GIS modelling for *Anopheles dirus*

Malaria as a disease is a biological phenomenon where all the three elements of the infection system, namely man, mosquito and parasite are influenced by various environmental variables. For full comprehension of this disease phenomenon, many physical attributes need to be studied in detail through an integrated well-defined prospective approach. Analysis of such variables for the mapping of the dangerous zones of malaria under the presence of different varieties of species, with the help of existing conventional procedures, is a very time-consuming and laborious job.

Anopheles dirus being a species of deep-forested area, its surveys have always posed a great challenge to entomologists. An attempt made by Aruna Srivastava *et al.* (*Curr. Sci.*, 2000, **80**, 1129–1134), using GIS technology to predict distribution of *An. dirus* is most commendable and laudable. *An. dirus* is one of the most successful vector species of malaria in India, spreading endemic malaria in deep-forested areas with *P. falciparum* predominance. This species of parasite is commonly known in India as 'killer parasite'. Spreading and prevalence of this specific mosquito species require a right mix of shady vegetation, temperature and humidity, along with special type of soil composition with an irrigability gradient which can permit an unhindered geometrical growth of the species. As explained in the said article, use of topo sheets to prepare thematic maps of forest cover, altitude, rainfall and temperature and by overlaying and using binary operator, has established an accurate procedure for isolating the effected areas due to the presence of such species. The results validated through the presence of the earlier reported distribution were found correct, and therefore many new areas have been spotted. The study has brought out very important information essential to build-up an evidence-based locally adapted control strategy through multiple intervention methods. Such an approach opens up a new field for mapping of distribution of entire fauna and flora, especially through the use of remote sensing technique. However when integrated with the help of GIS technology it would make it all the more versatile and accurate. This approach can be used for studying the bio-diversity of various species. The results and findings of the paper are of immense use to the National Anti-Malaria Programme and State Health Departments for their appropriate planning and implementation of cost-effective sustainable control strategy.

The present GIS technology provides a big boost to the Global Malaria Control Strategy Programme (WHO, 1992) which lays emphasis on identification of malaria determinants and dynamics of transmission of disease. Application of GIS technology in stratification of malarious areas and vector distribution would provide the requisite knowledge to promote global effort for eradication and control of malaria.

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Systematics and biodiversity research in India

The recent paper by Pushpangadan and Narayanan Nair (*Curr. Sci.*, 2001, **80**, 631–638) on the future of systematics and biodiversity research in India to evolve a national strategy for systematic biology research is a timely attempt to draw attention to a vital economic as well as academic issue that confronts the country in the new millennium. The authors have touched upon most of the important relevant points and identified important problems that systematic and biodiversity researches are facing in India. The paper is a good and sincere attempt for the 'crisis management' (as the authors themselves have put it). I congratulate the authors for conceiving and publishing such a paper and thus taking an initiative to salvage the subjects of systematics and biodiversity studies from the slush into which they have been thrown in India.

My only disappointment is that the authors, and those who subsequently expressed their reactions through *Current Science*[1,2], have not said loud and clear what ought to have been said, so that those who feign ignorance will have no excuse to continue their neglect. I fully agree with the authors that blaming anyone is no solution, but at the same time there is no escaping the fact that a reluctance to call a spade a spade would only be sending wrong signals.

In their paper, the authors have cited several important publications on global initiatives, global assessments, global conventions and global commissions. But nearer home, except for certain official reports, even the few attempts made to analyse the malaise, are not noticed. To my mind this is truly vexing, particularly because the paper in question is supposed to be an attempt to clear up the local stable.

The authors have meaningfully and piquantly quoted Peter Raven that 'It is too late in the history of the world to think that there is time to produce ordered classification of all plants... while these organisms are still extant'. This point cannot be over-emphasized in the Indian context. While we know that in many of the European countries not a single new species of flowering plants (for example) was located during the past quarter century, in Kerala alone about 250 new species of flowering plants could be discovered during the

same period. In this context, the authors are absolutely correct to follow Raven's pointer and mention 'inventorying and monitoring biodiversity' as the first priority that should be accorded in the country. However, their 'priority list' contains fifteen items, with several items containing many sub-items, thus effectively diluting the importance of the priorities. By making such a long list of priorities, the authors are giving a long rope to the self-centred scientist administrators at the helm of policy-making bodies to strangle *the* most important one. At this point of time in the history of life on earth, we cannot afford to waste our energy and resources on comparatively minor matters which can safely wait and do not fall in our emergency list, which anyway, can as well be attended to by others who do not face the threat of mass extinction of their not yet known biodiversity. Their 'list of major challenges of systematic biology research in India' also has the same pitfalls.

In the paper, the beam of spot-light is occasionally focused on the real culprit who murdered the subject of systematics in the country (thus creating the present 'crisis'), but does not stay steady on him long enough for the public to recognize him. The dog-in-the manger policy and the step-motherly attitude of the controlling 'expert' scientists in the funding agencies, who are more interested in polishing domes and hanging chandeliers, than laying a strong foundation, effectively wiped out major systematic research works as well as systematic biologists from our country. That this happened despite sincere attempts by the successive governments in the centre, sincerely supported by the political leadership and administration, to revamp researches of national importance by allocating plenty of funds, was the unkindest cut of all.

It is appalling, therefore, to read the authors' statements such as: 'It is time to have an introspection by... systematic biologists as to how best... the programmes and policies could be implemented to contribute... to India's social, cultural and economic development goals'. If any one needs introspection, it is *not* the systematic biologists, but the invincibly ignorant policy-making scientific leadership in the field of biological sciences, who do not care to see beyond their noses. The 'stake holder' is the humanity in general and our country in particular, not the poor systematic biologist who is only a humble cog in the wheel.

The authors have singled out big central universities like Delhi, Kolkata, Chennai and BHU, which have been receiving hundreds of crores of rupees as central assistance during the past few decades, as examples where research in systematics is *not* being done. I wonder what made them think not worthwhile to mention the names of a few small universities and colleges in the country which, working against all odds and with practically no funding from our generous agencies, have managed to earn a position for themselves in the world map of centres of systematic research!

The paper also mentions about the failure of the BSI (and ZSI) in achieving their targets, which indeed is a matter of 'concern' to all of us also. I think a change in our attitude towards the BSI is long overdue. BSI should not be looked upon just as yet another petty department of the Government. It should be recognized by all concerned as an important national facility, which is needed by all those working in systematics, floristics and biodiversity in India. As such, it is in the interest of the country to strengthen it. In comparison with the vastness of the country and the diversity and richness of the flora, the BSI is pathetically understaffed. Even among the sanctioned technical posts, about 50% is lying vacant. What is the use of flogging the horse for not pulling the cart faster, when the cart is fitted with only one wheel?

The students of systematic botany in India would thankfully remember that, for over the past decade, DST has been trying to revive systematic research in the country by conducting training courses, workshops and brainstorming sessions in the subject and by supporting a few research projects in the field, when it was still looked down upon by others as an old, useless and unfashionable subject. It is gratifying now to find that MoEF, DBT, ICAR, CSIR and such other agencies are slowly waking up to reality. In the context of growing global need for natural drugs in the coming decades, the new Intellectual Property Rights and Biological Patent Laws, it is essential that our plant wealth is accurately identified and inventoried immediately to prevent our own medicinal and other useful plants from being patented by others. When everything else is said and done, anyone with a rudiment of common sense will agree that a strong indigenous expertise in systematics alone will come to our rescue in this matter. The frustrated lot of systematic and biodiversity researchers in the country look up to persons like Pushpangandan, to give a new sense of direction to the botanical research administration and planning in India, and to see that something good and useful comes out of this long-delayed awakening.

1. Sundaresan, V., Kathiravan, K., Seshadri, S. and Ignacimuthu, S., *Curr. Sci.*, 2001, **80**, 912.
2. Ananthakrishnan, T. N., *Curr. Sci.*, 2001, **80**, 913.

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Reply:

It is heartening to see that our article has evoked some very interesting responses from some of the most renowned biologists and taxonomists of the country.

'Reluctance to call a spade a spade ...': The purpose of our writing the article was to express our concern at the sad plight of the systematic biology research in India today and to share some of our ideas and thoughts with the distinguished readers, particularly those who are committed to the cause of this scientific discipline, and thereby to build up collective opinion and consensus on possible strategies and action plans needed to revive and revitalize the practice of systematic research in our country. We thus tried to provide a balanced approach in analysing the problems associated with systematics and biodiversity research in India and have deliberately avoided accusing or criticizing any individual or institution/organization for the present plight of taxonomic research in the country. We believe that blaming anyone at this

stage will only lead to unwarranted confrontation, rather than finding any possible solutions for the whole gamut of issues which we have raised in our article. It is time for all of us to forget our differences of opinion and take collective responsibilities to streamline the systematic research programmes in a meaninfgul way.

'National initiatives on revival of systematics research in India': We admit that we have inadvertently missed to mention about a few substantial efforts made in the country to strengthen systematics, especially systematic botany under the aegis of the 'Indian Association of Angiosperm Taxonomy (IAAT)' – an organization that was founded at the Department of Botany, University of Calicut in Kerala in 1980s. IAAT has made a 'niche' of its own by promoting systematic botany research activities in India and also by its good publication of a journal *Rheedea*. The pioneering efforts of an excellent team of taxonomists of calibre under the able leadership of K. S. Manilal, V. V. Sivarajan, etc., at the Botany Department of Calicut University should be appreciated in this context.

However, we believe that we have made every attempt to touch upon all such recent initiatives made by major Ministries and Departments like MoEF, DST, DBT, ICAR, etc. to revamp systematic research programmes in the country, In fact, one of the reasons that prompted the senior author to write this article was his involvement in the formation of a recent global initiative, 'The Gran Canaria Declaration (April 2000)' which aims at a global strategy for plant diversity conservation. The need for strengthening and supporting country-wise R&D programme on 'inventorying and monitoring plant diversity' was highlighted in that global document. It was in this context we made references to several global assessments, global reports, global commissions, etc.

Raven's statement on 'it is too late in the history of the world to think that there is time to produce … while these organisms are still extant'. Peter Raven's above statement was quoted by us by adhering to the original intention as conceived by Raven himself. It was quoted to project the richness and diversity of tropical floras (like India) on one hand and to caution about an impending crisis of mass species extinction, which is currently underway in many of the 'hot spots' of the tropical floras, on the other. Manilal has rightly drawn out the comparison between the richness and diversity of unparalleled floristic wealth of a country like India and that of a well-explored and taxonomically well-documented flora of any European country. The thrust of the idea mooted by Raven and Manilal is the same, and would rather lead to the conclusion that inventorying and monitoring biodiversity in these underexplored and unexplored tropical floras (like in India (Kerala)) are the urgent priorities to be undertaken much before the known as well as unknown biota in these flora vanish forever.

'Priority lists': The 15 items listed under the priority areas, where taxonomy finds an increased role and utility, were made truly from a global perspective. Each of these priority areas may require refinement and further classification by each country, depending upon its immediate needs and options. We are aware of the fact that it would be virtually impossible and unwise to waste resources and energy to implement all the items in any order of priority in any country. We have not made the list to impress upon the Indian systematists to follow and pick up any of these 15 items in an arbitrary manner. Throughout the article, our concern and focus was on the relevance of reviving classical taxonomy research and 'inventorying and monitoring', in particular. However, we also subscribe to the idea that, along with our inventorying programmes, simultaneous efforts should be made to identify, characterize, document, evaluate and substainably utilize our bioresources. This would become rather inevitable for any developing country like India to convert all its biological resources of actual or potential values to economically viable and ecologically-friendly products of multifarious utilities. In this context, taxonomy would become a knowledge-intensive science that may provide for many untold utilitarian prospects of our biodiversity resources.

That is why we have included in the list of 'major challenges of systematic biology research in India' several other priority items like chemotaxonomy, molecular taxonomy, computer-based documentation and IT services on taxonomy etc. This, however, never dilutes the importance of inventorying and monitoring, which we kept as the most important priority area. We are also equally concerned about Manilal's apprehension as to any likely attempt by anyone to 'strangle' this top-priority item. Let us be optimistic that the scenario would change and we would be able to come out with concrete solution for the issues that happened in the past.

'Introspection by systematic biologists': The statement calling for an introspection by systematic biologists was made in view of the ever deteriorating quality and standard of many of the taxonomic publications emanating from many centres in our country. It, however, does not mean that quality publication and good work in systematics is not taking place in India. There is good work of international standards being pursued in India. But they are only a handful. The quality and utility of many taxonomic publications (floras, faunas, checklists, revisions, monographs, etc.) are very poor and need some regulation/rating. Most of the taxonomic researches are often undertaken either to extricate the unresolved issues or to answer questions of phylogeny, evolution and other related aspects. Although such studies are interesting, they have very little contemporary relevance. Much of the floras written are mere description of species or taxa and that too from previously recorded specimens and floristic works. Such studies do not throw any light on the actual picture of rare, endangered or extinct species. There is also an urgent need to present taxonomic findings, whether it be a revision, monograph, flora or fauna, in a more user-friendly manner so that the non-specialist, end users, especially the bioprospectors, policy makers, managers, administrators, politicians and even the lay public can understand, appreciate and effectively contribute in conservation and sustainable utilization of the biological resources. It was mainly in this context that we wanted an introspection by systematic biologists, so that any further improved efforts by them can help pool their data for any utilization purpose.

We are aware of the significant contributions of centres such as the Department of Botany, University of Calicut, Kerala in the field of plant sys-

tematics. We have not listed this in that particular context where we have mentioned about other universities (Delhi, Kolkata, Chennai, Mumbai, BHU, etc.) because these centres are not now contributing much towards classical taxonomy in recent times. We excluded the name of Calicut University, because all are aware of this centre, where significant work on systematics is still being carried out by an excellent team of taxonomists.

Throughout our article we have made an appeal to strengthen these premier taxonomic centres of our country, so that they can become leaders in any future coordinated programme as proposed in our article. Unless this attempt is made on a war-footing scale, we will be losing much of our material and data sources of biodiversity and infrastructural system. Strengthening and supporting BSI, ZSI and other centres through adequate core staff, facilities, etc. are an important responsibility of our nation.

We may conclude by saying that it is enormously important for us to evolve a dynamic strategy that could help revive and rejuvenate the systematic research in India. Both long-term and short-term strategies are to be formulated after conscientious discussions and consultations among all the stakeholders who are concerned and committed to setting systematic biology research agenda of the country in order.

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Faith and rationality

This is with reference to the editorial 'The astrology fallout' (*Curr. Sci.*, 2001, **80**, 1085–1086). Learning from Meghnad Saha about his work on a problem of astrophysics, a friend of his father commented, 'What's great with it? All these things are already documented in the Vedas!' On cross-examination by Saha, the old man had to admit that he did not read the Vedas, but subsequently he asserted his belief again. The genesis of the recent proposal of UGC to introduce Vedic astrology in the university curriculum lies in such a belief that all the achievements of modern science have their root in traditional Indian knowledge. Going through various scriptures (the Vedas and the Upanishads), Saha failed to get anything which could substantiate this belief; but it does exist and will continue to exist. It is this traditionally nurtured belief which inspires people at the helm of affairs, from time to time, to rejuvenate our clasical knowledge.

Looking from a broader perspective, the present battle is between faith and rationality. Needless to say, in this never-ending crusade, faith has got an edge over rationality. Science research does not necessarily inculcate rationality in the mind of a researcher. That is why we see that some people, working in premier research institutes of India, are taking the help of gem-stones to ward off various problems in their personal lives or are rushing to get a special type of garland (which increases in length with time) for the treatment of jaundice. The 'defenders of a policy of openness' by and large represent this section of people. It is unfair to blame common people for blind faith, since they draw inspiration from these so-called scientists.

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