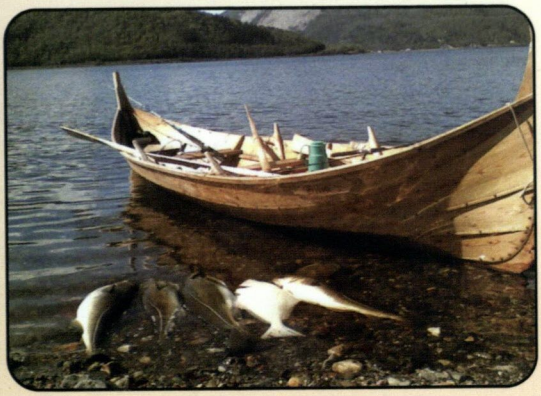
BIODIVERSITY CONSERVATION OF NORTH-EAST INDIA



Adv. Imotemsu Ao

Himalayan temperate and subalpine zone forests extend from northern Pakistan and adjacent Afghanistan through North-east India to Southwest China. Each of the eight States of the region, namely Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, boast of several endemics in flora as well as fauna. This region represents an important part of the Indo-Myanmar biodiversity hotspot, one of the 25 global biodiversity hotspots recognised currently.

North-east India is gifted with a wide range of physiography and eco-climatic conditions. The State of Assam has extensive flood plains, while mountain Khangchendzonga in Sikkim stands 8586 m. tall. Cherrapunjee in the State of Meghalaya holds the record for the highest rainfall in a single month (9,300 mm) as well as the most in a year (26,461 mm) in India, while the nearby Mawsynram has the world's highest average rainfall (11,873 mm). The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and cold deserts.

Despite the presence of this elusive animal in all the eight states of the region, its habitat is shrinking at an alarming rate. Vast tracts of forests, especially in the State of Arunachal Pradesh, where the animal reigns free, could remain safe for this magnificent animal, provided such forests are kept away from developmental activities, including the construction of roads. The Eastern Himalayan part of North-east India supports 22 restricted-range bird species.

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He has authored many books including Drug Abuse; Rural Development in North-East India; Rethinking Tribal Culture and Development; Globalisation & Economic Growth of North-East India; and Tribal Education in India. He has also been a Member of the Editorial Team of many Encyclopaedias related to Ecology and Environment, Disaster Management, Sustainable Development, Criminology, Forensic Sciences etc.

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He has received many national as well as international Awards & Appreciations instituted by reputed transnational bodies on peace studies and conflict resolution.

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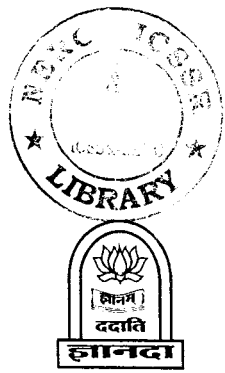

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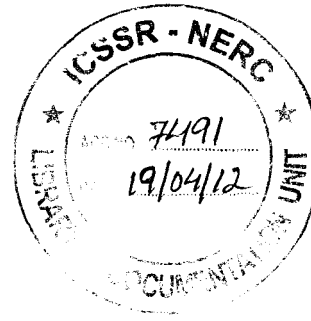

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BIODIVERSITY OF NORTH-EAST INDIA

Introduction

The immense variety of the climatic, edaphic and altitudinal variations in India have resulted in a great range of ecological habitats for which North-east India takes the pride of place. Lying between 22-30 degree N latitude and 89-97 degree E longitude, and sprawling over 2,62,379 sq. km., North-east India represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese biogeographic regions and a meeting place of the Himalayan Mountains and Peninsular India. It was the part of the northward migrating 'Deccan Peninsula' that first touched the Asian landmass after the break-up of Gondwanaland in the early Tertiary Period. North-east 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 values. It is in this lowland-highland transition zone that the highest diversity of biomes or ecological communities can be found, and species diversities within these communities are also extremely high.

North-east India is blessed with a wide range of physiography and eco-climatic conditions. The State of Assam has extensive flood plains, while Khangchendzonga in Sikkim stands 8586 m. tall. Cherrapunjee in the State of Meghalaya

holds the record for the highest rainfall in a single month (9,300 mm) as well as the most in a year (26,461 mm) in India, while the nearby Mawsynram has the world's highest average rainfall (11,873 mm). The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and cold deserts. There are regions, for example, in the State of Sikkim, where the faunal assemblages also change rapidly from tropical to subtropical, temperate, alpine and finally to cold desert forms.

After the Andaman and Nicobar Islands and the Western Ghats, North-east India forms the main region of tropical forests in India, especially the species-rich tropical rain forests. The tropical semi-evergreen and moist deciduous forests in the lowlands of this region extend south and west into the subcontinent, and east into Southern China and Southeast Asia. The subtropical forests of the region follow the foothills of the Himalaya to the west; also extend into Southeast China in the east. Himalayan temperate and subalpine zone forests extend from northern Pakistan and adjacent Afghanistan through North-east India to Southwest China. Each of the eight States of the region, namely Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, boast of several endemics in flora as well as fauna. This region represents an important part of the Indo-Myanmar biodiversity hotspot, one of the 25 global biodiversity hotspots recognised currently.

Flora

The vegetation of the north-eastern region is fairly well known. With about 1,67,000 sq.km. area under forest, this region accounts for approximately 7500 species of angiosperms. The State of Sikkim alone holds about 5000 species of flowering plants. Out of 315 families of Angiosperms in India, more than 200 are represented in North-east India and this region accounts for nearly 50 per cent of the total number of plant species in India as a whole. Though the flora of this region exhibits an Indo-Malayan affinity, the floral elements

of other parts of India, and of neighbouring and far off countries, have also contributed to its richness and diversity. It is of interest to note that about one third of the flora of North-east India is endemic to this region.

The striking feature of the flora of North-east India is the presence of many primitive flowering plants e.g. Magnolia pealiana, M. qustavii, Tetracentron sinense, Holboellia latifolia, Exbuchlandia populnea, Manglietia sp., Myrica esculenta and Corylopsis himalayana. The Coriariaceae, Nepenthaceae, Turneraceae, Illiciaceae, Ruppiaceae, Siphonodontaceae and Tetracentraceae are monogeneric families represented in this region. Furthermore, some of the important gene pools of citrus, banana, mango and rice are reported to have originated from this region. Of these, mango and banana show the maximum diversity in this region. The carnivorous Pitcher Plant (Nepenthes khasiana) is endemic to Meghalaya and is listed in Appendix I of CITES and placed in Schedule VI of the Wildlife (Protection) Act, 1972. Siroy Lily (Lilium mackliniae), a ground lily that produces beautiful flowers, is a narrow endemic found in the eastern border area of Manipur.

The tropical forests found in the Indo-Myanmar border areas have many representative species in the Indian context, such as—Dipterocarpus tuberculatus, D. turbinatus and Melanorrhea usitata to name only a few. Similarly, Sikkim Himalayan region is a wonderland as Sino-Japanese floristic elements (e.g. species of Quercus, Schima), Western China elements (e.g. Aletris pauciflora, Anemone rupicola, Magnolia campbelli), Tibetan elements (e.g. Hippophae, Prezwalskia), Siberian elements (e.g. Potentilla, Pedicularis) and other floristic elements from near and far-off lands have a significant presence in the region. In addition to this, there are very interesting areas in the region that are termed as 'Isolation belts' that have led to the isolation of certain species. Meconopsis bella, Cathcartia lyrata, Senecio chola, Sausrea laneana, Geranium spp., Primula elwesiana, P. wattii and Swertia burkilliana serve such examples in the Sikkim Himalaya.

Orchids, believed to have evolved in this region, form a very noticeable feature of the vegetation here. Of about 1300 species of orchids, belonging to 158 genera reported from India, North-east India sustains the highest concentration with about 700 species. As many as 34 species of orchids from North-east India are listed among the threatened plants of India. The following are some ornamental orchids of the region: Paphiopedilum fairieanum, P. insigne, P. villosum, P. spicerianum, P. hirsutissimum, P. venestum, Anoectochilus sikkimensis, Vanda coerulea, Vanda teres, Renanthera imschootiana, Pleione maculata, Cymbidium eburneum, Dendrobium hookerianum, D. densiflorum, D. devonianum, D. thyrsiflorum and Thunia marshalliana. There are 550 species of orchids in Arunachal Pradesh alone – the highest number in any State (Of these, 350 are epiphytes, 160 are autophytic terrestrials, and about 20 are saprophytes). Many species of orchids are of medicinal importance. For example, the fresh as well as dried stem of the orchid Dendrobium nobile is used in the preparation of the Chinese drug 'Shih-hu', used as an aphrodisiac, analgesic and for longevity.

The Sikkim Himalaya harbours as many as 190 wild plants that are suitable for human consumption. In the State of Tripura, more than 60 such species are used as vegetables. In Manipur more than 430 species are being used for medicinal purposes. In parts of Assam and Manipur, the tree Parkia roxburghii yields good timber and also provides edible flowers and pods that are highly prized. Agarwood (Aquillaria malaccensis) that occurs in the tropical forests of the North-eastern region is highly prized.

Rhododendrons are known for their showy flowers and foliage. Out of 82 species of rhododendrons recorded from Himalaya, 70 species are confined to eastern Himalaya. Hooker's expedition to Sikkim in 1848 revealed 45 new species, which included the yellow flowered Rhododendron campylocarpum and R. wighti; the red-flowered R. thomsoni, the small tree R. falconeri and the large R. griffithianum with massive white flowers. However, unfortunately, nearly half of the Rhododendron species have become rare and

threatened and some of the very ornamental species are now facing extinction e.g. Rhododendron nuttalli, R. falconeri, R. edgeworthii, R. elliotii, R. hookeri, R. macabeanum and R. watti. Hedychiums of the family Zingiberaceae make excellent ornamental plants and the following are rare and threatened ornamental species of this group: Hedychium luteum, H. aureum, H. radiatum, H. robustum, H. dekianum.

Out of 136 species of bamboos found in India, 63 species in 22 genera are found in North-east India, spread over an area of 30,500 sq.km. Distribution patterns of bamboos in the region reveal that the species of Bambusa, Dendrocalamus, Dinochloa, Cephalostachyum and Neohouzeoua are mostly confined to the lower altitude ranging between sea level and 600 m. above sea level Species of Arundinaria, Chimonobambusa, Semiarundinaria, Sinobambusa, Thamnocalamus and Phyllostachys are found in altitudes between 800 and 3500 m. The largest contribution to the growing stock is from Dendrocalamus strictus (45%), followed by Melocanna baccifera (20%), Bambusa bambos (13%), D.hamiltonii (7%) and B. tulda (5%), with the rest sharing 6 per cent. About 25 species of bamboo are considered rare in North-east India.

In North-east India, 28 species of conifers are recorded. Pinus kesia is mentionworthy as it could be seen growing in pure patches at elevations of 900 to 1800 m. and it is one of the fast growing trees of this region. Cycas pectinata is a rare gymnosperm that occurs in Kamrup and Gnetum gnemon occurs in Khasi, Jaintia and the Naga hills. Podocarpus nerifolia, a broad-leaved gymnosperm is reported from the Khasi hills, but also occurs in the tropical forests of Barak Valley in Manipur State and in Assam.

North-east India is also known for a variety of saprophytic plants like Monoropa uniflora, Epipogeum roseum, Aeginitia indica and the giant orchid Galeola falconeri. The largest root parasite, Sapria himalayana is a rare species of the region which produces large (about 35 cm. in diameter) crimson flowers. Similarly, Belanophora dioica, Mitrastemon yamamotai (a polyendemic), Boschniackia himalaica,

Epipogeum roseum, Euryale ferox etc. are botanical curiosities of the region. North-east India also has a high diversity of non-flowering plants. Of about 1000 species of ferns found in India, nearly half are represented in North-eastern India. Dipteris wallichii, Asplenium nidus, Osmunda cinnamomea, O. claytoniana, O.regalis, Helminthostachys zeylanica, Botrychium lanuginosum, Angiopteris evecta, Cyathea gigantea, C. spinulosa, Psilotum nudum, Phagopteres auriculata etc, are some of the rare and interesting non-flowering vascular plants. Of these, Platycerium wallichii (Staghorn Fern) from Manipur appears to be the first report of its occurrence within India. This epiphytic fern grows in the moist deciduous forests in the Indo-Myanmar border areas in great profusion. Fern-allies such as Lycopodium and Selaginella are also diverse in this region.

The region is exceedingly rich in lichens, mosses and liverworts. These seemingly unimportant plants need to be investigated, studied, appreciated and above all, protected, as they serve vital ecological roles as soil protectors; contribute to the recycling of nutrients and water, offer food and shelter to an assemblage of invertebrates and take a part in air purification and carbon sequestration.

FAUNA

Mammals

There is a paucity of exploration and research concerning the fauna of North-east India. Mammals are often considered the best-known groups, especially the ungulates. However, a new species of barking deer, 'Leaf Deer (Muntiacus putaoensis), which was recently discovered in Myanmar, is reported from the forests of Arunachal Pradesh in the year 2003 as a new record for India, and this amply justifies the above observation that much is yet to be identified, named and studied in North-east India. The remoteness of the region, difficult terrain as well as the severe hunting pressures exerted by the people around their immediate surroundings in many parts of the region make it extremely difficult to document the fauna of the region.

Primates

North-east India sustains eleven species of primates, if we follow the recent revisions in primate taxonomy. It is but unfortunate that except three species, which could be considered common in Assam, they face an uncertain future in this region.

The Hoolock (Bunopithecus hoolock) is the only ape in India. The eastern limit for this lesser ape is Salween River in Myanmar and its range extends to Southern China. It occurs in Assam, Arunachal Pradesh, Manipur, Meghalaya, Tripura and Mizoram States in North-east India, and its continued existence in the State of Nagaland is uncertain. Despite the wide area in which the animal occurs, it has become a rare animal, all over its range. Monogamy, frugivory and adaptation to brachiation make the species highly susceptible to habitat fragmentation and degradation. Most of the tropical forests that harbour this species are subjected to slash and burn or shifting cultivation and therefore, the ape's habitat is highly degraded and fragmented. It is hunted for the pot and the belief that its flesh and blood have medicinal properties has made it a highly prized commodity. It is also highly prized in the pet trade. All these are detrimental to the survival of the species.

The Golden Langur (Trachypithecus geei) is one of the most localised species, between Manas and Sankosh Rivers in the Himalayan foothills along the Assam - Bhutan border areas. This narrow endemic was discovered in Chakrashilla Hills Reserve in the Dhubri District of Assam, and the area has been turned into a wildlife sanctuary.

Within 5.8 per cent of the state's protected area in Tripura, one can count seven species of primates. The Phayeri's Langur (Trachypithecus phayeri) assumes high conservation significance, as this species is restricted in distribution to the State with reported existence of a few troops in North Cachar Hills of Assam, adjacent to the northern boundary of Tripura. Yet another species of particular interest is the newly designated primate species, Semnopethicus schistaceus (Nepal

Langur), which is endemic to the higher elevations in Sikkim and Nepal. The Capped Langur (Trachypithecus pileatus) is also a rare animal with limited distribution in North-east India.

The Stump-tailed Macaque (Macaca arctoides) and the Northern Pigtailed Macaque (M. leonina) have sympatric distributions in North-east India and both have become endangered. The Slow Loris (Nycticebus bengalensis) is an inhabitant of tropical forests south of the Brahmaputra River in North-east India. This highly endangered animal is listed as Schedule I animal, and in Appendix I of the CITES.

Carnivores

If India has the distinction of harbouring six largest cats of the world, the State of Arunachal Pradesh prides itself for sustaining four large cats of Asia – the Tiger (Panthera tigris), Leopard (Panthera pardus), Snow Leopard (Uncia uncia) and the Clouded Leopard (Neofelis nebulosa). Of these, the Indian population of the Clouded Leopard is restricted to the North-eastern region. With a very long tail for balance and large paws for climbing, the Clouded Leopard is well suited for life in the canopy. It also has the longest upper canines proportional to its skull size of any cat, reminiscent of the saber-toothed cat. Despite the presence of this elusive animal in all the eight states of the region, its habitat is shrinking at an alarming rate. Vast tracts of forests, especially in the State of Arunachal Pradesh, where the animal reigns free, could remain safe for this magnificent animal, provided such forests are kept away from developmental activities, including the construction of roads.

Tiger has become a very rare animal in the entire region and perhaps Assam provides the safest asylum for this large cat. There is a reliable report of this magnificent animal (a tigress with a cub) appearing in the forests of Tripura, after an absence of almost 25 years! The more adaptable Leopard has managed to survive in greater numbers. Little is known about the status of Snow Leopard, which ekes out a living in the high altitudinal zones of Arunachal Pradesh and Sikkim.

North-east India sustains diverse assemblages of small carnivores, and this region is perhaps the richest region for small carnivores in the entire planet. The tiny State of Manipur, with an area of 22327 sq.km., apart from sustaining three large cats, harbours the Marbled Cat (Pardofelis marmorata), Golden Cat (Catopuma temmincki), Leopard Cat (Prionailurus bengalensis), Fishing Cat (Prionailurus viverrinus) and the Jungle Cat (Felis chaus). It also has 3 Mustelids and 7 Viverrids: Yellow-throated Marten (Martes flavigula), Ferret Badger (Melogale sp.), Hog badger (Arctonyx collaris), Eurasian Otter (Lutra lutra); and among the Viverrids, Small Indian Civet (Viverricula indica), Large Indian Civet (Viverra zibetha), Common Palm Civet (Paradoxurus hermaphroditus), Himalayan Palm Civet (Paguma larvata), Binturong (Arctictis binturong) and Spotted Linshang (Prionodon pardicolor). Two other species of Otter, namely Smooth-coated Otter (Lutrogale perspicillata) and Small-clawed Otter (Amblonyx cinereus), known from elsewhere in India, may also occur in Manipur State, while Arunachal Pradesh and Sikkim, may have even more species of small carnivores than Manipur.

The mind-boggling assemblage of small carnivores and other biota in the North-eastern States could be attributed to the wide ranging altitudinal variations that one comes across in the region and also to the heavy rainfall and humidity that triggers luxurious plant growth especially in the lower elevations. It needs to be emphasised that all these rare animals occupy narrow bands of forests in the hills and valleys of the region, and, living in small populations, they are extremely susceptible to habitat degradation and hunting pressures. Many of the species in lowland forests are already on the brink of extinction as these forests were the first to be occupied, altered and degraded by man. Of the Mustelids, the Ferret Badger and the Hog Badger found in the North-eastern India take the pride of place not only because of their rarity but also because of their uniqueness. The Red Panda (Ailurus fulgens) is yet another flagship species of this region, restricted to the higher altitudes.

All the bear species that occur in India are recorded from the North-eastern region. Besides, North-east India forms the western end of the range for Malayan Sun Bear (Helarctos malayanus). Bears of the lower elevations are under especially serious threats owing to habitat degradation as well as persecution by man, as the bile of the animal is considered highly medicinal. Wild Dog or Dhole, is yet another rarity in the wilderness of North-east India. Wild Dog found in Sikkim (and in Kumaon, Nepal and Bhutan) is considered Cuon alpinus primaevus. The Cuon alpinus adjustus found in eastern Arunachal Pradesh is considered to be the same subspecies found in northern.

WILDLIFE IN NORTH-EAST INDIA

Bats and Rodents

Inventories, especially for bats and rodents, are wanting from North-east India. Though, with about 65 species, bats dominate the mammalian fauna of North-east India, reliable information available on them is sparse. The Wroughton's Free-tailed Bat (Otomops wroughtonii), recorded from the Barapede cave in North Kanara district of Karnataka was believed to be a narrow endemic. However, now it has now been reported from Siju Cave in South Garo Hills of Meghalaya in North-east India, and also from Cambodia. The Government of India has listed the Wroughton's Free-tailed Bat in Schedule I of Wildlife (Protection) Act, 1972.

The Namdapha Flying Squirrel (Biswamayopterus biswas) is a little known narrow endemic found in the State of Arunachal Pradesh. It was first described from Deban in 1981. The Namdapha National Park, one of the largest parks in the country holds a number of other squirrels–Hairyfooted Flying Squirrel (Belomys pearsoni) and Particoloured Flying Squirrel (Hylopetes alboniger), Orange-bellied Himalayan Squirrel (Dremomys lokriah), Malayan Giant Squirrel (Ratufa bicolor), Hoary- bellied Squirrel (Callosciurus pygerythrus) and Himalayan Striped Squirrel (Callosciurus macclellandi) could all be seen in this park. The Hispid Hare (Caprolagus hispidus) is yet another habitat specialist that is facing the threat of elimination from the region.

Ungulates

Of the 28000 wild elephants in India, about 33 per cent are found in North-east India. In fact, Assam alone accounts for more elephants than Myanmar, Thailand, Indonesia or any other country in Asia. However, elephant population is dwindling sharply in North-east India. There has been a very serious decline in the elephant population in central Assam whereas those in the southern parts have virtually vanished. The population has seriously declined in Tripura and there are only a few elephants left in Manipur and Mizoram and probably none in Nagaland. Heavy loss of prime elephant habitat is an issue of great concern as loss of elephant habitats heralds doom for smaller creatures as well.

Great Indian Rhinoceros (Rhinoceros unicornis) is the largest of all the rhinos now inhabiting the world. In North-east India, this species is now restricted to Kaziranga, Pabitora and Orang in Assam. The population at Manas in Assam is believed to have been decimated in recent years. Historical records suggest that both the one-horned Javan Rhinoceros (Rhinoceros sondaicus) and the two-horned Sumatran Rhinoceros (Didermocerus sumatrensis) were once found in parts of North-east India. Both the species are now extinct from the region.

The Water Buffalo (Bubalus bubalis) found in North-eastern India has a rather alarming genetic problem. A large number of domestic buffalo, most of them genetically a 'cocktail species' bred by man, are grazed in the habitats of the wild buffalo and the interbreeding revitalizes the domestic strain but has the opposite effect on the wild strains. The Banteng (Bos javanicus) occurred in the hills of Manipur as late as 1990s, but is now not reported from the State.

The Brow-antlered Deer (Cervus eldi eldi) is endemic to the State of Manipur. Sangai, as the deer is locally known, is one of the rarest and the most localised subspecies of deer in the world. Reported to be extinct in 1951, this deer was subsequently discovered in a small pocket on the floating mats of vegetation, called 'phumdi' in the Loktak Lake. Though

just fourteen heads were counted in the first aerial census in 1974, their number has steadily increased since then. Loktak Lake is now a RAMSAR site and there are now about 150 individuals in this undoubtedly the most fragile habitat of the region. The Swamp Deer (Cervus duvauceli) found in Assam is yet another Cervid of great conservation significance. The Serow (Capricornis sumatraensis), Goral (Naemorhedus goral) and Red Goral (Naemorhedus baileyi) are three other species that are of great conservation significance in the region. The Pygmy Hog (Sus salvanius) is the smallest and the rarest wild suid in the world, and only a few isolated wild populations survive in North-east India.

Other Mammals

In the State of Sikkim, at the heights above 3600 m. where the tree line ends, the alpine Scrub and grasslands support some of the most unique fauna of the planet, the Yak (Bos grunniens), The Tibetan Wild Ass (Equus hemionus kiang), Markhor (Capra falconeri), Ibex (Capra ibex), Great Tibetan Sheep (Ovis ammon hodgsoni), Blue Sheep (Pseudois nayaur), are only to name a few.

It is recorded that the Chinese Pangolin (Manis pentadactyla) ranges westwards through Assam and the Eastern Himalaya to Nepal, Myanmar and South China. However, the Indian Pangolin (Manis crassicaudata) is also reported from the Indo-Myanmar border areas and this confirms that both species exist in North-east India. Ganges River Dolphin (Platanista gangetica) is yet another mammal of great conservation importance that can still be found in the Brahmaputra River in North-east India.

Birds

North-east India supports some of the rarest, least known and most sought-after birds of the Oriental Region. This region perhaps supports the highest diversity of bird species in the Orient. More than 400 species of birds are recorded from Kaziranga National Park alone in Assam and although not thoroughly explored, the State of Arunachal Pradesh has a

record of 665 species of birds. Though birds are one of the most studied organisms, there is acute paucity of information concerning the avian fauna of the region and at the same time, new species are continuously being added to the region's list. The following account should provide a general picture concerning the birds of North-east India.

Poor dispersers such as babblers and laughing thrushes are important forest understorey passerines in the rainforests and they have diversified locally and contribute significantly to the diversity of the avifauna of North-east India (they constitute about 10 per cent of the Eastern Himalayan avifauna). The Brown-capped Laughing Thrush (Garrulax austeni) is only known from the hills south of the Brahmaputra in the North Cachar Hills (Assam), Nagaland, Manipur and Mizoram. The bird's habitat consists of oak and rhododendron forest, secondary growth and bamboo from 1200 m. to 2700 m. The Elliot's Laughing Thrush (Garrulax elliotii) and Brown-cheeked Laughing Thrush (G. henrici) are two species that have been recently added to the region's list, from Arunachal Pradesh. Both these species had previously been recorded only in China.

The Assam Plains and the Eastern Himalaya have been identified as Endemic Bird Areas by Bird Life International. The Assam Plains holds Blackbreasted Parrotbill (Paradoxornis flavirostris) and the Marsh Babbler (Pellorneum palustre) and in this region one can always hope to rediscover the Manipur Bush Quail (Perdicula manipurensis). The Eastern Himalayan part of North-east India supports 22 restricted-range bird species (those that have a total world range of less than 50,000 square kilometres); of these 19 are endemics. Perhaps, with the exception of Manipur Bush Quail (Perdicula manipurensis), which is considered to be extinct, one could perhaps hope to see all the other 21 bird species in North-east India, which holds one of the largest concentrations of globally threatened birds in Asia. The relatively high species richness of birds at high altitude zones in the region, compared with other taxa, is also notable. White-winged Wood Duck is perhaps the rarest duck in the world today and this bird

occupies the pride of place among the avifauna of the region. However, extensive destruction of its natural habitat ranging from Assam and Arunachal Pradesh to Java has pushed this species into isolated groups of small populations. Greater Adjutant (Leptoptilos dubius) is a globally threatened bird with the majority of the world's population now found in Assam. Spot-billed Pelican (Pelicanus philippensis), Blacknecked Stork (Ephippiorhyncus asiaticus), Lesser Adjutant (Leptotilos javanicus), and Pale-capped Pigeon (Columba punicea), are only to name a few of the globally threatened birds found in the region. Swamp Francolin (Francolinus gularis), found in North-east India, is endemic to the Indian subcontinent. The Bengal Florican (Houbaropsis bengalensis) is one of the rarest bustards in the world. Manas National Park has the largest population of this bird in the world. Hornbills, too, exhibit high species richness in north-east India, found in few places elsewhere in the world.

Lesser Fish Eagle (Icthyophaga humilis) is the rarest of the fish and sea eagles, and there are reports of its sightings in Namdapha in Arunachal Pradesh. Jerdon's (Blyth's) Baza (Aviceda jerdoni) is a very rare resident bird of India, and the chances of sighting this globally endangered bird are bright in evergreen forests of North-east India. Burmese Hobby (Falco severus severus) is an uncommon breeding resident of North-east India, south of Brahmaputra River. Pied Falconet (Microhierax melanoleucos) is also one of the rarest Indian raptors found in North-east India.

The Sclater's Monal (Lophophorus sclateri) and Blyth's Tragopan (Tragopan blythii) are among the rare and beautiful pheasants that live in a limited range of the eastern Himalaya. With the exception of a status survey conducted on the Blyth's Tragopan in Blue Mountain National Park in Mizoram, which is recorded to harbour 38 birds, no detailed study has been carried out to date on these two species in any part of their range. It is even now a custom in certain hill areas of the region to present a Tragopan or Mrs. Hume's Pheasant (Syrmaticus humiae) to a visiting dignitary (to be slaughtered and eaten). All the pheasant species that occur in this region

are to be considered endangered. Ward's Trogon (Harpactes wardi) is yet another beautiful resident bird reported from Arunachal Pradesh and Sikkim. The bird is sighted in the State of Manipur also.

Buff-throated Partridge (Tetraophasis szechenyii) is a rare resident of rocky ravines and Rhododendron thickets in the subalpine zone of central Arunachal Pradesh. At higher altitudes in Sikkim, birds include Snow Partridge (Lerwa lerwa), Blood Pheasant (Ithaginis cruentus), Himalayan Monal (Lophophorus impejanus) and Ibisbill (Ibidorhyncha struthersii).

The highly endangered Rufous-vented Prinia of the eastern population, regarded as a separate species 'Swamp Prinia' (Prinia cinerascens), is reported from the Pobitora Wildlife Sanctuary in Assam. Beautiful Nuthatch (Sitta formosa) is a resident of primary forests of North-east India. The Khasi Hills Swift (Apus acuticauda) is one of the world's rarest and least known Apus species, and is known only at its breeding cliff near Cherrapunjee in Meghalaya from late February to the end of April. The movements of this endemic bird outside the breeding period are largely undocumented. Pink-headed Duck (Rhodonessa caryophyllacea), as its local name 'nganu koknganbi' in Meitelon, suggests that it was once a common bird in Manipur and elsewhere in North-east India. It is now extinct. India's only Buff-throated Warbler was collected from Meghalaya in 1953, and no further records exist in India. Rufous-bellied Eagle (Hieraetus kienerii) found in this region is also probably extinct. Burmese Peafowl (Pavo muticus), found in the Indo-Myanmar border areas, is also seldom sighted in the region.

Though there is less information about the migration routes of birds in North-east India, the Brahmaputra River and her tributaries are thought to form a flyway for birds from North-east Asia.

Lower Vertebrates

The reptilian fauna of North-east India has the greatest affinity to the Oriental, Indo–Malayan and Indo–Chinese

regions. According to existing records, there are 137 species of reptiles in North-east India, but in reality there could be many more species that are yet to be identified. With better sampling and studies on the herpetofauna, the number of species is expected to change considerably for each of the states and for the region as a whole.

Among the component of reptilian fauna, the Gharial (Gavialis gangeticus) found in Brahmaputra River is of great conservation significance. North-east India has the highest diversity of turtles. Of the 26 species of non-marine chelonians reported from India, 19 are found in this region. However, the information on this group of reptiles is also quite inadequate as most of the available records concerning the known species available are from the Brahmaputra Plain and adjoining areas in lower Eastern Himalaya. The hill states, especially south of Brahmaputra basin, viz., Nagaland, Manipur, Tripura, Meghalaya and Mizoram, remain poorly studied.

As recently as 2000, a chelonian species Amyda cartilaginaea, was reported from Mizoram as a first record for India, the previous range for this species being from southern Myanmar to central Vietnam, Laos, Cambodia, and Thailand. This species was not found to be particularly rare in the study area, but was not reported as no herpetofaunal survey had been conducted earlier in Mizoram. Asian Roofed Turtle (Kachuga sylhetensis) is endemic to the region. The Elongated Tortoise (Indotestudo elongata), Asian Brown Tortoise (Manouria emys), Narrowheaded Softshell Turtle (Chitra indica) and Indian Flapshell Turtle (Lissemys punctata) are very rare among the recorded species.

The lizard fauna of North-east India is profoundly influenced by the Indo-Chinese connection. Published records indicate 20 lizard species from the State of Assam, and 18 species from the tiny state of Manipur. Of the three species of Monitor Lizards found in the region, Varanus flavescens is listed in Schedule I under Wildlife (Protection) Act, 1972 and listed in Appendix I of CITES. The Tokay Gecko (Gekko gekko) is the largest gecko alive today and is found in North-east

India. The Burmese Glass Snake (Ophisaurus gracilis) is yet another interesting reptile of North-east India.

Fifty eight species of snakes have been recorded in Assam and 34 from Manipur. Python reticulatus, the largest snake in India, is found in North-east India and Python molurus bivittatus is known from a single specimen from the Arunachal Pradesh, which was a first record for India. One can expect to sight both the snakes in 'Mouling National Park' in the Upper Siang District of Arunachal Pradesh. King Cobra (Ophiophagus hannah) is the most awe-inspiring reptile of the region. Typhlops jerdoni, T. tenuicollis, Stoliczkaia khasiensis, Elaphe mandarina, Oligodon melazonotus, Xenochrophis punctulatus, Bungarus bungaroides, Trimeresurus jerdoni are just a few examples of very elusive and rare snakes of North-east India.

Existing records indicate the presence of 64 species of amphibians in the North-east India but this figure again could be a gross underestimate as they are a poorly studied group in North-east India. A survey of amphibians conducted in the State of Nagaland from 1998 to 2002 has resulted in 19 species as new records for the State and 5 species (Megophrys wuliangshanensis, M. glandulosa, Amolops viridimaculatus, Rana humeralis and Rhacophorus gongshanensis) as new records for India.

Only four species of caecilians, Ichthyophis garoensis, Ichthyophis hussaini, Ichthyophis sikkimensis and Gegeneophis fulleri are known from North-east India. The Himalayan Newt (Tylototriton verrucosus) deserves a special mention, as it is the only species of Salamander known from India, occurring in Manipur, Khasi Hills and Sikkim in North-east India. Hitherto, they were little affected by man, but use of the pesticides in paddy cultivation is posing a threat to the species.

Fishes are the most ancient and numerous of vertebrates. Over 24,000 species of fishes are known in the world, and a majority of these are from warm tropical waters. North-east India is exceptionally rich in freshwater fishes, and it is

heartening to note that the region has been extensively surveyed, and accounts for 236 species. From the State of Manipur alone, 167 species of freshwater species belonging to 11 orders, 31 families and 84 genera are recorded. The fish fauna of Loktak Lake in Manipur comprises 64 species. Two of these species, Monopterus albus and Osteobrama belangeri are restricted in their distribution to the Yunan State of China, Myanmar, and in India only to the State of Manipur. The Loktak Lake also serves as the breeding ground for several species of migratory fishes e.g. Labeo dero, L. bata and Cirrhinus reba.

Sone Lake (12.5 km long and 3.0 km. wide), is one of the biggest tectonic lakes in Assam. It sustains 75 species of fishes under 24 families and 49 genera and of which, 20 species are widely distributed while 8 species are native to North-east India. Despite a very high diversity of fresh-water fishes, North-east India does not have many endemic species (the fish fauna of India contains 2 endemic families, both of which are absent from the region).

Invertebrates

The Biodiversity Strategy and Action Plan for North-east Ecoregion suggests that 3,624 species of insects and 50 molluscs are recorded from the region. Butterflies and moths are by far the best-studied invertebrate organisms in North-east India, and the region contributes the maximum number of species for the group in the country. A decade ago, 689 species of butterflies were recorded from the State of Sikkim. An ecological study on Mammals, Birds, Herpetofauna and Butterflies carried out in Teesta Basin, Sikkim, revealed nearly 350 species of butterflies in altitudes less than 900 m. (In the study area the family Nymphalidae is recorded to be the most species rich forming 50 per cent of the observed species, followed by Lycaenidae and Pieridae (17.2% each). Papilionidae and Hesperiidae have relatively low species richness, forming only 8.6 per cent and 7.0 per cent of the species, respectively). As species richness in the study area was found to be far greater than that reported earlier, especially at higher altitudes, this particular study highlights

the importance of altitudinal gradients in the distribution of butterflies, and in their conservation.

One of the largest known tropical Lepidoptera is the Atlas Moth (Attacus atlas), is common in many parts of North-east India. Princeps polyctor ganesa, which occurs in North-east India, is one of the most beautiful butterflies in the country, while, Erysmia pulchella and Nyctalemon patroclus are very beautiful moths that occur in the region. It is pertinent to add that sericulture is an age-old occupation for some people in states like Assam and Manipur, especially in the 'Loi' community in Manipur who have rendered the skill of silkworm rearing and silk weaving to art form.

Honey bees, render very valuable ecological services like pollinating wild and cultivated plant species apart from producing honey, and their advanced eusocial behaviour has always been a source of fascination for man. Four indigenous species of honey bees are recognised from India: Apis cerana, A. dorsata, A. florae and A. andreniformes. Of these, Apis andreniformis is only known from a few specimens collected from North-east India where the species is exceedingly uncommon. It is an unfortunate practice that people in certain parts of North-east India not only consume the honey and larvae of this insect, but also fry and eat the honey bees themselves.

Deforestation

The primary vegetation in extensive areas of the North-east India has been disturbed and modified and in some places destroyed by seismic activities, frequent landslides and resultant soil erosion. While these natural causes have contributed only marginally to the change in vegetation type, it is the activity of man that has led to the irreversible transformation in the landscapes and has resulted in colossal loss of biodiversity in the entire region. Human influences have pushed many species to the brink of extinction and have caused havoc to natural fragile ecosystems. Such devastations to natural ecosystems are witnessed almost everywhere in the region and is a cause of great concern.

North-east India has 64 per cent of the total geographical area under forest cover and it is often quoted that it continues to be a forest surplus region. However, the forest cover is rapidly disappearing from the entire region. There has been a decrease of about 1800 sq.km. in the forest cover between 1991 and 1999 (*Forest Survey of India*, 2000). More worrisome still is the fact that the quality of the forest is also deteriorating, with the dense forests (canopy closure of 40 per cent or more) becoming degraded into open forest or scrub. Though there is a succession of several edaphic formations, a vast area of land has already been transformed into barren and unproductive wastelands. This being the case, the statistics of 'more than 64 per cent of the total geographic area in this region under forest cover' could be misleading. For example, though the forest cover in Manipur extends to 78 per cent of the total geographic area, only 22 per cent of forest area is under dense forest cover and the rest has been converted to open forests.

Except in the Brahmaputra and Barak valleys of Assam where substantial areas are under agriculture, little of the land is available for settled cultivation. Hence, shifting agriculture or slash-and-burn agriculture is the major land use in North-east India and extends over 1.73 million ha (*Forest Survey of India*, 1999). Different agencies have come up with different figures concerning the total area under shifting cultivation (*jhum*) in the region. What is not disputable is that with an ever shortening jhum cycle, the other human influences have caused environmental degradation with disastrous consequences.

Though North-east India is predominantly mountainous, the region is very rich in aquatic ecosystem diversity. A large number of bheels, ponds and marshlands in the lowlying and floodplain areas of Assam, Arunachal Pradesh and Tripura represent the diversity in lentic ecosystems. However, deforestation and the resultant loss of soil, especially in the hill areas, are leading to increased siltation of rivers and streams. The deep pools that are the favoured habitats of many species, are rapidly becoming shallow and choked with

silt, leading to a decline in habitat. At the same time, swamps, marshes, and other wetlands are increasingly being reclaimed for urban and agricultural expansion.

The forests of Assam once acted as a sponge, absorbing the tremendous impact of the monsoons. The natural drainage of the vast North-eastern Himalaya is channelled through Assam and with the loss of thick forest cover, Brahmaputra, one of the largest and fastest flowing rivers of the subcontinent is creating havoc in the State. Floods that have devastating effects are now common to North-east India and protecting the forests is one vital step in containing this terrible problem.

Balakrishnan (1981) gives a graphic description of decimation of the vegetation of the region. In 1851, J.D. Hooker, on his expedition to Jaintia Hills had collected seven headloads of live Vanda coerulea (Blue Vanda orchid) plants for cultivation in England. Balakrishnan states that after 100 years, during various field trips stretching from 1965 to 1970, he could hardly spot a dozen plants even in remote forest areas of Nertiang where Hooker had made his collections. This is an indication of the rate at which primary forests and the wealth it carries are being irrevocably destroyed.

As early as in 1986, while describing the state of affairs concerning the forests of Arunachal Pradesh, A.K. Agarwal remarked, "the economics of forestry hinges on not only how good the forests are, but how effectively and how intelligently they are utilised. On this point the Arunachal Pradesh's record is decidedly poor". It is unfortunate that over two decades, things have only worsened. In all, at present more than 700 species of plants from the North-east India are facing the threat of survival in the wild.

Species Loss

Raman, (2001), studied bird occurrence and abundance patterns in secondary successional and mature tropical rainforests in a shifting cultivation mosaic habitat in Dampa Tiger Reserve, Mizoram. He found that many forest bird species, especially those with ranges restricted to North-east

India declined in abundance or disappeared in successional fallows unless regeneration exceeded 10 years.

Studies conducted by Gupta and Kumar (1994) revealed that the Phayrer's Langur (T. phayrei) could survive in secondary forests, provided that regeneration is allowed to continue at least for 9-10 years. However, a progressively shortening cycle of shifting cultivation and degradation of forests poses a threat even for such adaptive animals. Similarly, studies conducted by Raman, (1997) reveal that arboreal mammal species such as Malayan Giant Squirrel (Ratufa bicolor), Pallas's Squirrel (Callosciurus erythraeus) and Hoolock are dependent on tall, undisturbed primary forests or at least, late successional vegetation (25 years old, or more). However, it is a stark reality that in most parts of North-east India, fallow periods have declined to 5-10 years, and in some places may be as short as 3-5 years. With sharp decline in their populations, the role of birds, bats, ungulates and primates as seed dispersers is decreasing, leading to further impoverishment of the primary as well as the secondary forests.

Choudhury, while describing 'Meghalaya's Vanishing Wilderness' writes that there are good populations of Hoolock (Bunopithecus hoolock) in the forests of West Khasi Hills, but those are private and community lands and he is not too optimistic about their future there. It should be a matter of disquiet that only a meagre 4.4 per cent of the geographical area is under State Forest department, the rest being land belonging to other categories like Private Forest, Clan Forests, Community Forests, etc.

A vast majority of the indigenous inhabitants of this region are meat-eating in their food habits and almost all communities have expert hunters, trappers and fishermen. One can find bones, skulls and hides of large and small mammals in tribal huts. It should be noted that though the traditional practices of trapping, snaring etc. of animals are carried out in very remote areas, in most parts of North-east India shooting wild animals with guns is prevalent, giving very little chance for the denizens of the forests to recoup

from such pressures. Besides, certain meat is valued as medicinal and such animals are persecuted as great efforts are made by a few individuals to seek such animals and bring back home their body parts.

In the past, the hunting/trapping was done with considerable prudence with many taboos and restrictions. For example, the Anaal Naga in Manipur did not consume turtle or tortoise meat. The Maram Naga did not eat pork and the Thangkhul Naga did not eat any member of the cat family. Unfortunately, such taboos no more hold any sway among the people now.

It is a great irony that in many parts of North-east India some people poison the rivers, streams and other water bodies to get good catches of fish. Apart from using plant poisons, lime, DDT, copper sulphate (Cu SO_4) and, other synthetic chemicals are being used for fishing. Some are even using dynamite and gelatine sticks for the same purpose. This has serious ill effects on the entire aquatic ecosystems. Fish stocks are being entirely wiped out; several species of amphibians, birds and other fish predators are also being affected in the process; and nothing is known as to what happens to human beings on consuming such poisoned fishes.

North-eastern India is often called India's forgotten corner and it was perceived that the remoteness of the place has helped preserve its biodiversity. However, the penetration of roads into interior areas has already exposed the local populace to market economy, unscrupulous urban traders and middlemen in most parts of the region. A series of proposed dams that are across North-eastern region may lead to submergence of vast tracts of rainforests. Comprehensive environmental impact assessments, which are mandatory as per the law of the land, reveal the possible danger that these projects pose to the biodiversity of the region.

Conclusions

The ethnobotanical knowledge among the people of North-east India is praiseworthy. However, colossal deforestation

and the loss of species in the region is a matter of serious concern. Some research findings speak contrarily to the widely accepted view that the slash- and- burn type of cultivation is destructive in nature. Whatever be the results of studies on jhum cultivation *per se,* it cannot be ignored that certain ecosystems such as the rain forests are highly susceptible to man-made disturbances and there is a crying need for areas to be free from jhum in order to conserve the region's unique biodiversity. It is recommended that every State shall have at least 5 per cent of the geographical area under National Parks and Wildlife Sanctuaries, which cover natural ecosystems and greater emphasis need be given towards anti-poaching measures in such protected areas.

In order to achieve this, there ought to be an increase in forest personnel, who are appropriately trained and equipped, especially in the ranks of Forest Guard, Forester and Range Forest Officer. In areas outside the Protected Area Network, other forms of protection that involves participation of local communities should be followed. The impregnability of certain forests in North-east India is a source of protection, as this factor itself offers some hope for the survival of many species.

REFERENCES

Agarwal, A K (1986) Planning for the Development of Arunachal's Forests—an Approach. In: *Forestry Development in North-east India.* Gupta, M D; Gangopadhyay, A K; Bhattacharya, T and Chakraborti, M (eds). Omsons Publications, Guwahati.

Ahmed, M F (2003) *Amphibians of North-east India.* The Rhino Foundation for Nature in NE India, Newsletter No. 4. The Rhino Foundation, Guwahati.

Ali, S (1962) *The Birds of Sikkim.* Oxford University Press, New Delhi.

Ali, S and Ripley, S D (2001) *Handbook of the Birds of India and Pakistan.* Volume 1-10. Oxford University Press, New Delhi.

Anon. (1999) *Orchids of Manipur.* Wildlife Wing, Forest Department, Government of Manipur, Imphal.

Ao, J M; Bordoloi, S and Ohler, A (2003) Amphibian fauna of Nagaland with nineteen new records from the State including five new records for India. *Zoos' Print Journal* 18(6): 1117-1125.

Asham, B and Thapliyal, G S (1993) Natural distribution and ecological status of non-human primates in Arunachal Pradesh. *Indian Forester* 119(10): 834-843.

Balakrishnan, N P (1981) *Flora of Jowai*. Vol. 1. Botanical Survey of India, Kolkata. pp 1-30.

Bhupathy, S; Choudhury, B C and Moll, E O (1994) Conservation and Management of Freshwater Turtles and Land Tortoises of India. Final Report of the Turtle and Tortoise Conservation Project. Wildlife Institute of India, Dehra Dun. pp 46-62.

BirdLife International (2001) *Threatened birds of Asia: The BirdLife International Red Data Book*, Cambridge, UK.

Bist, S S (2002) *Conservation of elephants in NE India: Past, Present and Future*. pp 7-10. The Rhino Foundation for Nature in NE India, Newsletter No.4. The Rhino Foundation, Guwahati.

Budruk, M (1996) *Chakrashila golden langur haven. Sanctuary Asia* XVI(2): 26-31.

Choudhury, A U (1997) *Kaziranga. Sanctuary Asia* XVII(4): 42-50.

Choudhury, A U (2002) Tail Carriage in Pigtailed Macaque (Macaca nemestrina). *Tiger Paper* XXXIX(1): 1-2.

Choudhury, A U (2003) Meghalayas Vanishing Wilderness. *Sanctuary Asia* XXIII(5): 30-35.

Choudhury, A U (2003) *Status of Serow* (Capricornis sumatraensis) in Assam. *Tiger Paper* XXX(2): 1-2.

Choudhury, A U (2003) The Pig-tailed Macaque (Macaca nemestrina) in India—Status and Conservation. Primate Conservation. *The Journal of IUCN/SSC Primate Specialist Group*. (19): 91-98.

Choudhury, K D (1991) Captive Breeding of Comb Duck at Miao Aviary. *Zoos' Print Journal* 6(3): 4-5.

Daniel, J C (2002) The Book of Indian Reptiles and Amphibians. *Bombay Nat. Hist. Soc.*, Oxford University Press, Mumbai. 238p.

Daniels, R J R (1998) *A Field Guide to the Birds of Southwestern India*. Oxford University Press, Chennai. pp 1-16.

Daniels, R J R (2002) *Freshwater fishes of Peninsular India*. Indian Academy of Sciences, University Press, Hyderabad. 288p.

Das, I (1990) Distributional records for Chelonians from North-eastern India. *J Bombay Nat. Hist. Soc.* 87(1): 91-97.

Datta, S (1998) A Report on the discovery of Golden Langur at Chakrashilla Wildlife Sanctuary and its conservation. *Tiger Paper* XXV(2): 23-26.

Deb D B (1961) Monocotyledonous Plants of Manipur Territory. *Bull. Bot. Surv. Ind.* 3(2): 115-138.

Dehingia, A S (1991) Management of White-winged Wood Duck in captivity at Namdang Aviary, Assam. *Zoos' Print Journal.* Vol. 6, No.7.

Devashish K, Dey, SC; Swarupa Kar; Michael, R G and Madhav Gadgil (1996) Ichthyoecology, management and conservation of fish resources of Lake Sone in Assam. *Tiger Paper* XXIII(3): 27-32.

Dutta, A; Pansa, J; Madhusudan, M D and Mishra, C (2003) Discovery of the leaf deer Muntiacus putaoensis in Arunachal Pradesh: an addition to the large mammals of India. *Current Science* 84(3): 454-458.

Engel, M S (2002) Honey Bees of India, Hymenoptera: Apidae. *J Bombay Nat. Hist. Soc.* 99(1): 3-7.

Ghose, D (2002) First sighting of clouded leopard Neofelis nebulosa from Blue mountain National Park, Mizoram, India. *Current Science* 83(1): 20-21.

Ghose, D; Kaul, R and Saha, G K (2003) Status survey of the Blyth's Tragopan in Blue Mountain National Park, Mizoram, India, using call-count technique. *Current Science* 84(1): 95-97.

Grimmet, R; Inskipp, C and Inskipp, T (2000) *Pocket guide to the Birds of the Indian Subcontinent.* Oxford University Press. 384 p.

Gupta C A; Chandiramani, S S and Naik, R N (1999) Whitewinged Wood Duck rediscovered in Namdapha. *Tiger Paper* XXVI(2): 27-28.

Gupta, A (2000) The Beleaguered Chelonians of North-eastern India. Turtle and Tortoise Newsletter. *The Newsletter of chelonians and conservationists.* Silchar.

Gupta, A K (1994) Status and Conservation of non-human primate in Tripura, India. pp. 101-111 In *Current Primatology*, Vol.1: Ecology and Evolution. B Thierry; J R Anderson; J J Roeder

and N Herrenschmidt (Eds.). University of Louis Pasteur, Strasbourg.

Gupta, A K (2002) Primates Inside Wildlife Institute of India. *Sanctuary Asia* Vol. XXII.

Gupta, A K and Kumar, A (1994) Feeding ecology and conservation of the Phayre's leaf monkey, Presbytes phayrei, in North-east India. *Biological Conservation* 69(3): 301-306.

Hajra, P K (1996) *A contribution to the flora of Namdapha Arunachal Pradesh*. Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata. pp 1-18.

Hajra, P K and Verma, D M (1996) Flora of Sikkim. Vol.1 (Monocotyledons). Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata. pp 1-14.

Hajra, P K; Verma, D M and Giri, G S (1996) *Materials for the Flora of Arunachal Pradesh*. Vol. 1. (Ranunculaceae–Dipsacaceae). Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata. pp 1-9.

Hazarika, A A (1997) A report on the tiger census conducted in Dibrusaikhowa sanctuary and a prospective tiger reserve in upper Assam. *Tiger Paper* XXIV(1): 14-16.

Hynniewta, T M; Kataki, S K and Wadhwa, B M (2000) *Orchids of Nagaland*. Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata. pp 1-8.

Islam, M.Z. and Rahmani, A.R. (2002). Threatened Birds of India. *Buceros, ENVIS Newsletter: Avian Ecology and Inland Wetlands* 7 (1 and 2): 1-69.

Jha, A (2000) A preliminary status survey of cats in Sikkim. *Tiger Paper* XXVII(3): 12-14.

Johns, A., Kumar, Y and Sharma, J (2001) Orchids of India II. *Biodiversity and Status of Bulbophyllum Thou*. Daya Publishing House, Delhi.

Johnsingh, A J T (2002) *Bear Human Conflict in India*. Mitigating Human-Wildlife Conflicts: Towards a National Consultation Process. Centre for Environmental Science, Indian Institute of Science, Bangalore.

Kumar, A; Vijayan, L and Bhupathy, S (2003) An Ecological study on Mammals, Birds, Herpetofauna in Teesta Basin, Sikkim, In: Annual Report I (2002-2003) of the Salim Ali Centre for Ornithology and Natural History, Coimbatore.

Lal, R B and Ramakantha, V (1991) A Status Report on the Tropical Forests of Manipur. In Abstracts from 'International Workshop on Sustainable Forestry in Tropics'. Indian Environmental Society, Delhi.

Meena, H (1992) *The Butterflies of Sikkim Himalaya and their Natural History*. Sikkim Nature Conservation Foundation, Gangtok.

Mittermeier, R A; Myers, N and Mittermeier, C G (2000) *Hotspots*. Earth's biologically richest and most endangered Terrestrial Ecoregions. Cemex Conservation International, Cemex, Sierra Madre, Mexico City. pp 319-337.

Mondal, D K (1998) Lepidoptera 311-318 In *Faunal Diversity of India. Alfred*, J R B; Das, A K and Sanyal, A K(eds). Zoological Survey of India, Kolkata.

Mukhopadhayay, S K and Mukhopadhayay, D (1998) Emerald Mouling. *Sanctuary Asia* XVIII(3): 35-37.

Murthy, T S N and Ravichandran, M S (1998) Reptilia. pp. 434-447. In *Faunal Diversity of India*. Alfred, J R B; Das, A K and Sanyal, A K (eds). Zoological Survey of India, Kolkata.

Murthy, T S N; Sanyal, D P and Duttagupta, B (1993) Rare Snakes of India. *The Snake* Vol. 25, pp. 135-140.

Myers, N; Mittermeier, R A; Mittermeier, C G; Da Fonseca, G A B and Kent, J (2000) Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

Pawar, S S and Choudhury, B C (2000) An inventory of Chelonians from Mizoram, North-east India: new records and some observations on threats. *Hamadryad*. 25(2): 144-158.

Pillai, R S and Ravichandran, M S (1999) *Gymnophiona (Amphibia) of India: A taxonomic study*. Occasional Papers of the Zoological Survey of India 172: 1-117

Prater, S H (1971) The Book of Indian Animals. *Bombay Natural History Society*. Mumbai. 316p.

Ramakantha, V (1994) *A Pangolin episode*. Wildlife Institute of India News Letter. Vol.9, No.2. Wildlife Institute of India, Dehra Dun.

Ramakantha, V (1994) Natural distribution and ecology of mustelids and viverrids in Manipur, North-east India. The Newsletter and Journal of the IUCN/SSC. Mustelid, Viverrid and Procyonid Specialist Group. Number 11. IUCN.

Ramakantha, V (1995) A report on the threatened orchids of Manipur. *J Bombay Nat. Hist. Soc.* 92(1):144-145.

Raman, T R S (1997) Impact of shifting cultivation on diurnal squirrels and primates in Mizoram, North-east India: A preliminary study. *Current Science* 70(8): 747-750.

Raman, T R S (2001). Effect of slash- and-burn shifting cultivation on rainforest birds in Mizoram, North-east India. *Conservation Biology* 15: 685-698.

Rao, N A (2003) Medicinal marvels from the mountains of Arunachal Pradesh. *Amruth* 7(5): 3-8.

Rao, P R and Hajra, P K (1986) Floristic diversity of the eastern himalaya – in a conservation perspective. In *Proc. Indian Acad. Sci. (Anim. Sci./Plant. Sci.) Suppl.*, Indian Academy of Sciences, Bangalore. November 1986. pp 103- 125.

Rodgers, W A and Panwar, H S (1988) *Planning a Wildlife Protected Area Network in India.* Vol.2. Wildlife Institute of India. Dehra Dun.

Sahagal, B (1997) Fifty Indian Tragedies in the making. *Sanctuary Asia* XVII(5): 20-41.

Sahagal, B (2000) North-east India. Threatened Paradise. *Sanctuary Asia* Vol. XX No. 3.

Sen, D (2001) The Last Eden: Land of the Sherdukpen. *Sanctuary Asia* XXI(3): 24-29.

Shukla V and Baishya A K (1979) A contribution to the flora of Manipur. *J. Bombay Nat. Hist. Soc.* Vol.76, No.2.

Singh, K K; Kumar, S; Rai, L K and Krishna, A P (2003) Rhododendrons conservation in the Sikkim Himalaya. *Current Science* 85(5): 602-606.

Singh, N P; Chauhan, A S and Mondal M S (2000) *Flora of Manipur.* Vol. 1. (Ranunculaceae–Asteraceae) Botanical Survey of India, G.O.I., Kolkata.

Singh, N P; Singh, K P and Singh, D K (2002) *Flora of Mizoram.* Vol.1. Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata, pp 1-26.

Singh, R (1975) Keibul Lamao Sanctuary and the Browantlered Deer –1972 with a notes on a visit in 1975. *J. Bombay Nat. Hist. Soc.* Vol.72, No. 2.

Singh, T H and Singh, S R K (1994) Ramsar Sites of India. *Loktak Lake*. WWF-India. New Delhi. 69p.

Singh,Y P; Gangwar, S K; Kumar, D; Kushwaha, R V; Azad Thakur, N S and Mahesh Kumar (1995) Rodent Pests and their Management in North-eastern Hill Region. *Technical Bulletin. Division of Entomology*, ICAR Research Complex for NEH Region, Meghalaya. 35p.

Sinha, S C (1996) *Medicinal Plants of Manipur*. Mass & Sinha, Imphal.

Srivatsava, A (1999) *Primates of North-east India*. Megadiversity Press, Bikaner.

Sundriyal, M and Sundriyal, R C (2003) Underutilised edible plants of the Sikkim Himalaya: Need for domestication. *Current Science* 85(6): 731-736.

Takhtajan, A (1969) *Flowering Plants, Origin and Dispersal*. Oliver and Boyd, Edinburgh.

Taylor, E H (1961) Notes on Indian Caecilians. *Journal of the Bombay Natural History Society* 58(2): 355-365

Taylor, Jesse Oak (2000). In search of the Clouded Leopard. *National Geographic*. 198(3): 114-123.

Tripathi, R S and Barik, S K (2003) *National Biodiversity Strategy and Action Plan Report for North-east India*. Ministry of Environment and Forests, New Delhi.