

Vertebrates of Assam

A checklist with IUCN status



ASSAM SCIENCE TECHNOLOGY AND ENVIRONMENT COUNCIL

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CONTENTS

	Page
1. FOREWORD	iii
2. PREFACE	iv
3. INTRODUCTION	1
Biodiversity Hotspots in India	3
4. ASSAM: AN OVERVIEW	5
Topography	5
Soil	6
Climate	7
Forests and Vegetation	8
5. ZOOLOGICAL EXPLORATION IN ASSAM AND NORTHEAST INDIA ..	11
6. ENUMERATION OF VERTEBRATES	
Actinopterygii (pisces/ fishes)	14
Amphibia (amphibians)	52
Reptilia (reptiles)	63
Aves (birds)	84
Mammalia (mammals)	249
7. PHOTOGRAPHS OF SOME VERTEBRATES	285
Actinopterygii (pisces/ fishes)	285
Amphibia (amphibians)	314
Reptilia (reptiles)	317
Aves (birds)	326
Mammalia (mammals)	344
8. REFERENCES	348
9. INDEX TO FAMILIES	352
10. INDEX TO GENERA	354
11. INDEX TO ENGLISH NAMES	359
12. INDEX TO LOCAL NAMES	374

INTRODUCTION

Biodiversity is the variation of life forms within a given ecosystem, biome or on the entire earth. The biodiversity found on the earth today consists of millions of distinct biological species. It includes the variability of species in terrestrial, aerial and aquatic habitats, the diversity of ecosystems and the diversity of genes they harbour. It is an essential component of the nature and it ensures the survival of various species by providing welfare resources. Biodiversity is not distributed evenly on earth, but is consistently rich in the tropics and in specific localized regions; it is less rich in Polar Regions where fewer species are found, but endemism is high. Biodiversity can be defined in three levels, they are Genetic Diversity: genetic variation among the living organisms; Species Diversity: variation encountered within a genus and Ecosystem Diversity: diversity of ecological complexity showing variations in ecological niches, trophic structure, food web, etc.

There are 12 “Mega diversity” countries in the world, which together hold maximum number of endangered flora and fauna. These 12 “Mega diversity” countries are Brazil, Columbia, China, Mexico, South Africa, Former USSR, Indonesia, Venezuela, USA, Equador, India and Australia. Besides, IUCN also declared many areas around world to be called as “Biodiversity Hotspots”.

Various studies and research works are going on for estimation of genetic diversity in the world. The total number of taxa/ species increases substantially every year. Among faunal diversity, the greatest species diversity exists among insects, which accounts for about 1 million of earth’s species, whereas mammals make up one of the smallest group with 5490 members.

It has been estimated that 62,305 vertebrate species, 1,305,250 invertebrate species and 372,775 plant species are known to be occurred in the earth’s oceans, lakes, continents and islands.

The current estimates of known living species in the world are as given below.

Category	No. of species
<u>Animal diversity</u>	
<i>Vertebrates</i>	
Mammals	: 5,490
Birds	: 9,998
Reptiles	: 10,038 (Aug. 2014)
Amphibians	: 7,297 (2014)
Fishes	: 31,300
<i>Invertebrates</i>	
Insects	: 1,000,000
Spiders and scorpions	: 102,248
Molluscs	: 85,000
Crustaceans	: 47,000
Corals	: 2,175
Others	: 68,827
<u>Plant diversity</u>	
Flowering Plants (Angiosperms)	: 2,81,821
Conifers (Gymnosperms)	: 1,021
Ferns and Horsetails	: 12,000
Mosses	: 16,236
Red and Green algae	: 10,134
Lichens	: 17,000
Mushrooms	: 31,496
Brown algae	: 3,067

Source: The World Conservation Union 2010. IUCN Red list of threatened species.

India is the seventh largest country in the world and Asia's second largest nation with an area of 3,287,263 square km. The Indian mainland stretches from 8°4' to 37°6' N latitude and from 68°7' to 97°25' E longitude. India's northern frontiers are with Xizang (Tibet) in the Peoples Republic of China, Nepal and Bhutan. In the northwest, India borders with Pakistan; in the northeast, China and Myanmar; and in the east, Myanmar. The southern peninsula extends into the tropical waters of the Indian Ocean with the Bay of Bengal lying to the southeast and the Arabian Sea to the southwest. For administrative purposes India is divided into 29 states and 7 Union Territories.

As stated above, India is one of the total 12 "Mega Diversity" countries of the world. It embraces a great range of topography and climate; from snow covered high Himalayan ranges to plains at sea level, islands, tropical evergreen rain forests, fertile alluvial plains, hot deserts and high altitude cold deserts. Both rainless areas as well as the highly rainfall areas are seen in India too. The climate ranges from tropical and sub tropical in Indo-Gangetic plains and peninsular regions to temperate and arctic in the Himalayan region. The habitat types vary from humid tropical Western Ghats to the hot deserts of Rajasthan, from cold desert of Ladakh to the long, warm coast line stretches of Peninsular India. Thus, a wide variety of climatic and altitudinal variations couple with different ecological habitats have contributed largely to the varied flora and fauna and thus generating a very unique bio diversity in India.

India holds a unique position among global biodiversity. A large number of flora and fauna species are native to India. It is home of many endangered flora and fauna which are not found elsewhere in the world. Research and discussions are being conducted for identification of many new species as well as for estimation of diversity of flora and fauna in India. The following table shows the estimated number of animal species found in India.

Category	No. of species	Category	No. of species
Protista		Insecta	: 53400
Protozoa	: 2577	Chilopoda	: 100
Animalia		Diplopoda	: 162
Mesozoa	: 10	Symphyla	: 4
Porifera	: 486	Merostomata	: 2
Cnidaria	: 842	Phoronida	: 3
Ctenophora	: 12	Bryozoa (Ectoprocta)	: 200
Platyhelminthes	: 1622	Endoprocta	: 10
Rotifera	: 330	Brachiopoda	: 3
Gastrotricha	: 100	Chaetognatha	: 30
Kinorhyncha	: 10	Tardigrada	: 30
Nematoda	: 2850	Echinodermata	: 765
Acanthocephala	: 229	Hemichordata	: 12
Sipuncula	: 35	Chordata	: 4952
Mollusca	: 5070	Protochordata	: 119
Echiura	: 43	(Cephalochordata+Urochordata)	: 2546
Annelida	: 840	Pisces	: 209
Onychophora	: 1	Amphibia	: 456
Arthropoda	: 68389	Reptilia	: 1232
Crustacea	: 2934	Aves	: 390
		Mammalia	: 390

Source: Alfred, J.R.B. (1998) *Faunal Diversity in India: An Overview*, ENVIS Centre, Zoological Survey of India, Calcutta

Recently, 6 species of large mammals have been discovered in India. These are Large-antlered muntjac, Annamite muntjac, Grey-shanked douc, Annamite striped rabbit, Leaf deer, and the Saola. The northeast region of India is the home to several primate species such as monkeys, langurs and gibbons. Many of the species, especially some freshwater turtle species found in this region, are endemic. Almost 1,300 bird species exist in this region including the threatened white-eared night-heron, the grey-crowned Crocias, and the orange-necked partridge.

Source: *Biodiversity hotspots.org (Burma)* Accessed: Nov 15, 2010 and *Biodiversity of India, A wiki resource for Indian Biodiversity, "Biodiversity Hotspots in India"*, by Gaurav Moghe, October 7, 2011.

The northeast region of India comprises of 8 States, i.e. Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland and Sikkim. The whole North eastern region can be physiographically categorised into the Eastern Himalayas, northeast hills (Patkai-Naga Hills and Lushai Hills) and the Brahmaputra and Barak Valley plains. The northeast India, being at the confluence of three major bio-geographical realm of the world i.e. Indo-Malayan, Indo- Chinese and Indian bio geographical realms, is extremely rich in floral and faunal biodiversity consisting of several endemic and native species as the region provides all necessary climatic, edaphic and altitudinal variations required for the growth of floral and faunal species. In the northeast region, about 70% of the total geographical area is mountainous and hilly and the rest 30% is under Brahmaputra and Barak valley systems. The forests of this region are extremely rich and diverse with wide variety of flora and fauna. The region is rich in medicinal plants and many other rare and endangered taxa in both flora and fauna.

Northeast India represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese bio geographic regions and a meeting place of the Himalayan Mountains and Peninsular India. Northeast India is thus the geographical 'gateway' for much of India's flora and fauna, and as a consequence, the region is one of the richest in biological value. The northeast region has always been in focus for its high biodiversity and the region has been a priority as it leads many conservation agencies of the world. The whole on northeast India is blessed with a wide range of physiographic and ecoclimatic conditions. Each of the eight States of the region, namely Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, are home to several endemic flora and fauna. This region represents an important part of the Indo-Myanmar biodiversity hotspot, one of the biodiversity hotspots across world recognised currently.

Source: *Biodiversity of India: An Overview, By V. Ramakantha, A.K. Gupta, Ajith Kumar.*

An overview of diversity of vertebrates found in the northeast region of India including Assam is summarized as below.

States	Vertebrates				
	Mammalia	Aves	Reptilia	Amphibia	Fishes
Arunachal Pradesh	241	738	78	39	143
Assam	192	841	128	67	232
Manipur	69	586	9	14	141
Meghalaya	139	540	94	33	152
Mizoram	84	500	71	13	89
Nagaland	92	492	62	10	108
Sikkim	92	612	31	21	64
Tripura	54	341	32	19	129

Source: *Fauna of Meghalaya Part-I, Fauna of Arunachal Pradesh Part-I, Fauna of Nagaland, Fauna of Mizoram, Fauna of Manipur Part-I, Fauna of Sikkim Part-I (BSI), State of Environment report of Tripura 2002, Birds of Arunachal Pradesh (A.U. Choudhury 2006), Birds of Nagaland (A.U. Choudhury 2004).*

BIODIVERSITY HOTSPOTS IN INDIA

A Biodiversity Hotspot is a biogeographic region with a significant reservoir of biodiversity that is under anthropogenic threat. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot-map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics and
2. It has to have lost at least 70% of its primary vegetation.

Source: *Myers, N. et al. Nature 403, 853–858 (2000) and Biodiversity of India, A wiki resource for Indian Biodiversity, "Biodiversity Hotspots in India"*, by Gaurav Moghe, October 7, 2011.

In India, three Biodiversity Hotspots have been identified where abundant numbers of threatened and native species of flora and fauna are found. These are:-

I. Eastern Himalayas

The region is situated between Central Nepal in the west to Myanmar in the east, occupying southeast Tibet in China, Sikkim, North Bengal, Bhutan and North-East India. The area has been declared a biodiversity hotspot by Conservation International. The region is geologically young and shows high altitudinal variation.

The hotspot has nearly 163 globally threatened species including the One-horned Rhinoceros (*Rhinoceros unicornis*), the Wild Asian Water buffalo (*Bubalus bubalis arnee*) and in all 45 mammals, 50 birds, 17 reptiles, 12 amphibians, 3 invertebrate and 36 plant species (*Source- Conservation International 2006 and Ecosystem Profile: Eastern Himalayas Region, 2005). The Relict Dragonfly (*Epiophlebia laidlawi*) is an endangered species found here with the only other species in the genus being found in Japan. The region is also home to the only salamander species found within Indian limits i.e. Himalayan Newt (*Tylototriton verrucosus*). *Source- *Amphibian Species of the World - Desmognathus imitator* Dunn, 1927. Several threatened endemic bird species such as the Himalayan Quail, Cheer pheasant, Western tragopan along with some of Asia's largest and most endangered birds such as the vulture and White-bellied heron are found in this hotspot. The hotspot is the home to almost about 300 species of mammals, maximum which are endemic. Mammals like the Golden Langur, Himalayan tahr, Pygmy Hog, Langurs, Asiatic wild dogs, Sloth bears, Gaurs, Muntjac, Sambar, Snow leopard, Black bear, Blue sheep, Takin, Gangetic dolphin, Wild water buffalo, Swamp deer are widely distributed in this region.

Source: *Biodiversity hotspot.org (Himalayas) at the Hotspots Explorer. Accessed: Oct 10, 2011 and Biodiversity of India, A wiki resource for Indian Biodiversity, "Biodiversity Hotspots in India", by Gaurav Moghe, October 7, 2011.*

II. Western Ghats

Western Ghats are a chain of hills that run along the western edge of peninsular India. They have different vegetation types: scrub jungles and grasslands at low altitudes, dry and moist deciduous forests, montane grasslands and shoals, and the precious tropical evergreen and semi evergreen forests. Complex topography, high rainfall and relative inaccessibility have helped the region retain its biodiversity

There are over 6000 vascular plants belonging to over 2500 genera found in this hotspot, of which over 3000 are endemic. Much of the world's spices such as black pepper and cardamom have their origins in the Western Ghats. Nearly 77% of the amphibians and 62% of the reptile species found here are found nowhere else. The region is also home to over 450 bird species, about 140 mammalian species, 260 reptiles and 175 amphibians. Over 60% of the reptiles and amphibians are completely endemic to the hotspot.

Source: Daniels, R. J. R. (2001) *Endemic fishes of the Western Ghats and the Satpura hypothesis. Current Science* 81(3):240-244; *Biodiversityhotspots.org (Western Ghats and Sri Lanka) at the Hotspots explorer. Accessed: Oct 11, 2011 and Biodiversity of India, A wiki resource for Indian Biodiversity, "Biodiversity Hotspots in India", by Gaurav Moghe, October 7, 2011.*

III. Indo-Burma

The Indo-Burma region encompasses several countries. It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand. The hotspot encompasses 33 terrestrial ecoregions, which include tropical and subtropical moist broadleaf forests, tropical and subtropical dry broadleaf forests, tropical and subtropical coniferous forests, temperate broadleaf and mixed forests, and mangroves.

Source: Wikramanayake, Eric; Eric Dinerstein; Colby J. Loucks; et al. (2002). *Terrestrial Ecoregions of the Indo-Pacific: a Conservation Assessment. Island Press; Washington, DC.*

ASSAM: AN OVERVIEW*

TOPOGRAPHY

Assam is bounded by Bhutan and Arunachal Pradesh on the north; Arunachal Pradesh, Nagaland and Manipur on the east; Mizoram and Meghalaya on the south and Bangladesh and West Bengal on the west. It is located at the central part of the north-east India, with an area of 78,438 sq. km of which, 77667.99 sq. km is rural and 770.01 sq. km is urban area. The state of Assam is situated in between 24°08'10" N and 27°58'15" N latitudes and 89°42'05" E and 96°01'14" longitudes. Topographically, Assam can be divided into two major divisions: plains and hills. Plains can further be divided into two physiographic divisions: Brahmaputra Valley and Barak Valley. The hills are also divided into two physiographic divisions: Karbi Plateau and Barail Range.

Plains

Brahmaputra Valley: The Brahmaputra Valley is the largest unit in the state. It is largely an alluvial plain with a total area of 56,339 sq. km. It extends from east to west for about 720 km and average width of 80 km. It covers about 72% of the State's total area. It is bounded on the north by the Bhutan and Arunachal Himalaya, on the east by Patkai hills and its branches lying in Arunachal and on the south by the hills of Nagaland and the plateaus of Karbi Anglong and Meghalaya. The Brahmaputra plain in its east-west direction has four distinct physiographic divisions *viz.* (a) The Northern foothills, (b) The North and South plains, (c) The floodplains and (d) The Southern foothills. The Brahmaputra, the biggest river in Assam and one of the biggest rivers in the world, rolls down the plain of Assam from east to west for a distance of 640 km up to the Bangladesh border. This river is known as the Tsangpo in Tibet, the Siang or Dihang in Arunachal Pradesh and the Brahmaputra in Assam and Jamuna in Bangladesh. It traverses a total distance of 2906 km through the Tibetan Plateau, Himalayan Mountain and the hills and plains until reaching the Bay of Bengal in Bangladesh. The Brahmaputra river system drains a unique physical setting of diverse biotic environment with its major tributaries like Manas, Pagladia, Puthimari, Jia Bhoroli, Ranganadi, Subansiri, etc. on the north and Krishnai, Kolong, Kopili, Dhansiri, Dikhow, Burhidihing, Lohit, etc. on the south.

Barak Valley: The Barak Valley is situated in the southern part of Assam. It is also of alluvial origin and surrounded by North Cachar hills in the north, in the east by Manipur hills, in the south by Mizoram hills and in west by Sylhet plain of Bangladesh. The valley is about 85 km long from the east to the west and about 70 km wide on average from the north to the south. It covers an area of about 6962 sq. km accounting for about 9% of the total geographical area of the State. It is characterised mainly by presence of numerous scattered low hillocks which is locally known as 'Tilas' with maximum height of about 100m. The Barak plain contains numerous swamps, 'Beels', 'Jheels', and rivers. The Barak is the second largest river in north-east India as well in Assam. It rises on the southern slope of the Barail Range near the border of Manipur and Nagaland. The river with a total length of 900 km from its origin to mouth covers an area of 52,000 sq. km while it traverses a distance of 532 km up to the Indo-Bangla border in India. In Assam, the Barak has a total length of 225 km and it drains the southern part of Assam which includes Cachar, Karimganj, Hailakandi and the southern part of Dima Hasao district. The important north bank tributaries of Barak river are Jiri, Siri, Madhura, Jatinga and Larang, while important south bank tributaries include Sonai, Rukni, Ghagra, Dhaleswari and Katakahal. Many ox-bow lakes are also present on both banks of Barak River.

*(Adopted from *PLANT DIVERSITY OF ASSAM: A checklist of Angiosperms & Gymnosperms*)

Hills

Karbi Plateau: It is the northeastern extension of the Meghalaya Plateau. The whole region consists of two unequal hilly parts, which are separated by Kapili River and its tributaries like Diyung, Lumding, etc. The two hilly parts are: The *Central Karbi Plateau*, which is the eastern part of the plateau. It is about 7400 sq. km. The region is dome shaped, while the *Hamren plateau*, is the southwestern part of the plateau and all streams and rivers present here are tributaries of Kapili River. It covers about 3000 sq. km.

Barail Range: The Barail Range of Assam, which covers Dima Hasao and Cachar districts are actually the continuation of Barail Range towards west stretching from Kohima across Nagaland. In the middle part of the Dima Hasao district, the Barail ranges attain their highest peak. It divides the N.C. Hills into two main parts namely Brahmaputra basin and Barak basin. The northern part falls under Brahmaputra basin and southern part falls under Barak basin. The main Barail range is like common water shed of both Brahmaputra basin and Barak basin. In southern region of the Karbi Plateau, the Barail range rises from 300m and attains a maximum height of about 1959m. Processes like weathering, erosion are very much active in this region due to which deep valleys and steep slopes are seen.

SOIL

Soil is the most important resource and it serves as one of the prime requisites of life. Soils turn the land through their relative fertility, support all agricultural activities and plant growth and thereby act as the most important element of the natural ecosystem. As regards the soils of Assam, geology (parent material), topography and climate seem to play a vital role in their formation. Therefore, under varying geological conditions, topographical characteristics and agro-climatic situation five major types of soils are found in the hills, piedmonts, plateaus and plains of Assam, viz. (i) Entisols, (ii) Mollisols, (iii) Alfisols, (iv) Ultisols and (v) Histosols.

Entisols

Two types of Entisols are found in Assam- Udifluvents, *i.e.* Younger Alluvial Soils and Ustorthent, *i.e.* Bhabar soils. The Younger Alluvial soils are found mostly in the flood prone areas and these soils are deposited by floods of the rivers carrying silt. The texture of the soil is sandy, silty or clayey-loam. These soils are often neutral to alkaline with a pH value of 5.5. They are rich in phosphate, potash, calcium and nitrogen and suitable for cultivation of rice, jute, pulses, mustard, potato, vegetables, etc.

Mollisols: Haplaquolls or Tarai Soil

Haplaquolls or Tarai Soils form in semi-arid to semi-humid areas. These soils are coarse alluvium formed by debris of pebbles, cobbles and coarse sand and have deep, high organic matter, nutrient-enriched surface soil and are acidic in nature. They are formed along the south of the Bhabar region with dense vegetation of eastern Himalayas and is known as Tarai zone. In Assam, these soils are found particularly in the northern parts of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Darrang, Sonitpur and Lakhimpur districts.

Alfisols

Alfisols are acidic in nature with pH value ranging from 4.5 to 5.0. In Assam, three types of Alfisols are found.

Paleustalfs, Haplaquants (Older Alluvium): This type of soil is found mostly in the zone above the annual flood level and occupies the areas between the upper limit of Brahmaputra flood plain and fringe areas between Karbi Anglong and Kopili and Dhansiri valley. The old alluvium extends in certain parts of the flood plains of Kamrup, Nalbari, Bongaigaon, Kokrajhar districts and the tracts bordering hill ranges extending from north to south in Karimganj and Hailakandi. The texture of the soil varies from coarse sand to clayey loam.

Haplustalfts, Paleustalfts, Rhodustalfts (Red Sandy Soil): This soil is formed by sediments derived from crystalline metamorphic rocks which consist largely of granite and gneisses and occupies the area covering the Precambrian Plateau tracts of Karbi Anglong and the regions bordering Meghalaya with Kamrup and Goalpara districts. Red sandy soils are found in some isolated areas within the Brahmaputra alluvial plain in Kamrup, Kokrajhar, Dhubri, Bongaigaon districts, the southern part of the Borail Range in Dima Hasao district and the elongated tracts in southern Cachar district. The texture of the soil varies from coarse to fine sand and clay.

Haplustalfts, Paleustalfts, Rhodustalfts (Red Loamy Soil): The Red Loamy Soil is comprised of sand, silt and clay mixed pebbles brought down by rain from higher slopes. It is found as elongated tracts lying in the north-south direction in Cachar, Hailakandi and Karimganj districts. It is also found towards the Assam-Meghalaya border areas in Karbi Anglong and Dima Hasao districts.

Ultisols

Ultisols are highly acidic with pH value varying between 4 to 4.5 and poor in plant nutrients. This type of soil is classified into two groups:

Palehumults (Brown, Red and yellow soils): These soils are found in long strips of land between border areas of Bhutan hills and districts of Darrang, Kamrup, Nalbari, Barpeta and Kokrajhar. Another patch is seen bordering Arunachal Pradesh in either sides of Subansiri river. This type of soil is derived from oxidation and hydrolysis of Iron minerals and comprises sandy clay originated from sedimentary formation.

Plinthaqualts, Plinthustulcs, Plinthudults (Lateritic soil): The Lateritic soil is highly leached soil, developed under the conditions of high rainfall with alternating dry and wet period. It occupies the area situated between old alluvium and red loamy soil in south and south-western part of Golaghat, south-eastern part of Nagaon district and almost northern part of Dima Hasao district. The Lateritic soil is also found between the Barak alluvial plain and foot hills of Barail Range bordering Cachar with Dima Hasao district.

Histosols

Troposaprists (Peaty and saline Peaty Soils): This type of soil comprises silt and clay materials. It occupies the low-lying areas of the Brahmaputra flood plains and the riverine tracts of Lakhimpur, Barpeta and Jorhat district of Assam. It is also found in Barak flood plains especially in the western part of Barak alluvial plain in Karimganj district.

CLIMATE

Climate of Assam is governed by a number of factors which include orography, alternating pressure cells of north-west India and Bay of Bengal, periodic western disturbances, local mountain valley winds, geological configuration, extensive water bodies, local depression and forests. The climate of the state is characterised by high humid tropical climate with heavy rainfall and moderate temperature. The greater part of two hilly districts, viz. Karbi Anglong and Dima Hasao, enjoys sub-tropical monsoon climate. The climatic year in Assam is divided into four seasons: Winter, Pre-monsoon or Summer, Monsoon or Rainy and Post Monsoon or Autumn.

Winter

It extends from December to February. This season is characterised by the northerly and north easterly cold winds and damp fogs. Besides, foggy morning, dry days along with misty and cold long nights are other general characteristics of this season. Average minimum temperature during this period is around 7°C and the average maximum temperature is around 24°C in the Brahmaputra valley, while slight variation is being noticed in the Barak Valley and the hilly districts of Assam. The minimum temperature generally remains around 11°C at an

average while average maximum temperature remains around 26°C in the Barak Valley, whereas in Karbi Anglong and Dima Hasao, it goes down to 5.5°C and rises to 23°C. Rainfall is scarce and it does not exceed 3 cm at an average. The Relative Humidity varies from 60% to 90% in average. During the early part of this season the deciduous trees shed their leaves and start leafing in the latter part of February.

Pre-monsoon or Summer

It extends from March to May. During this season the temperature rises, fogs gradually disappear and at the later part of the season there is occasional thunderstorm and often the weather remains windy and dusty. The wind usually blows south-west to north-west and is often accompanied by cyclonic storm and torrential rains. Average rainfall during the months of March, April and May is found to be 60, 190, 240 cm (mean) respectively. The maximum temperature varies from 29°C to 32°C and minimum temperature varies from 24°C to 26°C.

Monsoon or Rainy

It extends from June to September. The season is characterised by cloudy weather, more or less incessant rain with heavy precipitation and high atmospheric humidity. Though there are more rainy days in the season, the temperature rises to maximum of 38°C. The State of Assam receives an average annual rainfall of 200 cm. It is found to be as high as of 335 cm and 323 cm respectively in North Lakhimpur and Silchar and as low as of 129 cm in Lunding.

Post Monsoon or Autumn

It extends from October and continues till the onset of winter. Clouds start disappearing with progressively clear weather and gradual fall of temperature. The weather is quite stable and is often accompanied by mist and fogs with the advancement of the season. The temperature does not rise beyond 28°C, rainfall is negligible and humidity ranges from 78% to 90%.

FORESTS AND VEGETATION

Vegetation of Assam is primarily of tropical and sub-tropical types. On the basis of floristic composition, the forest area can be divided as follows:

Tropical Forests

(a) Tropical wet evergreen forests: This type of forest lies along the foothills of Arunachal Pradesh, Lakhimpur, Tinsukia, Dibrugarh and southern parts of Sivasagar district adjoining Nagaland and the Barak Valley, foothills of Barail ranges and south-eastern parts of Cachar district comprising Loharbund Reserve Forest. Often, single species dominance in the top canopy are observed such as *Dipterocarpus retusus*, *Mesua assamica*, *Mesua ferrea*, *Shorea assamica*, etc. in upper Assam while *Dipterocarpus turbinatus*, *Mesua floribunda*, etc. in Barak Valley. Characteristic floristic elements include: *Altingia excelsa*, *Dipterocarpus retusus*, *Dipterocarpus turbinatus*, *Magnolia* sp., *Mesua assamica*, *Mesua ferrea*, *Schima wallichii*, *Shorea assamica*, *Stereospermum tetragonum*, *Terminalia chebula*, etc. These tree species form the main canopy. Smaller trees and shrub species found in this type of forest include: *Bauhinia* sp., *Cinnamomum* sp., *Clerodendrum* sp., *Holarrhena pubescens*, *Ixora* sp., *Pavetta indica*, etc. Lianas and climbers which include: *Acacia* sp., *Entada rheedii*, *Gnetum montanum*, *Pothos* sp., *Thunbergia laurifolia*, etc. while *Musa* sp., *Phrynium* sp., *Arenga* sp., *Calamus* sp. and *Pinanga* sp. are common in damp slopes.

(b) Tropical semi-evergreen forests: These forests are found in the Brahmaputra Valley and along the foot hills of Barail ranges and Manipur hills in the Barak Valley. In these regions, the forests are characterised by emergent deciduous species. Common tree species include *Phoebe goalparensis* in the western Assam districts and *Phoebe cooperiana* and *Phoebe attenuata* in

Sivasagar and other similar localities. Other tree species include *Castanopsis indica*, *Dillenia indica*, *Dillenia scabrella*, *Dysoxylum* sp., *Michelia champaca*, *Schima wallichii*, *Cedrela toona*, etc. along with deciduous species like *Albizia lebbek*, *Albizia procera*, *Bauhinia purpurea*, *Dillenia pentagyna*, *Shorea robusta*, etc. *Clerodendrum glandulosum*, *Gnetum gnemone*, *Litsea* sp., *Morinda angustifolia*, etc. are some of the shrubby species. *Apostasia odorata* and *Apostasia nuda* are the two interesting ground orchids which remain restricted to the vegetation of Garampani and Joypur Reserve Forests. Epiphytic flora is also rich in these forests. Numerous species of Orchidaceae, Asclepiadaceae, Piperaceae are some common families found here.

(c) Tropical moist deciduous forests: These forests comprise the Sal forests and major parts of scrub forest in the state, which are seen in the districts of Kokrajhar, Goalpara, Kamrup, Nogaon, Dima Hasao and plains of Barak Valley. The dominant species in the Sal forest areas is *Shorea robusta*. Other species include *Derris robusta*, *Dillenia pentagyna*, *Gmelina arborea*, *Lagerstroemia parviflora*, *Schima wallichii*, *Cedrela toona*, etc. Woody climbers and lianes are scarce. The common ones include *Combretum* sp., *Bauhinia vahlii*, etc.

(d) Grasslands: These are grass dominated biomes. Extensive areas of Assam are covered by grasslands in alluvial flood plains of Brahmaputra Valley. The grasslands are most conspicuous in all the national parks of Assam and most of the wildlife sanctuaries of Assam viz., Sonai Rupai, Laokhowa, Pabitora, Bornadi, Burachapori, etc. Besides these grasslands also occur in the riparian vegetation, marshes and swamps, marshy depressions, beels and hoars. Vegetation studies reveal that there are two different types of grasslands in Assam: (1) Grasslands occurring in recent alluvial deposits in low lying and Char areas annually inundated and flood water retained for a considerable period of time. These are wet alluvial pure Grasslands. Some of the dominant grasses are *Apluda mutica*, *Arundo donax*, *Brachiaria villosa*, etc. (2) Grasslands in old alluvium deposits of high land. The dominant grasses include : *Apluda mutica*, *Digitaria abludens*, *Imperata cylindrica*, *Neyraudia reynaudiana*, *Panicum auritum*, *Saccharum arundinaceum*, etc.

(e) Riparian Forests: These forests occur all over the evergreen and semi-evergreen zones in Assam along river banks and extended in several areas. In low lying areas, species like *Albizia lebbek*, *Dillenia indica*, *Dalbergia stipulacea*, *Semecarpus anacardium* are some of the common species while on slightly higher level, species like *Mesua ferrea*, *Michelia doltsopa*, etc. are found. A variety of orchids and ferns are the major component of the epiphytic flora in these areas.

(f) Swamps: The total wetlands have been estimated to be 2.1% and occupy an area of 1,036.76 sq. km. i.e. about 1.32% of the total geographical area (78,523 sq. km.) of the State. The plants growing in wetlands are usually termed as Hydrophytes. Aquatic families such as Araceae, Cyperaceae, Eriocaulaceae, Lemnaceae, Nymphaeaceae are common in these beels. Common species of the genera in this type of vegetation include *Cyperus* sp., *Nelumbo* sp., *Nymphaea* sp., *Ottelia* sp., *Scirpus* sp., etc.

Sub-tropical Forests

(a) Subtropical Broad-leaved Forests: These forests are confined only to places where elevation rises above 900 m and mainly found in Hamren Sub-Division of Karbi Anglong district and Dima Hasao district. Ascending upwards from 900 m – 1700 m the vegetation is predominated by broad-leaved plants. Common species include *Alseodaphne petiolaris*, *Antidesma bunius*, *Chaetocarpus castanocarpus*, *Cinnamomum tamala*, *Ficus albelii*, *Ficus squamosa*, *Glochidion zeylanicum*, *Glochidion sphaerogynum*, *Helicia robusta*, *Litsea nitida*, *Phoebe lanceolata* and *Schima wallichii*. Associated species of shrubs and undershrubs are less in number, some of which are *Alchornea tiliifolia*, *Boehmeria clidemioides*, *Eriosolena involucrata*, *Oreocnide frutescens*, *Pouzolzia sanguinea*, etc. The herbaceous angiosperms

chiefly belong to members of Asteraceae, Lamiaceae, Araceae, Zingiberaceae and Poaceae. Higher up beyond 1700 m the broad-leaved vegetation is replaced by pure stand of pine forests but not dense. The species here is *Pinus kesiya*. Associated species of other angiosperms are less in number and mostly with species like *Schima wallichii*, *Betula alnoides*, *Quercus semiserrata*. Annual burning of pine needles affects the undergrowth vegetation much. Only a few hardy herbaceous plants of the families viz, Asteraceae, Rosaceae and Theaceae are found scattered.

(b) Subtropical Pine Forests: These forests occur at an elevation from 900 -1800 m, having moderate rainfall and found in areas of Dima Hasao bordering Jaintia hills district of Meghalaya and Karbi Anglong district. The pine forests *i.e.* mainly *Pinus kesiya* are intercepted by tree species like *Cinnamomum* sp., *Engelhardtia spicata*, *Myrica esculenta*, *Quercus griffithii*, *Schima wallichii*, *Symplocos* sp., etc. The floor is generally devoid of plant growth due to deposition of pine needles and very few plant species occur.

(c) Bamboo forests and cane brakes: There is as such no bamboo forest in both the valleys of Assam. Bamboo brakes are mostly found along the edges of Reserve Forests and residential compounds, often cultivated by the villagers, with scattered distribution of a few species. Pure bamboo forests are found in the two hill districts of Assam and mostly along the foothills of Barail range near Jatinga of Dima Hasao and in hilly slopes of Karbi Anglong district predominated with *Chimonobambusa callosa* and *Melocanna baccifera*. Langting Mupa Reserve Forest of Dima Hasao and in parts of Karbi Anglong are mostly with *Melocanna baccifera* in association with *Bambusa tulda*, *Dendrocalamus hamiltonii*, *Dendrocalamus hookeri*, *Dendrocalamus strictus*, *Gigantochloa parvifolia*, *Phyllostachys mannii* interrupted by moist semi – evergreen and deciduous species. Similarly in slightly more wet places different species of *Calamus* such as *Calamus erectus*, *Calamus floribundus*, *Calamus tenuis* form thick patches in Karbi and Dima Hasao hills.

ZOOLOGICAL EXPLORATION IN ASSAM AND NORTHEAST INDIA

Northeast India is known worldwide for rich biodiversity including cultural diversity. This part of the country has continuous landscape with the adjacent countries namely Bhutan, China, Myanmar and Bangladesh. Highly diversified landscapes with numerous specific ecosystems operating within each of them makes the region paradise of life and also justifies its unique position, being the part of two biodiversity hot spots namely, Eastern Himalaya and Indo-Myanmar, among 34 hotspots of the world.

There is dearth of exploration and research concerning the fauna of northeast India. The remoteness of the region, difficult terrain as well as severe hunting pressure exerted by people around their immediate surroundings in many parts of the region make it is extremely difficult to document the fauna of the region. The government of British India had an agenda that grew out of commercial pressure from both at home and in the colonies, to collect and supply materials of Botany, as well as Zoology and Mineralogy in the territory of the East India Company (BASTIN 1981). Pioneering naturalists of the time more often than not looked well beyond the mandate provided by their superiors, and large numbers of zoological specimens were collected, and frequently documented pictorially through coloured sketches prepared by local artists. The early exploration of faunal composition in the Eastern Himalaya including northeast India was carried out by the officers of East India Company and the tea planters. The notable contribution was made by Hodgson (1800 - 1894), Cantor (1809 – 1860), Blyth (1810 – 1873), Anderson (1833 – 1900), Annandale (1876 –1924) and others.

The river network of the Brahmaputra drainage system and Barak-Meghna-Surma drainage system constitutes the diverse fresh water fish habitats to Northeast India in general and Assam in particular. Starting from the pioneering works of Hamilton (1822) followed by Day (1878), a number of fish species was reported from the region. The species report with taxonomic description was further strengthened by H.L. Hora till the middle of 20th century.

As stated (Dey, 1984), Wade (1801) gave the earliest account of Assam in the initiating year of 19th century. However, he failed to mention the references of fish and fisheries in all of his works on the Province. Francis Hamilton (1808-1814) made a detailed survey on fish fauna of eastern provinces including Assam. During the rule of the Ahom King, due to some restrictions, Hamilton conducted his survey from Goalpara and Rangpur and collection of fish samples were possible through persons visiting Assam. In his publication on fishes of the River Ganges, Hamilton (1822), included type localities of 16 fish species of Assam Brahmaputra and 12 species from northeastern part of Bengal, probably in the lower Assam territory of the Chief Commissioner's Province as referred by Dey (1984).

John McClelland visited upper Assam for a long period of time and briefly studied the fish fauna of Assam. On his publication a memoir in Indian Cyprinidae in the second part of the 19th volume of the *Asiatic Researches*, described 138 fish species of various localities of India including Assam. Robinson (1841) put forward a comprehensive note on Assam and recorded 74 fish species from the province. He also highlighted various indigenous fishing devices like *Polo*, *Jakoi*, *Chip-Jaal*, *Khewali-Jaql* and various types of nets. Contributions of a host of workers (Muller and Troschel, 1845; Peters, 1861; Gunther, 1864 &1868) are also warmly recognized, who reported some fish species of the then Assam along with their taxonomic reports of fresh water fishes of the Indian subcontinent. Beaven (1877) published "*Handbook of Freshwater fishes of India*" which contains short description of almost 417 fresh water fish species of which 46 species were from the province of Assam. Later, Francis Day (1865 - 1877) made extensive studies of fish species, which were published in 54 research papers that covered many parts of India including Assam. In his works on *Fishes of India* (1878) and *Fauna of British India, Fishes* (1889), he highlighted the rich fish diversity of Assam, estimating the

prevalence of 81 fish species throughout the state. H.L. Hora (1941) made remarkable contribution to the ichthyology of the region till the middle of the 20th century along with his report on the Vernay-Hopwood Upper Chindwin expedition. In the last part of 20th century and beginning of 21st century, fishery scientists from all over the world started on ichthyofaunal exploration in southeast Asia including Assam and other northeastern states of India. As a result many new species have been discovered and many taxa have been reviewed from the region more particularly from Manipur having connection with the River Brahmaputra. Matwani *et al.* (1962) reported 126 species from the river Brahmaputra. Hunter (1979) gave a comprehensive description of fisheries of 11 districts of the province through some meticulous collection of data.

In the last part of 20th to the first part of this century some reports on the ichthyofaunal diversity are aggressively worked out by a host of fishery workers in relevance to Assam. The range of variation of fresh water fish species reported from Assam lies between 100 to 217 species, of which many species are found to be synonymic. Indeed, the present compiled list presents 232 fish species of Assam.

In the field of herpetology most of the reports of colonial era were from Khasi Hills, Naga Hills and upper Assam. T.C. Jerdon (1811 – 1872) collected specimens from Eastern Himalaya and Khasi Hills and planned major work with Gunther which did not materialized due to his untimely death. Anderson (1833 – 1900) published a monograph (1879) on vertebrates of Upper Burma-Yunnan region, with water-colours of turtles. This monograph is considered as an important record for vertebrate fauna of northeast India which has high similarity with Upper Burma-Yunnan region. Annandale (1876 – 1924), the first Director of Zoological Survey of India worked extensively on herpetofauna of the region and also carried an expedition to Abor Hill (1911 – 1912) from where several new species have been described. Malcom Arthur Smith (1875 – 1958) made the greatest contribution to the herpetology in India by authoring the FAUNA OF BRITISH INDIA series on Reptilia and Batrachia (1931-1943), covering “Testudines and Crocodylia” (Volume I; 1931), “Sauria” (Volume II; 1935) and “Serpentes” (Volume III; 1943). He provided information on status and distribution reptiles of northeast India based on works of Blyth (1851), Wall (1907, 1908, 1910 – 1911), Annandale (1912), Prater (1920, 1935), Loudon (1930) and collections housed in different museums.

The remarkable contribution of E.C. Stuart Baker (1864-1944) towards Indian Ornithology is worth mentioning. He took Assam as his study area and studied about various bird species and their nesting behavior. He authored of 8 volumes on birds in the second edition of “Fauna of British India” which were completed between 1922- 1930. E.W. Oates an engineer and W.T. Blanford, a geologist wrote 4 volumes “Fauna of British India” depicting information on birdlife of Assam which was published between 1889 and 1898. These volumes of the above mentioned book series provides many field data which were gathered across the country.

After independence there was lack of interest amongst the researchers with regard to herpetofauna of the region. Stray works have been made by scientists of Zoological Survey of India; notable workers were Pillai, Ghosh, Chanda, Sarkar, Roonwal and Kripalini. Since the last decade a spurt in herpetological research has been observed and workers of Arya Vidyapeeth College, Aaranyak, North East Hill University, Gauhati University, Assam University, Silchar, State Forest Research Institute, Arunachal Pradesh and Institute of Advanced Study in Science and Technology by their continuous efforts have enriched existing knowledge on fauna of the region.

Salim Ali (1896 – 1987) authored a book, “The Book of Indian Birds” published by Bombay Natural History Society, which represented details of all common birds most of them are found in Assam. The bird mystery of *Jatinga* of Assam is well known. Edward Pritchard Gee, a tea planter of Doyang Tea Estate, put light on the bird mystery of *Jatinga* through his famous publication “The Wild Life of India” (1964). However in Assam, the study of birds was

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conducted extremely during 1980s in the form of articles, notes, research papers on various aspects of study of birds. A regular illustrated column entitled, "Birds of Assam" which was published in the famous daily "The Sentinel" also helped to promote bird-watching (by Dr. Anwaruddin Choudhury, 1985-90). Another publication of Dr. Choudhury, "Checklist of Birds of Assam" also provided guidance to know more about the bird species of Assam. His contribution to the field of ornithology of Assam got attention in the form of articles, research papers, books, etc. Many projects, researches are being conducted on various aspects of different bird species which are expected to leave some mark in the field of Indian Ornithology.

Likewise in the field of mammalian fauna, various researches on different species of mammals are also being conducted. Various informative and descriptive books have been written on mammalian fauna of Assam. These books are notably *The book of Indian animals* (Prater, 1948), *The Wild Life of India* (Gee, 1964), the only authoritative systematic checklist is the *Checklist of Palaearctic and Indian mammals 1758 to 1946* (Ellerman & Morrison-Scott, 1951). In this context, Dr. Anwaruddin Choudhury's remarkable work is also worth mentioning. In his early days of research, he faced problems for listing of all mammalian species systematically. However, a comprehensive documentation of mammals could be made after his extensive field works. In 1986, he travelled to North Cachar Hills (presently Dima Hasao district) to start a two-decade long research on primates that extended to the entire Northeast India in later years. He also revealed for the first time that the Stump-tailed and Pig-tailed macaques are restricted by the Brahmaputra river towards west of their range. His authoritative works on the wild water buffalo have been published recently as the first monograph on this endangered species. His book "*Checklist of Mammals of Assam*", published in two editions by Gibbon Books covers details of all mammalian species and subspecies prevalent in Assam are arranged in systematically. The first edition includes comprehensive documentation of all mammalian species of the State, while the text of the second edition has been revised with more details on status and distribution of each species considering all significant changes in systematic, nomenclature and knowledge on mammals since Ellerman & Morrison-Scott (1951). His remarkable contributions towards the study of mammalian fauna in the form of research papers, books, monographs, etc. are noteworthy and proper guidance for all. In 2013, his comprehensive work, *The Mammals of North East India* came out in a book form with 432pp.