

Sad status of microbial taxonomy research in India

Never before had microbes and microbial diversity assumed importance that they have today. Owing to the importance of microbiome in general, and human microbiome in particular, they offer inexpensive, reliable and personalized solutions on the issues related to human health and agriculture. In order to exploit the benefits of microbial resources, there is a need to characterize them. Complete characterization of microbes, specifically bacteria is a highly skilled and multi-disciplinary exercise. As microbes have limited morphological attributes to distinguish them, historically microbial taxonomy depended heavily on a very detailed chemical analysis of the microbial cells that included cell wall and cell membrane composition and respiratory pigments. With a move towards DNA-based characterization, initially DNA base composition and DNA–DNA hybridization were considered a gold standard. This was then followed by gene sequencing and today it is the genome sequence. The full descriptions of new taxa require detailed comparative studies of the putative novel organism with the reference cultures using a battery of these techniques.

Prior to the beginning of this century India was lagging behind in the discipline of microbial taxonomy and systematics. There were very few, if any, new taxa described from India until 2000, whereas both China and South Korea dominated the area with majority taxa descriptions published by these two nations. Many Indian researchers at that time depended heavily on collaborations with laboratories of the developed world in the absence of expertise for many specific techniques. However, the situation improved at the beginning of this century, and today India has a long-list of experts in microbial taxonomy and systematics. This change could be attributed to the availability of resources and increased research funding. Throughout this growth period, a significant increase in the number of new bacterial taxa of Indian origin (including species and genus) has been described by Indian researchers. A majority of these publications were authored by indigenous expertise, without any collaboration with laboratories abroad. That set pace for the description of new species from India and from 2001 to 2015 more than 200 species were described from diverse ecological niches. It reached its peak around

2015–16 with more than 50 new species described that year from India. The period was also marked by the expansion of the microbial taxonomy from select national laboratories to university departments and even colleges. The places like University of Delhi and Jawaharlal Nehru Technological University made significant contributions and received global recognition.

India, being a vast country is home to diverse ecological niches and these niches too were represented in the studies. Some of the examples are Himalayan glaciers, cold deserts, hot deserts, hot springs, pristine environments, agricultural soils and insect guts. The new taxa descriptions were not just restricted to species but also included higher taxonomic hierarchies like genus, family and order. Several new taxa carried the names like *Indibacter*, *Cecembia*, *Emticicia* as genera *indica*, *indicum*, *assamensis* or the names of organizations like *isroensis*, *cecembensis*. Some species were also named after renowned scientists.

However, this growth was rather short term and the numbers started declining rapidly afterwards and in 2019 only six papers were published, and so far only five in 2020. If this trend continues there may be no new species described from India in 2021. Ironically, this time the reason is not the lack of expertise and facilities but it is the conflict between the rules of bacterial nomenclature and provisions of the Biological Diversity Act 2002.

Microbial taxonomy is governed by the International Committee on Systematics of Prokaryotes (ICSP, the Committee) which lays rules and procedures for the International Code of Nomenclature of Prokaryotes (ICNP, the Code). Moreover, although the new taxa can be published in any journal, they are validated only after their listing in *International Journal of Systematic and Evolutionary Microbiology (IJSEM, the journal)*. Present rules of the code necessitate that while describing a new taxon, a viable stock of the representative culture should be available in at least two culture collections in two countries for unrestricted distribution.

Thus, as per the Code, there are three organizations whose opinion matters: (i) the Committee (ICSP); (ii) the Editor and Editorial Board of the Journal (IJSEM); and (iii) In-charges of the receiving culture collections. On

the other hand, The Biological Diversity Act 2002 of India prohibits any non-Indian from accessing biological resources of Indian origin for either research, commercial utilization or even for bio-survey and bio-utilization without prior approval of the National Biodiversity Authority (NBA).

Thus, as per the Biological Diversity Act 2002 the deposition of any microbial culture in a culture collection outside India by an Indian researcher requires prior approval from NBA. Also, any non-Indian researcher intending to access an Indian-origin culture deposited with culture collections, including the non-India culture collections, must obtain prior approval from NBA of India. This is considered as 'restricted access' by the Committee (ICSP) as well as by the list editors of the IJSEM. This violates the rule of the nomenclature.

Due to this, now-a-days all major culture collections have stopped accepting the deposits of Indian-origin citing that the cultures have restricted access. In the absence of certificate of accession from two international culture collections, the publications on describing new taxa are being declined and returned to authors without any review. It is a double blow: while the Indian researchers are losing the publications, India at large is losing its claim on the description of several new bacterial taxa. The pile of rejection e-mails received from culture collections and journal editors stating 'since the culture is not available for restriction free distribution, the species name cannot be validated' is a proof of the plight of Indian microbial taxonomists. As a country, we now face the prospect of losing the claim to document bacterial diversity from India. At times, taxonomic descriptions have also been used for gaining geopolitical mileage. In an interesting case, South Korean researchers described several bacterial taxa by the Korean name of a disputed island, 'Dokdo' to legitimize their claim on this island. Till now, South Korean researchers have described one new genus *Dokdonia* comprising ten species, and twenty two 'dokdonensis' species belonging to different genera. Regardless of the advantages, it is now clear that the situation will not improve unless this issue is resolved.

Globally, it is becoming increasingly obvious that countries like Korea and China which contribute maximally to the descriptions of novel taxa every year have not restricted the access to their reference cultures. In contrast, India and other countries, such as Brazil and South Africa have similar restrictions, as a result of which the researchers are suffering. A plausible solution is to adopt a flexible approach that is based on the

process of scientific conduct and trust. A lot of things have changed since the Biological Diversity Act 2002. The Nagoya Protocol on *Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* was introduced in 2010 and today there are 92 signatories and 127 ratifications. Most culture collections honour the provisions of the protocol and have mechanisms to prevent commercial use of the cultures deposited with them. There also exists a mechanism to trace the movement of the culture through different users. The provisions of the present act should be reviewed in the light of these developments and suitable amendments must be made to encourage exchange of resources for at least taxonomic research. The researchers could be allowed to deposit the strain and make it available without restrictions for 'taxonomic purposes' only, while simultaneously regulating the access for all other purposes, including intellectual property rights and commercial exploitation. However, amendment of the act by the Parliament is a long process and we cannot let the researchers suffer till then. An interim solution is therefore the need of the hour. For instance, Russia has authorized culture collections for exchange of cultures and this is an example worth considering. The present act enables the NBA to 'delegate' some of its responsibilities. Through this, it could delegate the responsibility of approval for culture distribution to the concerned Designated Repositories under the Biological Diversity Act 2002. Following the Russian model, it may also consider such culture exchanges only through the designated repositories.

The issue needs an urgent solution, otherwise the microbial taxonomy research in the country will come to a standstill and we would lose opportunity to document the microbial wealth of the country which we claim to be very proud of. The new generation of researchers is unwilling to explore this area and those already working have shifted their research interest to other areas. With no new descriptions of Indian origin named as *indica* or *indicum*, we would have failed as a generation of Indian microbial taxonomists. It should be noted, the claim on this wealth is meaningless if we cannot document it.

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