CHAPTER 1

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Western Ghats

The Western Ghats is a chain of mountains running parallel to West Coast of the Peninsular India from the river Tapthi to Kanyakumari, the southern tip of the Peninsular India. The mountain chain is part of the Indian plate of the Gondwanaland by origin. The biogeographic province of Western Ghats covers 160,000 km² of which about 100,000 km² forms mountainous terrain. The Western Ghats straddle the states of Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra and southern Gujarat. Just as the Himalayas preside over the biogeography of India, the Western Ghats to a large extent presides over the ecology and biogeography of Peninsular India (Nayar, 1977). The mountain chains of the Western Ghats in the states of Maharashtra are steep on the windward side and sloping towards the Deccan Plateau on the leeward side. This gradient is reversed in the south of Palghat gap, where they are sloping towards the windward side in Kerala but are steep in the leeward side of Tamil Nadu.

The flora of Indian plate was subjected to different climatic stress during its passage from southern latitudes (c. 100 million years BP) resulting in the impoverishment of its palaeotropic flora (Nayar, 1972; Raven and Axelrod, 1974). The flow of Deccan lavas resulted in horizontally stratified mountains in the Deccan traps towards north of River Krishna. The southern Karnataka and Kerala regions escaped this Deccan volcanism and hence are
the oldest pre-cambrian rocks, from the Archaen divisions, aged over 2,400 million years (Krishnan, 1974).

Various forests such as tropical evergreen, semi-evergreen, moist and dry deciduous, savannas, scrubs, etc have become the major habitat for over 4000 species of flowering plants, 330 butterflies, 289 fishes, 135 amphibians, 156 reptiles, 508 birds and 120 mammals among which, many are endemic to the Western Ghats. It also forms an important watershed for the entire Peninsular India (Nair and Daniel, 1986).

The latitudinal position and altitudinal gradients with its rainfall patterns of South-West and North-East monsoons, changes of climatic shifts due to variations in dry months on the leeward side of mountains, the Deccan plateau, the presence of mosaic of soil types, soil nutrients have resulted in a diverse ecological islands, niches and refugia which favour high degrees of endemism in the Western Ghats. The annual rainfall varies from 2350 mm in the north to 7450 mm in the south, which makes the Western Ghats the watershed of the Peninsula (Nair and Daniel, 1986).

Studies by ecologists for a period of past two decades show that the vegetation of the Western Ghats today is a mosaic of patches of different ages and histories. Many of these patches are reported to be the relics of the most ancient forests such as the climax evergreen forests, merit ing high conservation value. Owing to the anthropogenic pressure the pristine forests in the Western Ghats are gradually decreasing.

Like other parts of the tropics, the Western Ghats are also one of the most highly human impacted mountainous tracts of the world. The human
Impacts include agriculture, extraction of forest products, horticulture, raising commercial plantation such as coffee, tea, rubber etc., monoculture of forest trees, hydroelectric projects, mining, township etc. These human activities and slash and burn cultivation practiced in the past have resulted in considerable forest fragmentation (Chandran, 1993).

**Western Ghats as a Biodiversity Hot-Spot**

Western Ghats of India and Sri Lanka has been considered as one of the 34 biodiversity hotspots of the world (Myers *et al.* 2000). These two regions together have 4,780 plant species, and 2180 of them are endemic. Biodiversity hotspots are recognised on the basis of extent of endemism in plants, vertebrates, their density per 100 km² and remaining primary vegetation as percent of original extent in the region (Myers *et al.* 2000). Anthropogenic activities such as destruction of habitats, over use of energy resources and environmental pollution in recent years, are responsible for the loss of a large number of life forms. This has led to the grim biodiversity scenario pushing numerous important plant and animal species to the verge of extinction and/or threatened or vulnerable status. This is more prevalent in tropical rain forests, known for the richest biodiversity in the globe (Ali *et al.* 2007).

The flora of Western Ghats comprises about 12,000 species from unicellular cyanobacteria to the flowering plants. In this spectrum the flowering plants of Western Ghats comprises about 27% of the Indian flora. Of more than 4000 species of flowering plants about 1600 species are
endemic (BSI, 2006) and nearly 63% of India’s arborescent evergreen taxa are endemic to the Western Ghats (Johnsingh, 2001). They occur nowhere else in the world.

The richness of the floristic diversity in the Western Ghats can be visualized by an example of Silent Valley, that supports about 1000 species of vascular plants in the stretch of just 90 km² (http://www.answers.com/topic/silent-valley-national-park). Similarly the mountains of Nilagiri District have a recorded flora of 2,611 species (Sharma et al. 1977). The Agastymalai Mountains in an area of about 2000 km² have floristic composition of more than 2000 species with 7.5% endemism (Henry et al. 1984). From the Agastymalai alone there are reports of 38 new taxa, of which many are endemic and relict species. The Kalakad-Mundanthurai Tiger Reserve (KMTRI) has about 150 localized plant endemics, and 33 fishes, 37 amphibians, 81 reptiles, 273 birds and 77 mammal species (Johnsingh, 2001). More than 260 new species are described from Western Ghats during the past 20 years. Most of the district floras from Western Ghats region of Karnataka like Flora of Udupi (Bhat, 2003), Flora of Hassan District (Saldanha, 1978), Flora of Coorg (Keshav Murthy and Yoganarasimhan, 1990) and Flora of Mysore (Rao and Razi, 1974) have described more than 1000 species with rich endemism.

Endemics are species with restricted range. A taxon is considered as endemic if confined to a particular area through historical, ecological or physiological reasons. At the global level endemic areas are of high conservation priority because if unique species are lost they can never be
replaced (Nayar, 1996). The Western Ghats endemism is of high conservation value. Several studies have shown that the Western Ghats endemics are more associated with evergreen forests (Chandran, 1993, 1997; Nayar, 1982 and Meher-Homji, 1983). The endemic vegetation patches are also apparently associated with perennial streams.

The endemic tree species of Peninsular India are mainly represented by the genera Poeciloneuron, Blepharistemma, Pseudoglochidion, Meteromyrtus, Otonephelium and Erinocarpus (Nayar, 1996). These woody life forms are generally considered to be relictual in nature. The tree genus Poeciloneuron, with two tree species P. indicum and P. parviflorum occurs in the evergreen forests of southern Western Ghats. The mangrove member Blepharistemma with single species (Blepharistemma serratum) is especially interesting endemic genus. This inland mangrove species had adapted itself to the lowland forest conditions of the southern Western Ghats. Carvia, Nilgirianthus, Phlebophyllum, Taeniandra, Xenacanthus are represented by shrubs that form undergrowth components of the tropical rain forests of Western Ghats.

Out of 620 listed threatened species in the Red Data Book of Indian Plants (Nayar and Sastry, 1987, 1988, 1990), 550 species are endemic to India. In this list about 96 species of trees coming under one or the other category of threat status, out of which 53 tree species are endemic to Western Ghats.

Based on General Principles of Location of Endemism Nayar (1996) has selected 24 micro endemic centres of plants in India. Among them
5 major regions coming under the Western Ghats are, Agastymalai hills (Ariankavu Pass to Aramboli Pass) with 189 endemic species, Nilgiri Silent valley-Wyanad-Kodagu (150), Anamalai and High Ranges (94), Palni Hills (43) and Shimoga-Kanara (58).

**Western Ghats of Karnataka**

The Western Ghats cover 38,019 km² in the state of Karnataka (Ali *et al.* 2007). It includes South Canara, Udupi, Chikmagalure, Coorg, Hasan, Mysore, Shimoga, Uttara Kannada and parts of Belgaum and Dharwad districts. The average rainfall is about 3000 mm and the annual rainfall is as high as 4000 mm in the coastal zone. The rainfall has a decreasing trend from south to north and from west to east (from windward to leeward). The average mean annual rainfall is 3964 mm in the coast, 1932 mm in the malanad and 903 mm in transition zone (Lele and Hegde, 1997; Venkatesh and Mathew, 2007). Agumbe in the Shimoga district has exceptionally high rainfall of 8280 mm. Similarly other places with high rainfall are Bhagamandala (603 cm), Pullingoth (594 cm) and Makut (505 cm) in Kodagu district (http://www.ias.ac.in/jess/aug2007/ds0618.pdf). The annual temperature varies between 20° to 38°C in the coast, 20°C to 27°C in malanad and 20°C to 35°C in the transition zone. As in case of Western Ghats, the soil types varies from lateritic in the coast to red loam in the ghats and mixture of black and red in the plains. The forest types vary from primary evergreen to semievergreen, moist deciduous, dry-deciduous, scrub and woodland savanna.
Being located in the central region of the Western Ghats, Karnataka is rich in endemic flora. Out of 7 ‘micro endemic centres’ of Western Ghats, two regions Shimoga-Kanara centre and Kodagu, part of Nilgiri Silent valley-Wyanad-Kodagu centre, belong to Karnataka. It forms the northernmost limit for many endemic tree species like *Dipterocarpus indicus*, *Poeciloneuron indicum*, *Hopea parviflora*, *Myristica fatua var. magnifica*, etc.

**A brief history of forest alteration in Western Ghats of Karnataka**

People have been living in the tropical forests for millennia and little of these forests, if at all, may be pristine (Chandran, 1997). The pre-agricultural phase of vegetational manipulation in the tropical forests, to increase the production of wild food plants may be traced to 30 to 40,000 years ago. With the beginning of agriculture, in less than 10,000 years back, the tropical forests began to lose their pristine nature.

According to Chandran (1997), the Western Ghats came under first human influence during the Palaeolithic or Old Stone Age, over 12,000 years BP. Mesolithic or Middle Age (12,000-5,000 years BP) witnessed the transition of hunter-gatherers into food growers. During the Neolithic or Stone Age (5,000-3,000 years BP), the Deccan Plateau people started primitive agriculture and pastoralism and in the megalithic period (3,000-2,000 BP), shifting cultivation was a major form of landuse in the Karnataka Western Ghats including the present study area. Slashing and burning through millennia, would have been one of the major reasons for the
decline of primary forests. The Western Ghats would have experienced the fourth millennium BP climate change, resulting in the decline of forests, both evergreen and deciduous and an increase in savanna plants, which is attributed to climatic aridity. But this vegetational change in Uttara Kannada region of lower altitude hills could have been more due to the arrival of agriculture and pastoralism (Chandran, 1997); the same case may be true for the western part of the neighboring Shimoga district.

In the early period of British occupation, the forest working mainly consisted of removal of shipbuilding timber trees like *Tectona grandis*, *Calophyllum tomentosum*, *Dipterocarpus indicus* and *Artocarpus hirsutus*. During 1890 to 1895, the forests were heavily worked for extraction of Railway sleepers, which contributed to the depletion of teak and other natural forest trees like *Poeciloneuron indicum*.

The great demand for all resources made the British to put various restrictions on shifting cultivation leading towards its near total ban by the close of 19th century. The prohibition in most places and strict regulations in others on slash and bum cultivation brought down the ecological role of fire along the evergreen forest belts, favouring the return of evergreens.

**Sharavathi River Basin**

River Sharavathi, one of the major West flowing river of Karnataka state, is very rich in diversity of flora and fauna within its basin. It comes under one of the 6 centres of endemism of Western Ghats. The forests range from climax evergreen to evergreen, semievergreen and moist deciduous
through which, several major streams and sub-streams flow out forming the major source of water.

The construction of dams to Sharavathi River began way back in early 1940’s. The Hirebhaskar dam in 1932, later the Linganamakki (1964-65) and Talakalale dams were built impounding a huge amount of water. The Mahatma Gandhi Hydro Electric Project was commissioned in 1948 and thereafter the Sharavathi Valley power scheme came into existence under which the Sharavathi Tailrace Dam was built at Gersoppa. Vast tracts of forests, including primeval and rare ecosystems like the *Myristica* swamps (presumably) were submerged. These have caused considerable fragmentation and degradation of natural habitats affecting regeneration of plant species.

Regeneration in many of the India’s forests including the forests of Western Ghats is inadequate to replace the adults (Ganeshaiah, *et al.* 1996). Thus in addition to quantitative assessment of plant diversity, we also need to assess the regeneration status of the forest communities, in particular the endemics.

Previous floristic studies in the Sharavathi River Basin, are ecological (Puyravaud *et al.* 1994 and 2003; Davidar *et al.* 2005, 2007), quantitative (Chandran, 1993) and both qualitative and quantitative (Ali *et al.* 2007). But these studies were made only for small part of river basin. The present study is undertaken throughout the Sharavathi river basin by quantitative assessment of the different forest patches.
Objectives of the Study

The study was carried out with following objectives:

- Study the diversity and richness of forest patches in the study area.
- Documentation of endemic tree species of the Western Ghats by vegetation sampling in the study area.
- Study of regeneration status of endemic trees in different forest patches.
- Study the effect of fragmentation on the regeneration of endemics.
- Prioritization of endemic trees for conservation.