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SYSTEMATIC ENTOMOLOGY IN INDIA—PAST, PRESENT AND FUTURE

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WHILE man originated about a million years ago, insects are known to have been in existence for the past 200 to 400 million years. Also insects have one to several generations every year or so, man one every 20 years or so. Consequently the insects have an immense degree of evolutionary maturity *vis-a-vis* that of man.

The number of species of insects known today is still empirical and no one can give an exact answer. It is even hard to guess what the insect fauna is the world over. According to one estimate in 1948 approximately 686,000 species of insects had been named and described for the entire world and it is probable that this number is nearer a million today. Whatever the number of species, one must realise that we are surrounded by millions of insects.

There is no doubt that insects were known to Indians from Vedic times. Lac, silk and honey, products of insects have been mentioned in classical literature. In Mahabharata we read the story of sage Mandavya who as a child innocently pinned a fly (Diptera) and had to pay for his sins in torturing the fly. The termitarium has also been mentioned in connection with the story of sage Chyavana and Sati Sukanya.

However, the earliest record of Indian insects in the modern era dates from Linnaeus¹ who included 12 species of insects from India in his treatise 'Systema Naturae'. It is a well known fact that several Christian missionaries and employees of the East India Company were amateur entomologists who collected insects and sent them to taxonomists in Europe. Fabricius studied and described over 1000 species of insects from India. When East India Company firmly established themselves on Indian soil and entered into politics and the warfare of the princely states of India, their army included several high ranking officers who were keen amateur entomologists. Insects were collected from various parts of India and were sent to several specialist entomologists in Europe for their diagnosis. The most noteworthy example is that of Dr

Koenig who was a student of Linnaeus. Koenig came to India as a medical officer to the Tranquebar mission. He collected a good deal of insects and these were studied and named by Linnaeus and Fabricius. Koenig² himself published what was then a real scientific contribution on termites of Tanjore district. The other important early publications were Donovans³ 'Natural History of insects of India' this was revised by Westwood⁴. Westwood⁵ also published 'Cabinet of Oriental Entomology'. Hope⁶ published a fine paper on the 'Entomology of the Himalayas and of India' in which he recorded and described several taxa belonging to the orders of Coleoptera, Dermaptera, Lepidoptera, Orthoptera, Heteroptera and Deptera.

The establishment of the Asiatic Society of Bengal in 1785 was the origin of entomology in India in its true sense. The Indian Museum was established in Calcutta in 1875 and all the insect collections of the Asiatic Society were transferred to the Indian Museum. Many early workers of the Indian Museum added further collections of insects between 1884 and 1894. The Bombay Natural History Society was founded in 1883 and the society naturally established its own insect collection and published very useful papers on the taxonomy and biology of several groups of insects.

The real impetus to taxonomy of insects was provided by the publication of a series entitled 'Fauna of British India', the first volume coming out in 1892 and the series is still being continued and published by the Zoological Survey of India as 'Fauna of India'. Mention must be made of the contributions of Bingham, Hampson, Bell and Scott on moths and butterflies (Lepidoptera); Brunetti and van Emden on Diptera; Bingham and Morley on Hymenoptera; Mouluk on Coleoptera. Letroy⁷ published Indian insect life and Fletcher⁸ made his monumental contribution by publishing a treatise on South Indian insects. The establishment of the Imperial Agricultural Institute at Pusa, Bihar in 1905; the Forest Research Institute with

its branch of Forest Zoology in 1906; the Zoological Survey of India in 1917, all provided further scope for taxonomic research and the collection and preservation of insects. The then Imperial Agricultural Research Institute under the dynamic administration of Lefroy started the National Pusa Collection (NPC). It was, however, during Fletcher's period (1913-1932) of leadership that taxonomy received the greatest attention at Pusa and the collection was greatly enhanced by many thousands of identified species of Lepidoptera. The NPC, now situated in the Division of Entomology, Indian Agricultural Research Institute, Delhi, is said to have over 16000 named species and over 150,000 unidentified specimens. The Forest Research Institute collection in Dehradun is known to have over 21000 species and is particularly rich in Lepidoptera, Coleoptera, Hymenoptera and Isoptera. The Zoological Survey of India at Calcutta has a collection known as National Zoological Collections (NZC) which has inherited the collections of the Asiatic Society of Bengal (1814-1875) and the Indian Museum (1876-1916). With a large network of entomologists spread over the length and breadth of India the 'NZC' naturally has a rich collection of both named and unnamed species.

Several workers⁹⁻¹⁴ have dealt with the progress of entomological research in India. Recently Ghorpade¹⁵ has succinctly reviewed trends in insect systematics in the Oriental region, naturally much of it pertaining to India. However, of the Indian pioneers of systematic entomology in India, the honour must go to Dr Ramakrishna Ayyar and Prof. Mani. The late Rao Sahib, Dr Ramakrishna Ayyar (1880-1952) was an outstanding entomologist of his era and his knowledge of both pure and applied entomology was phenomenal. He published more than 150 papers and books on various aspects of entomology. His outstanding achievements were in the field of thysanopteran taxonomy. He also described several new genera and species in Coccoidea, Braconidae and Chalcidoidea. It was Ayyar who noted with regret that rich as the insect fauna in India is, insect specimens had to be sent abroad for identification and description of new taxa, only because India did not possess the necessary collection of named insects and library facilities at a centralised place. In spite of the many obstacles, he tenaciously pursued his taxonomic studies and built his own collection and library at Coimbatore.

Prof. Mani made his debut in 1938 as an Assistant, Zoological Survey of India, Calcutta and contributed a series of papers on gall midges and beneficial parasitic Hymenoptera. His Indian Insect catalogues on Chalcidoidea, Euanidae and Serphoidea have filled some of the lacunae in our knowledge of gall forming insects and parasitic Hymenoptera.

Taxonomic Entomology today

The period between 1940 and 1980 has seen a great many publications on the taxonomy of insects covering almost all the orders of class Insecta. It is not possible to mention the names of all authors, but a few taxonomists whose contributions have been outstanding are referred to here. Pruthi on Homoptera; Ananthakrishnan and Bhatti on Thysanoptera; Raichoudhury on Aphidae; Joseph on Diptera; Mani, Narayanan, Gupta, Subba Rao and Hayat on Hymenoptera; Roonwal on Orthoptera and Isoptera and Channa Basavanna on Acarina are noteworthy. Dr Narayanan in his long reign as the Imperial Entomologist and then as Head of the Division of Entomology gave a lift to the much neglected and downgraded taxonomic entomology in India by his taxonomic studies on an important group of parasitic Hymenoptera and also initiating taxonomic research on Acarina.

In a recent publication Bastin and Ellis¹⁶ mention that the United States Department of Agriculture highlights the position of India as a wheat producer of global significance. By 1985 according to one assumption India could be importing 8.6 million tonnes of wheat, alternatively according to another assumption India could be exporting 5 million tonnes of wheat. Whatever be the assumption there is no doubt that India is geared to produce more and more cereals and as a consequence insect pests and plant diseases play a very important role in our agricultural production. Insects have survived for millions of years and no species of insect has disappeared from earth because of human interference. Yet, it is necessary to keep the insect population under check. Pest management is the key word today and whatever the means used to bring about the reduction in pest populations, accurate identifications of the organisms involved is the first requisite.

Apart from the well known centres of entomological research, like School of Entomology, St. John's College, Agra; Entomology Research Unit, Madras, School of Aphidology, Calcutta University and the School of Ichneumonoidea, University of Delhi, routine identifications of insects and acarines are expected to be handled by the three premier Institutions like IARI, ZSI and FRI. Unfortunately the number of identifications made for the Departments of Agriculture of Indian States and Agricultural Universities have been negligible and may not be satisfactory. No wonder the research scientists look elsewhere for their needs and most of these identifications are handled by the Commonwealth Institute of Entomology, London. With only 13 specialists and three other staff, the CIE handles more than 50,000 specimens a year of which more than 12,000 are from India. India contri-

butes substantially towards the funding of the Commonwealth Agricultural Bureaux and therefore this identification service is provided free. However, non commonwealth countries have to pay for the services rendered by the identification services.

Taxonomic Entomology of the Future

It is nearly 40 years since India attained political independence, yet, for our major identifications of insects and plant parasitic nematodes we are still dependent on foreign specialists, particularly of the Commonwealth Institute of Entomology and Commonwealth Institute of Parasitology, the British Museum of Natural History and to a limited extent the United States National Museum. It is high time that we should try to attain independence in the systematic determinations of insects and acarines. This can only be achieved by the establishment of an Institution employing an army of specialists in various group of insects and acarines.

Kapoor¹⁷ listed about 400 zoological taxonomists of India of whom more than 100 are employed by the Zoological Survey of India. Theoretically, the number of taxonomists working on various groups of insects compare well with the number of workers in any advanced country of the world. According to Ghorpade¹⁵, 10 volumes comprising 4899 pages, incorporating 426 papers were published in the issues of the 'Oriental Insects'. Despite these statistics, development of entomology, particularly systematic entomology, has not progressed much as compared with other disciplines of science. I believe, the establishment of an identification service in India is the only way to alleviate these problems. India has the resources and finance required for such an organisation. There are young and brilliant taxonomists working in various Universities and Research Departments and it would be necessary to bring them together to form a nucleus institution which should grow on the model of a US National Museum or Commonwealth Institute of Entomology. With the establishment of such an institution the following may be considered.

Title : National Institute for Identification of Insects and Acarines.

Location : A suitable place where temperature and humidity fluctuations are minimum as insect collection would deteriorate with high temperatures.

Functions: 1. To develop facilities for insect and acarine identifications.
2. To build and develop a reference insect and acarine collection. To achieve this, explore the possibilities of bringing together the collections of ZSI, NPC and

FRI, curating and incorporating into the 'National Collection'.

3. To establish an entomological library essential for taxonomic research.

4. To carry out faunistic studies and publish the results as fauna of India volumes; initially these studies restricted to more economically important groups of Lepidoptera, Coleoptera, Hemiptera, Orthoptera, Diptera, Thysanoptera and Hymenoptera.

5. The National Institute for identification of insects and acarines should have close collaboration during its teething stages with well established institutions such as British Museum of Natural History and the United States National Museum who have very good collections of insects and mites of Indian origin that include many types and paratypes. Efforts should be made to procure paratypes where possible or in lieu of this topotypes must be collected and compared with the types before incorporating into the 'National Collection'.

6. Maintenance of voucher specimens and lists of immigrant Arthropods.

Many basic and applied researchers involving a taxon require correct identification and naming of the material involved. It is the normal practice of many entomologists to discard the material once their project is completed. If voucher specimens are deposited in the 'National Collection' they are always available for future workers to restudy them and establish their true identities if an error has been made previously. The plant breeders have been importing genetic stocks from various sources for introductions and also for the improvement of the indigenous varieties. In spite of stringent quarantine measures, noxious insect and acarine pests may be introduced inadvertently and also many species of beneficial parasites and predators are introduced into the country for the biological control of insect pests. It is essential, therefore, to maintain a system by which information on foreign species newly introduced or discovered as established is readily made available.

Mites, ticks and insects infect man directly or indirectly with diseases. Malaria and kala azar which have been almost eradicated from India are showing signs of becoming serious again. There are other human diseases like elephantiasis, encephalitis and many other dreaded diseases, that are insect transmitted. Flies, ticks and other arthropods spread and perpetuate many live stock diseases. Our cultivated crops

suffer heavy losses because of virus disease and insects are the main cause for spreading the virus. Accurate identifications of these insects and acarines are very essential for any control measures to be envisaged. No doubt, some of these problems are tackled by the Veterinary Research Institute and the National Institute for Communicable diseases, but a separate wing to deal with problems of taxonomy relating to veterinary and medical entomology within the National Institute would be highly desirable.

Concluding this review, the author would like to emphasise that taxonomy has been badly neglected in India due to the lack of encouragement and support of administrators. Without accurate identifications any study on zoological material becomes meaningless. Insect systematics must be recognised as important to the development of agriculture in general and food production in particular. Young entomologists should take more and more to the study of systematics. To quote Ghorpade¹⁵, Taxonomists have a solemn responsibility to carry out work of a high international standard and to offer their expertise whenever and wherever it is required. Only by maintaining close contact and co-operation among themselves can they help serve mankind and justify their work.

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PLANT MERISTEMS AS MONITORS OF GENETIC TOXICITY OF ENVIRONMENTAL CHEMICALS

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ABSTRACT

The methods involved in using root meristems for monitoring the genetic damage by chemical environment are described. These include certain prerequisites preceding testing, protocols of assay for cytotoxicity, mitotoxicity and clastogenicity of the chemicals, processing meristems and sampling required at different stages. The meristem assay may be preferentially used in certain contingencies and universally employed as a first tier short-term screening method in genetic toxicology.

INTRODUCTION

THE utility of plant monitors in the genetic toxicology of environmental chemicals has been widely recognised^{1,2}. Of these, meristems were more

prominent owing to their continuous use ever since Levan³ developed the *Allium* test. However, much importance has not been accorded to the meristems due to the disrepute generated by an often inconsistent