Biogeography of the Reptiles of South Asia

by

Indraneil Das

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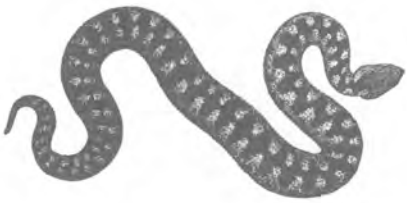

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Cover: Montane trinket snake (*Elaphe helena monticollaris*). Photo: Indraneil Das

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All photographs: Indraneil Das

THE AUTHOR

Indraneil Das received his doctorate in zoology from the University of Oxford for his work on community ecology. Between December 1991 and September 1993, he was with Universiti Brunei Darussalam, conducting a study of the distribution and ecology of rainforest amphibians and reptiles of Borneo. Currently, Dr. Das is a Fulbright Fellow at Harvard University as well as Chairman of the IUCN/SSC South Asian Reptile and Amphibian Specialist Group. Besides biogeography, he is interested in taxonomy and systematics of living amphibians and reptiles, fossil turtles, conservation biology, and community ecology. His other books include *Indian Turtles: A Field Guide* (1985); *Colour Guide to the Turtles and Tortoises of the Indian Subcontinent* (1991); *The World of Turtles and Crocodiles* (with Rom and Zai Whitaker, 1993); *The Turtles and Tortoises of India* (1995) and *The Animal Biodiversity of Borneo* (with Joe Charles, in preparation).

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Chapter 1

INTRODUCTION

South Asia supports a highly diverse and distinct reptile fauna, the high taxon richness figure following from the large area, covering *circa* 4.36 million square kilmetres, and its situation at the crossroads of two distinctive biogeographic realms, the Palaearctic and the Oriental. Responsive to the considerable climatic and physiographic variability, habitats range from coral reefs, mangrove swamps and closed-canopy rain forests to thorn scrub vegetation and deserts. The region also includes several extreme environments, including the highest mountain and wettest location on earth.

South Asia includes Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka (Figure 1). Elsewhere, this region is referred to as the Indo-Pakistan subcontinent, the Indian subcontinent, and the Indian region. With formidable geographic barriers impeding faunal movement, including oceans, mountains, and flood plains, the region represents a distinct biogeographic unit (*cf.* Ripley and Beehler, 1990).

The treatises of Smith (1931; 1935; 1943) continue to be the authoritative sources for identification of the subcontinent's reptile fauna, despite being over half a century old. A number of squamates, especially lizards, have been described since. Murthy (1985) attempted to list all valid species then known. His work, besides containing a number of errors and omissions, includes no analysis of distributional patterns and is restricted to India. Thanks to organisations (including the Bombay Natural History Society, Herpetological Laboratory at Rabwah, Madras Crocodile Bank Trust, Wildlife Institute of India, Zoological Survey of India, Zoological Survey Department of Pakistan, as well as numerous universities in the subcontinent) and a number of European and American colleagues, our knowledge of the distribution of reptiles is considerably more refined than during Smith's time.

Biogeographic analyses of the herpetofauna, mostly for individual countries within the subcontinent, have been attempted: Mahendra (1939) and Jayaram (1974) for south Asia, Biswas and Sanyal (1980) for the Bay Islands, Swan and Leviton (1962) for Nepal, Minton (1966) for Pakistan, de Silva (1990) for Sri Lanka, and Bauer and Günther (1992) for Bhutan. In the present work, I have drawn on these and other sources for the distributional data used, although not necessarily agreeing with these workers on the interpretation.

During publication of this text, several omissions came to my attention. These, along with new records for the region, are listed below:

1. Arnold and Leviton (1977) removed *Scincus mitranus* J. Anderson, 1871, from the fauna of Pakistan, arguing convincingly that the record from Sindh is probably based on trade animals.

2. Kluge (1993b) revived *Cyrtodactylus* for the bent-toed geckos listed here in the genus *Gonydactylus*.

3. Deraniyagala (1953) described *Hemidactylus brookii parvimaculatus* from Sri Lanka, considered by Kluge (1993b) to be valid.

4. My recent work on the herpetofauna of the Nicobar Islands shows that endemicity is higher than previously assumed, and several new species of amphibians and reptiles will shortly be described. This includes a *Gekko* (which will result in the removal of *G. smithii* from the south Asian fauna), a new *Lipinia* (previously identified as *L. quadrivittatum*) and a new *Cyrtodactylus* (thought conspecific with *C. rubidus* of the Andamans). The *Dibamus* from the Nicobars differs in a number of features from *D. leucurus*, and an old name available for the Nicobarese populations will be resurrected in the future.

5. Tikader and Sharma (1992) added two species of *Phrynocephalus* to the fauna of India: *P. reticulatus* (from Ladakh) and *P. euptilophus* (from western Rajasthan).

6. Auffenberg and Rehman (1995) showed *Calotes versicolor nigrigularis* Auffenberg & Rehman (1993) to be a junior primary homonym of *Calotes nigrigularis* Ota & Hikida, 1991, from Borneo, and proposed the trinomial *Calotes versicolor farooqi* for the Pakistani lizard.

7. Zhao (as Djao) in Djao and Jiang (1977) described *Trimeresurus medoensis* from southeast Xizang (Tibet), China, northern India and Myanmar.

8. Huang's (1982) *Trimeresurus tibetanus*, described from "Chokesumo, Nyalam Co., Xizang (Tibet) Autonomous Region, China, 3,200 meters", which is apparently the species Fleming and Fleming (1973) reported (as *Trimeresurus stejnegeri*) from Nepal. I thank Patrick David for drawing my attention to this record.

9. Obst (1983) revived *Daboia* and included *Vipera russelii* and *Vipera lebetina*.

10. Webb (1995) restricted *Pelochelys bibroni* to southern New Guinea and made available the name *Pelochelys cantorii* for populations of the giant Asian softshell turtle from the Indian subcontinent and other continental and associated insular regions of Asia.

Chapter 2

METHODS

Table 1 was compiled from the literature and from museum specimens, and was sent to many colleagues (see Acknowledgments) for comments. The cut-off date for literature search and museum work was the end of 1993.

Coefficients of Community (C*j*) between the physiographic zones were estimated using Jaccard's (1908) Index:

$$Cj = j/(a + b - j)$$

where, j = number of species in common between the two regions;
a = number of species in region A; and
b = number of species in region B.

C*j* values range from 0 (no overlap or complete faunal dissimilarity) to 1 (total overlap or entirely similar fauna).

Cheetham and Hazel (1969) describe the properties of the coefficient that is sometimes referred to as Jaccard's measure (*e.g.*, Magurran, 1988). Marine (Dermochelyidae, Cheloniidae and Hydrophiidae) and estuarine (*Batagur, Pelochelys, Acrochordus, Cantoria, Cerberus, Fordonia* and *Gerardia*) taxa (except *Crocodylus porosus*, which may occur in both estuaries and freshwater) have been excluded from these analyses, although included in the checklist.

Cluster analysis to examine faunal relationships (generic similarity) between the physiographic zones was performed using the software SYSTAT, Version 5.03 (Wilkinson, 1990).

Source material is the checklist presented as Table 1. The list has been largely compiled from literature, from material personally examined in various museums in America, Asia, and Europe, as well as printouts of the holdings of several North American collections. Distributional records of individual species that were suspect and could not be verified were omitted. Along with the amphibians of the Republic of India (reviewed by Inger and Dutta, 1986), information available on the taxonomy, distribution, and ecology of the region's reptile fauna is far from adequate for conservation needs. Major changes in the faunal list can be expected, including the addition of new species, range corrections (especially extensions), and the recognition of sibling

species within widely distributed taxa that are currently recognised as a single species (*cf.* Marx, 1988; Wüster and Thorpe, 1989).

But what exactly are species? Using Simpson's (1961) Evolutionary Species Concept (ESC), species are an "ancestral-descendent sequence of populations evolving separately from others and with its own unitary role and tendencies," as opposed to Mayr's (1942; 1963, and in subsequent works) Biological Species Concept (BSC), which defines species as groups of actually or potentially interbreeding natural populations reproductively isolated from other such groups. BSC has been challenged both by ornithologists (*e.g.*, McKitrick and Zink, 1988) and herpetologists (*e.g.*, Frost and Hillis, 1990), the primary flaw with this concept being that it is not historical (phylogenetic), and classifications based on reproductive compatibility are often inconsistent with the recovered history of evolution (Frost *et al.*, 1992).

If the rules of ESC are applied to the reptile fauna of south Asia, it would almost certainly increase the species list considerably. Some of the currently recognised subspecies, especially squamates of the continental island of Sri Lanka, will be elevated to the rank of species. Clearly, this promises to be a decade of great turmoil in the taxonomic arrangement of many groups of organisms worldwide. With further study, several taxa may not hold out even as valid subspecies (see for instance the fate of the subspecies of *Vipera russelii* from the Indian subcontinent in Wüster *et al.*, 1992). On the other hand, subspecific status has already been shown to be more appropriate for some long-established species (*e.g.*, the species of *Echis* from the subcontinent described in Auffenberg and Rehman, 1991). Here I adopt a conservative stance in unresolved cases. This work is thus an interim snap-shot of current taxonomic opinions and distributional information.

With the rapidly changing nomenclature and the continual accretion of species to the fauna, a few remarks on the nomenclature used are warranted. I have followed King and Burke (1989), Das (1991) and Iverson (1992a) for turtles (the term "turtle" will be used hereafter to refer to the entire Order Testudines). For squamates, the scheme of Smith (1935; 1943) has been followed, superimposed by more recent studies on particular taxa, including Kluge (1991; 1993b) for gekkonids, Arnold (1992) and Moody (1980) for agamids, Mittleman (1952) for lygosomine scincids, Gans (1966) for uropeltids, Kluge (1993a) for erycines, Gyi (1970), Lazell *et al.* (1991), Savage (1952), Malnate (1960), Malnate and Underwood (1988), among others, for colubrids; and Kharin (1984) for hydrophiids. I have used Burger's (1971) new genus (*Ovophis*) of crotalids, made available by Hoge and Romano (1981): see Smith (1989). Because of space constraints, I shall refrain from commenting at length on the recent reallocation of individual species. A synopsis of the reptiles of the south Asian region, comprising valid names, synonymy, information on primary types, distribution, and references is in preparation.

Chapter 3

PHYSIOGRAPHIC ZONES

Physiographic zones within the south Asian region used include:

1. The northern islands of the Bay Islands group, including the Andamans;
2. The southern islands of the Bay Islands group, including the Nicobars;

Figure 1. Map of south Asia showing the physiographical zones and their presumed boundaries.

3. Deccan and plains of northern India, hereafter referred to as "Deccan" (peninsular India minus the area included in the Western and Eastern Ghats, plus northern India, excluding the Himalayas, the Northwest and the Northeast);
4. Eastern Ghats (hills of southeastern India and associated plains to the east);
5. Himalayas (northern Uttar Pradesh, Nepal, Bhutan, Sikkim and northern West Bengal);
6. Northeast (northeastern India, northeastern and southwestern Bangladesh);
7. Northwest (northwestern India and the plains of Pakistan);
8. The continental island of Sri Lanka;
9. Trans-Himalayas (northern and western Pakistan and Jammu and Kashmir, separated from the Himalayas by the Sutlej river);
10. Western Ghats (hills of southwestern India and associated plains to the west);

General description of vegetation and physiographic features of south Asia can be found in Champion and Seth (1968), Collins *et al.* (1991), Fernando (1968), Mani (1974a), and Monga and Sahgal (1990).

The principal physical and biological features of the physiographic zones shown in Figure 1 are briefly described below.

1, 2. BAY ISLANDS (AN, NI)

The Andaman and Nicobar archipelago is situated between 5° 40'N and 92° 10'E, in the Bay of Bengal, the two groups separated by the 10° Channel. These islands form a chain of submarine mountains that sprawl in a crescent between Cape Negrais in Myanmar to Achin Head in Sumatra, Indonesia. The total land area of these islands is an estimated 8,293 km^2, including a larger Andamans group (6,340 km^2) and the much smaller Nicobars (1,953 km^2). Average annual rainfall exceeds 3,000 mm, and the great variety of habitats, including bays, coral reefs, mangrove, and rainforests on hill ranges that reach 700 m, support a species-rich herpetofauna.

As much as ten percent of the flora of these islands is endemic including 225 species of vascular plants. The human population on these islands is presently over 300,000. Over 33,000 tourists visited the Bay Islands in 1990, the high human presence leading to pollution and destruction of marine and land plant life (Sinha, 1992). The biology and threats to living resources of the Andamans have been discussed by Whitaker (1985).

The herpetofauna of the Andamans is an impoverished one from Myanmar, these islands being a part of the Tennasserim range of mountains, while that of the Nicobars, an oceanic group (P. Ashton, *pers. comm.*, 1993), is allied to that of Sumatra, presumably being established by overwater (waif) dispersal. Important reviews of the nonmarine herpetofauna of the Andamans and Nicobars include those of Annandale (1904, 1905), Smith (1940), Whitaker (1978), and Biswas and Sanyal (1977a; 1980).

3. DECCAN (DC)

The flat country that comprises peninsular India, excluding the hill ranges to the east and west, and south of the areas watered by the Himalayan rivers, has been referred to as the Deccan, a region of considerable aridity. Until the Miocene-Pliocene, evergreen forests were widespread in peninsular India, as indicated by palaeontological evidence. Ripley *et al.* (1987) argued for the existence of a "humid south Asian forest biota" even during the Late Pleistocene, covering much of the Indian region, including the Deccan. The conversion of these wet forests to deciduous forests is possibly an effect of the decline in rainfall, a result of the slight southern shift of the equator, the uplift of the Himalayas (but see Paterson, 1993 for an alternative viewpoint) and the rise of the Western Ghats (Meher-Homji, 1990), although human activities over the past 10,000 years must have also contributed to the change.

Nonetheless, a great variety of vegetation is represented. The following phytogeographic regions are from Meher-Homji (1990):

1. *Shorea-Cleistanthus collinus-Croton oblongifolius* type, in the northeast.
2. *Shorea-Buchanania-Cleistanthus* type, in central and south.
3. *Shorea-Syzygium operculatum-Toona ciliata-Symplocos spicata* type, in the north.
4. *Toona-Garuga* type, in the east-central.
5. *Hardwickia binata* type, to the south.
6. *Anogeissus pendula* type, to the northwest, and
7. *Acacia senegal-Angoeissus pendula* type, to the northwest.

Additional sources of information on the plant geography of the Deccan include Mani (1974b), Gadgil and Meher-Homji (1990), and Champion and Seth (1968).

Few concerted attempts have been made to survey the Deccan for its herpetofauna, despite it accessibility. Sanyal and Dasgupta (1990) surveyed the Bastar region of south-central India, and produced an inventory that shows no endemics.

4. EASTERN GHATS (EG)

The Eastern Ghats represent a weathered relict of the peninsular plateau, marked by a series of low isolated hills that run from the Khondmal Hills in the Baudh-Khandmal (Pulbani) District, Orissa State, southwards to central Tamil Nadu State, where it veers off towards the southwest to meet the Western Ghats (see below) in the Nilgiris. At 1,750 m, the Biligirirangan Hills is the highest peak in the region. The northern and southern sections of the Eastern Ghats are separated by the Godavari delta, which is approximately 130 km in width, other important breaks including the rivers Mahanadi and Krishna. The southern subzone is drier, with dry deciduous and thorn scrub, while the northern part is relatively mesic with dry and moist deciduous forests. General description of the region can be found in Krishna Raju and Subba Rao (1990), Krishna Raju *et al.* (1987), Legris and Meher-Homji (1982), and Subba Rao *et al.* (1982).

The dominant vegetation type is dry-deciduous, with patches of moist-deciduous and semi-evergreen forests. *Shola*-type and treeless zones are common only at high elevations. Herpetological diversity is higher than in the Deccan, but substantially lower than of the Western Ghats. Extensive deforestation of the natural forests, slash-and-burn agriculture, poaching, encroachment, mining, and monoculture plantations have reduced the quality of the natural vegetation and its extent.

The herpetofauna has been dealt with by McCann (1945), Pillai and Murthy (1983), Sharma (1965), Daniels and Ishwar (1993), and Sanyal *et al.* (1993).

5. HIMALAYAS (HM)

The Himalayan mountain range includes some of the highest mountains on earth, and profoundly affects the climate and vegetation of almost the entire Indian region. Eight rivers drain from these mountains (including the Ganga, Brahmaputra, Yangtze, Indus, and Mekong), these together carrying 25% of the dissolved material that reaches the world's oceans, although the area they

drain, including the plateau, is less than 5% of the earth's land area (Paterson, 1993). The Himalayas, including the Trans-Himalayas (see below) cover an area of 236,300 km^2, over parts of Pakistan, India, Nepal and Bhutan, and include a variety of vegetation, from moist deciduous, through subtropical broad-leaved forests, to coniferous, mixed coniferous and alpine scrub forests. Included in the region are the *terai*, a swampy belt of maximum width 13 km, the *bhabars*, which are deep, boulder deposits of maximum width 21 km, skirting the outermost hills of the Himalayas, and the *duns*, which are broad elevated valleys at *circa* 600 m altitude, at the outer range of the Himalayas.

The eastern Himalayas are wetter than the western part, receiving at least 2,000 mm of average annual rainfall, often much more. However, the winter months (November–March) are relatively dry. The monsoonal climax is in July. Secondary wet mixed forests exist in the low-lying areas of the eastern Himalayas, including the moister areas of the *terai* and the lower areas of the *bhabar*. Rainfall usually exceeds 2,500 mm a year, and the areas experience four dry months in a year. As a result of its ultravaried topography, both species diversity and endemism among plants is high, especially in many deep and semi-isolated valleys (Myers, 1988). Typical trees represented include *Michelia montana*, *Turpinia pomifera*, *Schima wallichii*, *Ilex godajam*, *Saurauja roxburghii*, and *Aporosa dioica*. Subalpine forests are represented in the western and central Himalayas, dominant vegetation being *Quercus incana* and *Q. dilatata*. Thickets of *Rhododendron hyperanthum*, *R. leptodotum*, and *R. pumilum* occur between 3,500–5,000 m altitude. Subtropical pine forests are recorded where temperature ranges are between 1,500–3,000 mm a year, and include *Quercus amellosa* and *Q. lineata*, *Rhododendron* spp., *Lyonia* spp., *Pinus roxburghii* and *P. insularis*. The absence of forests of *Pinus roxburghii* in Kashmir is considered due to the weakened southwestern monsoons (Champion and Seth, 1968).

At 4,000–5,000 m are the alpine pastures, considered grasslands although there is little grass represented, the dominant vegetation being perennial mesophytic herbs such as *Primula* spp., *Anemone* spp., *Iris* spp., and *Gentiana* spp. The vegetation of the Himalayas has been described by Rau (1974).

Levels of deforestation in the Himalayas have become severe (Numata, 1983; see also Myers, 1988, and references quoted therein). Forests of the Himalayas are being felled for demands for shifting cultivation and extensive potato cultivation. Other threats to the vegetation of the region are grazing at high altitudes and fires in the bamboo brakes.

The herpetofauna has been discussed by Agrawal (1979), Fleming and Fleming (1973), Nanhoe and Ouboter (1987), Swan and Leviton (1962), and Waltner (1975a, 1975b, 1975c, 1975d).

6. NORTHEAST (NE)

With rainfall exceeding 2,000 mm, the Northeast supports a rich tropical vegetation. The main vegetation types represented include moist deciduous, semi-evergreen and temperate montane forests, including *Lagerstroemia, tetrameles, Shorea robusta, Quercus, Juglans,* and *Magnolia.* Bamboos and grasses are specially diverse and common in both the wet and dry areas of the Northeast. Tropical evergreen forests in the region comprise forests with three-tiered structures, looming to about 46 m above the forest floor. Climatic fluctuations throughout the year are minimal, temperatures on average ranging from 20–30° C in the plains, although humidity can be as high as 80–90 percent. Descriptions of the plant life of the region can be found in Mani (1974c), Ramdas (1992), and Rao (1974).

Encroachment, felling for timber, and slash-and-burn agriculture, as well as hydroelectric projects and constructions of roads and railways, threaten the natural forests of Assam (Choudhury, 1993), the largest of the northeastern states.

Herpetological investigations in the region have been few. Mathew (1983) and Das (1988) reported on collections made from the Northeast in recent years.

7. NORTHWEST (NW)

The Northwest includes the eastern parts of Pakistan and the extreme western parts of India, and is bounded by the Indus and Nara Valleys in the west, the Aravalis in the east, and the Kutch to the south. To the north lie the Indian states of Haryana and Punjab, comprising the plains of the Sutlej and Chambal Rivers. The Thar region itself is 446,000 km^2 in extent. Archaeological evidence points to the fertility of the region around Mohenjo Daro, some 6,000 years before present (Mackay, 1934), where culverts carried storm water during 2,750 B.C. References to the physical and biological features of the Northwest are contained in Mani (1974c), Meher-Homji and Bharucha (1975), Roberts (1977), Singh (1978), and Gupta (1986).

The region is mostly composed of hills, stony plateaus, or peneplains. Severe winters characterize the area, which is outside the influence of the monsoons. Rainfall is 250–500 mm a year, and the mean maximum temperature over 45° C during May and June. Thorny thickets, dominated by *Acacia senegalensis, A. catechu, Prosopis cinoraria,* and *Zizyphus nummularia* are the common vegetation to be seen. The dry season lasts 8.5–10 months. Dominant tree species in the desert peneplains (annual rainfall 250 mm or less) include *Prosopis cineraria* (densities exceeding 25 trees ha^{-1}), *Zizyphus*

numularia, and *Capparis decidua*. In the western parts, in the Nara region of Pakistan, the vegetation is sparse, consisting of xerophytic shrubs like *Haloxylon* spp.

Heavily grazed and logged, the vegetation is today largely degraded. Large-scale deforestation of the *deodar* trees in the upper valleys of the Sutej, Jamuna, Beas, Ravi, and Chenab Rivers during 1850–1870 for the railway industry has left the region barren (Gaston, 1990).

Minton (1966), Mertens (1969), Biswas and Sanyal (1977b), and Khan (1985a) have reported on the herpetofauna of the arid Northwest.

8. SRI LANKA (SL)

Sri Lanka and the Indian peninsula together constitute the tectonic structure known as the Deccan Plate. The wet zone of Sri Lanka represents the only aseasonal area between Malesia and the eastern coast of Madagascar (Ashton and Gunatilleke, 1987).

The 65,000 km^2 continental island of Sri Lanka (formerly Ceylon) is generally divided into three climatic zones:

a. Low-country dry zone, including the northern half and the east,

b. Low-country wet zone, including the southwest; and

c. Montane zone, including the centre of the southern half of the island.

Sri Lanka's connection to the mainland, for the first time during the Miocene and many times subsequently (Cooray, 1967), has lead to the invasion of many species of distinctly Indian origin, although endemicity in the herpetofauna is also high. Jansen and De Zoysa (1992) showed that Sri Lanka has greater biodiversity per unit area than any other Asian country, this being concentrated to the mesic southwestern lowlands and the central highlands.

General accounts of the region including its physical and climatic features and the biota can be found in Erdelen (1989) and Hoffman (1990).

Reduction in Sri Lanka's forest cover between 1900 and 1988 has been estimated to be from 70% to about 20%, major causal factors being logging for timber, for settlement and agriculture, and the expansion of tourism (Preu and Erdelen, 1992). At present, natural forest covers about 30% of the dry zone and 9% of the wet zone (Erdelen, 1993).

Sri Lanka has had the attention of a number of active herpetologists: Deraniyagala (1953), P. H. D. H. de Silva (1980), A. de Silva (1990), and Taylor (1950, 1953).

9. TRANS-HIMALAYAS (TH)

The Zanskar, Ladakh, and Karakorum dominate the landscape of the Trans-Himalayas (outer Himalayas). To the east, the Zanskar and Ladakh reaches down to the Tibetan plateau, the region marked with brackish marshes and bogs. Included in the region is a large (1,180 km^2) glacier, the Siachen, the largest outside the polar regions. Within the Trans-Himalayas, Ladakh, with an area of 97,782 km^2, is worthy of comment. The region is composed of mountains that are up to 6,600 m and sandy valleys drained by the Indus. The sedimentary deposits are mostly marine in origin, and are up to Late Tertiary in age. The dry climate is due in part to the low temperature (below 0° C) that inhibits absorption of water by roots of plants during the winter and early spring when occasional showers take place.

The vegetation of the Trans-Himalayas include subtropical evergreen and coniferous forests as well as alpine steppe. In general, the rainfall increases along a west-east gradient, from 500 mm in Peshawar, Pakistan, to 1,000 in the Kumaon, Uttar Pradesh, in India. At higher altitudes, vegetation is xerophytic, dominated by *Salix denticulata*, *Juniperus communis*, *Mertensia tibetica*, and *Potentilla desertorum*. The alpine steppe vegetation shows high endemism. The vegetation of the Ladakh region has been described by Sapru and Kachroo (1979).

Growing numbers of pastoralists and their livestock, logging, and tourism are factors that threaten this unique and fragile world.

Important papers dealing with the herpetofauna of the region include those of Acharji and Kripalani (1951), Minton (1966), Duda and Sahi (1977), Gruber (1981), Murthy and Sharma (1976), and Murthy *et al.* (1979).

10. WESTERN GHATS (WG)

The southwest Indian forests along with those of southwestern Sri Lanka comprise the western-most outliers of the Indo-Malaysian Formation of the tropical moist forest (Richards, 1953). The Western Ghats run along the west coast of peninsular India 50–100 km inland and are a series of hill ranges often isolated from each other by flat savanna. The region extends from the central part of present day Maharashra state (where a modified type of evergreen forest survives) to the southern parts of Tamil Nadu and Kerala, including the hill ranges of the Nilgiris, Annamalais, and the Palnis, where hill ranges reach altitudes of 450–1500 m and receive average and annual rainfall in excess of 2,000 mm.

Typical flora of the Western Ghats include *Lagerstroemia lanceolata*, *Dalbergia latifolia*, *Toona ciliata*, and *Chukrassia tabularis*. Details of the Western Ghats, including its physiography and climate, can be found in Subramanyam and Nayar (1974) and Pascal (1988).

An important review of the herpetofauna of the region is that of Groombridge (1990), which predicted that as many as 150 species of amphibians and reptiles will prove to the endemic to the region. Collections from the Western Ghats have been made by numerous workers, including Inger *et al.* (1984), Das and Whitaker (1990), Malhotra and Davis (1991), and Murthy (1986).

The physiographic zones within India in this work are similar to those in Inger and Dutta (1986). The oceanic archipelago to the west of the Indian peninsula known as the Maldives, and the Indian Union Territory of Lakshadweep (formerly Laccadives) have been omitted, because these have no native species of reptiles.

Chapter 4

RESULTS AND DISCUSSION

4.1. BIODIVERSITY AND ENDEMICITY

The 632 species of reptiles recorded from south Asia (Table 1) belong to three orders, 25 families, and 185 genera. The fauna is particularly rich in turtles of the family Bataguridae (16 species); lizards of the families Gekkonidae (97 species), Agamidae (68 species), Scincidae (87 species); and snakes of the families Typhlopidae (23 species), Uropeltidae (47 species), Colubridae (176 species), Elapidae (16 species), Hydrophiidae (21 species) and Viperidae (25 species).

The accretion of species description to the fauna is shown in five-year intervals in Figure 2. A very large number of species have been described between 1850 and 1880. However, it is the activities of a single herpetologist, based at the Natural History Museum, London (then British Museum [Natural History]), over a period of several decades that explain the great additions to the fauna. John Edward Gray (1800–1875) added many species to the reptile fauna of the Indian region. Between 1827 and 1872, Gray described 54 species that are presently considered valid, including 14 Indian freshwater turtles. These figures are excluding six reptile species Gray described in collaboration with Thomas Hardwicke. Gray is also credited with the hiring of Albert Günther (1830–1914), who, between 1858 and 1881, described 60 reptiles species that are still valid, and in turn, employed George A. Boulenger (1858–1937), who between 1885 and 1918 described 37 species from this region that are still considered valid. The three aforementioned herpetologists are thus together responsible for describing a quarter of the subcontinent's reptile fauna.

The two world wars have had negative effects on the productivity of herpetologists worldwide (Gans, 1992). In south Asia, relatively few species of reptiles were described between the beginning of the First World War and the period subsequent to the Second World War and the time of independence of these former British colonies, till about the 1970's decade, when a revival appears to have taken place (Figure 2).

Eleven species have been described in the first three years of the 1990's decade, indicating a revival of interest in south Asia's reptile fauna. Clearly many new species will be added to the subcontinent's reptile fauna with more