OPINION

Misidentification makes scientific publications worthless – save our taxonomy and taxonomists

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Without accurate taxonomic identification, research carried out in academic and applied branches of life sciences is effectively worthless. In the present note the role of taxonomy and taxonomists in modern science is highlighted with the help of suitable examples. Yet, taxonomy is generally neglected or avoided due to the mistaken belief that it is a disused branch of life sciences. On the contrary, taxonomy needs to be encouraged and taxonomic research and knowledge require to be more thoroughly applied for the correct identification of biological material as used in both academic and applied research for the welfare of society and humankind. Certain policies and factors responsible for the gradual decline in quality of Indian taxonomic research, and pushing taxonomy and taxonomic expertise towards extinction are identified. Some suggestions for the furthering of taxonomy in Indian universities and institutions are also provided.

More than 10 years ago a paper entitled, 'On the occurrence of aphlebiae like structures in *Dennstaedtia scabra* (Wall. *ex* Hook.) Moore from Sikkim', was published by D'Rozario *et al.*[1]. Further information on these curious gemmae or bulbils was published by the same authors in their subsequent publications[2,3].

The present authors, however, found that the species referred to was not *D. scabra* (Wall. *ex* Hook.) T. Moore, which is common throughout most of the Indo-Himalaya, but is quite different as *D. scabra* has a hairy rhizome, a different overall laminar morphology, different segment shape, stiff, hairy stipe and differently positioned sori. The proliferous species misidentified as *D. scabra* by D'Rozario *et al*. is actually another common, well-known and easily recognizable East Indo-Himalayan species in Darjeeling, Sikkim and adjacent areas, *Monachosorum henryi* Christ. It has recently been placed in Dennstaedtiaceae[4], but was formerly placed in a monotypic family, Monachosoraceae, due to its distinctive appearance. *M. henryi* was widely known in India since the time of Hooker, Beddome and Clarke as *Polypodium subdigitatum* Blume[5–8], and since over a century as *M. subdigitatum* (Blume) Kuhn, a South East Asian species closely related and similar to *M. henryi*. It is quite distinct from *D. scabra* in its thick, succulent, non-hairy stipe, different segment-shape and above all, the distinctive proliferous rachis–bulbils, a key character for the species. These vegetatively reproductive bulbils, far from being an unusual occurrence, are a perfectly normal and constant feature of this species, just as they are in other well-known species such as *Polystichum lentum* (D. Don) T. Moore, or *Athyrium clarkei* Bedd., though in these species the bulbils are positioned subterminally beneath the lamina. They are not aphlebium-like, aphlebia being a non-reproductive, non-detachable, basal, pinna-like outgrowth of a stipe-base, modified into finely dissected, veinless and often lamina-less organs, for example, covering the crown-apex in certain non-Indian species of *Cyathea*, and also well known in fossil ferns. The proliferous bulbils of *Monachosorum*, situated one to three or more per frond on the top surface, were clearly mentioned and well illustrated in this species by Hooker[5] and Beddome[6,7] in his well-known books, which are the basic works on Indian pteridophytes. It almost defies belief as to how such a wide error could have come about when accurate illustrations and accounts of Hooker, Beddome and Clarke are available. Alternatively, a visit to one of the several major herbaria in India would easily have shown that *Monachosorum* fronds are not remotely like those of *D. scabra* and would have sorted out the identity of the species and the normality of its reproductive bulbils. Unfortunately, at present, few taxonomists take the trouble to study in India's herbaria, even though they are a most important national resource and source of learning, preferring instead to rush into generating poorly researched and hasty publications for the sake of career-advancement. Regrettably, even fewer authors accept and correct their own errors in the true spirit of scientific integrity, in order to prevent them from being perpetuated widely in the literature and misleading others.

Similar cases of misinterpretation concern reports of apospory in *Arachniodes palmipes* (Kunze) Feaser-Jenk. (*A. aristata* of South India, *non* (G. Forst.) Tindale) and *Pteris aspericaulis* Wall. *ex* J. Agardh and its relatives[9,10]. The outgrowths observed were not aposporous prothalli as thought to be, but were reported erroneously for the miniature 'witches broom'-like galls of the ascomycete fungal genus *Taphrina*. This parasitic fungus thrives in high-rainfall areas, and whereas *T. cornucervi* Giesenh. infects *Arachniodes* species, the commoner and larger-galled *T. laurencia* Giesenh. infects compound *Pteris* species as the host plant. Hope[11] had long since pointed out the identity of these galls in his widely known work, which is standard reading for Indian pteridologists (see also Fraser-Jenkins[4]).

Misidentification of fern species, often accompanied by comments on the supposedly interesting phytogeographical disjunction, or of a 'first report' from an area, are legion in Indian pteridology, again compounded by the lack of study in herbaria and failure to identify specimens properly, or to consult others who would be able to do so. Khullar[12,13], assisted by Fraser-Jenkins, spent much time visiting authors and herbaria in order to reidentify and sort out many anomalous records from West Himalaya, and the latter has subsequently carried out similar work throughout India[4,14]. Yet erroneous reports keep resurfacing, enshrined in the Indian literature in well-known journals, despite having been specifically corrected. Original errors are also increasing with the relentlessly regressive institutional pressure on young workers to publish anything, as frequently

as possible, for career-advancement. One of the more noticeable errors recently, was a report of an entirely Malaesian species, *Hypolepis alpina* (Blume) Hook. from India by Ganguly and Mukhopadhyay[15], following an initial erroneous report by Baishya and Rao[16], subsequently accepted by the latter authors as erroneous. It resurfaced because the initial report had not been corrected, and was based on a spurious idea that this species is diagnosed by having tripartite fronds. The authors had not consulted the well-known monograph of the genus by Brownsey[17], where they would have found that their material was not *H. alpina*. It can be easily seen from their illustration that the authors had an immature frond of the common, and only North Indian species, *H. polypodioides* (Blume) Hook. (*H. punctata sensu auct. Ind., non* (Thunb.) Mett. *ex* Kuhn), whose apical portion had arrested development so that each member of the basal pair of pinnae (always nearly opposite in this genus) was the same size as the apical part of the frond. This being misinterpreted as the frond being tripartite instead of normally pinnate as it is, and that, in turn, being misinterpreted as diagnostic for *H. alpina*, led to the error and spurious publication, which though corrected by Fraser-Jenkins[4], was not accepted or corrected by the authors concerned following correspondence, where it was made clear that they knew it to be correct. The yet more damaging problem of publishing spurious 'new species' has already been emphasized by Fraser-Jenkins[14], and although it had a considerable braking effect, we still find some surprising examples of 'new species syndrome'. Two salutary examples are as follows: first, the recent description of two supposedly 'new' *Cyathea* species[18] said to be endemic to a village next to the Botanical Survey of India campus, on the outskirts of Itanagar, Arunachal Pradesh. But on study by Fraser-Jenkins of both the types and the populations at the type-locality, they turned out be normal specimens of the well-known *C. andersonii* J. Scott *ex* Bedd. and the widely known plant long since identified by Holttum as probable *C. henryi* (Baker) Copel., and thence described, but without seeing the important stipe details, as *C. henryi* R.D. Dixit[19]. The second, most outstanding example is the description of some 47 'new' and supposedly endemic species by Singh and Panigrahi[20], from one small district of Arunachal Pradesh, every one of which, on detailed study turned out not to be new, but filling the original Ph D thesis with career taxa, even though strongly warned about in advance by Fraser-Jenkins[4,14]. Although many authors may now privately accept reidentification of their supposed novelties, none has the courage to publish the many corrections that are needed in order set the record straight. Most deliberately avoid looking again at the issues in a scientifically balanced and logical way, and steadfastly defend and re-list their erroneous taxa without giving viable or any factual reasons, as being of overwhelming personal import.

It is unfortunate that many such obvious misidentifications have resulted in more than a few papers worthless to science published in high impact factor Indian journals. On a wider scale throughout India many such publications are available in various journals (including some foreign journals where no referees are experienced in Indian ferns[21,22]) and often concern results of applied biological subjects such as ecology, biodiversity, cytology, morphology, anatomy, phyto-chemistry, ayurvedic pharmacognosy, ethnobotany, experimental biology, etc., but are based on serious and often obvious misidentifications. They may be useful career publications for the scientist or researcher concerned, but have no significance for science itself.

Taxonomy is the oldest and most basic foundation for all modern fields of study on living organisms and modern research in applied fields of biological sciences needs to be solidly based on accurate taxonomic identification and understanding[23]. Unfortunately taxonomists are generally neglected and not given funding like scientists working in other fields or those working in the molecular or applied branches of life sciences. In botany departments of Indian universities, taxonomy is now declining markedly due to the unavailability of subsequent jobs in the field, even though detailed expertise of taxonomists is required, now. During postgraduate interviews, even in BSI and ZSI, which are specialist taxonomic institutions, many of the committee members are from different applied branches of life sciences, or if they are in systematic botany, most work on higher plants, and not on lower groups of plants (algae, fungi, lichens, bryophytes or pteridophytes). Khoshoo[24] warned about the endangerment of Indian taxonomy as well as the imminent extinction of Indian taxonomists, along with all their gradually built up and irreplaceable expertise, but no major steps have been taken to nurture taxonomy and taxonomists in Indian universities and other institutions.

Taxonomists in India are still working only on simple, and usually very locally, nationally based and limited alpha-taxonomy. They have not been trained to update their research following recent trends and methodologies of taxonomy. This is in contrast to the Western countries and other Asian countries like China and Japan where taxonomists regularly visit Western herbaria and laboratories for consultation and training, and there are also many international joint projects. Investigative taxonomic research continues apace abroad, whereas Indian taxonomists too often have to depend more on identification from abroad. Only partly due to most of the types and older collections of Indian plants being preserved safely in herbaria in the West, it has more-or-less ground to a halt here, or if happening at all is incomplete, elementary and erroneously based on mistaken identification and mistaken ideas of over-important 'new taxa'.

The aim of the present article is neither to condemn anyone, nor belittle the work of applied branches of science, nor to denigrate Indian scientific institutions and journals compared to Western countries, but to highlight the importance of properly based taxonomy and taxonomic expertise in the applied fields of life sciences. Many of our research institutions are well supplied with modern equipment and are capable of doing world-class research in taxonomy. We therefore appeal for greater cooperation among different universities, research organizations and taxonomic institutions and the Government or private funding agencies. It is now becoming inescapably obvious that the lack of funds for taxonomy and its relegation to being a disused discipline is leading to severe problems, where species cannot be named or recognized any more. In addition, the floristic composition of India and its different regions is no longer properly understood, nor is conservation work served properly by inaccurate taxonomy. Thus the importance of a place for good taxonomists in modern sciences cannot be ignored. We believe that personal advancement-induced spurious publication of essentially fake,

or at best, ignorant new taxa and new records, and indiscriminate acceptance of such undesirable papers by journals are ultimately the result of the deliberate whittling down and removal of the funding-base of taxonomy. Taxonomy clearly needs to be acknowledged as a proper, modern, scientifically based discipline, and the lost expertise formerly available in all branches of botany and taxonomy in India must be encouraged to be built up again. At present, it is most unsatisfactory that taxonomy has to be introduced peripherally with the excuse of being a rider to ostensibly more important applied work (which may itself often have no application and merely be a repetitive and easy option for obtaining funding of, for example, pointless tissue-culture demonstrations – where seeds could have been used far more effectively!).

If taxonomy continues to be relegated to the archives, a situation will soon arise where such misidentifications as mentioned above are the norm, rather than the exception, for there will be no one left who knows the species and can identify them properly. Nor can anyone referee the incoming papers properly due to the dearth of detailed and accurate taxonomic know-how. If there are no experienced taxonomists left with true expertise in the subject, publications will be talking about applied or other aspects of plants in which, because the plants concerned are wrongly named, no one will know to which species the results apply. It is already apparent that the situation has gone too far, with few authors of taxonomic publications actually knowing what they are talking about. Instead we are publishing random and inaccurate papers in ever-increasing numbers due to misguided career pressure. Moreover, in many cases assessment-committee members only measure success in terms of quantity of publication, instead of quality. Nowadays, it is the common experience of editors and referees of journals in India to find that papers submitted are often 'constructed' by sampling paragraphs from various different sources and, without the authors being aware of any more than a small fragment of previous literature, re-reporting facts as if new that have been already published previously and often much more completely.

Perhaps the final nail in the coffin for taxonomy is the recent adoption in India of strict, new regulations under the Convention on Biodiversity (CBD), which obstructs taxonomic research, including pteridophyte taxonomy. Indian taxonomists are no longer allowed to collect any material without legal permission. Although the scientific committee recommended a way in which genuine domestic and international research interests could be catered to, the seriously deliberated and expertly formed recommendations of the committee were ignored and overridden[25]. The reason was to prevent foreign companies seeking to obtain and patent commercial plant strains. But this has nothing to do with taxonomic research and with the vast bulk of plants and animals that are of no known economic use. It is also widely assumed that CBD is a mainstay of conservation, but all the time massive destruction of forest and natural land for subsistence agriculture, building projects, tourist development, logging in the North East, road-building, etc. continue unabated. The new rules do nothing for conservation and are actually irrelevant to it, but have the disastrous and deleterious effect of obstructing both plant and animal, including insect, taxonomy. With collection-restrictions, transfer of natural material, including new or old herbarium specimens, to experts and institutions abroad is now difficult, if not impossible for taxonomists. International cooperation in taxonomy with well-known herbaria, botanic gardens, individual experts and biodiversity conservation institutions is therefore about to become a thing of the past. Herbarium-exchange and loan programmes with foreign herbaria, which were a most valuable and widespread in the past, are now no longer possible. As examples of the value of herbarium-exchange, we need only mention a few of the important collections, including many type-specimens, continually drawn on for research in the Central National Herbarium, Howrah, such as the full set of Japanese East Himalayan collections; a set of the fine Stainton, Sykes and Williams collections from Nepal; the duplicates of A. Henry's Chinese collections; the replacement Wallichian set obtained from Geneva in the 1960s, etc. Sending out material for identification, which was formerly the main basis of Indian pteridological taxonomy, is now prevented, imposing serious and unwanted isolation of the Indian scientists when we most need to cooperate widely and look beyond mere national frontiers. In addition, these rules have also affected joint Indian–Foreign cooperative expeditions and funding programmes from abroad, which have become almost pointless since the collection of live material by any taxonomist from abroad and taking it outside the country for further research and joint publication is now nearly impossible. It has become far more complicated, involving lengthy, detailed and time-consuming official formalities, justification and Memoranda of Understanding between institutions and governments. Many scientists in India now realize the unsatisfactory nature of the new Act and that it urgently needs to be modified and properly thought out in accordance with India's own taxonomic needs, because millions of herbarium sheets, including many type-sheets of Indian plants are housed in herbaria abroad. Furthermore, due to the similarity of the Indian flora and fauna, especially pteridophytes, with the adjacent South East and East Asian countries, including Myanmar, Thailand, the Malayan peninsula and Malaysian islands, Vietnam, China, Japan, Sri Lanka, etc., it is important to encourage international cooperation and not restrict it.

It is unfortunate that Indian taxonomy always seems to have to depend on foreign-based research findings (which anyway often filter through far too slowly) due to isolation. If proper credence and funding were given to plant and animal taxonomy, Indian workers could easily become experts in the field, who would be consulted internationally by the workers of all related fields. If things go on as at present in the absence of trained and experienced taxonomists, Indian taxonomy and most of the papers published in Indian journals will no longer be taken seriously.

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