

## Ethical crisis

This refers to the Guest Editorial by Madhav Gadgil<sup>1</sup> on 'Science in the service of a symbiotic society', a timely reminder to the current system of mistrust. An ideological symbiotic system with eroded ethical component may not be a solution to economic efficiency. Given the status of planning and implementation of developmental policies, without much impact on local community due to corruption and mistrust (the current political system is far from a symbiotic syndrome), the utopia of economic reliance is far-fetched. However, a ray of hope in the form of scientific acumen may offer timely medicine in this changing world priority. With climate change visualized as an economic impediment coupled with dwindling water resource with unpredictable precipitation pattern, the Indian state needs more cooperative co-determinism. A symbiotic society is

based on untiring efforts towards community involvement. A divided society without ethical inputs can be scientifically suicidal. After all scientists are social beings and are products of the prevailing social system. Sound scientific principles no doubt augur well to serve a symbiotic society. Unfortunately, need-based relationships at both micro and macro-levels have hardly helped our economic growth. There is a serious need to propagate ethical means of living in a complex society with multiplicity and differential resource distribution. Scientific methods at the service of our society in a sustainable paradigm require honest commitment at policy and implementation levels. The latter failed us due to unforeseen underground ethical vacuum. It is high time scientists as a community rise to the occasion and demonstrate symbiotic skills first before sitting on an

ideology of co-determinism. With the prevailing hierarchical system at major scientific, technological and managerial sectors, the direction of economy is moulded by political wisdom. The concern shown by Gadgil<sup>1</sup> is indeed appreciable and we keep our fingers crossed to see coalition of parties to redefine symbiosis! Let us clean the ecosystem we live in to create a salubrious environment.

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1. Gadgil, M., *Curr. Sci.*, 2014, **106**, 787–788.

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## Are pollen herbaria redundant? Their utility in botanical studies

While on one hand, the modern trends of taxonomic researches have recognized the significance of palynological findings in resolving various complexities and pollen integrated taxonomic studies are gaining momentum, on the other hand, the essentials of pollen herbaria are woefully veiled crippling many allied offshoots of botanical studies. The ever-expanding taxonomic vistas are witnessed to encompass micro-morphological and molecular methods in substantiating and evolving more lucid taxonomy wherein palynology, although a young science, has a pronounced role in solving intricate taxonomical problems where normal macro-morphological methods get plugged. Pollen grain, the single-cell entity holds significance no less than the other diagnostic features in deciphering the affinity or disparity of taxa even to the variety level. The detailed pollen morphological analysis involves in-depth observation of five groups of characters, namely germinal aperture, exine ornamentation, exine strata, grain size and shape in order of their importance and these character combinations provide entity to a particular taxon<sup>1</sup>. While pollen

shape, size and exine ornamentation can be viewed under light and scanning electron microscope, internal details such as the columella, exine strata and protoplasmic contents can be understood only through transmission electron microscopic studies. In order to observe the morphological details of pollen grains under light microscope they are procured from an authentic standard herbarium specimen or from live plants whenever possible. In the former case there is generally paucity of polliniferous material as it is never advisable and permissible to extract many anthers from the herbarium specimens, however in the latter instance material can be obtained in plenty, but only during flowering season of the plant if it is within reach, because it is not possible to collect pollen from an array of plants flowering simultaneously but occurring in different regions. The pollen grains are acetolysed by standard acetolysis method<sup>2</sup>, mounted on glass slides, sealed to make permanent preparations and deposited in a pollen herbarium.

Pollen herbarium is therefore a 'collection of permanent pollen slides of representative taxa pertaining to a taxo-

nomic group, family, genus or species, preserved and mounted on glass slides affixed with a label containing the details of its source taxa'. These slides are clutched in slide-holding trays within cabinets or in almirahs, and arranged according to a recognized system of classification, generally the Bentham and Hooker's system or any other readily accessible, indigenous system. In addition, the pollen herbarium may also hold the slides of pollen samples prepared for melittopalynological, aeropalynological, palaeopalynological or other related studies. Enrichment of a pollen herbarium is a difficult task mainly due to the hurdles in procuring authentic pollen material from live plants or from herbarium specimens<sup>3</sup>, as discussed above.

Pollen reference slides prepared from identified authentic plant specimens, either fresh, or from the herbarium, are essential to support individual pollen identification and authentication. Enormous data are generated through allied palynological vistas, wherein identification of recovered pollen particles from various landscapes underpins accurate assignment of pollen to their parent taxa

and in such circumstances the wealth of pollen herbarium finds undisputable application. For instance, pollen microfossil analysis is useful in deriving palaeo-vegetation and reconstruction of palaeo-climate (palaeopalynology); pollen recovered from animal dung (cow, horse, dinosaur, etc.) provide information regarding the vegetational patterns of the past and present (copro-palynology); pollen analysis of honey and honey-bee loads are elements of bee botany<sup>4</sup>, which facilitate validation of floral origin of honey and aid in understanding bee-plant co-relationship in the light of bee pollination services aimed at breeding and hybridization during crop improvement programmes (melittopalynology); pollen recovered from body parts of a suspect/criminal and victim along with those of the crime scene serve as useful forensic indices<sup>5</sup> in solving crimes (forensic-palynology); air pollen flora provides vegetation index of a geographic region (aeropalynology); pollen contained in pharmaceutical drugs and tinctures are indicators of their floral constituents and establish their authenticity (pharmapalynology); nasal tract pollen of 'hayfever' patients help ascertain the cause of pollen allergy for subsequent line of treatment (latropalynology).

The extensive utility of pollen herbaria in the diverse domains of palynological science suggests that they are most pertinent prerequisite during identification and analysis of pollen extracts as the constructed data are bottom-lined on precise pollen identification and their authentication through reference pollen preparations available in pollen herbaria. Pollen herbaria are therefore indispensable palynological legacies and their unequivocal function in the course of botanical studies parallels the general herbarium unambiguously during pollen identification, to catalyse standardized palynological conclusions. Can we ignore these merits and consider such a precious asset as redundant? The diminishing importance of palynological herbaria in the race of botanical modernization is alarming and calls for palynologists to join hands in an endeavour to restore this valuable botanical asset. Awareness on the significance of microscopic pollen 'types' preserved in the form of voucher slides in these herbaria in taxonomical

perspectives is yet to be understood, realized and accepted. The onus, however, rests equally on scientists, students, researchers and policy-makers to participate coherently towards creating a fertile platform with facilities for making palynology a more meaningful fraction of science and evolve unimpeded strategies of palynological herbarium maintenance. Inevitably, the momentous outputs on authenticated palynological findings referring pollen herbaria and supplemented with the voucher reference slides shall bear due acknowledgement to the respective pollen herbarium. Further, it is also recommended that the first pollen descriptions or the 'pollen protologue' of any taxa must include voucher pollen specimen and relevant pollen herbarium details because such slides hold importance equivalent to the type specimens, and may be designated as 'pollen type' slides. The benefit thus shared shall prove as an advance in palyno-taxonomy, where the entire palynological data are authenticated through cited voucher pollen reference specimen. Further, pollen extraction from herbarium specimens may appear unwanted at times, but considering essentiality, meticulous extraction of pollen material while conserving the herbarium specimen would clear the bottleneck and catalyse enrichment of pollen herbaria regarding this young science as an important and essential component of taxonomy. It is also possible to append miniature pollen herbarium as part of general herbarium in individual institutes for easy access to the pollen type slides and eventually erect a digitized virtual pollen/spore herbarium during future expansion of the botanical spectrum. For vivid taxonomical elucidation, the protologue of any new taxonomic entity carrying pollen description and mention of a reference pollen slide as distinct pollen type shall certainly raise an undisputed taxonomic entity.

Presently, there are not many extant pollen herbaria in our country. The most significant ones exist in: (1) the National Botanical Research Institute, Lucknow, holding the collections of many palynologists, including those of P. K. K. Nair, the doyen of Indian palynology and his co-workers, with about 5000 voucher slides of different families; (2) French Institute of Pondicherry, Puducherry with

the Thanikaimuni pollen slide collections (>22,000 preparations); (3) the upcoming herbarium at the Environmental Resources Research Centre, Thiruvananthapuram and a few other small herbaria with 500–1000 holdings, e.g. Birbal Sahani Institute of Palaeobotany, Lucknow (which started with 579 pollen slides in 1959, but has a stagnated growth of about 800); Bose Institute, Kolkata (c. 600 holdings), Agarkar Research Institute, Pune; Visva-Bharati, Santiniketan; Bangalore University and Jawaharlal Nehru Tropical Botanic Garden Research Institute, Thiruvananthapuram.

Finally, it is urged that during the race of embedding molecular and nanoscience in taxonomic methods, the significance of pollen types and pollen reference slides may not be lost. On the contrary, these must be conserved as precious components with a realization that a pollen representative 'type' slide prepared once from authentic pollen can never be replicated, duplicated or recreated. Further, complete representation of pollen representatives of any taxonomic group, if available, is the only pollen evidence on which future identifications can be based and no palynological identification can be authentic without confirmation through reference pollen slides.

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