

A brief overview of the Western Ghats – Sri Lanka biodiversity hotspot

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The Western Ghats of India and Sri Lanka biodiversity hotspot is often regarded as one unit because of shared biogeographical history. However, recent studies suggest that certain faunal components, particularly in the wet zones are distinct. This article looks at the existing information on species richness and endemism of taxa in both regions. Data are available on some taxa but not on others, and many taxa have not received equal attention in both regions. The natural ecosystems of this hotspot are under threat and urgent conservation action is needed, especially in augmenting the protected area network. There is also the need for increasing the level of scientific collaboration in biodiversity studies between the two countries.

Keywords: Biodiversity hotspot, deforestation, species endemism, protected areas, Sri Lanka, Western Ghats.

THERE is an ongoing global biodiversity crisis due to unprecedented loss of natural ecosystems^{1,2}. The most recent publication of the *IUCN Red List of Threatened Species* has reported that 39% of listed species are threatened with extinction³. Others estimate that by 2050, up to 350 bird species will become extinct². Therefore, the conservation of global biodiversity is an important priority, equivalent to facing the challenges of climate change.

Over 50% of the Earth's species are confined to the tropical latitudes, where poverty and population pressure put tremendous demands on natural ecosystems. Even within the tropics, some regions have higher levels of biodiversity and endemism and need to be prioritized for conservation. Therefore, the concept of biodiversity hotspots was first put forward by Myers⁴ and the Western Ghats of India and Sri Lanka (Figure 1) were included among the first 18 global biodiversity hotspots due to high levels of species endemism. The list of biodiversity hotspots⁵ has now increased to 34 reflecting a severe threat to biodiversity⁴.

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For example, in the Western Ghats/Sri Lanka (WG/SL) biodiversity hotspot, forest loss has been so rapid that out of the original extent of 182,500 km² of primary vegetation only 12,450 km² (i.e. 6.8%) remains⁶. There are high levels of topographic and climatic heterogeneity in the Western Ghats and Sri Lanka, which support diverse vegetation types and distinct fauna. However, the wet zone of Sri Lanka has a wetter and more aseasonal climate⁷. The wet evergreen forests of the Western Ghats and Sri Lanka have distinctive faunas and numerous species form endemic clades whereas the fauna and flora of lowland dry forests seem more similar⁸. This is probably because contiguities between the wet zones over the ice ages might have been

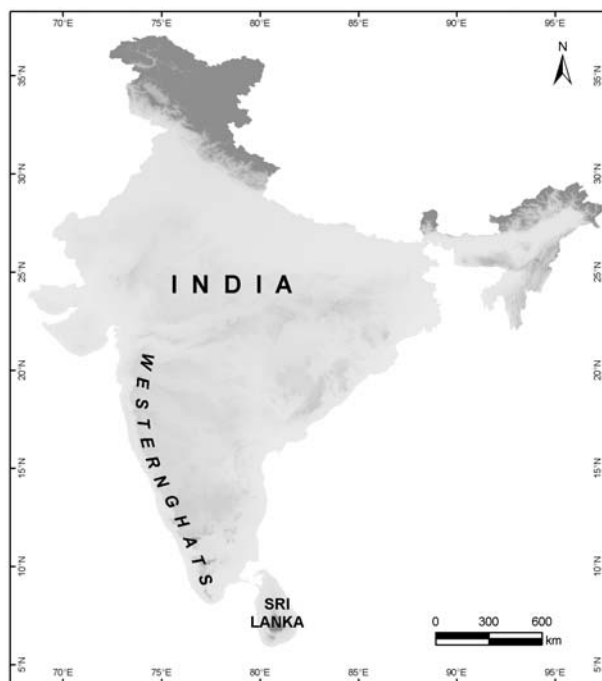


Figure 1. Map showing the Western Ghats and Sri Lanka biodiversity hotspot (courtesy Institut Français de Pondichéry).

Table 1. A comparison of species richness and endemism in the Western Ghats (WG) and Sri Lanka (SL)

Taxon	WG	WG endemism (%)	SL	SL endemism (%)	Remarks	Source
Mosses	682	28	568	11		22
Liverworts	280	43	250	Unknown		23
Evergreen trees (≥10 cm dbh)	645	56	211	~70%		12, 16, 70
Lianas	11-Nilgiris 13-Palnis	~40	10	40	WG-montane forest SL-Sinharaja plot	D. Mohandass (WG – unpublished), 12
Ants	~350	~20	~300	Unknown	Lowland wet evergreen forests	WG – A. Narendra. pers. commun. SL – N. R. Gunawardene, unpublished data
Odonates	174	40	120	48		29, 39
Butterflies	330	11	243	12		27, 28, 29, 71
Molluscs (land snails)	269	76	246	83		25, 26, 29
Fish (freshwater)	288	41	82	54	Threatened- 41% WG species SL: 9 spp. globally & 39 spp. nationally	29, 40–42, 72
Amphibians	~219	78	103+ (~88+)	86		29, 44, 46, WG - G. Shankar pers. commun.
Reptiles	225	62	183	104		29, 49, WG - G. Shankar, pers. commun.
Birds	500+	4	482	6.8		29, 50–53
Mammals	120	11	91	18	Threatened 14/18 endemic species	17, 29, 57

lower than between the dry zones. However, further comparative studies are needed to give a clearer picture of patterns of similarity and divergence between floristic and faunal assemblages.

Flora

Plant diversity in the Western Ghats is correlated with seasonality, with higher levels of alpha diversity towards the south^{9,10}. Similarly plant endemism is also higher towards the southern region¹¹, as in the wet zone of southwestern Sri Lanka¹². Montane cloud forests, locally called *shola*, and grassland ecosystems are found in the higher elevations of the Western Ghats and Sri Lanka, but comparative studies are lacking. The grassland ecosystems of the higher elevation of the Western Ghats have been fairly well studied, and shown to be primary and not of anthropogenic origin^{13,14}. The disjunct distribution of the genus *Eriochrysis* further indicates the relict nature of some of the floral elements. The recently rediscovered *Eriochrysis rangachari*, is an endemic swamp grass used extensively by the Toda ethnic group, inhabitants of the grasslands¹⁵. However, further studies need to be conducted to understand the biogeographical history of equivalent vegetation types of the Western Ghats and Sri Lanka. A breakdown of the species richness and endemism of different plant and animal groups is presented in Table 1.

Evergreen tree endemism (≥10 cm dbh) is about 56% along the Western Ghats¹⁶ with tree communities tending to vary in relation to the local topography within the wet zones of the Western Ghats⁹. The wet zone area of Sri Lanka represents less than one quarter of the island's land mass and yet harbours 95% of the endemic angiosperm flora of the country¹⁷. In Sri Lanka, 98% of the tree species in the Dipterocarpaceae family are endemic to the island; this is the highest degree of endemism for this group in the south and south-east Asian region¹⁸. The two main genera in this family, *Dipterocarpus* and *Shorea*, have a higher species richness in Sri Lanka compared with the Western Ghats^{19,20}. Amongst flowering plants in the WG/SL hotspot, 10% (4679 species) are under the IUCN 'threatened' category²¹.

The bryophyte diversity of the Western Ghats is high with about 850–1000 species⁷ (Table 1). Of these, 682 are mosses, 190 of which are endemic including one endemic genus *Nantheicum*²². Among the 280 species of liverworts and 14 species of hornworts, there are 121 and two endemic species respectively²³. Endemism appears to be higher in the Western Ghats ranges that lie south of the Palghat Gap⁷, a 30-km wide break in the Western Ghats that separates the south from the more northern stretch. The bryophyte diversity of Sri Lanka includes 568 species of mosses (63 endemic species), and approximately 250 species of liverworts and hornworts (Table 1). A collection in the uplands of Sri Lanka in 2002 revealed five

new species of mosses, suggesting that further investigation into less accessible montane ecosystems may yield additional new species²⁴.

Fauna

Invertebrates

Snails: Malacological studies in the Western Ghats and Sri Lanka also show high diversity and endemism. Raheem²⁵ has recorded about 247 species of land snails from Sri Lanka, out of which 83% are known to be endemic to the region. She also recorded 23 new species of land-molluscs, including six new species of *Cyathopoma* and a new endemic genus *Ratnadvipia*. About 269 species belonging to 56 genera of land-snails have been recorded from the Western Ghats, of which 76% were endemic²⁶. Molluscs, with their tendency to be highly localized in their distribution as compared with other taxa, are more vulnerable to extinction due to their sensitivity to habitat modification.

Butterflies: Among insects, 330 and 243 species of butterflies have been recorded in the Western Ghats and Sri Lanka respectively²⁷⁻²⁹. Pioneering studies on butterflies were conducted in the Ponmudi and Ashambu hills of Kerala, India, by Ferguson³⁰, where he reported 220 species. Wynter-Blyth³¹ listed 290 species from the Nilgiris. However, the most extensive documentation of Nilgiri butterflies was by Larsen³², who listed 299 species from the Nilgiris region alone. Butterfly endemism, which is about 10% in both regions, is much lower compared to other groups and many species are widespread in the sub-continent^{27,28}.

Ants: Ants can constitute up to 20% of the animal biomass in tropical forest and play essential roles in ecosystem functioning³³. While there have been a few studies of ants in the Western Ghats³⁴⁻³⁶, the study of ant communities in Sri Lanka is still in its infancy. Currently, there is a push to document the ant fauna of Sri Lanka. Historical records documented about 210 species of ant in 65 genera and 12 subfamilies for Sri Lanka, including the endemic relict ant *Aneuretus simoni* Emery³⁷. A recent study conducted in dipterocarp-dominated forest of the Sinharaja Biosphere Reserve recorded 173 species of ground-dwelling ants in 54 genera and 11 subfamilies (N. R. Gunawardene, unpublished data). In comparison, Gadagkar *et al.*³⁸ collected 140 species in 32 genera from 12 localities in the Western Ghats. Comparative studies between the Western Ghats and Sri Lankan ant faunas are necessary to assess the degree of diversity and endemism in the region.

Dragonflies and damselflies: The odonate fauna of the Western Ghats and Sri Lanka includes 223 species repre-

sented two sub-orders: dragonflies and damselflies. About 52% of the species belonging to these sub-orders are endemic. Generally, there are more endemics amongst the damselflies although the proportion might vary locally with the habitat heterogeneity. The families Gomphidae and Platystictidae have high levels of endemism within the region. The families Gomphidae, Cordulidae and Protoneturidae are very diverse in the Western Ghats³⁹, while the families Libellulidae and Platystictidae are the most diverse in Sri Lanka²⁹. Sixty-eight per cent of the species of odonates in the region use riparian habitats and 46% are restricted to that habitat. Many genera and species are restricted to one or two river catchments and long isolation and poor dispersal may have driven local diversification. This may partly explain why despite the considerable difference in the size between the wet zones of Western Ghats and Sri Lanka, the level of endemism in the odonate fauna is comparable. Sri Lanka, being a well-watered tropical island with a relatively aseasonal climate, offers a wide range of aquatic habitats for the local diversification of its odonate fauna³⁹.

Vertebrates

Fishes: Data on freshwater fishes of the Western Ghats are limited. Dahanukar *et al.*⁴⁰ estimated a species richness of 345 species, whereas 288 species have been recorded, of which 118 (41%) are endemic. An analysis of distributional patterns shows that southern Western Ghats are more species-rich than the northern and central regions. A number of new species have also been recorded from southern and central Western Ghats^{29,41,42}. In Sri Lanka, 82 species of freshwater dispersant fish have been recorded. Forty-four of these are endemic to the island with the majority having restricted ranges in the wet zone⁴³. During the past ten years, nine new species have been discovered in this area, which incidentally, is also the most heavily populated region of the country. Loss of freshwater habitats, introduction of exotic species and pollution of water bodies pose the most serious threats to fish populations.

Amphibians and reptiles: Amphibians and reptiles have the highest level of endemism among vertebrates in the WG/SL hotspot. Both regions are known to be a megahotspot for reptilian fauna, having over 50% endemic species and a number of these endemic species being in the IUCN 'threatened' category.

The amphibian diversity of the wet zone in Sri Lanka is remarkable; it has the highest species density (approx. 3.9 species per 1000 km²) compared to eight other 'megadiversity' countries in the world⁴⁴. Studies done thus far also indicate that many of the ancient amphibian lineages are confined to the Western Ghats and Sri Lanka⁴⁵. The Old World tree frog family Rhacophoridae represents up

to 85% of anuran fauna in Sri Lanka, the highest compared to any other region in the world. Alarming, about 19 species of amphibians have already gone extinct in the past two decades in Sri Lanka⁴⁴.

In the Western Ghats, the family Ranidae (true frogs) has the highest number of species (42% of total species) followed by Rhacophoridae (25%). The two genera *Nyctibatrachus* (11 species) and *Micrixalus* (seven species) are known to be endemic to the Western Ghats. As a whole, both regions have more species of terrestrial and arboreal amphibians than aquatic ones⁴⁶.

Recently, a spectacular new species of frog, the purple frog (*Nasikabatrachus sahyadrensis*) has been discovered in the southern Western Ghats. It represents a new genus of frog *Nasikabatrachus* of an ancient Indo-Madagascan line; recent studies show that the frog belongs to an already known family Euglossidae⁴⁷. The caecilian diversity in the Western Ghats is also quite high, supporting 16 out of 20 species known in India and all of them endemic to the Western Ghats^{46,48}.

A total of 225 and 183 species of reptiles have been recorded from the Western Ghats and Sri Lanka respectively^{29,49} (Gowri Shankar, pers. commun). There are several intriguing similarities in reptilian fauna. For example, the family Uropeltidae consists of primitive burrowing snake species and is restricted to mountain ranges of Southern India; the 12 Sri Lankan species all endemic to the island, occur in similar climatic conditions as that of the Western Ghats. In Sri Lanka six endemic genera (16 species) of Sauria and three endemic genera (nine species) of Serpents are considered geographical relicts²⁹.

Birds: Species richness and endemism of birds in the Western Ghats and Sri Lanka are similar. Western Ghats has about 500 species of birds of which 22 are endemic (4%), and of the 483 species described in Sri Lanka, 33 (6.8%) are endemic^{29,50-53}. Many endemic species such as the Nilgiri wood pigeon (*Columba elphinstonii*), Nilgiri pipit, *Anthus nilghiriensis* white-bellied shortwing (*Brachypteryx major*) from the Western Ghats and the Sri Lanka wood pigeon (*Columba torringtoni*), the green-billed coucal (*Centropus chlororhynchus*), the Sri Lanka white-headed starling (*Sturnus senex*), Sri Lanka blue magpie (*Cissa ornata*) and ashy-headed babbler (*Garrulax cinereifrons*) from Sri Lanka are also known to be endangered and rare⁵⁴. Changes in the land use throughout the Western Ghats have triggered the decline in endemic bird diversity and seven of the 22 endemic bird species are globally threatened^{55,56}.

Mammals: Currently, about 120 species of mammals have been recorded from Western Ghats and 92 in Sri Lanka. Endemism is quite low when compared to other taxa with only 18 endemics in both regions^{17,57}, though 14 of them are in the IUCN 'threatened' category⁵⁸. With increasing forest loss and fragmentation, some endemic species like

Nilgiri tahr (*Hemitragus hylocrius*), lion-tailed macaque (*Macaca silenus*) and Malabar civet (*Viverra civettina*) from the Western Ghats and purple-faced leaf monkey (*Trachypithecus vetulus*) and red slender loris (*Loris tardigradus*) from Sri Lanka have declined in number and have been added to IUCN 'vulnerable' and 'endangered' categories^{17,29}.

Protected areas

The percentage of area under protection is higher in Sri Lanka (25.6%) than in the Western Ghats (9%) (Table 2). The protected areas of the Western Ghats have more often been demarcated using *ad hoc* criteria, and many of the critical habitats such as lowland dipterocarp dominated evergreen forests and *Myristica* swamps are not adequately represented in the network^{11,59}. Of the 9473 km² of forest area recorded in the windward slopes of the southern Western Ghats in Kerala, only 49% were primary forests and the remaining were disturbed, secondary or degraded¹⁶. An analysis of 40,000 km² areas covering three Western Ghats states (Karnataka, Kerala and Tamil Nadu) showed a loss of 25.6% forest cover from 1973 to 1995 (ref. 60). In the central Western Ghats state of Karnataka alone, forest loss over a 20-year period (1977 to 1997) was about 12% (of 3.2 million ha) with an annual rate of loss of about 0.63%. Especially in coffee belt areas (e.g. Kodagu), land under coffee cultivation has doubled during this period at the expense of already fragmented forests, including sacred groves⁶¹.

Of 58 protected areas surveyed in the Western Ghats, it was found that hunting, timber felling, presence of exotics and invasive species, extraction of firewood/fodder, livestock grazing and fire were the most proximate threats to biodiversity⁶².

In Sri Lanka, natural forest covered 44% of the country in 1956, this dropped to 27% by 1980 and during the last decade 1.5% of that was further lost due to land conversion^{63,64}. Total forest cover in Sri Lanka remains at about 25% of its land area. Tropical rainforest is found

Table 2. Area and percentage of protected areas in both regions

	Western Ghats ^{7*}	Sri Lanka ^{**}
Total area (km ²)	160,000	65,610
% protected area	9%	26.5%
Number of protected areas		
Strict Nature Reserves (SNR)	Nil	03
National Parks (NP)	20	14
Nature Reserve (NR)	Nil	04
Sanctuaries	68	56
Biosphere reserve	01	04
Forest dept conservation forests ⁷³	Nil	53

*<http://web.biodiversityhotspots.org/xp/Hotspots/ghats/conservation.xml>

**<http://earthtrends.wri.org>

only in the southwest quarter of the country. Currently less than 5% of the original rainforest cover remains in the form of about 140 fragments^{65,66}. Even as recently as 2004, due to lack of management and protection, state forests adjacent to relict forest fragments were converted to cardamom and tea plantations, causing further isolation of these harbours of diversity⁶⁷. The rate of loss of forest and wildlife habitats in Sri Lanka is considered one of the highest in South Asia⁶⁸. As forests have been lost or degraded in this region, many species have been driven to critical status⁶⁹, there is an urgent need to take immediate steps to conserve the unique biodiversity of the Western Ghats and Sri Lanka.

Conclusion

The Western Ghats and Sri Lanka have similar levels of endemism among taxa, though the fauna of the wet zone have been found to be quite distinctive. Trees, bryophytes, odonates, land snails, reptiles and amphibians show higher levels of endemism than butterflies, birds and mammals. Therefore dispersal ability and habitat specialization could be related to levels of endemism among taxa. More comparative studies need to be conducted between India and Sri Lanka on equivalent vegetation types and taxa in order to understand the evolutionary history of the biota.

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