of microbiological journals, their associated editors, the number of manuscripts submitted and the strains covered, the task for each partner involved will be immense. Rather than trying to involve all journals at the start, a small selection of journals should enter a pilot phase.

The issue of strain selection needs careful consideration because of the possible reverse effect of the strategy if authors are told that strains they consider worth depositing will not be considered by some of the other stakeholders, or if authors omit strains from publications in order to minimize their obligations. A survey of holdings among four major public West European collections (Stackebrandt, 2010) indicated that they placed emphasis on those genera which are also most widely represented in the scientific literature, i.e. members of the phyla *Firmicutes*, *Proteobacteria*, *Actinobacteria* and *Bacteroidetes*, though each collection concentrated on a specific spectrum within each of these phyla. It is assumed that the same is also true for collections in other regional networks. Species of pathogenic, extremophilic, anaerobic, phototropic and recalcitrant taxa are already well covered but collections could benefit from the deposition of additional strains with specifically recorded properties of medical, technological or ecological importance. Among the taxa that should receive urgent attention are those that are under-represented in collections, such as mycoplasmas and their relatives, chlamydiae, verrucomicrobiae and planctomycetes and other phyla such as the Chloroflexi and Acidobacteria. The significant issue from a systematic viewpoint, with wide-reaching consequences for biodiversity, is the availability of additional strains of those
species that are solely represented by the type strain. Between 1990 and 2000, the number of species described that were based upon the characterization of only a single isolate remained at about 40%; by 2009, this number had increased to a staggering 79% (Stackebrandt, 2010).

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