

CHAPTER XVI

ANIMAL SCIENCES

INTRODUCTION

India is endowed with a rich and diverse fauna due to its unique biogeographic location, varied climatic conditions and enormous eco- and geo-diversity. India is one of the few countries that has the unique distinction of having a wide spectrum of biogeographical areas --montane, coastal, tropical rain forest and desert. The fascinating range of organisms that these regions harbour and their complex ecological relationships give India its unique and productive status. The species, ecological and genetic diversities of this vast land are all needed to preserve India's ecological systems. Towards this end, a number of premier national institutes and universities are undertaking path-breaking and painstaking research and documentation, which will ultimately be instrumental in halting the present rate of degradation of our environment and lead to restoration of the environment for equitable and sustainable development.

INDIA'S FAUNAL WEALTH

A total of 89,500 species of animals, from Protozoa to Mammalia, have been described inhabiting the Indian subcontinent. This constitutes 7.28 per cent of the total world animal fauna. However, according to experts what has been recorded may be only a small fraction of all those that actually exist. Some estimates put the number of species in India to be around 5,00,000. The majority of the unexplored ones will come from groups such as the Protozoa, Nematoda and Insecta. India is one of the 12 megabiodiversity centres of the world with two

very significant hotspots of animal diversity, one in the North-Eastern Region and the other in the Western Ghats. Earlier work on the Indian fauna was catalogued in several volumes under the title *Fauna of British India*. Its name was changed to *The Fauna of India* series after Independence. In the pre-Independence days Europeans showed a great fascination for the study of Indian fauna.

BEGINNINGS OF ZOOLOGICAL STUDIES

The establishment of the Zoological Survey of India (ZSI) in 1916 helped to identify and characterize the rich fauna of the Indian subcontinent. Since its inception, scientists of the ZSI have been carrying out regular surveys for the purpose of collection of animal specimens for taxonomical study. The contributions of S. L. Hora during 1930s on the study of fishes and that of Salim Ali during the last few decades of the past century on birds are of immense significance. Research in zoology remained largely confined to areas such as morphology, taxonomy and life cycle studies, well into the middle of the 20th century.

The teaching of zoology at degree and postgraduate levels was initiated in the Universities of Madras, Calcutta and Bombay started in 1857. This structured teaching was further expanded specially after Independence in a number of other universities. Teaching led to initiation of research almost simultaneously in many of these educational institutions. The Government of India provided sufficient funds directly to the Universities of Delhi and Banaras and Aligarh Muslim University from 1947 onwards which helped to focus on teaching and



Photo: CCMB, Annual Report, 1999-2000

Highly endangered species of Asiatic lion at Gir forest in Gujarat.

research in zoology. Several other universities and goal-oriented institutes were later established by both the Central and State Governments to impart teaching and research in various science subjects including zoology and marine biology. From those early days, and in keeping with the modern trend, research and teaching has diversified into various allied areas such as physiology, biochemistry, cell and molecular biology, immunology, genetics and development. During the past three decades significant progress has been made in several universities and research institutions in India. Research in the field of zoology and marine biology has been initiated from gross structure of the organism to its constituent cells leading to the understanding of intracellular functions at the molecular level. The focus at present is towards application of knowledge garnered over the years for

betterment of the quality of our lives and environment.

The establishment of the Indian Agricultural Research Institute (IARI) at New Delhi, Forest Research Institute (FRI) at Dehra Dun, National Institute of Oceanography (NIO) at Goa and the Central Arid Zone Research Institute (CAZRI) at Jodhpur, helped in initiating specific research on economically important fauna of India. The research work carried out by scientists at these institutes contributed significantly to the study of economically important insects, nematodes, protozoans, helminths and other parasites. In addition, the interaction of humans with various animals was deciphered in these studies. The study of many of the parasites, parasitoides, and pests, is now regarded as a part of agricultural or medical sciences, in particular entomology, nematology, medical and veterinary parasitology, rather than zoology.

DEVELOPMENTAL BIOLOGY

One of the challenges in zoology is the study of the events that lead to the adult organism starting from a fertilized egg. Developmental biology has been a subject of specialization in several institutions. There are two major path-breaking findings made by Indians working in India. They relate to the area of pattern formation as is seen in limb development. Both findings have received wide acknowledgement and international acclaim. An eminent scientist and his student working at the University of Rajasthan have shown (1978) that vitamin A and its derivatives could not only cause malformations in amphibian limbs during normal development, but, if applied after the larval limb was amputated, could lead to the regeneration of both the missing (amputated) body part as well as of extra, supernumerary, limb parts. Strikingly, at times the extra part was a mirror-imaged duplicate of the normal regenerate. The finding led to an explosion of research into the role of retinoids in early development that continues to this day. In particular, investigations have been focused on the possible role of retinoids as 'morphogens' and evocators of specific patterns of gene expression.

In 1992, a team of zoologists at Utkal University, Bhubaneswar, showed a remarkable effect of vitamin A treatment applied to tadpole larvae whose tails had been amputated. They discovered that on occasion the amputated tail would regenerate and give rise to a limb (leg), in effect converting what had been a tail into a leg. This was the first demonstration of a homeotic transformation in a vertebrate. Once again, a piece of pioneering research carried out in India initiated a line of work followed by many others worldwide.

ated with economic crops and the nematode vectors of viral diseases. The study on predatory nematodes--the mononchs--has received world wide attention. As these predatory nematodes feed voraciously on species of plant parasitic nematodes, they could be valuable in developing a biological control strategy.

FISHES AND FISHERIES RESEARCH

Fisheries research has gained special importance with the establishment of the Central Marine Fisheries Research Institute (CMFRI) at Cochin, Central Inland Fisheries Research Institute (CIFRI), Barrackpore, and some other institutes that are solely dedicated to research and training in this field. Important additions to our knowledge have been made by the scientists working at various fisheries institutes and universities in India on reproduction (Delhi, Nagpur and Visva Bharati), genetics (MKU), breeding and increased productivity (Barrackpore). A number of indigenous fishes were identified and their physiology and reproductive patterns were studied in depth.

Aquatic ecosystems, including wetlands and coastal ecosystems, are important biologically, as they are among the most productive. They are also very prone to human disturbance, which is the largest single cause of biodiversity losses. In this context, the research being carried out at various universities and institutes, such as the Department of Aquatic Biology and Fisheries, University of Kerala, and NIO, Goa, has far-reaching economic implications. Air-breathing fishes such as *Anabas testudineus*, *Clarias magur*, *Heteropneustes fossilis* and *Periophthalamus vulgaris* among others, living in the swamps and poorly oxygenated marshy waters of North Bihar, have been studied in great detail at the Department of Zoology, Bhagalpur University. These studies have traced the likely evolutionary history of the early air-breathing vertebrates. Basic studies at the

Uropeltis rubromaculatus, a reptilian species from Western Ghats.

Extensive studies were conducted in the field of developmental genetics using the fruitfly, *Drosophila melanogaster* at TIFR. Ultrastructural studies on the cell organelles were conducted using various types of specimens. Tissue culture studies were initiated to understand the structure-function relationship of cells.

NEMATOLOGY

Nematology has been pursued at several institutions, notably Aligarh Muslim University (AMU) and IARI. Besides studying the systematics and structural biology of nematodes, the AMU scientists have carried out extensive studies on the nematodes associ-

Photo: Wildlife Instt of India, Annual Report, 1999-2000

Madurai Kamaraj University (MKU) of limnetic energetics using predictive models, has led to easier ways of arriving at answers to a number of problems in bioenergetics of aquatic systems.

OCEANOGRAPHY

Oceanography has been a part of Indian science for the past two centuries. A number of expeditions were undertaken during the twentieth century to collect data on marine life. The international Indian Ocean Expedition of 1960s collected copious data on the physical characteristics of the Indian Ocean and its rich marine fauna. Scientists of the NIO have collected an enormous amount of scientific data on the biological life chain in the Indian Ocean. Several Indian expeditions were also conducted to collect the fauna of Antarctica.

ETHOLOGY AND SOCIOBIOLOGY

Scientists at the University of Jodhpur, MKU and Indian Institute of Science (IISc), Bangalore, have made significant contributions to the field of animal behaviour. Desert rodent behaviour and adaptations were the subjects of special study at Jodhpur. Extensive behavioural studies of bats in relation to hibernation, foraging and mutual entrainment of biological clocks by means of social cues and loss of entrainment by exposure to continuous light, have been carried out by chronobiologists at the Department of Animal Behaviour and Physiology, MKU. The Chronobiology Laboratory at MKU was also instrumental in discovering that the menstrual cycle in the human female is not coupled to the sleep-wake clock under prolonged social isolation. A Chronobiology Laboratory has been set up at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, to investigate the circadian rhythms in



Photo: Zoological Survey of India

Tirumala limniace leopardus (Butler).

fruitfly and carpenter ant.

The biologists of the Centre for Ecological Sciences (CES) at IISc have contributed significantly to our understanding of social organization, division of labour and evolution of insect societies, particularly those belonging to the order Hymenoptera. They have conducted long-term studies on Indian species of ants, bees and wasps. Some of the significant new findings arising out of these studies include behavioural caste differentiation among morphologically identical members of wasp colonies, pre-imaginal caste bias in a primitively eusocial wasp and the role of nutrition in caste determination. The most significant contribution has been to demonstrate the inadequacy of genetic theories for the evolution of eusociality and the development of a new class of theories for understanding the origin and evolution of social life in the order Hymenoptera. This work has resulted in over hundred technical publications and has culminated in a monograph entitled *The Social Biology of Ropalidia: Towards Understanding the Evolution of Eusociality* to be published by Harvard University Press. Other

areas of study in this school include the social behaviour of the Asian elephant culminating in an authoratative work *The Asian Elephant*, published by Cambridge University Press and investigations on plant-animal interactions.

ENTOMOLOGY

Pioneering work in entomology, especially insect-plant relationships, have been carried out in various laboratories in the country. Sustained research in biosystematics and ecology of thrips (Thysanoptera), chemical ecology and cecidology has been carried out in Entomology Research



Photo: Biodiversity India Newsletter, Dec 2000

Rana sp., a species common in the forests of Assam and Meghalaya, yet undescribed.

Institute, Loyala College, Chennai. The Division of Entomology, IARI, and Delhi University (DU) addressed to the study of physiology and mode of action of insecticides and the biochemical basis for host selection by insects, insecticide resistance in mosquitoes and physiology of insects have been studied at DU. An entire School to study Himalayan insects was set up at St. John's College, Agra. The work of this School is internationally recognized. The FRI at Dehra Dun, has a large collection of insect pests that damage forest trees and seasoned wood. It also has an extensive collection of Indian termites and locusts made by eminent zoologists like M.L. Roonwal.

ENDOCRINOLOGY

A number of significant additions to our knowledge of endocrinology and reproductive biology have been made in various universities and institutions in India. To name a few DU (M.R.N.Prasad and his students), Punjab Agricultural University (Ludhiana), Visva Bharati University (Santiniketan), CDRI (Lucknow), AIIMS (Delhi), National Institute of Health and Family Welfare (Delhi), National Institute of Immunology (NII, Delhi), IISc (Bangalore) and the Institute for Research in Reproduction (Mumbai). Studies ranging from the basic structural and physiological aspects of reproduction in lower vertebrates to contraceptive development for women and men, indicate the importance of this field of research. The inverse relationship between pineal activity and gonadal development was shown in tropical lizards. Scientists at the BHU elucidated the role of the thyroid gland in the mediation of the sexual cycle of a number of species of birds. These studies for the first time emphasized that the thyroid-gonadal interrelationships were essential regulatory components of animal biological cycles. Research conducted at Calcutta University clearly reveal that in birds, unlike mammals and other vertebrates, true insulin deficiency syndrome is not observed in a number of species. The avian endocrine pancreatic beta cells (which are the source of insulin secretion) are not vulnerable to the action of cytotoxic agents. Certain critical factors like high glutathione content, high somatostatin and elevated APP values may play significant roles in preventing diabetogenesis in birds. This knowledge can be used in future to work out better modalities of diabetic treatment in humans. The thyroid gland is now recognized as the mediator in the pathway, linking environmental signals, such as photoperiod, rainfall and humidity, to the control of gonadotropin-releasing hormone (GnRH) neurons. Studies on the qualitative and quantitative aspects of spermatogenesis in various vertebrates such as bird, sheep, goat and buffalo have shown that their reproductive efficien-

cy is greatly affected by the degeneration of germ cells at various stages of their development and differentiation.

Applications of DNA Fingerprinting: Significant contributions were made to understand chromosomal basis of sex determination in over 200 species of insects and Arachnids by scientists at BHU under the leadership of S.P. Raychaudhuri and at Delhi University students have continued the work at BHU, Kolkata and Hyderabad. The Bkm-derivel probe from the banded krait (snake) has been a landmark discovery at CCMB (based on the initial work done at BHU and Edinburgh). This probe has been extensively used in the development of an indigenous method for DNA fingerprinting for forensic investigations, solving paternity disputes and verification of seed stocks. A Laboratory for the Conservation of Endangered Species is being set up at Hyderabad by the Centre for Cellular and Molecular Biology (CCMB) in collaboration with the Nehru Zoological Park, Hyderabad, and the Government of Andhra Pradesh. This institute will create germplasm and tissue banks of endangered species, and carry out research in the areas of *in vitro* fertilization, artificial insemination, cloning and molecular breeding of endangered species such as lions and tigers. Scientists at the National Institute of Immunology (NII) and the Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad have developed novel oligonucleotide probes for DNA fingerprinting to uncover intra- and intersequence variability in the water buffalo, cattle, sheep and goats, and the one-horned rhinoceros (*Rhinoceros unicornis*) and the endangered swamp deer *Cervus durauceli branderi*. The unique species-specific cloned probe for the rhinoceros is useful for ascertaining the origin of biological tissues including those in the horn, in the event of poaching. Work has been initiated on the study of molecular profiles of the Mustelids, Viverids and Herpesids that include martens, badgers, otters, civets and mongooses of India. The objective is to understand their relationships, species delimitations and conservation status.

PROTECTION OF WILDLIFE

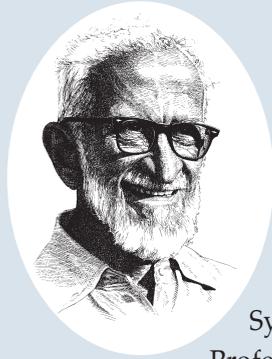
India has a very rich wildlife but the exponential growth of human population had an adverse impact on their population levels as also on their distribution. By 1986, India had only 6,15,095 sq. km area of wildlife habitat left, out of the original 30,17,009 sq. km., a loss of almost 80%. At the current rate of deforestation, about 5–10 per cent of the closed tropical forest species will become extinct per decade, i.e., about 100 species a day. The protection and nurture of wildlife has been recognized as an important function of the Ministry of Environment and Forests (MOEF), Government of India. The



Photo: Wildlife Instt of India, Annual Report, 1999-2000

Barred jungle owlet.

MOEF has set up protected areas in the form of sanctuaries, national parks and biosphere reserves to protect wildlife *in vivo* (see chapter on MOEF). The Ministry, in 1982, set up the autonomous Wildlife Institute of India at Chandrabani, Dehra Dun, with the mandate to strengthen wildlife conservation by providing trained professionals as wildlife scientists and managers and by making available scientific information. Towards this end the Institute conducts regular postgraduate and in-service, long- and short-term courses. The Institute has elaborate field-based



Salim Moizuddin Abdul Ali (1896- 1987) was born in Mumbai and had his early education at St.Xavier's High School and St.Xavier's College there. He was trained in Systematic Ornithology under Professor Erwin Stresemann at Berlin University Zoological Museum, 1929-30. Since then he went on ornithological expeditions to most of the unexplored and little known parts of the Indian subcontinent including the Western Himalaya, Sikkim, Bhutan and Arunachal Pradesh; also in Western Tibet and Afghanistan. He also studied birds in other neighbouring countries such as Myanmar and Malayasia as well and published numerous papers in scientific journals. The areas of special interest included zoogeography, ecology, conservation and biometrics of Indian birds. His surveys and individual bird studies were examples of how much information can be obtained with minimum of equipment, a notebook and pencil, a pair of binoc-



ular and an alert, analytical mind. He was probably the only person who had travelled to all the obscure regions of the Indian subcontinent. His knowledge and experience were respected and his timely intervention saved, for instance, Keoladeo National Park and Silent Valley National Park. He was recognized abundantly for his works, Gold Medal of Asiatic Society, Sundarlal Hora Memorial Prize and C.V. Raman Medal of INSA, Padma Bhushan and Padma Vibhushan to name a few.

Salim Ali has written a large number of books on the birds of the Indian subcontinent. His book on *Handbook of the Birds of India and Pakistan* with S.Dhillon Ripley, in 10 volumes (OUP, 1968-74) is the most highly respected work on the subject. *The Fall of a Sparrow*, an autobiographical account, is a

fascinating account of the person who was utterly dedicated to the study of birds. Salim Ali was associated with the Bombay Natural History Society for over sixty-nine years and the organization gradually became synonymous with him. It was his family and all he cared for. Salim Ali was elected a Fellow of the Indian

National Science Academy in 1958.

wildlife research programmes addressing biological, management and human dimension aspects conforming to national conservation priorities.

An important milestone in the field of conservation was the setting up of the Madras Snake Park in 1969 and the Madras Crocodile Bank Trust in 1974. In the mid -1970s, the Government of India set up the Indian Crocodile Conservation Project which has been instrumental in pulling back the once threatened crocodilians (gharial, mugger and salt water crocodile) from the brink of extinction. This project has also contributed invaluable knowledge of wildlife management, captive breeding and the training

of personnel for research and administration to other similar projects.

BIODIVERSITY AND CONSERVATION

Biodiversity is a buzz-word today. As defined by the Convention on Biological Diversity in Rio de Janeiro (1992), the term biodiversity is the *Variability among living organisms from all sources, including terrestrial, marine and other aquatic systems, and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems*. In other words biodiversity is the variety of life-forms including their genetic make up and all kinds of their assemblages. Biodiversity

is important for economic benefits, ecological services, cultural-anthropological utility, recreation and epistemic utility.

One of the greatest needs as well as challenges in any country is inventorying and monitoring of biodiversity. For a country of India's size with its wide range of biogeographical zones, the task is stupendous. Besides the expertise available in BSI and ZSI, national institutes and non-governmental organizations such as the Bombay Natural History Society (BNHS), Mumbai, Salim Ali Centre for Ornithology and Natural History (SACON), Coimbatore, Wildlife Institute, Dehra Dun, and the universities, there is an important need to mobilize the talent available in colleges and schools for surveys and also involve remote sensing facilities for understanding the distribution of vegetation types and functioning of the ecosystems.

A leading biologist of the CES at IISc, Bangalore has launched the preparation of People's Biodiversity Registers (PBRs) sponsored by the WWF-India to record folk knowledge and practices of conservation and uses of living resources. It was envisaged to prepare PBRs between 6-15 village clusters each in the six states of Assam, Bihar, Himachal Pradesh, Karnataka, Orissa and Rajasthan and one union territory -- Andaman and Nicobar Islands.

Another activity launched by the Indian Academy of Sciences, as a part of its initiative to enhance the quality of science education in India, was a project called 'Lifescape'. This came as a

tribute to the great Indian naturalist Salim Ali on the occasion of his birth centenary. This movement was also nurtured by the CES with the aim of publishing illustrated accounts of 2,500-5,000 Indian species of microbes, plants and animals. The beneficiaries of these accounts are the students and teachers of biology who would be able to identify the species and use them for accurate observations, field exercises and conservation efforts.

The MOEF has initiated a project to prepare India's National Biodiversity Strategy and Action Plan (NBSAP), supported by the Global Environment Facility (GEF) through UNDP. A Technical and Policy Core Group ((TPCG) consisting of experts from various fields and different parts of India from both government and outside has been constituted, with a representative of the NGO, Kalpavriksh, as the coordinator. Administrative coordination will be handled by Biotech Consortium India Ltd. This will be the biggest ever environment and development planning exercise in scale and participation. Started in the 2000, NBSAP aims to produce a series of planning documents dealing with the conservation of India's biodiversity, sustainable use of its biological resources and equity, including decisions regarding access to such resources and the benefits accruing from them. The end result of this exercise will be a series of action plans at local, state, inter-state, eco-regional and thematic levels, each independent, and also culminating in a National Plan.

