Palaeontology in India at crossroads

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Declining interest in the basic sciences and palaeontology in general, as a subject by teachers, students, science administrators and scientists is a matter of serious concern. Neglect of research in the universities, lack of vision for organized research among researchers and diminishing interest in peers have marginalized the discipline. Difficulty in attracting talented youngsters and indifferent behaviour of concerned agencies towards the situation would ultimately result in obliterating an important and interesting discipline altogether. The situation warrants urgent attention and interaction in the field of research among the university academics and institute scientists; their participation to strengthen the weakening situation of palaeontology is demanded. The main areas of concerns, problems and dilemmas related to the situation are discussed here and some plausible solutions have been put forth.

Palaeontology is an important discipline of natural sciences that records and unfolds the antiquity and evolutionary pathways that past life took through four billion years of earth's history. Palaeontology, including palaeobotany investigates the fossilized remains of flora and fauna and the use of data thus collected in unfolding past climates and environments, besides unravelling the successful and also unsuccessful history of the life forms through the eons. Not to be confused with archaeology, it is undoubtedly one of those scientific disciplines, which after archaeology now attracts the attention of the general public, courtesy films like *Jurassic Park* and *Evolution*. In spite of this, the palaeontologists have a 'stamp-collecting image' in the eyes of lay public as well as informed scientific community[1]. This is all the more surprising in the face of great contributions that palaeobiology has made to both biology (evolutionary history, biodiversity) and economic geology (fossil fuels). Does palaeontology have a future or is it to be relegated to just a historical event?

The question often asked is, 'Who needs palaeontology or palaeobotany today and why?' It is not a new question. A global conference and workshop, 'Paleo21', was convened at Frankfurt in 1997 to discuss threadbare the issues of 'Palaeontology in the 21st Century'. A similar meet on the theme 'New frontiers and application of palynology' (a sub-set of palaeobotany) was held earlier in Houston[2] (IPC). Related viewpoints were later discussed at various other levels at Nanjing[3,4] (IPC) and at Qinhuangdao[5] (IOPC). India, boasting a large group of palaeontologists, conspicuously was not represented at Frankfurt. Why? Did we foresee no role for palaeontology on the economic frontiers of the country during the 21st century? Or were we just not concerned? This behaviour is a matter of concern for us all.

Lately, Indian science policy-makers, science managers and scientists while formulating the Tenth Five-Year Plan have started thinking about the discipline, to chart the future of Indian palaeontology/palaeobotany. In the absence of a long-term policy it seems to be just a knee-jerk reaction. Why do we act so late and so little even to discuss questions crucial to all palaeontologists/palaeobotanists? Lane[1] correctly pointed out 'Palaeontology is today at crossroads. What, if any, routes should it take, and where will these routes lead science? With the difficulties it is facing, the palaeontological community must decide where the science is headed, or should be headed and proactively direct it along that path to success'. This contention is more so relevant for India. We have not yet completely broken free from the shell of traditional descriptive palaeontology and hence find ourselves unprepared to keep pace with advances in palaeontology. We can no longer wait to be led by others. We need to address the questions of the society that will make our science relevant.

Problems and dilemmas

Palaeontology/palaeobotany is often branded as a descriptive science[6]. No doubt, palaeontological investigations involve descriptions, but who stops us from crossing the *Lakshman Rekha* of descriptive nature of the discipline? We will have to chart pathways where descriptive palaeontology ends and relevance emanates out of it. Working overtime just to generate basic data but unable to translate the data into meaningful interpretations and conclusions, we prove ourselves irrelevant to the society at large. Abdul Kalam, in his book *Wings of Fire*[7], has quoted Wernher von Braun – who made the first IRBM: 'There are some people who build rock-walls all their lives. And when they die there are miles of walls, mute testimonials to how hard those people had worked. But there are other men who while placing one rock on top of another have a vision in their minds, a goal. It may be a terrace with roses climbing over the rock walls and chairs set out for lazy summer days. Or the rock wall may enclose an apple orchard or mark a boundary. When they finish, they have more than a wall. It is the goal that makes the difference. Do not rocketry be your profession, your livelihood – make it your religion, your mission.' Insert the word 'palaeobotany or palaeontology' in the previous sentence in the place of 'rocketry' and see what a well-meaning advice it would be for all of us who are adding to an extensive database year after year, and confirm the belief of many regarding palaeontology/palaeobotany – a descriptive science.

Palaeontology/palaeobotany is considered as a soft science because there

is very little in the testable hypotheses and experimental falsification. Secondly, there is very little attention paid about its image, informing and educating the public about what it does, what it constitutes, and what is its role in understanding the life history[8]. As public outreach is extremely limited and focused, a larger part of the discipline is unharvested. Palaeontology therefore has no concerted public perception and urgently needs a forum to address it.

It is not surprising that a vast majority of the Indian society does not know what palaeontologists do; except a smattering of the subject gathered from *Jurassic Park* and *Evolution*. That too is limited to the concept of dinosaurs, godzillas, etc. but not much beyond that. This is lopsided knowledge about the discipline. When funding is becoming critical for researches in the basic sciences, it is all the more important for the palaeontologist to be able to explain to the policy-makers and funding agencies about the relevance of palaeontology and its need for the society. Many a times utility of the discipline is marred by the debates regarding basic/applied science[9,10]. Undoubtedly, applied science gets an edge over basic science in the present-day scenario, though applied science has no existence without basic science. It is therefore more pertinent for the palaeontological fraternity to address this question, as public understanding and appreciation are important for funding support.

Up to the 1950s, palaeobotany was taught in many of the universities at the postgraduate level; some of the universities even encouraged research in palaeobotany. Over the years, most of the botany departments have shelved courses in palaeobotany, and research is neglected. There is a dearth of good teachers and researchers in palaeobotany in the universities. Positions earlier occupied by palaeobotanists are being abolished or are being made part-time. No university or college department in the country now boasts of a full-time palaeobotanist on its regular faculty. It is really an alarming situation. The University Grants Commission (UGC) and academic councils of the respective universities do not find a course in palaeobotany anymore relevant to their students. Even the students are not interested because there are no jobs available. Why is there this apathy towards palaeobotany? Either palaeobotanists have not changed according to the needs of the society, or they have failed to communicate the new advances in their field to the students and public, or both. Whatever be the reason, the onus of failure lies on palaeobotanists. The future of palaeobotany depends on maintaining a supply of good interested students who are prepared to take up the challenge in the field. Failing in this endeavour, we as palaeontologists are bound to fade away from the scene. User agencies also must understand that palaeontological expertise cannot be conjured up on demand, but must be maintained as a resource pool[8].

Solution

Palaeontological research, like that in any other branch of science, may be considered as innovative/additive/repetitive. Society would no longer be able to support repetitive research in future and hence new dimensions have to be given or sought to define the course of research. Proving what has already been proved will have no takers. Additive research may be required at times, but it can no longer be the first preference or the only target. It can only be undertaken to achieve an ultimate goal. Innovative research is the need of the hour, not only just to satisfy our curiosity, but also to meet societal needs. For example, for the petroleum industry, coal mining, environmental studies, hydrological analysis, global climatic changes, natural hazards and engineering, search for new resources, extra-terrestrial life, and the future of life. Past of the present we know but we can attempt to predict the future; without astrology of course!

To understand the situation better, we have to learn to distinguish between organized and unorganized research. Organized research is directed towards a set goal, a mission, identified by policy-makers to meet a certain requirement of the nation. For this purpose national and government-funded laboratories and institutions have been set up. Unorganized research is one in which an individual scientist is interested. It is sort of an academic exercise that may or may not be of immediate benefit to the scientist concerned, his sponsor, or the nation. However, such an individualistic approach is a misfit in institutions/laboratories of research. University and college departments can support such research.

The responsibility of universities/colleges

Arrest of declining interest in palaeontology in the universities and colleges, a source of future researchers, depends to a certain extent on the pains the teachers take to make the subject interesting and of topical relevance. At the same time the teachers themselves need to be motivated by the concerned agencies, such as UGC and DST. The incentives could be in the form of financing of their research projects without any hassle, availability of funds for presentation of their achievements at regional, national and international conferences, creation of enough jobs for their students, etc. Creating research councils in the universities would be a correct step towards research support in the universities[11].

Palaeontology has already made a niche amongst the educated, thanks to *Jurassic Park* and *Evolution*, Dinosaurs and Godzilla. They have now to be provided with the real feel of the fossils. Nature is the best laboratory for this purpose. Classical fossiliferous localities in the country can be used as laboratories to let the people touch and feel the fossils and realize their relevance and utility. Volunteer speakers/demonstrators (professional palaeontologists) can play a major role by imparting knowledge in schools and colleges, particularly about hands-on palaeontology. They can also help in developing teacher education programmes and in organizing workshops. This can be easily accomplished as most botany, geology and zoology departments include a paper on evolution of life (through fossil records) at the postgraduate level; only the subject is not properly taught due to lack of trained and motivated teachers. Academic councils of various universities can only help in rejuvenating the topic in the science curricula. Students should be provided with job openings in the subject.

Palaeontology is a pluridisciplinary science and currently it derives strength

from physics, chemistry, biochemistry, and even mathematics. Descriptive palaeontology alone does not have much role now. Multidisciplinary research projects are need of the hour, whether it is exploration for fossil fuels, or environmental studies, or climatic deductions based on fossils. There shall be added advantage of publication of results drawing support from different branches of science, in journals other than traditional palaeontological journals. This will increase the visibility of palaeontologists in other fields.

Career enhancement/progress programmes run by UGC or state departments must include professional palaeontologists to ensure transfer of latest knowledge. Stress should be on those areas of palaeontology which have applied aspects, e.g. biostratigraphy based on certain fossils groups, or maturation level of organic matter that helps in characterization of the source rock, or tracing evolutionary lineages, etc. Sincere efforts are required to channelize human resources. Increase in the number of scholarships/fellowships followed by research scientist positions at the university level and finally absorption in mainstream research/teaching/exploration/curatorial positions is the only solution. Students are attracted to a subject only when they are assured of a career. The career opportunities are dwindling in palaeontology, but there is an increase in the number of museums and museum visitors all over the country. Most of the new museums confine their activities to the historical period. Museums are perfect places where persons with a palaeontological background can acquire a curatorial post, or work as an evolutionary biologist, research scholar or demonstrator. Not only science and technology departments, but also agencies governing museums, UGC and other similar organizations can support such activities. Contact with media can be most effective because of common interest in the history of life, fossils and dinosaurs, etc.

The role of teaching staff

As said earlier we have to improve and modify the archaic teaching pattern at the university, college and high school levels. Teachers should adopt new methods, incorporate new tools and update sources of knowledge. The Internet is doing marvels and reducing the time gap in information generation/dissemination. This can be used to advantage by both teachers and students.

Students in the age group of 5–12 years are aware of dinosaurs and other pre-historical creatures. But most of the teachers are not exposed to earth sciences, let alone to palaeontology. Improved teachers' training can rectify this situation. Professional palaeontologists can be roped in for establishing communication at the level of local schools in various districts and to inculcate the habit of inquiry in the children. Even at the secondary level (13–18 years) the percentage of teachers with earth sciences background is abysmally low. Professional palaeontologists can help college and secondary school teachers by organizing teacher education workshops.

University students look towards a subject only in the context of a career. If they are assured of a permanent job, a few will definitely opt for palaeontology considering the excitement palaeontologists have as adventurous investigators, finding remnants of ancient animals and plants.

Here, one may ask why I rely so much on professional palaeontologists? What will they get in return? Instead of spending time on serious research, why should they get involved in popularization of palaeontology? My answer is that they have to do it in self-interest; otherwise they will not get replacements.

Students can be involved, during their vacations, in palaeontological exploration; probably they can be paid some stipend for this period. Earth sciences societies can publish teacher-friendly field-guides to fossil localities. They can also incorporate in their newsletters information about fossil exploration activities, so that interested students, teachers and lay people can participate in them. DST can initiate a programme with universities and institutions in bringing out regional guides. The United States Geological Survey, Palaeontological Research Institution and NASA, USA are running similar programmes with great success for the last two years. The Geological Survey of India, State Geology and Mining Departments can initiate similar programmes.

Like any other branch of science, in palaeontology too we have to identify our priorities to meet societal needs, set targets, plan and co-ordinate. National/societal priorities over-ride individual interests and aspirations. It is here that institutionalized research has taken a beating. While discharging our responsibilities as either research administrators or managers/advisors, we fight shy of identifying priorities or setting targets. Individual palaeontologists/palaeobotanists who are ill-advised about national priorities and targets are allowed to plan their own research, thus defeating the whole planning effort. Like in space or nuclear research, in palaeontology too, administrators and counsellors should work out priorities and targets. Individual scientists should then be drafted to meet those targets and goals. Here they can be free to decide their course of action to meet those targets. Even sponsored research should also be within the ambit of societal priorities and national targets. 'Preferential' research can best be left to the universities and colleges. This is all based on the assumption that those steering the branch are well-versed with organized research in palaeontology and know what are its possibilities and limitations. It means that they have to be practising palaeontologists. Aliens can help, but only a little.

Palaeontologists have compartmentalized their working into geographical localities, geological age or fossil groups. They are unable to put their individual research interests in broader contexts of geology and biology within which palaeontology plays a contributing role. Therefore research administrators, advisors and scientists have to identify new frontiers. The ultimate prevailing rule has to be the national goals that have to be set, by institutions and concerned academic bodies. Then come the individual projects. National aspirations may be different and priorities are already set, but that can be sharpened and a few changes can be made in the programmes.

But all this revolves around a scientist. To bring in a change in the 'instrument of change' – a scientist – is a Herculean task. Change in the mindset without compromising individual freedom, which is very dear to all scientists,

would require great acumen and there is no readymade solution for it. Its handling varies from person to person, situation to situation and organization to organization. The question is how to merge the line between individual interest and institutional goals. Work without personal interest and commitment lacks sheen, and work without national goals is irrelevant to the society. How to achieve a *sangam* of the two is a big question before the science policy-makers? *Ekla Chalo Re* may sound good to individuals, but can hardly replace planned goal-oriented visionary research efforts targeted to meet societal needs.

Setting clear thrust areas, according to the available expertise at the institutions, is a challenge to science managers and individual contribution to achieve those goals is the ultimate success for both the institution and the organization, and is relevant to the society. Some people may disagree with the idea of thrust areas[10]. The participants of Senckenberg Conference issued a Vision statement in which palaeontology provides[12]:

- A unique historical perspective on the place of humankind in nature;
- Tools for the discovery and development of resources on which industry and agriculture depend;
- A framework for understanding the sensitivity of the global system to past perturbations and for identifying possible consequences of ecosystem change for human society.

Gastaldo *et al.*[13] questioned whether a group of scientists can transcend these vagaries (step back from one's own interest and apply experience and expertise to a big picture in an unpredictable future in varied political settings of uncertain stability) and find agreement on what needs are apparent and must be addressed on a global scale.

Abdul Kalam[7] noted, 'The truth is that there is a great deal that most of us can individually do to increase our freedom' and suggested, 'We can fortify ourselves with the qualities and conditions that promote individual freedom. In doing so, we help create a stronger organization capable of achieving unprecedented goals'. If it can be achieved, it will bring out the change in society. But they could be more advantageous if made into distinctive groups. Groups have greater impact that need to be harnessed and realized and this can only be done by a good science manager.

Individual freedom is sacred, but is subservient to the interest of the society at large. For example, in the dyeing section of a textile mill, neither the craftsman, nor the Master Craftsman or dyeing master can have freedom to dye the fabric in the colour of his choice. It has to be dyed in the colour chosen by the management according to market requirements. It applies to organized (institutional) research. Individuals are called for conducting research on set lines and goals. No deviation can ever be permitted. Unfortunately however, it happens that in most of our institutions, the charter of the organization is not clear to many and hence the process of preparation of state-of-the-art reports and also the planning of research is left in the hands of even new entrants to research. The result is that the organization is deprived of setting proper goals for national needs within the framework of the organizational charter.

About group success Kalam[7] observed: 'In their formative stages, teams are much like children in spirit. They are excitable, full of vitality, enthusiasm, curiosity and desire to please and excel. As with children, however these positive attributes can be destroyed by the behaviour of misguided parents. For teams to be successful, the environment must offer scope for innovation and risk taking.' A perfect blending of the two would be the key to success.

In palaeontology many new vistas are opening up, e.g. astropalaeobiology, palaeoclimatology, macroevolution, etc. and many quasi-research programmes are coming up. One may ask what is new in this! Maybe nothing new visible in it. It is an approach and address system with innovative ideas that makes the difference. Once again it is a reading between the data sets. For example, we all know that stomata are functional organs of plants that change according to environmental needs. There is a relationship between stomatal abundance and growing CO_2 concentration. But it is only recent analysis[14] of published data that opened the pathway for our understanding and established the environmental changes recorded in these organs over a long period (continuous record of 300 million years) in earth's history. It is an innovative approach. Systematics was, is and will remain the fundamental aspect of palaeontology, though emphasis has changed over the years. Palaeoinformatics, development of electronic databases, is required on a large scale to maintain continuity and to avoid pitfalls of repetition by the researchers of developed and developing countries.

The areas of research in the field of palaeontology/palaeobotany that emerged after the Senckenberg Conference and Workshop to draw attention of the society are (1) astropalaeobiology, (2) biostratigraphy and geochronolgy, (3) analytical approach to morphology, (4) geobiology, (5) macroevolution, (6) palaeoclimatology, (7) palaeobiology and taphonomy, (8) palaeo-oceanography, (9) systematics – the *sine qua non* of palaeontology. These working groups are as well very relevant on the Indian scenario. From the recent trends, if these are any indicators, it is clear that use of sophisticated analytical tools would increase. SEM, TEM, AF microscope studies and computer-based statistical analysis and numerical modelling will be increasingly used in palaeontology.

Astropalaeobiology is a new and emerging discipline looking into the signatures of life elsewhere in the solar system and in the outer space. The primary goal is to locate the source, place and time of origin of life and processes leading to it. Presently, maximum activity taking place at NASA. Indian agencies may soon take part in the exploration and Indian palaeontologists should prepare themselves to join in such efforts. Astropalaeobiology is inspirational, not only for scientists but also for the young people and the public at large. It can make a major contribution to the programme of public outreach that will benefit all palaeontologists.

Recent increasing interest in global warming and climate has stimulated the interest in Quaternary palynology and dendrochronolgy, which will spearhead research in climate and climate change. For understanding monsoon-related processes and their behaviour, there will be emphasis on palaeoclimatic studies. It is projected that consulting palaeontologists will have a viable career in the 21st century with an expanding clien-

tele. Research work on the petroleum industry, coal and mining, environmental studies, hydrological analysis, global climate change, natural hazards and engineering, search for new resources and extraterrestrial life would be pursued in the future. It is hoped that in this century the global demand for energy will continue in developing countries[15]. Fossil fuels will provide energy for at least the next 60–80 years. Therefore biostratigraphy is and will continue to be an integral part of all the palaeontological studies[8,15].

The entire gamut of palaeontological activities could be divided into two groups. Those answering the societal questions may be put in the applied group and others addressing the human inquiry into evolution and extinction put in the academic group. This seems to be a natural grouping. For issues directly or indirectly related to the society, there could be fossil-energy groups, biostratigraphy and geochronology group, palaeoclimatology groups, etc. The eternal questions about the antiquity of life, evolution of the plant kingdom, human history and public perceptions through natural history museums, etc. make the part of basic sciences. These groups can do marvels. There may be some overlapping in these groups that can be addressed by a competent management. Such grouping would evolve into powerful teams to address any question.

Only palaeontologists can provide the fundamental intellectual inputs for understanding the interactions between biological entities and physico-chemical factors through time. What is required is good marketing of palaeontology through which it can also capture the popular imagination. Who knows it better than palaeontologists that unfit got extinct and fit and relevant survived. Palaeontology will not be able to survive, if the concerned scientists and research counsellors do not take corrective measures. Palaeobotanists/palaeontologists should draw up constructive relevant programmes. I am confident that, a suitable strategy that would evolve, in consequence to the debate, would show the pathway for survival of the science of palaeontology.

The winds of change are sweeping so fast that even journals in the field of palaeontology/palaeobotany are feeling the heat. Those run by societies and groups are most vulnerable. The *Palaeontologia Electronica* is a sign among the journals going the electronic way. The classical journal(s) have expressed their concern in these regards (see *Palaeontographica*). We cannot remain unconcerned about these matters. Better tools, which are now available, would have to be used, leaving our archaic psychic.

There is an urgent need to develop a clear public outreach programme in palaeontology. Many aspects are visual, which can easily be disseminated to the public. The peers, I am hopeful, would shelve the stigma associated with outreach by the scientists and interact with the public and the politicians. This can only be achieved by bringing all the interested parties together and by utilizing all the modern developments. Museums hold a great promise for palaeontological research and public education. This source is virtually untapped. Many of the museum holdings have a large collection that has yet to be studied. Small seed money for curatorial purposes and development of databases are analogues to fresh new collections. International, national and individual support to museums and outreach programmes would help in the promotion of palaeontology.

There is a need to address many of these questions immediately and what could be a better opportunity than the timing of next Five-Year Plan for the discipline. Demand and supply principle of the market-oriented society at present rules the scientific domain as well. Science as a whole is expensive, so is palaeontology. The latter however is not as costly as the experimental space ventures or genetic engineering or geophysics, which require extensive investments in laboratory, instrumentation and space. Palaeontologists have to create a demand for themselves, lest they fade away. It is now or never to change and become relevant. Let it not be too late, otherwise the discipline itself would become a part of the museum for fossils.

1. Lane, H. R., *Palaios*, 1997, **12**.
2. Boyd, W. E. and Hall, V. A., *Rev. Palaeobot. Palynol.*, 1998, **103**, 1–10.
3. Zhu, W., Abstr. Vol., International Organization of Paleobotany Conference-VI, Qinhuangdao, 2000, p. 160.
4. Boulter, M. C., *ibid*, p. 12.
5. Bezusko, T. V. and Bezusko, L. G., Abstr. Vol., Sixth International Palynological Conference, Nanjing, 2000, p. 13.
6. Venkatachala, B. S., *Geophytology*, 1986, **16**, 1–24.
7. Abdul Kalam, A. P. J. and Tiwari, Arun, *Wings of Fire*, Universities Press, Hyderabad, 1999, p. 180.
8. Farley, M. B. and Armentrout, J. M., *Geotimes*, 2000, **45**, 14–17.
9. Sadasivan, T. S., *Palaeobotanist*, 1988, **37**, 134–141.
10. Pant, D. D., *Curr. Sci.*, 1998, **75**, 994–996.
11. Narliker, J. V., *The Times of India*, Lucknow Edition, 13 March 2002, p. 10.
12. Paleo21, Draft Proceedings of Senckenberg Museum and Workshop on Palaeontology in 21st Century.
13. Gastaldo, R. A., Ashley, G., Lane, H. R., MacLeod, N., O'Neill, B. J. and Cheng-Yuan, W., *Palaios*, 1998, **13**, 87–90.
14. Retallack, G. J., *Nature*, 2001, **411**, 287–290.
15. Fyfe W. S., *GFF*, 1997, **119**, 85–90.

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