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Palaeontology: In search of an identity in the 21st Century

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ABSTRACT

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This article tries to examine how the study of palaeontology can be made more effective and visible at a time when the country faces several other acute problems of resources limitation and natural hazard mitigation. It looks at the subject in a larger planetary framework specially with regard to the origin of life, extinction, climatic fluctuations, as a tool for oil and mineral fuel exploration and above all, as a contributing factor in identified thrust areas of Indian geology.

Key-words—Remedial Measures, Indian Palaeontology.

जीवाश्मविज्ञान : 21वीं सदी में पहचान की तलाश में

अशोक साहनी

सारांश

यह लेख जीवाश्मविज्ञान की जाँच का प्रयास करता है कि इसका अध्ययन एक साथ अधिक प्रभावी एवं दृश्यमान कैसे बनाया जा सकता है जब कि राष्ट्र संसाधन सीमाओं और प्राकृतिक आपदा उपशमन की अन्य तीव्र समस्याओं का सामना कर रहा है। यह विषय की विशालतम भू-मंडलीय रुपरेखा विशेषतः जीवन की उत्पत्ति, विनाश, जलवायु उतार-चढ़ाव का सम्यक ध्यान रखते हुए, तेल एवं खनिज ईंधन अन्वेषण के सूत्र के रुप में तथा कुल मिलाकर, भारतीय भू-विज्ञान के पहचाने हुए विशिष्ट क्षेत्रों में योगदान गुण के रुप में अवलोकन करता है।

संकेत-शब्द—सुधारवादी उपाय, भारतीय जीवाश्मविज्ञान।

INTRODUCTION

EVERY discipline in the Arts or Sciences has seen a fluctuation through time in its popularity, importance and acceptance by contemporary society. Palaeontology is no exception and this is a matter of some concern (Sharma, 2002). It is also one of the many Basic Science disciplines which is fighting a losing battle against technological advance and relevance in a societal or national building context. This is a natural weaning out process because man's curiosity and resources cannot focus on all the issues that are threatening his very existence and therefore it makes sense that mankind pays greater attention to the more pressing needs of survival in a hazard-mired and resource-limited world largely of his own making. However, Palaeontology offers a unique perspective to the chronology of events that Planet Earth has passed through and therefore the truism, that knowledge of the past is the mirror of the future, cannot be denied and must receive its just recognition (Prasad, 2006).

In various disciplines (such as palaeontology) whose very existence depends upon interfaces with others fields of scientific enquiry, the issue of identity is always in flux. Such disciplines do not enjoy the same status as for example, mathematics which is perhaps the most pristine of sciences,

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elegant, self sufficient and essential in understanding and quantifying natural phenomenon from subatomic to cosmic scales.

Palaeontology suffers from another drawback: It is largely an interpretive science which requires field related finds of new materials and therefore newer interpretations must await more and more fossil discoveries and this process has no set limits and the uncertainty continues. Field related fossil finds also give rise to needless controversies regarding the authenticity and priority of the discoveries and consequently, the discipline is prone to malpractice, particularly in inaccessible regions where the fossils are not reproducible.

Related disciplines such as sedimentology do not as a rule have as severe a problem. Although also based on inferential deduction, there are still several analogous depositional environments where sedimentologists can derive basic concepts at least for Tertiary and Quaternary models. It is possible that far back in time, in the Precambrian when lithospheric and atmospheric models were different to those existing today and the biosphere had just started to interact with them, that interpretations may be more difficult to make. This applies also to extreme conditions on earth related to unprecedented anoxic, catastrophic, thermal or greenhouse events which can only be conjectured at the present moment. But by and large, sedimentologists have not felt the pinch of indifference in the present day and the axe of deletion and /or dilution from several Indian university geology curricula as has happened for palaeontology, has not affected them as severely. The fact remains that the subject of Palaeontology and its sub-discipline Palaeobotany have been actively been removed from the B.Sc and M.Sc. syllabi not only in departments of Geology but also in sister departments of Zoology and Botany. If one looks at this phenomenon in a cold dispassionate manner (as one should) it is because of the perceived lack or relevance of palaeontology in solving burgeoning issues affecting man today. The only issue to which palaeontology is making or has made a substantial contribution is climate change and quaternary geology. The past glory that it enjoyed specially in the oil-boom years of the 1940's, 1950's and 1960's has disappeared as more techniques can be used to interpret subcrop facies, stratigraphy and structural traps. Micropalaeontology which had uplifted the status of palaeontology in the mid-twentieth century, has lost most of its importance but still holds some sway in explaining and perhaps to some degree forecasting ocean-current and monsoon models.

I will try to deal with the issues of the current identity of palaeontology under some special headings:

The identity of Palaeontology in India and elsewhere in the world

The first systematic study of palaeontology as a branch of science used vertebrate anatomy as a tool to place the fossil taxa in a system of Linnaean classification and offer insights into lineage chrono-histories including the descent of man, can be attributed to the efforts of the great French savant George Cuvier (1769-1832) who was the first to teach palaeontology as a subject. Therefore the history of palaeontology as a scientific discipline is not more than 300 years old. It was rigorously defined in 1838 and had many daughter disciplines Palaeozoology (1857). Palaeobotany (1872) and Micropalaeontology (1883). Palaeobiology which these days is often confused with its mother discipline of Palaeontology was born much later, and sprang out from emerging interest in living organisms and their environments (Aktuopalaeontolgie). In fact palaeobiology has been defined as : *"A branch of palaeontology that deals with the origin and growth and structure of animals and plants as living organisms"* (wordnet.princeton.edu)

The history of palaeontology can simply be divided into four phases:

a. Origin and development of the branch mainly as a classificatory tool to show affinities to modern day taxa based on anatomical and morphological relationships.

b. Post-Darwinian stage when the systematic description of fossils acquired meaning to all life science studies as the recent and past was all woven up in the thread of evolution. This stage lasted for about 90 to 100 years from about mid-19th century to the mid-20th century and saw a substantial growth and interest in the subject.

c. The biggest spurt in palaeontology came during and just after WW-II years when industrialization saw a greater need for energy resources and oil exploration had already accelerated because of the growing demands. This can in a way be termed as the golden period of palaeontology as industry needed trained micropalaeontologists and palynologists to build data bases connected with three main features of oil (and to some degree coal) exploration: foraminiferal and pollen-based biostratigraphy, well to well correlation at different spatial scales, facies delineation and organic matter maturation studies. However, the boom did not last long as all the easily available shallow oil reservoirs had been explored or at least this was the perceived notion at that time. For the last thirty years, the discipline of palaeontology is in doldrums and in search of its own identity. At present its major role is in climate studies, past, present and future both on land and in the oceans (palaeo-oceanography). The other branches of palaeontology are not doing well in the country and do not have the prominence they once had. The biggest casualty in this country is mega-invertebrates with the notable exception of ammonite biostratigraphy which still is able to contribute in high resolution biostratigraphy.

Surprisingly, at the international level, the subject of palaeontology (or of its branches) though overshadowed to a certain extent by the introduction of subjects such as ground water, natural hazard mitigation, ocean management, have

managed to hold their own in this technological world and this contribution has been recognized from several articles that appear at regular intervals in high impact journals such as Nature and Science. For example, who can deny the importance of the evolutionary stages that have led to our human lineage or the changing environments that have ordered this change? There is also a sizable number of scientists in the western world who are still attracted to palaeontology and who pursue this profession either on a academic or commercial basis from interest derived from their childhood days by visits to museums or collecting sea shells at a beach or fossils in the neighbourhood. Such opportunities are few and far between for those of us in the developing world where resources are limited and the necessity of earning a living by our own interests and inclination may not be an option.

But it is true that employment opportunities for palaeontologists at all levels have fallen to an alarming degree all over the world and jobs are scarce.

Indian Palaeontology: the need to break artificial barriers within the discipline

Let me start by saying that Palaeontology in India has had a glorious past but its future is uncertain. The pioneers of Indian palaeontology came from all walks of life and were Europeans of the 19th century who had had a grounding in the natural sciences or in medicine and were either in the army or had access to protection from it in inhospitable areas. This was necessary prerequisite in the early mid-1800's specially in the fringe areas of the Indian subcontinent such as Baluchistan, Northwest Frontier Province, Sindh, Tibet and Myanmar where central authority did not hold sway. Early discoveries were made by clergymen, soldiers, surveyors and medicinal doctors who had the means and opportunity of travelling in largely unmapped territory. The early explorers were British, French, Austrian, Swiss and other Europeans who saw in India a vast potential of fossil exploration. In about 50 -70 years time, i.e. in the early part of the nineteenth century the main outlines of the palaeontological richness of the subcontinent had been explored and described. The meticulous work that these early explorations still lives on in the works of Hislop, Feistmantel, Carter, Stoliscka, Deiner, King, Blanford, Pilgrim, Wynne and many others. Pre-independence Indian palaeontologists and stratigraphers did commendable work specially in the universities and the studies of Profs Rajnath, Birbal Sahni, D.N. Wadia, M.S. Krishnan, L. Rama Rao and others are outstanding. The Geological Survey of India led the way in mapping and recording palaeontological data with care and precision and there was a close bond between academic and professional palaeontologists. These Indian pioneers were not constrained by narrow artificial sub-disciplinary boundaries and used all the data available for their reports. However, soon after independence, the scenario changed as disciplines became increasingly institutionalized and barriers between what were once considered to be sister disciplines began to become insurmountable. For most Indian palaeontologists, the oil exploration boom of the mid-20th century micropalaeontology past by unnoticed as the monolithic ONGC had the monopoly of oil exploration and they had limited success in earning their living independent of this organization. Nonetheless, even in the university, interest rose to some extent in this branch of science.

However after the 1950's, many branches of geology were institutionalized and the barriers between the sub-disciplines grew more formidable. Although, attempts have been made at the academic and the administrative level to use a multi-disciplinary, integrated science project based model, these initiatives lack the free communication and critical skills for success. At present, though there is lip-service for an integrated approach, it seems to me that for many projects, this has not taken place. Of course there are notable exceptions. Palaeontologists have become quite territorial in their approach and defend the identities of the sub-discipline vigorously.

It is essential that for the future all research in palaeontology and its sub-branches take into account in each study, at least the sedimentological aspects and vice versa. It is only then that a suitable research foundation will be built for undertaking any further detailed work.

The relevance and future of palaeontology

It is an irony that while several palaeontology-related papers with Indian co-authors have been published in high impact journals such as Nature and Science, the status of palaeontology in the country continues to decline. Does this imply that the work being done in palaeontology is more appreciated in the international scientific scenario than it is in India?

I personally believe that the discipline will get its rightful place in the hierarchy of scientific disciplines as it alone provides insights into several aspects of planetary evolution, an issue which is increasingly going to concern us in the next and coming decades (Sahni, 2007).

a. As man's exploration of space continues, the question of how life originated on earth will become a pivotal point in determining whether life exists in planets with the same fragile equilibrium as on Earth. At present, this issue arouses only sporadic interest amongst some scientist but I feel that it deserves greater attention from an integrated biochemical and increased fossil sampling approach including the bridging of the *gap-in-data* areas, specially for the period 3.5 to 2 Ga when energy was largely derived from non-solar sources (pre-photosynthesis phase) and possible by fermentation processes. The Black Smokers are being studied as alternate energy resources but as the data is largely inaccessible, several interested scientists find it difficult to study this phenomenon specially in this country. Funding for such projects is not as easy to get but these issues must be seen in the context of

planetary exploration and not as local areas of isolated interest. The Indian palaeontologists who are looking at issues concerned with the origin of life must have access to whatever meteorite collections are available in the country and biogeochemical studies must be conducted on this precious material. Also periodic biotic extinctions must be looked at as a planetary phenomenon and as a possible threat to life on earth.

b. More focus is needed on the process of fossilization in the context not only on the origin of life but also on an experimental basis. Although we have some idea why delicate structures (for example animal embryos) are preserved in the Precambrian and not (lets say) in the Tertiary, we still do not know the taphonomy or the geochemistry behind this kind of preservation. It is therefore essential that in India we organize several groups to study the various processes of fossilization specially those related to the cell content-silica replacement chemistry.

c. Biomechanics is an important tool in understanding the functional adaptation of organisms and such studies have not really got a foothold in the country. These studies can provide insights into terrestrial (Newtonian) and marine planktic (essentially non-Newtonian) systems with regard to several life processes and the response to physical stresses in both systems.

d. India-centric studies: The rock record of the subcontinent provides an unique opportunity of looking at the process of rifting, drift and collision of the Indian Plate with Asia which by itself is a remarkable example of a planetary phenomenon. That this process also had a biotic fall-out is now being gradually understood. Several studies are underway that look at the dynamic model of the Indian Plate to account for the distribution and dispersal of biotas into and out of India. By their very nature such studies integrate several other sub-disciplines of geology, geophysics and palaeo-oceanography.

e. Palaeoclimates: At present, this theme is not only pertinent to questions of contemporary climate change but provides several different proxies for evaluating major climatic system shifts ranging from small silica cells (phytoliths) embedded in grass cuticles, to tree ring analysis through fluctuations in time and space of key taxa (foraminifers, ostracodes and others) as a function of increased monsoon river discharge and the transition of grasslands and tropical forests through time.

f. Molecular palaeontology: In recent years there has been a growing collaboration between those who are studying phylogenetic divergence based on the DNA molecular data and those looking at the branching of evolutionary lineages based on fossils. Such linkages will lead to a greater awareness of the strengths and weaknesses of each other fields and result in better science.

g. Aktuopalaeontologie: It is essential to bridge the gap between the recent and the past and this discipline offers the way forward. A case in point are the recent Indian mangrove ecosystems as well as the Sunderban coastal marshes which form excellent analogs to study ancient ecosystems available in the Tertiary rock record. This essentially implies that the palaeontologist spends considerable time and effort in understanding the dynamics of the recent systems before he or she analyses the fossil ecosystem counterpart. Such studies can be taxon-centric (*Rhizophora* for example) or feature centric such as the development of semi-arid palaeosols in the Lameta Formation and the development of similar calcretes in recent Quaternary deposits of Gujarat and Rajasthan, or ecosystem-centric as has already been mentioned.

Steps towards consolidation

Several steps are here suggested to overcome the challenge posed to the very existence of palaeontology in the present day.

1. A conscious effort to truly look at and try to understand the significance of data from other fields with respect to ones own expertise and see what are the possible common solutions.

2. To try and tackle thrust areas identified by National bodies such as the Department of Science and Technology and the CSIR so as to fully integrate the palaeontological effort into areas where little input exists. A good example of this kind of approach has been the efforts in the last two decades of several palaeontologists and palaeobotanists and micropalaeontologists who have worked on the age and stratigraphy of the Deccan volcanic provinces and integrated the geophysical, geochronological and magnetostratigraphy data to bring out a truly holistic picture of this vast continental flood basalt province.

3. To get greater "visibility" in the public's eye by scientific journalism, opening up of new museums and National fossil parks and monuments and by making a concerted effort to excite young minds of school children through talks, lectures and discussion groups.

4. To try and identify those areas of special interest in the country where the fossil record is uniquely excellent. Such areas include monsoon initiation events, the rise of the Himalayas in terms of climate and sedimentation, the deep sea fans and the Indo-Gangetic plain deposits, ancient life and the control of micro-organisms in the Banded Iron Formations, the biota of the Gondwana sequences and the type of soils associated, the rise of the angiosperms and their diversification in the Cretaceous, the rise of mammals and their ascent from therapsid reptiles. All these and many more are topics that can good sedimentary records in the country.

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organizers of the Symposium in inviting me to state my views. Finally, I am sure that deserved recognition will come to the field of palaeontology if we are able to break artificial barriers surrounding us and are responsive to the needs of the times.

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