

## CONSERVING BIODIVERSITY IN THE SPECIES-RICH FORESTS OF ANDHRA PRADESH IN EASTERN GHATS, INDIA

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**ABSTRACT.** Varied physiographic and climatic conditions in the Eastern Ghats region of India once supported biodiverse flora, fauna, and habitats. Apart from mangrove forests, the Eastern Ghats has largely deciduous forests, dry and moist, alternately occupying scrub jungles. Because of deforestation and the swidden or shifting cultivation practiced by tribal groups, dense forests are now limited to only a few pockets. As a result, wildlife species are affected by an increasing threat to their survival. For instance, the cheetah is now extinct in the region, and the tiger is being pushed to the edge. Diversity is drastically reduced among plants, animals, and habitats. The author reports on the current status of species richness among faunal groups in the region.

**Key words:** Biodiversity, conservation, species richness, Eastern Ghats, Andhra Pradesh, India

### INTRODUCTION

In 1900, forests covered 40% of India's land. By 1964, forest coverage was reduced to 34%; and today it is 10–11%. Most surviving forests, as well as most surviving wildlife, are located at higher elevations. The Himalayas, Vidhya, Western Ghats, and Eastern Ghats form India's chief mountain ranges; but in contrast to the mountain peaks of the Western Ghats, the Eastern Ghats are a long chain of broken isolated hills. Information on the ecology of the Ghats remains meager.

As weathered relics of peninsular India, the Eastern Ghats reach varying altitudes and include plateaus, escarpments, mesas, butts, and intermountain basins, valleys, and gorges. Parallel ridges of crystalline metamorphic rock run north-to-east and south-to-west, with elevation varying from a few meters to 1750 m at Biligiri Rangan Hills.

The Eastern Ghats chain is spread over three states (FIGURE 1): Orissa (three districts), Andhra Pradesh (14 districts), and Tamilnadu (seven districts). Andhra Pradesh is home to 35% of Indian sub-continent vertebrates and to some of India's rarest species. The chain of hills forms continuous, parallel ridges in most districts, except for interruptions between the Godavari and Krishna deltas. Perennial rivers, such as the Godavari, Krishna, and Pennar, have their origins in Western Ghats; but ephemeral rivers, such as the Nagavali, Varnsadhara, and Sarada, originate in Eastern Ghats. Eastern Ghats coastal areas have foothills and hillocks running parallel to the Bay of Bengal.

Because of the comparatively rich variety of wildlife found in Andhra Pradesh, the author chose this state for his study of biodiversity con-

servation. Based on ecological conditions, the Ghats in Andhra Pradesh are classified into three zones: Northern Ghats, Central Ghats, and Southern Ghats.

**Northern Ghats.** The forests of Northern Ghats cover foothills, plateaus, and coastal plains in Sileru in the Machkund Basin and in the Godavari River Basin in the districts of Srikakulam and Khammam. Average elevation is 1150 m, with the highest elevation at 1501 m in Mahendragiri near the Orissa state border. Semi-evergreen forests support moist vegetation, and deciduous forests support moist-to-dry vegetation, riverines, and streams. Foothills and plateaus are covered by dry deciduous and occasionally scrub vegetation. Legris and Meher-Homji (1982) classified Northern Ghats vegetation in three strata: upper canopy, intermediate stories, and scrub-covered ground. Semi-evergreen vegetation is characterized by the presence and prominence of sal, *Shorea robusta*; and deciduous vegetation is characterized by teak, *Tectona grandis*. Forest density varies from 0.3% to 0.8%.

**Central Ghats.** The Nallamalai formations occur mostly in the Central Ghats zone in the districts of Guntur, Prakasam, and Kurnool. The elevation of these continuous hills is 750–1000 m. The Krishna River flows through the Nallamalai, and perennial streams support forests of tropical, semi-evergreen, and moist and dry deciduous vegetation. The three general types of Nallamalai forests are upper canopy, dry and moist deciduous isolated patches, and evergreen vegetation along perennial streams. After the rainy season, grass cover is often continuous but gradually disappears during summer (TABLE 1).

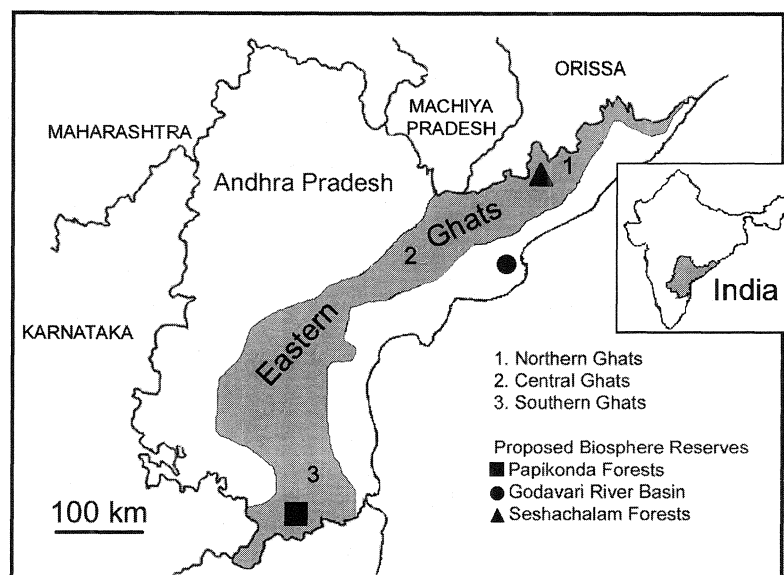


FIGURE 1. Distribution of Eastern Ghats forests in Andhra Pradesh classified into three zones: 1. Northern Ghats, 2. Central Ghats, and 3. Southern Ghats; and proposed Biosphere Reserves.

**Southern Ghats.** The Seshachalam and Eramalais are Southern Ghats formations in the Andhra Pradesh districts of Chittoor, Nellore, and Anantapur. These comparatively small ranges with dry conditions receive lower annual rainfall and have higher temperatures and less humid conditions than the other two regions. The main vegetation is dry evergreen and deciduous-to-scrub vegetation, mostly of the thorny type (TABLE 1).

#### ECOLOGICAL SIGNIFICANCE

The Andhra Pradesh State Forest has half of its area in the steep, peak-studded hills of Eastern Ghats, with 1 million ha in the Northern Ghats zone and 2.2 million ha in Central and Southern Ghats. Northern Ghats forests, while smaller in area, are dense and of high quality. Central and Southern Ghats forests receive less rainfall and have higher temperatures.

**Physiography.** The Eastern Ghats chain is made up of various rocks, such as khondalites, charnockites, gneises, and schists of igneous and sedimentary origin (Krishnan 1958). Ancient metamorphic rocks of diverse material are composed of highly complex substances of different ages, dating back 2.4 billion years to the Jurassic. Sedimentary rocks, formed in Eastern Ghats and highly metamorphosed, include quartz, mica schists, manganiferous sediments, and crystal-

line limestones. A conspicuous member is khondalite with quartz garnets and sillimanite-graphic schists. Phosphorous-rich granites, alumina, iron, and bauxite also occur in the Eastern Ghats.

**Climate.** The climate of the Eastern Ghats chain is typically tropical with a thermal potential sufficient to support development of luxuriant forest vegetation. The region has three seasons: summer (March–May), rainy (June–October), and winter (November–February). The Northern Ghats zone is characterized by low temperature, high humidity, and medium-to-heavy rainfall. The Southern Ghats zone has high temperature and relatively low humidity and rainfall. Temperatures vary from 41°C in summer to a low of 6°C in winter, and annual rainfall is 1200–1500 mm.

**Tribal groups.** Of the 33 officially recognized tribal groups of Andhra Pradesh, 27 live in the Eastern Ghats chain. The Chenchus and Yanadis are the dominant groups in the Southern Ghats zone. The government of India has recognized the Chenchus and Kondareddi as primitive tribal groups. Swidden or shifting cultivation, a major cause of environmental problems in the Eastern Ghats, is practiced by tribal groups from the Adilabad district along the Godavari River to the Karimnagar district between the Srisailem and Nallamalai formations. To

TABLE 1. Distribution of forest types and key plant species in the Eastern Ghats range of Andhra Pradesh, India. This chain of steep hills is divided into three zones: Northern Ghats, Central Ghats, and Southern Ghats, adjoining coastal plains on the Bay of Bengal.

Forest type: Semi-evergreen. Distribution zone: Northern Ghats		
<i>Artocarpus lakoocha</i>	<i>Macaranga peltata</i>	<i>Pittosporum napaulense</i>
<i>Bridelia tomentosa</i>	<i>Mangifera indica</i>	<i>Polyalthia cerasoides</i>
<i>Dellina pentagyna</i>	<i>Michelia champka</i>	<i>Xylia xylocarpa</i>
Forest type: Moist deciduous. Distribution zone: Northern and Central Ghats		
<i>Adina cordifolia</i>	<i>Dendrocalamus strictus</i>	<i>Schleichera trijuga</i>
<i>Anogeissus latifolia</i>	<i>Kydia calychna</i>	<i>Terminalia tomentosa</i>
<i>Bridelia retusa</i>	<i>Polyalthia cerasoides</i>	<i>Xylia xylocarpa</i>
<i>Careya arborea</i>	<i>Pterocarpus marsupium</i>	
Forest type: Dry deciduous. Distribution zone: Central and Southern Ghats		
<i>Cassia fistula</i>	<i>Pterocarpus marsupium</i>	<i>Terminalia alata</i>
<i>Madhuca longifolia</i>	<i>Sterculia urens</i>	<i>Terminalia chebula</i>
Forest type: Scrub. Distribution zone: Southern Ghats		
<i>Acacia chundra</i>	<i>Cassia auriculate</i>	<i>Hugonia mystex</i>
<i>Albizia amera</i>	<i>Dodonaea viscosa</i>	<i>Lantena camera</i>
<i>Anogeissus latifolia</i>	<i>Eupatorium</i> sp.	<i>Xerophis spinesa</i>
<i>Carissia apinarum</i>	<i>Euphorbia tiricallia</i>	
Forest type: Mangrove: Mangrove. Distribution zone: Coastal Plains		
<i>Acanthus ilicifolius</i>	<i>Bruguiera gymnorrhiza</i>	<i>Rhizophora candellaria</i>
<i>Avicennia officinalis</i>	<i>Excoecaria agallocha</i>	<i>Sesuvium portulacastrum</i>
<i>Bruguiera cylindrica</i>	<i>Lumnitzera racemosa</i>	<i>Sonneratia apetala</i>

counteract swidden cultivation and other causes of environmental problems, such as monoculture practices, timber exploitation, and industrial activity, efforts are being made to increase forest cover through afforestation and Joint Forest Management (JFM) programs now in progress.

**Flora.** The vegetation of the Eastern Ghats is mainly dry deciduous and moist deciduous. Forests, apart from the mangrove forests in Andhra Pradesh, are largely dry with moist deciduous vegetation alternately occupying scrub jungles. Dense forests are limited to a few pockets. Patches of semi-evergreen forests survive scattered among moist deciduous vegetation at high elevations. In addition, a vast spread of dry deciduous forest has degraded into thorny scrub. The Northern Ghats zone consists of mixed deciduous vegetation, moist and dry, as well as semi-evergreen patches. The Southern Ghats zone largely supports dry deciduous and thorny scrub (TABLE 1). In Andhra Pradesh, valuable forest vegetation includes medicinal plants (TABLE 2).

**Fauna.** In Andhra Pradesh, eight species of amphibians and 41 species of reptiles are recorded (Subba Rao 1992, see TABLE 3). These include a golden gecko, *Calodactylus aureus*, recorded in this state for the first time, and four other reptiles with new distributional records. Also recorded are 19 species of rare and endan-

gered birds (TABLE 4) and 46 species of mammals (TABLE 5). Besides faunal diversity, the author has studied the distribution, habitat, and abundance of reptile, amphibian, and mammal species. Among the wildlife found in Andhra Pradesh are more than 1000 species of mammals, 500 varieties of birds, and nearly 100 species of reptiles and amphibians, as well as several other terrestrial and aquatic species. Endangered animals include the tiger, leopard, fishing cat, Asian elephant, black buck, chinkara, four-horned antelope, mouse deer, slender loris, and smooth Indian otter. The Indian bustard and Jerdon's courser are both threatened birds. Salt-water crocodiles, once found throughout the coastal marshy plains, have disappeared from their original habitat (Subba Rao and Bustard 1992). The golden gecko, among India's rarest species, is found only in the Eastern Ghats of Andhra Pradesh, at Seshachalam hills in Chittoor district (Daniel 1985) and Ananthagiri hills of Visakhapatnam district (Subba Rao 1989). Thought to be extinct for nearly a century, this reptile was only recently rediscovered. Another reptile species, the limbless lizard, *Barkudia insularis*, is also endemic to Visakhapatnam (Subba Rao 1992).

## RESULTS

For the first time in India, a comprehensive study of herpetofaunal and mammalian resourc-

TABLE 2. Selected medicinal plants of the Eastern Ghats range of Andhra Pradesh, India.

<i>Acacia nilotica</i> ssp. <i>indica</i> (Benth.) Brenan	<i>Helicteres isora</i> L.
<i>Achyranthes aspera</i> L.	<i>Hemidesmus indicus</i> (L.) Schult.
<i>Adenia wightiana</i> (Wall. ex Wt. & Arn.) Engl.	<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex Don
<i>Adhatoda zeylanica</i> Medic.	
<i>Aerva lanata</i> (L.) Juss.	<i>Ichnocarpus frutescens</i> (L.) R. Br.
<i>Ailanthus excelsa</i> Roxb.	<i>Ipomea aquatica</i> Forsk.
<i>Alangium salvifolium</i> (L. f.) Nees	
<i>Albizia lebeck</i> (L.) Benth.	<i>Jatropha gossypifolia</i> L.
<i>Andrographis echinoides</i> (L.) Nees	
<i>Andrographis panichulata</i> (Burm. f.) Nees	<i>Kalanchoe pinnata</i> (Lam.) Pers.
<i>Annona squamosa</i> L.	<i>Kirganelia reticulata</i> (Poir.) Baill.
<i>Argemone mexicana</i> L.	<i>Lepidagathis cristata</i> (Retz.) Wt. & Am.
<i>Aristolochia bracteata</i> Lam.	<i>Leucas cephalotes</i> (Roth) Spreng.
<i>Aristolochia indica</i> Lam.	<i>Limonia elephantum</i> (Correa) Panigrahi
<i>Asparagus racemosus</i> Wild.	<i>Litsea monopetala</i> Pers.
<i>Asystasia gangetica</i> (L.) Aanders.	
<i>Azadirachta indica</i> A. Juss.	<i>Macaranga peltata</i> (Roxb.) Muell.
	<i>Madhuca longifolia</i> (Keon.) Macb.
<i>Balanitis aegyptiaca</i> (L.) Del.	<i>Mallotus philippensis</i> (Lam.) Muell.
<i>Boswellia serrata</i> Roxb. ex. Coleb.	<i>Martynia annua</i> L.
<i>Bridelia ratusa</i> (L.) Spreng.	<i>Mollugo cerviana</i> (L.) Ser.
<i>Buncharania axillaris</i> (Dres.) Ramamurthy	
	<i>Ocimum americanum</i> L.
<i>Caesalpinia bonduc</i> (L.) Roxb.	<i>Ocimum gratissimum</i> L.
<i>Calotropis gigantea</i> (Retz.) R. Br.	<i>Ocimum sanctum</i> L.
<i>Carica papaya</i> (Lour.) Cogn.	
<i>Cassia occidentalis</i> L.	<i>Passiflora foetida</i> L.
<i>Catharanthus roseus</i> (L.) G. Don	<i>Pergularia daemia</i> (Forsk.) Chiov.
<i>Celosia argentea</i> L.	<i>Phyllanthus nodiflora</i> (L.) Green
<i>Ceropegia candelabrum</i> L.	<i>Phyllanthus emblica</i> L.
<i>Cleistanthus collinus</i> (Roxb.) Diels	<i>Phyllanthus amarus</i> Schum. & Thonn.
<i>Cleome gynandra</i> L.	<i>Piper triocum</i> Roxb.
<i>Cleome viscosa</i> L.	
<i>Clerodendrum serratum</i> (L.) Moon	<i>Rauwolfia serpentina</i> (L.) Benth.
<i>Cocculus hirsutus</i> (L.) Diels	<i>Ricinus communis</i> L.
<i>Coldenia procumbens</i> L.	<i>Rubia cordifolia</i> L.
<i>Colebrookea oppositifolia</i> Smith	<i>Rungia pectinata</i> (L.) Nees
<i>Cordia dichotoma</i> Forst.	
<i>Costus speciosus</i> (Koenig) Smith	<i>Salacia chinensis</i> L.
<i>Cryptolepis buchananii</i> Roem. & Schult.	<i>Schrebera switinioides</i> Roxb.
	<i>Semecarpus anacardium</i> L. f.
<i>Datura metel</i> L.	<i>Solanum indicum</i> L.
<i>Digera muricata</i> (L.) Mart.	<i>Solanum sarrattense</i> Burm. f.
	<i>Solena heterophylla</i> Lour.
<i>Ecbolium viride</i> (Forsk.) Alston	<i>Soymida febrifuge</i> (Roxb.) A. Juss.
<i>Eclipta prostata</i> (L.) L.	<i>Stemodia viscosa</i> Roxb.
<i>Euphorbia hirta</i> L.	<i>Strychnos nux-vomica</i> L.
<i>Euphorbia tirucalli</i> L.	
<i>Evolvulus alsinoides</i> (L.) L.	<i>Terminalia cordifolia</i> (Willd.) Hook. f.
<i>Ficus heterophylla</i> L.	<i>Trianthema poortulacastrum</i> L.
	<i>Tridax procumbens</i> L.
<i>Gloriosa superba</i> L.	
<i>Gmelina arborea</i> Roxb.	<i>Vitex altissima</i> L. f.
<i>Grangea maderaspatana</i> (L.) Poir.	<i>Vitex negundo</i> L.
<i>Guizotia abyssinica</i> (L.) Cass.	
<i>Gymnema sylvestre</i> (Retz.) R. Br.	

es in the Eastern Ghats of Andhra Pradesh was made based on a systematic survey and intensive investigation including species richness. During the study, eight species in four families of Amphibia and four species in 13 families and four orders of Reptilia were recorded. Rediscovery of the golden gecko, *Calodactylus aureus*, was a major find. Four other reptiles were reported with new distributional records, along with the limbless lizard, *Barkudia insularis*,

which is endemic to Visakhapatnam (Subba Rao 1992). The study recorded 19 species of rare and endangered birds and 46 species of mammals in nine orders (Subba Rao 1993). These included three Insectivora species, four Chiroptera spp., four Primate spp., 14 Carnivora spp., 11 Artiodactyla spp., seven Rodenta spp., and one species each of Proboscidae, Lagomorpha, and Pholidota (TABLE 5).

In addition to these faunal discoveries, the

TABLE 3. Herpetofauna of the Eastern Ghats range of Andhra Pradesh, India.

Class	Order	Family	Species	
Amphibia	Anura	Ranidae	<i>Rana hexadactyla</i> <i>Rana cyanophlyctus</i> <i>Rana tigrina</i> <i>Rana cressa</i>	
		Bufonidae	<i>Bufo melanostictus</i> <i>Bufo fergusonii</i>	
Reptilia	Testudinata	Rhacophoridae	<i>Rhacophorus leucmystax</i>	
		Chelonidae	<i>Lepidochelys olivacea</i> <i>Eretmochelys imbricata</i> <i>Chelonia mydas</i>	
		Emydadae	<i>Lissemys punctata granosea</i> <i>Kachuga tectus tenerica</i>	
		Testudininae	<i>Geochelone elegans</i>	
		Loricata	Crocodylidae	<i>Crocodylus porosus</i> <i>Crocodylus palustris</i>
			Squamata	Gekkonidae
	Sub-order: Sauria	Chamaeleonidae	Chamaeleonidae	<i>Chamaeleon zeylanicus</i>
			Scincidae	<i>Mabuya beddomii</i> <i>Mabuya carinata</i> <i>Lygosoma dussumieri</i> <i>Riopa punctata</i> <i>Barkudia insularis</i>
		Ophidia	Varanidae	<i>Varanus bengalensis</i>
			Typhlopidae	<i>Typhlops beddomii</i>
			Boidae	<i>Python molurus</i> <i>Eryx johani johani</i>
			Colubridae	<i>Oligodon arnensis</i> <i>Amphiesma stolata</i> <i>Atretium schistesum</i> <i>Dryophis pulverulentus</i> <i>Enhydris enhydris</i> <i>Lycodon striatus</i> <i>Lycodotrevancoricus</i> <i>Lycodon auricus</i> <i>Natrix piscator</i> <i>Bungarus molurus</i> <i>Naja naja naja</i> <i>Naja hannah hannah</i>
Elapidae	<i>Vipera russe</i>			
Viperidae				

study considered the status of individual species with regard to their distributional habitats. It also surveyed reptile, amphibian, and mammal abundance.

As a result of the study, comprehensive management programs have been developed to conserve threatened and endangered reptiles, such as the Olive Redley sea turtle, *Lepidochelys olivacea*; the color-changing lizard, *Chamaeleon*

*zeylanicus*; and the monitor lizard, *Varanus bengalensis*.

#### CONCLUSIONS

With more than half of India's fauna already threatened or endangered, establishment of a balanced environment is essential to ensure survival of existing diversity. Faunal resources are

TABLE 4. Rare and endangered avian fauna in the Eastern Ghats range and surrounding areas of Andhra Pradesh, India.

Species	Common name	Rare	Endangered
<i>Anastorus oscitans</i>	Open-billed stork	*	
<i>Anphracoceros coronatlis</i>	Pied hornbill		*
<i>Ardea cinerea</i>	Grey heron	*	
<i>Choriotus nigriceps</i>	Great Indian bustard		*
<i>Cursorius bitorguatus</i>	Jerdon's courser		*
<i>Dinopium benghalensis</i>	Golden-backed woodpecker		*
<i>Gallus gallus</i>	Red jungle fowl		*
<i>Gallus sonneratii</i>	Grey jungle fowl		
<i>Haliaeetus leucogister</i>	White-bellied sea eagle	*	
<i>Haliastur indus</i>	Brahmini kite		
<i>Larus brunnicephalus</i>	Brown-headed quill	*	
<i>Leptoptilos dubius</i>	Adjusant stork	*	
<i>Libis luecocephalus</i>	Painted stork		*
<i>Pavo cristatus</i>	Peacock or peafowl		*
<i>Pelecanus philippensis</i>	Grey pelican		*
<i>Phenicopterus roseus</i>	Flamingo		*
<i>Picoides manus</i>	Pigmy woodpecker		*
<i>Sypheotides indica</i>	Lesser florican		*
<i>Tockus birostris</i>	Grey hornbill	*	

being depleted mainly because of economic exploitation, habitat destruction, and an uninformed public.

India's National Forest Policy is to maintain 33% forest cover; and although state forest departments control 23% (75 million ha) of total land area, satellite imagery shows only 9% (28 million ha) in forest cover. Human activity, including various development schemes, is the chief threat to forest ecology. Swidden or shifting cultivation, a common agricultural practice among tribal groups in the Eastern Ghats, results in the loss of valuable plant cover and removal of invaluable top soil affecting fertility. The study found complete disappearance of certain plant species at Aruku and Ananthagiri.

Monoculture alters microclimatic conditions and mineral cycles and results in poor underground vegetal growth. Construction works, such as roads, buildings, and the laying of railway tracks and electrical cables, increase accessibility but also threaten the ecological balance. As a result, sensitive species, such as many bryophytes, are becoming sparse in areas where their growth was luxuriant a decade ago. Mining is a major cause of forest degradation. An ever-growing demand for timber and firewood results in increased deforestation, which leads to adverse environmental changes.

Industrialization is the root of ecological disruption in the Eastern Ghats, as the ecosystem simultaneously acts as source (e.g., forests supply wood for the paper industry) and sink (e.g., bodies of water receive industrial discharge). The wildlife depletion observed in this study is

attributable mainly to destruction of natural habitats by expanding agriculture, urbanization, and industrialization. Among the culprits are overgrazing by domestic animals; poaching for meat, eggs, skin, fur, and ivory; and the export of some species.

Most herpetofaunal habitats are being lost, degraded, or decimated as the result of human activity. Although woody habitats are the most affected areas, scrub jungles and fallow lands also are deteriorating rapidly. In the Eastern Ghats of Andhra Pradesh, a number of organisms face severe habitat loss. These include reptiles (Indian chameleon, golden gecko, and limbless lizard); birds (Jerdon's courser, Indian bustard, and lesser florican); and mammals (slender loris, musk deer, and black buck). As for aquatic ecosystems, both freshwater and estuarine habitats are being threatened. Many bodies of water are deteriorating because of erosion or siltation.

Human activities in the Eastern Ghats include both official and unofficial programs. In the first category are forest operations approved by the government of India, rural agricultural and tribal development programs, and a large amount of permitted development by individuals and local governments. Unofficial activities lack approval and are in violation of existing law; for example, swidden or shifting cultivation or unregulated collection of forest produce and game.

No scientific work has been conducted in the forest sanctuaries of the Biosphere Reserves in Andhra Pradesh, except for a few working plans prepared by the State Forest Department. These

TABLE 5. Mammals of the Eastern Ghats range of Andhra Pradesh, India.

Species	Common name (* = endangered)
<i>Antelope cervicapra</i>	Black buck
<i>Axis axis</i>	Chital or spotted deer
<i>Bandicoota bengalensis</i>	Bandicoot rat
<i>Bos gaurus gaurus</i>	Indian bison*
<i>Boselaphus tragocamelus</i>	Nilgai or blue bull
<i>Bubalus bubalis</i>	Wild buffalo*
<i>Canis aureus</i>	Indian jackal
<i>Canis pallipes</i>	Indian wolf
<i>Cerus unicorn</i>	Sambar
<i>Cyon alpinus</i>	Wild dog
<i>Elephas maximus</i>	Indian elephant*
<i>Felis chaus</i>	Jungle cat
<i>Felis vierrina</i>	Fishing cat
<i>Funambulus palmarum</i>	Striped palm squirrel
<i>Gazella benneti</i>	Indian bison
<i>Gerbillus indica</i>	Indian gerbelle
<i>Herpestes mungoose</i>	Common mungoose
<i>Hyaena hyaena striata</i>	Hyena
<i>Hystrix indica</i>	Porcupine
<i>Lepus nigricollis</i>	Common hare
<i>Loris tardigradus</i>	Slender loris*
<i>Lutra vulgaris</i>	Water otter
<i>Macaca muletta</i>	Rhesus monkey
<i>Macaca radiata</i>	Bonnet monkey
<i>Manis crassicaudata</i>	Scaly anteater
<i>Melursus ursinus</i>	Sloth bear
<i>Muntiacus muntjac</i>	Barking deer
<i>Mus booduga</i>	Indian field mouse
<i>Mus rattus rattus</i>	Common house rat
<i>Panthera pardus</i>	Indian panther
<i>Panthera tigris</i>	Tiger*
<i>Pareuchinus nudiventris</i>	Hedgehog
<i>Pipistrellus coromandra</i>	Indian pipistrelle
<i>Presbytis entellis</i>	Common langur
<i>Pteropus giganteus</i>	Indian flying fox
<i>Ratufa indica</i>	Indian giant squirrel
<i>Rousettus leschenaults</i>	Fulvous fruit bat
<i>Suncus caeruleus</i>	Musk shrew
<i>Sus cristatus</i>	Indian wild boar
<i>Taphozous melanopogon</i>	Bearded sheath-tailed bat
<i>Tetracerus quadricornis</i>	Four-horned antelope
<i>Tragulus meminna</i>	Mouse deer*
<i>Tupia ellioti</i>	Tree shrew
<i>Viverricula indica</i>	Indian civet cat
<i>Vulpes bengalensis</i>	Indian fox

plans, mainly for social forestry plantations, deal very little with conserving wildlife habitat.

From survey data, habitat trends indicate that all seven recognized reptile habitats in Andhra Pradesh are being fragmented at an alarming rate. Thus habitat restoration needs to be a vital component of forest management programs to improve reptile habitat, help ensure a balanced ecosystem, conserve native flora and fauna, and serve as a model for other regions.

As a first step, certain areas need protection from human activities. Based on the quality of Eastern Ghat's environment and its species di-

versity, the author proposes the creation of three Biosphere Reserves (FIGURE 1). Such protected areas will have manifold uses besides creating a continuous stretch of habitat in which native flora and fauna may survive under natural conditions. Reserves will need to be monitored by an independent body appointed by the State Wildlife Division. New legislation will be needed to assure that governmental departments and quasi-governmental groups conduct their activities in compliance with instructions issued by the Biosphere Reserve executive board. Reserves will need well-qualified wildlife conservation per-

sonnel and infrastructural, financial, and administrative facilities.

Based on the study results, the author recommends that the following conservation measures be taken immediately to protect and manage wildlife:

- 1) Protect natural habitats;
- 2) Maintain a viable number of species in protected areas, such as sanctuaries, national parks, and Biosphere Reserves;
- 3) Establish Biosphere Reserves for plants and animal species;
- 4) Pass new protective legislation; and
- 5) Educate the public on the need for environmental protection.

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