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Towards a strategy to achieve post-publication deposit of microbial strains

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Background

A few years ago, I made a survey on the number of non-type strain depositions into public collection for 8 European microbiology journals. This number was dismal as of the 20.200 prokaryotic strains studied in 1261 papers only a minute fraction of less than 1% were deposited to ensure their long-term availability and controlled quality and to allow other scientists to verify published results (Stackebrandt, 2010). Two follow-up questionnaires were sent. One, anonymous, to a small number of scientists asking for sharing specific strains that had just been included in the literature: less than 20% agreed, most of the other did not even respond. A second questionnaire on author's opinion on strain deposition was sent out to thousands of scientists. Surprisingly, and in contrast to practice, the vast majority of those who returned the questionnaire (14.7%) did not only agree on a more stringent deposition policy (88%); they also agreed to the recommendation that journals publication guidelines should contain a distinct request to deposit strains with particular properties in public strain culture collections in order to maintain them for further research (79%). The same authors also speculated on the reason why authors do not deposit or share the strains during the publication process or post-publication. In the order of number of responses the reasons were: Protection of intellectual property and fear of competition and challenge; loss and unavailability of strains; problems related to quarantine, custom, bio-safety issues, transport, and reference to the Convention on Biological Diversity (e.g., legal problems with sending strains after September 2001, mailing restrictions); commercial aspects (e.g., industrial applications, patent submission); other comments such as: not allowed to send any strains; no interest in sending strains.

Most of these arguments are comprehensible but less valid in the greater picture: it is the credibility of science, of funding agencies and of authors which is at stake. Authors deny transparency of their research results if biological resources are not shared. Scientists lose as they are denied of reference material and bio-economy suffers as valuable material is likely to be lost or, if at all, re-isolated with immense costs (Stackebrandt, 2011a,b).

The Dilemma

Why are the huge investments in publicly funded research not protected for confirmation of results and future use? While documentation of gene and/or genome sequences in public databases and of type strains of novel prokaryotic species in at least two public service collections and in at least two different countries are two examples for a functioning implementation, deposition and release of material and data are, in practice, left to the authors' discretion. Some journals may have a stricter

implementation policy than others but generally enforcement mechanisms do not exist. **An alternative option to direct requests to authors for strains is the deposition of 'key' material in public collections**. In a recent workshop participants agreed on a mechanism that would ask authors during the submission process of manuscripts for an evaluation of the uniqueness of strains sufficiently novel to be worth depositing in public collections.

- Uniqueness, based on a cutoff point of ≤98% of 16S rRNA gene sequence similarity to the most closely related species with a validated name.
- Metabolic uniqueness, based on the presence of a new pathway, modification of an existing pathway, metabolic differences compared to the type strain or novel products
- Genomic uniqueness, such as significant differences (≥20%) in genome size, genome architecture or new regulatory mechanisms.
- Resources and parts thereof with fully sequenced genomes (microorganisms, phages, plasmids).
- A second strain of those species or subspecies for which only the type strain has been deposited.

Table 1: Criteria for the evaluation of key (non-type) strains worth maintaining long-term in public collections.

Let us assume that authors do agree to ask public collections (BRCs) for depositions of those strains that would match the criteria mentioned in Table 1. At present nobody knows even an approximate number of such strains, which will easily reach several thousand annually worldwide (this is only for prokaryotes). At this moment BRCs or other public collections of microorganisms would not be prepared for this avalanche of strains as many of them already today struggle to accept even the type strains of newly described species. Only a very few are equipped to hold huge holdings and most of these concentrate on non-fastidious, non-extremophilic and aerobic strains which are relatively easy to maintain. As depicted in Fig. 1, today most of the strains accessioned by the larger public collections are non-type strains and the range of expertise in collections worldwide is so large that these, after appropriate expansion, would be able to cope with the depth and breadth of material that could be expected to arrive from authors.

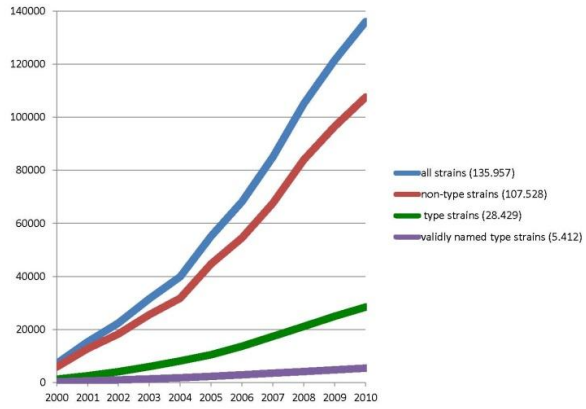

Fig. 1. Cumulative deposits (2000-2010) of type and non-type strains by some major public service collections*. Numbers of validly named species are included for comparison

*Data from ATCC (USA); BCC (Thailand); BCCM/LMG (Belgium); CCGMCC and CCTCC (China); CCM, Czech Republic; CCMM, Morocco; CCUG (Sweden); CECT (Spain); CIP (France), KACC and KCTC (Korea); DSMZ (Germany); NCIMB, UK; NCAIM, Hungary; NBRC, Japan; NCCB, The Netherlands.

The Stakeholders

From what is said, stakeholders other than **authors** and **collections** need to be involved in a global strategy. There are the **funding bodies of public collections** which span a wide range, from governmental funding agencies to academic and national research institutions. These agencies must recognize the need to support BRCs in their novel task by increasing the number of technical personnel and curators as well as technical and personnel infrastructure. There are also the **funding bodies of research** which need to support appropriate shipping according to national and international rules and regulations, especially when the accepting BRC is located outside the country of research. There are the **publishing managers and the editors** who have to implement and to supervise into appropriate journals mechanisms that strains are actually deposited. And last not least there should be a **central gate**, offering a discussion forum for communication between editors, authors and public collections/BRCs to smoothen the dialog about strain deposition in a most professional way.

The identification of stakeholders is straightforward but the implementation of a strategy is not. They are all connected in a vicious circle which is difficult to break: Collections will only be in a position to accept the expected high number of strains provided financial support by their funding agencies. These will not see the necessity to enlarge collection facilities and staff as already today legitimate claims of collections for additional support is often grossly ignored (fortunately there are positive examples for the major national collections).

Post-publication strain deposits

Let us assume we could in the future by and large estimate the annual number of strains worth depositing. The 2008 survey on 8 journals revealed that the majority of the 20.200 strains studied were from the phyla Proteobacteria (68.5%), Firmicutes (16.8%) and Actinobacteria (8%) (it should be mentioned that this number refers to all strains studied, not to those matching one or more of the criteria indicated in Table 1). As this number is largely composed of aerobic and chemoheterotrophic strains most collections will have no problems in coping with their maintenance, provided the removal of the infrastructural bottleneck mentioned above. The number of strains with special growth requirements is much smaller and need to be handled by the few BRCs with the appropriate know-how.

In order to initiate a discussion with collection managers about funds needed to be prepared for the expected increased post-publication requests for strain deposition, we need to have a better estimate of these strain numbers. I have just initiated a link with the Springer Publishing Company and FEMS (Federation of European Microbiological Societies) who agreed to have a short questionnaire attached to the acceptance letter in several of their microbiology journals, asking authors on a voluntary basis to indicate the number of strains to be deposited on the basis of criteria listed in Table 1. It is too early to provide any numbers and more journals should follow this innovative step to better assess the number of potential post-publication deposits. Unfortunately, since the response need to be anonymous, affiliation of numbers to countries/national collections is impossible but would certainly be advantageous in order to aid national public collections in their assessment of funds needed to expand their infrastructure.

Towards a strategy

Two minor steps of the many steps towards a world-wide accepted post-publication policy have now been initiated. Firstly, the public collections in the EMbaRC (European Consortium of Microbial Resource Centers) project, embracing most of the major BRCs in West Europe, have agreed in principle to participate (Stackebrandt et al., 2010). Secondly, a few journal managers have been contacted who agreed to take up this initiative and help in assessing the numbers of ‘key’ strains. But, as depicted in Fig. 2, the overall picture is much more complex

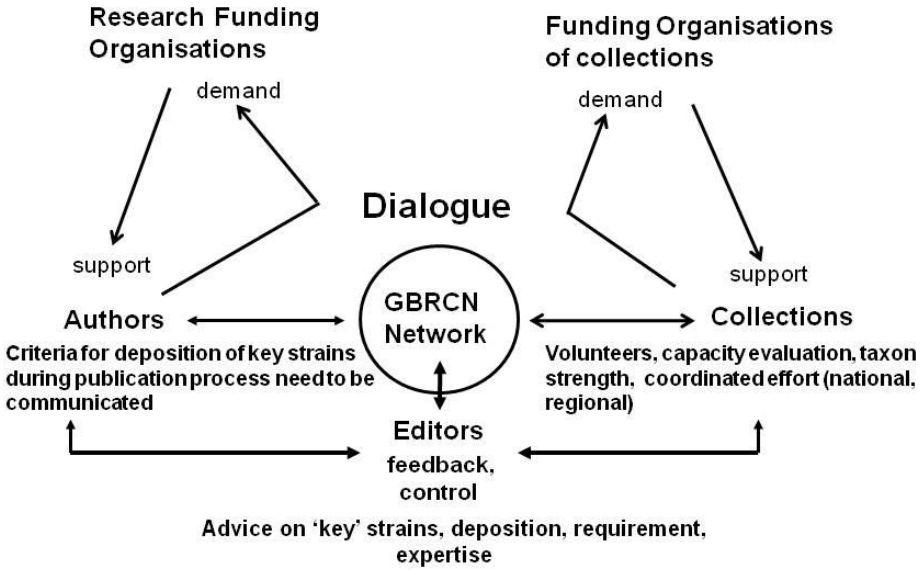

Fig. 2. Towards an improved deposition strategy

Stakeholders will act independently of the others and unfortunately there is no forum where all of them could meet and discuss this issue. As collection managers, because of their experience with safeguarding bio-resources, are likely to continue this initiative, they have to make sure that it develops globally, reaching out to their national stakeholders and to collections organized in the WFCC or in regional networks. This could be done on two levels:

- The first level is relatively straightforward and would involve the national and regional microbiological societies (IUMS, for example has been made aware of the issue and the BAMS delegates agreed unanimously during IUMS XIII in Sapporo). The more partners accepting the idea of post-publication deposit of strains, the stronger the microbiology voice towards other stakeholders.

- At the second level the process will be slower. Once BRCs and other public collections have gained an overview over the dimension of strain numbers likely to be deposited post-publication, they need to enter into a dialogue with their funding agencies. Demands for technical and personnel expansion must be put on the table and the importance of post-publication of strains argued with credibility of science, preservation of valuable resources and the like, as mentioned above. Only then, only after funding agencies commit themselves to the importance of collection support, authors should be notified that collections are prepared to accept 'key' strains. As appropriate preservation methods, administrative matters and shipping are costly, authors will have to negotiate additional funding with their respective research agencies.

There is actually an alternative, which would shift the financial burden more to the author side. In case funding agencies for collections hesitate to support their national centers, the latter would have to charge authors for strain deposition to cover the cost for long-term maintenance. In this case the costs need to be asked from funding agencies of research and appropriate segments are to be included in grant applications. Possibly, time will show that a combination of both alternatives will be the most likely solution.

The last point to be made is the outline of the procedure of how do authors know where to deposit strains post-publication. Most strains will certainly be kept in the national collection though in those cases where collection did not receive funds for expansion or the number of strains to be deposited is too large, alternative collections accepting such strains must be made visible. Also, expertise in international shipping regulations, as well as specific curator expertise must be made available at a central site. Here several options exist were to place such information gateway for authors and curators to get into direct contact before sending out strains: the WDCM (http://www.wdcm.org/) website or, as indicated in Fig. 2, the envisaged GBRCN (http://www.gbrcn.org/) website. At the regional level the Asian Consortium for Conservation and Sustainable Utilization of Microbial Resources (ACM), the Brazilian Network or the European Microbial Resource Research Infrastructure (MIRRI) initiative can play an influential role.

Final word

The global dimension of the problem and the enormous impact this initiative will play on the sustainability of BRCs and other public culture collections on the availability of important microbial resources and on the credibility of science in general makes it necessary to take a coordinated approach. We are just at the beginning and I have noticed how slow progress develops. I would welcome any ideas and comments and do not hesitate not only to contact and inform your national microbial societies, the publisher of national microbiological journals and granting agencies but also me under erko@dsmz.de for further discussions and advice.

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