

TWENTY-FIVE YEARS PROGRESS IN THE HISTORY OF BIOLOGICAL SCIENCES IN INDIA

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ABSTRACT

The paper presents a critical review of the progress achieved during the last twenty-five years in the history of biological sciences in India. The review suggests the necessity of proper evaluation and scrutiny of the data, dating of literature and its correlation with archaeology and scientific experimentation to prove or disprove the validity of literary information and a true scientific approach in all efforts towards evaluation of the data both in the historical and scientific perspectives. Lastly it recommends the publication of an annotated bibliography of Indian literature written in various languages both Indian and foreign.

INTRODUCTION

The last twenty-five years and more particularly the last decade have seen a phenomenal progress in building up the history of biological science in India. The role played by the Indian National Science Academy (formerly the National Institute of Sciences of India) is laudable indeed. Through encouragement and financial support extended to various specialists and through organising symposia in the years 1950, 1961, 1968, 1971, this premier scientific organization has not only enthused interest among Indian scholars but has also provided a common platform for discussion and exchange of thought. The efforts of this organisation have resulted in the publication of "A Concise History of Science in India" by the National Commission (BOSE, SEN & SUBBARAYAPPA, 1971) for the compilation of History of Sciences in India and this indeed marks climax in progress achieved during the last twenty-five years. Apart from these sponsored and official attempts, O. P. Jaggi's "History of Indian Science" (JAGGI, 1972) is solely a private enterprise in this regard. There have been renewed attempts too during the last 25 years towards extracting biological knowledge not only from the Vedic but also from the Tamil and Pali literature, from epics and from the medieval literature. Archaeology has not lagged behind in unearthing more materials which have received the attention they deserved.

The growing interest and enormous research activities toward compiling the history of biological sciences in India particularly during the last decade require a proper evaluation of the progress particularly in its historical prospective. The attempts at amassing wealth of information have often been guided by over-enthusiasm, and with a sense of pride and a feeling of superiority complex. This psychic attitude has carried away many a scholar to read and infer in the ancient literature far more than the text conveyed. Equipped with the knowledge of modern biological science, it is but natural that an enthusiastic scholar overwhelmed with this psychic attitude should provide in roads for partiality and imbalance of opinion both of which arise chiefly out of the preconceived notions. The facts observed, read or inferred should be accepted for their actual worth and assessed in proper historical perspective. It has therefore been felt necessary to sound a note of caution against

this attitude, otherwise considered unscientific, through this communication so that the wealth of information gathered so far and the future attempts at it should be freed from this kind of attitude.

However, a critical appraisal of the hitherto-made progress has revealed certain areas which demand intensive research to settle important issues and to provide measures for scrupulousness of the results so far obtained. We should not take things (observations, inferences) lying down, rather subject them to the touch-stone of modern scientific enquiry. Where proven fallacious they should be accepted as absurd and the others high lighted. It is high time that the next twenty-five years should be devoted to settle the dating of literature, to bridge the gap between archaeology and literature and to scrutinise the dogmas and concepts of ancient Indians through experimentation so that the biological facts known to the ancients are adjudged and evaluated in proper perspective.

The new vistas and new areas of research unfolded by the progress so far made are tied up with yet another important problem concerning the cultural contacts of the ancient Indians. Intensive research is equally necessary not only in this regard but also in shifting information from the wealth of knowledge that we have today at our disposal to assess the extent of indigenous biological knowledge in ancient India and to determine the extent to which it has been diffused out. This interaction and diffusion of knowledge from within and outside is yet another area of research which should be explored during the next twenty-five years.

The vast literature on history of biological science in India is scattered in obscure to easily available books and periodicals published in foreign and diverse languages of India. Much of it has been collected through the efforts of several specialists but there still remains some which has escaped notice. The task before us during the next twenty-five years should be to prepare an annotated bibliography of literature on history of biological science in India.

NECESSITY FOR A SCIENTIFIC ATTITUDE

A glimpse at the progress so far achieved reveals that some if not all the researchers have been carried away with the enthusiasm of extracting biological information from the ancient texts and more often in the light of our present scientific knowledge have tried to create the impression that the ancient literatures in India possessed as good a knowledge of biology as we have today. A critical appraisal given elsewhere (VISHNU-MITTRE, 1970) reveals that the ancient Indians did possess some biological concepts though in a crude form as on evolution, nutrition, and even reproduction and classification of both plants and animals. They did have a system of naming the plants and animals but much short of what we know today as the "Binomial Nomenclature". This crude form of knowledge is of considerable historical importance as early and independent steps towards scientific enquiry, and this is what it is worth and nothing beyond.

Attempts at identification of plants mentioned in ancient literature through their meagre description with the well-established latin taxa are likewise not free from pit falls. Nevertheless attempts have been made (ROY, 1970). An impartial approach and attitude will certainly be most fruitful than being carried away by a pseudo-superiority complex that our ancients knew all arts and sciences, and what we know today is a rediscovery. As stated earlier (VISHNU-MITTRE, 1970) certain concepts of ancient Indians would stand disapproved and discarded by modern biology such as Evolution with a mixed feeling of Divine Creation; power of hearing in plants; circulation of water up the leaves by destiny; the effect of worship on the growth of trees; the composition of manures; the classifications of plants, ani-

mals, and of lands and soils; the generic-specific concepts and the nomenclature of plants; the pretreatment of seeds before sowing and supplying of fresh acrid fish along with milk of *smuhi* plant believed to be *Euphorbia antiquorum* or other kinds of manures such as pork or vension, milk, ghee, etc. A critical appreciation of ancient knowledge in proper historical perspective is all the more necessary. It will indeed be meaningful that way than reading or inferring anything more than that.

The ancient Indians during the Vedic Period were agriculturists. It would indeed be inferring too much from their practice of two crops in the same field (rice in summer and pulses in winter) that they knew the significance of rotation of crops as we understand it today, RAY CHAUDHURY, GOPAL AND SUBBARYAPPA (1971, p. 356) do rightly remark that there was hardly any conscious development of the concept of crop rotation with the help of scientific observations. They did practice two or three crops and also knew of their requirements and the harvest seasons. Was there really even rudimentary knowledge of what we infer from this as rotation of crops, although they had practised it?

In addition to emphasising the classifications of land by the ancient Indians, it would be important to determine a comparative and progressive or otherwise approach in classifications, if any, given by Kautilya, Susruta, Charaka and Panini particularly in historical perspective.

The same may be said about concepts of the ancients regarding the classification of plant diseases caused by disorders of wind, phlegm and bile and by vermin and frost; the novel methods for their cure through administration of flesh, lymph, fat and ghee and through fumigation with oils in which soap berry, cow's horn, horse's hair, black pepper, ghee, etc., were boiled; watering the trees with decoctions of various kinds; devices to destroy insects and to restore health to the broken trees. How far these crude methods were successful and how far they can be justified by our modern knowledge is important to determine.

In comparison with our modern knowledge of biology, most observations of the ancients appear as the most humble and elementary ones which, as mentioned earlier (VISHNUMITRE, 1970), are possessed today by villagers in areas where modern biological knowledge has not penetrated yet. The detailed knowledge of the internal structure of plants was not known then except the gross anatomical features such as, for instance, the distinction of wood from the softer parts of a tree by the Rigvedic people. In comparison with or in analogy to human body Brhadaranyakopanisad equates various parts of a plant to those of a human body viz., leaves with human hair, bark with skin, sap with blood, fibres of a tree with nerves, soft tissues with flesh, wood with bones and pith of a tree with marrow of a bone. That was the kind of anatomy known then.

Around and after the beginning of the Christian era, however, the observations were no longer humble and elementary. There is decisive advancement in knowledge. For evaluation in historical perspective of the scientific observations recorded therein, the establishment of precise dating of Parāśaraś Vrksayurveda would be necessary. If this literature is really as old as believed (between the first century B.C. and first century A.D. : SEN, 1971, p. 56) the ancient Indians at this time had indeed developed a highly advanced knowledge of botany better than what was known in Europe in the sixteenth century A. D.

A statement in Mahābhārata that "Plants drink water with the help of air just as water is sucked to the mouth through the lotus petiole" should not be accepted even as an imperfect analogy with the suction force known in plants. Likewise the knowledge of ancients about the presence of colour in the leaves and their expression that "*ranjakena pacyamanat*" (digested with the help of colouring matter) should not be taken seriously to suggest that they had knowledge of the process of food manufacture in the leaves known today as photo-

synthesis. The concepts of Varāhamihira and Kasyapa about the factors causing plant diseases such as cold climate, wind and sun are too elementary to be considered of any scientific value. The same applies to the vague ideas about sexuality in plants. This reveals how poorly and incorrectly informed the ancient Indians were, for example, Caraka defines male plants with white flowers, large fruits and tender leaves and the female ones with yellow flowers, small fruits and short stalk.

Some of the ideas expressed by Caraka and Suśruta that the fertilised ovum contains in miniature all the organs of a plant and the male sperm cells have minute elements derived from each of its organs and tissues have been taken to suggest that the ancient Indians knew what Darwin and Spencer in the twentieth century have described as "gemmules" and "ids". A critical evaluation indeed is essential here. Likewise one encounters most primitive, simple and humble to elaborate observations on animals as one scans through the Vedic to the later literature. The most ancient literature (Rigveda) began with a division of animals into the wild and the domesticated ones but its elaborations follow in the subsequent literature. The earlier classification of animals comprising animals born from egg, born from womb, born from sprout (Chāndogya Upanishad) reveals how simple their observations and conceptions were. Another category added later is *svedaga* (born out of sweat) inferred by scholars as generated by hot moisture. Can we take liberties of interpreting sweat as hot moisture? This group includes flies and worms. Patānjali believed that the *durva* grass can grow from deposits of hair of goats and cows just as scorpions are seen to develop from cow dung. Did he really believe in the transformation of organic matter into grass and scorpions? Such observations recorded in literature deserve careful assessment for evaluation of the biological knowledge of ancient Indians.

There is hardly any denying that the ancient Indians being primarily agriculturists had built biological knowledge through their involvement with agriculture, and through their search for the medicinal and other economic uses of plants. This knowledge had been piled up gradually. The observations were most humble to begin with and were elaborated later. Several of their observations are like the common day observations of illiterate farmers today in remote villages, such as a plant has a root, stem, leaf and flowers and that there are trees, shrubs, herbs and twinners, and that there are wild and domesticated animals. The progression of knowledge achieved later is witnessed in the information on manures; diseases; and plants, lands and animals classifications. Their observations had indeed extended to several other aspects. A thorough evaluation in proper historical and scientific perspective is essential rather than our attempts to draw inferences in the light of our modern biological knowledge. These inferences have often led us to read more than the ancient Indians had expressed vaguely in their simple statements. It is, therefore, highly necessary that a proper scientific attitude be adopted to scrutinise and assess the information so far gathered and to put it in the right perspective.

AREAS FOR INTENSIVE RESEARCH

The sizeable information of the history of biological science in India, assembled both from literature and archaeological excavations during the past twenty-five years, has brought to light certain areas which require intensive research during the forthcoming quarter of a century. One such important area is the correlation between the archaeological and literary data. Much of it can be achieved through establishment of chronology of literature which can go a long way in identifying the literary periods with the archaeological periods dated by C14 assay. The latter are defined on stone and metal industries and the future

research can certainly take advantage of this criterion to precisely date our entire ancient literature in regard to archaeology. Max Muller's dating of Rigveda to 1200 B.C.—1000 B.C. may not be off the mark, since the mention of metals both iron and copper in the Rigveda would correlate it with the Iron Age, which on C14 assay is known to begin about 800 B.C. The long chronology advocated by several scholars would, however, date our most ancient literature to several millenia prior to the beginning of Iron Age. It now appears that the entire ancient literature of India up to the epics was written within a period of some centuries before the beginning of the Christian Era, and the overlap in time for many literatures would not be surprising, for instance, the Pali canons and the literature by PANINI, KATAYANA and KAUTILYA are believed to have been written between 485 B.C.—150 B.C. There is likewise an overlap between Manusmṛiti, Mahābhārata and Rāmāyana. Similar overlap exists in later literature also. Whether factual or arising out of our insufficient knowledge of their chronology, these overlaps do, however, suggest the existence of contemporary schools of thought. It is high time that these be brought out for whatever bearings they may have on the history of biological science in India.

The Chronological Committee of the National Science Academy be reconstituted with specialists on linguistics, history, archaeology and sciences to go into the matter of chronology to bridge the gap between the cultural periods known from archaeology and those known from literature. This problem is connected with the Aryan Hypothesis in India. Sankalia's and Vishnu-Mittre's articles suggest that there are other methods of approach (SANKALIA, 1964; VISHNU-MITRE, 1969-70) towards the solution of this problem.

Among the numerous attempts at extrication of biological information from ancient literature written in archaic language both in prose and poetry, some, out of utter enthusiasm, have brought out results which deserve not only scrutinisation but also intensive research to prove their validity. The foremost among these is the identification of plant and animal names mentioned in ancient literature with the latin taxa known today. This is the area which ought to receive serious attention it deserves. The soma plant of Rigvedic people has been identified with several plant taxa such as *Ruta graveolens*, *Periploca aphylla*, *Coculus* spp., *Setaria glauca*, *Eleusine coracana*, *Cannabis sativa*, *Centenella asiatica*, *Hydrocotyle rotundifolia*, *Rheum* sp., *Crinum asiaticum* and others by earlier workers of which most favoured ones are *Sarcostema viminalis* (SUBBARAYAPPA 1971, p. 285), *Sarcostema brevistigma* (SUBBARAYAPPA, 1971, p. 327), *Dioscorea* sp. (KARNIK, 1969), *Ephedra* sp. (SRIVASTAVA, 1966, 1970), or *Ceropegia* sp. (ALI & NARAYANSWAMI, 1970), by Indian workers and a mushroom by WASSON (1969, 1971). Wasson's identification of Soma plant with fly agaric, *Amanita muscaria*, through his researches from almost all angles is indeed epoch-making. Likewise *Dhattura* mentioned in literature is believed to be the same species known today as *Dhattura fastuosa*. Howsoever laudable the work of Mira Roy may be (ROY, 1970) her recognition of plant names mentioned in literature with the latin taxa is based upon too insufficient data. Such identifications would certainly not find approval by modern science. However, there is much in the geographical distribution of the taxa identified to throw light on the validity of some of these identifications. This ought to be matched with the geography of the areas as defined in a particular ancient text.

The attempt of KRISHNA MURTHY (1965) giving latin equivalents of Sanskrit names of trees, herbs and other constituents of forests from their mention in Rāmāyana, Mahābhārata, Rāghvaṃsa and Sukranītisara of Sukracharya is of exceptional interest. With the latin names of trees listed from Rāmāyana, which comprised the then forests of Panchvati, Citrakuta, Sahaya, Malya and Lanka, it would not be possible to recognise these areas and to determine the botanical changes they have undergone since the time the Epic was

written. Likewise there is description of the Raivataka and Dandakaranya forests in Mahābhārata. The latter occurred along the source of the river Godavari. How far the latin equivalents of Sanskrit names given by KRISHNA MURTHY (1965) may be correct becomes clear from the following observations—

- (a) In the coastal tropical rainforest with deciduous trees is mentioned the occurrence of Devadaru (usually believed to be *Cedrus deodara*)—a temperate plant species which does not descend down the Himalayas today. There seems no possibility that it had done so in the past for on no ecological grounds it can be a constituent of a forest comprising the deciduous genera of tropical climate.
- (b) A high altitude plant *Betula utilis* is inferred from Bhurja a tree among the tropical trees mentioned by Sukracharya. It is another impossibility.
- (c) The latin equivalents given by Krishna Murthy would have us believe that there is a strange mixture of trees of tropical rainforest and of temperate Himalayan spp. (*Cedrus deodara*, *Juglans regia* and *Pinus* species) in Kalidasa's works.

On the other hand the above observations strongly tend to suggest the geographical movements of ancient Indians as indicated by the possible inference of plant species of varied geographical distribution mentioned in the literature, a fact to which attention has hardly been paid.

There is yet another area of investigation which concerns the medicinal and edible values of plants mentioned in ancient literature. Should not it be possible at the present to prepare Soma juice today from the plants identified by us and test their rejuvenating and longevity promoting properties as repeatedly mentioned in literature. This would indeed be a high ranking discovery of present times for the benefit of humanity at large. One indeed highly appreciates Wasson's scientific experimentation to prove that a kind of mushroom (*Amanita* sp.) was perhaps the Soma plant of the Rigvedic people. The identification of plants from ancient texts does, however, require caution and it must be exercised.

The various kinds of manures, and the recipes to induce flowering or to cure the diseases of plants indeed require experimental work to prove their validity. To this may be added ploughing several times for a rich yield of a crop.

The information of past climatology and meteorology from ancient literature and their role upon sowing and reaping of crops is another fruitful area of research.

The work on history of cultivated plants from archaeobotanical remains and the comparative study of cultivated plants from literature has opened up new vistas. Archaeobotanical and cytogenetical researches suggest that wheat and barley have been diffused into India from Western Asia, rice from South and Southeast Asia and millets from Africa suggesting ancient cultural contacts with Western Asia, South-east Asia and Africa. How, when and under what circumstances, they were brought to India is an interesting problem awaiting research. For African contacts both archaeology and literature are silent. Closely allied to it is another interesting problem concerning the history of maize in India. Domesticated in Central America, when and under what circumstances was it introduced into India? The enigmatic maize in Sikkim is no less puzzling and mysterious in view of the mention of maize cultivation in Vrksayurveda dated to 1st Century B.C. to 1st Century A.D. (RAYCHAUDHURY, GOPAL & SUBBARAYAPPA, 1971, p. 346; SEN 1971, p. 65). This literary evidence if soundly dated and properly interpreted is sure to put to rest the controversy on introduction of maize into India by the Mughals or by the Portuguese or by people preceding them. It would lend support to the pre-Columbian (archaeological) evidence of maize in India (VISHNU-MITRE, 1966, 1968a, b, 1974) which has let loose controversies among some specialists in USA and Africa. A combined archaeological and literary studies is

certain to unfold the ancient Indian cultural contacts with central America, Africa and Southeast Asia.

*Horse in the ancient literature is a very common animal of which remains from archaeological sites are usually absent or doubtfully and rarely recognised and only from the superficial layers at Mohenjo-Daro, for instance. It is amazing, however, that in the Painted Grey Ware (Iron Age) dating from 1000 B.C. allegedly equated with the Aryans only a few bones of horse are met with in the late (top) levels. Likewise cat, dog, ass, pig and camel known from the Harappan and Neolithic sites do not find mention in the most ancient Vedic literature. A proper assessment of the comparative information of data is indeed highly necessary for a clear picture of the history of biological science in India.

THE NEED FOR PUBLICATION OF ANNOTATED BIBLIOGRAPHY

The Indian literature on the history of biological sciences has largely been collated but now and then additional literature is discovered which has escaped notice by scholars or compilers of information on this subject. The publications have often appeared in diverse journals of history, linguistics, archaeology and science and also in books dealing with these subjects and that explains as to why the scientists engaged in extricating historical information sometimes remain unaware of articles published in journals with restricted distribution.

The trend adopted in collating information of history of science is, as apparent from "A Concise History of Science in India", reveals that subjects such as History of forests, of plants and animals preserved by nature which had existed long before man had evolved the art of writing also form part of history of biological science. Enormous literature exists which has yet to be collated. It would therefore be advantageous to publish an Annotated Bibliography of Literature on History of Biology in India. This could constitute a part of a wider programme and its undertaking in the near future is highly recommended.

CONCLUSION

A sizeable information on the history of biological science in India has been gathered particularly during the last twenty-five years and especially through organised efforts during the last decade. The collection of data should continue but time is ripe today to organise efforts at proper evaluation of the data both from historical and scientific viewpoints. We should desist from being carried away by enthusiasm, superiority complex or such other notions. This evaluation would also require critical scrutiny of the data so as to properly appreciate the biological knowledge of the ancient Indians.

To achieve proper evaluation and scrutiny of the data it is also necessary to concentrate intensive research in certain areas such as the dating of literature and its correlation with archaeology, and the scientific experimentation to prove or attest the validity of information from literature. The gap between archaeology and literature must be bridged through synthesis of data throwing light upon the past cultural contacts of ancient Indians with outside lands and people the source areas for diffusion and exchange of past biological information.

*Remains of horse have now been discovered at the Harappan site Surkotada (Lat. 23° 37'N, Long. 70° 50'E) about 12 Km north-east of Adesar and 160 Km north-east of Bhuj in Kutch, Gujarat. (Personal Communication from Archaeological Survey of India).

Lastly it is essential to publish an annotated bibliography of Indian literature scattered in diverse and less widely dissipated journals, books and periodicals written in various languages, both Indian and foreign.

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