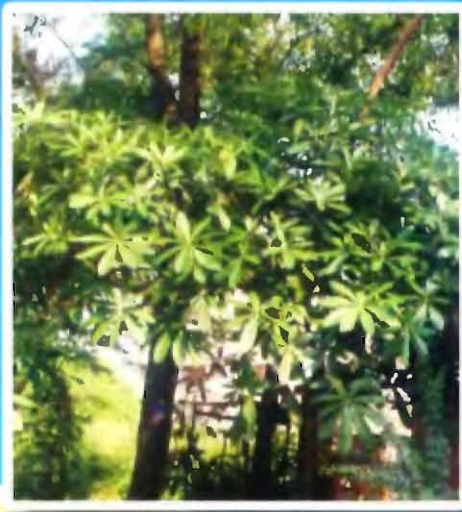




Status of Biodiversity of West Bengal

**A.K. SANYAL, J.R.B. ALFRED
K. VENKATARAMAN, SANDEEP K. TIWARI
SANGITA MITRA**



ZOOLOGICAL SURVEY OF INDIA

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सत्यमेव जयते

**ZOOLOGICAL SURVEY OF INDIA
KOLKATA**

CITATION

Sanyal, A.K., Alfred, J.R.B., Venkataraman, K., Tiwari, S.K. and Mitra, Sangeeta, 2012. *Status of Biodiversity of West Bengal* : 1-969 + 35 Plates (Published by the Director, *Zool. Surv. India*, Kolkata).

Published – January, 2012

ISBN 978-81-8171-299-8

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PRICE

India : ₹ 2750

Foreign : \$ 170; £ 140

PREFACE

The term 'Biodiversity' though known earlier, during the Rio Summit in 1992 it earned the center stage of attention and today it is one of the foremost areas of concern all over the world and has become a household nomenclature. The assessment of Biodiversity is an important component of strategic planning process for any conservation and management of ecosystem. The process of assessment can be a two dimensional exercise, *i.e.* identifying areas of maximum diversity within distinctive ecosystems and to provide data for species diversity and related information. The starting point for any such venture should be literature search for getting groupwise information down to the species level.

The State of West Bengal in India has been endowed with rich biodiversity. Data on the state's biodiversity have been generated both qualitatively and quantitatively. However this information is lying in a scattered manner and not readily available to the policy makers and managers of biodiversity. The present publication is therefore an attempt to compile all available information on the State's biodiversity. It is expected that information given in this document will provide not only the benchmark data but also fill up the gaps. Thus, it may serve as an important tool for planning, so that future development programmes need not be at the cost of our biological diversity, but at the same time to identify and use these biological resources on a sustainable basis.

The authors express their grateful thanks to the Department of Environment, Government of West Bengal for funding this project, to Dr. S. Sanjappa, Director and Scientists of Botanical Survey of India for their keen interest and sincere help in preparation of the report by providing and checking the informations relating to the floral diversity in the State. They are also extremely grateful to Shri Pranabesh Sanyal, Former Additional Principal Chief Conservator of Forests, Dr. Dhrubajyoti Ghosh and Sri Debal Roy, Senior Environment Officers, Department of Environment, Government of West Bengal for their sincere help and valuable suggestions during the preparation of this report.

They gratefully acknowledge the help extended by the Director, Zoological Survey of India. They are also deeply indebted to the officers and staffs in Zoological Survey of India for assistance and suggestions throughout the course of this project. Special thanks are due to Dr. J.K. De, Scientist-D, Zoological Survey of India for his constant help in processing the scientific data.

Sincere thanks are also due to Professor S.C. Santra, University of Kalyani for providing informations on flora of wetlands of West Bengal and to Dr. Sandeep Basak for his help in preparation of a part of floral list in the preparatory stage and photographs provided by him.

Helps received from Dr. Sujit Kumar Chakraborty, former Joint Director, Zoological Survey of India in the form of valuable suggestions and inputs towards the improvement of the document is thankfully acknowledged. They are highly obliged to Dr. Tushar Mukherjee, Reader, Presidency University, Kolkata for providing valuable information.

Thanks are also due to Dr. S.K. Dutta, Utkal University, Sri Hirak Nandi, Smt. Supriya Nandi, Sri Joydeep Sarkar, Lt. Col. S.R. Banerjee, Sri Biswajit Roychowdhury, NEWS, Kolkata, Sir V.K. Yadav, Chief Conservator of Forests, Government of West Bengal and Sri Anjan Roy for extending sincere help by providing data pertaining to flora and fauna of West Bengal and relevant photographs.

Authors are also thankful to Dr. A. Chattapadhyay, Assistant Zoologist and Shri Amitava Roy, Sr. Statistical Assistant, Zoological Survey of India, for their help in computerization of huge amount of data.

Thanks are also due to Smt. Bela Sardar, Sr. Stenographer, Shri Shakthivel, Zoological Assistant, Sri Amitava Chatterjee, Zoological Assistant, Sri Z. Ziauddin, Sr. Stenographer, Smt. Paramita Basu and Sri Debabrata Bhattacharya for constant help in the final stage of preparation of the publication.

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PART-I

INTRODUCTION

Biological diversity refers to the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UNEP, 1992). Biodiversity is not only an essential component of our life support system but also the raw material for meeting human needs. The rapid degradation of major ecosystems and the necessity of conservation, and also the sustainable use of biodiversity has assumed both national and international importance with the adoption of 'Agenda 21' and the 'Convention on Biological Diversity (CBD)' at the 'Earth Summit' held in **Brazil** in 1992. The CBD came into force in 1993 (for India in 1994) after being ratified by the requisite countries. India's effort, since then, has been to review the conservation measures taken so far, and to identify the gaps which require immediate attention at different levels. The implication of the CBD for India has been dealt with by Chauhan (1996a, b, 1997a, b, c). These initiatives are at different stages. Developing and establishing adequate conservation measures and mechanisms for sustainable utilization of biological diversity pose a multidimensional challenge, involving scientific, socio-economic, administrative, legal and political issues.

India is a vast country and has been richly endowed by Nature in terms of a great diversity of physical environment. From the Indian ocean to the lofty Himalayas and beyond to the cold deserts of Ladakh, the physiognomic diversity and myriad of climatic situation have given rise to a countless habitats across the length and breadth of the country (Alfred *et*

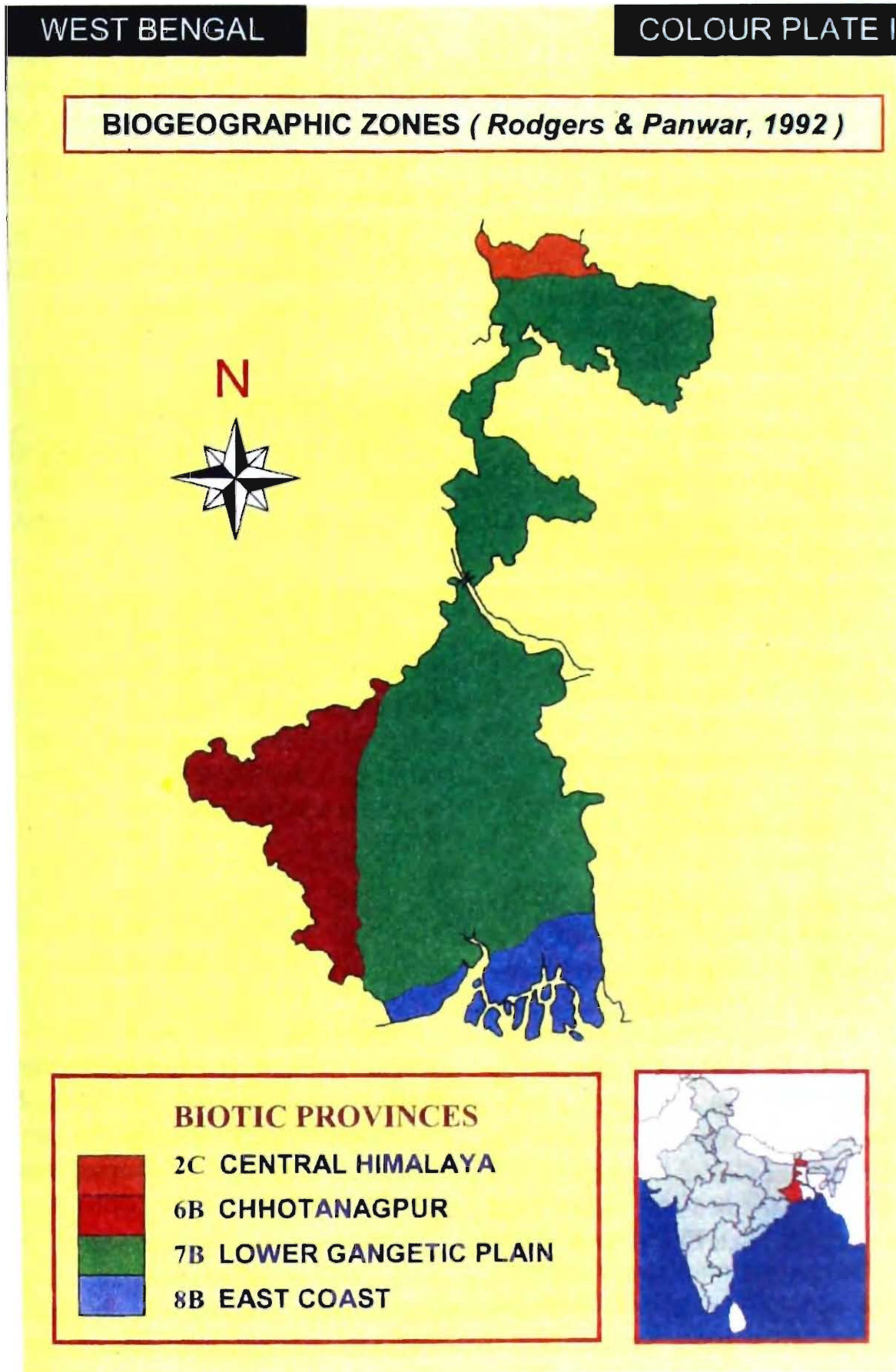
al., 1998; Venkataraman, 2007). Further, in respect of religion, ethos, culture, socio-economy, politics and life pattern, one region of the country differs widely from the other. As such, challenging issues of biodiversity conservation and its sustainable utilization become complex and multifarious. To attain the desired goal of conservation, it become obligatory to set the priorities and identify essential elements for framing the action plan at the national as well as regional levels. Each state or region within the country has specific necessary elements concerned with biodiversity, which need to be integrated into the framework of action plan, keeping in view the implications arising due to the ratification of the CBD. It is primary requirement for regional policy makers and managers of biodiversity to have a status report dealing with aspects like 'HOW MANY', 'WHERE', 'UNIQUENESS', 'UTILISATION', 'THREATS', 'CURRENT PRACTICES', 'GAPS IN KNOWLEDGE', and other related aspects. Further, the overall concern of traditional practices connected with the conservation of biological diversity is another important element which varies regionally. Documentation of such traditional practices for conserving species while being used, and protection of habitats through selection, domestication, cultivation and breeding of useful plants and animals is also another key factor in formulating the regional Action Plan. It is necessary to integrate and blend the essence of these practices in the process of conservation.

So far, West Bengal is concerned, huge amount of biodiversity related data have already been accumulated through surveys, identification and inventorying activities of the

Botanical, Zoological, Anthropological, Forest and Fishery Survey of India, State Forest Department, and several other institutes from the university systems, autonomous bodies as well as NGOs. Over all data on the species composition, distribution, population, and Keystone, Umbrella, Endemic and threatened species particularly of major groups are available. Unfortunately, these valuable data are very much scattered and have limited academic use, only to specialists. For greater effectiveness, it is essential that relevant and user friendly data bases are prepared and made available through modern information technologies. Wider access to information would facilitate the effective conservation and sustainable use of the biological resources in a particular community or locality. In the present book, based on published as well as unpublished information, an attempt has been made to compile the biodiversity related data of West Bengal and analyse the same with emphasis to meet up the queries of policy-makers and managers of biodiversity.

West Bengal, the only state in India, which touches the Himalayas in the north and has sea on its south. As such the physical environment of the state varies from Bay of Bengal in the south to the snow-capped Himalayas in the north through vast stretches of alluvial plains in the middle, small patches of hills and isolated mounds in the western part. Soil characteristics, temperature and rainfall also vary widely from one part to other. These have resulted rich and diverse vegetative cover consisting of almost all forest types, vast expanses of grasslands, different agricultural crops as well as cropping practices. Each of these supports a particular type of biodiversity. Varieties in aquatic ecosystem such as freshwater, brackish water, estuary and marine also contributed to the richness of state's biodiversity. Further, West Bengal falls in the transition zone between peninsular Indian subregion, Indo-Malayan subregion of Oriental

zone and Palaearctic region. This also helped West Bengal in its great array of natural ecosystems embellished with ingress, colonization and interspersions of life forms from all the adjoining regions. Richness of biodiversity is reflected by the fact that, West Bengal though only 2.7 percent of the total area of the country, but four, *viz.*, the Himalaya (Central Himalaya), Gangetic Plain (Lower Gangetic Plain), coast (East Coast) and Deccan peninsula (Chhotanagpur), out of ten recognized biogeographic zones of India are represented in the state (Map 1). On the other hand, owing to favourable agroclimatic condition, West Bengal is always one of the most populated regions of the country and the population is further increasing for one or other reasons. The pressure of such an enlarged and impoverished population along with rapid urbanization and industrial development have taken a heavy toll of natural areas of the state through shrinkage and degradation. Further, market pressure on a host of non-wood forest products has led not just to their depletion, but often their collection practices are destructive and damaging to the habitat and productivity parameters themselves. In fact, since 19th century, quite a number of floral and faunal species have either become extinct from the state or lost large parts of their earlier range and restricted to certain pockets with small populations. It is obvious that the country as well as the state of West Bengal have taken several positive measures for conservation and management of biodiversity through legal and policy frameworks, surveys and monitoring, in-situ and ex-situ conservation, sustainable utilization including benefit sharing, institutional frameworks and capacity building for human and infrastructural resources, research, developmental activities and others. However, majority of these efforts are diverted for conservation and management of few charismatic ecosystems or species, without



Map-1 : Biogeographic zones of West Bengal.

total consideration of the entire spectrum of biodiversity. It is heartening that the State Biodiversity Strategy and Action Plan : West Bengal (2002) has been finalized. The same has recommended various actions such as 'Information about biodiversity status to be enriched', 'Biodiversity data base for each district should be completed' and others.

The present compilation has been made to meet up some of these recommendations. Further, it is expected that the report will be helpful in the processes of evaluating the essential elements required for conservation and sustainable use of biodiversity in state level.

METHODOLOGY

The present report derives information mainly from the published literature, field reports and record books of Forest Department officials on the flora and fauna of the state. Further, management plans of different Protected Areas of the state contain numerous data and as such those have also been consulted. As it is not within the scope to provide the complete bibliography on the biota of the state only few references are cited below.

Fauna :

Agrawal *et al.* 1992, Agrawal and Ghosh 1995, Ahmed 1992, Ahmed and Dasgupta 1992, Alfred 1998, Alfred *et al.* 1998, Alfred and Nandi 2001, Annandale 1907, Bal and Basu 1995, Barman 1993, Basu and Mitra 1995, Bhattacharyya 1997, Biswas and Biswas 1992, Biswas and Biswas 1995, Biswas and Ghosh 1995, Biswas *et al.* 1995, Choudhuri and Chattapadhyay 1997, Das *et al.* 1993a, b, c, d, Ellerman 1963, Ghatak 1995, Ghosh 1995, Ghosh 1996, Hazra 1993, Haldar 1995, Haldar and Choudhuri 1995, Maiti and Saha 1993, Majumdar *et al.* 1992, Mandal and Nandi 1989, Meggilt 1933, Misra 1995, Mukhopadhyay

1998, Nandi *et al.* 1993, Rao and Misra 1986, Ripley 1982, Sanyal 1992, Sarkar 1984, Sarkar *et al.* 1992, Sharma 1979, Soota 1991, Soota and Ghosh 1977, Southwell 1913, Srivastava 1993, Subba Rao and Barua 1983, Varshney 1998, Willis 1951.

Flora :

Anderson 1862, Anonymous 1957, Banerjee 1957, Banerjee 1968, Basak 1979, Biswas 1966, Chakravarty 1957, Champion and Seth 1968, Chauhan 1996, Cowan and Cowan 1929, Culshaw 1952, Director, B.S.I. (ed.) 1997, Ghosh 1997, 1998, 2001, Ghosh 2002, Karthikeyan 2000, Maji and Sikdar 1983, Malick 1966, Molla *et al.* 1984, Mukherjee 1988, Mudgal and Hazra (eds.) 1997, Prain 1963.

General :

Alfred *et al.* 2004, Anonymous 2000, Biswas and Trishal 1993, Chaudhuri and Choudhuri 1994, Cowardin *et al.* 1979, Das 2001, Dept. of Environ. and R.K.M. 2002, Mitra 2000, Mitra and Pal 2002, State Forest Dept. and NEWS 1996.

The above is only a fraction of the references consulted for the purpose. For writing of the different chapters numerous documents contained in 42 periodicals, 92 books (including district Gazetteers), 17 project reports, 14 management plans, 7 theses, 38 tour reports, 17 leaflets, 12 unpublished papers have been taken into consideration. All the documents have been scanned and information specially related to the following aspects fed into the computer.

1. Species name
2. District-wise distribution,
3. Significance (endemism, taxonomy, zoogeography, economy, evolution),
- 4 Threats,
5. Management and
6. Ecology.

PROFILE OF WEST BENGAL

GEOGRAPHICAL PROFILE

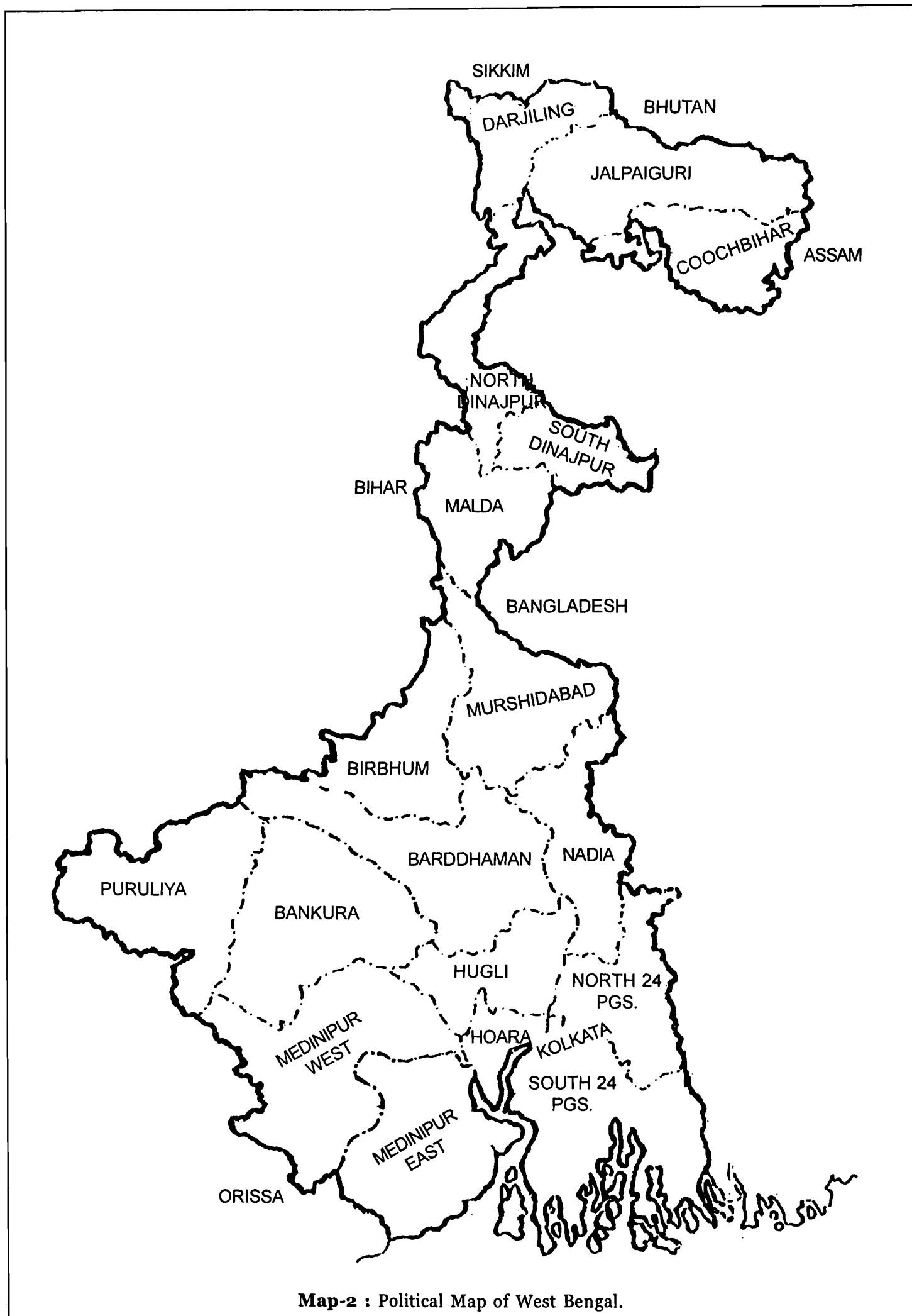
Following independence of India in 1947, the state of West Bengal came into existence as the western part of erstwhile Bengal. Situated within 21°38' - 27°19' N. latitudes and 85°50' - 89°50' E. longitudes, the state stretches from the Himalayas in the north to the Bay of Bengal in the south covering an area of about 88,752 sq.km. Five states (Sikkim, Assam, Bihar, Jharkhand and Orissa) and three countries (Bhutan, Nepal and Bangladesh) surround West Bengal-Sikkim to the north, Bhutan to the North-East, Assam and Bangladesh to the east, Nepal, Bihar and Jharkhand to the west, and Jharkhand and Orissa to the south-west (Map 2).

Till the end of seventies, the state had 16 administrative districts. Later, due to increase in human populations and to facilitate administrative control three more districts have been recognized by dividing erstwhile 24-Parganas, West Dinajpur and Medinipur districts. At present 19 districts are placed under three Divisions. The districts Bankura, Birbhum, Bardhaman, Puruliya, Hugli, East and West Medinipur come under Bardhaman Division; Kolkata, Haora, Nadia, Murshidabad, North and South 24-Parganas under Presidency Division; whereas, Darjiling, Jalpaiguri, Koch Bihar, Maldah, South and North Dinajpur remain under Jalpaiguri Division. Industrial development has taken place at a faster rate in Kolkata, Haora, Hugli, North 24-Parganas and parts of Bardhaman districts, while rest are still basically agro-based.

With direct access to the sea and a network of national as well as international air links, the state's geographic location makes it the gateway to the North-East India and adjoining countries. A system of roadways and railways radiate out into the state to connect it with all the major centers of activity in the country.

Excepting the Darjiling Himalaya and hilly tracts of Puruliya, major land area of West Bengal is almost a flat alluvial plain. Central and southern regions of this plain are mainly derived from silt depositions of the Ganga, while northern part extending from Siliguri subdivision of Darjiling and Jalpaiguri to North Dinajpur is formed by the deposition of Teesta, Mahananda, Torsa, Raidak and other rivers. Northern part of the plain is also known Terai and Duars plain. The proper Gangetic plain can be broadly divided under four micro physiographic zones. These are : (i) The northern parodelta of the Ganga and the *Barind* tract in Maldah and parts of North and South Dinajpur, (ii) *Rarh* plain spreading over East and West Medinipur, Bankura, Birbhum, Puruliya and parts of Bardhaman. This also includes Contai coastal strip of land along the seacoast, which is characterized by frequent sand dunes and salt marshes, mingled with each other. The western part of *Rarh* plain show undulated rocky terrain of Archaean Gneiss and other metamorphic rocks as well as coal belts of Gondwana specially in Bardhaman district. Spurs of Chhotanagpur plateau also penetrate in Puruliya and Bankura resulting low hilly areas, (iii) Moribund Delta comprising of Murshidabad and Nadia districts. It is even and extensive plain having a span of 40-80 km. on both sides of the river Bhagarathi, (iv) Proper Delta consisting of Kolkata, Hugli, Haora, North and South 24-Parganas and parts of Bardhaman. Southern part of this plain particularly South 24-Parganas is characterized by large assemblage of deltaic islands amidst the creeks and rivers, and collectively known as Sundarban.

Except the plains of Siliguri subdivisions, entire Darjiling district physiographically comes under the Himalayan region. It is mainly formed by the extension of high Singalila range of the Himalayas from Nepal side. The region



Map-2 : Political Map of West Bengal.

is characterized by changing elevation, hill streams cutting through the rocks and forming longitudinal valleys, preponderance of length over breadth, steep slope and frequent land slides. Elevation goes up to 3900 m., where almost alpine condition prevails.

ECOLOGICAL PROFILE

Climate : The state being located at the head of Bay of Bengal on one side with rampart of the Himalayas only 500 km. from the sea, the climatic condition exhibits a regional uniformity. It is stated that major climatic differences within the state are due to precipitation totals.

The temperature condition, excluding the Himalayan region, shows limited variation. The diurnal range between maximum and minimum temperature in the coldest month of January remains nearly uniform at 13°C in the plains (irrespective of latitudes), and mean January maxima, minima and absolute decrease with increasing latitudes. Temperature reaching between 35°C-45°C in May, while during monsoon which normally starts in the middle of June, the temperature ranges from 28°C-32°C. In the northern mountainous region, the temperature varies with altitude. The highest observatory at Darjiling (c 2137 m.) records a normal mean temperature of 26°C (summer) and 7°C (winter) absolute below 0°C and snowfall occur occasionally.

The state remains under the influence of monsoon current from June to September. However, certain precipitation may also derive from winter rain, premonsoon rainfall and cyclonic disturbances. The amount of rainfall varies between deltaic plains and traditional drought prone area as also between the northern mountains and southern landmass, the highest being always in the Himalayan area reaching 800 mm in the month of July in a bar-graph. Annual rainfall of the state is roughly as follows :

- Northern mountains and the submontane region : 2000-6000 mm.
- South-Western region : 900-1400 mm.

- Coastal region : 1700 mm.

Based on rainfall, temperature, humidity, the state may be divided into four climatic regions (Map 3) as detailed below.

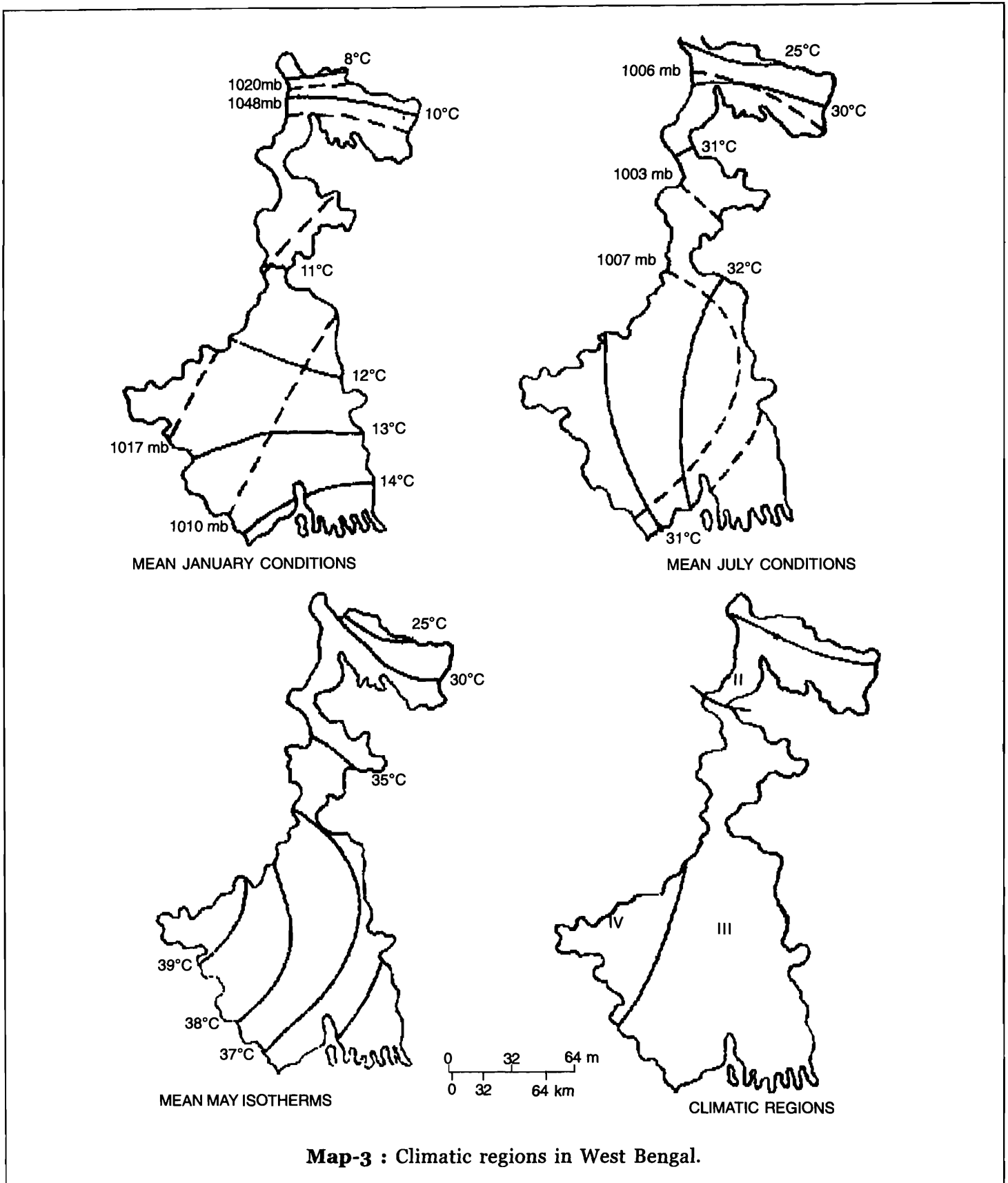
Region I : Extends over the Himalayan tract, mean temperature in winter 6°C–10°C at different altitude. Rainfall 3060 mm, Norwesters occur rarely.

Region II : Higher winter temperature (17°C), frequent Norwesters, more Relative Humidity and higher rainfall (3329 mm).

Region III : The most dominant climatic region of the state. Temperature higher than Region II by an average of 5°C in summer and 3°C in winter. Norwesters and annual rainfall 50 percent less than Region II.

Region IV : Show continental characteristics; summer temperature is higher by 3°C, while Relative Humidity, winter temperature, frequency of Norwesters, annual rainfall (180 mm) much less than Region III.

Soils—The physical and chemical characteristics of the soil vary from place to place depending on physiography, climate, etc. The hilly terrain in Darjiling district consists mainly of brown forest soil which is acidic and varies from sandy loam to clayey loam. In the sub-Himalayan tract (Jalpaiguri and Koch Bihar) soil is greatly leached because of high rainfall, and is poor in base and available plant nutrients. Such soils are highly acidic and sandy. Most places in the alluvial tract consists of fertile soils which support a very intensive and prosperous agriculture. The soil reaction varies from acidic to neutral. In south-western part of the state, soil is red laterite with honey-combed ferruginous concretions at depth of 15 to 30 cm. Soil is poor in plant nutrients and subject to drought. Soil pH ranges from 6.5 to 7.5 with electrical conductivity varying from 3.0 to 18.0 mh/cm mainly due to accumulation of Sodium Chloride. The drainage is poor, but otherwise it is fertile due to continuous silt deposit. Soil in the coastal areas is characterized by high salinity.



Rivers and waterbodies—Ganga is the only perennial snow fed river in the West Bengal delta; it divides near Giria of Murshidabad district. One branch flows southeast as Padma and enters Bangladesh, while the other goes south in West Bengal as Bhagirathi upto Nabadwip and then known as Hooghly to meet Bay of Bengal. The western

region of the state is flanked by the coalesced fans of seasonal flashy torrent tributaries of Ajay, Damador, Mayurakshi, Kangsabati, Rupnarayan, Anadpur and Haldi, all of which fall to a dead delta zone along the Hooghly river bank. The Teesta, Jaldhaka, Mahananda, Nagar, Torsa, Atrai, Punarbhaba are some of the notable rivers of North Bengal which drain

out massive water during rainy season from their catchment in the Himalayas causing devastating floods. Many dry river beds with boulders, pebbles and sand is a common feature in the northern part carrying no or thin flow in dry summer months and come into spate during monsoon. Tributaries of the old river system occurring in the district of south 24-Parganas have converted the famous part of Sundarban into an intricate network of tidal water system towards the sea. However, the salinity in the Hooghly river has been considerably reduced since Bhagirathi is being fed by freshwater after constructing a barrage at Farakka.

The state is also dotted with numerous wetlands in the form of 'Ponds', 'Jheels', 'beels' and the natural/excavated drainage system of 'Khals' These wetlands enrich the aquatic ecosystem of the state. While detail listing will be made later, some important wetlands are mentioned below.

- **Himalayan and Sub-Himalayan** : Rasik beel, Malian Dighi, Mirik.
- **Gangetic plain** : Katiganga-Motijheel, Mathura Beel, Jamuna Beel, East Kolkata,

Saheb band, Ballavpur, Santragachhi.

- **Coastal** : Gabaria Beel, Atampur, Dadanpatrasar.

There has been sharp reduction of natural wetland areas of the state during last few decades due to urbanisation, reclamation for agriculture and developmental initiatives.

Forests—Except the Central Alluvial tract, all agro-ecological zones have important forest resources with distinctive floristic compositions. In North Bengal, total forest area is about 3050 sq. km. (about 26 percent of the recorded state forest) and contains the most productive forests. Forest in south-west West Bengal are mostly scattered in relatively small and widely dispersed blocks of degraded Sal interspersed with farm land. The most compact area is the mangrove forests in the coastal saline zone which covers 4260 Sq. Km. (approximately 36 percent of recorded state forest land). However, nearly 40 percent of the forest land in the coastal saline zone is actually made up of numerous rivers and creeks. Distribution and classification of forests in different region has been provided in Table 1.

Table-1 : Distribution and classification of forests in different zones of West Bengal (*Source* : Dept. of Environment & Ramkrishna Mission, Narendrapur, 2002, West Bengal State Biodiversity Strategy & Action Plan. Ramkrishna Mission, Narendrapur and Annual Report, 2008-2009, Forest Dept., West Bengal).

Region	Reserve Forest		Protected Forest		Unclassified State Forests and others		Total (sq.km.)
	Area sq. km.	% of Total	Area sq. km.	% of Total	Area sq. km.	% of Total	
Hill, Northern Circle and Forest Dev. Corpn.	2598	85	259	9	194	6	3051
Western Circle	206	5	3399	78	742	17	4347
Central Circle and Sundarban Tiger Reserve	4250	95	114	2.5	117	2.5	4481
Total	7054	59	3772	32	1053	9	11879

Further, afforestation outside recorded forest land has been carried out under social forestry programmes. Till 2000, 26,000 ha. have been brought under strip plantation, 2,400 ha. under village woodlot and 212,000 ha. under farm forestry.

Forests in Sundarban shrunk by about 2,590 sq.km. in the last 200 years and 1,295 sq.km. during last century to provide land for agriculture and settlements. In Medinipur, Jungal Mahal had 3,108 sq.km. forest in 1862 and now reduced to 1,315 sq.km. However, the annual gross increment of West Bengal forest compares favourably with that of the national figures. The following are the average annual increment in different forest types of West Bengal.

HIGH FORESTS	AVERAGE ANNUAL INCREMENT
Hills	0.8 Cu.M./ha.
Plains	1.65 Cu. M./ha.
South-West Bengal	3.0 Cu.M./ha.
Coppice (10 year rotation)	
PLANTATIONS	
Hills (Conifers)	12.5 Cu. M./ha.
North Bengal Plains	5.0 Cu. M./ ha.
South-West Bengal (<i>Eucalyptus</i>)	6.0 Cu. M./ ha.

Table-2 : Birth rate, death rate and infant mortality rate in West Bengal as compared to whole of India (per thousand) in 2009.

	India	West Bengal
Birth rate	22.22/1000 population	18.6
Death rate	6.4/1000 population	6.3
Infant mortality rate	30.15/1000 live births	38.0

Table-3 : Decadal change in the proportional of rural-urban population of West Bengal (Adopted from Bhatt, S.C. 1998. The Encyclopaedic District Gazetteers of India, Vol. 9. Gyan Publishing House, New Delhi).

Census decades	1951-61	1961-71	1971-81	1981-1991	*1991-2001
Total	+32.82	+26.87	+23.17	+24.73	+17.84
Rural	+31.81	+26.38	+20.36	+23.01	+27.21
Urban	+95.97	+28.41	+31.76	+29.49	+21.32

* Figures of mid-year 2002.

DEMOGRAPHIC AND ECONOMIC PROFILE

It has already been stated that owing to favourable agroclimatic condition, West Bengal has always been one of the most populated states of the country. Further, the problem of population explosion has been aggravated due to huge immigration from East Pakistan, now Bangladesh since 1947. Birth rate is lower than that of the country as a whole, but that has been compensated by lower death rate and infant mortality (Table 2.).

As per census 2011, population of West Bengal has reached 913.47 lakh (fourth among Indian provinces) and population density standing 1029 per Sq. Km. (second to Kerala). Since 1971, the population of West Bengal has become more than double. Male and female population in state have reached 469.27 and 444.20 lakh respectively.

From 1901, there has been change in the proportion of rural-urban population but only of little significance except for the decade 1951-61 (Table 3, Text-fig.1). As compared to 1971 urban population and rural population has increased by 117 percent and 79.6 percent respectively. Percentage of male and female in the population remains almost constant from

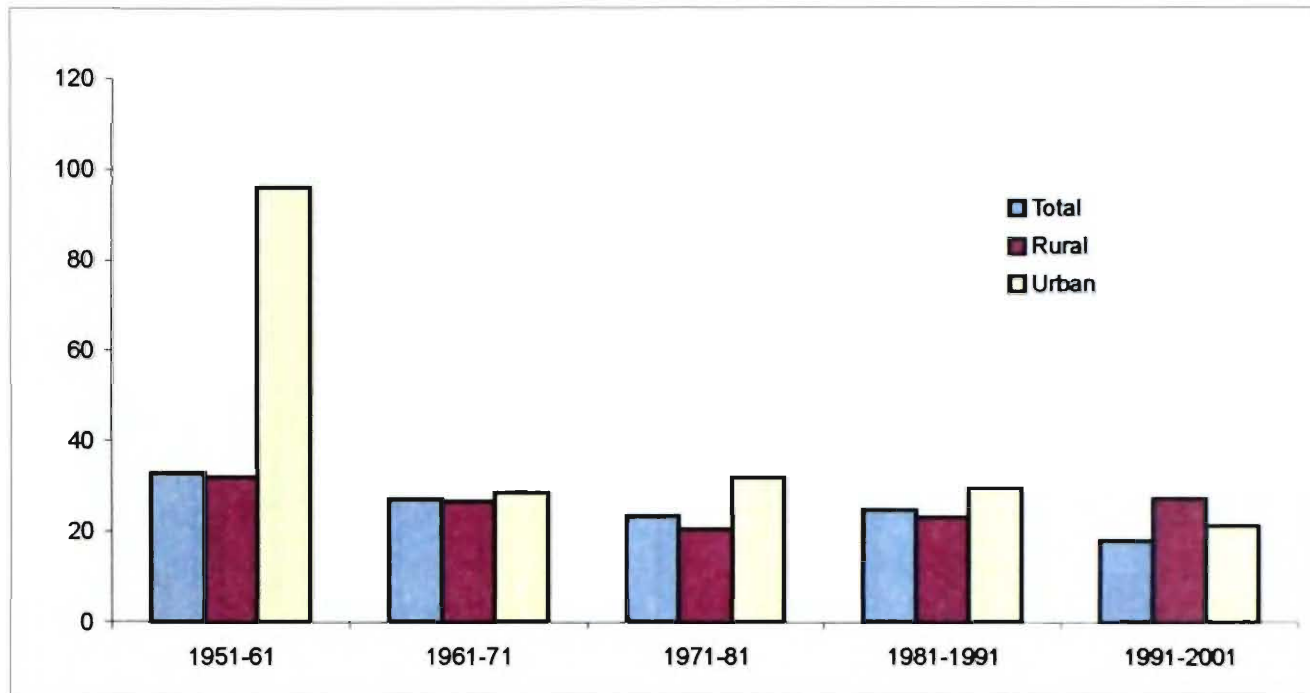


Fig. 1 : Percent decadal variation of population from 1951 to 2001

Table-4 : Some important demographic changes of West Bengal as revealed in last four census.

Census year	1971	1981	1991	2001
Total population(lakh)	443.12	545.81	680.76	802.21
Number of males(lakh)	234.36	285.61	355.11	414.87
% of males to total population	52.89	52.33	52.16	51.72
Number of females (lakh)	208.26	260.20	325.67	387.33
% of females to total population	47.11	47.67	47.84	48.28
Urban population (lakh)	109.67	144.47	187.08	*238.00
% of Urban population to total population	24.75	26.47	27.48	*28.46
Rural population (lakh)	333.45	401.34	493.70	*599.00
% of rural population to total population	75.25	73.53	72.52	*71.54

* Figures of mid-year 2002

1971. Some important demographic changes as revealed from the last four census have been provided in Table 4 and Test-fig. 2. It has been seen that only 28.00 percent of people of West Bengal may be considered as urbanized against the world average of 45 percent.

West Bengal has at least 38 major categories of tribal people. Majority of these tribes, such as, Santhal, Oraon, Munda, Kora, Mehali, Lodha, Malpaharia have migrated from Santhal Parganas during 19th century and settled mainly

in Puruliya, Medinipur, Bankura, North and South Dinajpur; while few others, viz., Bhutia, Lepcha, Mech, Toto, Rava are residents of the hill section of Darjiling and plains of Jalpaiguri. Tribal population of West Bengal also shows a steady increase from 38.04 lakh in 1991 to 46.77 lakh in mid-year 2000. Economy and life styles of tribals are linked with the natural resources of the areas in which they occur. They are labour-based and dependent on the sustained production from their environment.

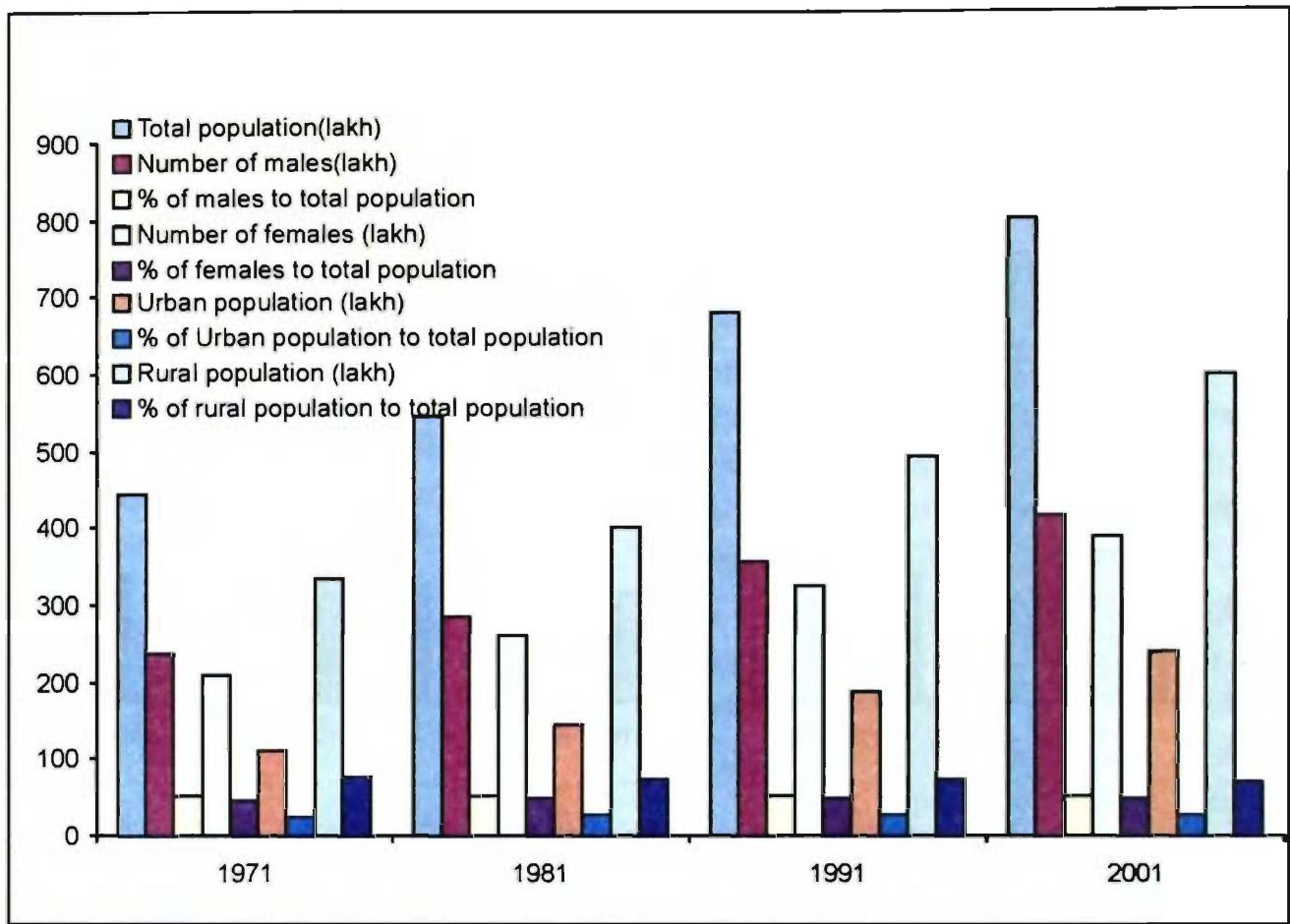


Fig. 2 : Some important Demographic Changes as revealed in last four Census

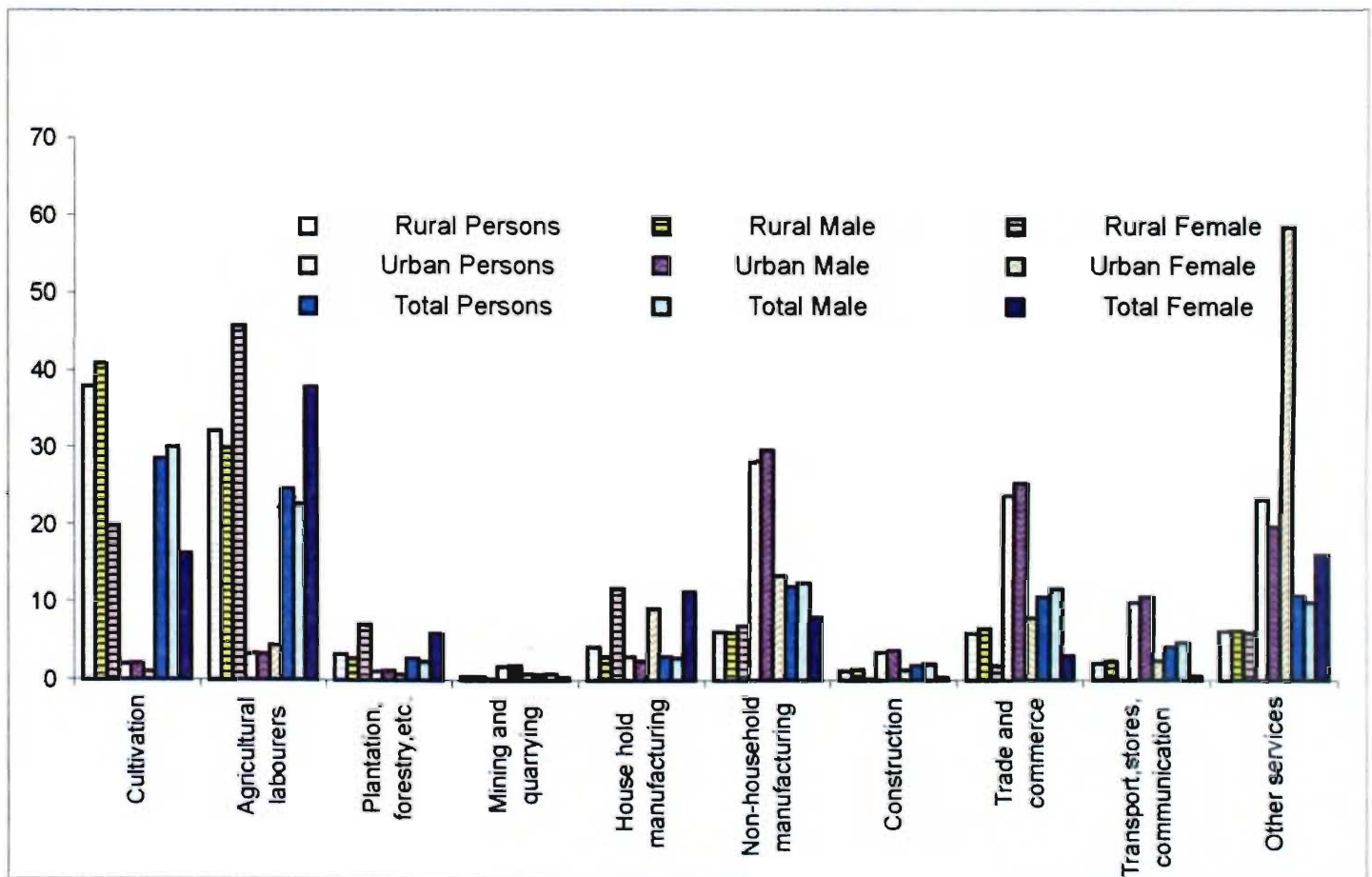


Fig. 3 : Percentage distribution of working force by main activity in West Bengal.

Traditionally, the tribal's social, cultural and religious systems are ecofriendly in nature. Due to increased population and for other obvious reasons, a section of these ecosystem-people have lost right of their own land. This has compelled them to exploit the forest resources in a way out of their traditional ethics.

In spite of gradual increase in the percentage of urban population, still nearly 72 percent of people of West Bengal reside in rural areas spreading over nearly 43,000 villages. According census 2001, nearly 61.55 percent of the land area is under cultivation (Bartaman, Nov. 29, 2001). As such economy of West Bengal may be described as agrobased. An analysis of the working force on the basis of

main activity, working people is directly related to agriculture either as cultivators or labourers. In many of the activities such as agricultural labour, plantation, house hold manufacturing, etc., percentage of female working force is significantly higher than male. A detailed distribution of working force by activity in West Bengal is reflected in Table 5 and Text-fig.3.

In fact, nearly 95 percent of rural population are engaged in agricultural activities. Pattern of land utilization since 1985-86 also shows a slight increase in net area shown (Table 6).

The average per capita income is Rs. 25223.00 (2005-06) in the state (as on 31.01.2008).

Table-5 : Percentage distribution of working force by main activity in West Bengal as per census 1991 (Source : Govt. of West Bengal 2001. Economic Review, Statistical Appendix, Kolkata).

Sl. No.	Category	Rural			Urban			Total		
		Persons	Male	Female	Persons	Male	Female	Persons	Male	Female
1	Cultivation	37.97	40.88	19.87	1.94	2.03	1.02	28.40	30.15	16.23
2	Agricultural labourers	32.24	30.04	45.89	3.36	3.25	4.39	24.56	22.65	37.88
3	Plantation, forestry, etc.	3.32	2.71	7.09	1.17	1.22	0.78	2.76	2.30	5.87
4	Mining and quarrying	0.43	0.47	0.21	1.74	1.83	0.89	0.78	0.84	0.34
5	a. House hold manufacturing	4.22	3.00	11.84	3.03	2.41	9.19	3.00	2.84	11.33
	b. Non-house hold manufacturing	6.22	6.11	6.91	28.21	29.69	13.47	12.06	12.62	8.17
6	Construction	1.24	1.41	0.19	3.54	3.76	1.30	1.85	2.06	0.41
7	Trade and commerce	5.98	6.63	1.92	23.84	25.44	7.95	10.72	11.82	3.08
8	Transport, stores, communication	2.15	2.48	0.12	9.92	10.67	2.46	4.22	4.74	0.57
9	Other services	6.23	6.27	5.96	23.25	19.70	58.55	10.75	9.98	16.12

Table-6 : Pattern of land utilization in West Bengal since 1985-86 (Area in thousand ha.)
(Source : Govt. of W.B. 2001. Economic Review. Statistical Appendix, Kolkata).

Classification of land	Reporting year									
	1985-86		1995-96		1997-98		1998-99		1999-2000	
	Area	%	Area	%	Area	%	Area	%	Area	%
Net area sown	5262	59.5	5462	62.8	5465	62.9	5440	62.9	5472	63
Current fallows	65	0.7	220	2.5	219	2.5	229	2.7	208	2.4
Forests	1186	13.4	1196	13.8	1192	13.7	1192	13.7	1192	13.7*
Area not available for cultivation	1730	19.6	1642	18.9	1651	19.0	1668	19.2	1659	19.1
Other uncultivated land excluding fallows	606	6.8	175	2.0	160	1.9	158	1.8	158	1.8
Total reporting area (excluding Kolkata)	8849	100	8695	100	8687	100	8687	100	8689	100

*Differs slightly from the figure provided by the Directorate of Forests, W.B.(2000)

POLITICAL PROFILE

The state Government was run by the Communist party of India-Marxist dominated Left Front for more than three decades. Following the West Bengal State Assembly election in April-May, 2011, the All India Trinamool Congress and Indian National Congress Coalition under the leadership of All India Trinamool Congress was elected to power. The state administration is strengthened through the functioning of a three tier panchayat system, except in Darjiling Hill Council areas of Darjiling district. There are at present 3437 Gram Panchayats (at village level), 331 Panchayat Samities (at block level) and 18 zilla parishads (at district level). The administrative structure has a hierarchical pattern with independent department put in charge of particular subjects of governance. The departments related to biodiversity conservation and sustainable use are forest, agriculture, animal husbandry, fisheries, environment and panchayat. Conservation of biodiversity is also the responsibility of general administration and police departments. These state level administrative units work with Central Government counterparts of the respective ministries. Various programmes for

raising the standard of living have directly or indirectly contributed to the conservation of state's biodiversity. The Minimum Needs Programme (MNP) launched in 1974, aimed for improvement of health services, housing, water supply, energy of various sources, nutrition, sanitation, production activities, marketing and environment of rural people. The programme of land reform envisages changes in the agrarian relation between the land and litter of the soil on one hand, while the litter and the owner of the land on the other. The thrust of the land reforms is to restructure the agrarian set up as to achieve an egalitarian social structure. Area oriented Fuel Fodder project in the forest fringe areas of fuel deficit districts aims to supply fuel and fodder to the local populations so that illicit felling in Government forests is reduced and at the same time local fringe population get some employment to sustain themselves during lean months. Apart from these many other policies and programmes directly or indirectly related to biodiversity have been adopted by the Government and those will be discussed in the respective chapter. However, the trickle-down effect of them is still very little and achievements are being neutralized by the pressure of ever-increasing human population growth.

ECOSYSTEMS OF WEST BENGAL

Ecosystem is defined as a dynamic complex of interactive and interdependent biotic communities and their abiotic environment, functioning within a definable boundary. However, as variations and gradations between ecological communities are yet to be adequately and properly understood, it is difficult to provide full proof and universally accepted definition and classification of ecosystem. In reality, there is unanimity in identifying the ecosystem boundary and there is no discrete discontinuous unit in natural environment. Therefore, an ecosystem may be as large as biogeographic region or as small as natural habitat and its diversity may be considered at three levels – biogeographic region, biotic province and biomes. In the present report for the sake of convenience, ecosystem diversity has been considered at biome level. Biome can be equated to Champion and Seth's (1968) broad forest vegetation types with the addition of non-forest categories such as grassland, wetland, etc.

A. I. FORESTS :

Willis (1951) defined forest as a closed assemblage of trees allowing no break in the overhead canopy, homogenous of one species or diversified. Depending on the climatic, edaphic, altitudinal, anthropogenic and other factors, forest type varies widely from one part of the earth to the other in respect of floristic and in turn faunistic composition. It has already been discussed that West Bengal exhibits great variations in altitude, climate and edaphic features. This has favoured not only the growth of forest cover but also led to great diversity of forest ecosystems in the state.

The recorded forest of West Bengal is about 11879 Sq.Km. i.e., 1.54 percent of the recorded forest of India and 13.4 percent of the state's total geographical area (Dept. of Environment & R.K.M., 2002). Legal status-wise, Reserve

forest constitutes 59.38 percent, protected forest 31.75 percent and unclassified forest 8.78 percent.

Following Champion and Seth's (1968) classification of forests of the country, ten different types of forest can be recognized within the territory of West Bengal (Table 7). From the table 7 it is obvious that the forests are mainly concentrated in three large patches of north, south and south-west parts of the state. Maximum diversity is being exhibited in the forests of north. In the north, which includes the outer Himalaya, the forest zone begins with alpine/subalpine meadows and rhododendron with junipers at its highest altitudinal situation. Below this, occurs the Temperate forests of Oaks, Chestnuts, Laureh, Magnolia, Alder, Birch, Bucklandia, etc. along with *Tsuga* in patches. Epiphytic flora is exceptionally rich and almost all the trees are covered with thick layer of epiphytes. Fern dominates over the flowering plants. The lowest slopes, which continues into plains of 'Duars' and 'Terai', supports tropical and subtropical mixed forests ranging from moist deciduous to semi-evergreen and moist sal forests. Most of these forests are not typical natural deciduous forests but only subclimax. Introduced weedy species of the genera *Mikania*, *Eupatorium*, *Lantana*, etc., could be seen during dry season. Epiphytes and lianas flora are extremely low. In the flood plains of this zone, riparian forests of Khair, Sisso, etc. occur along with an alluvial Savannah wood land formation. Further south, lower alluvial plains of Ganga and Mahananda in the districts of Maldah, North and South Dinajpur, freshwater swamp forests of *Barringtonia acutangola* could be seen. At the southern extremities, the estuarine of Ganga system bear the tidal Mangrove forests. South Western part of the state has dry deciduous forests mainly of Sal, Mahua, etc.

Table-7 : Forest types of West Bengal (Source : Dept. of Environment and Ramkrishna Mission, Narendrapur 2002. West Bengal State Biodiversity Strategy and Action Plan).

Name	Location	Area(Km ²)
Northern Tropical Wet Ever green	North Bengal plains up to 150M.	167
Northern Sub-tropical Semi Ever Green	North Bengal Hills from 151-300 M.	25
North Indian Moist Deciduous	North Bengal plains up to 150M.	1757
Littoral and Swamp-Mangroves	Estuarine South Bengal	4263
Littoral and Swamp-Tropical Seasonal Swamp	Maldah and South Dinajpur	20
Northern Tropical Dry Deciduous	South West West Bengal	4527
Northern Sub-Tropical Broad Leaved Wet Hill	North Bengal Hills from 301-1650M.	800
Northern Montane Wet Temperate	North Bengal Hills from 1651-3000M.	150
East Himalayan Moist Temperate	North Bengal Hills from 1500-1800M.	150
Sub-Alpine	North Bengal Hills from 3001-3700M.	20

All the above forests may be subdivided into a number of sub-types or biomes, each of which supports a particular ecosystem with particular combination of physiography, climate, soils and biotic components. While mangroves and grasslands will be considered separately, other forest ecosystems are discussed below.

A.I.I. Alpine and Temperate Forests of Darjiling :

(i) Altitude (2400-2700 M) : Comprise a fascinating temperate vegetation predominated by *Quercus lineata*, *Q. lamellosa*, *Lithocarpus pachyphylla*, *Castanopsis purpurella*, *Magnolia campbelli*, *M. globosa*, *Michelia excelsa*, *Eurya ocluminata*, varieties of *Rhododendron*, *Euonymus frigidus*, etc. Temperate conifers mainly restricted to Singalila range include *Abeis pindrow*, *Larix griffithi*, *Tsuga brunoniana*, *Pinus roxburghii*; the latter is found only in dry inner valleys. The other typical plants are : *Acer* sp., *Berberis* sp., *Betula* sp., *Celastrus stylosus*, *Landera* sp., *Sambucus* sp., *Vaccinium* sp. The region also abounds with fascinating herbaceous undergrowth with many temperate and alpine species of flowering herbs and handsome ferns and numerous species of orchids. The

vicissitude of orchids is an indicator of extremely rich biodiversity of this zone. The characteristic distribution of scrub forest communities could be found generally on the sites of abandoned shifting cultivation and in the areas which are excessively over grazed or where trees have been ruthlessly lopped. In the deep valleys where soil is more moist due to seepage of water and minerals, formation of mixed and merophyllus communities are met with.

(ii) Altitude (2700 M and above) : In the highest limit Conifer-Rhododendron forest is predominant. The dominating element in this forest is *Arundinaria racemosa* which is found to grow as a pure crop or as element in the undergrowth of this high forest. Lower zone of this forest is chiefly represented by different species of *Rhododendron* with patches of conifers and scattered growth of *Lithocarpus pachyphylla*, *Quercus spicata*, *Acer campbellii* and *Magnolia campbellii*. Among the conifers, *Taxus baccata* is scatteredly distributed at higher elevations of the Tonglu Range. But further upwards, towards phaloot *Taxus* is replaced to a large extent by *Tsuga dumosa* and thence higher up merge with *Abeis spectabilis*.

Ultimately this is replaced by *Rhododendron* of higher distribution and by *Betula utilis* in the highest limit. Sometimes pasture lands come across on the boundary of Nepal and West Bengal.

Faunal species also exhibit some extent of altitudinal zonation. While large-sized mammalian species are mainly restricted in the lower slopes, the smaller forms like Voles (*Pitimys* sp.), Water Shrew (*Nectogale* sp.), Pika (*Ochotona* sp.), Long-eared Bat (*Plecotus* sp.), Barbastelle (*Barbastella* sp.), etc. are mainly concentrated at higher elevations. Among the mammalian species of Temperate forest Tiger (*Panthera tigris*), Leopard (*P. pardus*), clouded Leopard (*Neofelis nebulosa*), Leopard cat (*Prionailurus bengalensis*), Himalayan Black Bear (*Selanarctos thibetanus*), Red Panda (*Ailurus fulgens*), Yellow-throated Marten (*Martes flavigula*), Barking Deer (*Muntiacus muntjak*), Goral (*Nemorhedus goral*), Serow (*Capricornis sumatraensis*), Flying squirrels (*Petaurista* sp., *Belomys* sp.), etc. are of conservation significance. Enchanting plumage display, chirpy calls of a wide range of avifauna provide an unique dimensions to these forests. Many of the threatened bird species *viz.*, Satyr Tragopan (*Tragopan satyra*), Kaleej Pheasant (*Lophura leucomelana*), Blood Pheasant (*Ithaginis cruentus*), Hill Partridge (*Abroptila mandelli*) find shelter in the hill forest. Only Indian Salamander (*Tylototriton verrucosus*) also found in the aquatic and semiaquatic habitats and grasslands of lower hill region. Faunal groups which are often associated with soil, litter, understone, woods and grasslands such as Isoptera, Dermaptera, Orthoptera, Coleoptera, Dictyoptera, Annelida, Collembola, Acarina are also found in large number. A mammoth diversity of moths and butterflies (Kaiser-I-Hind, Krishna Peacock, Lunar moth, Five ring butterfly, Oak leaf butterfly) spiders, wasps are met with, but detailed inventory and taxonomic study are yet far from the complete.

Anthropogenic impact on the forest ecosystems of mountains is developing critical situations at a faster rate than on most other types of ecosystems. Vast land areas of the Himalayas may be considered environmentally 'derelict land' due to poor land maintenance practice, altered agricultural practices, and over-intensive land use. Landmasses are highly susceptible to soil erosion and landslides. Soil properties are also deteriorated owing to monoculture, ruthless destruction of native plant species and overgrazing. Increased and mostly unplanned tourism resulting noise, huge fuel-wood consumption and frequent movement through forests. All these are disturbing the normal activities of Wildlife as well as their feeding and breeding grounds. Further, the unused material like plastic containers, glass bottles, etc. are converting many areas into slums.

A.I.2. Tropical and Subtropical Forests of North Bengal :

Number of rivers like Mahananda, Teesta, Torsa, Jaldhaka, Sankosh and their tributaries intersect extensive tracts of lower hills and plains of North Bengal. This helps in subtending various kinds of magnificent Tropical, Sub-tropical forests and grasslands. Annual rainfall (3100-5400 mm) with range of temperature between 31°C to 40°C provide ideal conditions for the development of four main kinds of forests, *viz.*, i. Tropical Semievergreen, ii. Moist Sal, iii. Riverine *Acacia catechu* *Dalbergia sisso*, iv. Savannah.

Under the prevailing warm damp climatic condition though wet evergreen forests are likely to develop yet such forests are located in restricted patches near rivers and streams of submontane plains. The common trees of notable dimensions include : *Aphanamixis semiserrata*, *A. spectabilis*, *Actionodaphne obovata*, *A. angustifolia*, *Cinnamomum obtusifolium*, *C. cecicodaphne*, *Chisocheton puniculatus*, *Chukrasia tabularis*, *Cryptocarya* sp., *Dysoxylum* sp., *Elaeocarpus robustus*, *E.*

varuna, *Elaeodendron glaucum*, *Ehretia acuminata*, *Kurrimia pulcherrima*, *Knemal longifolia*, *Symplcos* sp., *Tetrameles nudiflora*, *Vatica lancifolia*, *Walsura tabulata* and others. A number of shrubby species like *Phlogacanthus thyriflorus*, *Marinda angustifolia*, *Coffea bengalensis*, *Leea* sp., *Ixora* sp., etc. and flourishing growth of ferns are also visible as undergrowth. North-eastern parts of Jalpaiguri district have rattan brakes as a conspicuous vegetation set up specially in swampy situation. The well-represented species are *Calamus inermis*, *C. jagellum*, *C. guruba*, *C. tenuis* and *Daemonorps jenkinsianus*. Among the wild bamboo species, *Dendrocalamus bassifonii*, *Cephalostachyum capitatum* and *Bambusa* sp. are commonly found. On the submontane gentle slope a special type of vegetation dominated by members of Convolvulaceae could be found. In this vegetational layout large trees like *Michelia champaca*, *Amoora wallichii*, *Duabanga grandiflora* and magnificent *Acrocaupus fraxinifolius* grow a part with a number of herbaceous or subwoody climbers entangling beneath.

Forests with *Acacia catechu* and *Dalbergia sisso* as predominating species are found on sandy soil and characteristically prevalent on the beds of perennial and seasonal rivers. Here, other commonly associated species are *Acacia concinna*, *A. stipulata*, *Albizia procera*, *Bombax ceiba*, *Bridelia stipularis*, *B. tomentosa*, *Capparis olacifolia*, *Cassia tora*, *Coffea bengalensis*, *Cordia dichotoma*, *Croton caudatus*, *Dalbergia hircina*, *D. lanceolaria*, *D. stipulacea*, *Erythrina indica*, *Grewia laevigata*, *Milletia auriculata*, *Premna latifolia*, *Toona ciliata*, *Trewia nudiflora*, etc. Undergrowth is mainly composed of *Mimosa himalayana*, *Saccharum spontaneum* and *Eupatorium odoratum*. Further on land, where soil formations have been progressed, a crop predominantly of *Albizia lebeck* and *Bombax ceiba* in association with *Erythrina* sp., *Trewia*

nudifera, *Adina cordifolia*, *Bichoffia javanica* at the top storey is found. Here lower storey is mainly composed of *Alstonia* sp., *Premna bengalensis*, *Ulnus lancifolia* and others.

The moist Sal (*Shorea robusta*) forests of North Bengal in general are of plantations by the State Forest Department. Common associates are *Sterculia villosa*, *Lagerstroemia parviflora*, *Schima wallichii*, *Chukrassia tabularis*, *Morinda angustifolia*, *Maesa indica*, *Terminalia bellirica*, *Strobilanthes capitatus* and others. Surubs like *Ochna pumila*, *Coffea bengalensis* alongwith climbing *Asparagus racemosus* are also found to grow in these forests mixed with grasses, viz., *Cantotheca lappacea*, *Microstegium ciliatum*, etc.

Impressive grassy terrains are found mainly on clear land formed by erosion and washing away by rivers. It supports grasses like *Saccharum spontaneum*, *S. procerum*, *Phragmites karka*, *Erianthus elephantinus*, *Themeda villosa* and *Anthestaria gigantea* with scattered trees like *Albizia procera*, *Bombax ceiba*, *Butea monosperma* and others. At places these grasslands are replaced by a typical mixed deciduous forest of *Dillenia pentagyna*, *Careya arborea*, *Toona ciliata*, *Shorea robusta* and *Dalbergia sisso*. Details of grasslands will be considered under grassland ecosystem.

Floral richness of Tropical and Subtropical forests can be evidenced from a study of Mahananda Wildlife Sanctuary by State Forests Department and Nature Environment and Wildlife Society (1996). Within 129.04 Sq.Km. area of the Sanctuary as many as 39 species of trees, 56 species of herbs, 54 species of shrubs and 22 species of climbers have been recorded (Text-fig.4).

The rich foliage cover and presence of an wide array of flora invariably offer a host of microclimatic conditions and niches for huge diversity of faunal species in these forests. Mammalian species include at least 4 species of shrews, 19 of bats and 11 of rats and mice.

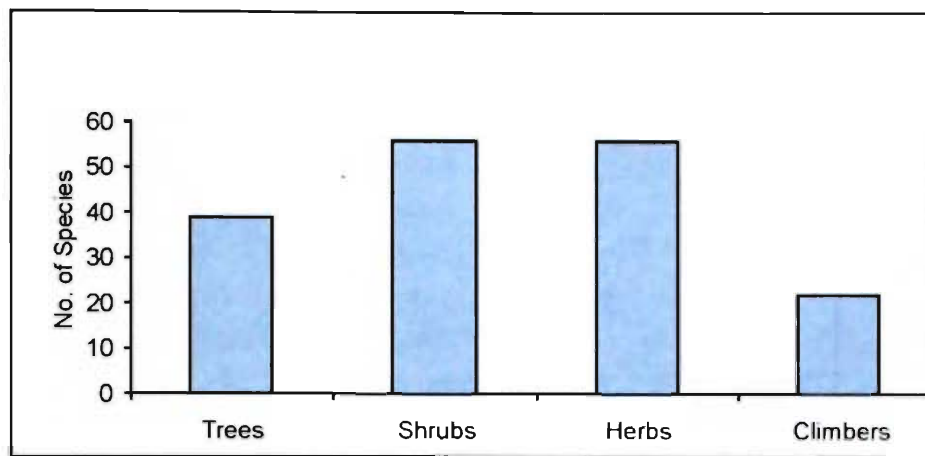


Fig. 4 : Floristic richness of Mahananda Wildlife Sanctuary.

Scaly mammal *Manis* sp. is fairly common. Large number of carnivore species like Tiger (*Panthera tigris*), Leopard (*P. pardus*), Mongoose (*Herpestes* sp.), Bears (*Selanarctos* sp., *Melursus* sp.), Otters (*Lutra* sp.), Civets (*Viverra* sp., *Viverricula* sp.), Cats (*Felis* sp., *Pardofelis* sp., *Neofelis nebulosa*), Fox and Jackal (*Vulpes* sp., *Canis* sp.), etc. play the role of predators at various levels. A good number of ungulate species, viz., Elephant (*Elephas maximus*), Sambar (*Cervus unicolor*), spotted Deer (*Axis axis*), Hog Deer (*Axis porcinus*), Goral (*Nemorhedus goral*), Gaur (*Bos frontalis*), Wild Boar (*Sus scrofa*) are fairly common, while Great one-horned Rhinoceros (*Rhinoceros unicornis*) is confined to two protected areas of these forests within West Bengal outside Assam. Reports of the occurrence of most critical species, Pygmy Hog (*Sus salvanius*) is also available from here. Large number of arboreal species of mammals, viz., Monkeys (*Macaca* sp.), Langur (*Semnopithecus entellus*), Squirrels (*Petaurista* sp., *Callosciurus* sp., *Ratufa* sp., *Dremomys* sp.) adorn the canopy. Nearly three hundred species of birds including Pea Fowl (*Pavo cristatus*), Openbill stork (*Anastomus oscitans*), Lesser adjutant (*Leptoptilos javanicus*), Osprey (*Pandian haliaetus*), Kaleej pheasant (*Lophura leucomelana*), Barn Owl (*Tyto albo*), Great Pied Hornbill (*Tockus birostris*) contribute significant biomass to the forest ecosystem of this zone. A very small population of Bengal Florican (*Eupoditis bengalensis*) is still found

in the grassland area. Among the poikilothermus vertebrate species, Tree Frog (*Polypedates leucomystax*), Balloon Frog (*Uperodon globulosus*), Leaping Frog (*Rana erythraea*), Python (*Python molurus*), Cobra (*Naja naja*), King Cobra (*Ophiophagus hannah*), Krait (*Bungarus* sp.), Indian Tent turtle (*Kachuga tentoria*), Leaf Turtle (*Cyclemys* sp.), ornamental flying snake (*Chrysopalea ornata*), Monitor Lizard (*Varanus* sp.) and many others abound the forest floor. A great diversity of insects, spiders, acarines, earthworms, molluscs and other invertebrate groups inhabit the soil, ground, litter, under stone and decaying woods, grassland and trees. They play the most important role of decomposers and also the pollinators in the forest ecosystem. Faunal richness is evident from the glimpses of species diversity in three protected areas, viz., Jaldapara Wildlife Sanctuary (216.5 Sq.Km.) Mahananda Wildlife Sanctuary (129.04 Sq.Km) and Gorumara National Park (79.99 Sq.Km.) (Text-Figs.5-7). Entire Tropical and Sub Tropical Forest ecosystem of North Bengal is very much vulnerable mainly owing to tremendous human population pressure. Encroachment of forest land for settlements, regular felling practices for a pretty long period, grazing, hunting, damming, mining, developmental activities, random use of pesticides in the tea garden combined with recent terrorist activities have already deteriorated the ecological situation to a great extent. Occasional flash flood is one of

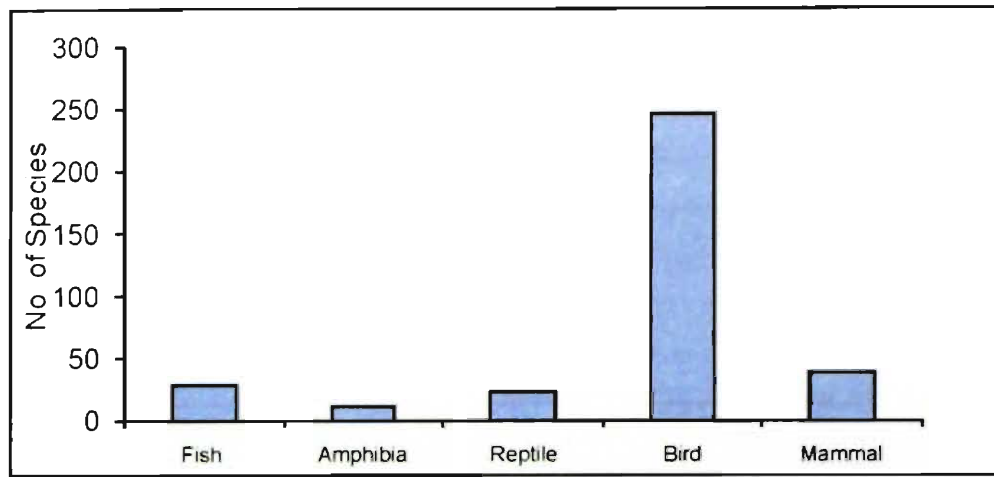


Fig. 5 : Faunal richness of Jaldapara Wildlife Sanctuary.

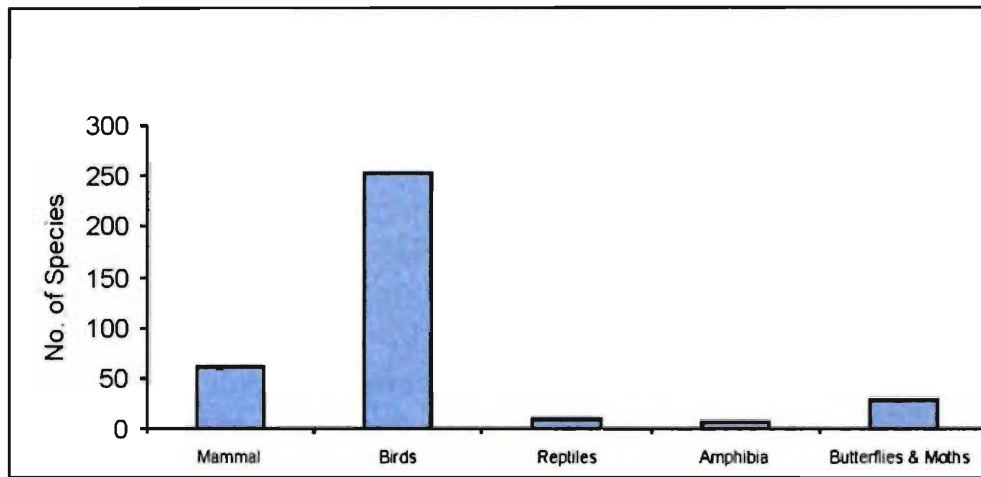


Fig. 6 : Faunal richness of Mahananda Wildlife Sanctuary.

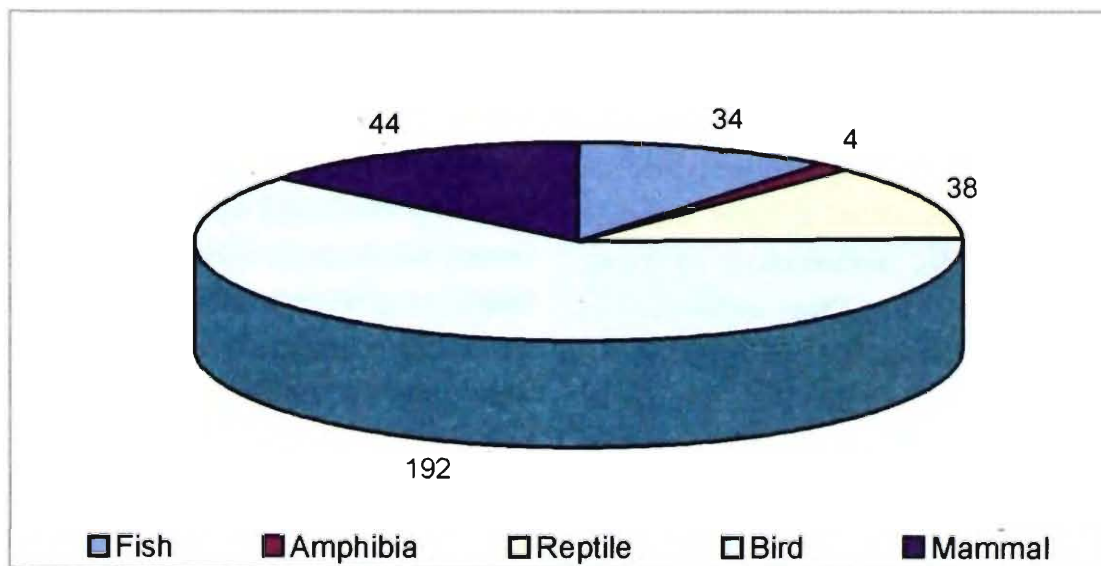


Fig. 7 : Faunal richness in Gorumara Wildlife Sanctuary.

the most important natural threats of this region.

A.I.3. Tropical Dry Deciduous Forests of South West West Bengal :

Due to extension of the floristically rich hilly plateau of Bihar and Orissa along the Western boundary of West Bengal, vegetation in these areas of the bordering districts represents a

distinct type of flora related to the adjoining drier areas of the two states. Excepting a few heavy showers during the monsoon, the region is considerably dry. The hot spell of summer with high temperature has allowed in the development of only one kind of forest under Tropical Sub-humid Deciduous type dominated by Sal. The associated elements are *Acacia*

catechu, *Aegenitia indica*, *Alangium salvifolium*, *Albizia lebeck*, *Apluda mutica*, *Anogeissus latifolia*, *Ardisia solanacea*, *Azadirachta indica*, *Bauhinia vahlii*, *Bombax ceiba*, *Borassus flabellifer*, *Boswellia serrata*, *Breynia vitisidaea*, *Butea sp.*, *Cassia fistula*, *Celastrus paniculata*, *Cleistanthus collinus*, *Dioscorea sp.*, *Emblica officinalis*, *Eulaliopsis binata*, *Ficus bengalensis*, *F. religiosa*, *F. virens*, *Flemingia chappar*, *Holarrhena papescens*, *Holoptilea integrifolia*, *Justicia adhatoda*, *Lantana camara*, *Madhuca indica*, *Miliusa sp.*, *Mallotus philippensis*, *Naravelia plicata*, *Phoenix sylvestris*, *Pothas scandens*, *Sapindus emarginatus*, *Smilax zeylanica*, *Solanum surattense*, *Syzygium cumini*, *Tamarindus indica*, *Terminalia arjuna*, *T. bellirica*, *T. chebula*, *Ventilago denticulata*, *Viscum album*, *Xylia xylocarpa*, *Zizyphus sp.* and many others. In addition to the forested tracts, large number of floral species are associated with the wastelands of this part. Notable species are *Aerva lanata*, *Acanthospermum hispidum*, *Calotropis gigantean*, *Datura metel*, *Ficus hispida*, *Hyptis suaveolens*, *Martynia annua*, *Panicum psilopodium*, *Scoparia dulcis*, *Perotis indica*, *Setaria glauca*, etc. Another important aspect of the forest ecosystem of south west West Bengal is the large scale plantations of *Eucalyptus sp.*, *Akashmoni-Acacia auriculiformis* and *Sal-Shorea robusta* in the degraded sal forest areas since sixties and seventies.

Large range of entomological species are found in the forests, agricultural fields as well as wastelands. Predominant groups are Coleoptera, Lepidoptera and Hemiptera. Marbled Toad (*Bufo stomaticus*), Ornata Microhylid (*Microhyla ornata*), Painted Frog (*Kaloula pulchra*), Skipping Frog (*Rana cyanophlyctis*), Jerdon's Bull Frog (*Rana crassa*), Tokay (*Gekko gekko*), Dwarf Rock Lizard (*Psammophilus blanfordanus*), Yellow Monitor (*Varanus flavescens*), Rat Snake (*Ptyas mucosus*), Water Snake (*Enhydris endris*), Wolf Snake (*Lycodon aulieus*), Cobra (*Naja naja*), are some of the poikilothermus species of the region. From the qualitative point of view, mammalian and Avian fauna in this ecosystem is very rich containing Indian Pangolin (*Manis crassicaudata*), Wolf (*Canis lupus*), Fox (*Vulpes bengalensis*), Mongoose (*Herpestes sp.*), Leopard (*Panthera pardus*), Spotted Deer (*Axis axis*), Indian Elephant (*Elephas maximus*) and more than hundred species of birds. However, most of these species are represented by a very small number of individuals in a fragmented manner. Qualitative richness of faunal species in the Dry deciduous Forest Ecosystem of South West West Bengal is evident from the study of faunal composition in Ajodhya Hills of Puruliya district (Text-Fig. 8).

Continuous biotic influences have considerably changed the natural characteristics of Dry Deciduous Forests of South Western region. The present quality and

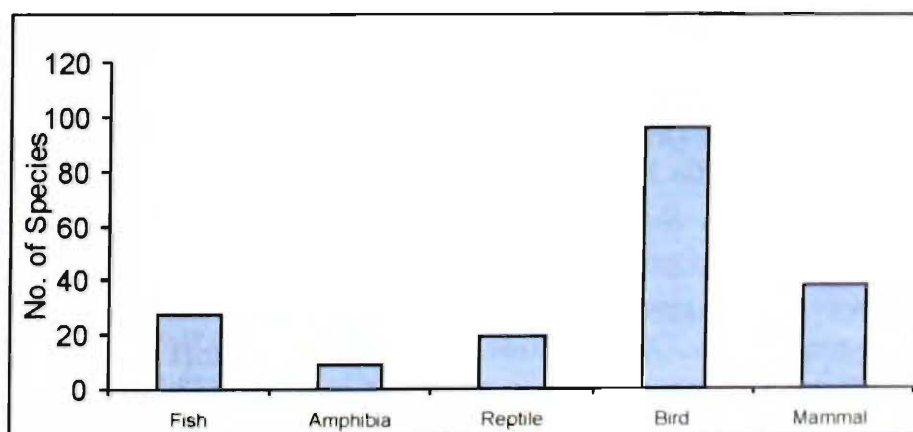


Fig. 8 : Faunal richness in Ayodhya hills of Puruliya District.

density of forests are very different than what these were in the past. Continuity of forests in this stretch has been broken by topographical features and finally by human interference. Forests are generally in patches and considerably degraded due to massive industrialization, mining, settlements and felling. Faunal resources have also been depleted due to continuous hunting pressure particularly from tribals.

A.2. GRASSLANDS :

Grassland means a landscape in which the grasses are the dominant plants. It is one of a number of seral phases of vegetation. The vegetation structure is dynamic, one ecological association follows another in an orderly sequence, known as the 'Sere' Dabadghao and Shankaranarayan (1973) have recognized five main/broad grass cover types of India, of which following three are found within the territory of West Bengal.

A.2.1. Phragmites-Saccharum-Imperata type :

Found mainly in the alluvial plains. The predominant grasses are *Saccharum procerum*, *S. spontaneum*, *Arundo donax*, *Phragmites karka*, *Imperata cylindrica*, *Bothriochloa pertusa*, *Apluda mutica*, *Vetiveria zizanioides*, *Setaria intermedia*, *Erianthus arundinacea*, *Pennisetum glaucum* and others.

A.2.2. Themeda-Arundinella type :

This grass cover extends to humid montane region and moist sub-humid areas of Darjiling hills around 350 M to 2,100 M. The tract between 1,800 M and 3100 M may also be considered as transition zone. The dominant perennial grasses are *Arundinella bengalensis*, *A. nepalensis*, *Themeda* sp., *Bothriochloa intermedia*, *B. pertusa*, *Chrysopogon fulvus*, *C. gryllus*, *Erianthus longisetosus*, *Cynodon dactylon*, *Cymbopogon* sp., etc. Areas where the grassland is subjected to light disturbances as cutting or grazing, have luxuriant growth of *Themeda* sp.

A.2.3. Temperate-Alpine type :

This type of grassland could be seen above 1,500 M and further up to the highest point of Singalila range in Darjiling district. Slopes and flats are mainly covered with *Aconitum palmatum*, *Agrostis* sp., *Ajuba lobata*, *Anaplialis* sp., *Begonia* sp., *Campannula colorata*, *Cardamine* sp., *Carex* sp., *Edgaria darjeelingensis*, *Fragaria-versa* sp., *Gynura angulosa*, *Hypoxis aurea*, *Mazus dentatus*, *Lysimachia japonica*, *Origanum vulgare*, *Pilea* sp., *Poa* sp., *Senecio alatus*, *Phleum alpinum*, *Stipa* sp. and many other species of flowering herbs and handsome ferns.

Grasslands primarily support a large number of herbivore species from minute insects to largest land animal—the elephant (*Elephas maximus*). This in turn makes grasslands happy hunting grounds of a large range of carnivorous species of different groups and sizes. Most of the grass lands have some common vertebrate species, such as, Tiger (*Panthera tigris*), Elephant (*Elephas maximus*), Deer (*Axis* sp., *Cervus* sp.), Hare (*Lepus* sp.), Rats and Mice (*Rattus* sp., *Mus* sp., *Bandicota* sp.), Grass Warbler (*Prinia* sp.), Partridge (*Francolinus* sp.), Munia (*Lonchura* sp.), Baya (*Ploceus* sp.) and many others. However, depending upon the geographical locations, ecological set up and management practices, many grassland possess some characteristic faunal elements. One will find Gaur (*Bos frontalis*), Hog Deer (*Axis porcinus*), Great One-horned Rhinoceros (*Rhinoceros unicornis*), Ferret Badger (*Melogale* sp.), Bengal Florican (*Eupodotis bengalensis*), etc. in the plains of North Bengal. While in the upper zones, Pika (*Ochotono* sp.), Vole (*Pitimys* sp.), Goral (*Nemorhedus goral*), Red Panda (*Ailurus fulgens*), Sikkim Blood pheasant (*Ithaginis cruentus*), Kaleej Pheasant (*Lophurus leucomelana*) and wide variety of butterflies are met with. In the grassland of Sundarban, Wild boar (*Sus scrofa*), Spotted Deer (*Axis axis*) and Tiger (*Panthera tigris*) are the most eminent species.

Natural calamities like forest fires, floods, changes in the course of rivers, etc., along with overgrazing and various socio-economic development activities are the major factors threatening grass lands of West Bengal.

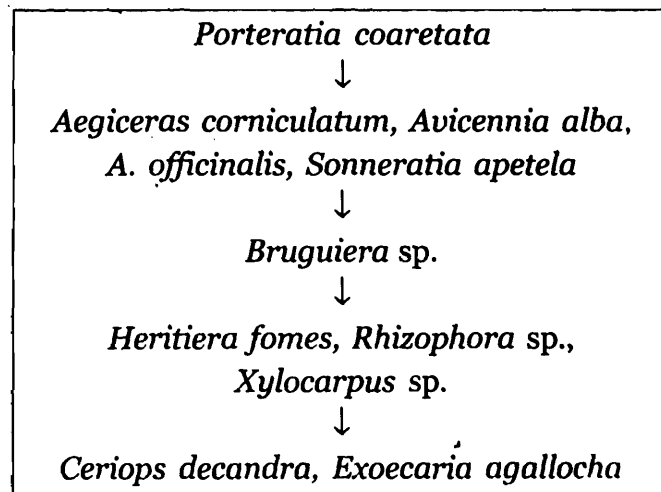
A.3. MANGROVE :

Mangrove is a part of the forest ecosystem, but discussed separately as it represents a characteristic littoral forest dominated by some specially adapted salt tolerant plant community that grow at land-sea interphase and border sheltered sea coasts and estuaries of tropical and subtropical regions. The mangrove forests comprise a diverse composition of trees and shrubs exhibiting unique adaptation to an environment which is periodically inundated by salt water from one side and freshwater from the other. The mangrove ecosystem is highly productive and exchanges matter and energy with adjacent marine and terrestrial ecosystems.

The southern most part of the state is indented by numerous river openings, *viz.*, Harinbanga, Gosaba, Matla, Thakuran, Saptamukhi, Muriganga and Hugli. All these rivers ultimately end up at the Bay of Bengal, but on the way have encompassed about 108 islands crisscrossed and intersected by various creeks and delta distributaries. This deltaic complex at the apex of Bay of Bengal is the Indian Sundarban. With a total land and water area of about 1,000,000 ha., the Sundarban support the largest mangrove block (nearly 2,123 sq.km. according to 1998 FSI Data) of the country.

The floral community of mangrove ecosystem is well adapted to encounter higher salinity, oppressive heat, tidal extremes as well as water logging. In Indian Sundarban a total of 69 floral species belonging to 20 families and 50 genera have been recognized, out of which 34 species are true mangrove type (Mittra 2000). The typical woody genera represented in the mangrove forests of Sundarban are : *Aegiceras*, *Avicennia*, *Amoora*, *Bruguiera*,

Ceriops, *Excoecaria*, *Heritiera*, *Rhizophora*, *Sonneratia* and *Xylocarpus*. The mixed forest of *Heritiera* is quite dense and extends over a fairly large areas in saline water. The highest canopy is occupied by *Heritiera fomes*, *Excoecaria agallocha*, *Ceriops decandra*, *Xylocarpus granatum* and others. However, at present density of *Heritiera fomes* is very much depleted due to extraction. Typical mangroves of moderate heights include *Avicennia alba*, *Ceriops tagal*, *Xylocarpus moluccensis*; some of the bushy shrubs like *Acanthus ilicifolius*, *Dalbergia spinosa*, *Derris scandens* are found to form dense patches along the muddy flat lands. *Nypa fruticans* and *Phoenix paludosa* are the two common palms in mangroves and both are much depleted due to long exploitation. Few of the important grasses exclusive of the mangroves are *Myriostachya wightiana*, *Paspalum disticum*, *Zoysia matrella*, etc. In addition to the true mangrove fairly rich mesophytic flora containing species like *Abutilon graveolens*, *Acacia intsia*, *Bergia ammonoides*, *Calotropis gigantea*, *Capparis sepiaria*, *Cyperus* sp., *Merremia* sp., *Sapium indicum*, *Tribulus* sp, *Vicoa vgestita*, *Wedelia biflora* are also met with. Various marsh grasses, sand binders and macroalgae are also associated with the mangroves. The role played by *Porteratia coaretata* in the event of ecological succession in deltaic Sundarban can not be ignored. This salt marsh grass acts as the pioneer species as represented here in the flow chart (Mittra and Pal, 2002).



Mangrove ecosystem is highly dynamic with constant phenomena like erosion and accretion taking place due to waves, tides and currents. The erosion of soil and dune formation are largely controlled by *pomoea pescapre*, a common sand binder.

Invertebrates exist both as planktonic form in the aquatic subsystem and also as benthic form in and on the substratum, which may be the intertidal zone or the mangrove forest floor. Among planktonic forms, the zooplankton community comprises a heterogenous assemblage of copepods, mysids, lucifers, gammarid, amphipods, cladocera, ctenophores under the haloplankton category; and polychaete, mollusca, echinoderm, crustacean larva, fish eggs under the meroplankton category. Almost all the major invertebrate phyla are represented in the mangroves with considerable species richness; this includes at least 41 species of Platyhelminthes, 78 species of Annelida, 476 species of Arthropoda, 142 species of Molluscs, 20 species of Echinodermata (Mitra and Pal, 2002). The area also invites two important fascinating marine creatures, *Carcinoscorpius rotundicauda* and *Tachypleus gigas* during their breeding in premonsoon months. The Sundarban mangrove ecosystem is also a unique reservoir of vertebrate fauna. About 141 species of Fishes, 8 species of Amphibians, 57 species of reptiles, 161 species of birds and 40 species of mammals have been reported from the mangrove ecosystem of Sundarban (Mandal and Nandi 1989). However, according to Chaudhuri and

Chaudhuri (1994) number of vertebrate species in Sundarban is much more being 654. While Das and Nandi (1999) estimated total number of faunal species (Protista + Animalia) as 1586 and Das (2001) provided the number of macrofaunal species as 1434. The Tiger (*Panthera tigris*) is the Key Stone species of Sundarban. Interestingly, besides Sundarban (including its Bangladesh counterpart) no other mangrove areas of the world harbour tiger population. Apart from tiger, number of other threatened species like fishing Cat (*Prionailurus bengalensis*), Snub-nosed Dolphin (*Orcaella brevirostris*), Little Porpoise (*Neophocaena phocaenoides*), Giant heron (*Ardea goliath*), Lesser Adjutant (*Leptoptilos javanicus*), Osprey (*Pandion haliaetus*), Estuarine Crocodile (*Crocodylus porosus*), Olive Ridley Turtle (*Lepidochelys olivacea*) and many others find shelter in Sundarban. At least five vertebrate species have become extinct from this ecosystem during last 200 years (Table 8).

Mangrove area of West Bengal have been reduced to more than 50 percent, during the last few decades (4,200 sq.km 1987 to 2,123 sq.km. in 1998), revealing clearly the mangrove ecosystem is under considerable threat. Natural threats generally include cyclone, soil erosion and soil sedimentation due to natural cause. Anthropogenic threats mainly include tree felling primarily for fuel and timber, hunting, conversion of mangrove areas for agriculture and aquaculture, human settlement, cultivation, fragmentation, digging of salt pans, lime generation, introduction of exotic species,

Table-8 : Species disappeared from Sundarban mangrove ecosystem since last 200 years (Source : Chaudhuri and Chaudhuri 1994).

Scientific name of extinct species	Common name
<i>Cairina scutulata</i>	White Winged Wood Duck
<i>Muntiacus muntjak</i>	Barking Deer
<i>Cervus duvaucelii</i>	Swamp Deer
<i>Bubalu bubalis</i>	Wild Buffalo
<i>Rhinoceros unicornis</i>	Javan Rhinoceros

and over exploitation for various purposes. In Sundarban, unregulated use of shooting nets of small mesh-size for the collection of Tiger Prawn (*Pinaeus monodon*) seeds for trade results in tremendous loss of faunal diversity. Developmental activities like opening of port and harbour, erection of dykes and embankment, discharge of oil, industrial effluent, domestic sewage and pesticides are also posing considerable threats to the mangrove ecosystems of Sundarban.

A.4. WETLAND :

The wetlands are lands transitional between terrestrial and aquatic systems where water table is usually at or near the surface or the land is covered by shallow water (Cowardin *et al.* 1979). The wetlands are highly productive ecosystem, and perform essential functions including flood control, natural sewage treatment, stabilization of shorelines against wave erosion, recharging of aquifers and supporting rich biodiversity.

In West Bengal, there are about 54 natural and nine man made wetlands which are more than 100 ha. (Biswas and Trisal, 1993) and in addition to these there are numerous small water bodies including ponds, puddles, etc. The two categories combine to cover an area of about 3,44,527 ha. which is about 8.5 percent of the total wetland area in India. A compilation from the satellite imagery data has shown that spatial distribution of wetlands varies from one district to other both in number as well as in area (Dept. of Environ. and R.K.M. 2002). Among the natural wetlands, seasonal waterlogged type of wetland (WSL) in Medinipur and Maldah; cutoff meander (COM) in Koch Bihar; marsh and swamp in South and North Dinajpore and Oxbow type lakes (OL) in Nadia and Murshidabad are significant. In case of Inland man-made wetlands (IMMW), maximum number of reservoirs are observed in Bankura; tanks in Puruliya; man-made water logged (MMWL) in Birbhum; abandoned quarries (AQ) in Bardhaman and ash ponds/

cooling ponds in Murshidabad and Medinipur. Coastal wetlands mostly fall in two districts, *viz.*, South 24 parganas and East Medinipur. From the Biodiversity point of view each and every type of wetland is significant and as complete listing of them is not possible some important ones are mentioned below :

A. Sub Himalayan Region-Extends from hills of Darjiling to Maldah :

1. Rasik Beel, 2. Malian Dighi, Altai Dighi, Gour Dighi Complex, 3. Teesta Reservoir, 4. Mirik Lake and 5. Kulik.

B. Gangetic Region-Includes the entire south and south west West Bengal excluding the active delta and coastal region :

1. Kaliganga-Motijheel Complex, 2. Barity Beel, 3. Chupichar, 4. Mathura Beel, 5. Jamuna Beel, 6. Kajla Dighi, 7. Sahebandh, 8. Alipore Zoo, 9. Mudiali, 10. Tilpara Barrage, 11. Durgapur Barrage, 12. East Kólkata, 13. Nalban, 14. Santragachi and 15. Palta.

C. Coastal Region-covering parts of North and South 24 Parganas and East Medinipur :

1. Gabaria Beel, 2. Alampur and 3. Dadanpatrabar.

Diversity of wetland plants of West Bengal is richest in India and is represented by more than 380 species belonging to 170 genera and 81 families (Ghosh 1996). Wetlands of West Bengal covering only about 8.5% of the Wetland areas (considering water bodies 100 ha) of India, provide shelter for more than 60% diversity of aquatic and wetland flora (Ghosh *op.cit.*). Wetlands of West Bengal are home of 8 species of aquatic fern and fern allies belonging to 6 genera and 6 families; strictly aquatic dicot and monocot are represented by 12 species (8 genera) and 36 species (19 genera) respectively. Large number of terrestrial flowering plant families have also representatives in wetland habitat of West Bengal (Table 9).

Table-9 : Flowering plant families having representatives in Wetland habitat of West Bengal
(Source : Ghosh, 2002).

Family	No. of Genera	No. of Species
Acanthaceae	2	5
Aizoaceae	1	1
Amaranthaceae	2	4
Amaryllidaceae	1	1
Apiaceae	3	3
Araceae	5	6
Asclepiadaceae	1	1
Asteraceae	7	9
Balsaminaceae	1	1
Boraginaceae	2	4
Brassicaceae	1	1
Burmanniaceae	1	2
Campanulaceae	1	2
Cannaceae	1	1
Commelinaceae	3	5
Convolvulaceae	1	3
Cyperaceae	11	68
Droseraceae	1	3
Elatinaceae	1	2
Eriocaulaceae	1	9
Fabaceae	6	9
Gentianaceae	1	1
Haloragaceae	1	2
Hydrophyllaceae	1	1
Lamiaceae	1	1
Lentibulariaceae	1	15
Lythraceae	3	11
Onagraceae	1	4
Orchidaceae	1	1
Pandanaceae	1	1
Poaceae	24	45
Polygonaceae	1	5
Ranunculaceae	1	1
Rubiaceae	2	4
Scrophulariaceae	6	27
Solanaceae	1	1
Sphenocleaceae	1	1
Verbenaceae	2	2
Xyridaceae	1	2
Total	103	265

A major portion of the open water interface of the unmanaged water bodies are now occupied by a number of exotic weeds of which *Eichhornia* sp., *Altemanthera* sp. are fairly common. Many of the aquatic floral species of West Bengal, such as, *Aldrovandra vesiculosa*, *Caldesia oligococca*, *Drosera burmannii*, *Euryale najas marina*, etc. are now threatened.

It is obvious that wetlands of West Bengal supports a huge diversity of invertebrate species including Protozoa, Annelida, Arthropoda, Mollusca and others but no exact estimate is available. However, it is interesting to note that the single relict species of Dragon Fly, *Epiophlebia laidlawi* is associated with the hill streams of Darjiling.

Fresh water fish of West Bengal is represented by 172 species distributed in 36 families and 12 Orders (Dept. of Environment and R.K.M. 2002). Wilderness fishes like Chanda, Ghute, etc. are now rare due to indiscriminate use of pesticides. In the aquatic and semiaquatic condition of West Bengal various species of Toads and Frogs, Turtles, Common Indian Monitor, Cobra, Checkered Keel Back, Smooth Water Snake, Russel Viper, Bandicoot Rat, Otter, Fishing Cat and Mongoos are found in fairly good number. Only

representative of Indian Salamander-*Tylototriton verrucosus* is confined to the wet lands of Darjiling. Wetlands of West Bengal provide an ideal habitat for a large range of resident and migratory species of birds. More than 113 species of birds including Great Crested Grebe (*Podiceps cristatus*), Cormorant (*Phalacrocorax carbo*), Darter (*Anhinga rufa*), Grey Heron (*Ardea cinerea*), Openbill Stork (*Anastomas oscitans*), White Ibis (*Threskiornis aethiopica*), Lesser and Large Whistling Teal (*Dendrocygna javanica*, *D. bicolor*), Ruddy Shelduck (*Tadorna ferruginea*), Pin Tail (*Anus acuta*), Red-crested Pochard (*Wetta rufina*) and others have been recorded from the water bodies of West Bengal.

Each and every wetland of the state is facing problems peculiar to it as a result of geographical location, cultural practices and developmental activities. But most of the Wetlands of the state are facing with a common set of problems which may vary in intensities from one location to other. These are :

1. Siltation,
2. Eutrophication,
3. Shrinkage,
4. Encroachment and Reclamation and
5. Pollution.

Major threats to frewhwater wetlands of India and the threatened species therein have been listed by Alfred and Nandi (2001).

SPECIES DIVERSITY IN WEST BENGAL

Since the living world is most widely considered in terms of species, Biodiversity is very commonly used as a synonym of species diversity, in particular of species richness which is the number of species in a site or habitat. The present account of species diversity in West Bengal has been compiled mainly on the basis of State Fauna Series : 3, Parts 1-12 (1992-2000), Flora of West Bengal (Director, B.S.I., 1997), *Paschim Banglar Udvid* (Ghosh, 1997, 1998, 2001) published by the Zoological Survey of India and the Botanical Survey of India. In addition, numerous other publications as mentioned under Methodology have also been taken into consideration. It has been felt that vast areas of the state particularly districts like Maldah, East and West Dinajpur, Murshidabad, Nadia, North 24 Parganas, Puruliya, Birbhum and Bankura have not yet been properly explored in respect of many of the groups. Detailed lists of plant and animal species occurring in West Bengal along with their district-wise distribution have been provided in Parts II and III. However, for some of the groups list is incomplete due to non-availability of species name. It is sure that there will be manifold increase in the existing number of species with the systematic survey and

taxonomic studies particularly in respect of minor groups. Again many of the floral and faunal species are represented by a large number of subspecies, varieties and races, resulting enormous richness in respect of genetic diversity. The account has certain shortcomings in respect of the coverage of some groups due to non-availability of data. The number of the species shown under different groups in the present report may vary slightly from that shown for that group in other literature. Mostly such discrepancies are owing to the differences in opinion in the taxonomic treatment. In recent time district Medinipur and West Dinajpur has been divided into two districts each. However, in the analysis of district-wise richness, undivided Medinipur and West Dinajpur have been taken into consideration.

I. Floral Diversity

Floral diversity of the state is equally impressive as the fauna and exhibits distinct zonation in respect of species composition which has already been discussed in connection with ecosystem diversity. So far, over 7000 plant species excluding viruses have been described from the state as against nearly

Table-14 : Recorded number of species in some major plant groups in India and West Bengal (Adopted from Mudgal and Hazra 1997 and Dept. of Environment & Ramkrishna Mission 2002).

Groups	No. of Species		Percent in West Bengal
	India	West Bengal	
Bacteria	850	96	11.29
Algae	6500	865	13.30
Fungi	14500	860	5.93
Lichens	2051	600	29.69
Bryophyta	2850	550	19.29
Pteridophyta	1200	450	37.50
Gymnosperms	64	21	35.00
Angiosperms	17500	3580	20.45

46000 species in India. Group-wise break up of number of species in some major plant groups in the state as compared to that of country has been provided in Table 14. Due to nonavailability of all the literature, particularly for Bryophyta, only the list of major plant species of West Bengal are appended in this book.

I.1. *Bacteria* : Over 85 species under 57 genera have been recorded from West Bengal.

Most of the genera are known by single species in the state. However, the genera *Pseudomonas*, *Staphylococcus* and *Staptomyces* have 5, 8, 4 species respectively. Detail account of the bacterial species from the different regions of West Bengal has not yet been worked out, however, a list of few specific *lytic* bacteria recorded from Indian Sunderbans is given in Table 15.

Table-15 : List of a few specific lytic bacteria in Indian Sundarban (Source : Dept.of Marine Science, Univ.of Kolkata. 1987. Multidisciplinary Research Approach and Report on Mangrove Ecosystem of Sundarban).

Name of bacterium	Cellulolytic		Chiti nolytic	Pec- tino- lytic	Pro- teo- lytic	NH ₃ For- mation	NO ₂ For- mation NH ₃	NO ₃ For- mation NO ₂
	C ₁	C ₂						
<i>Bacillus alvei</i>	-	-	++	++	+	++++	+	+
<i>Bacillus cereus</i>	-	X	-	X	X	X	X	X
<i>Brevibacterium</i> sp. (St.1)	+	-	+	++	+++	++++	+++	++
<i>Bravibacterium</i> sp. (St.2)	+	-	+	X	++	+++	X	X
<i>Bravibacterium</i> sp.	-	-	-	-	+++	++	++	++
<i>Bravibacterium</i> sp.	-	X	X	X	X	X	X	X
<i>Marinopiscosum</i> sp.	-	-	-	++	X	++	++	++
<i>Bravibacterium</i> sp. (St.4)	X	-	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.5)	+	+	++	-	X	++	++	++
<i>Bravibacterium</i> sp. (St.6)	-	+	-	X	X	++	++	++
<i>Bravibacterium</i> sp. (St.7)	++	X	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.8)	+	-	+++	-	X	++	++	++
<i>Bravibacterium</i> sp. (St.9)	X	X	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.10)	X	X	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.11)	X	X	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.12)	X	X	X	X	X	X	X	X
<i>Bravibacterium</i> sp. (St.13)	X	X	X	X	X	X	X	X
<i>Butyribacterium</i> sp. (St.1)	+	X	-	-	X	++	++	++
<i>Butyribacterium</i> sp. (St.2)	X	X	X	X	X	X	X	X
<i>Clostridium weneri</i>	+	X	-	-	X	++	++	++
<i>Clostridium</i> sp. (St.1)	-	-	-	++	X	++	++	++
<i>Clostridium</i> sp.	X	X	X	X	X	X	X	X
<i>Corynebacterium</i> sp.	++	-	+	X	++	++	++	X

Table-15 : Cont'd.

Name of bacterium	Cellulolytic		Chiti nolytic	Pec- tino- lytic	Pro- teo- lytic	NH ₃ For- mation	NO ₂ For- mation NH ₃	NO ₃ For- mation NO ₂
	C ₁	C ₂						
<i>Kurtbia bessonii</i> (St.1)	++	-	-	-	++	++	++	X
<i>Kurtbia bessonii</i> (St.2)	-	X	-	++	X	X	X	X
<i>Kurtbia Bessonii</i> (St.)	-	Xx	+	-	X	X	X	X
<i>Kurtbia Bessonii</i> (St.3)	++	X	X	X	X	X	X	X
<i>Kurtbia</i> sp. (St.b)	-	-	X	-	X	X	X	X
<i>Kurtbia</i> sp. (St.c)	-	X	++	X	X	X	X	X
<i>Kurtbia</i> sp. (St.d)	++	-	++	+=	X	X	X	X
<i>Kurtbia</i> sp.(St.e)	-	-	-	++	X	++	++	++
<i>Kurtbia</i> sp. (St.f)	X	X	X	X	X	X	X	X
<i>Lactobacillus</i> sp. (St.1)	+	+	—	—	+++	++++	++	++
<i>Lactobacillus derbrueckii</i>	-	X	-	X	X	X	X	X
<i>Lactobacillus</i> sp. (St.2)	X	X	X	X	X	X	X	X
<i>Lactobacillus</i> sp. (St.3)	X	X	X	X	X	X	X	X
<i>Lactobacillus</i> sp. (St.4)	X	X	X	X	X	X	X	X
<i>Lactobacillus</i> sp. (St.5)	X	X	X	X	X	X	X	X
<i>Listeria</i> sp. (St.1)	-	-	+	X	+	++	X	X
<i>Listeria monocytogenes</i>	-	X	-	X	X	X	X	X
<i>Macrococcus agilis</i>	-	-	+++	X	++	++	++	X
<i>Macrococcus</i> sp. (St.1)	-	-	X	++	++	++	—	X
<i>Micrococcus candidus</i>	-	X	-	X	++	++	—	X
<i>Macrococcus</i> sp. (St.2)	-	X	+	X	X	X	X	X
<i>Pseudomonas</i> sp. (St.1)	++	X	X	X	++	++	++	+
<i>Pseudomonas</i> sp. (St.2)	X	X	X	X	X	X	X	X
<i>Pseudomonas</i> sp. (St.3)	X	X	X	X	X	X	X	X
<i>Pseudomonas</i> sp. (St.4)	X	X	X	X	X	X	X	X
<i>Pseudomonas</i> sp. (St.5)	X	X	X	X	X	X	X	X

+ : Positive, - : Negative, X : Not experimented yet.

II.2. *Thallophyta* : Represents the oldest and the most primitive type of plants characterised by the simplicity of structure of their vegetative bodies and of reproductive method. Two main groups, viz., Algae and Fungi stand out prominently within the Thallophytes. Algae possess green colouring matter or chlorophyll,

Fungi on the other hand never possess chlorophyll.

II.2.A. *Algae* : As many as 6500 species under 666 genera are known from India. In the state nearly 865 species, i.e. 13.30 percent of Indian species, under 189 genera and 15 families have been recorded. Some of the

genera such as *Cosmarium*, *Oscillatoria* and *Euastrum* exhibit great diversity in the number of species, containing 86, 41 and 30 species each respectively. However, fairly good number of genera *viz.*, *Noctiluca*, *Pithophora*, *Synedra*, *Wollea*, etc. are represented by single species in the state. District-wise distribution of algae in West Bengal is shown in fig.9.

II.2.B. *Fungi* : Only a small percentage (5.93%) of Indian fungal species has so far been recorded from West Bengal. About 860 species under 291 genera and 93 families are known from the state. Rich generic diversity is

exhibited by the families Moniliaceae (28), Polyporaceae (15) and Dothideaceae (10), while many of the families like Onygenaceae, Olpidiaceae, Erysiphaceae, Laboulbeniaceae, etc., are represented by single genus and species. Great species diversity could be observed in the genera *Cereospora* (49), *Polyporus* (33) and *Aspergillus* (28) of families Dematiaceae, Polyporaceae and Moniliaceae respectively. Highest number of species (240) is known from Darjiling district followed by Kolkata (190). District-wise distribution of fungi in West Bengal is shown in fig. 10.

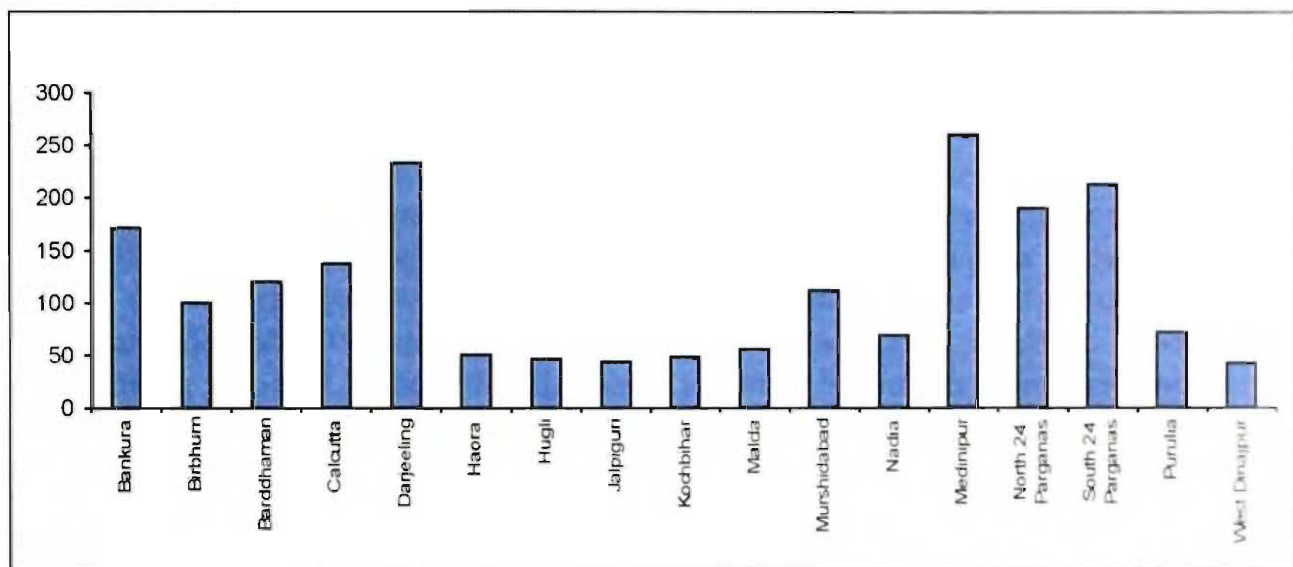


Fig. 9 : Districtwise distribution of algae in West Bengal.

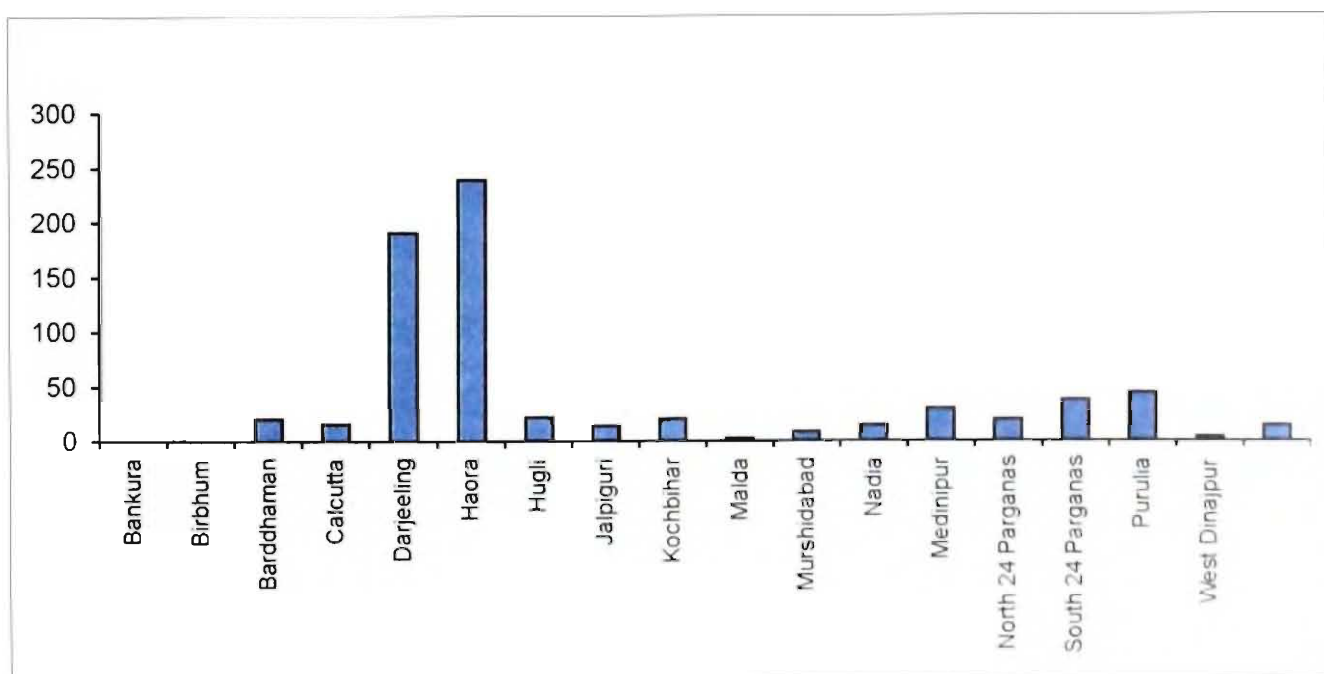


Fig. 10 : Districtwise distribution of fungi in West Bengal.

II. 2.C. *Lichens* : Lichens represent a symbiotic association between two different group of plants, viz., Fungi and Algae. From India 2051 species under 248 genera have been recorded, out of which nearly 600 species spreading over more than 93 genera and 39 families are known from West Bengal. Family Permelaceae contains the highest number of genera (11), while the genus *Opergrapha* of the family Opergraphaceae holds the highest number of species (11). Maximum number of species is known from South 24 Parganas (169) followed by Darjiling (166).

II.3. *Bryophyta* : Comprise a small group of terrestrial plants containing liverworts and mosses; growing mostly in moist situations. Representatives of all the three classes, viz., Hepaticae, Anthocerotae and Musci are found in the country as well as in the state. A total of nearly 2850 species under 490 genera have been reported from the country, and about 19.29 percent of them, i.e. 550 species belonging over 33 genera are known from the state.

II.4. *Pteridophyta* : Include plants like ferns, horse tails, club-mosses and their allies. About 1200 species under 204 genera are known from the country, and nearly 37.5 percent of them, i.e. 450 species have been recorded from West Bengal.

II.5. *Gymnosperms* : Regarded as an intermediate group between Pteridophytes and Angiosperms. There are about 64 species under more than 20 genera and 8 families in India. West Bengal shares 21 species spreading over 17 genera and three families. Except for few genera like *Pinus*, *Cycas*, etc., others are represented by single species in the state. Many of these species are usually cultivated in garden as ornamental plants. However, very few species occur naturally in plains and almost all the species are recorded from Darjiling district.

II.6. *Angiosperms* : These are 'close-seeded', very complex seed-bearing plants. Huge diversity could be marked in this group and all

the districts of the state are supporting a large number of species. Many of them are being cultivated since the dawn of civilization and became a part of our Agriculture system.

II.6.A. *Monocotyledons* : Contain only one cotyledon in their embryos. Nearly 5000 species under 702 genera and 44 families have been recorded from India. From West Bengal only about 500 species i.e. nearly 10 percent of country's total are known. These are distributed over about 250 genera and 35 families. Great generic diversity is exhibited by the families Gramineae and Orchidaceae containing 76 and 39 genera respectively. Genus *Cyperus* of the family Cyperaceae holds the highest number (36) of species. Monocotyledons are well distributed through out the state but best represented in Darjiling district with over 250 species. As many as 240 species have also been recorded from Haora district, but great majority of them are found in the Indian Botanic Garden, Shibpur. District-wise distribution of monocot plants in West Bengal is shown in fig. 11.

II.6.B. *Dicotyledons* : These plants have two cotyledons in their embryos. India supports great diversity of dicotyledonous plants having nearly 12000 species under nearly 2282 genera and 203 families. In West Bengal there are about 3080 species distributed in over 1000 genera and 170 families. Family Leguminosae contains as many as 76 genera, followed by family Asteraceae with 71 genera. Family Balsaminaceae is represented in the state with only two genera, viz., *Impaticus* and *Hydrocera*, but the former exhibits greatest species diversity (34) among the different dicotyledonous genera of the state. Darjiling harbours the highest number of species (ca. 1214) followed by Jalpaiguri (ca.591). District-wise distribution of dicot plants in West Bengal is shown in fig. 12.

II. Faunal Diversity :

The state of West Bengal is adorned with remarkable richness of faunal species mainly due to diverse ecosystems as well as flow of

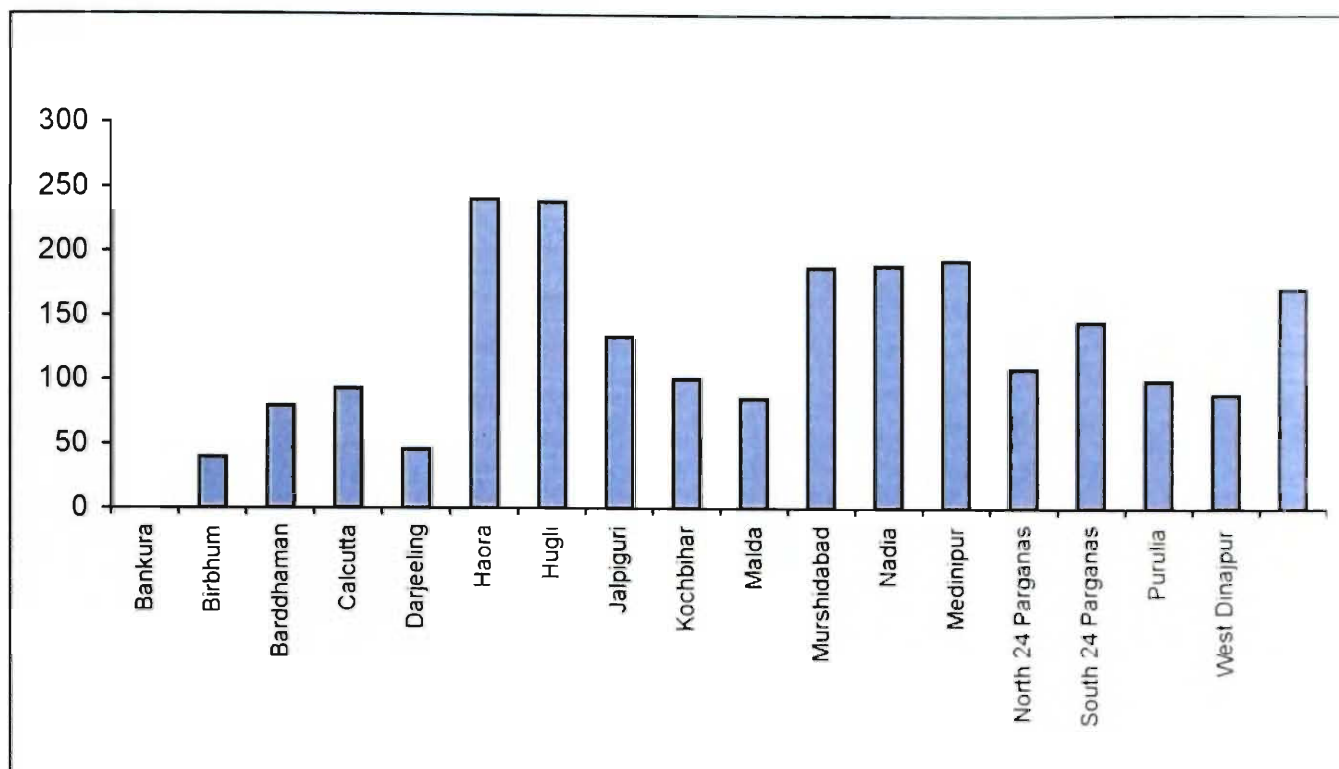


Fig. 11 : Districtwise distribution of monocot in West Bengal.

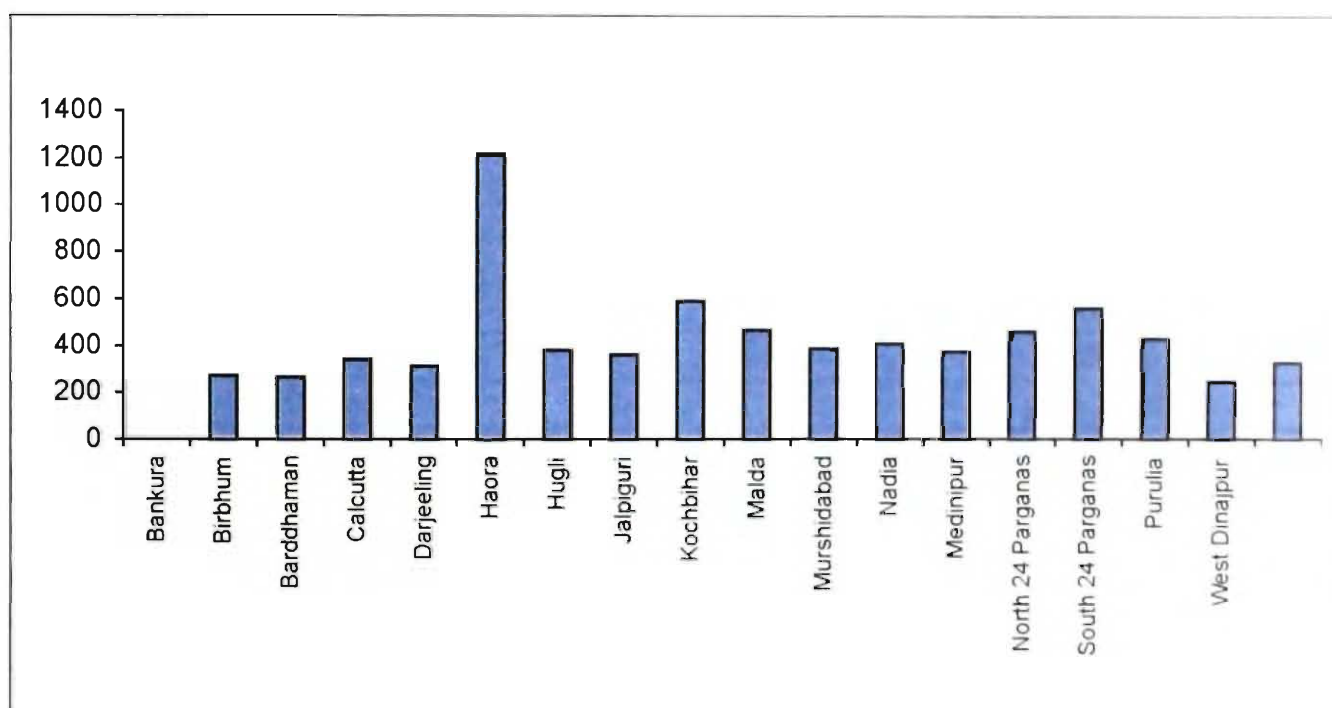


Fig. 12 : Districtwise distribution of dicot in West Bengal.

palaeartic, Indo-Malayan and Afro-tropical elements. The known faunal diversity of the state consists of at least 11,042 species out of 91,771 species present in our country and 12,39,166 in the world. Species diversity in faunal groups of West Bengal as compared to India and world has been provided in Table 16. It appears that the state is represented by 12.03 percent of our country's fauna and 0.89 percent

of the world's fauna. The lists of major animal species of West Bengal are appended in Part III of this report. The number of family, genus and species of faunal groups in the state, distribution of animal species in the districts and distribution of chordate species in districts are shown in Table 17, 18 and 19 respectively. The diversity of some major faunal groups are discussed below.

Table-16 : Faunal diversity of West Bengal compared to world and India (No. of species).

Sl. No.	Taxonomic Group	No. of Species		
		World	India	West Bengal
1.	PROTISTA (Protozoa)	31250	2577	1136
2.	ANIMALIA	1207916	90240	9906
	Mesozoa	71	10	-
3.	Porifera	4562	500	16
4.	Cnidaria	9916	956	23
5.	Ctenophora	100	12	2
6.	Platyhelminthes	17504	1626	248
7.	Nemertinea	600	-	-
7.	Rotifera	2500	330	147
8.	Gastrotricha	3000	100	24
9.	Kinorhyncha	100	10	5
10.	Nematoda	30022	2872	306
12.	Nematophora	250	-	-
11.	Acanthocephala	800	229	15
12.	Sipuncula	145	35	3
13.	Mollusca	66535	5152	274
14.	Echiura	127	43	3
15.	Annelida	12700	841	194
16.	Onychophora	100	1	-
	Arthropoda	998920	70293	6785
17.	Crustacea	35536	2941	251
	Insecta	867381	61238	5407
	Arachnida	73440	5829	1094
46.	Araneae (Spider)	30000	1443	409
47.	Scorpiones	1400	104	14
48.	Acari	40000+	2270	671
49.	Pycnogonida	600	17	-
51.	Paupoda	360	-	-
50.	Chilopoda	3000	100	9
51.	Diplopoda	7500	162	22
52.	Symphyla	120	4	-
53.	Merostomata (Xyphosura)	4	2	2
54.	Phoronida	11	3	1
55.	Bryozoa (Ectoprocta)	4000	200	9
56.	Entoprocta	60	10	-
57.	Brachiopoda	300	3	1
	Pogonophora	80	-	-
	Priapulida	8	-	-

Table-16 : Cont'd.

Sl. No.	Taxonomic Group	No. of Species		
		World	India	West Bengal
	Pentastomida	70	-	-
58.	Chaetognatha	111	30	-
59.	Tardigrada	514	30	-
60.	Echinodermata	6223	765	22
61.	Hemichordata	120	12	1
	Chordata	48467	5131	1827
62.	Protochordata	2106	119	-
63.	Pisces	21727	2634	610
64.	Amphibia	5162	289	39
65.	Reptilia	5817	460	148
66.	Aves	9026	1232	846
67.	Mammalia	4629	397	188
Grand Total (Protista + Animalia)		1239166	91771	11042

Source : National Biodiversity Action Plan, MoEF, Govt. of India, 2008 & Animal Discovery-2010, Zoological Survey of India.

Table-17 : Number of family, genus and species under different faunal groups in West Bengal.

Sl. No.	Taxonomic Groups	Family	Genus	Species
1.	Protista : Protozoa (Freeliving Protozoa)	80	131	267
2.	Protista : Protozoa (Symbiotic Protozoa)	8	23	126
3.	Protista : Protozoa (Parasitic Protozoa)	67	144	743
4.	Porifera	1	9	16
5.	Cnidaria	16	20	23
6.	Ctenophora	2	2	2
7.	Platyhelminthes : Cestoda	17	43	93
8.	Trematoda (Vertebrate excluding fishes)	30	68	97
9.	Digenetic Trematodes of Fishes	21	35	58
10.	Rotifera	18	30	147
11.	Gastrotricha	8	15	24
12.	Kinorhyncha	3	3	5
13.	Nematode Parasites of Vertebrate	38	113	236
14.	Plant Parasitic Nematodes	10	25	70
15.	Acanthocephala	6	8	15
16.	Sipuncula	1	3	3
17.	Freshwater & Land Mollusca	35	70	180

Table-17 : Cont'd.

Sl. No.	Taxonomic Groups	Family	Genus	Species
18.	Estuarine & Marine Mollusca	42	65	94
19.	Echiura	1	1	3
20.	Annelida	40	93	194
21.	Crustacea	45	135	251
22.	Insecta : Thysanura	2	7	9
23.	Insecta : Collembola	2	10	15
24.	Insecta : Diplura	1	1	1
25.	Insecta : Odonata	15	93	180
26.	Insecta : Plecoptera	4	10	21
27.	Insecta : Embioptera	1	2	8
28.	Insecta : Orthoptera	12	126	210
29.	Insecta : Dermaptera	7	36	79
30.	Insecta : Ephemeroptera	5	10	17
31.	Insecta : Mantodea	7	24	35
32.	Insecta : Phasmida	4	15	28
33.	Insecta : Dictyoptera	8	17	23
34.	Insecta : Isoptera	4	23	52
35.	Insecta : Psocoptera	15	24	39
36.	Insecta : Hemiptera	44	505	966
37.	Insecta : Anoplura	6	7	20
38.	Insecta : Thysonoptera	4	75	124
39.	Insecta : Neuroptera	12	49	73
40.	Insecta : Mecoptera	2	2	3
41.	Insecta : Coleoptera	25	524	1570
42.	Insecta : Siphonoptera	3	8	13
43.	Insecta : Strepsiptera	2	7	14
44.	Insecta : Diptera	21	143	413
45.	Insecta : Lepidoptera	33	532	1020
46.	Insecta : Trichoptera	10	26	44
47.	Insecta : Hymenoptera	12	180	430
48.	Palaeotracha-Xiphisura	1	2	2
49.	Arachnida : Arannene (Spider)	37	169	409
50.	Arachnida : Scorpines	4	8	14
51.	Acari : Ticks (Metogtigmata)	1	9	32
52.	Acari : Mite : Astigmata	8	19	33
53.	Acari : Mite : Prostigmata	29	121	258
54.	Acari : Mite : Cryptostigmata	61	142	282
55.	Acari : Mite : Mesostigmata	7	15	66
56.	Diplopoda	5	9	22

Table-18 : Cont'd.

Taxonomic Groups	Districts of West Bengal								
	Bankura	Birbhum	Bardhaman	Darjiling	Haora	Hugli	Jalpaiguri	Koch Bihar	Maldah
Annelida	25	12	23	54	29	17	25	18	16
Crustacea	04	32	06	11	48	33	02	04	04
Insecta	293	203	254	3062	248	207	951	128	314
Xiphosura	-	-	-	-	-	-	-	-	-
Araneae	04	14	23	103	20	31	208	14	20
Scorpion	-	-	02	02	01	-	-	-	-
Acari	41	88	43	228	32	60	116	26	44
Diplopoda	-	-	-	18	01	01	-	-	-
Chilopoda	01	01	02	06	01	01	01	01	01
Phoronida	-	-	-	-	-	-	-	-	-
Brachiopoda	-	-	-	-	-	-	-	-	-
Freshwater Bryozoa	04	03	03	01	03	03	02	01	04
Echinodermata	-	-	-	-	-	-	-	-	-
Hemichordata	-	-	-	-	-	-	-	-	-
Chordata	115	77	52	584	114	89	461	77	83

Table-18 : Cont'd.

Taxonomic Groups	Districts of West Bengal							
	Murshidabad	Medinipur	Nadia	North 24 Pgs.	South 24 Pgs.	Purulia	Dinajpur	Kolkata
Protozoa (free living)	13	20	31	48	58	17	28	128
Protozoa (symbiotic)	07	03	-	03	17	-	-	107
Protozoa (parasitic)	48	56	162	109	118	38	31	258
Porifera	-	03	01	04	02	01	01	05
Cnidaria	-	13	-	-	15	01	-	01
Ctenophora	-	02	-	-	-	-	-	-
Cestoda	18	11	06	13	14	08	05	58
Trematoda (excluding fish)	01	25	02	22	24	17	05	59
Trematode (fish)	-	30	-	-	26	-	-	10

Table-18 : Cont'd.

Taxonomic Groups	Districts of West Bengal							
	Murshidabad	Medinipur	Nadia	North 24 Pgs.	South 24 Pgs.	Purulia	Dinajpur	Kolkata
Rotifera	-	28	19	43	102	-	-	58
Gastrotricha	-	14	-	04	12	-	-	-
Kinorhyncha	-	02	-	02	02	-	-	-
Nematode (vertebrate)	12	04	-	19	18	02	05	174
Nematode (plant)	09	05	05	11	11	-	04	01
Acanthocephala	-	-	-	01	01	-	-	13
Sipuncula	-	02	-	-	01	-	-	-
Fresh water and land Mollusca	09	18	24	33	41	19	25	67
Esturine and Marine Mollusca	-	51	-	03	73	01	-	10
Echiura	-	03	-	-	03	-	-	-
Annelida	16	39	18	11	80	18	18	45
Crustacea	04	35	05	19	177	01	04	35
Insecta	289	275	216	286	352	285	79	1189
Xiphosura	-	02	-	-	02	-	-	-
Araneae	16	24	29	80	73	05	11	98
Scorpion	-	03	-	02	01	01	-	08
Acari	44	101	74	55	118	29	21	96
Diplopoda	-	-	-	-	-	-	-	-
Chilopoda	01	01	01	01	01	01	01	02
Phoronida	-	01	-	-	-	-	-	-
Brachiopoda	-	01	-	-	-	-	-	-
Freshwater Bryozoa	02	06	03	-	-	03	02	04
Echinodermata	-	14	-	-	17	-	-	-
Hemichordata	-	-	-	-	01	-	-	-
Chordata	74	154	146	257	364	99	48	129

Table-19 : Distribution of species of Chordata in different districts of West Bengal.

Districts of West Bengal	Chordate Groups			
	Amphibia	Reptilia	Aves	Mammalia
Bankura	09	14	65	27
Birbhum	09	10	30	28
Barddhaman	04	08	130	30
Darjiling	24	73	365	122
Haora	06	24	58	26
Hugli	06	05	45	33
Jalpaiguri	12	42	323	84
Koch Bihar	10	03	36	28
Maldah	07	05	49	22
Murshidabad	08	08	34	24
Medinipur	11	19	79	45
Nadia	07	12	99	28
North 24 Pgs.	10	21	192	34
South 24 Pgs.	09	56	260	39
Puruliya	08	07	48	36
Dinajpur	08	04	15	21
Kolkata	01	34	48	46

1.1. *Protozoa* : Protozoa are single-celled eukaryotic organisms, which are, with some exceptions visible only with the aid of a microscope. Found in each and every habitat of all terrestrial and aquatic ecosystems as free-living, parasitic or symbiotic. A total of 1136 species belonging to 53 orders, 155 families and 298 genera have so far been recorded from the state. Free living and parasitic forms are represented by 131 and 144 genera respectively, while symbiotic species are distributed over 23 genera. Greatest species diversity is exhibited by the parasitic forms (743), followed by free-living (267) and symbiotic (126) (Text. fig. 13). However, the free-living forms are distributed over highest number of orders (30) and families (74).

Most of the families like Noctiluidae, Cryptorconadidae, Chromulinidae, Bionyxidae, Monocercomonadidae, Bedonidae and Adeleidae are represented by single genera and single species, while some families exhibit great number of genera and species such as Actinocephalidae (16 gen., 40 spp.), Ophryoscolecidae (9 gen., 94 spp.), Eimeriidae (9 gen., 124 spp.), Diffugiidae (6 gen., 36 spp.), etc. Among the genera highest species diversity is represented in the genus *Eimeria* (71), followed by *Trypanosoma* (44). Highest

number of species recorded from Kolkata (493).

1.2. *Porifera* : Commonly known as 'Sponges', includes a group of sedentary, diploblastic, filter feeding, porous bodied animals; mostly marine, but few occur in freshwater. From the state only the freshwater sponges belonging to the family Spongillidae have so far been recorded. A total of 16 species distributed over 9 genera are known. Genus *Eunapius* contains the maximum number (4) of species. Highest number of species recorded from Kolkata (5), while some of the districts like Darjiling and Murshidabad so far have no representatives.

1.3. *Cnidaria* : Body wall two layered-ectoderm and endoderm with an intervening acellular to rather cellular jelly-like mesoglea. Some ectodermal cells modified into specialized element called cnidoblasts or nematocysts. Predominantly marine. A total of 23 species belonging to 20 genera, 16 families and 7 orders are recorded from coastal waters of West Bengal. Except the family Haliactiidae which is represented by 4 genera, except the family Edwardsiidae and Catostylidae which contain 2 genera each, rest 13 contain one genus each in the state. All the species have been recorded from maritime districts *viz.*, Medinipur and South 24 Parganas.

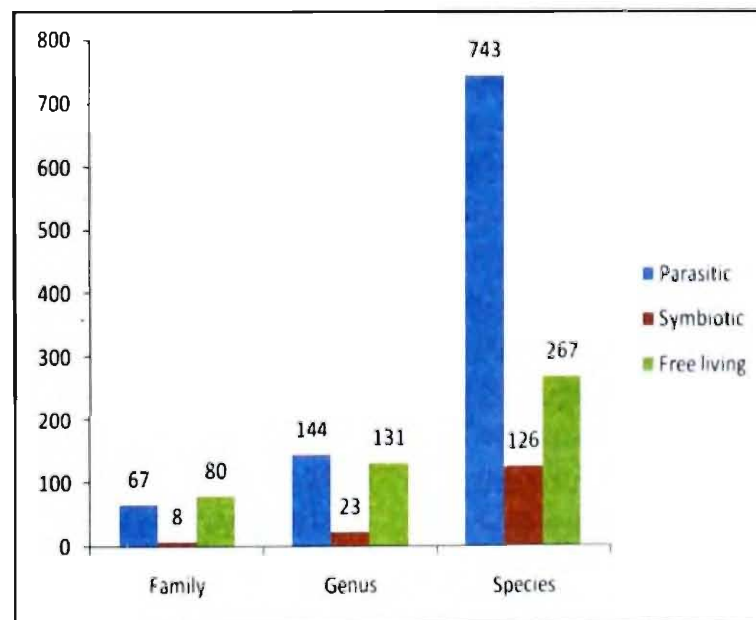


Fig. 13 : Protozoa diversity in West Bengal.

1.4. *Ctenophora* : Distinguished from Cnidarians by having eight meridional rows of ciliary plates or combplates. So far only two species belonging to two genera and two families are known from the state. Both the species are recorded only from the coastal waters of Medinipur and South 24 Parganas.

1.5. *Platyhelminthes* : Body dorso-ventrally flattened having an excretory or osmoregulatory system composed of Flame cells. From pathogenic point of view this is one of the most important group of animals. A total of 248 species have been reported from the state, i.e. about 15.25 percent of species known from India. Out of four classes, two viz., Cestoda and Trematoda are fairly well represented. Former contains 93 species under 43 genera, while latter is represented by 155 species under 103 genera. Maximum diversity of species (127) is seen in Kolkata.

1.6. *Nematoda* : Nematodes or round worms occur in every possible habitats as free-living, predaceous or parasitic in plants and animals. Economically very important both in negative and positive aspects. About 306 species representing 10.65 percent of species known from India is found in the state. Out of 306 species, 236 belonging to 113 genera have been recorded from vertebrate hosts, while 70 species under 25 genera from plants. Though highest number of species (175) have been recorded from different vertebrate hosts in Kolkata, but only a single species of plant nematode is known from the district. Plant nematodes are best represented (18) in Darjiling district.

1.7. *Rotifera* : Pseudocoelomate microorganisms with disc-like anterior end. Encountered in a wide range of aquatic and semiaquatic environs particularly of freshwater. Rotifera contribute significantly to overall biological productivity in fresh water by rapid turn over rate. So far, 147 species belonging to 30 genera are known from West Bengal. i.e. about 44.54 percent of the species

recorded from the country. Among the Indian states, West Bengal apparently harbours the highest number of species. Water bodies infested with different assemblages of aquatic macrophytes and ricefields exhibit richest species composition. Overall diversity of 72 species was recorded from these habitats of West Bengal (Sharma 1991). Highest number of species (102) is known from South 24 Parganas, followed by Kolkata (58).

1.8. *Gastrotricha* : Minute, unsegmented and free-living worms occurring in marine, brackish and freshwater habitats. Play an important role in trophic cycle by contributing remarkably to the regeneration of nutrients. Out of nine families in the country, eight are represented in the state by 15 genera and 24 species, i.e. 24 percent of the total species of India. Family Chaetonotidae contains the highest number of genera (5) and species (11). Further, it is the only family whose members are represented both in marine and freshwater, while others are confined in the marine environ. Though most of the genera are represented in the state by single species, but the genera *Acanthodasys* and *Polymerurus* are truly monotypic. Maximum number of species diversity (7) is exhibited by the genus *Chaetonotus*. Medinipur and South 24 Parganas contain 14 and 12 species respectively, while four species is known from Darjiling.

1.9. *Kinorhyncha* : Microscopic, spiny, segmented worm like creatures living exclusively in marine and estuarine sediments. Five species, i.e. 50 percent of Indian species, under three families and three genera are met in the state. Of the five species three belong to the genus *Echinoderes*, while the other two genera, viz., *Sphenoderes* and *Pychophyes* contain one species each. Species of Kinnorhyncha have been recorded from Medinipur, South and North 24 Parganas districts.

1.10. *Sipuncula* : Comprised of unsegmented spiny, coelomate creatures inhabiting coral,

rocky, or muddy habitats of marine and estuarine environments. Out of six families of the country, only Sipunculidae is found in the state and rerepresented by three genera each with single species. Known from Medinipur and South 24 Parganas.

1.11. *Echiura* : Unsegmented, coelomate worms inhabiting intertidal to the abyssal region. Out of four families of Indian waters, only one, *viz.*, Thalamematidae with 3 species under one genus is recorded from Kolkata and South 24 Parganas.

1.12. *Phoronida* : Includes slender, worm like, free-living, solitary and sedentary creatures housed in a self secreted tube. Of the two genera of the world, only the genus *Phoronis* is found in India with three species. West Bengal contains only one species, *viz.*, *Phoronis bhadurii*. The species is so far recorded only from sandy beach of Digha coast in Medinipur.

1.13. *Bryozoa* : Sessile, lophophorate, colonial, coelomate animals with recurved digestive tract, living in marine, estuarine and freshwater. Only the freshwater Bryozoans belonging to three families, five genera and nine species have been recorded from West Bengal. Family Plumatellidae is represented by three genera, while other two contain one genus each. Highest species diversity is exhibited by the genus *Plumatella* having four species. Though only 9 species have been recorded, but it is represented in the freshwater environs of all the districts, while maximum number of species (6) is known from Medinipur.

1.14. *Annelida* : True worms with a linear series of similar body segments. Marked externally by intersegmented grooves. Distributed over all the ecosystems. A total of 194 species, i.e. 23.09 percent of the Indian species are known to occur in the state and distributed over three classes, *viz.*, Polychaeta, Oligochaeta and Hirudinea. Many of the families like Lumbricidae, Naididae, Megascolecidae exhibit great generic diversity holding 6,7 and 7 genera respectively. Rich

species diversity could be observed in the genus *Perionyx* (18 spp.). Quite a number of species like *Plutillus ghumensis*, *Perionyx sikkimensis*, *Perionyx himalayanus* and *P. jorpokriensis* are restricted within the territory of West Bengal. Highest number of species is known from South 24 Parganas (76), followed by Darjiling (53).

1.15. *Arthropoda* : One of the largest and most successful group of animals in existence today is the Arthropod group. Characterised by segmented bodies, paired segmented (or jointed appendages), and usually hard exoskeleton. Occur in land, air and water; include animals commonly known as lobsters, crabs, shrimps, centipeds, spiders, insects, etc. Diversity in some major classes is discussed below.

1.15.A. *Crustacea* : Head bearing two pairs of antennae and nearly every body segment with one pair of legs. Majority are aquatic living in marine, brackish or freshwater, but land forms are also found. Represented in the state by 5 orders, 45 families, 135 genera and 251 species, the last one being over 8.53 percent of that in India. Maximum number of species (177) recorded from South 24 Parganas., followed by Haora (48) while it is poorly represented in Puruliya (1).

1.15.B. *Insecta* : Largest group among animals and plants. Body divided into three segments, pair of antennae at the top of head, three pairs of segmented legs. As per current estimate there are 61238 species of insects in India spreading over 619 families and 25-30 orders (number varying with different authorities). Distribution of insect species in different districts of West Bengal is shown in Table 20 and Fig.14. Species diversity in some major insect orders of the state is considered below :

Thysanura : Popularly known as 'Silver fish', soft bodied, wingless, scaled insects. Found on the forest floor; under bark, rock; nests of termites and ants; decomposing litter; books and other house hold goods. Out of five Indian families, two, *viz.*, Lepismatidae and Ateluridae

Table-20 : Distribution of species of insects in the districts of West Bengal.

Taxonomic Groups	Districts of West Bengal								
	Bankura	Birbhum	Bardhaman	Darjiling	Haora	Hugli	Jalpaiguri	Koch Bihar	Maldah
Thysanura	04	01	02	03	-	-	-	-	-
Collembola	-	-	-	03	02	-	-	-	-
Diplura	-	-	-	-	-	-	-	-	-
Odonata	26	19	11	96	28	09	53	11	21
Plecoptera	-	-	-	21	-	-	-	-	-
Embioptera	Locality not known								
Orthoptera	34	31	29	137	24	12	66	29	35
Dermoptera	05	03	-	67	02	01	06	-	04
Ephemeroptera	05	03	03	07	-	-	15	-	05
Mantida	01	02	02	15	01	02	02	01	02
Phasmida	-	-	-	17	-	-	02	-	-
Dictyoptera	09	06	03	17	03	01	09	02	09
Isoptera	04	03	04	20	01	04	10	06	02
Psocoptera	01	-	01	17	04	03	02	-	-
Hemiptera	45	17	24	474	35	22	178	23	32
Anoplura	-	-	04	-	-	-	-	-	-
Thysanoptera	17	23	-	40	27	04	02	22	-
Neuroptera	04	01	08	39	02	02	01	-	01
Mecoptera	Locality not known								
Coleoptera	56	38	34	1100	53	82	335	26	78
Siphonoptera	Locality not known								
Strepsiptera	-	-	12	-	-	01	-	-	04
Diptera	25	11	78	187	15	21	20	02	27
Lepidoptera	48	40	26	518	32	34	213	06	92
Trichoptera	02	02	01	34	-	-	01	-	01
Hymenoptera	07	03	12	250	19	09	36	-	01

Table-20 : *Cont'd.*

Taxonomic Groups	Districts of West Bengal							
	Murshidabad	Medinipur	Nadia	North 24 Pgs.	South 24 Pgs.	Purulia	Dinajpur	Kolkata
Thysanura	03	1	-	02	01	03	-	06
Collembola	-	-	04	02	03	-	-	11
Diplura	-	-	-	-	-	01	-	-
Odonata	14	26	02	07	26	08	17	41
Plecoptera	-	-	-	-	-	-	-	-
Embioptera	Locality not known							
Orthoptera	26	39	27	08	30	31	11	34
Dermoptera	-	04	01	01	03	04	-	08
Ephemeroptera	01	04	03	08	07	04	03	08
Mantida	02	05	06	03	06	02	01	06
Phasmida	-	-	-	-	01	-	-	08
Dictyoptera	04	03	03	02	01	-	08	07
Isoptera	07	15	10	08	08	01	-	15
Psocoptera	-	01	-	04	01	-	-	08
Hemiptera	34	40	38	46	56	26	16	205
Anoplura	-	04	-	-	02	07	-	02
Thysanoptera	19	04	06	02	32	08	02	33
Neuroptera	-	04	05	10	10	-	-	11
Mecoptera	Locality not known							
Coleoptera	110	68	53	64	95	28	12	355
Siphonoptera	Locality not known							
Strepsiptera	-	-	02	01	-	-	-	01
Diptera	15	15	24	36	16	16	-	55
Lepidoptera	47	35	17	51	35	14	07	314
Trichoptera	01	-	-	-	-	01	01	03
Hymenoptera	06	07	15	31	19	07	01	58

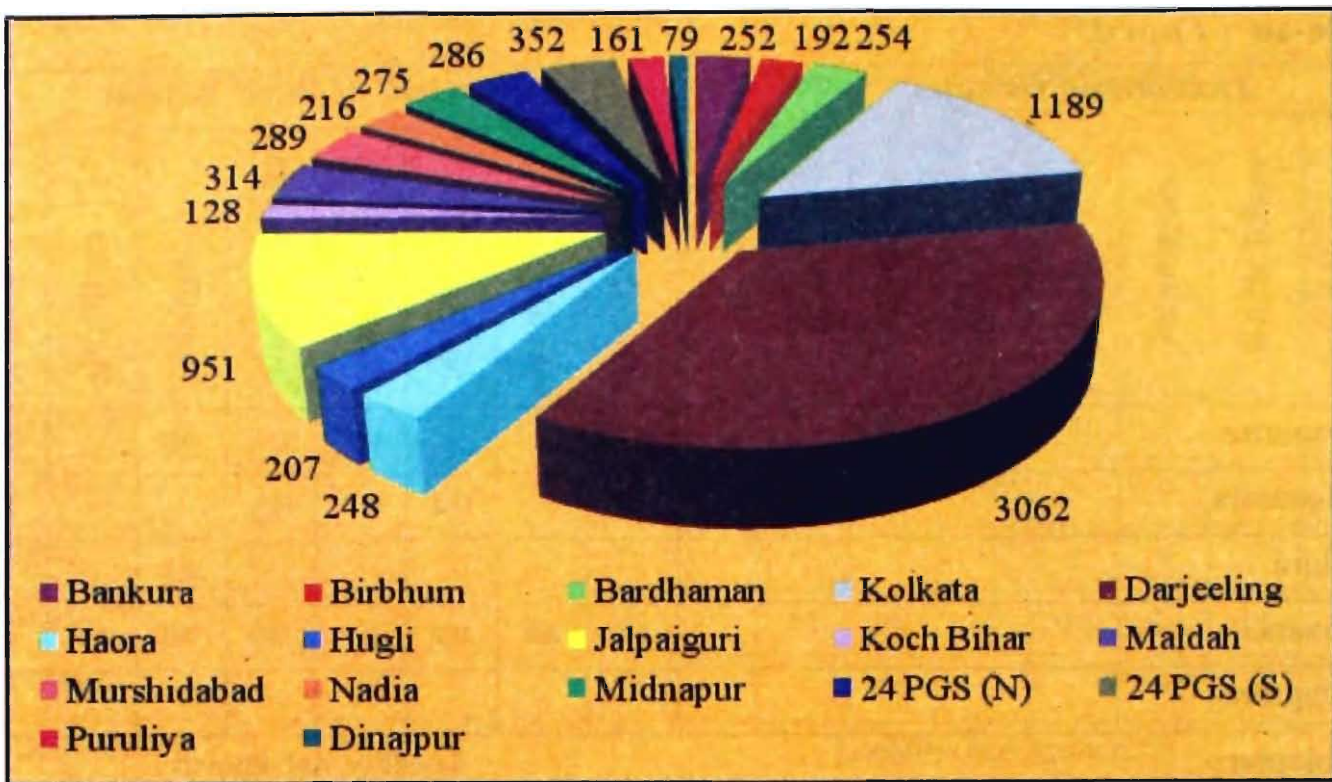


Fig. 14 : Species diversity of insect fauna in different districts of West Bengal.

are known from West Bengal. The former is represented by 7 species under five genera, latter by two species and two genera.

Collembola : Wingless, having spring like forked jumping organ underneath the fourth abdominal segment. Found in huge number specially in soil rich with organic matter content. Though as many as 210 species have been recorded from India but only 15 (7.14 percent) species found in West Bengal. All the 15 species belong to two families and 10 genera. Recorded only from 11 districts of the state and highest number of species (10) known from Kolkata.

Odonata : Odonata or 'Dragon flies' are amphibiotic, spending major part of life cycle in water and adults are flying. In India, total of 499 species belonging to 17 families are found. West Bengal has the representatives of 15 families with 93 genera and 180 species, i.e., 3.21 percent of the country's fauna. Family Libellulidae has the highest number of genera (32), while the genera *Agriocnemis* and *Pseudagrion* of the family Coenagrionidae contain the highest number of species (7). Maximum species diversity (96) is observed in Darjiling, followed by Jalpaiguri (53).

Plecoptera : Found in and around high altitude hill streams. Out of 113 Indian species, 21 species i.e. 18.58 percent belonging to 10 genera and 4 families are represented in West Bengal. Families Nemouridae and Perlidae contain four genera each, while the genus *Amphinemoura* of the former family holds the highest number of species (5). All the species are confined to Darjiling district.

Orthoptera : Contains grasshoppers, locusts, crickets, etc., in which forewings form more or less thickened tegmina with submarginal costal vein. Found mainly in grasslands, forests, crop fields, sandy tracts and also in snow-clad mountains. One of largest orders of insects, holding over 17250 species in the world and 1750 spp. in India. Nearly 11.88 percent of Indian species, i.e., 210 species spreading over 126 genera and 12 families are met with in the state. Family Acrididae is represented with highest number of genera (46) as well as species (61). However, greatest species diversity (7) is displayed by genus *Bollivaritellix* of the family Tetrigidae and *Pteronemobius* of the family Gryllidae. Darjiling possesses highest number of species (137) followed by Jalpaiguri (66).

Dermaptera : Commonly known as “Earwigs” and distinguished by the presence of a pair of unsegmented, chitinous forceps at hind end of the body. Found mainly near waterbodies, under stones, leaf-litter, decaying books and other similar places. All the 7 families recorded from India are represented in the state. Out of 320 Indian species, 79 species (24.68 percent) under 36 genera are known from the state. Highest generic diversity (8) is exhibited by the family Forficulidae, and the genus *Forficula* of the same family contains highest number of

species (12). Darjiling shows the greatest species diversity (67), while there is no record of this group in many of the districts, obviously due to lack of explorations.

Mantodea : Known as ‘Praying Mantis’ as adults hold their grasping forelegs in ‘Namaste’ posture while waiting for prey. Occur in green vegetable and different plant parts. Out of 8 families, 68 genera and 162 species occurring in India, state has the share of 7 families, 24 genera and 35 species (Text-fig.15). Darjiling contains the maximum number of species (15).

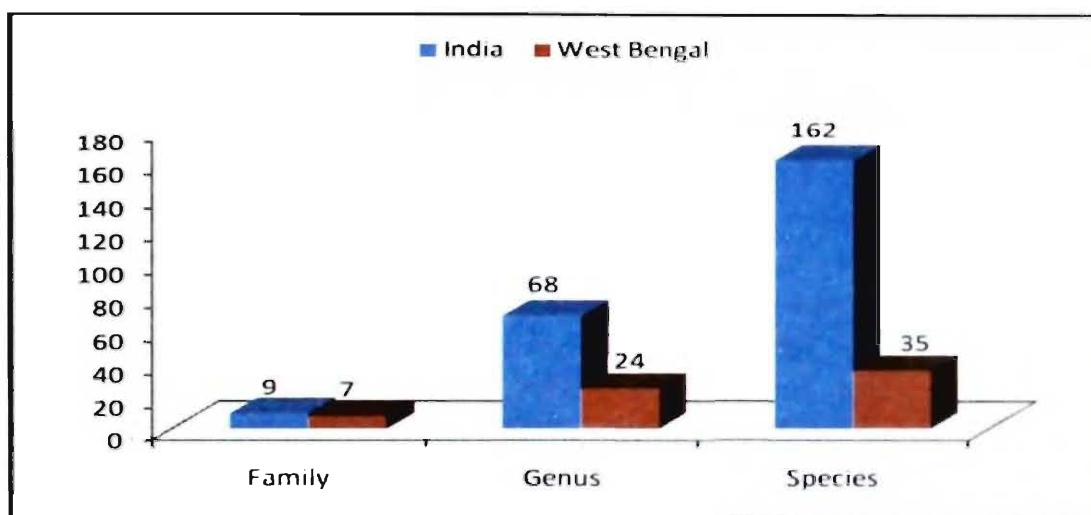


Fig. 15 : Diversity in Mantodea of West Bengal as compared to India.

Dictyoptera (Blattariae) : Includes ‘Cockroaches, in which head mostly or completely covered above by a large shield-pronotum. Found under stones, leaf litter, drains; domestic dark areas, food corners, etc. In India, 186 species spreading over 58 genera

and 12 families occur, of which 23 species under 17 genera and 8 families are represented in the state (Text-fig. 16). Highest generic diversity (5) as well as species diversity (7) is exhibited in the family Blattidae. Maximum number of species is known from Darjiling (17), followed by Jalpaiguri and Maldah with 9 species each.

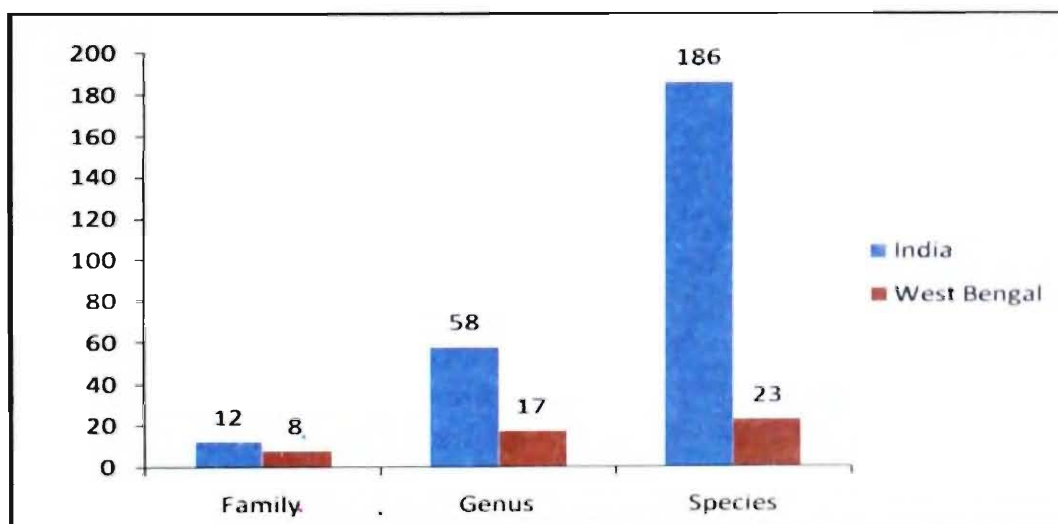


Fig. 16 : Diversity in Dictyoptera of West Bengal as compared to India.

Isoptera : Includes 'Termites', recognized by broad and grinding-biting type of mandible. Favoured habitats are logs; mud mounds; under stones; wood-work, etc. In West Bengal, 52 species belonging to 23 genera and 4 families occur as against 253 under 54 genera and 7 families of India (Text-fig.17). Family Termitidae is best represented in the state in

respect of number of genera (15) and species (34), while the family Stylotermitidae is monotypic, containing single genus *Stylotermes*. Highest species diversity (9) is observed in the genus *Odontotermes* of the family Termitidae. These creatures are well represented in the forested tracts of Darjiling as well as urban areas of Kolkata, which support 20 and 15 species respectively.

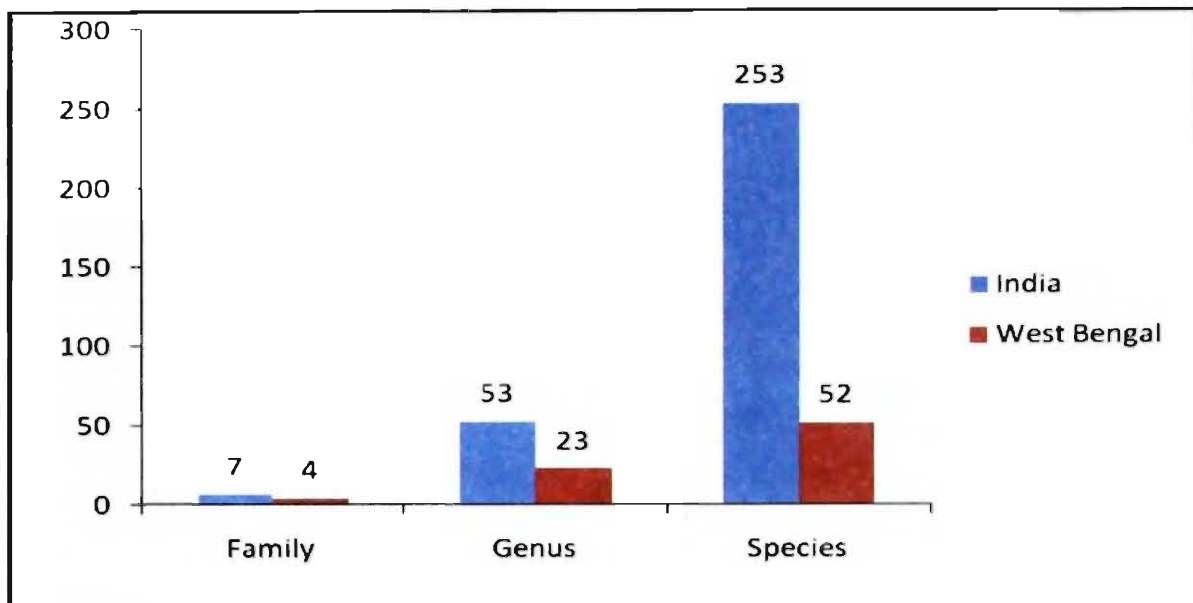


Fig. 17 : Diversity in Isoptera of West Bengal as compared to India.

Psocoptera : Psocids or 'Booklice' are small, soft-bodied, subglobular insects found amidst old stalk of papers/books, and among foliage. Out of 16 families occurring in the country, as many as 15 are found in the state harbouring 24 genera and 39 species, i.e., 43.33 percent of the species reported from India. Ten out of 15 families of the state have representative of one genus each, while family Pseudocaeciliidae contains as many as four genera. Genus *Peripsocus* of the family Peripsocidae and genus *Caececilius* of the family Caeciliidae contain five species each. Many of the districts, viz., Birbhum, Murshidabad, Nadia, Dinajpur, Koch-Bihar, Maldah, Puruliya do not have any record of Psocopteran insects, and Darjiling holds the highest number of species (17). Species richness in Darjiling district indicates that absence of these creatures in neighbouring districts is only due to lack of proper taxonomic exploration.

Hemiptera : Known as 'Bugs', have piercing and sucking type of mouth parts. Found in

aquatic, semiaquatic and terrestrial habitats. One of the largest exopterygote insect groups, and there are about 6500 species in India distributed over 77 families. From the state, 966 species (14.87 percent of country's total) under 505 genera have been reported. Species of the families Aphididae, Membracidae, Cercopidae, Fulgoridae, Cicadellidae, Belostomatidae, Nepidae, Gerridae, Velidae, etc. are well distributed throughout the state. A good number of species are known from almost all the districts, but Darjiling surpasses all others by holding 474 species followed by Kolkata (205).

Trichoptera : Hairy-winged insects, popularly known as 'Caddis flies'. Though as many as 812 species under 112 genera and 19 families have been reported from India, only 44 species (5.41 of country's total) spreading over 26 genera and 10 families (Text-fig.18) are known from the state. Majority of the species (34) are known from Darjiling, while no record

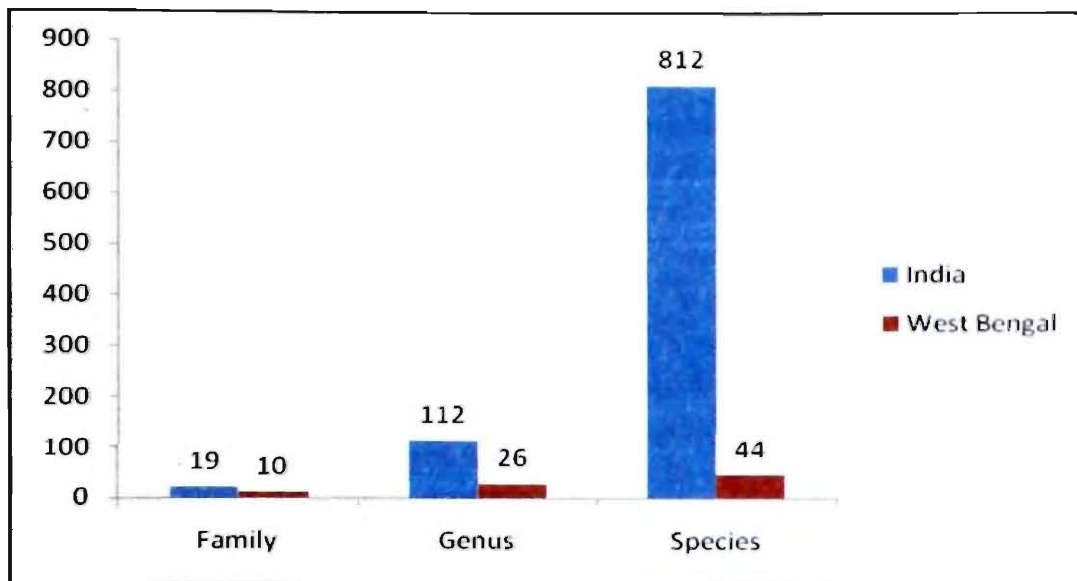


Fig. 18 : Diversity in Trichoptera of West Bengal as compared to India.

of these insects could be found from Murshidabad, Nadia, Medinipur, North-24 Parganas and others.

Thysanoptera : One of the smallest Pterygote insects having fringe-wings; mainly associated with plants. Out of five families occurring in India, four *viz.*, Aeolothripidae, Merothripidae, Thripidae and Phlaeothripidae occur in the state and represented by 124 species (17.89 percent of Indian species) under 75 genera. Highest number of species is found in Darjiling (40).

Neuroptera : Recognised by the fine network of veins of generally transparent wings. Adults mainly occupy grasslands, foliage and crop fields. India harbours 335 species belonging to 125 genera and 13 families. Out of 13 families, 12 are represented in the state, harbouring 73 species (22.08 percent of Indian species) belonging to 49 genera. Highest number of species (39) are met in Darjiling district.

Coleoptera : Coleopteran insects or beetles represent the largest groups of organism at the order level and are recognized by much thickened, veinless front wings. India holds about 15,500 species and West Bengal shares 1570 species under 524 genera and 25 families. Highest number of species (1100) are recorded from Darjiling.

Strepsiptera : These are entomophagus parasitoids, commonly known as 'Stylops'. A

total of 14 species belonging to 7 genera and 2 families have been recorded from the state. Highest species diversity (5) is expressed by the genus *Tridactylophagus* of the family Halictophagidae. There is no record of these insects from many of the districts, while Barddhaman has the highest number of species (12).

Diptera : Comprises of mosquitoes, midges, flies; exhibits a great diversity of habits, habitats and species composition. India holds nearly 6093 species under 1075 genera and 87 families of which West Bengal sharing 413 species (6.8 percent of country's total) spreading over 143 genera and 21 families. Maximum species diversity (187) is observed in Darjiling district.

Lepidoptera : Scale-winged insects; includes butterflies and moths which mainly occur on green vegetation. About 15000 species under 84 families have been reported from India, of which West Bengal has the representatives of nearly 1020 species (6.80 percent of the total Indian species) distributed under 532 genera and 33 families. In the state, highest generic diversity (110) is exhibited by the family Pyralidae, followed by Sphingidae (72). Genus *Dasychira* of the family Sphingidae, and *Neptis* of the family Nymphalidae contain the highest number of species (14). Greatest number of

species (518) is known from Darjiling, followed by Kolkata (314).

Hymenoptera : The Hymenopteran insects include bees, wasps, ants, etc., and occur in diverse habitats, such as, plants, soils, domestic areas and also as parasites of other insects. Of nearly 10000 Indian species, 430 (4.30 percent) species under 180 genera and 12 families have been reported from West Bengal. Darjiling contains the highest number of species (250).

I.15.C. Xiphosura : Composed almost entirely of extinct forms and commonly known as 'King Crabs' or 'Horse shoe Crabs'. Occur in marine, estuarine and occasionally in freshwaters. Out of four living known species

of the world, two belonging to two different genera are found in India and both of them have been recorded from Medinipur and South 24 Parganas districts of West Bengal.

I.15.D. Arachnida : Scorpions, spiders, ticks, mites, etc., are included under this class and characterized by absence of antennae, and body of two parts, viz., cephalothorax and abdomen. As many as 5818 species of Arachnids belonging to 7 orders are known from India. From the state though nearly 1094 species have been recorded, but majority of them belong to two orders, viz., Araneae and Acari, while other orders are yet to be explored properly. Diversity in some arachnid groups in the state is shown in figs. 19 and 20. Their distribution in the districts is shown in Table 21.

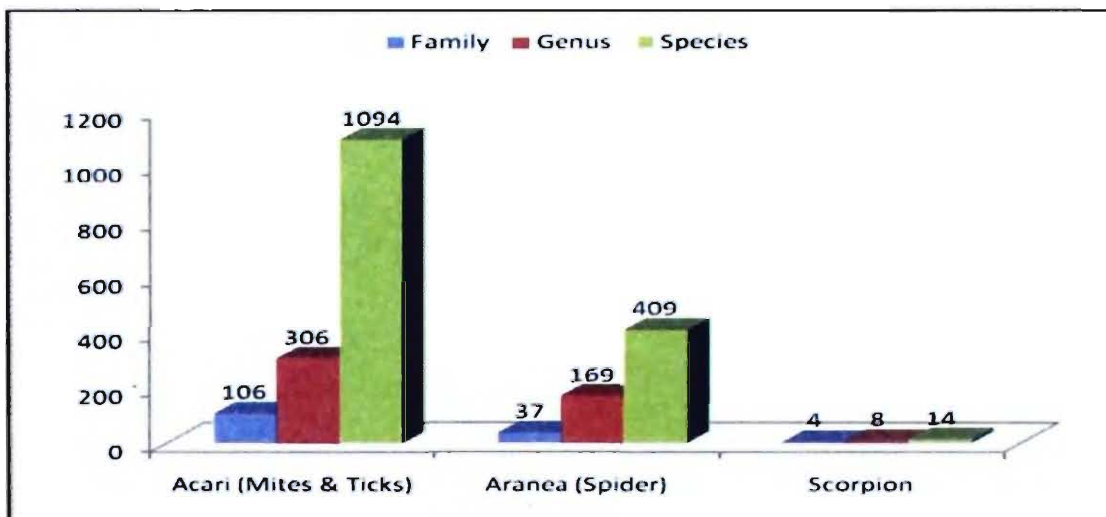


Fig. 19 : Diversity in some Arachnid groups in West Bengal.

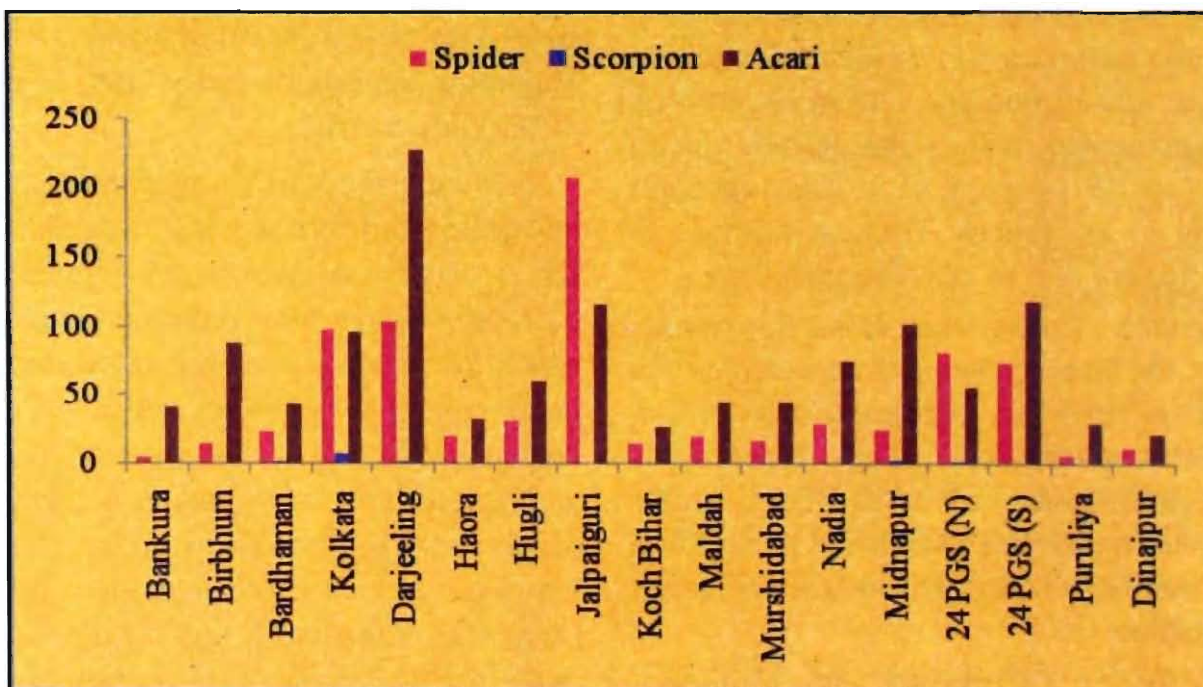


Fig. 20 : Diversity in some Arachnida in different districts of West Bengal.

Table-21 : Distribution of species of arachnida in the districts of West Bengal.

Districts	Number of Species							Other Arachnida	
	Meta-stigmata	Asti-gmata	Prosti-gmata	Meso-stigmata	Cryp-tostig-mata	Total Acari	Ara-neae	Scorp-iones	
Bankura	3	×	22	9	7	41	4	×	
Birbhum	2	×	9	4	73	88	14	×	
Bardhaman	3	4	13	3	20	43	23	2	
Kolkata	10	28	27	2	29	96	98	8	
Darjiling	17	2	52	39	118	228	103	2	
Haora	3	4	10	4	11	32	20	1	
Hugli	4	14	30	4	8	60	31	×	
Jalpaiguri	15	×	25	16	60	116	208	×	
Koch Bihar	3	1	8	7	7	26	14	×	
Maldah	4	1	19	14	6	44	20	×	
Murshidabad	3	×	14	15	12	44	16	×	
Medinipur	6	6	51	17	21	101	24	3	
Nadia	3	4	42	3	22	74	29	×	
North 24 Pgs.	6	1	12	7	29	55	80	2	
South 24 Pgs.	4	×	52	16	46	118	73	1	
Purulia	5	×	8	7	9	29	5	1	
W. Dinajpur	3	×	5	4	9	21	11	×	

Araneae : Spiders are grouped under this order. Out of 46 families, 240 genera and 1035 species of India 37 families, 169 genera and 409 (39.5 percent of Indian species) species are represented in the state. Family Araneidae includes the maximum number of genera (18), while the genus *Oxyopes* under the family Oxyopidae holds the highest number of species (15). District Jalpaiguri exhibits richest species diversity (208), followed by Kolkata (98).

Acari : Comprising ticks and mites in which somatic segmentation is inconspicuous or absent. There are about 2186 Indian species spreading over 5 suborders, 207 families and 643 genera. All the suborders are fairly represented in the state and species diversity under each suborder is provided in Table 22.

Table-22 : Species diversity of different suborders of Acari in West Bengal.

Suborders	No. of Families	No. of Genera	No. of Species
Astigmata	8	19	33
Mesostigmata	7	15	66
Metastigmata	1	9	32
Cryptostigmata	61	142	282
Prostigmata	29	121	258
Total	106	306	671

Suborder Astigmata is best represented in Kolkata having 28 species, while Darjiling holds the maximum number of species for all other suborders.

I.16. *Mollusca* : Soft-bodied animals, but majority of the species covered by one or more hard calcareous shell. Adapted to diverse habitats from deep sea to high hills. Overall species diversity of Indian marine molluscs is much higher than that of the combined freshwater and terrestrial ecosystem. Marine Ecosystem in India contains 3440 species under 521 genera and 247 families as against 1712 species under 193 genera and 48 families of freshwater and terrestrial ecosystems. However, in the context of West Bengal, reverse is true (Text. fig. 21). Freshwater and terrestrial ecosystems support 180 species under 70 genera and 35 families while there are 94 species belonging to 65 genera, 42 families in marine and estuarine ecosystems. Family Ariophantidae and Cyclophoridae show highest generic diversity (7) in land and freshwater, and family Neritidae has highest number of genera (5) in marine water. Most of the marine genera are represented by single species, but *Nactica* (Family Nacticidae) and *Stenothyra* (Family Stenothyridae), contain four species each. Among the freshwater and land molluscs, genus

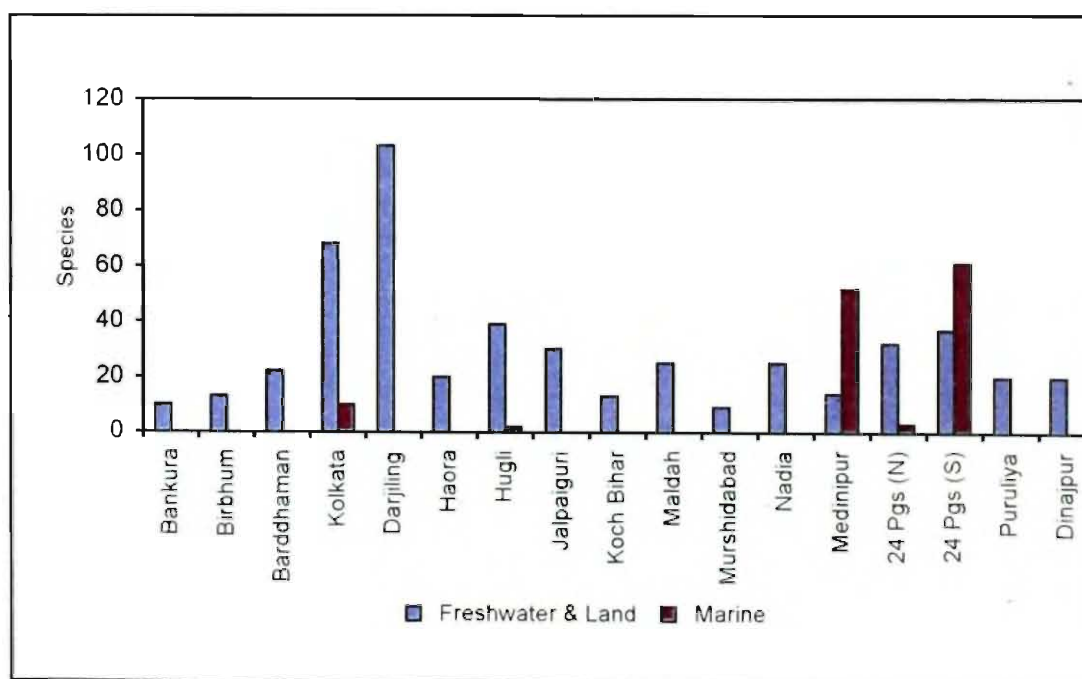


Fig. 21 : Faunal Diversity of Mollusca in West Bengal.

Macrochalamys (Family Ariophantidae) holds as many as 18 species, followed by the genus *Parreysia* (Family Amblemidae) containing 13 species. Highest number of land and freshwater molluscan species (94) reported from Darjiling, and district South 24 Pgs. is richest (73) in respect of marine mollusca.

1.17. *Echinodermata* : Characterised by water vascular system of coelomic origin, with radiating canals and pentamerous arrangement of body organs. Occur in sandy, muddy, rocky and coral environments from intertidal zone to deep sea. Only a very small percentage of Indian species (2.74 percent) is known from the state. There are 22 species spreading over 18 genera, 14 families and 4 orders reported from Medinipur, South 24 Parganas and Hugli districts.

1.18. *Hemichordata* : A so-called notochord present in the middle of the body. Occur from intertidal zone to deep sea. Out of 12 Indian species, only one under the genus *Saccoglossus* has been recorded from saline marshy areas of Sundarban.

1.19. *Vertebrate* : Vertebrate fauna of the state comprises 36.75% of all known vertebrates in the country (Text. fig. 22).

Pisces : Poikilothermus, have gills for respiration and one of the most important components of aquatic ecosystems. A total of 2634 species belonging to 969 genera, 254 families have been estimated from Indian waters. West Bengal represents 403 marine species under 250 genera, and 207 freshwater species under 113 genera.

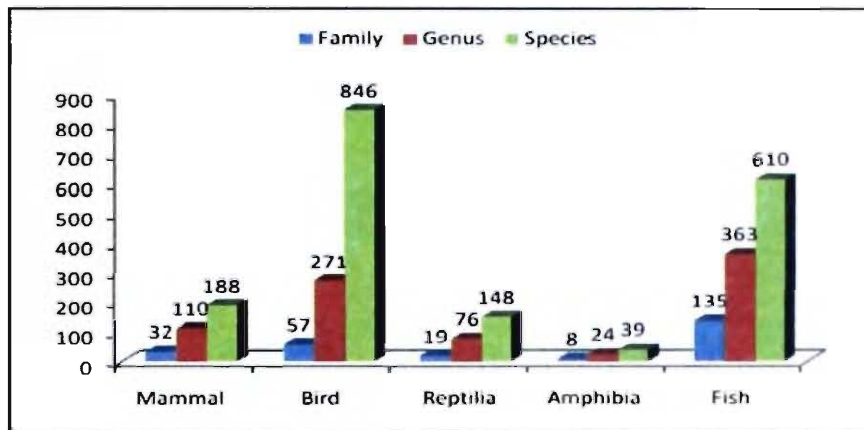


Fig. 22 : Vertebrate diversity in West Bengal.

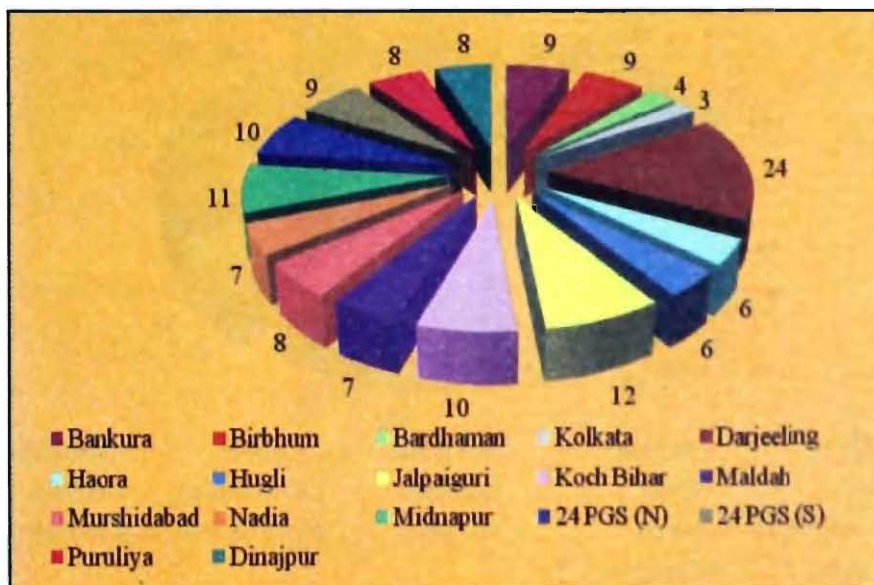


Fig. 23 : Amphibian Diversity in different districts of West Bengal.

Amphibia : Poikilothermus, with smooth skin. Lead a bimodal life in water as well as on land. From the country 289 species belonging to 38 genera, 3 families and 3 orders are known, out of which 39 species under 24 genera, 8 families and 3 orders recorded from the state. Family Dicroglossidae is represented by highest number of genera (7) and species (14). Darjiling not only contains highest number of species (24), but also all the three orders, viz., Anura, caudata and Gymnophiona, while in the rest of the state only the order Anura has been recorded. Diversity in amphibian in different districts of West Bengal is shown in fig. 23.

Reptilia : Poikilothermus, having body covering of scales. Found both in aquatic and terrestrial environment. Nearly, 456 species under 19 families and three orders are known from India, out of which 148 species spreading over 76 genera, 19 families and three orders are found in West Bengal. A family of snakes, viz., Colubridae under order Squamata exhibits the highest generic (30) as well as species (62) diversity. Maximum number of species (62) recorded from South 24 Parganas. Diversity in reptilian species in different districts of West Bengal is shown in fig. 24.

Aves : Body covered with feathers. Distributed over almost all the ecosystems.

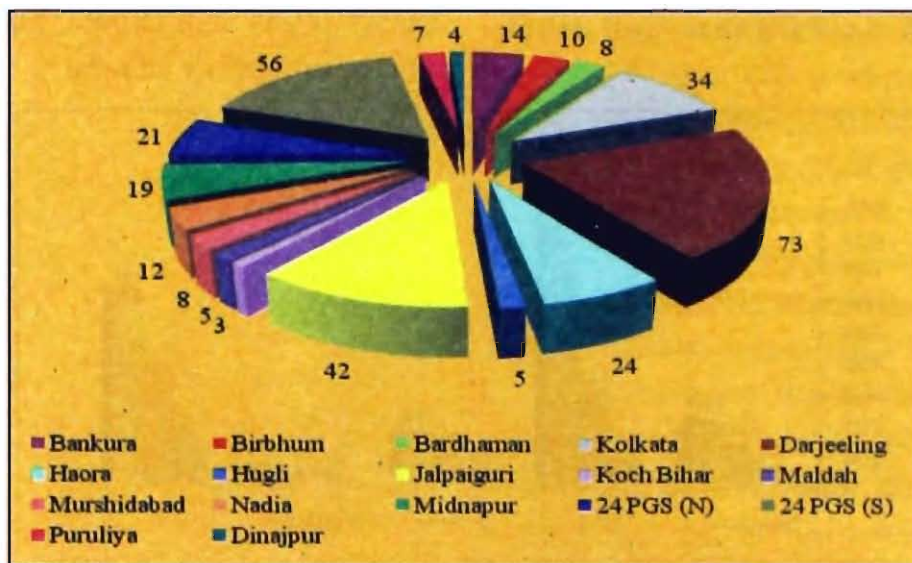


Fig. 24 : Reptile diversity in different district of West Bengal

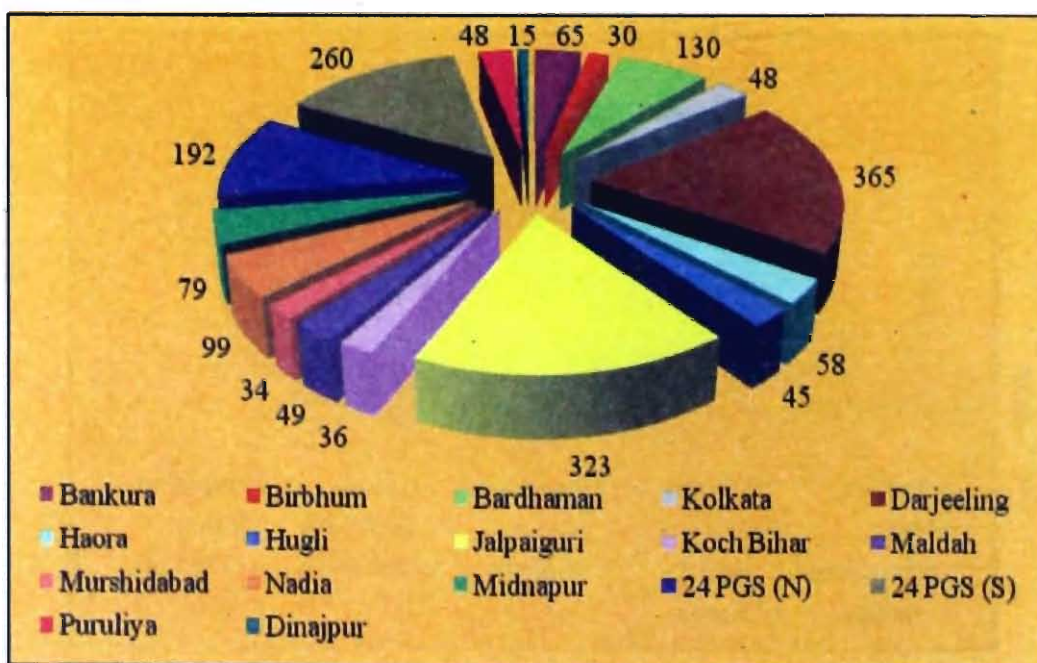


Fig. 25 : Avian diversity in different districts of West Bengal.

While India has 1232 species and subspecies under 405 genera, 78 families and 20 orders, West Bengal can boast of supporting 846 species and subspecies under 271 genera, 57 families and 16 orders. However, many of the species are only seasonal visitors of the state. Greatest diversity could be observed in the orders Passeriformes, containing 26 families 104 genera and 276 species and subspecies. District-wise avian species diversity is shown in Text. fig. 25. Darjiling holds the highest number of species (424).

Mammalia : Body covered with hairs at least during some period of life cycle. Found in all types of habitats exhibiting greatest adaptive radiation. From the country 397 species

belonging to 107 genera, 47 families and 13 orders are known. West Bengal shares 188 species and subspecies under 110 genera and 32 families, and 12 orders. Order Chiroptera, containing the flying mammals, exhibits greatest species diversity (60) under 7 families, followed by the order Rodentia with 40 species and 3 families. The order Carnivora holds the highest number of families (8). District-wise mammalian species diversity is shown in Text. fig. 26. District Darjiling represents the maximum number of species (122), followed by Jalpaiguri (84). For the sake of conservation, at least 65 mammalian species of West Bengal found place in the Schedules of Indian Wildlife (Protection) Act, 1972.

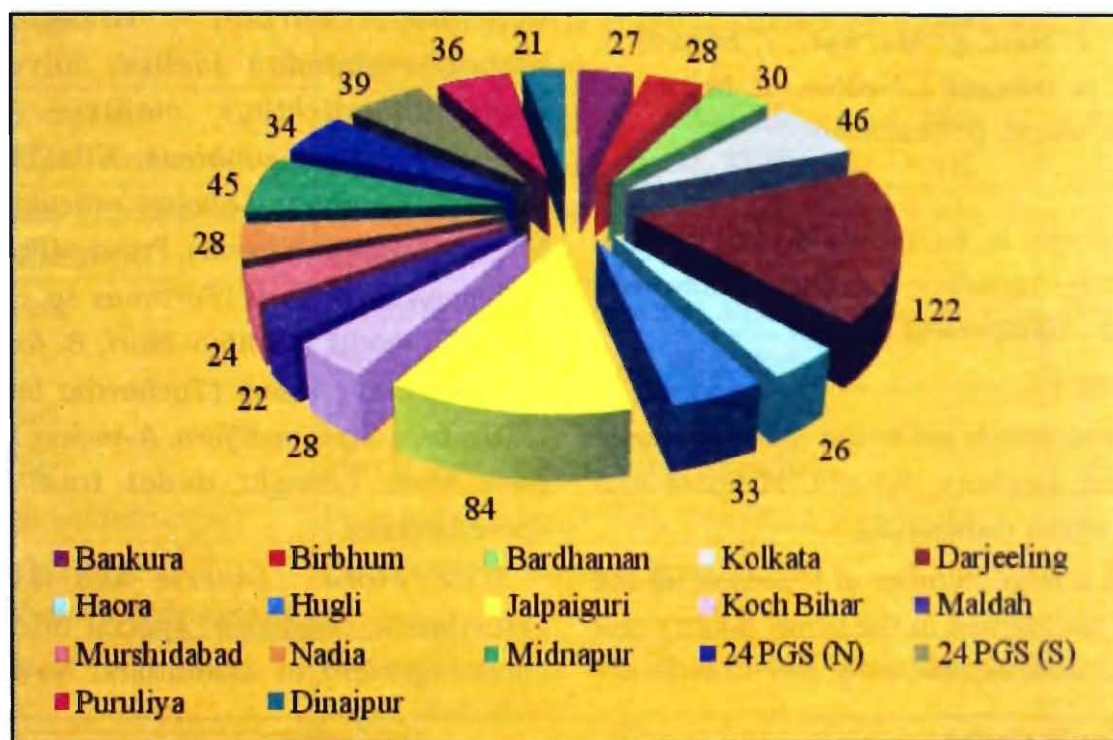


Fig. 26 : Mammalian Diversity in different districts of West Bengal.

III. Domestic biodiversity :

Since the earliest stage of human civilization, a large number of plant and animal species are being domesticated or brought under cultivation. During domestication, a large number of breeds or varieties for each of the species have been produced for getting better yield. However, after the introduction of High

Yielding Varieties, many of these breeds have been wiped out.

III.1. *Fauna* : So far, only a few species of animals have been domesticated by the human beings. In the state, most of the domestic species have a fairly good number of breeds and many of them were brought from other parts of the country. Some of the important breeds are mentioned below.

i. Cattle :

Milk breeds : a. Sahiwal, b. Sindhi, c. Gir, d. Deoni Dual purpose breed (Haryana, Ongole, Thar Parkar, Kankrej).

Draught breeds : a. Amrit Mahal, b. Malvi, C. Kangayam, d. Siri, e. Halli Kar.

ii. Buffaloes :

a. Murrah, b. Jaffarabad, c. Nili, d. Ravi, e. Bhadawari, f. Surti.

iii. Goat :

a. Kashmiri, b. Gaddi, c. Jamunapuri, d. Barbari, e. Beetal, f. Berari, g. Surti, h. Bengal Goat.

iv. Sheep :

a. Gaddi, b. Bhakarwal, c. Gurej, d. Chokla, e. Magra, f. Nali, g. Marwari, i. Sonadi, j. Kathiwari, k. Deccani, l. Nellore, m. Bellary, n. Mandya, o. Goral, p. Shahabadi.

v. Pigs :

a. Deshitype, b. Exotic types (Large white, Middle white, Yorkshire, Landrace, Tamworth, Saddleback, Hampshire).

vi. Poultry :

At least 16 breeds are found of which Rhode Island Red, Leghorn, Sussex, Minorea and Deshi are worth mentioning.

Though a large number of breeds of all the above are maintained in the farms, poultry and individual houses, but only few breeds are

native to the state. According to Dr. A. Chatterjee, Ex-Director, State Veterinary Department, following breeds may be considered original to the state.

Cattle : Siri-fum Darjiling-Almost extinct.

Goat : a. Black Bengal Goat-South and North 24 parganas and Hugli, b. Brown Bengal Goat-Maldah, c. White Bengal Goat-North and South Dinajpur.

Sheep : Goral-South 24 Parganas.

Poultry : Assel-Bankura, Birbhum, Puruliya.

Apart from these, various breeds of dogs (*Canis* sp.), native or exotic species of fish (*Salmotrutta ferio*, Trouts-*Salmo gairdneni*, *Cyprinus carpio*, Grass carp-*Ctenopharyngodon idellus*, Silver carp-*Hypophthalmichthys molitrix*, Tilapia-*Oreochromis mosambicus*, Nile Tilapia-*O. niloticus*, Gambusia-*Labestes reticulatus*, Thai Magur-*Clarias ganepenis*), Prawns (*Penaeus* sp. *Palaemon* sp.), crabs (*Portunus* sp., *Potamon* sp.), Silk moths (*Bombyx mori*, *B. fortunatus*, *B. nistry*), Lac insect (*Tachardia lacca*) and Honey bees (*Apis mellifera*, *A. indica*, *A. florea*) have been brought under total or part domestication.

III.2. *Flora* : Diverse and favourable agroclimatic condition; special interest and encouragement of Zamindars, Nawabs and

Fruit Crops	Varieties
xvi. Mango (<i>Mangifera indica</i>)	Fajli, Langra, Himsagar, Bombai, Golapkhas, Lakshmanbhog, Champa, Chandankosa, Anaras, Gopalbhog, Safdar Pasand, Rani Pasand, Shorikhas, Surjapuri, Ashwina, Kohitoor, Kalapahar, Dilshad, Gaurjit, Nawab Pasand, Sutan Pasand, Sinduria, Amrapali, Mallika, Madhu Kulkuli, etc. and number is above 150.
ii. Banana (<i>Musa sapientum</i>)	Champa, Chini Champa, Manik Champa, Kanthali, Mulbhog, Dudha, Kalibow, Martaman, Sabri, Kabuli, Giant Governor, Robusta, Amritasagar, Baise, Agnishwar, Kanaibashi, Anupam, Dudsagar, Beecha, Chini Beecha, Mandira, Beula, etc.
iii. Pineapple	Giant Kew, Queen, Baruipur Local, Singapore, Ceylon, Jaldhup, Mauritius.

iv. Litchi (<i>Nephelium litchi</i>)	Bombai, Muzaffarpur, China, Elachi, Kashba, Purbi, etc.
v. Guava (<i>Psidium guyava</i>)	Khaja, Kashi, L-49, Kafri, Apple, Safeda, Red Fleshed, Seedless.
vi. Papaya	Washington, Honey Dew, Ranchi, Solo, CO 1 to CO 5.
vii. Sapota (<i>A'chras sapota</i>)	Cricket Ball, Bahara, Gandevi Baroda, Dhakai, Small Oval, Badami.
viii. Citrus Fruits (<i>Citrus</i> sp.)	Limes, Lemons (Gandharaj, Seedless, Kadamba), Pummelo (Stalkart, Krishnagar 1, Krishnagar 3), Sweet Lime, Mandarin Orange, Sweep Orange and many others.
ix. Coconut (<i>Cocos nucifera</i>)	EC Tall, WCT, Local, Hazari, Hybrid, TXD, DXT, Malayan Dwarf.
x. Cashew (<i>Anacardium occidentale</i>)	Depali, and few others.
B. Vegetables	
i. Cauli flower	Jawahor Moti, Early Kuanri, Early Patna, Kalimpong. Dania, Snowball, Daina, Synthetic, Kalimpong Snowball, Pusa Dipali, Benaras, Jspanese.
ii. Cabbage	Golden Acre, Pride of India, Kalimpong English Ball, Kalimpong; Eclipse Drumhead.
iii. Garden peas (<i>Psidium sativum</i>)	Early Giant, Meteor, Arkel Alderman, New Line Perfection, Bonneville, Jawahar Matar, Krishnagar Dwarf.
iv. Tomato (<i>Lycopersicum esculentum</i>)	Sioux, Pusa Ruby, S-12, Punjab Topic, Roma Super, Marglobe, Krishnagar S 20.
v. Raddish	Kalpin Red, Kalimpong Red, Krishnagar Red Bombai, Contai, Long.
vi. Beet	Crimson Globe, Detroit Dark Red.
vii. Carrot	Pusa Kesar, Nantes.
viii. Turnip	Purple Top, White Globe, Snowball.
xi. Onion (<i>Allium cepa</i>)	Pusa Ratnar, Nasik Red, Pusa Red, Red Globe.
x. Lady's Finger (<i>Hibiscus esculentus</i>)	Pusa Sawani, Parwani Kranti.
xi. Chilli	Suryamukhi, G-3, NP 46 A, Patnai, Pusa Jwala, Bullet, Sali, Siti Sagar, Sundari.
xii. Pumpkin (<i>Cucurbita pepo</i>)	Chaitali, Barsati.
xiii. Cucumber (<i>Cucumis sativus</i>)	Japanese Long green, Poinseti, Krishnagar Selection.
xiv. Brinjal (<i>Solanum melongena</i>)	Pusa Kranti, Pusa Purple, Makra, Cluster, Pusa Purple Long, Muktakeshi, Noorki, Paiva Tuni, Rajpur Selection, Rajkrishna, Purple Round, Green Long.
xv. Bottle Gourd (<i>Lagenaria vulgaris</i>)	Pusa Summar, Desi Long, Bajoral Selection.
xvi. Sweet Potato (<i>Ipomoea batatas</i>)	Pusa sunheri, Pusa Safed, Pusa Lal.

wealthy persons; success of commercial horticulture and crop research centers; and several other factors make West Bengal, not only very rich in species of cereals, vegetables and fruits but also varieties in each of them. A glimpse of this richness in respect of variety is provided below in a tabular form.

Above description of varieties within the different species of fruits and vegetable is far from the complete. Numerous unnamed varieties of each of them are being cultivated and maintained mainly by the tribals

particularly in areas where modern agricultural facilities have not yet been reached.

In case of cereals, different kinds such as indigenous, improved indigenous variety (IIV), High yielding variety (HYV), and Hybrids are met with. Each of these kinds are represented by a number of varieties. However, depending on the agroclimatic condition and irrigation facilities some amount of geographical variation could be found in respect of number and prevalent varieties under cultivation in the different districts as detailed below.

Crops	Varieties	Number
DARJILING :	KHARIF	
Paddy	Indigenous	1
	IIV	3
	HYV	2
Maize	Indigenous	1
	Hybrids	2
Finger Millet	Indigenous	Several
Buck Wheat	Indigenous	1
Mashiam Kalai	Indigenous	1
Soyabean	IIV	2
	RABI	
Wheat	HYV	1
Mustard	IIV	2
Rai Sag	Indigenous	1
JALPAIGURI :	KHARIF	
Paddy (Aus)	Indigenous	1
Paddy (Aman)	Indigenous	10
	HYV	10
	RABI	
Italian	Indigenous	1
Sesame	Indigenous	1
	HYV	1
Mustard	Indigenous	1
	IIV	2
Wheat	HYV	2

Crops	Varieties	Number
NORTH DINAJPUR :	KHARIF	
Paddy (Aus)	11V	1
	HYV	10
Paddy (Aman)	Indigenous	6
	IIV	2
	HYV	28
Kulthi Kalai	Indigenous	1
Arahar	Indigenous	1
	IIV	1
Kalai	Indigenous	1
	IIV	1
Maize	Hybrid	3
Bajra	Indigenous	1
	RABI	
Paddy (Boro)	HYV	14
Wheat	HYV	8
Lentis	IIV	2
Gram	Indigenous	1
Khesari	IIV	1
Mustard	IIV	3
Groundnut	IIV	3
Sesame	Indigenous	1
	IIV	1
KOCHBIHAR :		
	KHARIF	
Paddy	Indigenous	2
	IIV	1
	HYV	8
Bajra	Indigenous	1
Jower	Indigenous	1
	RABI	
Indian Millet	Indigenous	2
Mustard	IIV	2
Sesame	Indigenous	1
	IIV	1
Khesari	Indigenous	1

Crops	Varieties	Number
MURSHIDABAD :		
	KHARIF	
Paddy (Aus)	HYV	5
Paddy (Aman)	Indigenous	5
Kalai	Indigenous	1
	IIV	2
	RABI	
Wheat	IIV	1
	HYV	3
Gram	Indigenous	1
	IIV	3
Lentil	Indigenous	1
	IIV	2
	HYV	5
Mustard	Indigenous	1
Arhar	IIV	1
SOUTH DINAJPUR :		
	KHARIF	
Paddy (Aus)	Indigenous	1
	IIV	1
Paddy (Aman)	HYV	8
	RABI	
Wheat HYV	2	2
Mustard	IIV	3
Lentel	Indigenous	1
	IIV	1
Gram	IIV	2
Khesari	Indigenous	1
MALDAH :		
	KHARIF	
Paddy (Aus)	Indigenous	3
	HYV	2
Paddy(Aman)	HYV	8
Kalai	Indigenous	2
	IIV	2
Maize	Indigenous	1
	Hybrid	2

Crops	Varieties	Number
Arhar	Indigenous	1
	IIV	1
	RABI	
Gram	Indigenous	1
	IIV	2
Lentil	Indigenous	1
	IIV	2
Mustard	IIV	5
BIRBHUM :		
	KHARIF	
Paddy (Aman)	HYV	12
Arhar	Indigenous	1
	IIV	2
Kalai	Indigenous	1
Sesame	Indigenous	1
	IIV	3
	RABI	
Wheat	HYV	2
Gram	Indigenous	1
	IIV	4
Lentil	Indigenous	1
	IIV	2
Mustard	IIV	2
BANKURA :		
	KHARIF	
Paddy (Aus)	IIV	2
	HYV	Many
Paddy(Aman)	Indigenous	2
	IIV	2
	HYV	9 +
Sesame	Indigenous	1
Kalai	Indigenous	1
	RABI	
Wheat	HYV	1
Mustard	IIV	1

Crops	Varieties	Number
HUGLI :		
	KHARIF	
Paddy	Indigenous	3
	HYV	4
	IIV	2
Kalai	Indigenous	1
	RABI	
Paddy(Boro)	HYV	5
Mustard	IIV	3
Wheat	Indigenous	1
	HYV	1
EAST MEDINIPUR :		
	KHARIF	
Paddy	Indigenous	Not Available
	HYV	3
Kalai	Indigenous	1
	IIV	1
	RABI	
Mung	Indigenous	1
	IIV	1
Paddy)Boro)	HYV	5
Khesari	Indigenous	1
	IIV	1
BARDDHAMAN :		
	KHARIF	
Paddy (Aus)	HYV	3 +
Paddy (Aman)	IIV	2
	HYV	9 +
Kalai	Indigenous	2
	IIV	2
	RABI	
Wheat	HYV	3
Mustard	Indigenous	1
	IIV	V
Paddy (Boro)	Indigenous	1
	HYV	3

Crops	Varieties	Number
WEST MEDINIPUR :		
	KHARIF	
Paddy (Aus)	HYV	8
Paddy (Aman)	Indigenous	2 +
	HYV	19
Arhar	Indigenous	1
	IIV	1
Mung	IIV	3
Sesame	Indigenous	1
Kalai	Indigenous	1
	IIV	3
	RABI	
Wheat	HYV	4
Khesari	IIV	2
Lentil	Indigenous	1
	IIV	3
Mustard	IIV	1
NORTH 24 PARGANAS :		
	KHARIF	
Paddy (Aus)	Indigenous	1
	HYV	3
Paddy (Aman)	Indigenous	7
	HYV	11
Kalai	Indigenous	1
	IIV	1
	RABI	
Wheat	HYV	2
Mustard	IIV	3
Gram	Indigenous	1
Lentil	Indigenous	1
Khesari	Indigenous	1
Paddy (Boro)	HYV	5
SOUTH 24 PARGANAS :		
	KHARIF	
Paddy (Aus)	Indigenous	1
	HYV	1

Crops	Varieties	Number
Paddy (Aman)	Indigenous	1
	HYV	14
	RABI	
Wheat	HYV	3
Mustard	IIV	3
Mung	Indigenous	1
	IIV	1
Kalai	Indigenous	1
PURULIYA :		
	KHARIF	
Paddy (Aus)	HYV	10
Paddy (Aman)	HYV	24
Maize	Hybrid	2
Sesame	Indigenous	1
	IIV	2
Kalai	Indigenous	1
	IIV	2
Arhar	Indigenous	1
	IIV	2
Mung	Indigenous	1
	IIV	2
	RABI	
Mustard	IIV	3
Wheat	HYV	3
Lentil	Indigenous	1
	IIV	1
Keshri	Indigenous	1
	IIV	1
Gram	Indigenous	1
	IIV	1
NADIA :		
	KHARIF	
Paddy (Aus)	IIV	1
	HYV	5
Paddy (Aman)	HYV	13
Kalai	Indigenous	1

Crops	Varieties	Number
	IIV	2
	RABI	
Paddy (Boro)	Indigenous	1
	HYV	4
Wheat	Indigenous	1
	HYV	3
Gram	Indigenous	1
	IIV	3
Lentil	Indigenous	1
	IIV	2
Sesame	Indigenous	2
	IIV	2
Mustard	IIV	6
Khesari	Indigenous	1
	IIV	1
HAORA :		
	KHARIF	
Paddy	Indigenous	3
	HYV	14
	IIV	2
Sesame *	Indigenous	1
	IIV	1
	RABI	
Mustard	IIV	1
Mung	IIV	
Wheat	HYV	5
Khesari	Indigenous	1
	IIV	1

SPECIES OF SPECIAL SIGNIFICANCE

The world stands today on the threshold of major changes brought about by revolutionary developments in the field of biotechnology. Under the Convention on Biological Diversity (CBD) regime, genetic resources are the sovereign property of a country. As such value has been added to each and every component of biodiversity. However, there are many species which deserve special mention and stand very much significant in respect of their taxonomic, zoogeographic, economic, medical, evolutionary, endemism, conservation and various other aspects. Biodiversity of West Bengal contains numerous such species and some of them are discussed below.

It has already been mentioned that biodiversity in all the ecosystems is under severe pressure resulting from commercial clear felling and selective clear felling; conversion for agriculture, settlements, roads, mining, river valley projects; conversion to monocultures; grazing; hunting and trade; fire; pollution; introduction of exotics and high yielding varieties and many others. As a result, large number of species succumbed to the changes of biotopes. Many of the species have been wiped out from the state during last hundred years or so. Quite a substantial number of species have lost vast areas of their earlier range and now restricted to certain pockets with very small populations. Survival of them depends totally on the species specific conservation programme. Populations of several others are dwindling at a very fast rate and surviving mainly in certain protected areas.

The population status of major endangered animals in West Bengal is shown in Table 23.

Among the species extinct or probably extinct from the state following are worth mentioning.

Mammals : Javan Rhinoceros – *Rhinoceros sondaicus*, Asiatic two – horned Rhinoceros – *Dicerorhinus sumatrensis*, Wild Buffalo – *Bubalus bubalis*, Nilgai – *Boselaphus tragocamelus*, Black Buck – *Antelope cervicapra* introduced in Ballavpur), Musk

Deer – *Moschus moschiferus*, Swamp Deer – *Cervus duvauceli* (recently introduced in Jaldapara), Snow Leopard – *Uncia uncia*, Indian Pilot Whale – *Globicephala macrorhynchus*, Black Finless Porpoise – *Neophocaena phocaenoides*.

Aves : Monal pheasant – *Lophophorus impejanus*, Mountain Quail – *Ophrysia superaliosa*, Pink – headed Duck – *Rhodonessa caryophyllacea*.

Plants : *Aldrovanda vesiculosa*, an aquatic plant belonging to Family Droseraceae was last collected during 1957 (Now probably extinct from West Bengal-Dept. of Environment & Ramkrishna Mission, 2002), Makhana – *Euryale ferox* (An aquatic dicot belonging to Family Nymphaeaceae. Commercially cultivated but there is no wild distribution – Dept. of Environment & Ramkrishna Mission, 2002).

There are number of faunal species which could not sighted within the territory of the state for a long period. Surveys by specialists in the probable areas of their occurrence are urgently needed to determine the exact status of these species in the state. This category includes a large number of arthropods and other invertebrates which are known mainly by the type specimens only, and subsequent to the original description no further material could be obtained. Among the vertebrates following species have not been recorded from the state for last few decades.

Mammals : Marbled Cat-*Pardofelis marmorata*, Golden Cat-*Catopuma temmincki*, Three-banded palm Civet-*Arctogalidia trivirgata*.

Reptiles : *Zaocys nigromarginatus*, Mock Viper – *Psammodynastes pulverulentus* (within Indian limit recorded only from North Bengal), Gore's Bronze Back- *Dendrelaphis gorei*, *Ahaetulla prosina*, Muggar-*Crocodylus palustris* (Occurrence in Damodar river reported, but requires confirmation- Chowdhary and Choudhury, 1994), Gharial-

Table-23 : Major endangered animals and their population status in West Bengal.

Year	Gorumara	Buxa	Jaldapara	Mahananda	Sundarbans	Other areas	Total
1979	7	27	12	10	205	35	296
1983	16	15	9	1	264	47	352
1989	8	33	7	8	269	36	361
1992	-	29	5	13	-	-	-
1993	-	29	9	12	251	34	335
1997	-	32	13	12	263	41	361
1999	-	33	12	13	284	23	365
2002	-	31	9	15	271	23	349
2004	-	27	6	16	274	21	344
2010	Data analysis being done using modern techniques						
Leopard : (Schedule 1)							
1984	14	8	7	12	-	41	82
1989	14	50	5	10	-	29	108
1992	-	63	-	-	-	-	-
1993	2	-	9	2	-	31	107
2002	47	149	33	18	-	84	331
2004	40-45	145-150	25-30	25-30	-	65-75	300-330
Gaur : (Schedule 1)							
Year	Total Number						
1989	240						
1993	425						
1997	550						
1998	530-560						
2002	1180-1284						
2009-10	Not less than 901 (Gorumara NP & Chapramari WLS only)						

Table-23 : Cont'd.

Elephant : (Schedule 1)			
Year	Total Number		
1989	175		
1993	186		
1997	230-250		
1998	230-250		
1999-2000	327		
2000	327		
2002	328*		
2005	N.B. 300-350 + S.B. 96		
2007	N.B. 300-350 + S.B. 25 (Excluding migratory population)		
2010	S.B. 123 (Preliminary report)		
Rhinoceros : (Schedule 1)			
Year	Jaldapara	Gorumara	Total
1969	75	12	87
1974	21	6	27
1978	19	8	27
1986	14	8	22
1989	27	12	39
1993	33	12	45
1996	42	14	56
1997	44	14	58
1999	55	19	74
2000	54	19	73
2002	74	22	96
2004	96	25	121
2006	108	27	135
2008-09	125	31	156
2009-10	125 (Figures from 2008-09 adopted)	35 (32 in Gorumara + 1 in Chapramari + 2 in Buffer areas of Gorumara NP & Chapramari WLS)	

Source : Annual Report (2009-2010), Wildlife Wing, Directorate of Forests, Govt. of West Bengal.

Gavialis gangeticus (Occurrence reported in Maldah, but requires confirmation-Chowdhary and Choudhary, 1994).

Amphibians : *Bufo abatus*, *Megophrys robusta*, *Philautus jerdonii*, *Occidozyga tima*

Some of the invertebrate species of this category are :

Odonota : *Epiophlebia laidlawi*, *Indoscelimena flavopicta*, *Ergatettix colossus*

Thysanura : *Tricholepisma graveleyi*

Dermoptera : *Haplodiplatys lobatus*, *H. bidentatus*, *Paralabella fulleri*, *Chaetospinia kurseongae*

Mollusca : *Alycaeus lectus*

There are some species which are surviving by a very small population in limited areas and only occasionally sighted or reported. A number of mammalian species such as Himalayan Tahr-*Hemitragus jemlahicus*, Pygmy Hog-*Sus salvanius*, Hispid Hare – *Caprolagus hispidus*, Asiatic Black Bear-*Selenarctos thibetanus*,

Three Banded Palm Civet – *Arctogalidia trivirgata*, Hog Badger – *Arctonyx collaris*, Burmese Ferret Badger – *Melogale personata*, Ratel – *Mellivora capensis* belong to this category. Among birds, Bengal Florican-*Eupoditis bengalensis* is only sporadically reported from the state. It is worthwhile to mention that all the above species are found in the forests of North Bengal.

Apart from the above, natural range and populations of a large number of floral and faunal species of the state have dwindled to a great extent. Some of them have already drawn the attention of appropriate authorities and various measures are being taken for conservation of them and their habitats. However, vast majority of such threatened species are yet to be covered by any specific programme of conservation. A list of some such threatened species of the state along with region of their main occurrence has been provided in Table 24.

Table-24 : Some of the threatened species of West Bengal along with the region of their main occurrence. EWB = Entire West Bengal; SWB = Southern West Bengal; NWB = Northern West Bengal; SWWB = South West Bengal.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
Flora	1	<i>Anogeissus latifolicus</i>	SWB
	2.	<i>Acanthus volubilis</i>	SWB
	3.	<i>Avicennia alba</i>	SWB
	4.	<i>Aeginlitis rotundifolia</i>	SWB
	5.	<i>Antistrophe oxyantha</i>	NWB
	6.	<i>Aristolochia tagala</i>	NWB
	7.	<i>Arundinaria falconeri</i>	NWB
	8.	<i>A. hookeriana</i>	NWB
	9.	<i>Acer hookeri</i> -Endangered	NWB
	10.	<i>A. osmastonii</i> -Endangered	NWB
	11.	<i>Bambusa nutans</i>	NWB
	12.	<i>Bauhinia macrostachya</i>	NWB
	13.	<i>Boehmeria rugulosa</i>	NWB
	14.	<i>Buchanania latifolia</i>	SWB

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	15.	<i>Butea superba</i>	SWB
	16.	<i>Bulleyia yunnanensis</i> -Rare	NWB
	17.	<i>Begonia satrapis</i> -Rare	NWB
	18.	<i>B. scutata</i> -Rare	NWB
	19.	<i>Caldesia oligococca</i>	—
	20.	<i>C. pamassifolia</i>	—
	21.	<i>Caesalpinia Crista</i>	NWB
	22.	<i>Calamus erectus</i>	NWB
	23.	<i>C. latifolius</i>	NWB
	24.	<i>Canarium sikkimense</i>	NWB
	25.	<i>Carissa spinarum</i>	NWB
	26.	<i>Chisoheton paniculatus</i>	NWB
	27.	<i>Cinnamomum cecidodaphe</i>	NWB
	28.	<i>C. zeylanicum</i>	NWB
	29.	<i>Crataeva religiosa</i>	SWB
	30.	<i>Cycas pectinata</i>	NWB
	31.	<i>Ceriops tagal</i>	—
	32.	<i>C. decandra</i>	—
	33.	<i>Cleome monophylla</i>	SWB
	34.	<i>Casearia graveolens</i>	SWB
	35.	<i>Codonopsis affinis</i> -Rare	NWB
	36.	<i>Christtella clarkei</i> -Vulnerable	NWB
	37.	<i>Cissus spectabilis</i> -Endangered	NWB
	38.	<i>Dalbergia latifolia</i>	NWB, SWB
	39.	<i>Daphne cannabina</i>	NWB
	40.	<i>Daphniphyllum himalayense</i>	NWB
	41.	<i>Dendrobium lituiflorum</i>	NWB
	42.	<i>D. sulcatrum</i>	NWB
	43.	<i>Desmodium gyrans</i>	V
	44.	<i>Dioscorea bulbifera</i>	NWB, SWB
	45.	<i>D. pentaphylla</i>	NWB
	46.	<i>D. prazeri</i>	NWB
	47.	<i>D. puber</i>	NWB
	48.	<i>Dodonea viscosa</i>	NWB

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	49.	<i>Drosera burmannii</i>	SWB
	50.	<i>D. peltata</i>	NWB
	51.	<i>D. indica</i>	
	52.	<i>Drypetes subsessilis</i>	NWB
	53.	<i>Diplomeris hirsuta</i> -Vulnerable	NWB
	54.	<i>Excoecaria agallocha</i>	SWB
	55.	<i>Elaeocarpus aristatus</i>	NWB
	56.	<i>E. ganitrus</i>	NWB
	57.	<i>Elaeodendron glaucum</i>	NWB
	58.	<i>Engelhardtia aolebrookiana</i>	NWB
	59.	<i>Eriobotrya dubia</i>	NWB
	60.	<i>Eulophia bicallosa</i>	NWB
	61.	<i>Feronia elephantina</i>	SWB
	62.	<i>Firmiana pallens</i>	NWB
	63.	<i>Flacourtia cataphracta</i>	NWB, SWB
	64.	<i>Geodorum densiflora</i>	NWB
	65.	<i>Gloriosa superba</i>	NWB
	66.	<i>Gnetum scandens</i>	NWB
	67.	<i>Grewia microcos</i>	NWB
	68.	<i>Habenaria marginata</i>	NWB
	69.	<i>H. oleosa</i>	NWB
	70.	<i>Helicteres isora</i>	SWB
	71.	<i>Homalium zeylanicum</i>	NWB
	72.	<i>Hova lanceolata</i>	NWB
	73.	<i>H. globulosa</i>	NWB
	74.	<i>Hymenodictyon flaccidum</i>	NWB
	75.	<i>Heydyotis brunonis</i>	NWB
	76.	<i>H. scabra</i>	NWB
	77.	<i>Heritiera fomes</i>	SWB
	78.	<i>Isoetes coromandelina</i>	
	79.	<i>Ichnocarpus frutescens</i>	NWB, SWB
	80.	<i>Juniperus pseudo-sabina</i>	NWB
	81.	<i>Knema erratica</i>	NWB
	82.	<i>Kandelin candal</i>	SWB

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	83.	<i>Leycesteria belliana</i>	NWB
	84.	<i>L. glaucophylla</i>	NWB
	85.	<i>Livistonia jenkinsiana</i>	NWB
	86.	<i>Luculia gratissima</i>	NWB
	87.	<i>Lumnitzera recemosa</i>	SWB
	88.	<i>Machilus clarkeana</i>	NWB
	89.	<i>M. glaucescens</i>	NWB
	90.	<i>M. parviflora</i>	NWB
	91.	<i>Mallotus philippinensis</i>	NWB, SWB
	92.	<i>Medinilla rubicunda</i>	NWB
	93.	<i>Michelia Montana</i>	NWB
	94.	<i>Micromeles thomsoni</i>	NWB
	95.	<i>Musa balbisiana</i>	NWB
	96.	<i>Miliusa velutina</i>	SWB
	97.	<i>Metathelypteris decipiens</i>	NWB
	98.	<i>Neohouzeana dullooa</i>	NWB
	99.	<i>Nervilia falcata</i>	NWB
	100.	<i>Nypa fruticans</i>	SWB
	101.	<i>Najas marina</i>	
	102.	<i>Oberonia ensiformis</i>	NWB
	103.	<i>O. rufilabris</i>	NWB
	104.	<i>Odina wodier</i>	NWB, SWB
	105.	<i>Olea dioica</i>	NWB
	106.	<i>Ormosia glauca</i>	NWB
	107.	<i>Ougeinia oojenensis</i>	SWB
	108.	<i>Ophiorrhiza lurida</i> -Rare	NWB
	109.	<i>Podocarpus neriifolia</i>	NWB
	110.	<i>Populus glauca</i>	NWB
	111.	<i>Pseudo-gardneria angustifolia</i>	NWB
	112.	<i>Pygmaeopremna herbacea</i>	NWB
	113.	<i>Polygala arillata</i>	NWB
	114.	<i>P. eroptera</i>	SWB
	115.	<i>Pimpinella tongloensis</i> - Endangered	NWB

Table-24 : Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	116.	<i>Polyalthia serasoides</i>	SWB
	117.	<i>Rauwolfia serpentina</i>	NWB, SWB
	118.	<i>R. tetraphylla</i>	SWB
	119.	<i>Reevesia pubescens</i>	SWB
	120.	<i>Rhododendron smithi</i>	NWB
	121.	<i>Rhynchostylis retusa</i>	NWB
	122.	<i>Saccopetalum longiflorum</i>	NWB
	123.	<i>Salix daltoniana</i>	
	124.	<i>Santalum album</i>	SWB
	125.	<i>Semecarpus anacardium</i>	NWB, SWB
	126.	<i>Siphonodon celastrineus</i>	NWB
	127.	<i>Sorbus ursina</i>	NWB
	128.	<i>Soymida febrifuga</i>	SWB
	129.	<i>Spiranthes sinensis</i>	NWB
	130.	<i>S. australis</i>	
	131.	<i>Strychnos nux-vomica</i>	SWB
	132.	<i>Styrax serrulatum</i>	NWB
	133.	<i>Symplocos racemosa</i>	NWB, SWB
	134.	<i>Solomonina ciliata</i>	SWB
	135.	<i>S. polygala</i>	SWB
	136.	<i>Sonneratia alba</i>	SWB
	137.	<i>S. casaeolaris</i>	SWB
	138.	<i>Scyphiphora hydrophylacea</i>	SWB
	139.	<i>Ternstroemia japonica</i>	NWB
	140.	<i>Tetracera sarmentosa</i>	NWB
	141.	<i>Tiliacora acuminata</i>	SWB
	142.	<i>Tylophora indica</i>	SWB
	143.	<i>Utricularia bifida</i>	NWB
	144.	<i>U. caerulea</i>	NWB
	145.	<i>U. scandens</i>	NWB
	146.	<i>U. stellaris</i>	
	147.	<i>U. striatula</i>	
	148.	<i>Vatica lancaefolia</i>	NWB
	149.	<i>Vitex peduncularis</i>	NWB

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	150.	<i>Xylia xylocarpa</i>	SWB
	151.	<i>Xylocarpus granalum</i>	SWB
	152.	<i>Zeuxine nervosa</i>	NWB
Fauna : Mammalia	153.	<i>Petaurista magnificus</i>	NWB
	154.	<i>P. nobilis</i>	NWB
	155.	<i>Ratufa bicolor</i>	NWB
	156.	<i>Myotis annectans</i>	NWB
	157.	<i>M. mystacinus</i>	NWB
	158.	<i>Rhinolophus trifolius</i>	NWB
	159.	<i>Manis crassicaudata</i>	EWB
	160.	<i>Canis lupus</i>	SWWB
	161.	<i>Cuon alpinus</i>	NWB, SWB
	162.	<i>Melurnus ursinus</i>	NWS, SWWB
	163.	<i>Ailurus fulgens</i> -Sch. I	NWB
	164.	<i>Lutra lutra</i>	EWB
	165.	<i>Aonyx cinerea</i>	NWB, SWB
	166.	<i>Herpestes palustris</i> -Sch. I	SWB
	167.	<i>Hyaena hyaena</i>	SWWB, NWB
	168.	<i>Prionailurus bengalensis</i>	EWB.
	169.	<i>P. viverrinus</i>	NWB, SWB
	170.	<i>Neofelis nebulosa</i>	WWB
	171.	<i>Panthera pardus</i>	EWB
	172.	<i>Panthera tigris</i> -Sch. I	NWB, SWB
	173.	<i>Elephas maximus</i> -Sch. I	NWB, SWWB
	174.	<i>Capricornis sumatraensis</i>	NWB
	175.	<i>Caprolagers hispidus</i> -Sch. I	SWB, NWB
	176.	<i>Rhinoceros unicornis</i> -Sch. I	NWB
	177.	<i>Cervus duvaucelli</i> -Sch. I	SWB, NWB
	178.	<i>Bos frontalis</i>	NWB
	179.	<i>Bubalus bubalis</i> -Sch. I	SWB, NWB
	180.	<i>Platanista gangetica</i> -Sch. I	SWB, NWB
	181.	<i>Orcaella brevirostris</i> -Sch. I	SWB
	Aves	182.	<i>Ardea goliath</i>
183.		<i>Ciconia ciconia</i>	NWB,

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	184.	<i>Leptoptilos dubius</i> -Sch. IV	SWWB, SWB
	185.	<i>L. javanicus</i> -Sch. IV	EWB
	186.	<i>Platalea leucorodia</i>	EWB
	187.	<i>Dendrocygna bicolor</i>	NWB, SWB
	188.	<i>Threskiornis aethiopica</i>	SWB
	189.	<i>Aviceda jerdoni</i>	NWB
	187.	<i>A. leuphotes</i>	NWB
	191.	<i>Accipiter nisus</i>	NWB'
	192.	<i>A. virgatus</i>	NWB
	193.	<i>Haliaeetus leucogaster</i>	SWB
	194.	<i>Sarcogyps calvus</i>	SWB
	195.	<i>Gyps indicus</i> -Sch. I	SWWB
	196.	<i>G. bengalensis</i> -Sch. I	EWB
	197.	<i>Pandion haliaetus</i>	SWWB, SWB
	198.	<i>Falco peregrinus</i> -Sch. IV	SWWB
	199.	<i>Polyplectron bicalcaratum</i>	NWB
	200.	<i>Ithaginis cruentus</i>	NWB
	201.	<i>Lophurus leucomelana</i>	NWB
	202.	<i>Pavo cristatus</i>	NWB
	203.	<i>Grus nigricollis</i>	NWB
	204.	<i>Haliaeetus leucoryphus</i>	NWB
	205.	<i>Tyto alba</i>	SWB
	206.	<i>Aceros nipalensis</i>	NWB
	207.	<i>Anthracoseros malabaricus</i>	NWB
	208.	<i>Pellomeum palustris</i> -Sch. IV	NWB
Reptiles	209.	<i>Aspideretes gangeticus</i> -Sch. I	SWB
	210.	<i>Aspideretes hurum</i> -Sch. I	SWB
	211.	<i>Melanochelys tricarinata</i> -Sch. I	SWB
	212.	<i>Gavialis gangeticus</i> -Sch. I	SWB
	213.	<i>Crocodylus porosus</i>	SWB
	214.	<i>Lepidochelys olivacea</i> -Sch. I	SWB
	215.	<i>Batagur buska</i> -Sch. I	SWB
	216.	<i>Eretmochelys imbricata</i> -Sch. I	SWB
	217.	<i>Chelonia mydas</i> -Sch. I	SWB

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	218.	<i>Kachuga kachuga</i> -Sch. I	SWB
	219.	<i>Geoclemys hamiltonii</i> -Sch. I	SWB
	220.	<i>Eretmochelys imbricata</i> -Sch. I	SWB
	221.	<i>Lissemys punctata</i>	NWB, SWB
	222.	<i>Chitra indica</i> -Sch. I	SWB
	223.	<i>Varanus bengalensis</i>	EWB
	224.	<i>V. flavescens</i>	SWB
	225.	<i>V. salvator</i>	SWB
	226.	<i>Python molurus</i> -Sch. IV	NWB
	227.	<i>P. reticulatus</i>	NWB
	228.	<i>Elachistodon westermanii</i> -Sch. I	NWB
	229.	<i>Ptyas mucosus</i>	EWB
	230.	<i>Naja naja</i>	EWB
Amphibia	231.	<i>Trilotriton verrucosus</i> -Sch. I	EWB
Pisces	232.	<i>Ompok pabo</i>	
	233.	<i>Carcharhinus gangeticus</i> -Sch. I	
	234.	<i>O. bimaculatus</i>	
	235.	<i>Ailia bengalensis</i>	
	236.	<i>Bagrius bagarius</i>	
	237.	<i>Eutropichthys vacha</i>	
	238.	<i>Puntius sarana</i>	
	239.	<i>Semiplolus semiplolus</i>	
	240.	<i>Osphronemus nobilis</i>	
	241.	<i>Labeo diacanthys</i>	
	242.	<i>L. fimbriatus</i>	
	243.	<i>L. goniis</i>	
	244.	<i>Anabas testudineus</i>	
	245.	<i>Notopterus notopterus</i>	EWB
	246.	<i>N. chitala</i>	EWB
	247.	<i>Pangasius pangasius</i>	
	248.	<i>Balitora brucci</i>	
	249.	<i>Gadusia chapra</i>	
	250.	<i>Meastacembelus armatus</i>	

Table-24 :Contd.

Group	Sl. No.	Name of the threatened species and IUCN status	Region of main occurrence
	251.	<i>Mystas tangra</i>	
	252.	<i>M. aor</i>	
	253.	<i>Rasbora rasbora</i>	
	254.	<i>Setipinna phasa</i>	
	255.	<i>Bengala elonga</i>	
	256.	<i>Wallago attu</i>	
	257.	<i>Nandus nandus</i>	
	258.	<i>Amblypharyngodon mola</i>	
	259.	<i>Tor putitora</i>	NWB
	260.	<i>T. tor</i>	NWB
	261.	<i>Raiamas bola</i>	NWB
	262.	<i>Barilius vagra</i>	NWB
	263.	<i>Odontamblyopus rubicondus</i>	SWB
Arthropoda	264.	<i>Burmagomphus sivalikensis</i> -Sch. I	SWB, NWB
	265.	<i>Lyriothemis tricolor</i> -Sch. I	SWB, NWB
	266.	<i>Epiophlebia laidlawi</i> -Sch. I	SWB, NWB
	267.	<i>Carcinoscorpius rotundicauda</i>	SWB
	268.	<i>Tachypleus gigas</i>	SWB
	269.	<i>Gerenia bengalensis</i>	NWB
	270.	<i>Hypolimnas missipus</i>	EWB
	271.	<i>Lethe distans</i>	WB
Mollusca	272.	<i>Alycaeus lectus</i>	EWB
	273.	<i>Austenia annandalei</i>	EWB
Annelida	274.	<i>Scolioscolides bergtheili</i>	NWB

Ascription of a country (ies) of origin to any genetic resource is evidently related to the patterns of geographical distribution of living organisms. Genetic resource or species confined to a country/geographical region is considered as endemic to that country or region. In the applications of Intellectual Property Right (IPR) and patenting the genetic resources, documentation of endemic species in the country level is the most important function particularly for countries with rich biological diversity. Alfred (1998) provided an estimate of endemic faunal species of the country. According to that estimate percentage of endemic species in different animal groups varies from 1 to 100 percent. However, except for higher vertebrates, there has been no indepth and standard study of the enumeration of endemic taxa in India for various reasons. Varshney (1998) has focused some of these reasons with reference to insect groups which

appear to be true for other groups. Firstly, the number of genera and species to be handled is extremely large; secondly, there has still not been thorough surveys conducted for all groups in the country; thirdly, a good number of genera and species are “known from their original record only”, giving the impression that they are endemic there, which may or may not be true due to insufficient surveys; and fourthly the detail taxonomic studies of all orders and families occurring in India could not be completed for want of experts. Analysis of the fauna of West Bengal reveals that not only a substantial percentage of Indian endemic species occur in the state but also there are many species which are exclusively endemic to West Bengal. Some of the Indian endemic species occurring in the State have been listed in Table 25, and those which are confined within West Bengal along with main region of occurrence are shown in Table 26.

Table-25 : Some Indian endemic species occurring in West Bengal alongwith main region of their occurrence in the state. (Abbreviations as in Table 24)

Group	Sl. No.	Species	Main region of occurrence
Mammals	1.	<i>Anathana ellioti</i>	SWWB
Aves	1a.	<i>Perdicula manipurensis</i>	NWB
	1b.	<i>Galloperdix lunulata</i>	NWB
Reptiles	2.	<i>Sitana ponticeriana</i>	EWB
	3.	<i>Psammophilus blanfordanus</i>	SWWB, SWB
	4.	<i>Japalura variegata</i>	NWB
Amphibia	5.	<i>Ichthyophis sikkimensis</i>	NWB
	6.	<i>Rhacophorus tuberculatus</i>	NWB
	7.	<i>Limnonectus mauphlangensis</i>	NWB
Pisces	8.	<i>Labeo gonius</i>	NWB
	9.	<i>Noemacheilus devdevi</i>	NWB
	10.	<i>N. multifascialus</i>	NWB
	11.	<i>Balitora brucei</i>	NWB
Arthropoda Coleoptera	12.	<i>Platyrhopalus denticornis</i>	SWB
	13.	<i>P. intermedius</i>	NWB
	14.	<i>Neocollyris attenuata</i>	NWB

Table-25 : Contd.

Group	Sl. No.	Species	Main region of occurrence
	15.	<i>N. distincta</i>	NWB
	16.	<i>N. fuscitarsis</i>	NWB
	17.	<i>Prothyma proxima</i>	SWWB
	18.	<i>Heptodonta nodicollis</i>	NWB
	19.	<i>Cicindela tetrastacta</i>	SWWB, SWB
	20.	<i>C. dromicoides</i>	NWB
	21.	<i>C. erudita</i>	NWB, SWB
	22.	<i>C. grammophora</i>	NWB, SWB
	23.	<i>C. ognata</i>	NWB
	24.	<i>C. albopunctata</i>	NWB
	25.	<i>C. bicolor</i>	EWB
	26.	<i>C. haemorrhoidalis</i>	SWB
	27.	<i>C. cyanea</i>	NWB
	28.	<i>C. striatifrons</i>	NWB
	29.	<i>Harpalus indicus</i>	NWB
	30.	<i>Dioryche nagpurensis</i>	EWB
	31.	<i>Oxycentrus parallelus</i>	SWWB, SWB
	32.	<i>Pachytrachelus cribiceps</i>	NWB
	33.	<i>Coleolissus perlucens</i>	SWWB
	34.	<i>Laccophilus anticatus</i>	SWB, WWB
	35.	<i>L. elegans</i>	WWB
	36.	<i>L. rufulus</i>	EWB
	37.	<i>Metheles indicus</i>	SWB
	38.	<i>Guignotus fulvescens</i>	SWWB
	39.	<i>G. regimberti</i>	SWB
	40.	<i>Clypeodytes bufo</i>	SWB
	41.	<i>C. indicus</i>	SWB
	42.	<i>Uvarus quadrilineatus</i>	SWB
	43.	<i>Hyphoprus oper</i>	SWWB, SWB
	44.	<i>H. bengalensis</i>	SWB, NWB
	45.	<i>Peschetius quadriscostaius</i>	SWWB
	46.	<i>Platynectes kashmirensis</i>	NWB
	47.	<i>Rhanthus ovalis</i>	NWB
	48.	<i>Cybister regulosus</i>	SWB
	49.	<i>Orectochilus similis</i>	SWB

Table-25 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	50.	<i>O. productus</i>	EWB
	51.	<i>O. haemorrhous</i>	SWB
	52.	<i>O. fletcheri</i>	SWWB, SWB
	53.	<i>O. cylindricus</i>	SWWB
	54.	<i>O. cardoni</i>	SWB
	55.	<i>Haliphus prathii</i>	SWB
	56.	<i>Spercheus gibbus</i>	SWB
	57.	<i>Sphaeridium cameroni</i>	SWWB
	58.	<i>Pachysternum cardoni</i>	NWB
	59.	<i>P. stenvensi</i>	NWB
	60.	<i>Laccobius rotundatus</i>	SWB
	61.	<i>L. simulans</i>	NWB
	62.	<i>Helochares lentus</i>	SWWB, SWB
	63.	<i>Hydrophilus olivaceus</i>	SWWB
	64.	<i>H. rufocinctus</i>	SWB
	65.	<i>Hypocacculus malabaricus</i>	SWB
	66.	<i>Abraeus paria</i>	NWB
	67.	<i>Acritus tuberisternus</i>	NWB
	68.	<i>Platylomalus oblisus</i>	NWB
	69.	<i>Paraepierus corticicola</i>	NWB
	70.	<i>Platylister atratus</i>	SWB, NWB
	71.	<i>Atholus silvicola</i>	NWB
	72.	<i>Micropeplus sikkimi</i>	NWB
	73.	<i>Eupiestus sikkimi</i>	NWB
	74.	<i>Eleusis sikkimensis</i>	NWB
	75.	<i>Priochirus rubiginosus</i>	NWB
	76.	<i>P. longicornis</i>	NWB
	77.	<i>P. sikkimensis</i>	NWB
	78.	<i>Thoracochirus assamensis</i>	NWB
	79.	<i>Pseudopsis prolixa</i>	NWB
	80.	<i>Megarthus chatterjeei</i>	NWB
	81.	<i>M. Septempunctatus</i>	NWB
	82.	<i>M. basicornis</i>	NWB
	83.	<i>Anthobium sikkimi</i>	NWB
	84.	<i>Planeustomus bengalensis</i>	NWB

Table-25 : Contd.

Group	Sl. No.	Species	Main region of occurrence
	85.	<i>Oxytelopsis andrewesi</i>	NWB
	86.	<i>Anotylus laetus</i>	NWB
	87.	<i>A. frater</i>	NWB
	88.	<i>Osorius sikkimensis</i>	NWB
	89.	<i>Stenus sikkimensis</i>	NWB
	90.	<i>S. pictus</i>	NWB
	91.	<i>S. fistulosus</i>	NWB
	92.	<i>S. kurseonginus</i>	NWB
	93.	<i>Dianous annandalei</i>	NWB
	94.	<i>D. cameronii</i>	NWB
	95.	<i>D. versicolor</i>	NWB
	96.	<i>Stenoesthelus quadrisulcatus</i>	NWB
	97.	<i>Pinophilus depressus</i>	SWB
	98.	<i>Palaminus indicus</i>	NWB
	99.	<i>Oedichirus longipennis</i>	NWB, SWB
	100.	<i>Astenus asitus</i>	NWB
	101.	<i>A. flavipennis</i>	NWB
	102.	<i>A. terminalis</i>	NWB
	103.	<i>A. semibrunneus</i>	NWB, SWB
	104.	<i>A. concolor</i>	NWB
	105.	<i>Paederus himalayicus</i>	NWB
	106.	<i>P. nigripennis</i>	NWB
	107.	<i>P. conicollis</i>	SWB
	108.	<i>Acanthoglossus testaceipennis</i>	NWB, SWB
	109.	<i>Stilicopsis pallida</i>	NWB
	109a.	<i>S. indica</i>	NWB
	109b.	<i>Scopaeus andrewesi</i>	SWB
	110.	<i>S. germanus</i>	NWB
	111.	<i>Lobochilus granulicollis</i>	NWB
	112.	<i>L. fortepunctatus</i>	NWB
	113.	<i>Dibelonetes sikkimensis</i>	NWB
	114.	<i>Thinocharis debilis</i>	NWB
	115.	<i>Pachymedon shugnuensis</i>	NWB
	116.	<i>Lathrobium triste</i>	SWB
	117.	<i>L. unicolor</i>	NWB

Table-25 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	118.	<i>Stilicus parvus</i>	NWB
	119.	<i>S. velutinus</i>	NWB
	120.	<i>Cryptobium sikkimense</i>	NWB
	121.	<i>C. fluviatile</i>	SWB
	122.	<i>Stiliderus umbratus</i>	NWB
	123.	<i>Indoscitalinus dispilus</i>	
	124.	<i>Platyprosopus fuliginosus</i>	SWB
	125.	<i>Philonthus industanus</i>	NWB
	126.	<i>Diceros childreni</i>	SWB
	127.	<i>Rhomborrhina glaberrima</i>	NWB
	128.	<i>Heterorrhina punctatissima</i>	NWB
	129.	<i>H. nigritarsis</i>	NWB
	130.	<i>Trigonophorus scintillans</i>	NWB
	131.	<i>Protaetia aurichalcea</i>	SWB
	132.	<i>P. peregrina</i>	NWB
	133.	<i>P. neglecta</i>	NWB
	134.	<i>Oxycetonia jucunda</i>	NWB, SWB
	135.	<i>Chiloloba acuta</i>	NWB
	136.	<i>Clinteria spilota</i>	NWB, SWB
	137.	<i>Cymophorus pulchellus</i>	SWB
	138.	<i>Heteronychus annulatus</i>	SWB
	139.	<i>Parastasia ochracea</i>	NWB
	140.	<i>Spilopopillia sexguttata</i>	NWB
	141.	<i>Mimela horsfieldi</i>	NWB
	142.	<i>M. globosa</i>	NWB
	143.	<i>M. marginalis</i>	SWB
	144.	<i>Anomala dorsalis</i>	
	145.	<i>A. aegrota</i>	NWB
	146.	<i>A. fulviventris</i>	NWB
	147.	<i>A. signaticollis</i>	NWB
	148.	<i>A. xanthoptera</i>	NWB
	149.	<i>A. crythroptera</i>	NWB
	150.	<i>A. pusilla</i>	NWB
Ephemeroptera	151.	<i>Claeon variegatum</i>	NWB, SWB
	152.	<i>Gilliesia hindustanica</i>	NWB

Table-25 : Contd.

Group	Sl. No.	Species	Main region of occurrence
Odonota	153.	<i>Aciagrion olympicum</i>	NWB
	154.	<i>Agriocnemis lacteola</i>	NWB, SWB
	155.	<i>A. splendidissima</i>	NWB, SWB
	155a.	<i>A. aborensis</i>	NWB, SWB
	156.	<i>Coeliccia renifera</i>	WWB
	157.	<i>Calicnemia miniata</i>	SWWB, NWB
	158.	<i>Ceylonolestes cyanea</i>	NWB
	159.	<i>Lestes thoracica</i>	
	160.	<i>Philoganga montana</i>	NWB
	161.	<i>Rhinocypha bifasciata</i>	NWB
	162.	<i>R. immaculata</i>	NWB
	163.	<i>R. trifasciata</i>	
	164.	<i>R. bifenestrata</i>	NWB
	165.	<i>R. unimaculata</i>	NWB
	166.	<i>Anisopleura lestoides</i>	
	167.	<i>A. comes</i>	NWB
	168.	<i>Allogaster latifrons</i>	NWB
	169.	<i>Jagoria martini</i>	NWB
	170.	<i>Cephalaeschna orbifrons</i>	NWB
	171.	<i>C. masoni</i>	NWB
	172.	<i>Gynacanthaeschna sikkima</i>	NWB
	173.	<i>Periaeschna magdalena</i>	NWB
	174.	<i>Gymacantha albistyla</i>	NWB
	175.	<i>Polycanthagyna erythromeles</i>	NWB
	176.	<i>Perissopgpmphus stevensi</i>	NWB
	177.	<i>Burmagomphus sivalikensis</i>	NWB
	178.	<i>Platygomphus dolobralus</i>	
	179.	<i>Anisogomphus occipitalis</i>	NWB
	180.	<i>A. bivittatus</i>	NWB
	181.	<i>A. arites</i>	NWB
	182.	<i>Stylogomphus inglisi</i>	NWB
	183.	<i>Onychogomphus aureus</i>	NWB
	184.	<i>Epophthalmia vittata</i>	NWB
185.	<i>Macromia flavicincta</i>		
186.	<i>Pseudotrimea prateri</i>	NWB	
187.	<i>Bradinopyga geminata</i>	NWB, SWB	

Table-25 :Contd.

Group	Sl. No.	Species	Main region of occurrence
Plecoptera	188.	<i>Amphinemoura luteipes</i>	NWB
	189.	<i>Gibosia needhami</i>	NWB
	190.	<i>Neoperla limosa</i>	NWB
	191.	<i>Cryptoperla torva</i>	NWB
Orthoptera	192.	<i>Eucriotellix dohertyi</i>	NWB
	193.	<i>Hebardittix quadratus</i>	NWB
	194.	<i>Loxilobus assamus</i>	NWB
	195.	<i>Synalibas perplexus</i>	NWB
	196.	<i>Thoradonta pruthii</i>	SWB
	197.	<i>Bolivaritettix dubius</i>	NWB
	198.	<i>B. laticeps</i>	NWB
	199.	<i>B. sikkimensis</i>	NWB
	200.	<i>Hyboella conioptica</i>	NWB
	201.	<i>H. obesa</i>	NWB
	202.	<i>H. tentata</i>	NWB
	203.	<i>Teredorus frontalis</i>	NWB
	204.	<i>Xistrella dromadaria</i>	NWB
	205.	<i>X. inermis</i>	NWB
	206.	<i>Paratettix rotundatus</i>	V
	207.	<i>Velarifictorus sikkimensis</i>	NWB
	208.	<i>Gyllodes sigillatus</i>	SWWB, SWB
	209.	<i>Loxoblemmus macrocephalus</i>	NWB
	210.	<i>L. nigriceps</i>	NWB
	211.	<i>Pteronemobius pantelchopardorum</i>	NWB
212.	<i>Cacoplistes rogenhoferi</i>	NWB, SWB	
213.	<i>Holopercna darjeelingensis</i>	NWB	
214.	<i>Chondronotulus bengalensis</i>		
215.	<i>Epistaurus sinetyi</i>	SWB, SWWB,	
216.	<i>Peripolus pedarius</i>	NWB	
217.	<i>Eupreponotus inflatus</i>	NWB, SWB	
218.	<i>Paraconophyma scabra</i>	SWWB	
219.	<i>Sanna regalis</i>	NWB	
220.	<i>Eucocephalus incertus</i>	SWWB	
Dermaptera	221.	<i>Paradipplatys gladiator</i>	SWB, NWB
	222.	<i>Diplatys sinuatus</i>	NWB
	223.	<i>Haplodiplatys rileyi</i>	NWB
	224.	<i>H. rufescens</i>	
	225.	<i>Euborellia annandalei</i>	NWB

Table-25 : Contd.

Group	Sl. No.	Species	Main region of occurrence
	226.	<i>Antisolabis formicoides</i>	NWB
	227.	<i>Forc ipula indica</i>	NWB
Dictyoptera	228.	<i>Trichoblatta sericea</i>	NWB
	229.	<i>Stictolampra plicta</i>	EWB
	230.	<i>Panesthia regalis</i>	NWB
Mantodea	231.	<i>Anaxarcha acuta</i>	NWB
	232.	<i>Ephestiasula amoena</i>	SWB
	233.	<i>Heliomantis elegans</i>	NWB
	234.	<i>Hestiasula inermis</i>	NWB
	235.	<i>Creobroter apicallis</i>	SWB
	236.	<i>Dysaules longicollis</i>	
	237.	<i>Leptomantis indica</i>	NWB
	238.	<i>L. montana</i>	NWB
	239.	<i>Heterochaetula tricolor</i>	SWB
	240.	<i>Parananomantis brevis</i>	SWB
	241.	<i>Amantis subirina</i>	NWB
	242.	<i>A. biroi</i>	SWB
	243.	<i>Gonypetyllis semuncialis</i>	SWB
	244.	<i>Hierodula butleri</i>	NWB
	245.	<i>Aethalochroa ashmoliana</i>	NWB
Psocoptera	246.	<i>Granthakita cuttackae</i>	SWB
	247.	<i>Pachytroctes georgi</i>	SWB
Hemiptera	248.	<i>Machaerota planitiae</i>	SWB
	249.	<i>Eugnathodus ocellatus</i>	NWB
	250.	<i>Halotrichosiphum rusellae</i>	NWB
	251.	<i>Pseudoastegopteryx himalayensis</i>	NWB
	252.	<i>Pemphigus vulgaris</i>	NWB
Diptera	253.	<i>Microtytum strigatum</i>	NWB
	254.	<i>M. trimelas</i>	NWB
	255.	<i>Simulium tenuistylum</i>	NWB
	256.	<i>S. dentatum</i>	NWB
Lepidoptera	257.	<i>Pseudopanthera himalayica</i>	NWB
	258.	<i>Boarmia diversicolor</i>	NWB
	259.	<i>B. atrostipata</i>	NWB
	260.	<i>Apocalypsis velox</i>	NWB
	261.	<i>Campsogene masoni</i>	NWB
	261a.	<i>Oxyambalyx matti</i>	NWB
	262.	<i>Anambulyx elwesi</i>	NWB
	263.	<i>Punacra moseri</i>	NWB

Table-25 : Contd.

Group	Sl. No.	Species	Main region of occurrence
Acari	264.	<i>Euteranychus maximae</i>	SWB
	265.	<i>Oligonychus magniferus</i>	EWB
	266.	<i>Malconothrus assamensis</i>	SWB
	267.	<i>Basilobelba indica</i>	EWB
Mollusca	268.	<i>Parreysia lima</i>	NWB
	269.	<i>Pisidium atkinsonianum</i>	NWB
	270.	<i>Sphaerium indicum</i>	NWB
	271.	<i>Cyclophorus aurora</i>	NWB
	272.	<i>C. polynea</i>	SWB
	273.	<i>Theobaldius phaenolopicus</i>	NWB
	274.	<i>Clithon reticularis</i>	SWB
	275.	<i>Scaphula celox</i>	SWB
	276.	<i>Macrochlamys petrosa</i>	SWB, SWWB
	277.	<i>Pterocyclus rupestris</i>	NWB
Rotifera	278.	<i>Lecane lateralis</i>	-
	279.	<i>L. pawlowski</i>	-
Annelida			
Oligochaeta	280.	<i>Dero indica</i>	SWWB, NWB
	281.	<i>Branchiodrilus semperi</i>	EWB
Porifera	282.	<i>Corvospongilla lapidosa</i>	SWB
	283.	<i>C. caunteri</i>	
Cnidaria	284.	<i>Edwardsia jonesli</i>	SWB
	285.	<i>E. tinctorix</i>	SWB
	286.	<i>Pelocoetes exul</i>	SWB
	287.	<i>Phytocoetes gangeticus</i>	SWB
	288.	<i>Nevadne glauca</i>	SWB
	289.	<i>Diadumene schilleriana</i>	SWB
	290.	<i>Paracondylactis indica</i>	SWB
Plants			
	291.	<i>Agrostris brachiata</i>	-
	292.	<i>A. sikkimensis</i>	NWB
	293.	<i>A. triaristata</i>	NWB
	294.	<i>Arundinella decempedalis</i>	NWB
	295.	<i>Bambusa balcooa</i>	NWB
	296.	<i>Dendrocalamus petellaris</i>	NWB
	297.	<i>Festuca leptopogon</i>	NWB
	298.	<i>Alysicarpu homosus</i>	EWB
	299.	<i>Cajanus villosus</i>	NWB
	300.	<i>Dysolobium tetragonum</i>	NWB

Table-26 : Some species exclusively endemic to West Bengal with region of their main occurrence. Abbreviations as in Table 24.

Group	Sl. No.	Species	Main region of occurrence
Mammals	1.	<i>Herpestes palustris</i>	SWB
Reptiles	2.	<i>Oligodon juglandifer</i>	NWB
Amphibia	3.	<i>Bufo abatus</i>	NWB
	4.	<i>Megophryus robusta</i>	NWB
	5.	<i>Rana senchalensis</i>	NWB
	6.	<i>R. annandalii</i>	NWB
	7.	<i>Rhacophorus jerdonii</i>	NWB
	8.	<i>R. dubius</i>	NWB
Pisces	9.	<i>Puntius dukai</i>	NWB
Arthropoda Strepsiptera	10.	<i>Trizocera pugipenis</i>	-
Coleoptera	11.	<i>Omoglymmius darjeelingensis</i>	NWB
	12.	<i>Heptodonta kraatzi</i>	NWB
	13.	<i>Cicindela seriepunctata</i>	NWB
	14.	<i>C. oberthuri</i>	NWB
	15.	<i>Amblystomus bivittatus</i>	SWB
	16.	<i>Chydaeus obscurus</i>	NWB
	17.	<i>Laceophilus kempi</i>	NWB
	18.	<i>Hydraena tenjikuana</i>	NWB, SWB
	19.	<i>H. wittmeri</i>	NWB
	20.	<i>Coelostoma subditum</i>	SWB
	21.	<i>Crenitis orientalis</i>	NWB
	22.	<i>Saprinus chalcites</i>	NWB
	23.	<i>Chaetabraeus fakir</i>	NWB
	24.	<i>Cypturus bengalensis</i>	SWB
	25.	<i>Apobletes bengalensis</i>	NWB
	26.	<i>Hyposotenus bengalensis</i>	NWB
	27.	<i>Chronus scaliformis</i> '	NWB, SWB
	28.	<i>Hister pullatus</i>	SWB
	29.	<i>Santalus parallelus</i>	SWB
	30.	<i>Micropeplus vulcanus</i>	NWB
	31.	<i>Apatetica sikkmi</i>	NWB
	32.	<i>Eupiestus angulatus</i>	NWB
	33.	<i>Siogonium indicum</i>	NWB
	34.	<i>Holusus rugipennis</i>	NWB

Table-26 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	35.	<i>H. lopchuensis</i>	NWB
	36.	<i>Thoracophorus montanus</i>	NWB
	37.	<i>Eleusis speculifer</i>	NWB
	38.	<i>E. rotundiceps</i>	NWB
	39.	<i>E. persimilis</i>	NWB
	40.	<i>Priochirus bengalensis</i>	NWB
	41.	<i>P. micrognathus</i>	NWB
	42.	<i>P. eucerus</i>	NWB
	43.	<i>P. gardneri</i>	NWB
	44.	<i>Thoracochirus denticollis</i>	NWB
	45.	<i>Tetradelus trigonuroides</i>	NWB
	46.	<i>Trogophloeus calcuttanus</i>	SWB
	47.	<i>Oxytelopsis bengalensis</i>	NWB
	48.	<i>Oxytelus punctipennis</i>	NWB
	49.	<i>Anotylus gardneri</i>	NWB
	50.	<i>Bledius suravius</i>	SWB
	51.	<i>B. totias</i>	NWB
	52.	<i>B. torsius</i>	NWB
	53.	<i>B. baltus</i>	NWB
	54.	<i>Osorius gardneri</i>	NWB
	55.	<i>O. lopchuensis</i>	NWB
	56.	<i>Mimogonus niger</i>	NWB
	57.	<i>Oxyporus excellens</i>	NWB
	58.	<i>O. terminalis</i>	NWB
	59.	<i>O. tricolor</i>	NWB
	60.	<i>Stenus vorticosus</i>	NWB
	61.	<i>S. confluens</i>	NWB
	62.	<i>S. obliteratedus</i>	NWB
	63.	<i>S. lopchuensis</i>	NWB
	64.	<i>S. mangpuensis</i>	NWB
	65.	<i>S. separandus</i>	NWB
	66.	<i>S. pseudopictus</i>	NWB
	67.	<i>Dianous championi</i>	NWB
	68.	<i>D. obliquenotatus</i>	NWB
	69.	<i>D. adjacens</i>	NWB

Table-26 : Contd.

Group	Sl. No.	Species	Main region of occurrence
	70.	<i>D. wittmeri</i>	NWB
	71.	<i>Edaphus binodulus</i>	NWB
	72.	<i>E. brevipennis</i>	NWB
	73.	<i>Aulacosthaetus indicus</i>	NWB
	74.	<i>Pinophilus indicus</i>	SWB
	75.	<i>Astenus bisalicus</i>	NWB
	76.	<i>A. gracilentus</i>	NWB
	77.	<i>Paederus atrocyaneus</i>	NWB
	78.	<i>P. hingstoni</i>	NWB
	79.	<i>Scopaeus bicuspis</i>	SWB
	80.	<i>Sclerochiton indicus</i>	NWB
	81.	<i>Lobochilus brachypterus</i>	NWB
	82.	<i>L. labralis</i>	NWB
	83.	<i>L. brevipennis</i>	NWB
	84.	<i>Dibelonetus bhaumiki</i>	NWB
	85.	<i>Charichirus immaculatus</i>	NWB
	86.	<i>Dolicaon longipennis</i>	SWB
	87.	<i>Leptacinus aethiops</i>	NWB
	88.	<i>Pachycorynus niger</i>	NWB
	89.	<i>Mitimorphus brevipennis</i>	NWB
	90.	<i>M. brachypterus</i>	NWB
	91.	<i>Xantholinus oeneus</i>	NWB
	92.	<i>X. ruficaudatus</i>	NWB
	93.	<i>Gauropterus marginalis</i>	NWB
	94.	<i>Othius monticols</i>	NWB
	95.	<i>Philonthus rupicola</i>	NWB
	96.	<i>Macronota westoodi</i>	NWB
	97.	<i>M. nigricollis</i>	NWB
	98.	<i>Rhomborrhina microcephala</i>	NWB
	99.	<i>R. mearesi</i>	NWB
	100.	<i>Heterorrhina dispar</i>	NWB
	101.	<i>Trigonophorus saundersi</i>	NWB
	102.	<i>Coenochilus cambelli</i>	NWB
	103.	<i>Eupatorus hardwickei</i>	NWB
	104.	<i>Anomata siligurio</i>	NWB

Table-26 :Contd.

Group	Sl. No.	Species	Main region of occurrence
Thysanura	105.	<i>Tricholepisma gravelyi</i>	SWWB
	106.	<i>Atelura typhioponsis</i>	NWB
	107.	<i>Stylifera wygodzinskyi</i>	SWB, SWWB
Ephemeroptera	108.	<i>Baetis tigroides</i>	NWB
	109.	<i>B. thurbonis</i>	NWB
	110.	<i>B. solitarius</i>	NWB
	111.	<i>Pseudocloeon inopinum</i>	NWB
	112.	<i>Coenis pica</i>	SWB
	113.	<i>C. piscina</i>	SWB
	114.	<i>Ecdyonurus bengalensis</i>	NWB
	115.	<i>Isca purpurea</i>	
Odonata	116.	<i>Himalagrion exclamationis</i>	NWB
	117.	<i>Drepanosticta polychromatica</i>	NWB
	118.	<i>Caconeura o' doneli</i>	-
	119.	<i>Orolestes selysi</i>	-
	120.	<i>Rhinocypha cuneata</i>	NWB
	121.	<i>Allogaster hermionae</i>	NWB
	122.	<i>Periaeschna unifasciata</i>	NWB
	123.	<i>Gynacantha o'doneli</i>	SWB
	124.	<i>G. rammohni</i>	SWB
	125.	<i>Gamphidia williamsoni</i>	NWB
	126.	<i>Macrogomphus seductus</i>	NWB
	127.	<i>Burmagomphus hasimaricus</i>	NWB
	127a.	<i>Gomphus o'doneli</i>	NWB
	127b.	<i>Megalogomphus flavicolor</i>	NWB
	128.	<i>Lamelligomphus risi</i>	NWB
	129.	<i>Onychogomphus M-flavum</i>	NWB
	130.	<i>O. duaricus</i>	NWB
	131.	<i>Macromia pallida</i>	NWB
	132.	<i>M. flavovittata</i>	NWB
	133.	<i>Idionys stevensi</i>	NWB
Plecoptera	134.	<i>Amphinemoura elegans</i>	NWB
	135.	<i>A. pulchera</i>	NWB
	136.	<i>Indonemouria indica</i>	NWB
	137.	<i>I. shergaoni</i>	NWB

Table-26 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	138.	<i>Nemoura magnicauda</i>	NWB
	139.	<i>Neoperla lushana</i>	NWB
	140.	<i>N. montivaga</i>	NWB
	141.	<i>Perla xenocia</i>	NWB
Orthoptera	142.	<i>Oxyphyllum pennatum</i>	NWB
	143.	<i>Epitettix elytratus</i>	NWB
	145.	<i>Indoscelimena angulasta</i>	SWB
	146.	<i>I. flavopicta</i>	SWB
	147.	<i>I. saussurei</i>	SWB
	148.	<i>Eucriotettix aequalis</i>	NWB
	149.	<i>Hebarditettix lobatus</i>	NWB
	150.	<i>Synalibs vagans</i>	NWB
	151.	<i>Bolivaritettix ghumtianus</i>	NWB
	152.	<i>B. singlaensis</i>	NWB
	153.	<i>Systolederus graveli</i>	NWB
	154.	<i>Teredorus carmichaeli</i>	NWB
	155.	<i>Ergatettix callosus</i>	NWB
	156.	<i>Hedotellix grossus</i>	NWB
	157.	<i>Paratettix alatus</i>	NWB
	158.	<i>Saussurella indica</i>	NWB
	159.	<i>Teleogryllus himalayanus</i>	NWB
	160.	<i>Melanogryllus carmichaeli</i>	NWB
	161.	<i>Callogryllus pallidus</i>	NWB
	162.	<i>Gryllopsis pubescens</i>	NWB
	163.	<i>Nemobiodes sukhadae</i>	NWB
	164.	<i>Pteronemobius rufipes</i>	NWB
	165.	<i>Scottiola diverna</i>	NWB
	166.	<i>S. elongata</i>	NWB
	167.	<i>Speonemobius decolyi</i>	NWB
	168.	<i>Speonemobius annandalei</i>	NWB
	169.	<i>Paratrignidium unifasciatum</i>	NWB
	170.	<i>Madasumma graveleyi</i>	NWB
	171.	<i>Dnopherula physopoda</i>	NWB
	172.	<i>D. rubripes</i>	NWB
173.	<i>Meristopteryx rotundata</i>	NWB	

Table-26 : Contd.

Group	Sl. No.	Species	Main region of occurrence
	174.	<i>Cercopephalus indica</i>	NWB
	175.	<i>Catantops erubescens</i>	NWB
	176.	<i>Gerania bengalensis</i>	NWB
	177.	<i>Diplatys brindlei</i>	NWB
	178.	<i>Haplodiptalys kurseongensis</i>	NWB
	179.	<i>H. bidentatus</i>	NWB
	180.	<i>H. lobatus</i>	NWB
	181.	<i>Anisolabis bhowmiki</i>	NWB
	182.	<i>Paralabella fulleri</i>	NWB
	183.	<i>Apovostox burri</i>	NWB
	184.	<i>Chaetospania kurseongae</i>	NWB
Mantodea	185.	<i>Cimantis fumosa</i>	NWB
	186.	<i>C. testacea</i>	NWB
Psocoptera	187.	<i>Liposcelis bengalensis</i>	NWB
	188.	<i>Tapinella fasciata</i>	SWWB
	189.	<i>Caecilius bengalensis</i>	NWB
	190.	<i>C. persimularis</i>	NWB
	191.	<i>Dypsocus fucosus</i>	NWB
	192.	<i>Stenopsocus pallidus</i>	NWB
	193.	<i>Amphipsocus heterothrix</i>	NWB
	194.	<i>Ectopsoeus ramburi</i>	SWB
	195.	<i>E. bengalensis</i>	SWB
	196.	<i>E. cinclus</i>	NWB, SWB
	197.	<i>Peripsocus sinensis</i>	NWB
	198.	<i>P. anoplus</i>	NWB, SWB
	199.	<i>P. scierotus</i>	SWB
	200.	<i>P. bhaktae</i>	NWB
	201.	<i>Heterocaecilius fuscipalpus</i>	NWB
	202.	<i>Allocaecilius heterothorax</i>	NWB
	203.	<i>Psococerastis asiatica</i>	SWB
204.	<i>Myopsicus pattoni</i>	NWB	
Diptera	205.	<i>Ammophilomima rufescens</i>	SWB
	206.	<i>Leptogaster ophionea</i>	SWB
	207.	<i>Laphlria furva</i>	NWB
	208.	<i>L. gilvoides</i>	NWB
	209.	<i>Laphystia indica</i>	NWB
	210.	<i>Maria bicolor</i>	NWB
	211.	<i>Nusa bengalensis</i>	NWB
	212.	<i>N. mukherjeei</i>	NWB

Table-26 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	213.	<i>Microstylum apicale</i>	NWB
	214.	<i>Oldroydia scatophogoides</i>	NWB
	215.	<i>S. nigrofasciatus</i>	NWB
	216.	<i>Damolis claripennis</i>	NWB
	217.	<i>Stchopogon bengalensis</i>	NWB
	218.	<i>S. menoni</i>	NWB
	219.	<i>Ommatius bengalensis</i>	NWB
	220.	<i>O. gopalpurensis</i>	SWB
	221.	<i>O. singlensis</i>	NWB
	222.	<i>O. subgracilis</i>	NWB
	223.	<i>Astochia femorata</i>	NWB
	224.	<i>Heligmoneura bengalensis</i>	NWB
	225.	<i>H. chaetoprocta</i>	SWB
	226.	<i>H. yenpingensis</i>	NWB
	227.	<i>Hoplopheromerus armatipes</i>	NWB
	228.	<i>Machimus infraferoralis</i>	NWB
	229.	<i>Neoitamus bengalensis</i>	SWB
	230.	<i>N. calcuttaensis</i>	NWB
	231.	<i>Nemochtherus himalayensis</i>	NWB
	232.	<i>Simulium dasguptai</i>	NWB
	233.	<i>S. ghoomense</i>	NWB
	234.	<i>S. gracile</i>	NWB
	235.	<i>S. nemorivagum</i>	NWB
	236.	<i>S. praelargum</i>	NWB
	237.	<i>S. purii</i>	NWB
	238.	<i>S. darjeelingense</i>	NWB
	239.	<i>S. asishi</i>	NWB
	240.	<i>S. biforamiferum</i>	NWB
	241.	<i>S. nigrifacies</i>	NWB
	242.	<i>S. tenuitarsus</i>	NWB
	243.	<i>Diamesa bicornipes</i>	NWB
	244.	<i>D. edentisyla</i>	SWWB, SWB
	245.	<i>Ablabesmyia alba</i>	SWWB, SWB
	246.	<i>A. ensiceps</i>	NWB
Lepidoptera	247.	<i>Gastropocha divaricata</i>	NWB
	248.	<i>Kosala flavosignata</i>	NWB
	249.	<i>Metanastria lineata</i>	NWB

Table-26 :Contd.

Group	Sl. No.	Species	Main region of occurrence
	250.	<i>M. obliquifascia</i>	NWB
	251.	<i>Arguda bheroba</i>	NWB
	252.	<i>Cosmotricha lidderdalii</i>	NWB
	253.	<i>Dasychir cymata</i>	NWB
	254.	<i>D. perdix</i>	NWB
	255.	<i>D. bhana</i>	NWB
	256.	<i>Aroa ochracea</i>	SWB
	257.	<i>Cyllogenes suradeva</i>	NWB
	258.	<i>Syntomis luciana</i>	SWB
	259.	<i>S. insueta</i>	SWB
Hemiptera	260.	<i>Tricentrus cinereus</i>	SWB
	261.	<i>T. dubius</i>	SWB
	262.	<i>Gargara brevis</i>	SWB
Acari	263.	<i>Olgonychus sapienticolis</i>	NWB
	264.	<i>Schizotetranychus cajani</i>	NWB
	265.	<i>Colopodacus combretus</i>	SWB
	267.	<i>Cosella ichnocarpasia</i>	SWB
	268.	<i>Epicecidophyes clerodendris</i>	SWB
	269.	<i>Allonothrus indicus</i>	SWB
	270.	<i>Heterobelba restrata</i>	NWB
Mollusca	271.	<i>Alycaeus lectus</i>	NWB
	272.	<i>Tanysiphon rivalis</i>	SWB
	273.	<i>Pupilla barrackporensis</i>	SWB
	274.	<i>Succinea crassinuclea</i>	SWB
Rotifera	275.	<i>Lecane vaishti</i>	-
	276.	<i>Lepadella triprojectus</i>	-
	277.	<i>Ptygura stephanion</i>	-
	278.	<i>Rotaria ovata</i>	-
Phoronida	279.	<i>Phoronis bhadurii</i>	SWB
Bryozoa	280.	<i>Membranipora hugliensis</i>	SWB
Porifera	281.	<i>Eunapis calcuttanus</i>	NWB, SWB
Plants	282.	<i>Acer osmastonii</i>	-
	283.	<i>Bulbophyllum roxburghii</i>	-
	284.	<i>Cardenthera uliginosa</i> var. <i>birbhumensis</i>	SWWB
	285.	<i>Cuscata sharmanum</i>	SWB
	286.	<i>Hydrocotyle himalayica</i>	NWB
	287.	<i>Hypericum assamcum</i>	NWB
	288.	<i>Dalbergia duarensis</i>	NWB

The state also contains a large number of floral and faunal species which deserve special mention owing to their taxonomic, evolutionary, distributional, economic, medicinal and other significance.

There are at least 15 species of carnivorous plants belonging to the genera *Drosera*, *Aldrovanda* and *Utricularia* found within the limit of the state.

A number of primitive flowering plants and animals occur in the state which serve as evolutionary link and often considered as living fossils. Among plants *Betula alnoides*, *Magnolia* sp., *Actinodaphne angustifolia*, *Exbucklandia populnea* while among animals *Carcinosepius rotundicanda*, *Tachypleus gigas*, *Epiophelbia laidlawi*, *Trilototriton verrucosus* are notable in this aspect.

West Bengal, particularly the northern part contributes significantly to the conservation of the world's genetic resources by way of harbouring a number of monotypic families and genera. Hippocastanaceae (*Aesculus assamica*), Stachyuraceae (*Stachyurus himalaicus*), Rhizophoraceae (*Caralia integmma*), Datisceae (*Tetrameles nudiflora*), Sonneretiaceae (*Duabanga grandiflora*), Scrophulariaceae (*Wrightia gigantea*), Proleaceae (*Helicia erratica*), Hamamelidaceae (*Exbucklandia populnea*) are few monotypic families of the state. At least 517 dicot and 171

monocot monotypic genera are also represented in the region. A large number of monotypic faunal genera such as *Anathana*, *Scotozous*, *Cuon*, *Melursus*, *Ailurus*, *Arctonyx*, *Mellivora*, *Arctogalidia*, *Paguma*, *Lutrogale*, *Neofelis*, *Hyaena*, *Pardofelis*, *Elephas*, *Cannomys*, *Nesokia*, *Caprolagus* (all mammals), *Netta*, *Butastur*, *Hydrophasianus*, *Metopidius*, *Philomachus* (all birds), *Catla*, *Rhinomugil* (Fish), *Oxyphyllum*, *Melanogryllus*, *Condronotulus*, *Meristopteryx* (Orthoptera), *Nevadne* (Cnidaria) and many others are also found. As there are no closely related genomes of these genera anywhere in the world, their conservation is of special significance.

Many of the species and genera occurring in the state exhibit extreme discontinuity in distribution. They occur in Penninsular south or West or even in Sri Lanka and other continent with an extensive intervening areas totally without them. Some examples of such discontinuous distribution have been shown in Table 27. There are also a large number of floral and faunal forms which are mostly confined to West Bengal and further north-east but do not enter the Peninsular India. This phenomenon is best exemplified by the distribution of Mammalian families, genera and species such as Rhinocerotidae, *Euroscaptor*, *Megaerops niphanae*, *Microtus sikkimensis*, *Cannymys badius*, etc.

Table-27 : Showing some discontinuously distributed faunal element (species and genera) of the state.

Group	Sl.No	Species/Genera	Region of occurrence
Porifera	1.	<i>Corvospongilla lapidosa</i>	W.B., Maharashtra
Annelida	2.	<i>Nais simplex</i>	W.B., Europe, N. America
	3.	<i>N. elinguis</i>	W.B., Europe
	4.	<i>Aelosoma bengalense</i>	W.B., Kerala, S. America
	5.	<i>Dero indica</i>	W.B., Andhra Pradesh, Karnataka
Mollusca	6.	<i>Succinea daucina</i>	W.B., Sri Lanka
Arthropoda			
Acari	7.	<i>Plateremaeus rotundus</i>	W.B., Indonesia

Table-27 : Contd.

Group	Sl. No.	Species/Genera	Region of occurrence
Hemiptera	8.	<i>Coccosterphus obscurus</i>	W.B., Sri Lanka
Lepidoptera	9.	<i>Crambus atkinsoni</i>	W.B., Sri Lanka, Myanmar
	10.	<i>Chartona consociella</i>	W.B., N. America
	11.	<i>Boarmia diversicolor</i>	W.B., Punjab
	12.	<i>Oxyambulyx matti</i>	W.B., Karnataka
Coleoptera	13.	<i>Guignotus fulvescens</i>	W.B., Nicobar
	14.	<i>Acritus pascuarum</i>	W.B., China
	15.	<i>A. tuberisternus</i>	W.B., Kerala
	16.	<i>Hypocacculus malabaricus</i>	W.B., Kerala
	17.	<i>Bacanius atomarius</i>	W.B., Honolulu
	18.	<i>Platylomalus oblisus</i>	W.B., Andamans
	19.	<i>Pachylister chinensis</i>	W.B., China
	20.	<i>Priochirus longicornis</i>	W.B., Tamill Nadu
	21.	<i>Trogophloeus simplex</i>	W.B., Sri Lanka, Australia
	22.	<i>Oxytelopsis andrewesi</i>	W.B., Tamil Nadu
	23.	<i>Stenus pictus</i>	W.B., Tamil Nadu
	24.	<i>S. fistulosus</i>	W.B., Tamil Nadu
	25.	<i>Palaminus indicus</i>	W.B., Tamil Nadu
	26.	<i>Astenus terminalis</i>	W.B., Tamil Nadu
	27.	<i>Scopaeus andrewesi</i>	W.B., Tamil Nadu
	28.	<i>S. germanus</i>	W.B., Tamil Nadu
	29.	<i>Anomala elata</i>	W.B., Tamil Nadu, Karnataka
Odonata	30.	<i>Macromia flavicineta</i>	W.B., Maharashtra
Orthoptera	31.	<i>Pteronemobius pantelchopardorum</i>	W.B., Kerala
	32.	<i>Dnopherula decisus</i>	W.B., Maharashtra
Mantodea	33.	<i>Ephestiasula amoena</i>	W.B., Tamil Nadu, Kerala
Amphibia	34.	<i>Ichthyophis</i>	W.B., N.E. India, Kerala
	35.	<i>Rana keralensis</i>	W.B., Kerala
Aves	36.	<i>Garrulax</i>	W.B., N.E. India, Peninsular India
Mammals	37.	<i>Ratufa</i>	W.B., N.E. India, Peninsular India
	38.	<i>Hemitragus</i>	W.B., Sikkim, Kerala
	39.	<i>Harpiocephalus harpia</i>	W.B., N.E. India, Tamil Nadu

Quite a large number of exotic floral and faunal species have become an important part of the natural biodiversity of the state. While some of them were brought by the human beings for some definite purpose, but many others got the entry without the direct intention of the people. Vast and rapid encroachment of few exotic species is gradually becoming a threat in many of the ecosystem, while many have been naturalized or commercially grown. Director, Botanical Survey of India (1997) provided the following concise list of major weed flora of the state indigenous to various countries and year of their first report from West Bengal in parenthesis.

1. **North America** : *Alternanthera pungens* (1966), *Calceolaria mexicana* (1954), *Cassia corymbosa* (1966), *C. laevigata* (1966), *Centrosema virginicum* (1970), *Eleutheranthera ruderalis* (1966), *Eupatorium adenphorum* (1966), *E. erythropappum* (1966), *E. ligustrum* (1970), *Gnaphalium purpurcum* (1881), *Hyptis pectinata* (1940), *Melichia pyramidata* (1969), *Nothosaerva brachiata* (1966), *Oxalis Latifolia* (1870), *O. maritima* (1969), *Parthenium hysterophorus* (1978), *Petiviero alliacea* (1961), *Pseudo-elephantopus spicatus* (1961), *Solanum glaucum* (1905), *Tithomia diversifolia* (1966), *Bromusunioloides* (1975), *Setaria paniculifera* (1970), *Argemone mexicana* (1903), *Malvastrum coromandelianum* (1903), *Malachra capitata* (1903), *Passiflora suberosa* (1903), *P. foetida* (1903), *Melochia pyramidota* (1969), *Erigeron karvinskianus* (1966), *Opuntia dillenii* (1903), *Neptunia plena* (1903).
2. **South America** : *Alternanthera ficoidea* (1964), *Boerhavia erecta* (1978), *Croton bonplandianum* (1905), *Gompherna celosioides* (1966), *Ipomoea carnea* (1978), *I. congesta* (1969), *I. fistulosa* (1966), *Solanum viarum* (1970), *Spermacace latifolia* (1976), *Turnera subulata* (1969), *Echinochloa craspavonia* (1970), *Eichornia*

crassipes (1928), *Paspalum dilatatum* (1976).

3. **Africa** : *Cleome rutidosperma* (1969), *Grossocephalum crepidioides* (1976), *Euphorbia chamaesyce* (1969), *Gisekia pharnacioides* (1976), *Hibiscus micranthus* (1966), *Indigofera spicata* (1969), *Ludwigia erecta* (1969), *L. hyssopifolia* (1966), *Micrococca mercurialis* (1966), *Mitracarpus verticillatus* (1979), *Brachiaria mutica* (1976), *Melinis minutiflora* (1970), *Rhynchelytrum villosum* (1980).
4. **Europe** : *Chrysanthemum leucanthemum* (1970), *Convolvulus arvensis* (1969), *Cuscuta campestris* (1966), *Lepidium ruderalis* (1970), *Rumex acetosella* (1969), *Senecio vulgaris* (1980), *Anthoxanthum odoratum* (1966), *Phalaris minor* (1975), *Lathyrus aphaca* (1903), *Vicia sativa* (1903), *Senebiera pinnatifida* (1903), *Alyssum maritimum* (1903), *Lepidium sativum* (1903).
5. **Malaysia and Australia** : *Cotula australis* (1969), *Dentella serpyllifolia* (1968), *Eryngium foetidum* (1979), *Ipomoea quinata* (1979), *Lobelia radicans* (1960), *Pseudarthia viscida* (1979), *Rothia trifoliata* (1966), *Digitaria adscendens* (1966), *D. prestii* (1960), *Polytrias amaura* (1960).
6. **China and Japan** : *Hydrangia macrophylla* (1966), *Viola thomsonii* (1916), *Primula malacoides* (1966).
7. **Western Asia** : *Euphorbia helioscopia* (1978), *Aeluropus lagopoides* (1965), *Capsella bursa-pastoris* (1903).

The major portion of the openwater interface of the unmanged waterbodies of the state are now occupied by exotic weeds mostly of South American origin. Among these *Eichhomia crassipes* and *Alternanthera philoxeroides* are fairly common in most of the waterbodies except in high altitudes. In addition to these *Sagittaria montividensis* occupies water edges of waste water canals. Free floating

aquatic weeds like *Salvinia molesta* and *S. cucullata* are also common in the brackish and nutrient rich water bodies. Submerged members of the family Hydrocharitaceae are mostly old-world species and considered as serious weedpest of the aquatic ecosystem of the state. *Cabomba caroliniana*, a strictly aquatic submerged weed introduced in India through aquarium plant and now becomes a part of the natural flora of the state.

A number of exotic spice species have enriched the state flora and exclusively cultivated. Among these Capsicum – *Capsicum annum* (America), Coriander – *Coriandrum sativum* (Mediterranean), Cumin – *Cuminum cyminum* (Levant), Carcuma – *Carcuma longa* (south east Asia), Fennel – *Foeniculum vulgare* (Mediterranean) are worth-mentioning. Gardens and avenues of the state are also flourished with variety of exotic ornamental floral species such as Snapdragon - *Antirrhinum majus* (North America), Bougainvillea - *Bougainvillea spectabilis* (South America), Croton - *Codiaeum variegatum* (North America), about 40 species of *Cactus* (Tropical America), Guldaudi - *Chrysanthemum indicum* (Japan), Gulmoho - *Delonix regia* (Madagascar), Larkspur - *Delphinium ajacia* (South Europe), Sunflower - *Helianthus annus* (North America), Champa - *Michelia champaca* (China), Surmaineel - *Indigofera articulata* (Egypt), Amarphal - *Monstera deliciosa* (Central America), Ipomea creeper *Mina lobata* (Mexico), Ashok - *Polyalthea longifolia* (Malaysia), Rajinigandha - *Polyanthes tuberosa* (Mexico), Gulab - *Rosa alba* (Turkey and Arab), etc.

Not much documentation has been made as regard the exotic invertebrate species of India or West Bengal. However, many of the invertebrate species particularly the arthropods are soil inhabiting animals and associated with agricultural crops, stored products and parasitic to other animals including migratory species of birds. As such, the chances of their

being transported/introduced from outside can not be ruled out. The study of Venkataraman, 1992 and Venkataraman and Das, 1993, 1994 (in Alfred and Nandi, 2001) revealed the occurrence of several temperate and palaeractic species of cladocera as detailed below in the flood plain wetlands of West Bengal. Migratory birds might have played significant role in the dispersal of Cladoceran species.

Exotic cladoceran species in West Bengal : *Daphnia similes*, *Diaphanosoma brachyurum*, *D. senegalensis*, *chydorus flavifrons*, *C. pubescens*, *Alona intermedia*, *A. rectangular*, *A. costata*, *Camptocercus australis*, *Pleuroxus similis*, *Grimaldina brazzai*, *Graptoleberis testudinaria*. *Leydigia australis*, *L. acanthocercoides*.

Country as well as the state of West Bengal have long history of introduction of exotic fish species for the purpose of bio-control, more production and adding glamour to the aquarium. The Gold fish - *Carassius auratus* and *C. carassius* which occur in nature all over China, Korea, Japan, Taiwan, and the Tench or shoemaker-*Tinca tinca* found in fresh water of Europe had been introduced as sport and ornamental fish. The Silver Carp, *Hypophthalmichthys molitrix*, a native of South and Central America was first brought to India from Japan in 1959. The consignment of Grass Carp-*Ctenopharhyngodon idella* (a riverine freshwater fish of Amur region) was brought to Kolkata in 1959. The Tilapia-*Oreochromis mossambica* (original home-East Coast of Africa) was brought to India in 1952 via Bangkok. The Gourami - *Osphronemus gorami* (natural habitats in Indonesia, Thailand, Malaysia and Vietnam) was introduced in Kolkata during the first half of nineteenth century via Java. The common Carp - *Cyprinus carpio* with three of its varieties (natural home China, Korea, Japan, Taiwan and Europe), Minnows-*Gambusia affinis*, *Poecilia reticulates* (naturally found in America), Thai Magur-*Clarias gariepinus* (Thailand) have been

introduced at different times for natural purposes. All the above species are well-established in the different aquatic ecosystems of the state as well as country. Some of exotic food fishes like Silver Carp, Grass Carp, Tilapia, Thai Magur, etc. have been incorporated in our composite fish culture and helped in enhancing aquaculture production in purely closed system. However, the exotic fish species may bring range of various diseases caused by bacteria, fungi, viruses, etc. The most virulent and menacing one threatening many species is the Epizootic Ulcerative Disease Syndrome (EUS). It has wiped out large populations of a number of native commercial and non-commercial species in West Bengal, and the rest of the country.

There are stray accidental introduction of exotic bird species in the state as well as country, chiefly concerned with the escaped imported pet birds like Javan Sparrow, but such individuals gradually exterminated from the wild within a short span after release. Until recently, before the trade restriction, there has been a considerable import of exotic bird species of family Psittacidae land Phasianidae mainly from southeast Asian countries, Australia, South America and Africa. Among the exotic species represented in captivity, Macacow, Coccoat, Lory, Pheasants, Cocatil, etc., are very prominent.

At least two exotic mammalian species, *viz.*, House Mouse-*Mus musculus* and the Norway Rat-*Rattus norvegicus* have spread over throughout the country. The former species has been well-established in diverse habitats alongwith number of subspecies.

From the published accounts on ethnobotany of West Bengal more than 550 species are found to be used by the tribals either medicinal or for other economic purposes. Similarly, the biomedical properties of more and more faunal species are also being revealed. Leaving apart the role of species yielding food, fuel, timber, household accessories, fodder, fibre, wood, feather, paint and many others, opportunity

has been taken to focus the species of West Bengal with bio-medical potential, as pharmacological study on the bioresources of the state as well as of India is still in the initial stages.

Sponges have come to limelight in recent years on account of certain chemical compound they contain. Many of these chemicals have biomedical potentials and hence species of sponges are being screened for 'wonder drugs' Arabinose nucleosides extracted from *Tetya crypta* is now used in the treatment of blood cancers and certain malignant tumours. Sea anemones and jellyfish contain a number of antibiotics, useful in curing a variety of cellular and bone diseases. Two species of Horse-shoe crabs, *viz.*, *Carcinoscorpius rotundicauda* and *Tachypleus gigas*, are potential source of bioactive substances-Carcinoscorpius Amoebocyte Lysate (CAL) and Tachypleus Amoebocyte Lysate (TAL). These reagents are highly sensitive and use for the rapid and accurate assay of gram negative bacteria. Annelids are source of various valuable compounds which can be extracted from their bodies for treating variety of ailments like haemorrhoids, jaundice, rheumatism, etc. 'Hirudin' an extract from Leeches (*Hirudinaria* sp.) is being experimented in research to understand the mechanism of blood clotting. Venomous snake species are the source of antivenin and other medically important chemicals.

It has been said that each and every plant species contains medicinal properties. However, only a few of them have so far been brought under the commercial arena, a few more are being used almost in crude forms by the 'Baidyas' and 'Kabirajs', and a large number of them are so far used mainly by the tribals. An attempt has been made to provide a list of some of the plant species of the state having medicinal properties and which may be commercially exploited in a sustainable way (Table-28). However, the list is far from the complete.

Table-28 : Some plant species of West Bengal having medicinal potential and their parts in use.

Sl. No.	Scientific name	Local name	Parts in use
1.	<i>Abelmoschus moschatus</i>	Muskdana	Seeds
2.	<i>Ambroma augusta</i>	Ulat Kambal	Whole
3.	<i>Acontium ferox</i>	Katbish	Root
4.	<i>Alpina galanga</i>	Kalanjan	Rizome
5.	<i>Acorus calamus</i>	Bach	Rhizome
6.	<i>Aloe vera</i>	Ghritakumari	Leaf
7.	<i>Atalantia missions</i>	Koklash	Fruit
8.	<i>Andrographis paniculata</i>	Kalmegh	Whole
9.	<i>Artemisia annua</i>	Vagdana	Whole
10.	<i>Argemone mexicana</i>	Sitalkanta	-
11.	<i>Abrus precatorius</i>	Lalgeri	-
12.	<i>Acacia pennata</i>	Arare Kanta	-
13.	<i>Aegale marmelos</i>	Bel	Fruit
14.	<i>Adhatoda zeylanica</i>	Vasaka	Leaf
15.	<i>Asparagus recemosus</i>	Satamuli	Root
16.	<i>Azadirachta indica</i>	Neem	Whole
17.	<i>Bargeris aristata</i>	Daruharida	Stem
18.	<i>Bixa orellana</i>	Latkan	Seed
19.	<i>Bacopa monnieri</i>	Brahmi	Leaf
20.	<i>Butea monosperma</i>	Palash	Seed, Flower
21.	<i>Boerhavia repens</i>	Punarnaba	Leaf
22.	<i>Berberis chitria</i>	-	Root
23.	<i>B. insignis</i>	-	Root
24.	<i>Bergenia ligutata</i>	-	Root
25.	<i>Centratherum authelminticum</i>	Somraj	Seed
26.	<i>Calendula sp.</i>	Calendula, Bhirngaraj	Whole
27.	<i>Cymbobogon sp.</i>	Lemon	Whole
28.	<i>Cannabis sativa</i>	Ganja	Whole
29.	<i>Cassia fistula</i>	Banar Lathi	Fruit
30.	<i>Cassia augustifolia</i>	Sonapata	Whole
31.	<i>Catharanthus roseus</i>	Nayantara	Whole
32.	<i>Cinchona sp.</i>	Cinchona	Bark
33.	<i>Curcuma domestica</i>	Halud	Rhizome

Table-28 :Contd.

Sl. No.	Scientific name	Local name	Parts in use
34.	<i>Croton tiglium</i>	Jayapala	Seed
35.	<i>Centella asiatica</i>	Thankuni	Leaf
36.	<i>Cordia dichotoma</i>	Boch	Seed
37.	<i>Datura sp.</i>	Dutro	Fruit
38.	<i>Digitalis sp.</i>	Fox Glove	Whole
39.	<i>Eclipta prostrata</i>	Keshut	Leaf
40.	<i>Entada phaseoloides</i>	-	Seed
41.	<i>Eupotarium triplinerve</i>	Ayapoma	Whole
42.	<i>Eupatorium adenophorum</i>	-	Whole
43.	<i>Emblica officinalis</i>	Amlaki	Fruit
44.	<i>Fagopyrum cymosum</i>	-	Seed
45.	<i>Glycyrrhiza glabra</i>	Jashtimadhu	Root
46.	<i>Gloriosa superba</i>	Bighalanguli	Seed, root
47.	<i>Gymnema sylvestris</i>	Merasingi	Leaf
48.	<i>Ginkgo biloba</i>	Ginko	Whole
49.	<i>Henidesmus indicus</i>	Ananatamul	Root
50.	<i>Hedera nepalensis</i>	-	Leaf, Seed
51.	<i>Hedyotis scandens</i>	-	Leaf root
52.	<i>Hedychium spicalum</i>	-	Root
53.	<i>Heracleum nepalense</i>	-	Root
54.	<i>Imperata arundinacca</i>	-	Root
55.	<i>Ipomoea digitata</i>	Bhuni Kumra	Tuber
56.	<i>Kaempferia galanga</i>	Aekangi	Rhizome
57.	<i>Lawsonia intermis</i>	Mehendi	Leaf
58.	<i>Mentha arrensis</i>	Pudina	Whole
59.	<i>Mucuna prusiens</i>	Alkushi	Seed
60.	<i>Mahonia nepalense</i>		Berries
61.	<i>Martynia annua</i>	Baghnok	Fruit
62.	<i>Nardostachys grandiflora</i>	Jatamansi	Root
63.	<i>Nyctanthes arbor-tristis</i>	Shiuli	Leaf
64.	<i>Ocimum sp.</i>	Tulsi	Whole
65.	<i>Plantago ovata</i>	Isafgul	Seed
66.	<i>Psorcalca corzlifolia</i>	Babchi	Seed

Table-28 :Contd.

Sl. No.	Scientific name	Local name	Parts in use
67.	<i>Piper nigrum</i>	Gol Morich	Fruit
68.	<i>P. longum</i>	Pipal	Fruit
79.	<i>P. retrofractum</i>	Chai	Stem
70.	<i>P. mullesus</i>	Pahari pan	Fruit
71.	<i>Pelargonium graveolens</i>	-	Whole
72.	<i>Paederia foetida</i>	-	Leaf
73.	<i>Polygala arillata</i>	-	Root
74.	<i>Rauwolfia serpentina</i>	Sarpagandha	Root
75.	<i>R. tetraphylla</i>	-	Root
76.	<i>Rhododendron arboreum</i>	Rhododendron	Flower
77.	<i>Rubia cordifolia</i>	Manjishthha	Whole
78.	<i>Rheum emodi</i>	Bangala reperachini	Rhizome
89.	<i>Strychnos nuxvomica</i>	Kuchilla	Seed
80.	<i>Swertia chirayita</i>	Chirata	Whole
81.	<i>Solanum surattense</i>	Konti Kari	Whole
82.	<i>S. viarum</i>	-	Fruit
83.	<i>Saraca asoka</i>	Asoka	Bark
84.	<i>Tinospora crispa</i>	Gulanha	Stem
85.	<i>T. cordifolia</i>	Gulanha	Stem
86.	<i>Terminalia chebula</i>	Haritaki	Fruit
87.	<i>T. bellirica</i>	Bhairah	Fruit
88.	<i>T. arjuna</i>	Arjuna	Bark
89.	<i>Tribulus terrestris</i>	Gokhur	Fruit
90.	<i>Tylophora indica</i>	Antamue	Leaf
91.	<i>Withania somifera</i>	Ashwagandha	Root
92.	<i>Vitex negundo</i>	Nisinda	Whole
93.	<i>Valeriana hardwickii</i>	-	Root
94.	<i>Viscum articulatum</i>	-	Whole
95.	<i>Xanthoxylum hamiltonianum</i>	-	Fruit
96.	<i>Zingiber officinale</i>	Ada	Rhizome

PROTECTED AREAS IN WEST BENGAL

It has already been stated that Protected area Network of West Bengal is extended over 15 Wildlife Sanctuaries, 5 National Parks and 2 Tiger Reserves (Overlapping with National Parks/sanctuaries) covering almost 34 percent of the recorded forest land. Each of these Protected areas has its own ecological significance supporting a rich biodiversity. A brief account of biodiversity contained in the most important ones has been provided in Annexure-I.

PRIORITISATION : PROTECTED AREAS

Using an analytic methodology, a series of global 'Hot-spot' areas have been designated for prioritisation of conservation efforts. The 'Hot-spot' approach identifies key localities of biotic richness under acute threat. As such, it enables conservationists to determine their priorities in a more informed and methodical manner than has often been the case to date. Based on the local situation and richness of biodiversity, certain areas of the state have already been earmarked for conservation. All these areas have been brought under the Protected Area network of the country. Various conservation measures and management programmes in different scales are being carried in these protected areas through state, national as well as international support. In the present chapter, based on available information regarding ecological situation, floral and faunal richness, number of threatened species, existing threats, an attempt has been made to designate some of these protected areas for prioritization of conservation programme. However, this prioritisation was not done on the basis of any mathematical or statistical analysis, but simply on the apparent floral-faunal richness, existing threats and role in conservation of threatened species. Though only three areas have been identified, but conservation of other protected areas is also no less important.

A. Sundarban Biosphere Reserve

Southern most part of West Bengal is indented by numerous river openings. The important rivers from east to west are Harinbhanga, Gosaba, Matla, Thakuran, Saptamukhi, Muriganga and Hugli, which ultimately end up at the Bay of Bengal. On the way they have encompassed nearly 100 islands criss-crossed and intersected by numerous creeks and delta distributaries. The region is popularly known as Sundarban. With its counterpart in Bangladesh Sundarban covers a total land and water area of about 1,000,000 ha. The area supports the world's famous mangrove block which is a well known ecosystem of the Tropics. Nearly 9630 Sq. km.; of the Indian Sundarban lying between 20° 32' north latitude and 22°40' and 80°05' and 89° east longitude has received the status of 'Sundarban Biosphere Reserve' in 1989. The Biosphere Reserve includes both forest and reclaimed area spreading mainly over civil district of South 24 Parganas and to some extent North 24 Parganas. Within the limits of Biosphere Reserve comes Sundarban Tiger Reserve (National Park, Sanctuary and Reserve Forest), South 24 Parganas Forest Division, Lothian Island Wildlife Sanctuary, and Halidaty Island Wildlife Sanctuary. A part of it in Sundarban Tiger Reserve has been considered as the world Natural Heritage site since 1985. The Biosphere is bounded by the Dampier-Hodges line on the north, Bay of Bengal in the south, Ichhamati- Kalindi- Raimangal on the east and river Hugli on the West. It includes 4264 sq. km. of mangrove forests (Core zone : 1700 sq. km.; Manipulation zone (Forestry) : 2400 sq. km.; Restoration zone 200 sq. km. App.). The balance area of the Biosphere Reserve (5367 Sq. km.) comprises lands outside the forests [Manipulation zone (Agri.)], but within the intertidal zone.

The mangrove ecosystem of Sundarban is the only ecological habitat of Tiger, *Panthera tigris* of its kind not only in India but also the world except in Bangladesh. The tidal forms and the mangrove vegetation in Sundarban are responsible for dynamic ecosystem with vigorous nutrient cycling both terrestrial and aquatic. The whole ecosystem is sensitive to changes in salinity, and the continuous cycle of

erosion, alongwith deposition. This is effecting the plant communities to give rise to dynamic changes. The plant communities are continuously adjusting to the new condition.

Two distinct types of mangrove forests, viz.. Littoral forest and Tidal Swamp forest could be recognized in Sundarban. Each of these is further subdivided into three subtypes with characteristic vegetation as shown in Table 29.

Table-29 : Forest types in Sundarban (adopted from Mitra and Pal, 2002).

TYPE	SUB-TYPE	DOMINANT VEGETATION
Littoral Forest	CLASS – I	<i>Dolichandrone spathacea, Erythrina variegata, Hibiscus tiliaceous, Ixora arborea, Tamarix troupii, Thespesia populnea, Trewia nudiflora, Vitex negundo, V. trifolia.</i>
	CLASS – II	<i>Acanthus ilicifolius, Croton sp., Lippia geminata, Porteresia coarctata, Saccharum spontaneum,</i>
	MANGROVE SCRUB	<i>Aegialitis rotundifolia, Avicennia alba, Ceriops decandra, Excoecaria agallocha, Phoenix peludosa, Acanthus ilicifolius, Brownlowia lanceolata.</i>
TIDAL SWAMP FOREST	MANGROVE FOREST	<i>Avicennia alba, Bruguiera conjugata, Ceriops decandra, Ceriops tagal, Excoecaria agallocha, Kandelia candel, Lumnitzera recemosa, Rhizophora sp., Sonneratia apetala, Xylocarpus granatum, X. mekongensis.</i>
	SALT WATER MIXED FOREST	<i>Aegialitis rotundifolia, Amoora cucullata, Avicennia officinalis, Bruguiera conjugata, Ceriops decandra, Excoecaria agallocha, Heritiera fomes, Xylocarpus mekongensis, Nypa fruticans.</i>
	BRACKISH WATER MIXED FOREST	<i>Avicennia officinalis, Bruguiera conjugata, Heritiera fomes, Sonneratia apetala, S. caseolaris, Xylocarpus memongensis, Amoora cucullata, Acanthus ilicifolius, Acrostichum aureum, Brownlowia lanceolata, Nypa fruticans, Ceriops decandra, Excoecaria agallocha, Phoenix peludosa.</i>

The variable salinity, pH, sandy and loamy soil, daily inundation by high tides, different grades of subsurface nutrient, weather hazard, etc. of Sundarban support specialized group of plants known as mangrove. The mangroves are salt tolerant halophytic seed plants that range in size from tall trees to shrubs with some similarities in architecture and physiology. In the mangrove forest of Indian Sundarban, a total of 69 floral species belonging to 29

families and 50 genera have been recognized, out of which 34 species are true mangrove type (Mitra and Pal, 2002). Apart from the higher plants, microbial community of deltaic Sundarban is equally impressive, and encompasses a large range bacteria, cyanobacteria and phytoplankton of the ambient aquatic phase. Banerjee *et al.* (2002) recorded a total of 64 phytoplankton species from the brackish water system of Indian Sundarban.

Sundarban provides characteristic type of habitat suitable for animals inhabiting vast tidal swamp area. Because of their intimate association with the estuarine environment, sizeable portion of aquatic animal communities are inter-related with the animals inhabiting the land area. In terms of faunal species diversity, mangals of Sundarban ranks first among the different mangrove ecosystems of the country with record of 1434 species representing 20 phyla (Das 2001). Faunal diversity includes both resident and the visiting or transient forms. Faunal diversity mainly comprises of Cnidaria (33 spp.), Mollusca (142 spp.), Crustacea (240 spp.), Insecta (201 spp.), Arachnida (33 spp.), Echinodermata (20 spp.), Pisces (176 spp.), Amphibia (8 spp.), Reptilia (58 spp.), Aves (163 spp.), Mammalia (40 spp.). However, there are certain differences as regard the number of species under different group (Mandal and Nandy, 1989, Chaudhuri and Chaudhuri, 1994, Das 2001). Though a number of vertebrate species like Javan Rhinoceros – *Rhinoceros sondaicus*, Wild Buffalo – *Bubalus bubalis*, Barking Deer – *Mutiacus muntjac*, White Winged Wood Duck – *Cairina scutulata* etc. have disappeared from Sundarban, still at least 20 species considered as threatened have found shelter in this ecosystem. It contains the country's largest Tiger – *P. tigris* population in its unique setting. Joint tiger Census with Bangladesh in 2004, revealed 274 Tigers in Indian Sundarban. The numerous creeks form the safe home of the Estuarine Crocodile – *Crocodylus porosus*, Salvator Lizard – *Varanus salvator*, River Terrapin – *Batagur baska*. Among the other threatened species of Sundarban Gangetic Dolphin – *Platanista gangetica*, Snub – nosed Dolphin – *Orcaella brevirostris*, Fishing Cat – *Prionailurus bengalensis*, Lesser Adjutant – *Leptoptilos javanicus*, White – bellied Sea Eagle – *Haliastur lencogaster*, Osprey – *Pandion haliaetus*, Indian Python – *Python molurus* are worth-mentioning. The deltaic islands serve as

the nesting ground of a number of globally threatened marine turtles particularly for Olive Ridley – *Lepidochelys olivacea*. Many heronries are formed here during postmonsoon and winter months. The area also serves as the temporary home for two species of Horse-shoe Crabs, viz., *Carcinoscorpius rotundicanda* and *Tachypleus gigas* during premonsoon period of high salinity. A number of plant species of conservation significance such as Sundari – *Heritiera fomes*, Golpata – *Nypa fruticans*, Genwa – *Excoecaria agallocha*, Goran – *Ceriops decandra*, etc. have also found suitable ecological habitats in Sundarban.

There is no denying the fact that the management of this most productive ecosystem is very tough because of its difficult geographic situation and hostile terrain, criss-crossed by a net work of turbulent streams and having long stretch of international boundary with Bangladesh. Sea and rivers provide vast fishing arena and draw thousands of trawlers, mechanised boats, country boats. This induces threats like poaching of animals, pilferage of woods and also seepage of soil in the water surface. Shooting of tiger prawn seed with nets of small mesh size by the huge number of local residents is also hampering the biodiversity to a great extent. Construction of embankments for the protection of reclaimed area is effecting the salinity gradient of rivers and thus may disrupt floral and faunal community structure. Further, storm, cyclone, flood are the frequent natural threats to Sundarban.

B. Jaldapara Wildlife Sanctuary

The sanctuary lies in the civil district of Jalpaiguri, in between 20°58' and 27°45' North latitudes, 89°08' and 89°55' East longitude. It covers an area of 216.51 sq. km. In the flood plains of river Torsa and other small rivers and supports vast tracts of grasslands. The Sanctuary is demarcated on the

north by the international boundary with Bhutan and Totapara village. Falakata–Koch Behar Road forms the southern limit. Eastern side is bounded by Jaigaon, National Highway No. 31D, Reserve forests and Tea estates. There are villages and cultivated fields on the south western side which may be considered to be bounded by the Madarihat–Falakata Road. Northwestern boundary is broadly demarcated by Hasimara–Madarihat railway line, several Tea estates and Reserve forests. However, in consideration of the to and fro movement of wild animals such as Rhinos, Gaurs, Elephants, Deers, Leopards, several species of birds, the ecological boundaries of the Sanctuary have extended far beyond the legal boundaries.

The sanctuary has great ecological significance as it forms the genepool reserve

for the great Indian One–horned Rhinoceros–*Rhinoceros unicornis* outside Nepal and Assam, and safeguards against any possible extinction of wild Rhino population elsewhere due to unforeseen events. Some forest blocks of the Sanctuary provide excellent elephant habitat. Elephant herds can be kept confined inside the forest for longer duration if sufficient food, water and cover are provided and biotic pressure is reduced. This, in turn, will automatically reduce elephant depredation incidences. The National Level Action Plan on Project Elephant has already identified this Sanctuary as part of the extended Elephant Reserve of Buxa- Manas Protected Areas.

The Sanctuary provides a wide range of wildlife habitats depending on the forest types (Table 30).

Table-30 : Forest types of Jaldapara Wildlife Sanctuary (Adopted from Management plan of Jaldapara Wildlife Sanctuary 1997-98 to 2006-07 by Wildlife Circle, Govt. of West Bengal, 1997).

TYPE	SUB-TYPE	DOMINANT VEGETATION
RIVERINE FORESTS	-	<i>Acacia catechu, Dalbergia sissoo, Lagerstroemia parviflora, Bischofia javanica, Toona ciliata, Gmelina arborea, Trewia nudiflora, Anthocephalus indicus, Bauhinia purpurea, Grewia lavigata, Dillenia indica, Bombax ceiba.</i>
SAL FORESTS	-	<i>Shorea robusta, Lagerstroemia parviflora, Dillenia pentagyna, Sterculia villosa, Careya arborea, Stereospermum tetragonum, Machilus villosa, Phoebe attenuata, Terminalia sp., Meliosma simplicifolia, Michelia champaca, Aphanamixis polystachya, Macaranga denticulata, Bauhinia purpurea, Prema bengalensis, Leea sp., Mikania sp., Mimosa sp., Albizzia sp., Amoora rohituka.</i>
WETMIXED FORESTS		<i>Syzygium sp., Amoora rohituka, Aphanamixis polystachya, Stereospermum chelonoides, Michelia champaca, Mesua ferrea, Myristica longifolia.</i>
SEMIEVER GREEN FORESTS	-	<i>Bauhinia purpurea, Chukrasia tabularis, Gmelina arborea, Michelia champaca, Schima wallichii, Toona ciliata, Duabanga grandiflora, Litsaea sp., Dysoxylum sp., Dendrocalamus hamiltonii.</i>
EVER GREEN FORESTS	-	<i>Shorea robusta, Bischofia javanica, Chukrasia tabularis, Cinnamomum sp., Calamus sp., Dysoxylum sp., Stereospermum sp., Mesua ferrea, Amoora wallichii.</i>

Table-30 : Contd.

TYPE	SUB-TYPE	DOMINANT VEGETATION
SAVANNAH FORESTS	MOIST SAL SAVANNAH	<i>Shorea robusta</i> , <i>Careya arborea</i> , <i>Lagerstroemia parviflora</i> , <i>Bauhinia purpurea</i> , <i>Emblica officinalis</i> , <i>Saccharum</i> sp., <i>Arundo donax</i> , <i>Phragmites karka</i> , <i>Imperata cylindrica</i> , <i>Themeda arundinacea</i> .
	LOW ALLUVIOM SAVANNAH WOODLAND	<i>Bombax ceiba</i> , <i>Albizia</i> sp., <i>Acacia catechu</i> , <i>Bischofia javanica</i> , <i>Trewia nudiflora</i> , and grass species similar to that of Moist Sal Savannah.
	EASTERN ALLUVIAL GRASSLAND	Almost pure grassland with species like <i>Saccharum spontaneum</i> , <i>S. procerum</i> , <i>Erianthus arundinacea</i> , <i>Arundo donax</i> , <i>Phrogmitis karka</i> .
HYDROPHYTIC VEGETATION		<i>Typha angustifolia</i> , <i>Eleocharis palustris</i> , <i>E. retroflexa</i> , <i>Ludwigia octovalvis</i> , <i>Alternanthera sessilis</i> , <i>Polygonum barbatum</i> , <i>Panicum paludosum</i> , <i>Najas minor</i> , <i>Sagittaria trifolia</i> , <i>Hydrilla verticillata</i> , <i>Leersia haxandra</i> .

A large number of perennial and seasonal streams flowing through the sanctuary which provide not only further diversity to the wildlife habitats but also a frequent changing scenario. Torsa, the main river which flows through the sanctuary, is rising and falling with great rapidity and changing its courses frequently. Within the sanctuary, it has occupied different positions over a tract of about 20 km wide from east to west, by shifting its courses time and again in the last one and half century. As a result, literally the whole tract comprises of a network of water pools, dead streams with abandoned river beds.

Diverse soil formation (Alluvial, Terai, Bhabar), huge ground water resource, good monsoons, combined with some amount of altitudinal variations resulted a great diversity of floral species. Nearly 733 species of plants belonging to 114 families have been listed from the sanctuary apart from numerous species of phytoplankton, mosses, fungi, etc. At least, 491 species of plants occurring in the Sanctuary considered as threatened in the state level. These include *Aristolochia togala*, *Bulbophyllum striatum*, *B. trista*, *Calamus erectus*, *C. tenuis*, *C. latifolius*, *Calanthe*

angusta, *Costus speciosus*, *Dendrobium lituiflorum*, *Discorea falcatum*, *D. bulbifera*, *D. puber*, *Drosera peltata*, *Nervilia falcata*, *Musa balbsiana*, *Gloriosa superba*, *Rauwolfia serpentina*, *Utricularia bifida*, *U. coerulea*, *U. scanadens*, *Zeuxine nervosa*, etc. Further, vast tracts of Savannah grassland have already been lost in North Bengal due to extension of agriculture and other developmental activities. The patches survived within the territory of Sanctuary provide ideal habitat for many threatened faunal species including Rhinoceros. As such these grasslands are also of great conservation significance. Faunal diversity, particularly in respect of invertebrate species, have not yet been totally worked out. However, as many as 29 species of fish, 12 species of amphibians, 24 species of reptiles, 246 species of birds and 39 species of mammals have already been recorded from Jaldapara and its surroundings. Apart from the great One horned Indian Rhinoceros, several other threatened species including Tiger-*Panthera tigris*, Leopard-*P. pardus*, Gaur-*Bos frontalis*, Indian Pangolin-*Manis crassicaudata*, Bengal Florican-*Eupodotis bengalensis*, Hill Myna-*Gracula religiosa*, Pea fowl-*Pavo cristatus*,

Indian Soft-shelled Turtle—*Lissemys punctata*, Python—*Python* sp. and many others are protected within the sanctuary. Recently, a small population of the Hispid Hare—*Caprolagas hispidus*, a critically endangered species, have been recorded from grasslands of the Sanctuary (Maheswaran, 2002). This has further increased the importance of Jaldapara from the conservation point of view.

The entire sanctuary is under management programme for a pretty long period. However, the total ecological set up alongwith rich biodiversity is under constant threat of erosion owing to various biotic and abiotic pressure. The flood of variable intensity is a frequent feature, which not only takes a heavy toll of wildlife species, but also changes the composition of forest. Changes in habitats are also very common on account of natural process of succession, e.g., invasion of grasslands by tree species. Fire, grazing, illegal felling, collection of non-timber forest produce and tourism are also resulting detrimental effects on the carrying capacity of different habitats. Poaching of rhino, elephant and other species is also serious matter of concern. In recent times, problem of insurgency is also building up within the Sanctuary, which makes the management activity more difficult.

C. Mahananda Wildlife Sanctuary

The Sanctuary falls in the transition zone between Peninsular Indian subregion and Indo-Malayan subregion of Oriental region. It covers an area of about 129.04 Sq. km. in the Terai region of the Eastern Himalayas on the West Bank of river Tista between latitudes 26°55′33 and 26°47′54 North, longitudes 88°33′31 and 88°23′36 East. Roughly, 60 percent of the sanctuary is hilly ranging from 150 M. to 1300 M. and comes under Darjiling district. However, it also includes Latlong block of forest falling within the district Jalpaiguri. The sanctuary is characterized by moderate, steep to precipitous mountain slopes and high ridges towards the north and gently sloping to almost flat stretches

of the terai and alluvial plains towards the south. In fact, sanctuary is unique in its topographical configuration as the Himalayan range meets the Bhabar tract in a continuum. Consequently there are a seasonal vertical migration of some species, which adds to the variety of fauna exhibited by the area. Further, the sanctuary falls in the region east of the Mechi river, a region reported to possess the richest variety of avian species in India. It is the largest compact block of forested habitat situated at the western end of the elephant migration route. It is, therefore, expected to play an extremely significant role in the control measures to be adopted for tackling the problem arising out of depredatory impact of migratory elephant herd in North Bengal.

Owing to many zigzag turns, it is difficult to describe the legal boundry of the sanctuary. Broadly, in the north it is bounded by Ruyem, Upper Ghoramara, Lat-panchar and Mana forest blocks; in the east by river Tista; by Latlong, Singimari, Hatisar, Mohorgong, Chamta and Adalpur blocks in the south; while Bandarjora, Punding, Kuklong, Adalpur and Kyananuka block in the west. Many of the forest blocks in north, south and west are extended beyond the limit of the sanctuary and act as spill over area for wild animal population. Conversion of higher hills into tea estates and Cinchona plantations has fragedmented the ecological boundary in the north.

Tista, a perennial snow fed river, flows down along the eastern boundary. Many other water courses, mostly spring fed, such as Mahanadi, Gulmakhola, Choklong, Nandikhola, etc., are found within the limits of the sanctuary. Except Mahanadi and Gulmakhola, flow of water in other rivers starts weakening from December onwards and finally during May-June confined to small pools along their courses. Presence of at least three natural salt licks makes the Sanctuary further suitable as Wildlife habitat.

Forest types and dominant vegetation of the sanctuary are provided in Table 31.

Table-31 : Forest types and dominant vegetation of Mahananda Wildlife Sanctuary (Adopted from Management Plan for Mahananda Wild life Sanctuary–1997-98 to 2006-07 by Wildlife Cycle, Govt. of West Bengal, 1997).

REGION	TYPES	DOMINANT VEGETATION
PLAINS	GRASSLAND	<i>Phragmitis karka</i> , <i>Saccharum munja</i>
	KHAIR-SISSO FOREST	<i>Acacia catechu</i> , <i>Dalbergia sissoo</i> , <i>Albizia</i> sp., <i>Erythrina</i> sp., <i>Eupatorium odoratum</i> , <i>Mimosa himalayana</i> , <i>Saccharum spontaneum</i> .
	SIMUL-SIRIS-FORESTS	<i>Bombax ceiba</i> , <i>Albizia</i> sp., <i>Erythrina</i> sp., <i>Adina</i> sp., <i>Tetramelas</i> sp., <i>Lantana</i> sp., <i>Tinospora</i> sp., <i>Dalbergia</i> sp., <i>Butea</i> sp.,
	MOIST SAL FORESTS	<i>Shorea robusta</i> , <i>Schima wallichii</i> , <i>Chukrassia tabularis</i> , <i>Garuga pinnata</i> , <i>Prema bengalensis</i> , <i>Eupatorium odoratum</i> , <i>Mimosa himalayana</i> , <i>Acacia himalayana</i> , <i>Lea</i> sp., <i>Terminalia crenulata</i> , <i>Machilus gamblei</i> , canes and ferns species.
	DRY MIXED FORESTS	<i>Shorea robusta</i> , <i>Dillenia pentagyna</i> , <i>Careya arborea</i> <i>Terminalia crenulata</i> , <i>Sterculia villosa</i> , <i>Bauhinia purpurea</i> , <i>Fagara budrunga</i> , <i>Lea</i> sp., <i>Mimosa himalayana</i> , <i>Tinospora cordifolia</i> .
	WET MIXED FORESTS	<i>Dillenia indica</i> , <i>Eugenia</i> sp., <i>Elaeocarpus lanceaofolius</i> , <i>Tetrameles nudiflora</i> , <i>Alpinia</i> sp., <i>Laforteia</i> sp., <i>Storchilanthes</i> sp., ferns and canes species.
HILLS	LOWER HILLS SAL FORESTS	<i>Shorea robusta</i> , <i>Schima wallichii</i> , <i>Terminalia crenulata</i> , <i>Careya arborea</i> , <i>Lagerstroemia parviflora</i> , <i>Albizia</i> sp., <i>Machilus</i> sp., <i>Clerodendron viscosum</i> , <i>Bauhinia vahlii</i> , <i>Dalbergia stipulata</i> .
	LOWER HILLS DRY MIXED FORESTS	<i>Terminalia crenulata</i> , <i>Gmelina arborea</i> , <i>Cedrella toona</i> , <i>Sapidus detergens</i> , <i>Ostodes paniculata</i> , <i>Melisome simplicifolia</i> , <i>Bauhinia purpurea</i> , <i>Wrightia tomentosa</i> , <i>Lea</i> sp., <i>Morinda certrifolia</i> , <i>Butea parviflora</i> , <i>Dalbergia stipulacea</i> , <i>Tinospora cordifolia</i> , Bamboo species.
	LOWER HILLS WET MIXED FORESTS	<i>Duabanga sonneratio-fraxinifolius</i> , <i>Cinamomus obtusifolia</i> , <i>Macaranga</i> sp., <i>Callicarpa arborea</i> , <i>Machilus</i> sp., <i>Travesia pulmata</i> , <i>Clematis</i> sp., <i>Lea</i> sp., Bamboos, Canes and ferns
	MIDDLE HILL FORESTS	<i>Schima wallichii</i> , <i>Castanopsis</i> sp., <i>Talacima hodgsonii</i> , <i>Betula alnoides</i> , <i>Phoebe attenuata</i> , <i>Macaranga</i> sp., <i>Wrightia tomentosa</i> , <i>Baccaurea sepida</i> , <i>Polygonum molle</i> , <i>Maesa indica</i> , <i>Clematis</i> sp., <i>Imilax</i> sp., Bamboos.

It is obvious that altitudinal variation coupled with varied edaphic factors and favourable monsoon have given rise to great floristic variety. This in turn resulted enrichment of faunal species. No detailed inventory of species composition has so far been made. However, a collaborative research

study on the 'Survey of Flora and Fauna of Mahananda Wildlife Sanctuary' in the year 1996 has provided a glimpse of biological diversity. The project prepared herbarium sheets for 39 species of trees, 55 species of herbs, 54 species of shrubs and 22 species of climbers. The actual number of floral species

is much higher, as for a large number of very common species such as *Acacia catechu*, *Dalbergia sisso*, *Bombax ceiba*, *Shorea robusta*, *Dillenia pentagyna*, *Sterculia villosa*, *Phragmites karka*, *Saccharum munja* and many others which were described under forest type, no herbarium sheet was made. Several threatened species of plants, viz., *Boehmeria rugulosa*, *Canarium sikkimense*, *Elaeocarpus aristatus*, *Machilus parviflora*, *Ormosia glauca*, etc. found protection in the sanctuary. In case of faunal composition qualitative richness is very much evident, but many of the species are represented by very small and scattered populations thus deserving special conservation measures. The project recorded 61 species of mammals, 253 of birds, 10 of reptiles, 6 of amphibian, 29 of butterflies and moths. Among the species of conservation importance Tiger–*Panthera tigris*, Gaur–*Bos frontalis*, Serow–*Capricornis sumatraensis*, Himalayan Black Bear–*Selenarctos thibetanus*, Hodgson's Frogmouth–*Batrachostomas hodgsoni*, Indian White-backed Vulture–*Gyps bengalensis*, Osprey–*Pandion haliaetus*, Kalij pheasant–*Lophura leucomelana* and many others have found shelter in Mahananda.

The entire ecological set up of the sanctuary has become fragile owing to local socio-economic situation. Since the reconstitution of the sanctuary in 1976, commercial exploitation of forest resources was stopped. This has resulted in substantial reduction of employ-

ment potential for both forest dwellers and fringe population and generating an element of hostility against conservation practices. Various illicit activities like poaching of wild animals, cattle grazing, lopping of trees for fodder, head and van loading of fuelwood are building up to meet the needs of local people. A section of city-based business community are also exploiting local people in these operations. Illicit timber removal is further facilitated due to a large number of water ways passing through the sanctuary. These when flowing in full provide opportunities for rafting down illicitly removed timber. Again, during summer, most of the streams and jhoras inside the sanctuary dry up resulting acute shortage of water. Subsequently, typical migration of animals from the dry zones to more wet zones takes place. This congregation of animals develops the acute intra-interspecific competition for food and also increases the chances of being poached. The metalled roads (NH 55, NH 31) and railway tract pass through the Sanctuary. This disrupts the free movement of animals and increases the chances of 'Road Kills' The Sanctuary is prone to natural fire hazards. The fire is often caused by the sparks of railway engine, throwing of burning match sticks or cigarettes, deliberate burning by poachers and graziers. Being in the vicinity of business center and tourist spots, it is regularly visited by a large number of tourists and obviously faces the hazards of tourism activities.

LOSS OF BIODIVERSITY AND CAUSES

The biodiversity in all the ecosystems of the state takes many pressures such as commercial clear felling and selective clear felling, conversion for agriculture, settlements, roads, inundation for developmental projects like multipurpose river valley projects, conversion to monoculture, army operation, grazing, mining, firewood collection, introduction of exotics, fire and pollution, tourism, disease, natural calamities, wildlife trade and many others. The marshes, river systems and other wetlands are threatened mainly by domestic pollutants and toxic effluents, agricultural run-offs containing residues of pesticides and

chemical fertilizers and excessive siltation from degraded catchments. Excessive withdrawal of water from water-bodies for industry, irrigation or domestic use, dredging and reclamation of water bodies, excessive fishing, building of dams and canals are other factors adversely affecting the wetlands. West Bengal State Biodiversity and Strategy Action Plan (Dept. of Environment and R.K.M. Narendrapur, 2002) provided a item-wise matrix on the loss of biodiversity and causes in the State. The same matrix is provided below with slight alteration and additional information.

Loss of Biodiversity and causes

Item I	Loss suffered II	Causes III
A. Plants 1. Govt. Forest Land i. Govt. Policy/Action Related		
a. Diversion of forest land for non-forest purposes	1660 ha. since 1980 involving Ayodha Hills, North Bengal forests.	Permission granted by Forests Dept. for irrigation, road, army, hydel and other projects.
b. Exotic tree monoculture	Teak plantation in North Bengal foot hills and plains = 25,980 ha. Conifer plantations in North Bengal hills = 11,600 ha. <i>Eucalyptus</i> + <i>Acacia auriculiformis</i> plantation in S.W. West Bengal = 2,59,000 ha.	Practice of monoculture plantation in West Bengal hills and plains after clearing high forest consisting of broad leaved species communities. Pure block plantation of <i>Eucalyptus</i> and <i>Acacia</i> on blank and degraded sites of S.W. West Bengal and Central Bengal.
c. Induced landslide and soil erosion	Landslide affected areas in North Bengal hills = 290 sq. km. Areas affected by sheet and gully erosion in S.W. West Bengal = 7500 sq.km.	About 70 percent of landslide in North Bengal hills are subjected to accelerated erosive processes due to faulty land use policy, deforestation and dearth of proper water disposal systems. Erosion in S.W. West Bengal is due to bad land use in uplands, poor watershed management, deforestation, etc.

Item I	Loss suffered II	Causes III
d. Habitat loss due to construction of flood control embankment	Grassland habitat in Jaldapara Sanctuary = 5000 ha. Erosion of mangrove forest lands of Sundarban.	Flood control embankment constituted along the right bank of Torsa river had resulted in loss of seasonal flood water flow through prime rhino habitat in Jaldapara sanctuary. This has caused elimination of preferred habitat for the ungulate and associated species. Embankments around reclaimed areas for defence against wave action, resulting more pressure and erosion on the forested islands of Sundarban.
ii. Industry policy/Action related		
a. Biodiversity loss due to fuel wood and fodder removal	1.2 million m ³ fuel wood and 2000 tonne green fodder are removed from hills and plain forests of North Bengal by tea garden labourers annually. Expansion of tea gardens in the past caused severe fragmentation in Duars region. Annually 1000 ha area in the buffer zone of S.T.R. bearing mature crop, is operated following the method of selection-cum-improvement felling on 20 years cycle.	There are 274 tea gardens in plains and hills of North Bengal. About 60% of these are abutting forests lands. Two lakhs labour force of the tea gardens plunder neighbourhood forest for fuel wood and fodder due to inaction by the industry concerned to provide alternatives. Twenty five percent of small wood and fuel wood extracted from the annual crops of Sundarban are given to local panchayets and rest of the produce is sold in the local markets by the allottees.
iii. Unorganised population action related		
a. Tree felling	There are on average 7000 detected illegal tree feeling cases per annum with seizure of 10,000 m ³ timber. An equal number goes undetected. Therefore, annual loss is 20,000 m ³ timber mainly from North Bengal forests. Deforestation leads to extinction of symbiotic microbes that are host specific and have poor dispersal ability. Owners of 26 saw-mill, 45 cane-processing units and 4 veneer factories in close proximity of B.T.R.	Forest and fringe dwelling poor people are engaged by wood based industries and mafia groups with interstate and international linkages for illegal tree felling at huge profits. Poor staffing and infrastructural facilities of Forest Depts., dearth of local level participation, lack of inter-state and across the boarder coordination coupled with infiltration of militants in the forested tracts have increased the problems.

Item I	Loss suffered II	Causes III
	<p>have always looked greedily on the resources of the reserve, and found willing partners among a large number of unemployed or underemployed youths for plundering the forests.</p> <p>The habitat of STR shows evidence of felling in the past and timber-smuggling is still a threat to this Tiger Reserve.</p>	
b. Fuel wood removal	<p>5 million M³ fuel wood in green form is removed from the forest every year by the villagers-about 60 percent of this in South West West Bengal and balance in North Bengal. An estimate revealed that nearly 300 ladies visit Ayodhya hills daily and return in the afternoon each with head load of about 50 kg of wood.</p>	<p>Fuel wood collection from the forest has become a custom and tradition in rural areas fringing forest lands. This resource drain has become alarming due to upsurge in population growth and lack of cheap alternatives at local levels. Social forestry endeavours from 1987 outside forest lands have not made any dent in the situation due to perception of farm forestry as an income generation enterprise from poles and pulp wood and not as a means to obtain fuel wood from outside forest lands.</p>
c. Cattle grazing	<p>Two third of the State Forest i.e. about 8900 sq.km. area visited by nearly 7 million cattle annually, causing severe damage to 10,000 ha. forest area every year. Apart from damage due to consumption, grazing also reduces the regeneration capacity of grassland.</p>	<p>Lack of grazing policy, loss of traditional common lands, uneconomic returns for development of pastures, retention of unproductive cattle for slaughter, uncontrolled cattle trade across the border.</p>
d. Encroachment	<p>Encroachment of forest lands even in the protected areas is very common throughout for one or other purposes. In the past large number deltaic islands in Sundarban had been occupied for human habitation. Seventy-three fixed demand licensees and other 181 individuals (including residents of forest villages) have encroached on to Reserve Forest Lands of B.T.R. to establish 300 ha. of orange orchards.</p>	<p>Land hunger, influx of people across the border, lack of consolidation efforts for forest land.</p>

Item I	Loss suffered II	Causes III
e. Unregulated NTFP removal	Excessive collection of leaves, fruits, seeds, roots, climbers, etc., as NTFP without regulatory measures. This has resulted a huge decline of biodiversity specially of species of medicinal importance in North Bengal and S.W. West Bengal.	Landless labours and huge number of unemployed persons have adopted this practice for livelihood. Products are so diverse and collectors are so many that the regulation and control is not possible through Government intervention.
f. Trade	Over collection has been disastrous for various species of orchids, cycads and medicinal plants.	Lucrative price in national and international market. Not much achievement in respect of artificial propagation.
g. Weed infestation	Weeds and climbers are acute problem in North Bengal. The most common and proliferating weeds are <i>Leea</i> sp., <i>Cassia tora</i> , <i>Mikania</i> sp., <i>Lantana camara</i> , <i>Eupatorium</i> sp., etc. Nearly 550 km. Forest lands comprised mostly of plantation areas, riverine tracts and the areas denuded by timber smugglers are affected by pernicious weed infestation – smothering natural regeneration, and hindering seed dispersal.	Timber smuggler's activities, creating opening without biological safeguards against weed infestation.
2. Non-Government Forest land		
i. Unorganised sector action related		
a. Habitat loss due to urbanisation	Vast areas of non-Government forest lands, orchards destroyed throughout the state and this is particularly true for those lying around metropolies.	Partition of land among the family members; soaring prices and demand of land for housing and industrial purposes.
3. Non-forest land		
i. Govt. policy/action related.		
a. Encouragement of high yielding agricultural crop	During pre-independence period 1015 indigenous and improved indigenous varieties of paddy were in cultivation, at present only 255 are in the field. Huge number of mostly non-descript local varieties of pulses, oilseeds, sugarcane, potato, jute, etc. which were in cultivation during pre-independence	Campaign to grow more food.

Item I	Loss suffered II	Causes III
	<p>period, are replaced by a few number of better yielding varieties. The only mung variety i.e. Sonamug endowed with a characteristic scent has been pushed to a backseat owing to its poor productivity. The short duration indigenous toria, part of the natural diversity in its center of origin – the foot hills of the Himalaya- is facing extinction due to urge of the farmers for higher productivity in rapeseed, <i>Brassica campestris</i>, and subsequent adoption to yellow sarson its place. The precious genotype of <i>Gitanjoli</i> variety of wheat known to withstand moisture stress in the soils is getting lost after the introduction of HYVs in the uncultivated arena.</p>	
b. Diversion of Coastal Lands	<p>Mangroves have been cleared in many pockets of coastal West Bengal for constructing shrimp culture farms. In Medinipur district coastal land is excavated to retain the tidal water, from which the salt is obtained. The process increases the salinity of soil and adjacent aquatic system. Various mangrove species like <i>Heritiera fomes</i>, <i>Nypa</i> sp. are threatened due to these processes and there is change in the orientation of pelagic community. More than 230 ha. foreshore land on Digha and Shankarpur beach have been utilized for construction of hotels and tourist facilities, fish stocking, etc.</p>	<p>High price of tiger prawn in the international market; Export policy. Tourism development without caring for ecological consequences.</p>
ii. Unorganised sector action related		
a. Conversion of common land and waste-lands	<p>65,000 ha. village common lands, earlier used as pasture and 2,20,000 ha. wastelands earlier used for fuelwood/fodder collection have been converted for agriculture/tree farming.</p>	<p>Land hunger, economic pursuits, promotion of social forestry.</p>

Item I	Loss suffered II	Causes III
B. Animals		
1. Govt. forest Land		
i. Govt. Policy/action related		
a. Loss of animal corridor and fragmentation of habitats	Elephant corridor disrupted over 150 km. length in North Bengal due to diversion of forest land for rails/roads/irrigation and army camps. Fragmentation leads to inbreeding hazards among the populations of confined area.	Development and defence priorities.
b. Loss of animals	On an average, four elephants are killed every year on the railway track between Siliguri and Binnaguri. Road kills are common affair in highways passing through forests. Sudden release of water from dams often washes away animals including elephants.	Railway tracks, roadways, irrigation canals passing through the forests.
ii. Unorganised sector action related		
a. Loss of species due to poaching and illegal trade.	Large number of species and their derivatives have great demand in the national and international market. Wide range of species from butterflies, horse-shoe-crabs, sharks, sea-horse, snakes, lizards, turtles molluscs, echinoderms, birds, mammals, etc. are victims of illegal trade. During the period 1997-98 to 2000-2001, at least 12 tiger skins, 9 leopard skins, 4 bear skins, 5 rhino horns, 3 elephant tusks, 6 pangolins, 6068 birds, 25 kg. peacock feather, 11075 turtles, 9609 amphibians and reptiles, 18 moths and butterflies and many other wildlife products involving flying squirrel, mongoose, fishing cat, hog deer, etc. have been seized by the State Forest and other departments.	Superstition, ego and supposed medicinal values have created a tremendous demand and soaring prices for various wildlife and their products. Lack of man-power and non-cooperation from neighbouring countries make it difficult to implement the legal action.
b. Loss of species due to ritual hunting	Ritual hunting on different auspicious days (Budh Purnima at Ayodhya and neighbouring hills; Bengalee New-Year day in North Bengal) involves mass killing of all the species sighted. Protected species such as Leopard, Pangolin, Spotted Deer, Peacock, etc. are also not spared on these days.	Lack of awareness. Political reasons.

Item I	Loss suffered II	Causes III
2. Non-Forest Land		
i. Govt. Policy/Action related		
a. Loss of indigenous fish varieties due to encouragement of high yielding fish varieties	Over 1100 sq.km. of water bodies is under cultivation of high yielding fish varieties including exotics. This has pushed back the population of indigenous fish varieties. Various diseases have also arrived causing harm to the native germplasm.	Profit motive. Government encouragement with seeds, loans and others.
b. Conversion of wetlands	Vast stretches of wetlands and swamps are being filled up. Reclamation of Salt Lakes for satellite township has taken a huge toll of avian and other biodiversity. 248 species of birds had been recorded from this area during 1964-69, reduced to only 135 during 1984-97. Only endemic mammalian species of the State- <i>Herpestes palustris</i> , and several other species have almost been wiped out from the area.	Provide shelter and other amenities to the evergrowing human population. Profit making.
c. Soil erosion and habitat alteration in both up-stream and down stream of dams and barrages	Soil erosion causing siltation of natural water bodies causing eutrophication and reduction in the productivity of the water bodies and subsequently the loss of species. Construction of dams and barrages are spoiling feeding and breeding grounds of aquatic species and their migration. This along with the changes in the salinity resulting the erosion of overall species composition.	Destruction of forest in catchment areas; to improve irrigation facilities and generation of hydel power.
2. Unorganised sector Action related		
a. Poaching	Poaching of local birds, frogs in different villages is a regular incidence. Collection of yellow monitors by the tribals in S.W. West Bengal for selling them to 'Hakim' for medicines. Foxes, jackals, squirrels, mongooses are being regularly hunted for pelts.	Poor economic condition and absence of alternative livelihood.

Item I	Loss suffered II	Causes III
b. Indiscriminate pesticides application	Microbial community of soil significantly affected. Pesticides also results tremendous reduction in earthworm population.	Increase of agricultural production.
c. Wanton destruction	Fishermen in Nadia and Murshidabad districts often fish in deep pools in the river courses using all possible gears, ultimately removing all fish including juvenile and brood fishes. In Jalpaiguri, Kochbehar and other places barricades are created in a particular section of shallow stream and extracts of some plants are mixed to the confined water. This kills not only all the fishes but also other faunal components.	Lack of awareness and to get quick return.
d. Prawn seed collection	Several thousands of people specially women and children in Sundarban are engaged in the collection of tiger prawn seeds. Unregulated use of shooting nets of small mesh-size results in tremendous loss in faunal diversity. It has been estimated for collection of single seed of tiger prawn, 208 juveniles on average mostly belonging to fishes, molluscs, crabs and other prawns are destroyed and as such creating a great pressure on the ecosystem.	Due to absence of hatchery in the state, entrepreneurs of shrimp culture depend on wild harvest of prawn seed.
e. Lime generation	Variety of molluscan species like <i>Telescopium</i> sp., <i>Saccostrea cucullata</i> , <i>Crassostrea gryphoides</i> , <i>Anadari</i> sp., etc., are sacrificed particularly in Medinipure and South 24 Parganas for generation of lime from their shells.	Calcium carbonete is the important component of molluscan shell and practically there is no measures in lime generation practices.
3. Organised sector Action related		
a. Antifowling paints and hydrocarbons	Antifowling paints applied to the numerous fishing vessels, petroleum hydrocarbons including diseal fuel originating in the harbours and ports result bioaccumulation in the existing flora and fauna of coastal water and pose serious negative stress on the planktonic community.	So far no regulatory measures have been devised to control this hazard.

CURRENT CONSERVATION INITIATIVES IN WEST BENGAL

Conservation has been defined as “.....the management of human use of the biosphere (*i.e.* all living things) so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the need and aspiration of future generations” In India conservation of biodiversity is integral to mainstream forest management and West Bengal has one of the oldest history of scientific management of its forest, which dates back to mid-nineteenth century. Detailed working plans were prepared by the British Foresters for management of this natural resources, which depended heavily on economic aspect of value-addition, but did not totally overlook the aspect of Biodiversity conservation. In late nineteenth and early twentieth century, the art and science of artificial regeneration were perfected in the lowly-productive, remote forest zones in North Bengal. Some of the most picturesque and beautiful plantations of conifer and other broad-leaved species like teak, sal, champ, etc. were raised during this period. The trend continued till mid-seventies. Meanwhile, in South-West West Bengal, in the districts of Bankura, Puruliya, Medinipur and elsewhere, large scale Eucalyptus and Akashmoni (*Acacia auriculiformis*) plantations were raised during sixties and seventies, as part of “Degraded Forest Regeneration” Sal plantations were also tried in degraded sal forest areas, however, with limited success due to heavy biotic pressure in the form of forest ground-fire, fuel-wood collection and grazing.

Early eighties saw the global resurgence of Biodiversity Conservation and renewed interest in the preservation of the endangered flora and fauna of the world. In keeping with the international and national trend, West Bengal too shifted its priority in forest management towards conservation of natural flora and fauna in their natural habitats and also in ex-situ condition. National Forest Policy of 1988 and the Forest (Conservation) Act, 1980 put severe restrictions on the harvesting of natural forests and their conversion into monoculture

plantations. The strategy of commercial exploitation of forests received a back seat. In the following a summary of current biodiversity conservation related aspects in the state has been provided.

1. Major Actors Relevant to Biodiversity Issues :

With the increased importance of Biodiversity Conservation, more and more agencies in the Government as well as non-Government levels are being involved directly or indirectly in the process of conservation.

1.1. Government Agencies :

1.1.1. Central Government Agencies :

* Ministry of Environment and Forests
 * Geological Survey of India * Anthropological Survey of India * Regional Meteorological Centre, Kolkata * Bose Institute, Kolkata
 * Central Soil and Salinity Research Laboratory
 * ICAR * Border Security Force * Coast Guard of India * Kolkata Port Trust * Indian Statistical Institute, Kolkata * Central Groundwater Board, Kolkata * National Atlas and Thematic Mapping Organisation * Department of Science and Technology * Department of Earth Science
 * National Biodiversity Authority * Zoological Survey of India * Botanical Survey of India
 * Central Pollution Control Board.

1.1.2. State Government Agencies :

* Department of Environment/Coastal Zone Authority * Department of Development and Planning * Department of Forests * Fisheries Department * Land and Land Reforms Department * Panchayet and Rural Development Department * Tribal Welfare Department * Urban Development and Municipal Affairs Department, * Public Health Engineering Department * Irrigation and Waterways Department * Water Investigation and Development Department * Health and Family Welfare Department * Department of Science and Technology and NES * Zilla Parishads in respective districts * West Bengal Renewable Energy Development Agency (WBREDA) * West Bengal State Pollution

Control Board * Sundarban Development Board
 * Haldia Development Authority * Digha
 Development Authority * West Bengal Forest
 Development Corporation * Eastern Forest
 Rangers College (Kurseong) * Institute of
 Environmental Studies and Wetland
 Management (IESWM).

1.1.3. Institutions :

* Indian Institute of Technology, Kharagpur
 * University of Calcutta * Jadavpur University
 * Kalyani University * Bidhan Chandra Krishi
 Vishwa Vidyalaya, Kalyani * West Bengal
 University of Animal and Fisheries Science
 * Burdwan University * North Bengal
 University * Vidyasagar University * Indian
 Institute of Management, Kolkata * Indian
 Institute of Science Education and Research,
 Kalyani.

1.2. Non-Government Organisations :

There are more than hundred Non-Government Organisations working directly or indirectly in the field of Biodiversity Conservation in West Bengal. These Organisations function mostly on the programmes/projects approved by the local administration, Central and State Governments. They are often supported by the international funding agencies as well as business houses like TATA, GODREJ, etc. As listing of all the NGOs is not within the scope of present report, some important ones are mentioned below.

* World Wide Fund for Nature-India (WWF)
 * WWF-India (Sundarban programme) * S.D.
 Marine Biological Research Institute
 * Ram Krishna Mission Lokasiksha Parishad
 * Pugmarks * Nature Environment and Wildlife
 Society * Prakriti Samsad * IBRAD * Kolkata
 Wildlife Society * Tagore Society For Rural
 Development * Friends of Trees * Centre For
 Study of Man and Environment * North Eastern
 Society For Preservation of Nature * Society
 For Wildlife Avifauna and Nature Study * Help
 Tourism * Forest Protection Committees
 * Ecodevelopment Committees, * Paschim
 Banga Bigyan Mancha * ENDEV * Paribesh
 Unnayan Parishad.

2. Policy and Legal Structure :

Multifarious activities such as survey of flora, fauna, forest habitat management, afforestation and regeneration of degraded areas; prevention and control of pollution; establishment of protected areas; regulation of hunting, felling and Wildlife-related trade; protection of environment; international collaboration and cooperation; research and awareness programmes and above all socio-economic development are intimately linked with the success of Biodiversity Conservation. All these activities are well supported and guided by a set of legislative and regulatory measures in the international, national and state levels.

The 73rd Amendment Act 1992 of the constitution of India on Panchayats, which adds as 11th Schedule in the constitution has eight entries that are linked to environmental protection and conservation. Entry 8 of the 12th Schedule added to the Constitution by the 74th Amendment Act 1992 assign the function of 'Protection of Environment and Promotion of Ecological Efforts' to urban and local bodies.

Different biodiversity related Action Plans and Policies have also been adopted by the Government of India. Indian Environmental Action Plan (1993, 1996) identified conservation and sustainable utilisation of biodiversity related to ecosystem as one of the seven priorities for further action. The National Conservation strategy and Policy Statement on Environment and Sustainable Development (1992), National Forest Policy (1998), National Wildlife Action Plan (1973, 2002) and National Biodiversity Action Plan (2008) provided due consideration to the needs of local people and their support as well as involvement in the conservation of Biological Diversity. Recently Ministry of Environment and Forests, Govt. of India has published, India's Fourth National Report to the Conservation of Biological Diversity (2009).

India is also a party to various international Conventions and Agreements relevant to biodiversity such as, CITES (1973), RAMSAR (1971), World Heritage (1972), Bonn

Convention on Conservation of Migratory species of Wild Animals (1979), CBD (1992), Convention on Wetlands (1971), Vienna Convention on Ozone layer (1985), Montreal Protocol on Ozone layer (1987), Basel Convention on Hazardous Wastes (1989), UNFCCC (1997), Cartagena Protocol on Biosafety (2000), UN Convention to combat desertification (1994) and many others.

Adopting a consultative process with the stake holders, a National Policy and Action Strategy on Biological Diversity has been drawn up as a macro-level statement of strategies, gaps and further actions needed for conservation, sustainable use and strategies and realization of actual as well as potential value of Biological Diversity.

Often the natural ecosystem areas are spread over the boundaries of neighbouring countries, e.g. Sundarban Mangrove in India and Bangladesh. Again, population of a species ranges different countries. Thus, for the conservation of such ecosystem or species, regional agreements are necessary. India is a member of South Asian Association of Regional Co-operation (SAARC), South Asian Co-operation for Environmental Programme (SACEP) and others.

Above all, there is Indian Board for Wildlife to devise ways and means for the conservation of Wildlife, Promotion of public interest in Wildlife and to advise Central Government on related matters.

West Bengal being a component state of Union of India is guided by the Acts (Box I), Actions and Policies adopted in the Central level. However, depending on the local situation, a number of Acts and Actions have been implemented in the state level. To advise State Government for formulating policy of protection and conservation, State Wildlife Advisory Board was established in 1955. According to a directive of the Supreme Court, a Green Bench has been established in Calcutta High Court to dissolve the cases on various environmental issues including felling of trees, filling of Wetland, etc. In order to effectively

draw up the charge sheets and pursue the cases in the court, one legal cell has been established in all the divisions under the Wildlife Wing. Orders related to Biodiversity Conservation have also been issued by different departments of the State Government. To Minimise the incidental catch and fishery related mortality of Olive Ridley Turtle, Fishery Department issued order No. 3209-Fish/C-V/IA-2/90 pt.1, dt. 17.11.2000 and Memo No. 1473-Fish/C-V/IP-5/37, dt. 20.11.2000 regarding mesh size of gill net and introduction of TED in fishing vessels.

For the conservation of Wetlands, the State Government has formulated several acts as follows.

*Town and Country Planning Act, 1979 : To control the land use change.

*Inland Fisheries Act, 1984 : For conservation of fish species and management of water bodies.

*Inland Fisheries (Amendment) Act, 1993 : For proper management as well as conservation of wetlands measuring 0.035 ha. or more.

West Bengal State Biodiversity Strategy and Action plan as a component of National Biodiversity Strategy and Action plan has been finalized and submitted in 2002. A set of ten desirable Actions have been prioritized. The most important Action suggested is the formation of Biodiversity Conservation Board at the state headquarters, which will have overall authority to obtain biodiversity related information and spearhead conservation-management initiatives in a sustained manner. The West Bengal State Biodiversity Board has been Constituted and is Working in full swing. During the years of activity the Board has published several 'People's Biodiversity Register' (PBR) and semitechnical books for identification of animals and plants by the non-scientific people. The most important achievement of the State Board is publication of State Biodiversity Rules (2005). Ghosh (2008) published the, 'Status of Environment in West Bengal—A Citizen's Report' In this report he attempted to project the views with

sufficient information/data to the maximum extent on the environment related critical issues including biodiversity.

3. *IN-SITU* CONSERVATION :

In West Bengal, the concept of conservation of natural habitats and the species therein is deep-rooted, as Senchal Wildlife Sanctuary was notified as early as in the forties vide No.10699 dt. 18.11.1940, Jaldapara sanctuary on 18.11.1940 vide No. 10694, Gorumara and Chapramari Sanctuaries were notified vide Nos.5181 dt. 2.8.1949 and 10694 dt. 18.11.1940 and No.8403 dt. 30.8.1941 respectively. All these notifications being issued under the Indian Forest Act of 1927 prior to promulgation of Wildlife (Protection) Act, 1972. However, with the advent of the latter Act, the conservation of natural habitat alongwith floral and faunal diversity received a tremendous booster and statutory support. Since then, large-tracts of forest areas including water bodies having ecological significance and importance had been identified by the state and declared as Protected Areas in the form of National Parks, Sanctuaries and Tiger Reserves to ensure an adequate network covering the almost complete range of Biological Diversity in the State. Further, considering the importance of the bio-geographic region and its unique biodiversity, the National Park area of Sundarban Tiger Reserve was included in the list of World Heritage Sites in 1985, and whole Sundarban area was declared as Biosphere Reserve in 1989. Till date, Protected Area network of the state includes 5 National parks, 15 sanctuaries, 2 Tiger Reserves and 1 Biosphere Reserve (Table 10). The existing Protected Area network comprises of 34 percent of state forest area and 4.6 percent of state geographical area. It may be interesting to note that in West Bengal, a unique effort was made to conserve the Himalayan Newt or Salamander by declaring sanctuary in its name and consequently, the Jorepokhri Salamandar Sanctuary was formed in Darjiling district. This is the only sanctuary in the country to be dedicated to the conservation of an amphibian species.

Scientific management plans for each Protected Area is a must to achieve the goal of Biodiversity Conservation. The plan must be based on the sound principles of Biology; it must be practicable in context of the resources at the command of the manager; must conform to laws, policies and regulations in force; must accord with the local socio-economical situation and must be ethically acceptable. As such making a management plan is a time taking affair and requires huge amount of information. West Bengal has made significant progress in the preparation of management plans for Protected Areas and the same for all the Protected Areas except the names below have been completed.

Box 1. Important Central and State Acts with relevance to Biodiversity

- △ Fisheries Act, 1897
- △ Destructive Insects and Pests Act, 1914
- △ Forest Act, 1927
- △ Agricultural Produce (Grading and Marketing) Act, 1937
- △ Tea Act, 1953
- △ Prevention of Cruelty to Animals Act, 1960
- △ Import and Export (Control) Act, 1980
- △ Seeds Act, 1966
- △ Customs Act, 1962
- △ Indian Wildlife (Protection) Act, 1972
- △ Water (Prevention and Control of Pollution) Act, 1974
- △ Water (Prevention and Control of Pollution) Cess Act, 1977
- △ Marine Products Exports Development Authority Act, 1972
- △ Economic Zone and other Marine Zones Act, 1976
- △ Environmental (Protection) Act, 1986
- △ Foreign Vessels Act, 1980
- △ Forest (Conservation) Act, 1980
- △ Foreign Trade (Development and Regulation) Act, 1992
- △ New Seed Development Policy, 1988

- △ Spices Board Act, 1986
- △ Hazardous Waste (Management & Handling) Amendment Rules, 2000
- △ Biodiversity Act, 2000
- △ Coastal Regulation Zone Notification, 1951
- △ West Bengal Forest Produce (Establishment and Regulation & Saw Mills) Rules, 1982
- △ Town and Country Planning Act, 1979
- △ Inland Fisheries Act, 1984
- △ Inland Fisheries (Amendment) Act, 1953
- △ Biomedical Waste (Management and Handling) (Amendment) Rule, 2003

The management plans for Raiganj, Ballavpur, Halliday and Lothian Island Wildlife Sanctuaries and Chintamani Kar Bird Sanctuary are under preparation (Annual Report, Wildlife Wing Directorate of Forest, Govt. of West Bengal, 2009-10).

Policy decisions were taken to handover administrative control of Protected Areas to Wildlife Wing for more intensive management from wildlife conservation angle.

Regular intensive patrolling and maintaining constant vigil over the PAs is the primary condition for preventing poaching of wild animals, illicit felling of timber, grazing, encroachment and other deleterious activities. For the purpose of patrolling, each Beat Officer arrange for daily and intensive scanning of the forest beat under his control, particularly the sensitive habitat areas by staff on foot, elephant back, launch and boats. During rainy season, rafting of timber along river is a serious problem in North Bengal. Temporary tree top camps are established during rainy season to control such theft of drift timber. Similarly, temporary camps are set up at regular intervals along the course of rivers passing through the PAs.

A host of activities are being regularly carried out in and around PAs for the habitat improvement. While these activities are primarily directed for developing the habitats for identified flagship species and sensitive species, but at the same time sufficient care is

taken for preserving the habitat and food base of associated species living in the PAs. Some of the habitat management activities in the protected areas are mentioned below.

Overwood removal and fodder plantation : Rhino and other herbivore species prefer riverine grass land and savannah grassland for food and shelter, controlling the invasion of grassland by the pioneer tree species is an important strategy for development of rhino habitat. As such the process of overwood removal followed by artificial regeneration for maintaining grassland habitat is an extremely important component of management and same is done in a phase manner in Jaldapara, Gorumara, Mahananda and others to halt the encroachment of wood land in grass land.

Plantation of indigenous grasses : The plantation of indigenous fodder grasses are taken up in Mahananda, Gorumara, Jaldapara and Buxa in degraded forest areas, or as follow up action of weed eradication and overwood removal. These plantations are done to increase the fodder base for wild animals, so that they get adequate food inside the PAs and do not stray out of the PAs into the human habitation or crop field. Such fodder plantations are being done under the Centrally Sponsored Schemes and State Plan. Only the indigenous species like 'Dhadda', 'Chepti', 'Malsa', 'Madhua', 'Ekra' (*Saccharum* sp.), 'Nal', (*Arundo donax*), 'Khagra' (*Phragmites karka*), 'Bhuttagrass' (*Coix lachrymajobi*), 'Purundi' (*Alpinia* sp.), etc. are locally collected and planted.

Weed eradication : Weeds and climbers are acute problems in most PAs in North Bengal. The most common and proliferating weeds are *Leea* sp., *Cassia tora*, *Mikania* sp., *Lantana camara*, *Clerodendron bengalensis*, etc., the growth of which often surpasses that of grasses. For eradication of *Leea* sp., uprooting is done at the time of flowering, i.e., around September, to prevent further propagation of the species through its seeds. Similarly, cutting of *Lantana camara* is done in the month of October. All weed eradication operations are done manually and no weedicides are applied.

Table-10 : Protected Areas of West Bengal (Source : Anon. 2002. Biodiversity Conservation in West Bengal, Govt. of West Bengal).

Sl. No.	Name Of Protected Area & District	Area (sq. km.)	Major Flora	Major Fauna
A. National Parks				
1.	Buxa N.P., Jalpaiguri	117.10	Sal, Simul, Siris, Khair, Champ, Sidha, Toon, Lali, Lampate, Mandane, Katus, Teak, Orchids.	Tiger, Leopard (Black Panther also) Elephant, Clouded Leopard, Himalayan Black Bear, Civet, Sambar, Serow, Barking deer, Gaur, Pangolin, Python, Raptors, Black-necked Crane and other birds, Moths, Butterflies, etc.
2.	Gorumara N.P., Jalpaiguri	79.45	Tropical moist deciduous Sal forests associated with Odal, Lali, Katus, Dilenia, Simul-Siris-Khair, Terai grassland.	Great Indian Rhinoceros, Leopard, Elephant, Sloth bear, Hog deer, Sambar, Wild boar, Python, Turtle, Migratory birds, Peafowl, Indian Pied Hornbill.
3.	Neora Valley, Darjiling	88.00	Odal, Pterocarpus, Chlanune, Michelia, Kawla, Katus, Buk, Oak, Bamboo, Rhododendron, Tree ferns, Orchids.	Tiger, Leopard, Himalayan Black Bear, Sloth Bear, Civet, Golden cat, Barking Deer, Sambar, Wild Boar, Serow, Goral, Red Panda, Wild dog, Leopard cat, Gaur, Kalij Pheasant, Satyr Tragopan and other Hill birds.
4.	Singalia N.P., Darjiling	78.60	Highest located National Park in West Bengal. Forest type changes with attitudinal Range at 2400-3636. Mailing bamboo, Buk, kawla, Magnolia, Bhujpatra, Rhododendron, Oak, Hemlock, Silver fir, Juniper.	Himalayan Black Bear, Red Panda, Couded Leopard, Leopard cat, serow, Wild Boar, Pangolin, Pika, Barking deer, Kalij pheasant, Satyr Tragopan, Blood Pheasant.
5.	Sundarban N.P., South 24-Parganas	1330.10	Largest Mangrove Forest with 64 species. Nipa palm, <i>Phoenix</i> , <i>Avicennia</i> , <i>Bruguiera</i> , <i>Ceriops</i> , <i>Exeoccaria</i> , <i>Rhizophora</i> , <i>Xylocarpus</i>	Tiger, Fishing cat, Rhesus Macaque, Estuarine-Crocodile, Water Monitor Lizard, Wild boar, Fox, Spotted deer, White bellied Sea Eagle, Goliath Heron, Migratory birds

Table-10 : Cont'd.

Sl. No.	Name Of Protected Area & District	Area (sq. km.)	Major Flora	Major Fauna
B. Wildlife Sanctuaries				
1.	Ballavpur	2.021	Sal, Akasmoni, Sisoo, Amla, Bahera, <i>Ficus</i> species, etc. (mainly plantations).	Spotted deer, Black Buck (introduced), Mongoose, Hare, Jackal, Bengal Fox, common birds.
2.	Bethuadahari WLS, Nadia	0.6686	Sal, Arjun, Teak, Sisoo, Siris, Mango, Gamar and other planted species.	Spotted deer, Jackal, Bengal Fox, Porcupine, Common Langur, Barking Deer, Sambar, Jungle Cat Parakeets, Indian Cuckoo, Hawk, Cuckoo, Barbets and other smaller birds, large Pythons, etc.
3.	Bibhutibhusan WLS, N. 24-pgs.	0.64	Simul, Mingiri, Arjun, Siris, Bamboo etc., all planted species.	Spotted deer. Rich in common birds.
4.	Buxa WLS, Jalpaiguri	267.92	A part of Buxa Tiger Reserve same as Buxa National Park, Buffer area.	Elephant, Leopard, Gaur, Spotted deer, Sambar, jungle cat, Fishing cat, Birds.
5.	Chapramari WLS, Jalpaiguri	9.60	Predominant Sal mixed forest lali, Chilaune, Kanchanan, Bahera, Kawla, Dilenia, Mallotus, etc.	Elephant, Gaur, Leopard, Sambar, Barking deer, Rhesus and Assamese macaque, Hornbill, lesser Adjutant Stork.
6.	Haliday Island WLS, South 24-Pgs.	5.96	Mangrove Forest of Sundarban.	Spotted deer, wild boar, barking deer, Rhesus macaque, Tiger.
7.	Jaldapara WLS, Jalpaiguri	216.51	Terai Grass land, riverine forest, sal forests, Simulo, Kyair, Sisoo, Sidha, Gamar, Mallotus, Kawla, Dilenia, <i>Ficus</i> .	Great Indian One horned Rhino, Tiger, Gaur, Elephant, Badger, Leopard, Sloth Bear, otter, Bengal Florican, King Cobra.
8.	Jorepokhri Salamander WLS, Darjiling	0.11	Developed into a tourist-spot very recently and artificially decorated.	One of the favourite breeding ground of Himalayan Newt or Salamander (<i>Trilotrion verrucosus</i>)

Table-10 : Cont'd.

Sl. No.	Name Of Protected Area & District	Area (sq. km.)	Major Flora	Major Fauna
9.	Lothian Island WLS, South 24-Pgs.	38.00	Sundarban Mangrove Forest.	Estuarine Crocodile, Olive Ridley sea turtle, spotted deer, jungle cat, Rhesus Macaque.
10.	Mahananda WLS, Darjiling	158.04	Tropical moist deciduous Sal forests, Khair, Udal, Lali, Champ, Teak, Jarul, Sisoo, Gamar, Mandane, Bamboos, Sidha, Ferns, Orchids.	Tiger, Leopard, Elephant, Gaur, Goral, Spotted deer, Golden cat, Himalayan Civet, Hornbill, Racket tail drongo, very rich in birds.
11.	Narendrapur WLS, South 24-Pgs.	0.07	Orchard plantation.	Rich in smaller birds, specially paradise fly catcher, Oriole, etc.
12.	Raiganj WLS, N Dinajpur	1.30	Kadam, Jarul (<i>Lagerstromia</i> spp.), Sisoo, Teak, Khair, Saccharrum grasses, etc.	Largest nesting place of open bill stork (60,000-70,000 nests). Night Heron, Cormorant, Egrets, Kingfisher, Wood peckers, Barbets, etc., Jackal, Bengal fox, Mongoose, monitor lizards.
13.	Ramnabagan WLS, Bardhaman	0.14	Teak and sal plantation, jamun, Ficus and other plated species.	Spotted deer, common langur, introduced species – Black Buck.
14.	Sajnekhali WLS, South 24-Pgs.	362.40	Mangrove Forest. A part of Sundarban Tiger Reserve.	Spotted deer, Rhesus Macaque, Wild boar, Tiger, Water monitor lizard, Fishing Cat, Otter, Crocodile, Batagur terrapin and Migratory birds.
15.	Senchal WLS, Darjiling	38.88	Magnolia cambelii, Rhododendron, Michelia Bamboo, Buk, Kawla, Utis, Hemlock, Pipli and Cryptomeria (planted species)	Serow, Goral, Barking deer, Himalayan Black Bear, Leopard, Leopard cat, Jungle cat, Assamese macaque, Giant Squirrel, Flying Squirrel, kalij, Hornbill, Imperial pegen, Thruses, and other hill birds.

Table-10 : Cont'd.

Sl. No.	Name Of Protected Area & District	Area (sq. km.)	Major Flora	Major Fauna
C. Tiger Reserves				
1.	Buxa Tiger Reserve (including WLS & N.P.), Jalpaiguri	760.87 (Core: 385.02, Buffer: 375.85)	As above	As above
2.	MSundarban Tiger Reserve, South 24-Pgs. & North 24-Pgs.	2585.00 (Core: 1330, Buffer: 1255)	As above	As above
Biosphere Reserve				
1.	Sundarban Biosphere Reserve, South 24-Pgs., & North 24-Pgs.	9630	As above	As above

Control burning of old grass plantations for natural regeneration : Fodder grass plantations in North Bengal PAs when become more than three years old start losing their importance as foraging areas, since the animals do not prefer coarse grasses. Such three year old plantations are usually brought under control burning operations during winter. In order to create minimum disturbance for animals and to provide them shelter and fodder while carrying out these operations, not more than 12 to 15 such patches of less than 5 ha. in each PA are undertaken in a year.

Control of wild fire : Accidental and man-made wild fire is common in most of the PAs of North Bengal. Several fire protection measures such as maintenance of fire line before fire season, construction of tower/tree machan for fire detection, engaging fire watchers during fire season and publicity and public awareness, and others have been adopted. Creation and maintenance of firelines are usually done under centrally sponsored scheme.

Control of grazing by livestock : Grazing by livestock from fringe villages is a great threat to the habitat. Domestic livestock not only competes with the wild herbivores for food but also spreads serious diseases. To minimize the hazardous impact of grazing various actions are being taken as detailed below.

- ★ Extensive patrolling specially along the forest boundaries and grazing prone areas.
- ★ The camps situated on the main roads are activated to prevent entry of cattle in the PAs.
- ★ Reduction of low yielding variety cattle through castration of bulls and artificial insemination for improvement of stock
- ★ Regular immunization of domestic cattle against Anthrax, FMD, HS, BQ diseases
- ★ Replacement of low-yielding varieties with high-yield variety.
- ★ Involvement of Eco-development Committee and seeking their cooperation to prevent illicit grazing.

Reforestation of degraded forest areas : Substantial chunks of blank areas or degraded forest areas along the boundaries of PAs in North Bengal have been brought under vegetation cover through plantation of indigenous timber, fruit and tree fodder species. Since the inception of Sundarban Biosphere Reserve, plantations are raised in the mangrove blocks, with special thrust on species like *Heritiera fomes*, *Xylocarpus granatum* and *X. mekongensis*.

Joint Forest Management (JFM) outside the PAs in West Bengal has its origin in the success achieved in rejuvenating a patch of 1270 ha. of degraded forests under a pilot project implemented during 1972 near Arabari in Medinipur. The JFM movement gathered momentum when in 1989 a programme of resuscitation and re-establishment of moribund sal and other hardwood forests in the districts of Medinipur, Bankura, Puruliya, Bardhaman and Birbhum was initiated with the active participation and involvement of local people and panchayets. Simultaneously a Government resolution was issued defining the principles of sharing of duties, responsibilities as well as benefit from the forests, with the participating local people living inside and in the fringe of forests. The procedure for establishment of the institution called Forest Protection Committee (FPC), consisting the participants as members, was formalized. The foundation of an innovative participatory forest development, protection and management system was thus laid for the forests of southwestern Bengal which now cover approximately 38 percent of the total forest area of the state. JFM contributed to conversion of vast tracts of scattered, over-exploited and degraded sal and miscellaneous scrub forests to productive pole crop with great improvement in quality and density in many regions of southwest West Bengal. JFM picked up and gathered

momentum after Government resolutions were issued for Sundarban, forests of North Bengal and those lying under the jurisdiction of Darjiling Gorkha Hill Council. A detailed area-wise number of FPC, total members, total protected area and forest land (ha.) per FPC members has been shown in Table 11. A mangrove rehabilitation project already launched envisages the afforestation of embankments with mangrove species over 3,300 ha. and protection of degraded mangrove forest land covering 25, 000 ha. through FPCs.

Eco-development project in and around PAs : The concept of JFM in the traditional forestry sector has been extended to the PAs in the name of 'Eco-development' The Government Order for the constitution of Eco-development Committee (EDC) was issued in the year 1996. The objective of the project is to conserve the floral and faunal biodiversity of the protected areas through direct involvement of the fringe population but with a clear distinction of non-sharing of products of PA. The strategy is to carry out ecologically sustainable economic development of fringe population, so that the biotic pressure on the forests for subsistence of fringe population is reduced with social control. Number of EDCs formed around the PAs of West Bengal has been shown in Table 12.

Others : Various activities such as thinning of older plantation, conversion of monoculture plantations into mixed plantation, soil and water conservation measures, development of salt-licks, mitigation of man-animal conflict, census of wild animals and others are being systematically carried out to achieve the goal of in-situ conservation.

4. *EX-SITU* CONSERVATION :

The principal institutions holding *Ex-situ* population of animal species are zoos, deer parks, snake parks, aquaria, while that of plant

species are botanical gardens, seed banks, gene banks, etc.

4.1. ANIMALS : Zoos play the most important role in *Ex-situ* conservation of animal species. The Zoo Management concept started changing drastically in the 20th Century where it had been felt through out the world that zoos have much important role to play rather than being a place of mere amusement and is now considered as an extension of forests. Captive breeding of endangered animals is the main aim of the modern zoo management and the concept "Nature to Zoo" has changed to the concept of "Zoo to Nature" The zoos are also playing a role in developing the awareness among the people and educating the people about the importance and significance of conservation. With the establishment of the Central Zoo Authority (CZA) in February 1992, a systematic documentation of facts regarding captive breeding and exchange of the same with various Zoos have been started. CZA also issues guidelines to be followed by every zoo with respect to captive breeding, maintenance of animals, exchange and loaning and others.

In West Bengal the concept of Zoo and Menageries started long back mainly under private capacity. Some of the oldest Zoos of the state are :

- ★ Barrackpur Menagerie, founded in 1801 and closed in 1879
- ★ Wazir Ali Shah's Menagerie, founded in 1830's and wound up in 1880
- ★ Alipore Zoo, founded in 1875 and continuing.
- ★ Padmaja Naidu Himalayan Zoological Park established in 1958 and continuing.

Alipore Zoological Garden is holding nearly 350 specimens (35 species) of mammals, 1300 of birds (65 species), 70 of reptiles (18 species) and 1000 of fishes. Animals are mostly

kept in cages, but with the financial assistance of the State Government and CZA, Open Air Moated Enclosures have been constructed for better housing of Sloth Bear, Tiger, Lion, Rhino and others. Opening of a freshwater aquarium in 1977 added a new dimension to the Alipore Zoo. The Zoo has made significant achievement in respect of captive breeding of a number of native as well as exotic threatened species. This includes Rhino, Lion, Tiger, Leopard, Leopard Cat, Chinkara, Manipur Deer, Hog Deer, Spotted Deer, Barking Deer, Giraffe, Common Marmoset, Common Pea Fowl, Pheasants, Painted Stork, Spoonbill, Marsh Crocodile and many others. Research works on conservation of wildlife in captivity are being regularly carried out by the officers and veterinarians. Regular awareness and training programmes are also organized in collaboration with the NGOs or other Government agencies.

Padmaja Naidu Himalayan Zoological Park (Darjiling) is the only high altitude zoo in this part of the world. It possesses (till March 2000) 70 specimens of mammals, 191 of birds and one of Reptiles. Most of its holdings are high altitude species such as Snow Leopard, Himalayan Wolf, Himalayan Black Bear, Red Panda, Yak, Ussuri Tiger, Markhor, Chir Pheasant, Kaleej Pheasant, etc. The zoo is successfully carrying out captive breeding of some of the endangered species of the Himalayan ecosystems, such as, Red Panda, Tibetan Wolf and Snow Leopard. It is also initiating release of the captive bred animals in their natural habitat.

Zoological Survey of India has opened on 4-2-2003 the **Marine Aquarium and Research Centre** at Digha for holding a spectrum of animals of our Marine Ecosystems. It is also educating, motivating and initiating awareness campaigns among the local people, students and tourists on the importance of conservation.

A number of **Deer parks** were established in the state during post-independence era mainly by the Forest Department. Some of these Deer Parks such as Parmadan, Ballavpur, Bethuadhari were elevated to the status of Sanctuary. Deer Parks mainly contain Cheetal and Barking Deer. Besides, antelopes, Nilgai and rescued specimens of other groups of mammals, birds, reptiles are also reared in some of the Deer Parks. Excess deer population from the existing Deer Parks are often translocated in the forested tracts particularly of South West Bengal. Wildlife wing built up a Deer Research Centre at Salt Lake in 1975 covering an area of 0.02 sq.km. Existing Deer parks of the state are listed below.

- ★ Deer Park, Dow Hill, Kurseong
- ★ Gor Chumuk Deer Park, Haora
- ★ Kumari Kangsabati Deer Park, Bankura
- ★ Bellilias Park, Haora
- ★ Corporation Park, Haora
- ★ Jhargram Deer Park, West Medinipur
- ★ Adina Deer Park, Maldah
- ★ Garhmandaran Deer Park, Hugli

Two **Snake Parks**, one in Badu (North 24 Parganas) and other in Kolkata are being maintained under private capacity. These are also maintaining a fairly good collection of reptiles and carrying out awareness programmes to grow love and affection for these creatures.

Captive hatching and rearing centers have been established for Salt Water Crocodile, Olive Ridley Turtle and River Terrapin at Sajnekhali and Bhagabatpur by the Forest Department. Wild laid eggs were collected and brought to the centers for captive hatching. Regular release of specimens to the wild is being done successfully from both the centers.

Reintroduction of wild animal : Scientists of Zoological Survey of India are

working on a project on reintroduction of once present pygmyhog in Gorumara National Park in collaboration with the department of forests, Government of West Bengal. The state government has decided to start a feasibility study of reintroduction of rhinoceros in Buxa National Park. This study will also be undertaken by ZSI scientists.

In West Bengal, the rehabilitation and restocking of some of the endangered wild animals have been initiated like translocation of more than 1100 Cheetal deers in the forest of South Bengal, Sundarban and North Bengal. The release of marsh Crocodile (421 Nos.) and *Batagur buska* are being done regularly in various creeks and rivers of Sundarban (Table-13). In addition, two Red Pandas have been released in Singalila National Park.

4.2 Plants : Large varieties of cereals, vegetables, horticultural crops and forestry related plants are traditionally under *Ex-situ* conservation through the numerous seed banks, nurseries, home gardens, etc. maintained by the Department of Agriculture and Forest, Agricultural Universities, as well as private bodies including farmers, scientists and business houses. In Darjiling district, particularly in Kalimpong, artificial propagation of orchids are being carried out in private capacity. However, largest center for *Ex-situ* conservation of plant species in West Bengal is the **Indian Botanic Garden**, Haora under the Botanical Survey of India.

The Indian Botanic Garden established way back in 1787 is presently a center of excellence. The Garden is the repository of more than 12,000 trees, shrubs and climbers representing over 1400 species together with a large number of wild and cultivated plants. The garden has played a very important role in the economic development of the country by introducing, improving and distributing a number of

economic plants, such as, Tea, Rubber, Jute, Cinchona, Sugar cane, Mahogany, etc. It preserves one of the best collection of native and exotic plants and large number of curious, rare and threatened species. Rich collection of Bamboo, Screwpine, Palm, Waterlily, Orchid, etc., are some of the proud possession of this Garden.

There are ten medicinal plant gardens in the state containing 150 species maintained by the Sylviculture Division of the Forest Department at Mirik, Darjiling. The garden established by the Darjiling Gokha Hill Council is one of the finest of its kind.

5. Training and Awareness Programme :

No Conservation programme can be successful without people's awareness, involvement and support. A host of activities thus directed towards educating common people, decision makers, enforcement staff and particularly the people living in multiple use areas through Central and State Governments as well as non-Government organisations.

Wildlife Institute of India (WII) is the main training center in order to train Indian Forest Service (IFS) and State Forest Service (SFS) officers as well as the Rangers. Further, WII imparts training on Wildlife management, captive breeding, ecodevelopment for Biodiversity Conservation, community participation in Biodiversity Conservation, wildlife study techniques, Tranquillisation and chemical immobilisation of wild animals and others. Regular training courses covering the subject area of tree planting, nursery techniques, etc. are being organized by the Institute of Forest Genetics and Tree Breeding. Indira Gandhi National Forest Academy arranges professional training to the probationers of the IFS officers to face challenges in the profession on technical

forestry and managerial aspects. For senior forest officials training courses on 'Application of Remote Sensing Techniques in Forestry' are being organized by the Forest Survey of India. Zoological Survey of India regularly organising various training courses on collection, preservation and identification of animals of economic importance, field ornithology, basic taxidermy and wildlife conservation for forest officials, teachers, students and members of the NGOs. Similarly, Botanical Survey of India conducts regular courses on field survey, herbarium methodology and identification of floral species. State Forest Department also organises various training programmes such as veterinary care, capture and release of wild animals, ecodevelopment (irrigation, pisciculture, etc.), wildlife census, handling of captive animals specially elephant, and others for his own staff, EDC, FPC members as well as NGOs.

Key of conservation success lies in the nature education and awareness generation among the common people. In recent years 'Environmental Science' has been included in the curriculum at school and college level. Dissemination of information on the importance, ways and objectives of Wildlife cum Biodiversity conservation is being done by the Central and State Government, NGOs, and business houses through the following means.

- ★ Establishment of well-equipped nature interpretation centers at Madarihat, Kunjanagar, Lataguri, Murti, Lava, Sukna, Darjiling Natural History Museum in North Bengal and Bethuadahari and Sajnekhali in South Bengal.
- ★ Installation of hoardings at strategic points on the National and State Highways, places of tourist interest.

- ★ Circulation of leaflets, brochures, posters to the common people, students, visitors of PAs, highlighting the importance of conservation as well as legal implications.
- ★ Organising regular relevant film shows at schools, colleges, fairs, panchayets and others.
- ★ Release of postage stamps depicting Wildlife.
- ★ Releasing advertisements with appeal for conservation through audiovisual media like TV, Radio, Cinemas, Newspapers, Magazines, etc.
- ★ Organising nature camps, sit and draw competition, debate, lectures for children and youngs.
- ★ Creation of ecotourism zone by involving NGOs and Social Forestry Division.
- ★ Rewarding commendable Biodiversity Conservation initiatives to individuals/groups
- ★ Building up of public opinions particularly by the NGOs to prevent any anti-conservation action or policy.
- ★ Celebration of World Environment Day, Wildlife Week, Forest Week, Biotechnology Day at Government and non-Government level by organising lectures, workshops, exhibition, distribution and planting of seedlings, cleaning operation, film shows and others.
- ★ Following the suggestion of IBWL, *Prionailurus viverrinus* (Fishing Cat), *Halcyon smyrnensis* (White-throated or White-breasted Kingfisher), *Alstonia scholaris* (Chhatim) and *Nyctanthes arbor-tristis* (Shepali/Siuli) have been identified as state animal, bird, tree and flower respectively. This has a very positive impact towards awareness and support for conservation (Plat-I, p. 133).

6. Research :

This is a critical component of Biodiversity Conservation. The objective of promotion of

research in multidisciplinary aspects of environmental protection, biodiversity conservation and development are to advance the scientific understanding and to generate information required to develop strategies, technologies and methodologies for better management plan. It also aims attempting solutions to practical problems of resource management, conservation of biodiversity and ecoregeneration of degraded areas. Large number of organizations, such as, Zoological Survey of India, Botanical Survey of India, Wildlife Institute of India, Forest Survey of India, Fishery Survey of India, ICAR, CSIR, Department of Science and Technology, State's Forest, Fishery, Environment, Agriculture Departments, Pollution Control Board, Universities, NGOs like Bombay Natural History Society, Prakriti Samsad, Nature Environment and Wildlife Society, Pugmarks, WWF-India, IBRAD and many others are carrying out extensive research work dealing with the biodiversity of the state, Central and State Governments are the main funding agencies of these research organizations. Further, project specific financial and technical supports are also extended by the international agencies like IUCN, UNDP, WWF-India, International Development Association and Global Environment Trust, U.S. Embassy and others.

It is not possible to provide the total range of research activities. As such some of the major areas of research works either completed or in progress have been mentioned below.

Botanical Survey of India (BSI) and Zoological Survey of India (ZSI) carry out surveys to inventorise and determine the status of floral and faunal resources at the state and national level. Documents of floral and faunal resources at the district and State level are

PLATE 1

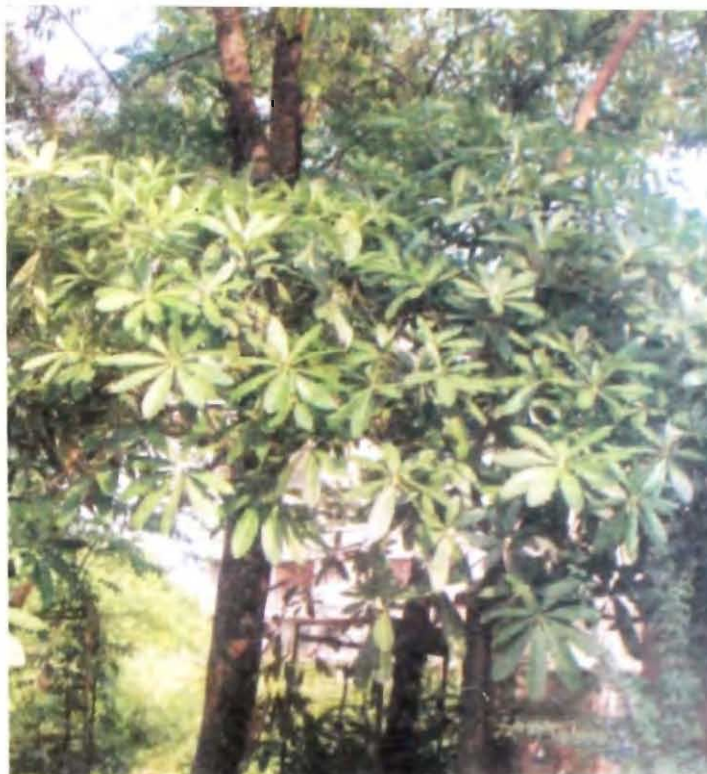
West Bengal State Flower, Plant, Bird & Animal

State Flower



Nyctanthes arbor-tristis
(Shephali)

State Plant



Alstonia scholaris
(Chhatim)

State Bird



Halcyon smyrnensis
(White Throated Kingfisher)

State Animal



Prionailurus viverrinus
(Fishing cat)

being published by them. Identification manuals for different groups have already been published. Red Data Book for vertebrate species and Lepidoptera have been completed and that for invertebrate is under preparation. Recently (2011) a book on critically endangered species of India has been published by ZSI. Number of volumes of Red Data Book on floral species have been published. Recently Ghosh (2010) has published a document on urban biodiversity of Kolkata. A national data base on the Bioperspective survey of plant resources to identify economically as well as ethnobotanically important species for their conservation has been developed at BSI. Similar database on faunal diversity is being developed by the ZSI. The Forest Survey of India publishes every three years, a report on the state of the forest in India based on remote sensing and ground truthing. A compilation of district-wise wetlands in West Bengal has been prepared by the Institute of Environmental Studies and Wetland Management (IESWM), Department of Environment, Govt. of West Bengal. The State Forest Department in collaboration with R.R.S.S.C., Kharagpur is carrying out forest change detection studies and wetland mapping through digital image processing of Indian Remote Sensing Satellite Data. State Wildlife Wing have inducted local universities, institutions and NGOs to undertake collaborative studies on ecosystems and identified endangered species. Such studies include i) Study of Red Panda and Satyr Tragopan in Singalila N.P. (Darjiling Govt. College), ii) Study of Bio-ecological Resources of Neora Valley N.P. (North Bengal University), iii) Food preference study of Rhino in Jaldapara WLS (Raiganj University College), iv) Survey of floral and faunal resources of Mahananda WLS (NEWS), v) Entomological studies in Buxa T.R. (Calcutta University). These studies were

sponsored by G.O.I. Other collaborative studies taken up under W.B. Forestry project (IDA-assisted) include i) Studies on Gaur (WWF-India), ii) Study on Control of illegal trade in Wildlife (Wildlife Protection Society of India, iii) Study on control of Tiger straying in Sundarban (NEWS), iv) Survey of avi-fauna and water quality monitoring in identified Wetlands of W.B. (NEWS) and v) Feasibility study on reintroduction of Pygmyhog in Gorumara National Park (ZSI). Contract studies initiated under the Wildlife and Biodiversity component of W.B. Forestry Project include i) Study on elephant (WII), ii) Study of leopard (WWF-India) and iii) Study of Rhino (WII).

Under "GOI-UNDP Sea Turtle project", NEWS has conducted the survey of sea turtles along the coast of W.B. on behalf of WII. Centrally sponsored projects like i) Population trends of some threatened species of W.B. (NEWS), ii) Ecological crop loss due to wild harvest of prawn seeds in Sundarban Biosphere Reserve (S.D. Marine Biological Research Institute), iii) Identification of Wetlands of Water fowl importance (SACON, Prakriti Samsad) and many others have been successfully undertaken.

Mapping of Environmentally Sensitive Zones and Industrial Sites (Statewise) programme has been taken up by Central Pollution Control Board under the Environmental Management Capacity Building Technical Assistance Projects of the World Bank.

There are many more significant research works related to conservation of biodiversity and their list will be unending. As such, it is concluded with the mention of WII's reviews of the Protected Area network of the country (2002), which has suggested the extension of some PAs in the state to ensure the conservation of the species there in.

Table-11 : Forest Protection Communities of West Bengal (Source : Dept. of Environment & Ramkrishna Mission, Narendrapur 2002. West Bengal State Biodiversity Strategy & Action Plan. Ramkrishna Mission, Narendrapur).

Division	Total No. of FPC	Total Area Protected (ha.)	Total No. of FPC Members	Forest land (ha)/FPC Members
E. Medinipur	315	41274	44686	0.92
W. Medinipur	542	62629	44017	1.42
Kharagpur	82	12068	18677	0.65
Rupnarayan	182	25296	22258	1.14
Bankura(N)	468	41146	44210	0.93
Bankura(S)	538	40858	50192	0.81
Panchet	221	27618	24865	1.11
Puruliya	174	25479	17865	1.45
Kangsabati I	186	14033	15855	0.88
Kangsabati II	293	24900	28446	0.87
Barddhaman	57	16380	16249	1.00
Durgapur	21	3053	2553	1.19
Birbhum	133	9068	8428	1.07
S-24 Parganas	23	39167	9652	4.05
Darjeeling	41	7827	2699	2.90
Kalimpong	35	15486	1171	13.22
Kurseong	18	2590	906	2.86
Jalpaiguri	49	18204	12169	1.50
Koch Bihar	21	5891	2872	2.05
Koch Bihar SF	22	3405	1458	2.33
Baikunthapur	55	7657	6113	1.25
Buxa T.R. (E)	17	10288	3454	2.98
Buxa T.R. (W)	24	16213	4083	3.97
Sundarban T.R.	10	17565	3875	4.53
Total	3545	488095	386753	1.26

Table-12 : Ecodevelopment Committees around the National Park/Sanctuaries in West Bengal (Source : Dept. of Environment & Ramkrishna Mission, Narendrapur, 2002. West Bengal State Biodiversity Strategy & Action Plan, Ramkrishna Mission, Narendrapur).

National Park/Wildlife Sanctuaries	Total No. of EDC	Total No. of families
Gorumara National Park	9	1418
Jaldapara Sanctuary	32	15022
Mahananda Sanctuary	11	1751
Singalila National Park	1	22
Sanchal Sanctuary	10	1277
Buxa Tiger ReServe	20	2524
Sundarban Tiger Reserve	16	4283
Total	99	26297

Table-13 : Year wise record of release of Crocodile Hatchling from Crocodile Project, Bhagabatpur under 24-Parganas (South) Division.

Year	Male	Female	Total	Progressive Total	Place of Release
1979	13	27	40	40	Parchamutli, Matla-II, Gosaba Pirkhali-I, Pirkhali-II, Lothian
1982	3	22	25	65	Netidhopani, Gowa-II, Chamta
1983	6	12	18	83	Netidhopani, Matla, Chandkhali
1984	6	15	21	104	Netidhopani, Chamta-II, Bhurkunda Khali, Bhagmari
1986	1	29	30	134	Netidhopani, Chotta Chamta, Arbiga
1987	17	13	30	164	Pirkhali-7, Chhota Hodi, Chamta-4
1988	15	12	27	191	Haldibari, Buridabri, Chamta
1989	1	12	13	204	Netidhopani, Panchamundi, Chamta-4
1991	11	9	20	224	Chamta-2 & 4, Netidhopani
1992	7	8	15	239	Matla-2 (Surajmukhi Khal)
1993	7	8	15	254	Khewra Shuli Narayantala, Chhoto Chamta-1
1994	3	18	21	275	Chotto Hardy Camp-2, Chand Khali Camp-4
1995	2	12	14	289	Ejukhali, Matla-1, Netidhopani
1996	5	10	15	304	Chamta-4, (Chandra Duani)
1997	4	10	14	318	Netidhopani, Chamta
1998	4	11	15	333	Netidhopani, Chamta
1999	14	6	20	353	Sajnakhali, Netidhopani, Bakkhali & Suddhannakhali
2000	-	-	-	-	-
2001	-	-	-	-	-
2002	5	15	20	373	Chamta, Netidhopani
2003	-	-	-	-	-
2004	1	1	2	375	Chulkati, Dhulibasani
2005	4	10	14	389	Chulkati-Sajnekhali
2006	2	4	6	395	Sundarikhati
2007	2	4	6	401	Sundarikhati khal in Ajmalmari-7 Reserved Forest Block
2008	-	-	-	-	-
2009	12	8	20	421	Chulkati-I

Source : Annual Report (2009-2010), Wildlife Wing, Directorate of Forests, Govt. of West Bengal.

DISCUSSION

Maintaining the highest number of species without considering their taxonomic position makes little sense in terms of biodiversity. For example 80 percent of the total species on earth occur in terrestrial ecosystem mainly because vascular plants and insects are so numerous on land accounting for 72 percent of all described species. But the sea contains greater proportion of higher taxonomic units. Marine ecosystem contains representatives of 34 phyla while terrestrial environments are home to only 28 phyla. Within the limits of the state, Medinipur may be considered as the maritime district and South 24 parganas to some extent. In terms of

taxonomic units, Medinipur district tops the list with representatives of 18 major and minor faunal phyla among the total 20 phyla recorded so far from the state (Text-fig. 27). South-24 parganas also have a diversity level nearest to Medinipur district with the occurrence of 16 phyla. However, diversity in respect of taxonomic unit is much less in Murshidabad with representation of only 8 phyla. When faunal species richness is considered, Darjiling district comes first with 4387 species and Kolkata share the next position with 2555 species (Text-fig. 28). Darjiling district contains significantly higher

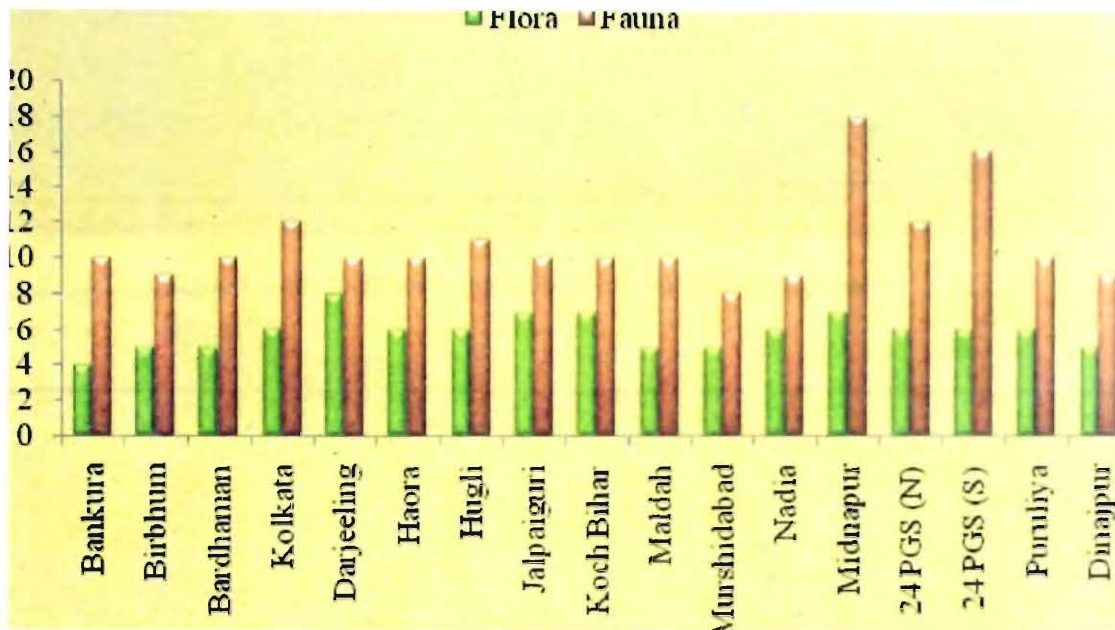


Fig. 27 : Diversity in phyla in fauna and flora in different district of West Bengal.

number of floral species also (2439 Nos.) followed by Medinipur (871 Nos.), while districts like Bankura, Birbhum, Puruliya have less than 500 species each (Text-fig. 29). Grid-wise concentration of species richness in different parts of West Bengal (Text-fig. 30) shows a higher number of species in northern and southern parts.

Alfred *et al.* (2004) found a positive correlation ($r=0.242$) between total forest cover and species richness in the districts (Text-fig. 31). It is true that agricultural land

shares a major part of total land area of the state, which obviously influences the distribution of fauna. There is a direct interaction and even conflict of human beings with both the major and minor animal groups in different parts all over the state in which a sq. km area is occupied by 904 individuals. Conserving these faunal elements occurring outside the protected areas matters more because they are equally valuable in maintaining the biodiversity in totality. Human population densities in different districts of the

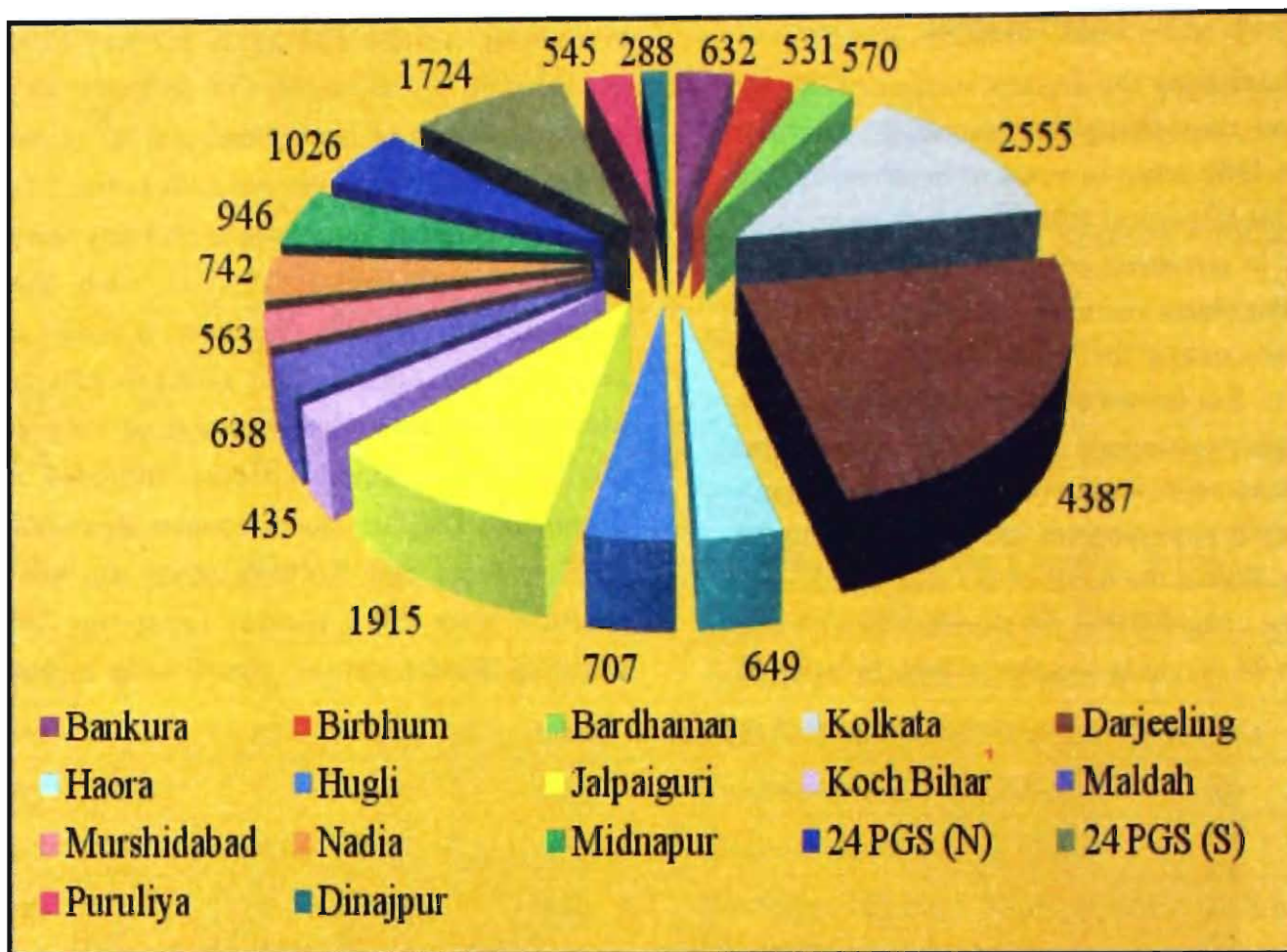


Fig. 28 : Diversity of faunal species in different districts of West Bengal.

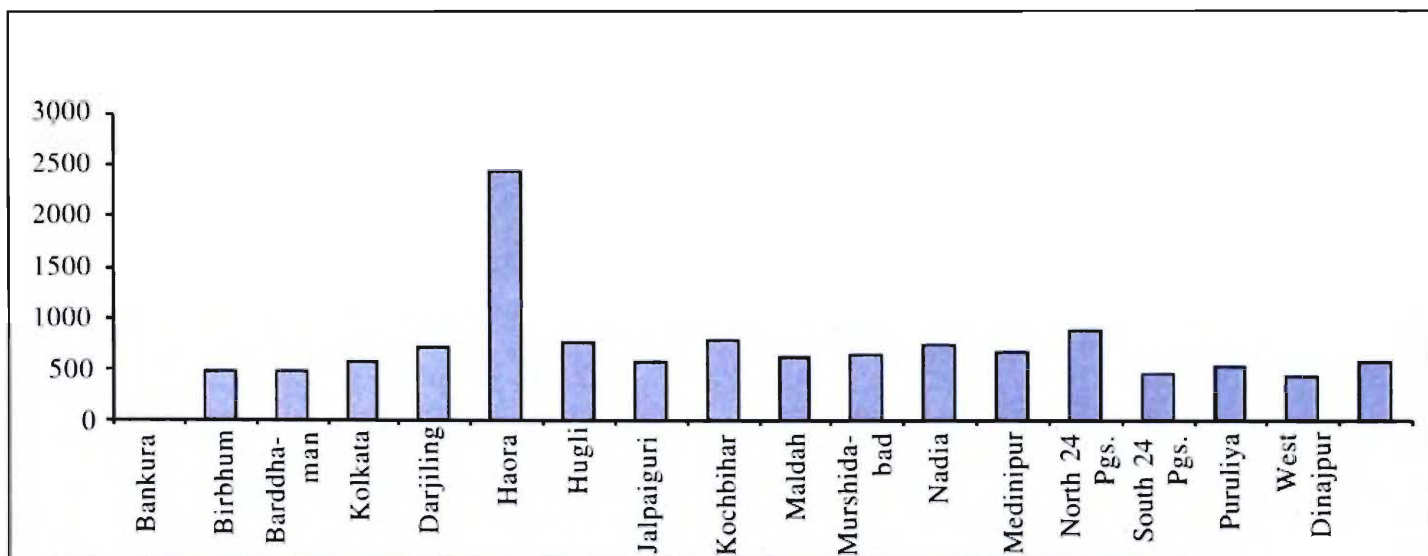


Fig. 29 : Districtwise floral species richness in West Bengal.

state show a negative correlation ($r = -0.226$) with the species richness comprising flora and fauna together (Text-fig. 32).

Some of the previous chapters provide a panoramic glimpse of the rich and diverse plant and animal life along with their rapid decline

even to the point of extinction in the state. Till recently our priority hitherto has been—Development, with a capital D! Mainly to accommodate the ever-growing human populations, all out efforts are being done with no respect for nature, no thought for other

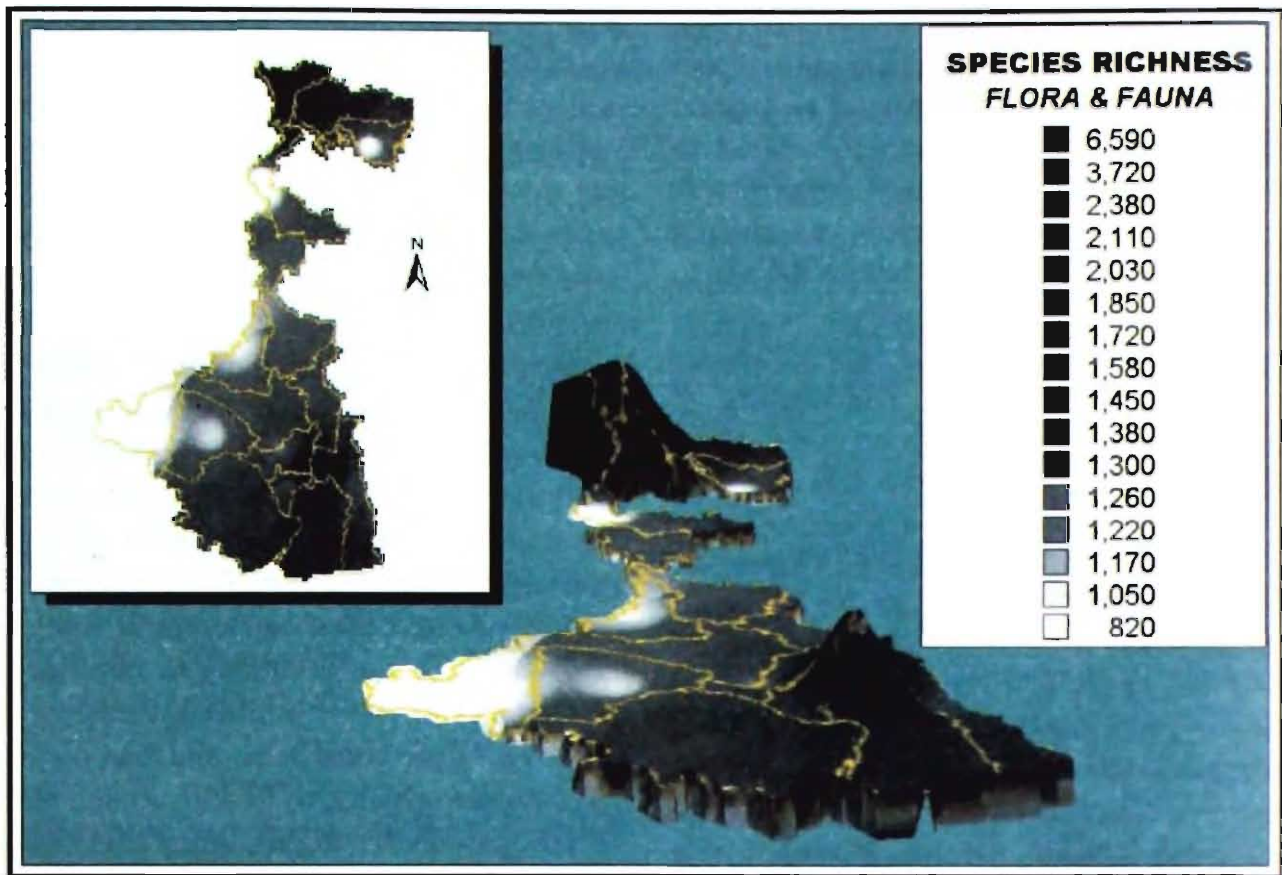


Fig. 30 : Grid-wise concentration of species richness in different parts of West Bengal.

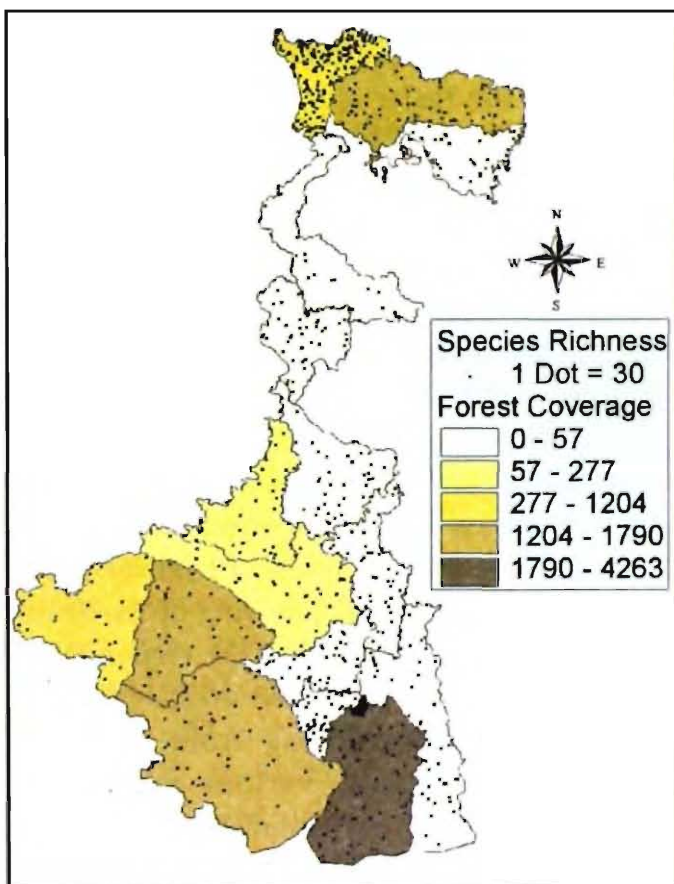


Fig. 31 : Status of forest cover (sq. km.) and species richness (flora & fauna) in West Bengal.

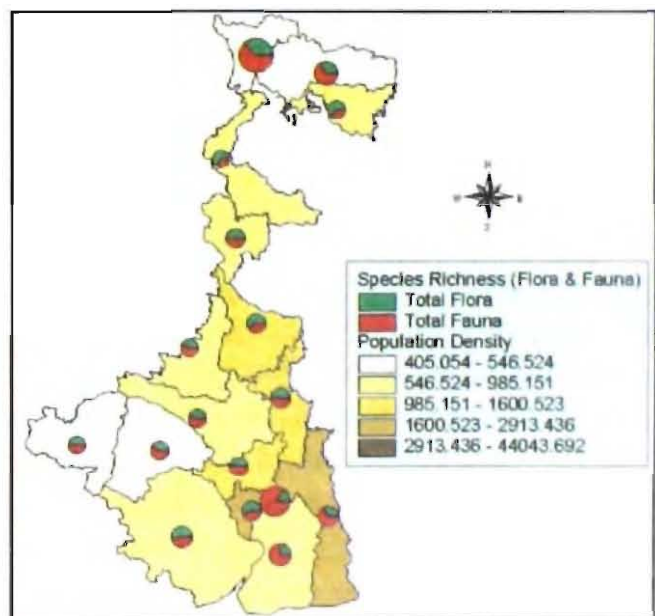


Fig. 32 : Human population density (per sq. km.) and species richness (flora & fauna) in West Bengal

living beings, and no concern for the tomorrow. However, it is heartening to note that in recent past scenario has been changed to a great extent. Since nineteen seventies there is growing concern for wildlife and subsequently the total aspects of biodiversity. As already stated various steps, policies, actions have been adopted not only to protect and preserve what remains of our fauna, flora and natural habitats but also to devise ways and means of augmenting this priceless natural resource. Now it is not necessary to plead the case for biodiversity any more than it is necessary to argue for the continued existence of mankind. The plain fact is that we can not live without it as we are a part of the unity called life on earth and if any part is injured or destroyed, other parts will certainly be impaired in their turn. This is the truth which just can not be ignored.

As a component of National Biodiversity Strategy and Action Plan, West Bengal State Biodiversity Strategy and Action Plan (2002) and Status of Environment in West Bengal—A Citizen's Report (2008) have been finalized by a team of experts from Government and non-Government sectors. The said plan worked out present status of environment and biodiversity in the State, gaps in our knowledge, strategies, needed action, respective actors, time frame for each action and other related aspects. In the meantime National Wildlife Action Plan (2002-2016), which is also concerned with the conservation of biodiversity, has also been finalized. However, from the understanding of the ecosystems and species diversity of the state, existing gaps and problems of their conservation alongwith ever increasing human populations certain further recommendations have been made in the following to ensure that we have sustainable development without destruction, and that we can take of the resources as we leave behind for the future generations.

I. Protected Areas :

Protected areas represent amongst our last reserves of biological diversity, as also the basis

of survival of culturally diverse and sensitive traditional communities. These areas must remain inviolate from urban and industrial pressures. However, the process of setting up and managing these protected areas has also resulted severe problems for local communities dependant on their natural resources for livelihood and sustenance. Almost always, areas have been declared national parks or sanctuaries without adequate consultation with these communities and have resulted in their rights being terminated, access to basic resources being cut off without adequate provision of alternatives. In this situation, a feeling of hostility amongst local communities has quite naturally built up, resulting in conflicts of various kinds. These conflicts threaten the objectives of protected areas and also the local communities which live in and around them. This people - conservation conflict tends to take attention away from the more deep - rooted problem facing both protected areas as also forest dwelling communities; over - exploitation of resources by dominant urban-industrial interests. The major aim of protected areas is the conservation of biological diversity present in them. However, human settlements and human modified ecosystems are a part of the systems being conserved. Traditional communities and their activities are as much a part of the ecosystem as the wild plants and animals and their protection should be a part of the objectives of protected areas. Indeed there are scientific evidences which suggest that limited forms of human intervention may actually increase local levels of biodiversity. At present by law, the wildlife wing of the Forest Department of the state has the responsibility of management of protected areas. Often the serious problems arising from a lack of coordination between various government departments operating in and around protected areas. Example of Sundarban may be given where often conflicts arising among he policies of Forest, Fisheries, Tourism and other departments.

It is necessary to resolve the above problems and to make conservation of biodiversity in protected areas as invocation of the local people and not imposition. But to do so, there is an urgent need for all concerned people and agencies to unite, and to build partnerships of joint decision making. As such Joint Protected Area Management policy as far as practicable is recommended. This is the conceptualization, planning, and management of protected areas and their surrounds, with the objective of conserving natural ecosystems and biodiversity, therein, while ensuring the livelihood security of local traditional communities, through mechanisms which ensure a partnership between these communities, government agencies, and other concerned parties. There is a need to study the diversity of experiences on how either government or community control had worked towards conservation of natural habitats; further, what could be the respective sharing of powers, rights, responsibilities and function of each partner (Community, Government agency, NGO, etc.).

II. Human resource development and personnel planning

Information on the biota is a prerequisite for undertaking appropriate conservation strategies and this has been emphasized in the CBD (1992). Documentation of biodiversity is the primary requisite for biodiversity conservation and therefore, in order to develop scientific conservation strategies, it is necessary to develop taxonomic skill. With the degeneration of taxonomic expertise in the current century, taxonomic investigations are at crossroads. Fortunately headquarters of two premier taxonomic institution *viz.*, Botanical Survey of India and Zoological Survey of India are located at Kolkata and both having enormous series of comparative material. These institutions should be provided with the fullest support to carry out advanced taxonomic researches and to render proper training for building up capacity of such researchers.

Conservation of biodiversity and its sustainable utilization is a challenging issue of the day and requires committed biologists and social workers who possess scientific competence, organizing and planning ability aided by communication skills. They also need sharp detection and enforcement capabilities against organized criminal elements nursed by big-money illegal trade. Frontline staff equally must have similar skills at the grassroots level. The current capacity building, personnel planning and management measures need to be greatly strengthened for the conservation of biodiversity which is distributed over diverse ecosystems and facing multifarious threats. Several organizations like Wildlife Institute of India (WII), Indira Gandhi National Forests Academy (IGNFA), Indian Institute of Forest Management (IIFM), Indian Institute of Public Administration (IIPA), Zoological Survey of India (ZSI), Botanical Survey of India (BSI), Eastern Forest Rangers College (Kurseong) and few NGOs organize regular training courses on biodiversity research and forest management. These training programmes often do not include the common people such as fishermen, peasants, minor forest produce collectors, and others who are in regular interaction with the local biodiversity. As compared to the richness and extension of the biodiversity and existing threats, the number of staff engaged in the conservation activities is far below the requirement. Understanding this ground reality, our Honourable Ex.Prime Minister, Shri Atal Bihari Vajpayee stated in the 21st meeting of Indian Board of Wildlife that State Governments should increase the staff engaged in conservation activities and give them better training, facilities and equipment.

Under the above circumstances, it is recommended that training programmes on biodiversity conservation, management and sustainable use to be organized at Panchayat level taking common villagers, traders, teachers, manufacturers, field staffs belonging

to Forest, P.W.D., Tourism, Fisheries, Tribal Welfare, Agriculture, Development and Planning departments as target group. Faculty members for such training programme should primarily be comprised of specialists from local Forest, Environment and Fisheries departments and NGOs. As and when necessary service of expertise from WII, IGNFA, IIPA, IIFM, ZSI, BSI, and other organisations may be sought for. However, care should be taken that language of the speaker may not be a barrier for understanding the subject. Special training programmes to be organized for members of different enforcement authorities such as Forest, Police, Customs, Coast Guards, Border Security Force, and others regarding preliminary identification of Schedule and CITES listed species; various legal implications and procedures related to biodiversity conservation. To combat with the poachers, smugglers, and militants, ground staff of the forest department should be equipped with sophisticated arms and ammunition after providing necessary training by the expertise from Defence department. As the management of biodiversity in different situation requires full time service of large number of persons, it is necessary to fill up immediately all the posts lying vacant particularly at the field level in the Forest, Fisheries, Environment and other related department. It is a fact that the resources of the State Government is limited. However, as Honourable ex-Prime Minister suggested, "This limitation can be considerably over come through innovative initiatives such as redeployment of surplus employees in other departments, hiring local people on a voluntary or honorary basis, raising donations from business houses and other members of the public in return for a greater role for them in implementing programmes" Apart from the basic training on the conservation of biodiversity, advanced courses on the wildlife census, use of Internet, GIS, Radio-telemetry and related technology are to be imparted at

appropriate level. A data base for basic-trained and another for advance-trained persons to be developed and maintained in a central office.

III. Monitoring and Research

It has been clearly stated in the National Wildlife Action Plan (2002-2016) that monitoring and research are tools for a better understanding of nature, its functions and to enable optimum or sustainable utilization of its resources, as well as to evaluate the conservation status of species and habitats and the extent of impact of conservation endeavours undertaken. Such understanding will also help to reduce man-animal conflicts. Developmental projects are often undertaken on expediency rather than hard data and this sometimes results in permanent damage to fragile ecosystems. There is no doubt numerous long-term and short-term biodiversity related research projects are being carried out by the universities, State and Central Government Organisations, NGOs and others. Findings of these researches helped a lot in the management and conservation of biodiversity in the State. However, several basic information necessary for the proper management of biodiversity are still lacking. Handbooks for identification of threatened and CITES related species are not yet available for many of the groups; species-inventory of protected areas are not complete; Methodology for sustainable commercial use of most of the medicinally or economically important plant and animal species not yet developed; reintroduction and restocking feasibility of threatened species not been properly evaluated; and many others indicate existing gaps in this regard.

It has already been stated that large number of organizations are carrying active research for the success of biodiversity conservation. However, often there is lack of coordination among these organizations. Thus it is recommended that a committee may be formed with appropriate representatives of the different organisations under the control of

State Biodiversity Board. The committee will assess the current state of knowledge and determine the priority of the research projects to be taken and help to build up necessary coordination among different organizations. Considering the local situation following aspects of research may take priority in action.

- a. Inventorisation of species in different habitats and molecular characterisation of the economically valuable species alongwith key stone, umbrella, rare, endangered species.
- b. Documentation, inventorisation and utilization of ethnic knowledge for conservation; sophistication of ethnic knowledge about various utilization of bioresources for commercial viability.
- c. Feasibility of reintroduction/restocking of threatened species.
- d. Carrying capacity of Protected areas with special reference to key species.
- e. Mapping of sensitive sites and identification of sensitive species.
- f. Developing warning system against natural calamities.
- g. Veterinary aspects with special reference to wildlife species.
- h. Impact of mass scale use of chemical pesticides and fertilizers.
- i. Identification of wild relatives of domesticated plants and animal species.
- j. Monitoring and mitigation of man-animal conflicts owing to fragmentation of wildlife habitats and success of JFM.
- k. Utilisation of remote-sensing techniques in the field of land use, flood control, weather forecast, forestry, crop disease, marine resource assessment, soil conservation, limnological studies, etc.
- l. Sustainable utilisation of species and ecosystem.
- m. Restoration of indigenous species lost due to encouragement of high yielding varieties.

- n. Improvement of socio-economic condition and alternate income generation.
- o. Status of pollinators in different ecosystem.

IV. Management of natural habitats outside the Protected areas

Vast stretches of natural habitats covering patches of forests, wetlands, grasslands, coastal lands, crop lands, orchards, wastelands, etc. used to serve as hosts of large number of wild species from micro-organisms to mammals. Several districts of south and north Bengal maintain sacred groves, which are declining fast under the anthropogenic pressure and continuing encroachment on land. In the tribal belts of Puruliya and Medinipur such tradition are still going on. In Medinipur fresh blood of a fowl is offered at the base of a grove where their deity "Marangburu" resides. 'Panchvati" in Dakhineswar is also one such sacred grove worshipped in a different way. Many other such folk lores are associated with different rituals performed by various sections of the common masses in this state. Further, these lands are of critical importance in respect of grazing, fishing, fuelwood/fodder/medicinal plant collection, animal corridor, spatial movement of spillover species outside Protected Areas. More over, the occurrence of a species in a protected area is no guarantee of long-term security. It has already been described that many of the protected areas are subject to continuing pressures of encroachment, degradation and hunting. Even areas which are adequately protected are often too small to maintain the viable populations of species which live at low population density or which are nomadic or migratory. These problems are becoming increasingly pressing as habitats outside protected areas become more and more altered and degraded, leaving protected areas as 'islands' of natural or seminatural habitat. Natural habitats outside Protected Areas are rapidly losing their characteristics and degraded owing to encouragement of high yielding agricultural crops, urbanisation,

promotion of social forestry, construction of roads, industrial development and others. These has affected not only the biodiversity of natural habitats but also increased pressures on the forested tracts and disturbance in the movement of forest dwelling species. Under the circumstances, the areas outside protected area are in need of more active management if they are to be maintained for their ecological integrity and continue to play their role in preventing the extinction of species.

To restore the degraded natural habitat areas and to prevent further degradation, mapping of district-wise available natural habitats particularly those outside private holdings to be done on priority basis. Any transformation of mapped areas for development or other purposes should preceded by impact assessment on the biota. In a recent trend it has been noticed that age-old trees are being cut or swamp areas are filled up without considering the consequences on the biodiversity. A definite policy is to be evolved to curve this trend. Traditional and current use pattern of private property, common lands and waterbodies to be preserved. Specific programmes to be framed through participatory management for restoring degraded or partly degraded areas and subsequent monitoring of the impact.

Without doubt, the need to save the biodiversity is of utmost urgency. Human ego, greed and population pressure have already done irreparable damage of the biodiversity. Fortunately there is a growing awareness among the policy makers and common people about the significance of biodiversity conservation and this is particularly true for the State of West Bengal. Existing national and State conservation strategy for living resource conservation and sustainable development are providing both an intellectual framework and practical guidance for conservation actions. However, certain gaps exist as regard to

implementation and follow up actions. Lion share of the budget is spent for high sounding projects dealing with charismatic species ignoring other equally important (if not more) species living in the ecosystem. Often these projects do not involve the son of the soils who understand the situation and actual requirement better than the people coming from outside. No doubt expertise is required, but at the same time involvement of local people alongwith their traditional knowledge will contribute in the better achievement and percolation of resources at ground level. Base line data on the population, behaviour, feeding and breeding habits, habitat utilization, movement threats and other ecological processes are important requirements for planning management of biodiversity. Authentic data in these aspects can be procured from the local people easily after providing appropriate scientific training. Scientific processing and subsequent interpretation of data thus obtained can be utilized suitably. Such practice will automatically improve the economic condition of the poverty-stricken forest and rural people which in turn automatically reduce the direct pressure on biological resources. Strict imposition of several biodiversity-conservation related Acts have taken away the traditional rights of the large section of economically deprived people on the biological resources. For livelihood they often become party to illegal timber and other wildlife trade resulting enormous permanent loss of biodiversity. As such goals of conservation can only be achieved not by prohibition but through sustainable utilization of under used biological resources and generating gainful employment in conservation related activities.

SUMMARY

Huge amount of biodiversity related data of West Bengal have been accumulated particularly for higher groups of plants and animals. Challenging issues of biodiversity conservation and its sustainable utilization

become complex and multifarious. Each state or region within the country has specific necessary elements concerned with biodiversity, which need to be integrated into the framework of action plan. It is the primary requirement for regional policy makers and managers of biodiversity to have status report. Unfortunately, most of the valuable data on the biodiversity of the state are very much scattered and have limited use. It is essential that relevant and user friendly data bases are prepared and made available through modern information technologies.

Owing to favourable agroclimatic condition, West Bengal was always one of the most populated states of the country. The problem of population explosion has been aggravated due to huge immigration from East Pakistan (now Bangladesh) since 1947. As per census 2011, population of West Bengal has reached 913.47 lakhs (fourth among Indian provinces) and population density standing 1029 per sq.km. (second to Kerala). Since 1971, the population of the state has become more than double. This has created tremendous pressures on the natural habitats and resources alongwith transformation for agriculture, developmental projects and urbanization.

Varied physical environment of the state have given rise great diversity in ecosystems in one region to other. The recorded forest of West Bengal is about 11,879 sq.km. i.e. 1.54 percent of the recorded forest of India and 13.4 percent of state's total geographical area. At least 10 different kinds of forests can be found within the limits of the state. Maximum diversity of forest ecosystems are met within the northern parts mainly due to altitudinal variations. Northern Tropical Dry Deciduous type has the greatest coverage (4,527 sq.km.) but in a very much degraded state. Littoral and Swamp (Mangrove) forest is extended over 4,263 sq.km in estuarine south West Bengal. It is the only mangrove forest of the world (except Bangladesh) which supports population of

Tiger – *Panthera tigris*. North Indian Moist Deciduous forests alongwith its grasslands in North Bengal provide second home to a Great On - horned Rhinoceros – *Rhinoceros unicornis*, and many other threatened species including Hispid Hare – *Caprolagus hispidus* , Bengal Florican – *Eupodotis bengalensis*, etc. Out of five main grass covers of India, three, *viz.*, Phragmites – Saccharum – Imperata type, Themeda – Arundinella type and Temperate-Alpine type are found in the state. There are 54 natural and nine man-made wetlands which cover more than 100 ha. These alongwith numerous small water bodies cover an area of about 3,44,527 ha. which is nearly 8.5 percent of the total wetland area in India. Diversity of wetland plants of West Bengal is richest in India and is represented by more than 380 species belonging to 170 genera and 81 families.

With the increased importance of biodiversity conservaton, more and more agencies in the Government as well as non-government levels are being involved directly or indirectly in the process of conservation. Multifarious activities such as survey of flora, fauna, forests and wildlife; habitat management; regeneration of degraded areas; prevention and control of pollution; establishment of protected areas; regulation of hunting, felling and wildlife related trade; research and awareness; socio-economic development; sustainable use of natural resources; *Ex-situ* conservation; international collaboration and cooperation and many others are being taken. All these activities are well-supported and guided by a set of legislative and regulatory measures in the international, national and state levels. Different biodiversity related Action Plans and Policies such as Indian Environmetnal Action Plan (1993), National Forest Policy (1988), National Conservation Strategy and Policy Statement on Environmment and Sustainable Development (1992), National Wildlife Action Plan (1973, 2002), etc. provided due considerations to the needs of local people and

their support. West Bengal State Biodiversity Strategy and Action Plan as a component of National Biodiversity Strategy and Action Plan has been drawn up.

The known faunal diversity of the state consists of at least 11042 species out of 91771 present in the country and 1239166 in the world. The number of floral species goes upto 7000 against nearly 49000 species known from India. A large number of species of both the groups are represented by several subspecies, varieties and races. This has resulted further richness in respect of genetic diversity. Explorations of a number of districts are not yet been done properly. However, districts of Darjiling and Kolkata exhibit higher species richness. Domestic biodiversity of the state is equally impressive. With large number of varieties and breeds. An attempt has been made to provide lists of species.

State biota is enriched by holding a enormous number of species having significance in respect of conservation, zoogeography, taxonomy, economy, endemism and other aspects. Some of these species have been focussed and listed.

Biodiversity and significance of the Protected Areas of the state have been discussed. Sundarban, Jaldapara and Mahananda have been identified as top priority areas in respect of conservation.

Various factors resulting loss of biodiversity in different sectors have been dealt with alongwith the causes behind them.

It has been found that species richness of the state is directly proportional with the forest cover, while the same is almost inversely proportional with human population density.

Objectives of Protected areas often can not be fulfilled owing to the resistance of the local communities who were dependant on the

natural resources for livelihood and sustenance. To resolve the problem there is urgent need for all concerned people and agencies to unite, and to build partnerships of joint decision making. Thus, Joint Protected Area Management Policy as far as possible has been recommended.

The current capacity building and personnel planning and management measures need to be greatly strengthened to meet the challenging issues of conservation. Large number of organizations are conducting training programmes. However, such training programmes often do not include common people such as fishermen, peasants, minor forest produce collectors and others who are in regular interaction with the local biodiversity. For human resource development, training programmes to be organized at Panchayet level taking common villagers and field staffs of biodiversity related departments as target groups. Care to be taken that the language of the speakers may not be a barrier for understanding the subject. A data base for basic trained and another for advance-trained persons to be developed and maintained in a central office.

Numerous biodiversity related researches are being carried out. Findings of these researches helping a lot in the management and conservation of biodiversity. However, researches related to the local situation should be given priority in action. Further to obtain authentic data, project authorities should involve the local people living in and around the natural habitat areas.

Goals of conservation can only be achieved not by prohibition but through sustainable utilization of under used biological resources and generating gainful employment in conservation related activities.

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