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# Status of Forest in Shimoga District, Karnataka


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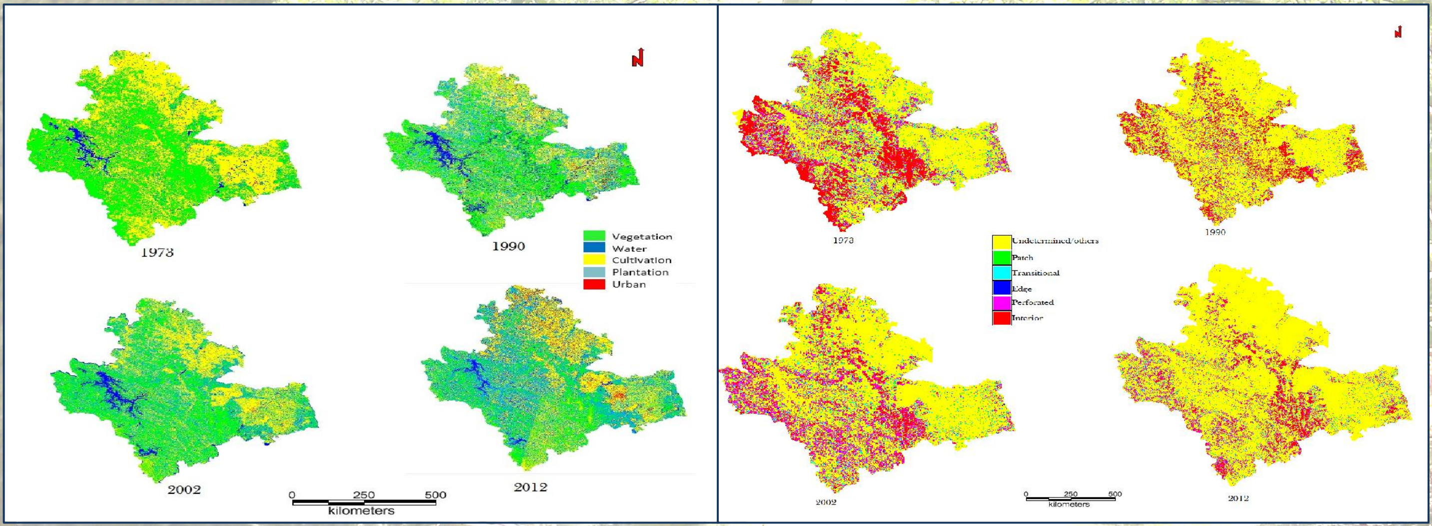


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Report prepared at the invitation of Sri Ananth Hegde Ashisar,
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## EXECUTIVE SUMMARY


The Western Ghats is rich with flora and fauna and is considered as one of the 34 biodiversity hotspots (also one among eight hottest hotspots of biodiversity) of the world (http://www.conservation.org). The region with a wide range of forest types ranging from tropical wet evergreen forests to grasslands is a repository of rich flora and fauna evident from the occurrence of over 4,000 species of flowering plants (38% endemics), 330 butterflies (11% endemics), 156 reptiles (62% endemics), 508 birds (4% endemics), 120 mammals (12% endemics), 289 fishes (41% endemics) and 135 amphibians (75% endemics). The forests of Western Ghats, in view of their floristic diversity and numerous multipurpose species, are considered a varietal storehouse of economically important plants. The tropical climate complimented by heavy precipitation from southwest monsoon and favourable edaphic factors create an ideal condition for the rich biodiversity, which can be seen only in few parts of the world. The forests which lost their earlier aura of sacredness (during community-based management regime) did not get any special consideration from the state and were subjected to routine forestry operations to meet state needs, harming their special biodiversity preserved through ages. Last few decades, however, have seen increased awareness on the need for conservation and sustainable use of the natural resources. The 1988 ban on timber extraction from natural forests has kindled hopes on biological revival of the Western Ghat forests. The stretch of Central Western Ghats ranges from 12° to 15° covering areas of Coorg district, Hassan, Chikmagalur, Shimoga, and Uttara Kannada.

Shimoga district of Karnataka state is situated in the heart of the Western Ghats region. The Malanad region consists of Western Ghats chain from where many rivers originate and the inland plain region of Deccan plateau. Such regions always have high priority for conservation, primarily for the diversity and for the provision of the ecosystem goods and services.

Shimoga, a malnadu district of the Karnataka State with a geographical area of 8465 sq.km is situated in the mid-south-western part of the State at 13°27' and 14°39'N and 74°38' and 76°4'E. Shimoga district has a rich and varied flora, the major contributing factors to this variety being differences in rainfall and topography within the district. In the region of the Western Ghats, the rainfall is heavy, Agumbe has the distinction of receiving higher annual rainfall of 8,275. 7 mms. A rapid transition from evergreen flora to the scrub type, i.e., from mesophytic to xerophytic, occurs as one moves from the west to the east. The forests of Shimoga district consists of Evergreen and Semi-Evergreen climax forests and degradation type and deciduous climax forests and degradation type.

Persistence of the Western Ghat endemics and relic species in this forest calls for serious attention to initiate programs immediately for recognizing and salvaging more fragments of such ancient forests that lie hidden amidst a sea of secondary forests. The fact that water course forests have not only rare species but also high biomass and greater carbon sequestration potential also calls for revision of forest management policies, as the innumerable stream courses of Western Ghats offer tremendous potential for carbon stocking per unit area while also bettering the hydrology of these mountains, which form the main watershed for the entire Indian Peninsula. Millions of subsistence farmers and other forest dwellers of Western Ghats can not only be partners in micro-level planning for prudent water use but also stand to gain in a big way from carbon credits for their new role as promoters and guardians of watershed vegetation. This study re-affirms Western Ghats, a repository of biological wealth of rare kind, both in its aquatic and terrestrial ecosystems and indicates strongly the need for adoption of holistic eco-system management for conservation of particularly the rare and endemic fauna of the Western Ghats. The premium should be on conservation of the remaining evergreen and semi-evergreen forests, which are vital for the water security (perenniality of streams or streams having water throughout the year) and food security (sustenance of biodiversity). Through appropriate management there still exists a chance to restore the lost natural evergreen to semi-evergreen forests.

The forested Shimoga district in the central Western Ghats of Karnataka are dotted with several groves with lofty lush-green forest cover known as ‘kaans’; literally meaning “thick evergreen forests”. These Sacred forests served many functions like conservation of biodiversity and watershed, moderation of climate, and enhancement of landscape heterogeneity which promoted varied wildlife.

State monopoly over forests, beginning with the British, early in the 19th century, spelt an end to the community-based landscape management. Most sacred groves, secondary forests and other unclaimed lands came under state monopoly as reserve forests. State driven and revenue oriented forest management policies focused mainly on timber extraction and on raising of tree plantations. Even the sacred groves of primeval nature were treated like any other forests. Whereas such relic forests, remaining isolated amidst human habitations suffered from extraction pressures from local people themselves, who were denied their traditional rights in the reserved forests, the larger groves of thinly populated areas got merged with secondary forests and lost their sacred value. Their remains today with rare relic species went almost unrecognized in conservation circles, until studies have been initiated from the angle of ecological history.

The fact that water course forests have not only rare species but also high biomass and greater carbon sequestration potential also calls for revision of forest management policies, as the innumerable stream courses of Western Ghats offer tremendous potential for carbon stocking per unit area while also bettering the hydrology of these mountains, which form the main watershed for the entire Indian Peninsula.

Analyses of land cover dynamics highlight the decline of vegetation cover from 96.57 (1973) to 91.72% (2012). Land use analysis reveals that forest vegetation decline from 43.83% (1973) to 22.33% (2012) due to the conversion of forests to agriculture, industrial and cascaded developmental activities. Forest fragmentation analysis indicated that domination of forests receded during post 90’s with the formation of patch and edge forest in all three divisions. Land use changes from forests to non-forests with intensified human interference had been very high especially in Bhadravathi division. Interior forest decreased by 12% during 4 decades. The extent of interior forests ranges from 12.91 (Shimoga) followed by 4.76 (Sagar) and 3.79 % (Bhadravathi). During the last four decades the interior forest declined from 22.9 (1973) to 13 % (2012) in Shimoga, and 15.90 (1973) to 4.76% (2012) in Sagar, and 4.10 (1973) to 3.79 % (2012) in Bhadravathi divisions emphasizing the need for an immediate eco-restoration measures to arrest fragmentation and consequent reduction in goods and services apart from the increase of human animal conflicts.

Encroachment of forest land (26385 hectares) and conversion to agricultural land is the principal cause of degradation at local levels, apart from land releases for major developmental activities. Talukwise encroachment of forest indicates that Bhadravathi taluk has highest number of encroachments (24.74%), followed by Sagar (17.8), Shikaripur (15.93), Shimoga (15.71), Sorab (11.68%).

Land use and fragmentation analysis reveals that the forest in the district is fragmented necessitating immediate ecological restoration to enhance the hydrological regime in the region. The degradation of the forest in the river basins of Varada and Sharavathi has led to conversion of perennial stream to seasonal stream leading to scarcity of water during monsoon season. In order to provide water to the dependent people throughout the year, there is an urgent need to take up the catchment treatment in all river basins. The catchment treatment essentially involves planting of native species of plants and enriching the region with grass species (wherever grassland occurs).

The *Myristica* swamps mainly in the downstream catchment area of Sharavathi are highly threatened but nevertheless are ecologically important ecosystems. These swamps have rare and endangered species such as *Semecarpus kathalekanensis, etc*. Whereas the *Myristicas* once faced threat from plywood industry, the present threat is from forest encroachers who convert such swamps into arecanut gardens, with telling consequences on watershed and biodiversity. For safeguarding these special habitats the Forest Department, JFM committees and Self Help Groups should work together. These swamps and their surroundings are very important water yielding forests; at the same time they are most vulnerable places for agricultural encroachment (e.g., Joginmata, Kathalekan, Halsolli etc.). Local forest committees of villagers have to be formed for the protection of such swamps. Rights for harvesting NTFP from surrounding forest may be given to local villagers as an incentive.

The major NTFP of the area is leaves of *Diospyros melanoxylon* and *Cinnamomum zeylanicum*. Apart from these, on a minor scale, *Emblica officinalis, Terminalia chebula,* and various medicinal plants, cane, *Bambusa* sp., and honey are also collected. Destructive methods of collection of NTFP by lopping the branches of trees like, *Myristica malabarica*, *Garcinia gummigutta, Cinnamomum zeylanicum* etc. will affect the endemic tree species.

The industrial extraction of timber from the primary evergreen forests in the past has led to the depletion of valuable endemic species and loss of many special habitats such as *Myristica* swamps. NTFP collection is to be banned in the core zone of the sanctuary area since it may pose a threat to the endemic tree species and their regeneration. But, in some areas, the community-based approach can be carried out instead of collections done by tenders given to non-locals by the forest department. This approach will be more appealing since each villager will become more responsible for conserving the forests, as removal of a tree would curtail the financial gains through NTFP. Destructive methods of collection of NTFP by lopping the branches of trees have to be stopped.

In SVWS (Sharavathi Valley Wildlife Sanctuary), forest enclosures play an important role in order to maintain viable wildlife population. Madenur, Muppane, Hallibyle and Shashichowka are the few forest enclosures with high density of gaur, sambar, and mouse deer. The intention of these enclosures is to provide protection to both flora and fauna of the region. These forest enclosures serve a better protection to some of the vulnerable species from the poachers. Most of these enclosures are planted with monoculture species like, Acacia, Casuarina, etc., which in turn not a suitable habitat for the above mentioned wildlife. In order to maintain the high density of these species, gradual conversion of monoculture into native species As the territories of wild animals extend beyond these enclosures, flocking of wild animals and futile attempts to cross these barriers have been noticed. This suggests the expansion of existing enclosures and creation of new enclosures, which has to be undertaken based on rigorous monitoring of wildlife movement.

Effective vigilance has to be exercised by the forest department in order to stop the further encroachments and poaching of wild animals inside the sanctuary. To avoid water scarcity, large number of water holes/percolation ponds should be constructed inside the sanctuary. The existing awareness programmes such as wildlife weeks, wildlife census, etc., have to be expanded and strengthened in the sanctuary and surrounding areas in order to educate and create awareness among local people. Interaction of forest officials with local people helps to arrive at solutions based on clear understanding of situation in the sanctuary.

Timber smuggling is a major problem even in the sanctuary area. Timber is smuggled even out of the Linganmakki islands, indicating the involvement of some organized groups. The timber smugglers take advantage of the remoteness of the islands from the human settlements for their illegal activities. During the course of the field work, timber harvesting is noticed at many places like, Karani, Banukuli, Kanur etc., within the sanctuary, calling for greater and effective vigilance from the authorities and the village forest committees (VFCs).

Due to fragmentation and reduction of natural habitats with the uncontrolled growth of agricultural practices over several years has resulted in repeated stress over the forest areas and acted negatively on the wildlife. Conflicts between wildlife and human have emerged as a problem in the arena of wildlife management. The conflicts, which result from the destruction of crops and damage to property, have raised both social as well as conservation issues. Efforts to keep animals out of crop fields by wildlife officials have been futile and sometimes result in people perceiving the animals as being malevolent. Thus, human- animal conflict is a common scene over the entire area. Herbivore and omnivore animals like Indian gaur, Indian porcupine, sambar, wild boar, rodents, etc., inflict considerable damage to agricultural crops. Several incidences of sloth bear attack have been reported in the core and buffer zones of the wildlife sanctuary (villages like, Kattinkaru, Karani, Kanur and Kogar). To tackle this problem, fencing the crops is a common procedure, which is detrimental to both wildlife and forests. The fencing material is usually the locally available wooden log, brought from nearby forests. For supplementing the wooden logs, large number of regenerating forest trees were cut down thereby jeopardizing the forest growth itself. These fences act as enclosures for wildlife movement from one place to another.

Hunting is practised as a sport, for subsistence, for crop protection and as a part of religious tradition by many village communities. During night-times, people form groups and go for hunting. A number of communities (Nayaks, Edegaru and Namadari gowdru) in the sanctuary carry out poaching activity. They target on wild animals like mouse deer, rabbit, wild boar, etc., due to which, the wild animal population is decreasing at a rapid rate. People support hunting as it reduces the probable damage to crops. Even some of the birds like spotted dove, cattle egret, pond heron, jungle fowl, peacock etc., are being hunted for meat by the local tribes. Poaching for money is seldom indulged in and gaurs constitute the main victim. Outside people are believed to be coming to the area to carry out this kind of poaching. At least one or two episodes do occur every year. The remoteness of the area and sparsely distributed human settlements are again advantageous to these poachers. In aquatic environment high fishing activity of the local people, licensed fishermen and migratory fishermen has threatened the indigenous fish population along with the endangered tortoise population of the region.

Significant parts of Sharavathi Valley wildlife sanctuary (15.27%) have been planted with monoculture plantations depriving the wildlife of their habitats. Preference of single species in forest plantations is another reason responsible for depletion of fodder for animals. This could become a major drawback to any kind of habitat restoration programmes as well as energy improvement technologies. The practice of planting of acacia and casuarina is still in progress in open areas of Muppane, Aralagodu, Karani, etc. These monoculture plantations have no other advantages to the wildlife, other than aiding as hiding places for some of the small mammals and agricultural pests. Changes in microclimate and huge litter cover in plantations adjacent to the evergreen and semi evergreen forests would inhibit the growth of younger tree species of natural forests.

Grasslands have been converted to monoculture plantations in the forest enclosures like, Madenur, Muppane, and Shashichowka denying the fodder to herbivores like gaur, sambar, spotted deer, etc. The monoculture of any exotic should be strictly discouraged in the areas of high animal population and movement. Any such reforestation activity should be in accordance with the local need and with indigenous species. Gradual shifting of natural plant species in the monoculture plantation areas is to be done. Habitat improvements with fodder plants species preferred by wild animals are to be planted instead of monocultures of acacia, pinus or casuarinas.

Usually in this region, forest fires are associated with highly fragmented areas. The main reasons for the fire are the dryness of the forest and the deciduous vegetation.

Humans on a yearly basis to enhance the growth of grasses burn much of the forest ground vegetation. While fire generally does not kill adult trees, it will effectively destroy the seedlings and young trees, thus preventing tree regeneration, creating senescent forests and eventually leading to the disappearance of forests. Almost every year forest department burnt the grassy blanks in some places to improve the quality of fodder for wild animals; this phenomenon also affects the habitat of burrowing small mammals. The fire has become a major factor in the degradation of forests. In order to restore the vegetation, these forests must be protected from fire, by preventing it by undertaking measures such as creation of awareness on the implication of fire among the local communities and proper maintenance of fire line. This plays an important role in the distribution of ungulates and bovines.

Wildlife present in the region are seasonal migrants from adjacent sanctuaries and hence, the corridors used by these animals should be given more attention. Three micro-habitat corridors have been proposed for linking fragmented habitats, so as to have continued link of populations to maintain sufficient viable reproductive groups to permit breeding. Corridors are to be developed with the native species of plants, which meet the food and fodder requirement of fauna during all seasons. The Sharavathi valley wildlife sanctuary has to be extended further so as to link to the Mookambika wildlife sanctuary to facilitate the better movement of wild animals and also conservation of endangered and endemic fauna (like Lion-tailed Macaque) and pristine forest areas (like, Kodachadri, Gurta, Malemane and Kathalekan).

There is an urgent need to establish Sharavathi Valley Ecologically Sensitive Area (SVESA) and Heritage sites for conservation, rehabilitation and sustainable management of ecosystems. It is required to complete the legal procedures for final notification of existing and new protected areas in the Sharavathi River Basin (Sharavathi valley wildlife sanctuary, notified vide government order AFD 70 FWL 71, 20/04/1972). The Wildlife Protection Act and other environmental laws need to be used in conjunction, so that the ecologically fragile habitats within and outside protected areas including islands, fish breeding areas, mangroves are protected. Wildlife biodiversity conservation programme needs to join hands with other sectoral programmes of the government.

It should be encouraged to voluntary re-location and rehabilitation of people living within the protected areas as in Kanur, Salkodu, Hebbankere, Karani, etc. Local Biodiversity Management Committees and Local Biodiversity Funds (under the Biological Diversity Act, 2002) will have a major role in wildlife conservation of a region. Conservation incentives have to be given to the Joint Forest Planning and Management (JFPM) Committees, forest development agencies and individuals who help and participate actively in the conservation of wildlife and biodiversity. Effective mechanisms for compensation due to loss of life and crops from wildlife need to be worked out. There is a great need to streamline the procedural aspects dealing with compensations to the affected families. Capture and translocation of species (such as leopards, snakes, etc.), and rewards to staff for successful conservation of species need to be worked out. Degraded habitats outside-protected areas must be developed as buffers to withstand the pressures from the peripheral human habitations. Raising and protection of food plants for wildlife in forest blanks as well as in areas dominated by monocultures to be given due importance.

Fish farming may be promoted in de-silted forest ponds to supply more protein food to the people and to wean them from hunting. Poaching and illegal trade has to be prevented by evolving strategies. Creation of awareness and education about the protected areas by effective dissemination of information on wildlife biodiversity conservation needs to be formulated. Formation of eco-clubs/village wildlife protection committees in forest villages is necessary to monitor ecosystems and to create awareness. Creation of wildlife corridors and micro-corridors will facilitate unhindered animal movements and minimise human wildlife conflicts. Limited tourism to promote a positive attitude towards wildlife bio-diversity needs to be done.

In the adjoining areas like, Gerusoppa, Uttarakoppa, Aruvakki etc., Kyasanur Forest Disease (KFD) is more prevalent due to high degree of forest degradation, that has led to the extensive growth of weeds, where in ticks, the main disease vector inhabit. Therefore restoration of full-canopied natural forest in the sanctuary area is of paramount importance.

Encroachment is a major threat to the forests of the region, which should not be allowed and the forest department should take serious steps to stop future encroachments. Here the agriculture and horticulture departments have a vital role to play. The drawbacks in agricultural practices, which lead to hazards like landslides, should be clearly explained to local people. Guiding the farmers for sustainable agriculture should be the primary duty of these departments.

Dependence on fuelwood, dry leaf litter etc. could be minimised by switching over to viable alternatives like biogas, etc., which needs initiations at the village level. Promoting the Gram Panchayaths to organize the villages and form village committees to monitor and manage the village resources can lead to success. There are excellent examples of success through efficient management of the resources in villages like Halkar of Uttara Kannada District, Hunasuru, Kugwe and Alalli of Shimoga, and Maradavalli of Shimoga. The traditional firewood sellers should be brought under strict supervision. The firewood collection should be limited only to dead and fallen trees and on particular days of weeks in the presence of Forest Department officials.

Grazing is a serious problem to forest regeneration and should be controlled. Forest department should encourage the local people to opt for either stall feeding or grazing in grasslands. Advantages of stall feeding include increased dung availability and biogas along with farmyard manure.

Legal actions need to be taken against unauthorized quarrying. The Mines and Geology Department should take immediate initiations towards evacuating the mining area and suitable conservation measures.

The strategy followed in MPM plantation should be reviewed. Only barren lands should be allowed for plantations. Grasslands should not be used for plantation, but for fodder to domestic animals within the village. Depending upon the livestock population of the village and the related constraints in raising the plantations, village specific strategy should be worked out involving local people.

In plantations, preference should be given to human energy instead of mechanized energy during planting and harvesting. This shift has couple of advantages like less disturbance to soil surface and increased employment opportunities to local people.

Most of the degraded forest patches have excellent regeneration capacity considering the rainfall of the area and progress made in protected patches under the scheme of JFPM.

A number of small tanks in the study area have excellent potential to irrigate the agricultural areas. Thus, there is a need to restore the deteriorated tanks, keeping in view the multiple benefits from these tanks.

Stream diversion can negatively act upon the riparian vegetation. The drinking water needs of the village people can be met from the well-conditioned village tanks.

Sharavathi River Basin is rich in the wild relatives of cultivated plants such as mango, jackfruit, *Garcinia,* gooseberry, nutmeg, ginger, pepper, cinnamon, pepper, turmeric, bitter gourd, snake gourd, pulses, brinjals, grapes, yams, aroids etc. Such plants are part of the *gene bank* of crop plants. Forests and other wilderness areas in ecologically sensitive area, which harbour the gene pool of such cultivated plants, are to be conserved.

**Domesticated Animal Biodiversity:** Effort should be made to document, monitor and encourage through incentives, if necessary, *in situ* conservation, breeding and distribution of the existing animal diversity. A livestock farm needs to be initiated for the conservation of *Malnadu Gidda*, the indigenous cattle of the Western Ghats.

**Energy and Socio-economic aspects:** In the Sagar Forest Division, about 8,903.27 ha of forestland is under *Acacia auriculiformis* of Mysore Paper Mills Ltd. Large-scale conversion of forests into plantations has deprived the basic NTFP resources to local people and hindered the movement of wild animals. The major impacts were felt in the areas like Ambargodlu and surrounding villages of Sagar Taluk, Jala, Haroyethige, Adugodi, Koteshirur near Nitturu and areas around Melina Besige, Sutta of Hosanagara taluk.

There is a great scope to switch over to biogas to meet domestic energy requirements as most of the households have the potential (animal residues) to install biogas plants. With present available technology, a minimum of four animals is required for family size biogas plant. The study shows that about 88% of the total households have more than four livestock and have the potential to install a biogas plant.

More importantly, in order to cope with the stressful energy situation massive afforestation programmes are very essential. Considering the village commons, Soppina bettas and other traditional use of the lands, village level land use planning is vital in energy planning. The programmes should aim at satisfying the firewood, fodder, timber, NTFP, and greens for farmyard manure requirements of the village.

**Conservation of traditional varieties**: The genetically diverse traditional varieties are well suited to the local environment. Disappointingly, they are vanishing due to adoption of high yielding varieties, and greater spread of commercial and horticultural crops. The study also revealed that improper usage of modern techniques in agriculture has resulted in devastating effects on the environment. Extensive use of inorganic fertilizers with the adoption of modern agricultural practices has resulted in the conversion of self-sustained traditional system to a system depending on external interventions. This is contributing to non-point source of pollution in the eastern region. The mitigation measures to conserve the traditional varieties are:

- Before introducing any new variety to a particular region, its applicability, suitability and impact on the entire system has to be understood.
- The departments should evaluate any new introduction before prescribing for this fragile ecosystem.
- The authorities should document and monitor the continuous changes in agriculture. Farmers need to be supported in capacity building to develop their skills and organize their activities.

Small scale conservation of indigenous crops, including tree crops such as mango, jackfruit, kokum, gooseberry, tamarind, drumstick etc. should be promoted for household food security. Women play a greater role in promotion of home gardens using indigenous biodiversity. Home gardens provide food security and provide an additional source of income for women. Even very poor could be part of this production system. Home gardens are important genetic resources of cultivated plants, and other folk knowledge related to the plants.

**Organic farming**: The concept of organic farming needs to be promoted among the farmers by the concerned Government departments as well as NGOs. Farmers need to be educated regarding the use of biopesticides, compost and vermiculture. Civic bodies to work in close coordination with agriculture department so that organic wastes are regularly composted and made available to the farmers. Pharmaceuticals to sponsor growing of medicinal plants by farmers using organic methods. The creation of village fodder farms will promote stall feeding of cattle and make available more quantity of cattle manure. Organic farming/consumer movement to be promoted by NGOs so that the farmers get better returns for their farm produce.

***Kan* Forests**:

The *kan* forests of Central Western Ghats of Karnataka, were most often climax evergreen forests, preserved through generations by the village communities of Malnadu regions, as sacred forests, or sacred groves, dedicated to deities and used for worship and cultural assemblage of the local communities. Various taboos and regulations on usage of the *kans* were self-imposed by the local communities. In the normal course trees were never to be cut, but the adjoining villagers enjoyed the privileges of taking care and gathering of wild pepper, that was abundant in the *kans*, and many other non-wood produce, demarcating portions of the *kans* informally between the different families for collection purposes.

The landscape of pre-colonial times had *kans* forming mosaic with secondary, timber rich forests, grassland and cultivation areas, promoting also rich wildlife. *Kans* were characteristic in the traditional land use of Shimoga, Uttara Kannada and Chikmagalur districts specially, and were equivalent to the *devarakadus* of Kodagu region. The *kans* functioned as important sources of perennial streams and springs used for irrigation of crops and for domestic needs. They moderated the local microclimate favouring the spice gardens in their vicinity, and were also fire-proof being evergreen in nature.

With the domination of Central Western Ghats region of Karnataka by the British, the State asserted its control over the *kan* lands, which were in thousands, each *kan* measuring originally from few hectares to several hundred hectares in area. The curtailment of community rights in the *kans*, including heavier taxation for collection of forest produce resulted in the abandonment of many of them, causing various hardships to the villagers.

Whereas most *kans* of Uttara Kannada got merged with the rest of the forests ensuring the conservation of rare and endemic species of Western Ghats, in Shimoga district the *kans* were not properly documented except in Sorab taluk and to some extent in Sagar and Thirthahalli taluks. Moreover the Shimoga *kans* were brought under either the forest or revenue departments. As communities lost their traditional biomass collection privileges in secondary deciduous forests, in many places they resorted to *kans* for fuelwood, timber and leaf manure, causing their decline.

As the *kans* were not of much timber value due to the growth of easily perishable softwoods in them, the British thought it suitable to keep many such under the control of the revenue department. The revenue authorities started allotting these precious watershed areas and reserves of biodiversity for expansion of cultivation, especially of coffee and garden crops, creating widespread fragmentation of the *kans*. The practice of allotments ranging in area per applicant, individual or organization varied from one or two acres to hundreds of acres each. As the *kans* under revenue department was given more importance as land resources than as forests, the forests were cleared partially or entirely for alternative land uses.

The rampant use of fire for clearing the evergreen vegetation for cultivation areas or creating grassy areas caused change of climax evergreen vegetation to savannas, scrub and secondary deciduous forests with diminished water flow in the streams and rivers, which can be detrimental to the livelihoods of people in malnadu and beyond even in the drier Deccan plains.

Large chunks of *kan* lands were allotted to the Mysore Paper Mills for raising of pulpwood plantations, especially in Shimoga district.

Soil erosion, consequent on the clearance of *kans*, has adversely affected forest regeneration and is also detrimental to cultivation as well as causing siltation of water bodies, resulting in the abandonment of many irrigation tanks adjoining the *kan* lands.

Kurnimakki-Halmahishikan and Kullundikan in the Thirthahalli taluk of Shimoga district, which are facing severe threats from rampant allotments of large areas to private parties for non-forestry purposes and from conflicting claims of ownership, with the forest department not enjoying adequate power to save these *kans* from *liquidation* of their natural vegetation.

The study in the Kurnimakki-Halmahishi *kan* of about 1000 ha reveals the vegetation of the kan, though heavily fragmented, due to ever increasing human impacts, nevertheless, is a mosaic of various kinds of forests. The most significant is the discovery of swampy areas within this kan which have few individuals of large sized threatened tree species *Syzygium travancoricum,* classified in the IUCN Red List as "Critically Endangered". The tree is on the verge of extinction, and for the Shimoga district, the only occurrence of this tree is the Kurnimakki-Halmahishi *kan*.

The Kullundikan of about 453 ha has a narrow belt of original tropical rainforest dominated by the tree *Dipterocarpus indicus,* considered 'Endangered' by the IUCN. The revenue department in control of this *kan*, being totally ignorant of its vegetation richness has made several grants within the *kan* for cultivation of coffee and arecanut. The grantees have also done encroachments within this climax forest area of high watershed value. The cutting of the climax forest for raising coffee or any other crop is totally unjustified.

We therefore recommend that the Government of Karnataka take immediate action to arrest the degradation of *kan* forests on priority basis by:

- Proper survey and mapping of boundaries of all *kans*;
- Assign the *kan* forests to the Forest Department for conservation and sustainable management;
- Constituting Village Forest Committees for facilitating joint forest management of the *kan* forests;
- Taking speedy action on eviction of encroachers from the *kans*;
- Giving proper importance to the watershed value and biodiversity of the *kans*;
- Taking special care of threatened species and threatened micro-habitats within the *kans*;
- **Heritage sites status to '*kans*' under section 37(1) of Biological Diversity Act 2002, Government of India** as the study affirms that *kans* are the repository of biological wealth of rare kind, and the need for adoption of holistic eco-system management for conservation of particularly the rare and endemic flora of the Western Ghats. The premium should be on conservation of the remaining evergreen and semi-evergreen forests, which are vital for the water security (perenniality of streams) and food security (sustenance of biodiversity). There still exists a chance to restore the lost natural evergreen to semi-evergreen forests through appropriate conservation and management practices.

# Status of Forest in Shimoga District, Karnataka

## 1.0 INTRODUCTION

Western Ghats mountain ranges constitute the gorgeous array of mountains along the west coast of India, separating the Deccan Plateau and a narrow coastal strip (along the Arabian Sea). The mountain range starts from the southern part of the Tapti River near the border area of the states of Gujarat and Maharashtra. Western Ghats mountain ranges cover a length of around 1600 km (8° to 22° N, 73° to 78 °E ) running through a geographical area of about 160,000 $km^2$of Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala states finally terminates at Kanyakumari district, in the southern-most tip of the Indian peninsula (Daniel, 1997).Western Ghats starts as a bold westerly escarpment south of the Tapti estuary in Gujarat, reaching almost immediately to a height of over 3000 feet (914.4 m) and then extends in the form of a wall down to Kanyakumari (Cape of Comorin) with only one break or gap at Palghat (Palghat gap); throughout this length the Ghats retain an average elevation of 900 m above sea level with peaks as high as 1800-2400 m, and traverse many geological formations of differing physical and structural characteristics (Gunnel and Radhakrishna, 2001). The landscape is unique in terms of geology, hydrology, biodiversity and ecology. Geology and geomorphology coupled with high rainfall makes the Western Ghats as one of the most ecologically diversified landscapes.The complex geography, wide variations in annual rainfall from 1000-6000 mm, and altitudinal decrease in temperature, coupled with anthropogenic factors, have produced a variety of vegetation types in the Western Ghats. Tropical evergreen forest is the natural climax vegetation of western slopes, which intercept the south-west monsoon winds. Towards the rain-shadow region eastwards vegetation changes rapidly from semi-evergreen to moist deciduous and dry deciduous kinds, the last one being characteristic of the semi-arid Deccan region as well. All these types of natural vegetation degrade rapidly in places of high human impact in the form of tree felling, fire and pastoralism, producing scrub, savanna and grassland. Lower temperature, especially in altitudes exceeding 1500 m, has produced a unique mosaic of montane 'shola' evergreen forests alternating with rolling grasslands, mainly in the Nilgiris and the Anamalais (Pascal 1988).

The Western Ghats is rich with different kind of vegetation and topographical features. This bioregion is highly rich with flora and fauna and is considered as one of the 34 biodiversity hotspots (also one among eight hottest hotspots of biodiversity) of the world(http://www.conservation.org).The region with a wide range of forest types ranging from tropical wet evergreen forests to grasslands is a repository of rich flora and fauna (Daniels, 2003; Sreekantha et al., 2007; Gururaja, 2004) evident from the occurrence of over 4,000 species of flowering plants (38% endemics), 330 butterflies (11% endemics), 156 reptiles (62% endemics), 508 birds (4% endemics), 120 mammals (12% endemics), 289 fishes (41% endemics) and 135 amphibians (75% endemics). The forests of Western Ghats, in view of their floristic diversity and numerous multipurpose species, are considered a varietal storehouse of economically important plants. The tropical climate complimented by heavy precipitation from southwest monsoon and favorable edaphic factors create an ideal condition for the luxuriant growth of plant life, which can be seen only in few parts of the world (Gadgil, 1996). The forests which lost their earlier aura of sacredness (during community-based management regime) did not get any special consideration from the state and were subjected to routine forestry operations to meet state needs, harming their special biodiversity preserved through ages. Last few decades, however, have seen increased awareness on the need for conservation and sustainable use of the natural resources (Chandran 1998; Pathak 2009). The 1988 ban on timber extraction from natural forests has kindled hopes on biological revival of the Western Ghat forests.

The stretch of Central Western Ghats ranges from 12° to 15° covering areas of Coorg district, Hassan, Chikmagalur, Shimoga upto south of Uttara Kannada.Shimoga district of Karnataka state is situated in the heart of the Western Ghats region.The Malanad region consists of Western Ghats chain from where many rivers originate and the inland plain region of Deccan plateau. Such regions always have high priority for conservation, primarily for the diversity and for the provision of the ecosystem goods and services.

Due to unplanned developmental activities, large blocks of adjoining forests are being reduced to remnant patches of secondary habitats, affecting the ecology and biodiversity. The impacts of these human induced changes are evident from extinction of species and increased population of exotic/invasive species (Daniels, 2003); vast stretches of barren lands, barren hill tops, reduced water infiltration and lowering of water table with ever increasing demand for water. Implications of the changes in ecosystem structure, function, and distribution, due to global climatic changes and land-use practices have raised serious concerns and also brought a paradigm shift in the approach towards ecosystem from **human versus ecosystem** to **human and ecosystem** along with the concept of 'sustainable development' in conservation and management of natural resources.(Sameer Ali et.al, 2007). This report assesses the status of forests in Shimoga district, Central western Ghats, and the biological richness of forgotten groves/kans along with the hydrological and ecological linkages. The objectives of current study are:

i). To assess the present status of forests of Shimoga;
ii). Land use and land cover [LULC] dynamics in the district considering temporal remote sensing data;
iii). Extent of fragmentation of forests and its impact on the ecosystem;
iv). Identification of factors responsible for large scale landscape dynamics – land diversions, extent of encroachment, etc.
v). Status of kans/sacred groves in Shimoga district;
vi). Appropriate mangement strategies to sustain forests in the district.

## 1.1 SHIMOGA DISTRICT PROFILE

SHIMOGA, a malnadu district of the Karnataka State with a geographical area of 8477 sq.km is situated in the mid-south-western part of the State at 13°27' and 14°39'N and 74°37' and 75°52'E (Shimoga district statistics, 2011). The district is bounded by Uttara Kannada district on the northwestern side, Udupi district on the south western side, Chickmagalur district on the south and south eastern side, Davangere district on the eastern side and Haveri district on the north eastern side (Figure 1).

The name of the district (Shimoga) is related to God Shiva, viz., 'Shiva-mukha' (the face of Shiva), 'Shivana moogu' (the nose of Shiva) and' Shivana-mogge' (buds of flowers meant for Shiva). The place has several old sacred places dedicated to Shiva. According to a legend, the place had the ashram of the famous sage Durvasa who was noted for his sharpness of temper. He used to keep on the oven a pot boiling with sweet herbs. Once, some cowherds, who chanced upon it, tasted the beverage out of curiosity and called the place 'Sihi-moge' (sweet pot)', which was later called as Shimoge. In some epigraphs, the place is referred to as Sheemoge and Seemoge (vide Shimoga-10, 108 and 3 of 1085 and 1671 A.D. respectively in Epigraphia Carnatica, Vol. VII, 1902). The name is written and pronounced in Kannada as Shivamogge and in Englishform as ' Shimoga ' (Shimoga district Gazetter, 1975).

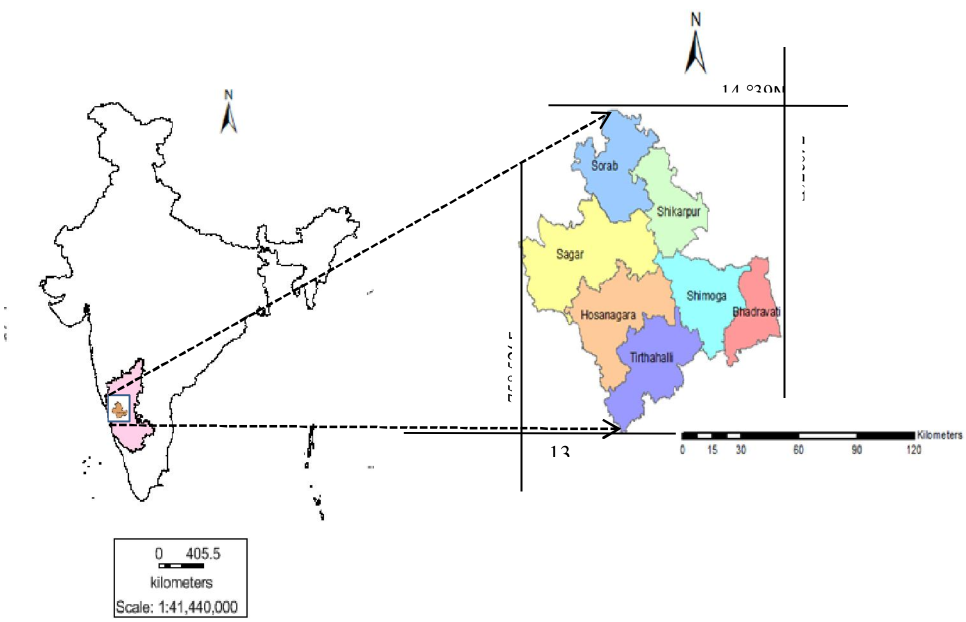



**Figure 1: Geographic location of Shimoga district, Karnataka State, India**

## 1.2 ADMINISTRATION HISTORY

The region was under the control of Mauryas and during third century A.D., the Satavahanas took control of the district. Subsequently, during fourth century A.D., the Kadambas of Banavasi rose to power in the region. While the Kadambas ruled the western portion of the district, the Gangas of Talakad administered the eastern part. In the 6th century, the Chalukyas of Badami defeated both the Kadambas and the Gangas who, however, continued as the feudatories of the former (Shimoga District Gazetter, 1975). Later, the Gangas lost a major portion of their territory in the district. In the seventh century, a principality was established at Humcha by Santara Deva, a Jaina chieftain. During the next century, the Rashtrakutas of Malakhed established their supremacy over this and other regions.

In the 10th century, Banavasi region along with some other parts were added to the Ganga kingdom by the Rashtrakutas in recognition of the help rendered by the Gangas in defeating the Cholas. In the 11th century, the Hoysalas became powerful and ruled over the district. As a result of several wars between the Hoysalas and the Sevunas (Yadavas) of Devagiri, the northern parts of the district were held by the latter for some time.The Kalachuris were in power for only a short period during the 11th century. Belagutti in this district was the capital of a principality during this time and also later. After the Hoysala power came to an end in the 14th century, the district became a part of the Vijayanagara empire. Araga in this district was the capital of a province under Vijayanagara. About the beginning of the 16th century, the house of the Keladi Nayakas (also sometimes called Ikkeri or Bidnur Nayakas) established themselves in the area. There was also a small principality of Basavapatna in the east of the district. In 1763, Haidar Ali captured Bidnur, the capital of the Keladi Nayakas, and as a result, this district along with other areas of their kingdom was added to Mysore (Shimoga District Gazetter, 1975).

After 1799 A.D., during the early period of the Wodeyars of Territorial Mysore, the Nagar Faujdari included the present Shimoga and changes Kadur (now called Chikmagalur) districts. In 1862, the Shimoga, Kadur and Chitradurga districts were formed into the Nagar Division which was, however, abolished in 1879. The Kumsi hobli (revenue circle) was made a separate sub-taluk under the Shimoga taluk in 1862. Nyamati was made the headquarters of the Honnali taluk in 1869.The headquarters of this taluk was again transferred to Honnali in 1882. Davanagere taluk was transferred to this district in 1882, and it was reverted to Chitradurga in 1886. Till 1882, the Tirthahalli taluk was called Kavaledurga taluk. The area of the Nagar taluk was extended in 1832-33 by combining it with the Anantapur (now Anandapuram) taluk, but the latter was re-established as a taluk in 1857-58 and continued as a taluk till 1875 when it was merged in Sagar taluk. The headquarters of the Nagar taluk was transferred to Kallurkatte (now called Rosa-nagar) in 1893. Twenty-three villages, which formed a part of the Shikaripur taluk, were transferred to the Sagar taluk on 1st October 1923. Between 1941 and 1950, the Kumsi sub-taluk was merged with the Shimoga taluk, and a separate new taluk of Bhadravati with the Bhadravati hobli (excluding five villages) and Kudlagere hobli and twenty villages of the Hole-Honnur hobli of the old Shimoga taluk was constituted. Between 1941 and 1951, three villages namely, Kote-Shirur Nagodi and Hebbige of South Kanara district which was in the erstwhile Madras State were transferred to the Hosanagar taluk (Shimoga District Gazetter, 1975).

## 1.3 PRESENT ADMINISTRATIVE PROFILE

Shimoga district with headquarters in Shimoga city is divided into 2 sub-divisions and 7 Taluks. The Shimoga Sub-division comprises the taluks of Shimoga, Bhadravathi and Thirthahalli. The Sagar sub-division comprises Sagar, Shikaripura, Sorab and Hosanagara. The Shimoga district administration is headed by the Deputy Commissioner with additional role of a district Magistrate. Assistant Commissioners, Tahsildars, Shirastedars, Revenue inspectors and Village Accountants help the Deputy Commissioner in the administration of the district (*http://* www.**shimoga**.nic.in).

## 1.4 POPULATION (http://censusindia.gov.in)

Current population in the district is 17,52,753 and there has been an increase of 6.7% during the last decade. The population in 2001 was 16,42,545 with a population density of 193.77 per sq km implying a growth of 13% during 1991-2001 (http://censusindia.gov.in). The Shimoga taluk with the maximum and Hosanagara taluk minimum population density as can be seen in table 2. Nearly 65% of Shimoga district lives in villages and remaining 35% in towns. Table 1 lists rural and urban population density in 2001 and 2011. There has been an increase of 6.7% during 2001 (1642545) to 2011 (1752753), which is relatively lower compared to 1991-2001 (13.1%). Male population has increased by 5.6% while female population shows an increase of 7.8% during the last decade. Talukwise population and population density is given in Table 2. The district has population density of 206 persons per sq.km (2011) with highest in Badravathi (503.9), followed by Shimoga (462.24) and lowest in Hosanagar (86.16).Talukwise population increase show the variation from 2.2 (Sagar) to 12.06 (Shimoga taluk) during 2001 to 2011. Spatial distribution of population density during 1991, 2001 and 2011 is given in Figure 2, 3 and 4 respectively. Villagewise population densities during 1991, 2001 and 2011 are given in Figure 5, 6 and 7.

| Sl No. | | Persons | | Males | | Females | |
|---|---|---|---|---|---|---|---|
| | | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 |
| 1. | Total | 16,42,545 | 17,52,753 | 8,30,559 | 8,77,415 | 8,11,986 | 8,75,338 |
| 2. | Rural | 10,71,535 | 11,29,026 | 5,40,238 | 5,65,821 | 5,31,297 | 5,63,205 |
| 3. | Urban | 5,71,010 | 6,23,727 | 2,90,321 | 3,11,594 | 2,80,689 | 3,12,133 |

**Table 1: Population of Shimoga as per 2001 and 2011census**

| Taluk | Area(Sq. Km) | Population (1991) | Population (2001) | Population (2011) | Population density(per sq.km)1991 | Population density(per sq.km)2001 | Population density(per sq.km)2011 |
|---|---|---|---|---|---|---|---|
| **Bhadravathi** | 690 | 324673 | 338989 | 347337 | 470.54 | 491.29 | 503.39 |
| **Hosanagara** | 1423 | 102714 | 115000 | 122603 | 72.18 | 80.82 | 86.16 |
| **Sagara** | 1940 | 177157 | 200995 | 205459 | 91.32 | 103.61 | 105.91 |
| **Shikaripura** | 909 | 188752 | 213590 | 231293 | 207.65 | 234.97 | 254.45 |
| **Shimoga** | 1113 | 365522 | 445192 | 514474 | 328.41 | 399.99 | 462.24 |
| **Soraba** | 1148 | 162370 | 185572 | 197107 | 141.44 | 161.65 | 171.70 |
| **Thirthahalli** | 1254 | 131071 | 143207 | 150068 | 104.52 | 114.2 | 119.67 |
| **Total** | **8477** | **1452259** | **1642545** | **17,52,753** | **171.32** | **193.77** | **206.77** |

**Table 2: Talukwise statistics of population and population density**

## 1.5 TOPOGRAPHY

The greater part of the district lies in the malnad; the region to the west of a line drawn from Shikaripur to Gajanur. The eastern portion lies in the maidan region (bailu-seeme) which is an open country. The western region consists of valleys and hill ranges sloping west to east with a maximum altitude of 640 and 529m. The Malnad region is characterized by mountains with heavy rainfall, covering Thirthahalli, Sagar, Sorab and Hosanagara taluks.The semi-malnad regions comprising Shimoga, Bhadravati and Shikaripur taluks lie in the eastern part having vast stretches of plain lands with low and rising hillocks with low vegetation (Shimoga district Gazetter, 1975). The western side of the district is a very mountainous area and is part of the Western Ghats. The famous ghats in the district are Agumbe ghat, Hullikal ghat and Kollur ghat, the peaks are Kodachadri-1343m, Agastya-parvata-848m, Govardhanagiri-848m, Chandragutti-848m amsl in the central zone. The prominent hills in the eastern part of the area are Kavaledurga-969m and Kabranagara-1031m amsl. Kodachadri is a fine peak of 1,343 m height situated about 16.1 kms North-west of Nagar (Shimoga district Gazetter, 1975). The lowest point in the district at Nagavalli valley in Sagar Taluk is just 66 m above the sea level. The interior part of the district is traversed by a series of hills, running from Mandagadde northwards between Anandapura and Kumsi and by a range from Allawadi westwards through Ikkeri to Talguppa (Ramaswamy et.al, 2001).

## 1.6 CLIMATE

The western parts of Shimoga district forms part of the Western Ghats and Malnad region, which includes the mountainous and forest areas lying to the western edge of the Ghats. Remaining portion of the district falls under southern maidan area consisting of broad undulating plateau with elevations ranging from 600 to 1000 m. The area enjoys tropical climate throughout the year. Generally, the weather is hot and humid in the eastern part and very pleasant in the remaining parts of the area. The relative humidity ranges from 27 to 88%, the wind speed recorded is between 4 and 7 km/hr (Government of India, CGWB, 2007). The evapo-transpiration is normally high in ghat section as compared to plain in the east.

Summer prevails between March to early June, the wet months start from early June to September. October and November month experiences small amount of rain by North East monsoon.The winter commences in mid-November and ends in the middle of February. After January, there is rapid increase of temperatures. April is usually the hottest month with the mean daily maximum temperature at 35.8°C and the minimum at 22°C.On individual days during the summer, the day temperature rises upto about 38°C .With the onset of the south-west monsoon in the district early in June, there is appreciable drop in the day temperatures.After October, both the day and night temperatures decrease steadily till about January and later begin to increase. In December, the mean daily maximum temperature is 29.2°C and the mean daily minimum is 14.9°C (Government of India, CGWB, 2007).

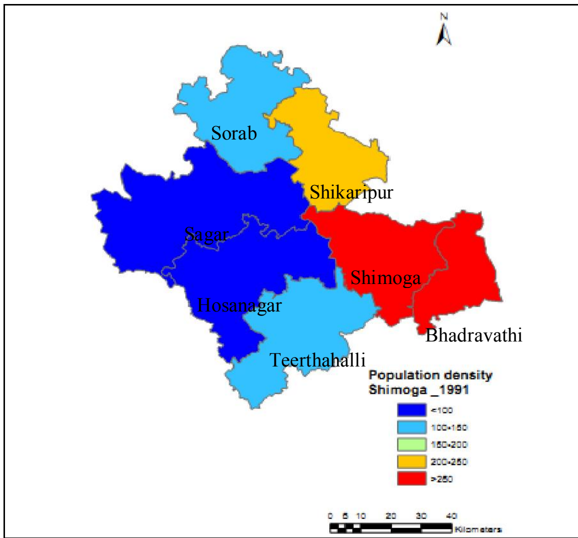



**Figure 2: Population density (1991) across taluks of Shimoga district**

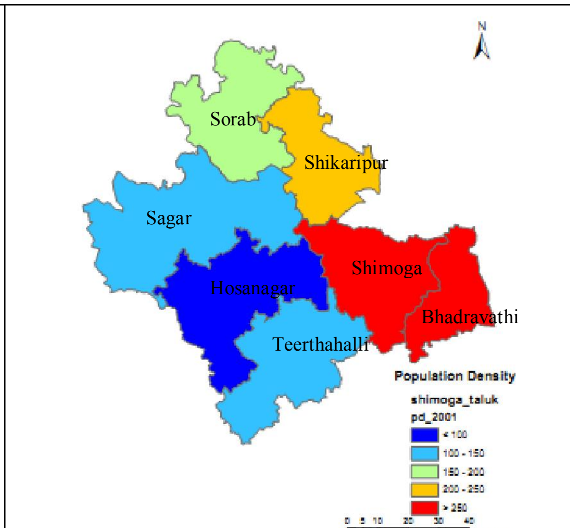



**Figure 3: Population density (2001) across Taluks of Shimoga district**

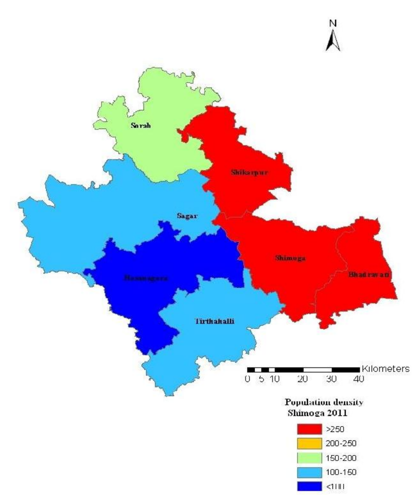
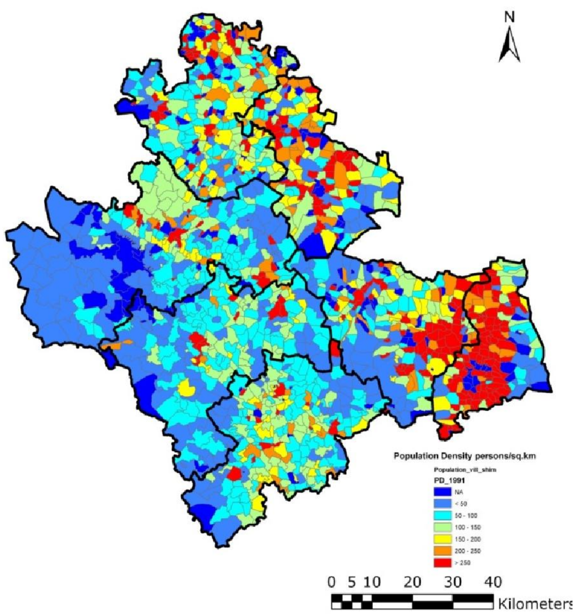
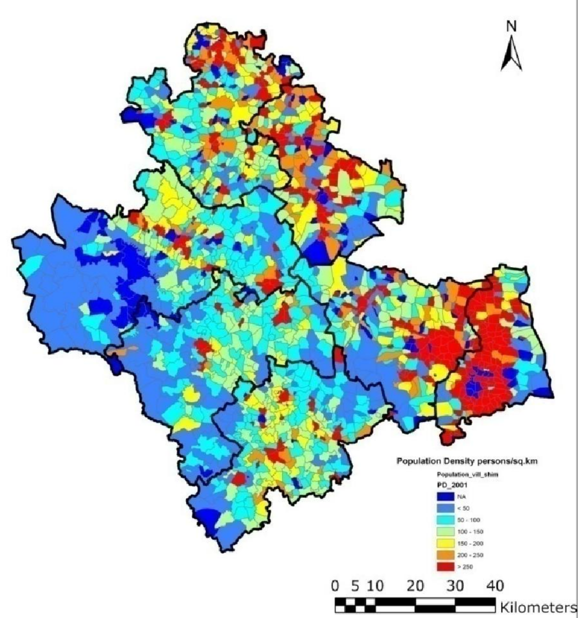



**Figure 4: Population density (2011) across Taluks of Shimoga district**




| Figure 5: Population density Villagewise 1991 | Figure 6: Population density Villagewise 2001 |
|---|---|

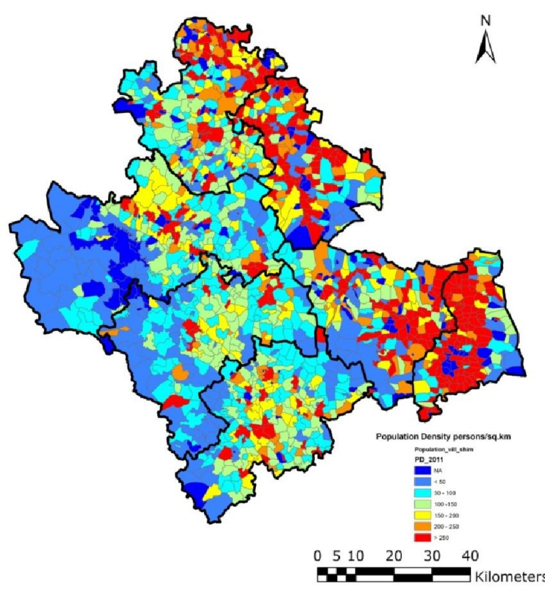



**Figure 7: Population density villagewise 2011**

## 1.6.1 RAINFALL

Shimoga district receives an average rainfall of 2421mm (Government of Karnataka, Annual rainfall report 2011). Table 3 lists rain gauge stations in the district. Taluk wise rainfall data for the last 10 years, suggests that average annual rainfall in the district varies between

769.4 mm at Bhadravati, which is located on eastern most part of district and 3201 mm at Hosanagar located on western most part of the district (Government of Karnataka, Annual rainfall report, 2011). Table 4 lists talukwise rainfall during 2011.

Daily rainfall data of 87 rain gauge stations for 109 years (1901-2010) was collected from the Bureau of Economics and Statistics, Govt. of Karnataka. Mean annual rainfall and the standard deviation were calculated for all the rain gauge stations to know annual variability.In Tirthahalli taluk a place named Agumbe, which records highest rainfall in Karnataka has recorded an average annual rainfall of 2671mm. The taluk head quarters Sorab, which is the northern most taluk, has recorded an average annual rainfall of 1410mm. The rainfall pattern suggests a steady decline in rainfall as we move from west to east. The highest annual rainfall of 4380.80 mm was recorded at Hosanagar during the year 2000 and the lowest annual rainfall of 407.0 mm was recorded at Sorab during the year 2001 (Government of India, CGWB, 2007). Spatial variation in the annual rainfall is depicted in Figure 8 and monthwise variations are illustrated in Figure 9.

| TALUK | RAINGAUGESTATIONS | TALUK | RAINGAUGE STATIONS |
|---|---|---|---|
| BHADRAVATHI | Bhandigudda | HOSANAGAR | Arasalu |
| | Bhadravathi | | Ginikal |
| | Br Project | | Hosanagar Srrg |
| | Gangur | | Hulikal |
| | Hallikere | | Mathikai |
| | Holehonnuru Srrg | | Mathiga |
| | Kudligere | | Nagara |
| | Kallihal | | Neralamane |
| | Anaveri | | Sunnadamane |
| SAGAR | Anandapura | | Vatagod |
| | Aralagod | | Yadur |
| | Byakody ( Karur) | | Humcha |
| | Guttanahalli | | Melusunka |
| | Jog Iii A B Site | | Rippanpete |
| | Kargal | | Nilskal |
| | Koralikuppa | | Mani Dam |
| | Kogar | | Sampekatte |
| | Linganamukki | | Savehakkalu |
| | Nagavalli | SHIKARIPUR | Kappanahalli |
| | Sagar I B Srrg | | Kutrahalli Hms |
| | Sagar Rly | | Shikaripura Srrg |
| | Talakalale | | Shiralkoppa |
| | Talaguppa | | Thogarsi |
| | Tagarthi | | Hosur |
| | Avinahalli | | Talagunda |
| | Genasinakuni | | Udagani |
| | Yelakundele | | Haragavalli |
| | Padavagoud Auto Srrg | | Anavatti |
| | Ayanur | | Chandraguthi |
| | Katikere | | Kuppagadde |
| | Kumsi | | Sorab Srrg |
| | Shimoga D C Office | | Ulavi |

| | | | |
|---|---|---|---|
| SHIMOGA | Shimoga Rly | SORAB | Jade |
| | Umblebylu | | Baadada Bylu |
| | Holalur | | Hulthi Koppa |
| | Haranahalli | | Mudi |
| | Nidhige (Bidare) | | Bannur |
| TIRTHAHALLI | Agumbe T B Srrg | | Kuppe |
| | Araga | | Nallur |
| | Aralasurali | | |
| | Devangi | | |
| | Hebbagilu | | |
| | Humchadakatte | | |
| | Konandur | | |
| | Malur | | |
| | Megaravalli | | |
| | Thirthahalli | | |
| | Kannangi | | |
| | Mrugawadhe | | |
| | Mandagadde | | |

**Table3: Raingauge stations of Shimoga district**

| Sl.no. | Taluk | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bhadravathi | 0 | 0 | 0 | 54 | 43 | 127 | 186 | 151 | 86 | 155 | 14 | 0 | 816 |
| 2 | Hosanagar | 0 | 0 | 1 | 34 | 30 | 1552 | 1610 | 1380 | 885 | 138 | 67 | 0 | 5697 |
| 3 | Sagar | 0 | 0 | 0 | 56 | 22 | 844 | 969 | 814 | 523 | 130 | 44 | 0 | 3402 |
| 4 | Shikaripur | 0 | 0 | 0 | 46 | 30 | 144 | 222 | 197 | 140 | 127 | 19 | 0 | 925 |
| 5 | Shimoga | 0 | 0 | 0 | 83 | 48 | 149 | 180 | 145 | 111 | 128 | 30 | 0 | 874 |
| 6 | Sorab | 0 | 0 | 0 | 50 | 19 | 365 | 470 | 315 | 222 | 154 | 51 | 0 | 1646 |
| 7 | Thirthahalli | 0 | 0 | 0 | 44 | 28 | 836 | 1004 | 780 | 599 | 119 | 31 | 0 | 3441 |
| Average rainfall | | 0 | 0 | 0 | 51 | 30 | 710 | 802 | 659 | 442 | 135 | 41 | 0 | 2870 ±1850 (SD) |

**Table 4: Talukwise Average Monthly Rainfall (mm)-2011**(Annual rainfall report-2011,GoK)

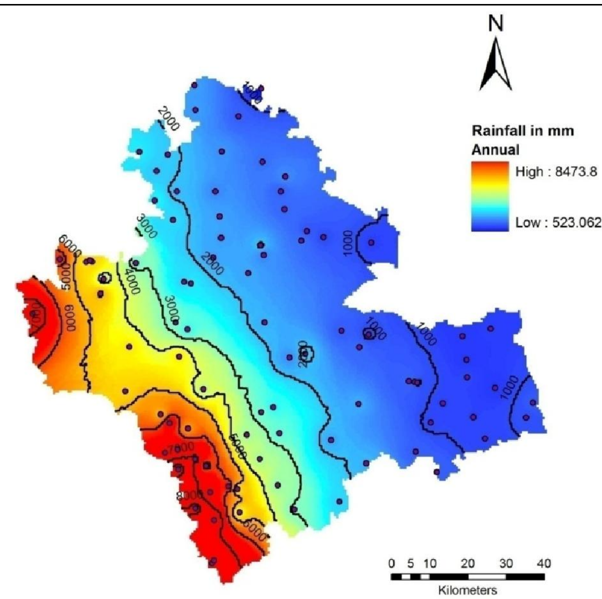
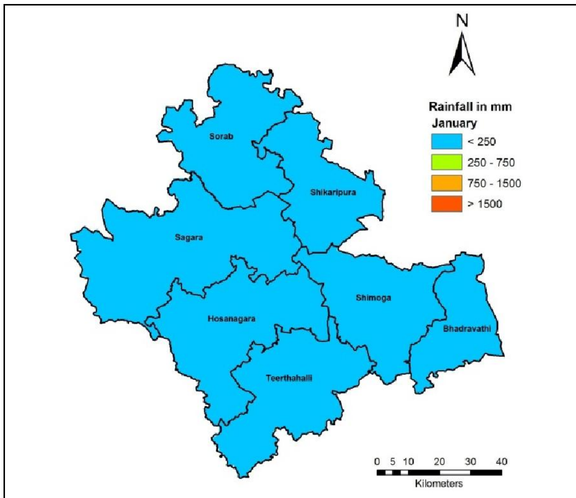
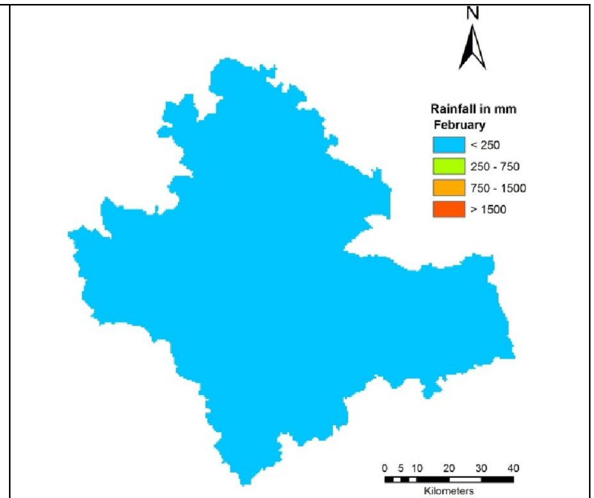


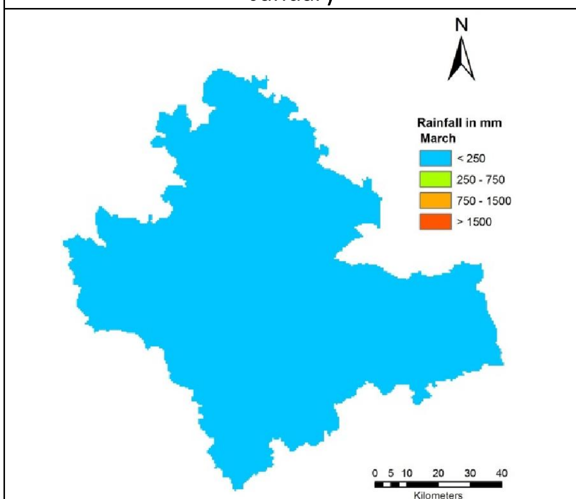

**Figure 8: Mean Annual rainfall distribution from 1901-2010 for Shimoga district**



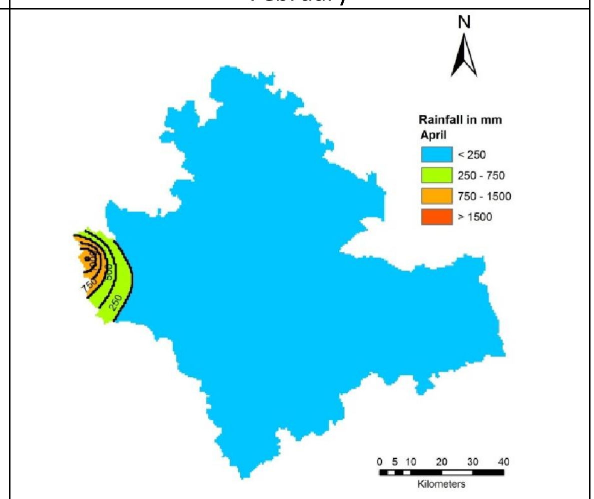

January



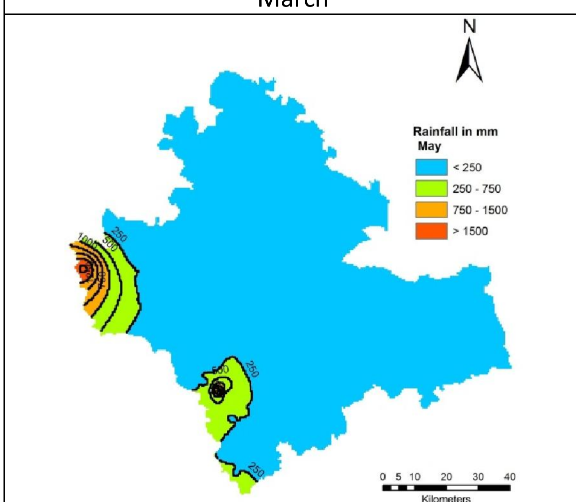

February



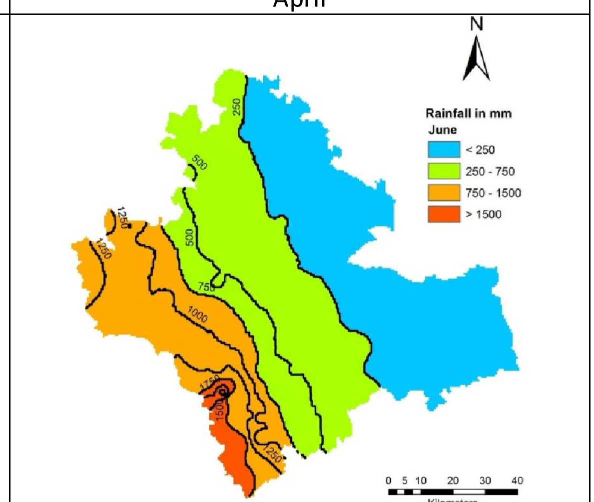

March



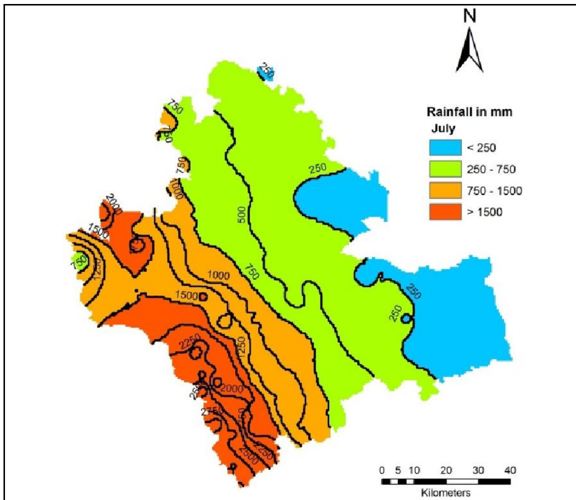

April



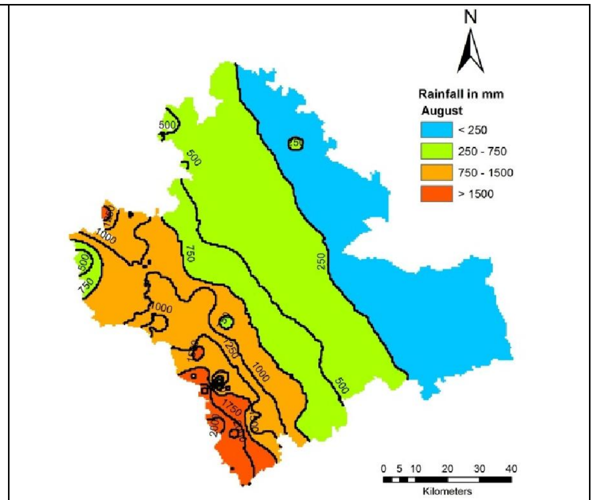

May



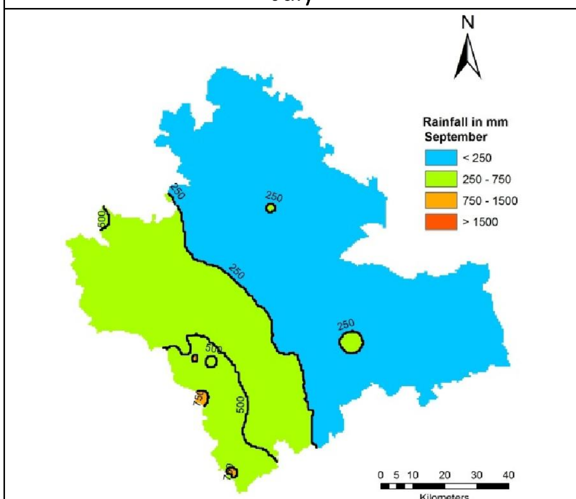

June




July




August

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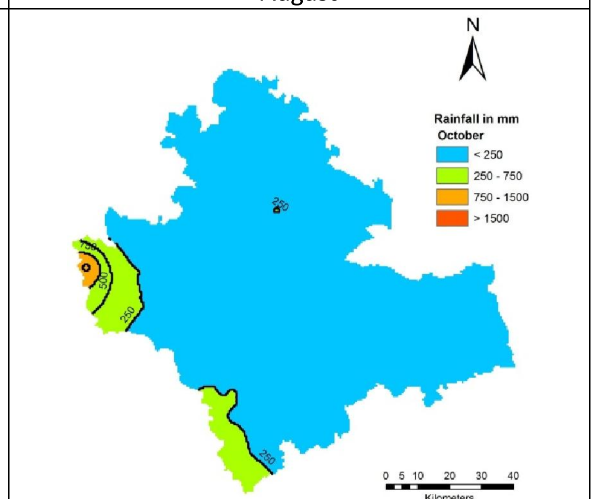
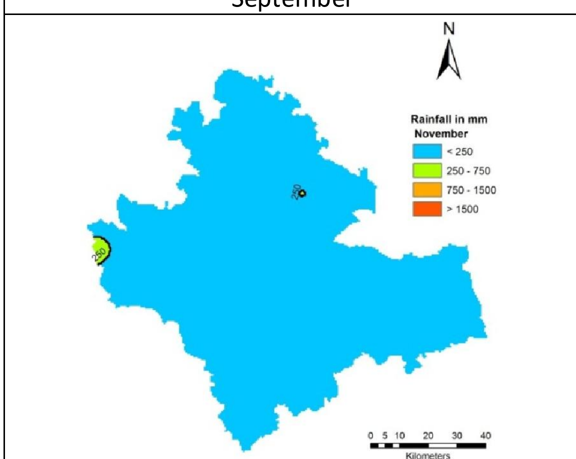
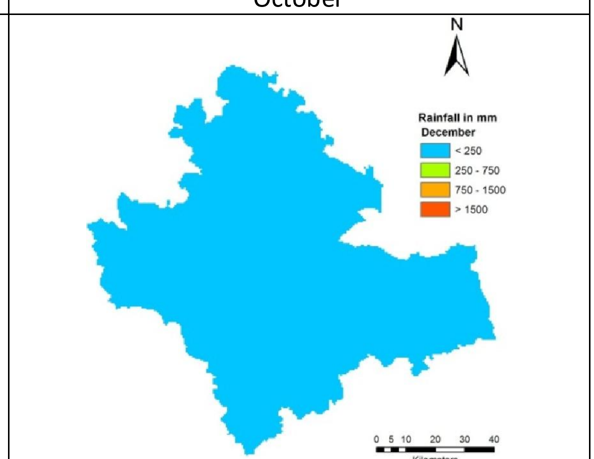



October




November




December

**Figure 9: Monthwise mean rainfall for Shimoga district**

## 1.7 RIVERS

The important rivers that flow through the Shimoga district are Tunga, Bhadra, Tungabhadra, Sharavati, Kumudvati and Varada. Figure 10 provides the network of streams of each of these rivers. Figure 11 provides the location of major rivers in the district. The Tunga and the Bhadra unite to form the Tunga-bhadra at Kudali in Shimoga taluk, 14 kms From Shimoga. The Kumudvati and the Varada are tributaries of the Tungabhadra (Shimoga district Gazetter, 1975).

i. **Tunga:** The River Tunga rises in the Western Ghats at Gangamula (1,199 m) in Varaha Parvata in Chikmangalur district and flows in Shimoga district for a length of 64.4 kms. First it flows towards north-east past Sringeri to Baggunji, where it turns north-west and continues in the same direction till it reaches Tirthahalli taluk. Near Tithahalli Begarahalla from Sringeri joins it. Then it flows north east past Shimoga to Kudali where it unites with the Bhadra. Near Mandagadde it branches for a short distance into seven streams and it is called Yelukallu Seelu (Shimoga district Gazetter, 1975).

ii. **Bhadra:** The Bhadra traverses a distance of 51.5 Km in the district is one of the two main tributaries (Bhadra and Tunga) which union to form Tungabhadra. Like its sister stream Tunga it also arises in the Western Ghats at Gangamula in Varaha Parvata in Chikmangalur district. It flows along the western base of the Baba Budan mountains and enters the Shimoga district in the south of Shimoga Taluk. Then it runs north past Bhadravathi and Hole-Honnur and unites with Tunga at Kudali in Shimoga Taluk. Across this river a reservoir has been constructed near Lakkavalli (Shimoga district Gazetter, 1975).

iii. **Tungabhadra:** The river Tungabhadra traverses a distance of 48.3 Kms in Shimoga is formed by the union of Tunga and Bhadra tributaries at Kudali. The river runs north of the district to the border and there from takes a northeastern direction to Harihar. From there it runs north until it joins Varada at left. Then it turns north-east and joins Krishna a few kms below Kurnool town in AndhraPradesh (Shimoga district Gazetter, 1975).

iv. **Sharavathi:** The River Sharavathi rises at Ambuteertha near Kavaledurga in Teerthahalli Taluk. Its total length in the district is 32.2 kms and flows in a north-westerly direction and receives the Haridravati on the right below Pattaguppe and the Yenne-hole on the left above Barangi. Near the border of the district, it bends to the west and hurls down the ghats near Jog. It joins sea at Honnavar in North Canara /Uttara Kannada district.

v. **Kumudvati:** The Kumudvati or Choradi, a tributary ofthe Tungabhadra, rises in Agastya-Parvata or the Bileshvara-betta near Humcha and flows for a distance of 17.7 kms in the district. Itflows north near Kumsi and Shikaripur and continuing in thesame direction, it forms the large Madaga tank on the veryborder of the district. From there, turning north-east, it runsinto the Tungabhadra at Mudanur.

vi. **Varada:** The Varada, another tributary of the Tungabhadra, rises at Varadamula near Ikkeri in Sagar taluk,runs north past Chandra-gutti (Sorab taluk) and Banavasi (Sirsi taluk of North Kanara)andturns to the north-east. Entering the Dharwar district, it flows north, bending round gradually to the north-east. South of Bankapur and Savanur, it runs with an easterly course into theTungabhadra at Galaganatha below Havanur (Shimoga district Gazetter, 1975).

vii. **Minor streams:** A number of small streams rise in this district.The Haridravati, the Sharmanavati, the Kushavati, the Gargita, the Varahi and the Dandavati. The first three rise in Agastya-Parvata or Bileshvara-betta near Humcha. Haridravati and the Sharmanavati flow north-west into the Sharavati, the Kushavati runs south into the Tunga. The Gargita rises between the Kodachadri-Parvata and Kavalednrga and descends to South Kanara from the head of the Haidar-ghar ghat. The Varahi, rising in Tirthahalli taluk, flows through Hosanagar taluk and enters the South Kanara district at Kunchikal-Abbe (Kunchikal Falls). In Sorab taluk, flow a good number of small streams of which Nagarahalla, Yelavatadahalla, Gudvihalla, Kannanamanehalla and Kuppehalla are relatively more important. Many small streams unite into the Dandavati, which, rising near Sorab, flows north and west into the Varada near Jade.

Figure 12 lists the distribution of numerous waterbodies (lakes, ponds, etc.) occurring in the drier part of the district. 1643 wetlands occupy 4.6% of geographical area with an area 40630.9 ha. District has three reservoirs viz., Linganamakki reservoir, Talakakale Balancing reservoir, Ambligola reservoir. Geological area covered by the wetlands based on their size is given in the table 5.

| | Number of wetlands | Area covered in hectares | % Geographical area covered |
|---|---|---|---|
| <2 ha | 292 | 2488.25 | 0.282 |
| ≥2 ha<5 ha | 830 | 2616.52 | 0.297 |
| ≥5 ha <10 ha | 338 | 2368.15 | 0.268 |
| ≥10 ha <50 ha | 164 | 3118.17 | 0.354 |
| ≥50 ha<100 ha | 12 | 709.313 | 0.080 |
| ≥100ha | 7 | 29330.5 | 3.331 |

**Table 5: Number of wetlands and % area covered based on the size of wetlands**

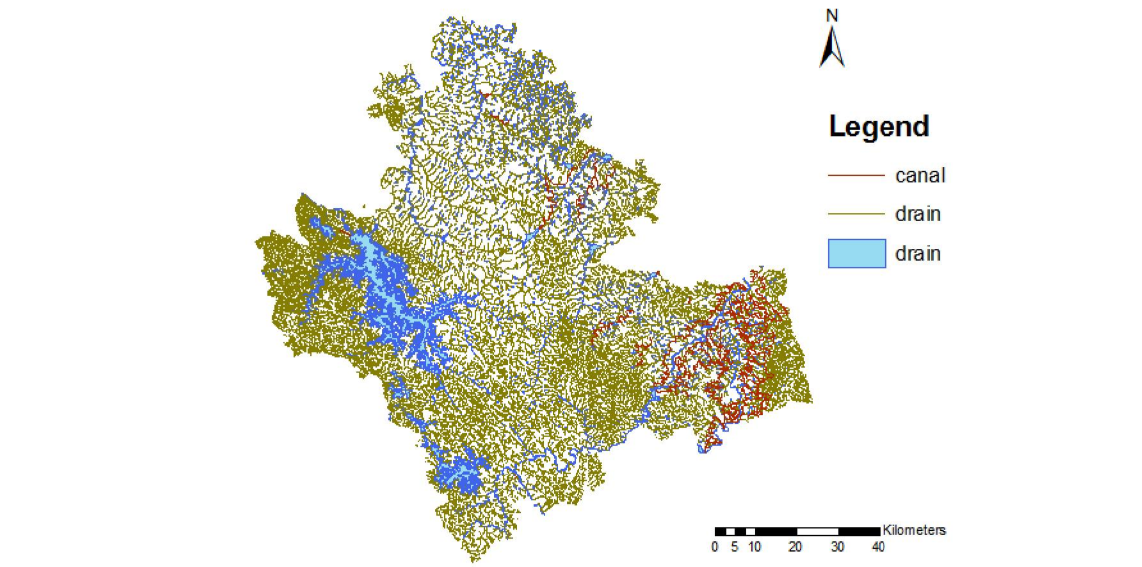



**Figure 10: Drainage network of Shimoga district**

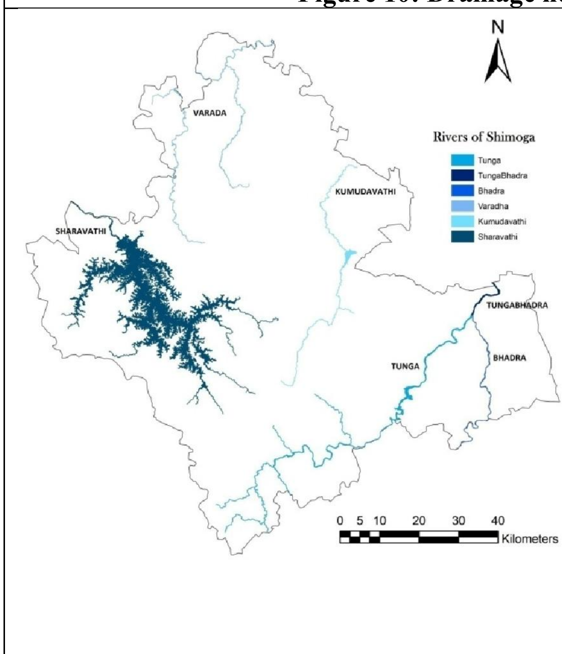



**Figure 11: Major Rivers of Shimoga district**

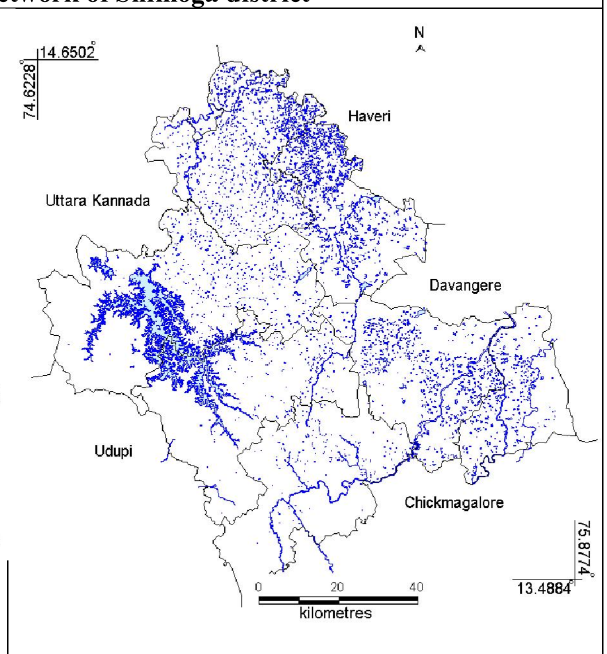



**Figure 12: Water bodies of Shimoga district**

## 1.8 GEOLOGY

Geologically, the Shimoga district consists of the most ancient rock formations (Figure 13) of Archaean complex,which are composed chiefly of two systems, the Dharwar system (usually called Dharwarschists) and the gneissic system (Shimoga district Gazetter, 1975). Nearly a two thirds area of the district is covered by the Dharwar schists, the Shimoga band forming a prominent belt from west to east and occupying a larger area. This belt is made up of various types of schists, chiefly chloritic and in places micaceousor hornblendic, associated with volcanic rocks of different types. Along with them are found some highly altered sedimentary rocks such as quartzites, conglomerates, limestone, shales and banded iron stones (ferruginous quartzites) (Shimoga district Gazeeteer, 1975).The gneissic system is much younger than the Dharwar Granitie system and it chiefly consists of granites and granitic gneisses.The granitic rocks vary in their structure, texture, colour and other similar characteristics.The granites in Shimoga district occur as islands in the schists forming three principal exposures. One of them surrounding Honnali is called "Honnali Granite", the second one near Saulanga is called " Saulanga Granite", and the third one to the north-west, north-east and east of Shimoga is called " Shimoga Granite " (Shimoga district Gazetter, 1975). Fairly extensive outcrops of gneisses are noticed along thewestern parts of the district. The rock, which is banded, consists of quartz feldspar and biolite mica in variable proportions. Laterite is another geo1ogical formation which occurs in patches in the western parts of the district.Some of the laterites contain ferruginous and manganese patches (Shimoga district Gazetter, 1975).

## 1.9 SOIL

Reddish to brownish clayey loamto lateritic soil occur in major parts of the district (Figure 14). Thin strips of yellowish loamy soil are seen along the banks of major river and nallah courses. In general these soils are acidic in nature. The thickness varies from few centimeters to 3.50 m. The sandy soil is also identified in the areas where the Archaean gneissic complex occurs. It is coarse grained highly porous and permeable in nature. The thickness of this soil varies from few cms to 5.00 m. The rate of water infiltration in this soil is remarkably higher than the clayey loam. Red soil as noticed at the contacts of granites and schistoserocks is medium grained, highly permeable and having neutral pH value.The thickness of the soil varies from less than one metre (<1m) to 9.00 m and is having an average rate of water infiltration capacity about 2.4cm/hr. The mixed soil occurs in the areas where the schistose rock is predominant. It is of medium to fine-grained and permeable with higher moisture content. The thickness of this type of soil ranges from 0.5 m to29 m and is having the water infiltration capacity of about 0.60 cm/hour (Government of India, CGWB, 2007).

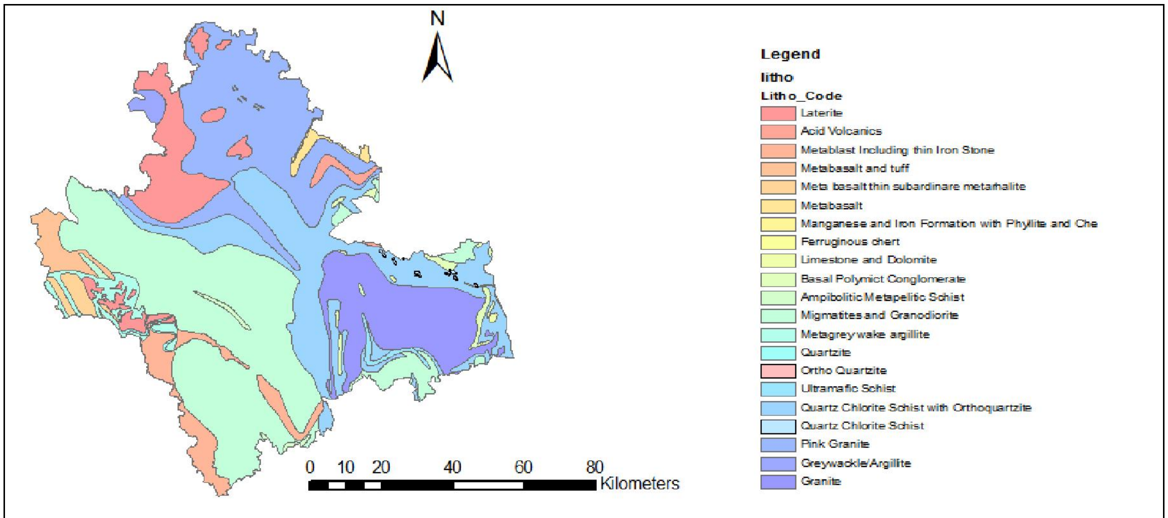



**Figure 13: Geology of Shimoga**

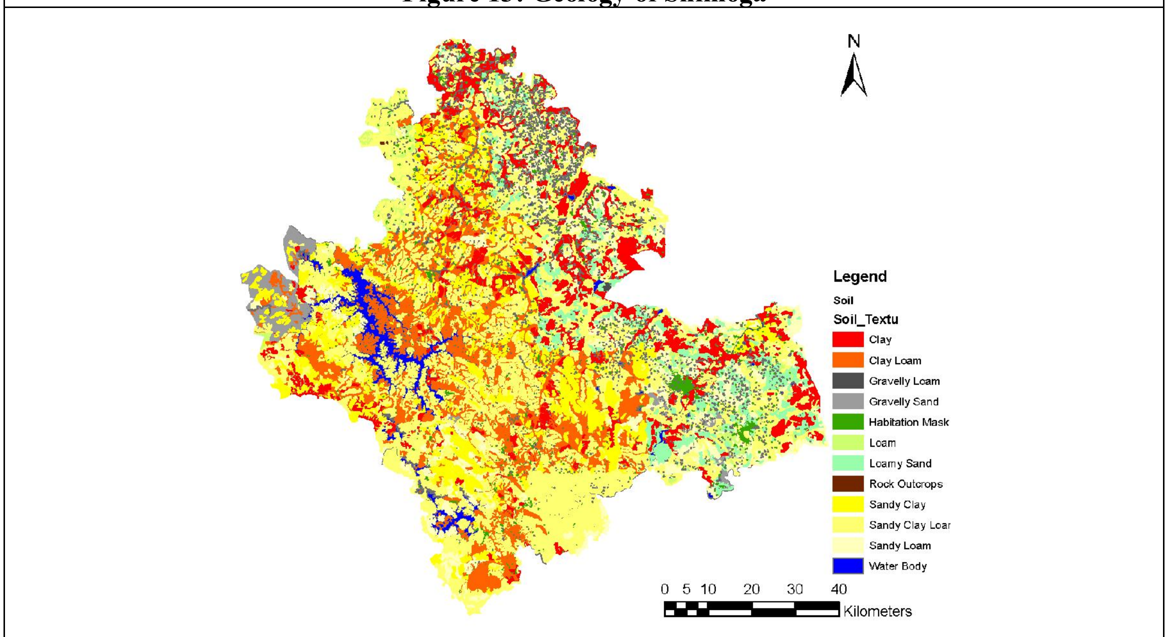



**Figure 14: Soil of Shimoga**

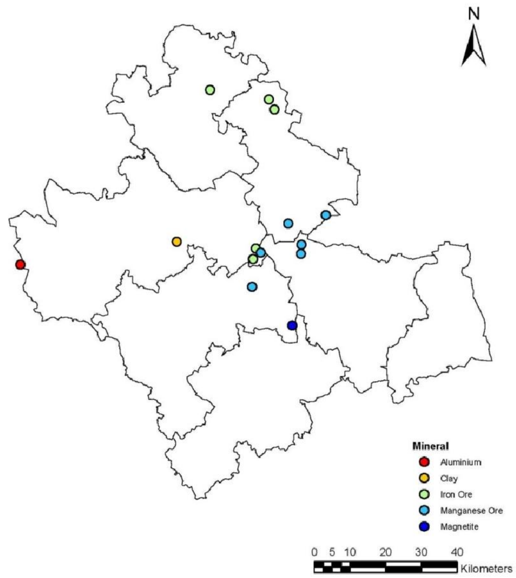



**Figure 15: Minerals of Shimoga**

## 1.10 MINES AND MINERALS

Mining has been known to have flourished in the past in the Mines and district. It is one of the important districts known for mining at present also. Several places in the district have relics of ancient iron industry which prove that the people of the district were familiar with mining and details of old workings of mines are not available.Most of the economic minerals of the district such as iron ore, manganese ore, limestone, etc., occur in the Dharwar schists (Figure 15).

- **Iron ore:** Iron ore deposits (haematite and limonite) are found in the Dharwar schist belt. Limonitic types occur near Shankaragudda and Chattanahalli near Kumsi and capping the hill ranges near Agumbe. The recent investigations of the Department of Mines and Geology in the Western Ghats region have disclosed the existence of many deposits of iron ores of medium grade. They are located near Mattimane, Kodachadri, Kotebare and Ambar-gudda. The deposits in the Kotebare area are of the haematitic type (Shimoga district Gazetter, 1975).
- **Manganese ore:** There are fairly extensive deposits of low to medium grade manganese ore in the district whichare distributed into four zones.One zone runs north-south, bordering the western edge of the Shimoga granite and consists of Kumsi deposits in the north passing southwards through Shankaragudda and Mandagadde deposits, ending with Jayapura deposits of the southern end. The second zone runs within the schists to the north of Saulanga granite and forms the Shikaripur group consisting of Markande,lttigehalli, Ballur, Hosur and Kagenalli deposits (Shimoga district Gazetter, 1975) The third zone lies to the east of Shimoga granite area and comprises groups of deposits in the Tarikere and Channagiri taluks. These groups include a number of small deposits to the south of Joldhal,

Badigunda, Siddarahalli and Balekallu. The fourth zone consists of a few deposits in the ferruginous quartzite area, which are exposed in the neighbourhood of Shantisagar(Sulekere) forming high ridges to the north-west and south-west of the lake.

- **Lime-stone:** Lime-stones, varying in compositions from high calcium to dolomitic siliceous, argillitic and other types, occur as bands for a long distance in Dharwar schists. They occur to the north-east of Kumsi, to the north of Bikkonahalli to the east of Bhadravati, to the north-west and north-east of Honnali, to the south of Channagiri and a few other places in the district.
- **Chromite:** Chromite, the principal ore of chromium, has been found near Harenahalli, Jhandimatti and Antargange, associated with iron-ore grains. Two small patches have been located in association with serpentine (a secondary mineral, the fibrous varieties' of which form the asbestos-chrysotile) to the south of Ambikatta hill. However, these deposits are found to be of low grade and of no commercial importance.
- **Building Stones:** Building stones of different types (granites, some type of schists, dark-gray basic traps, jaspery rocks, lime stones, soap-stones, laterite, etc.,) are found in abundance all over the district. Granites vary in their colour, structure, texture and grain size, giving rise to numlemus varieties such as pink, red or gray granites, homogeneous or porphyritic coa:rse, medium or fine-grained, uniform or veined and so on. Many of these are being quarried and used locally. Granite, laterite and sand are used as building and road-constructional materials.
- **Clay:** Clay of good quality occurs at Tirthahalli. It is being mined and levigated. The washed clay is being utilised in the paper and porcelain manufactures.

## 1.11 ROAD AND RAIL NETWORK

Shimoga has a total road length of 6632 km with 2 national highways (222 km) and 11 state highways (402 km). Figure 16 depicts the distribution of road and rail connectivity in the district.

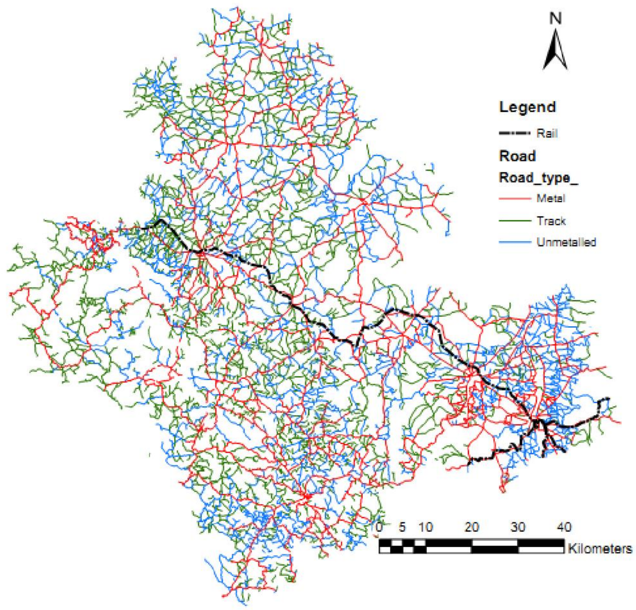



**Figure 16: Rail and road network of Shimoga**

## 1.12 VEGETATION

The Shimoga district has a rich and varied flora, the major contributing factors to this variety being differences in rainfall and topography within the district. In the region of the Western Ghats, the rainfall is heavy, Agumbe getting an annual average rainfall of 8,275. 7 mm. As one proceeds to the east, the rainfall decreases very rapidly, Honnali recives annual rainfall of about 600 mms. Terefore, a rapid transition from evergreen flora to the scrub type, i.e., from mesophytic to xerophytic, occurs as one moves from the west to the east. Magnificent evergreen flora covers a narrow belt in the Western Ghats and it gradually merges into the moist deciduous towards the east and south. The far-eastern and northern portions are scrubby and comparatively little-wooded.The forests of Shimoga district consists of Evergreen and Semi-Evergreen climax forests and degradation type and deciduous climax forests and degradation type (Pascal et.al, 1982). The Evergreen and Semi-Evergreen climax forests and degradation type consists following categories: *Dipterocarpus indicus-Humboldia brunonis-Poeciloneuron indicum* type, *Dipterocarpus indicus-Diospyrus candolleana-Diospyros oocarpa* type, *Dipterocarpus indicus-Persea macrantha* type, *Persea macrantha-Diospyros spp.-Holigarnaspp*. type, *Diospyros spp.- Dysoxylum malabaricum-Persea macrantha* Kan forest type of low elevation(0-850m). The secondary or degraded type contains secondary moist deciduous forests. The Deciduous climax forests consist of moist deciduous type-*Lagerstoemia microcarpa-Tectona grandis-Dillenia pentagyne* type and dry deciduous-*Anogeissus latifolia –Tectona grandis-Terminalia tomentosa* type (Figure 17). The areas of different types of forests are given in Table 6 and spatial distribution (derived from Figure 17) is given in Figure 18.

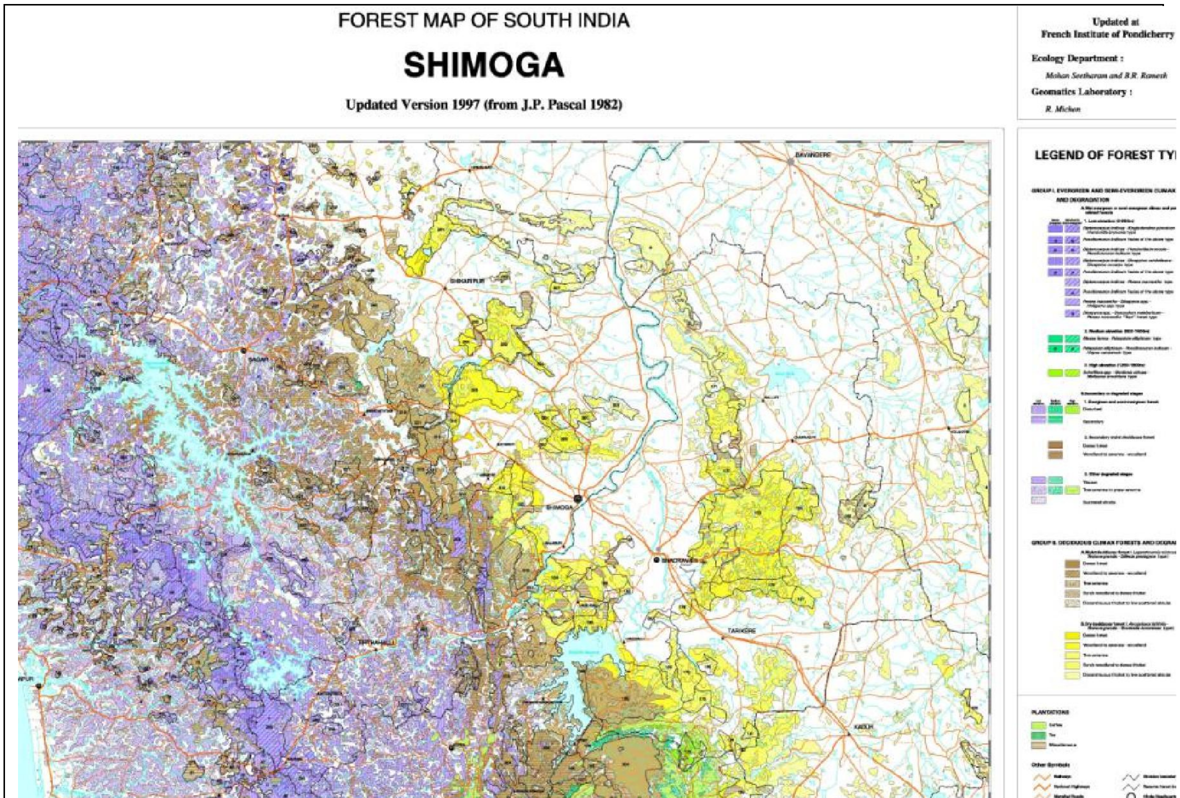



Figure 17: Taluk wise forest distribution (Pascal et.al, 1982)

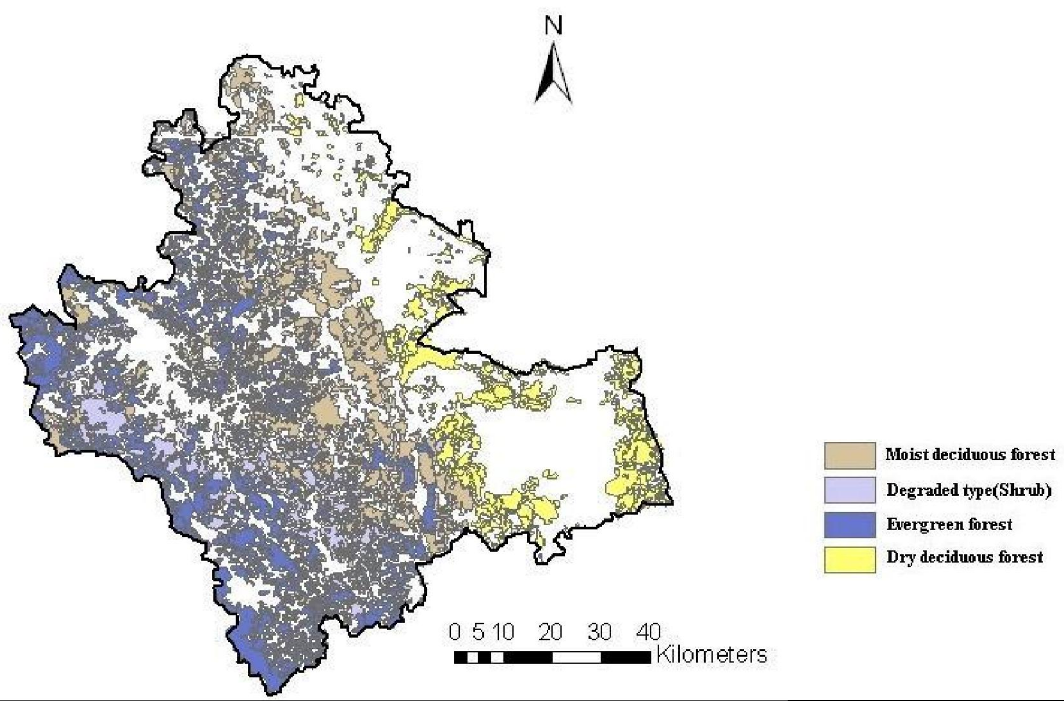



Figure 18: forest types in the district

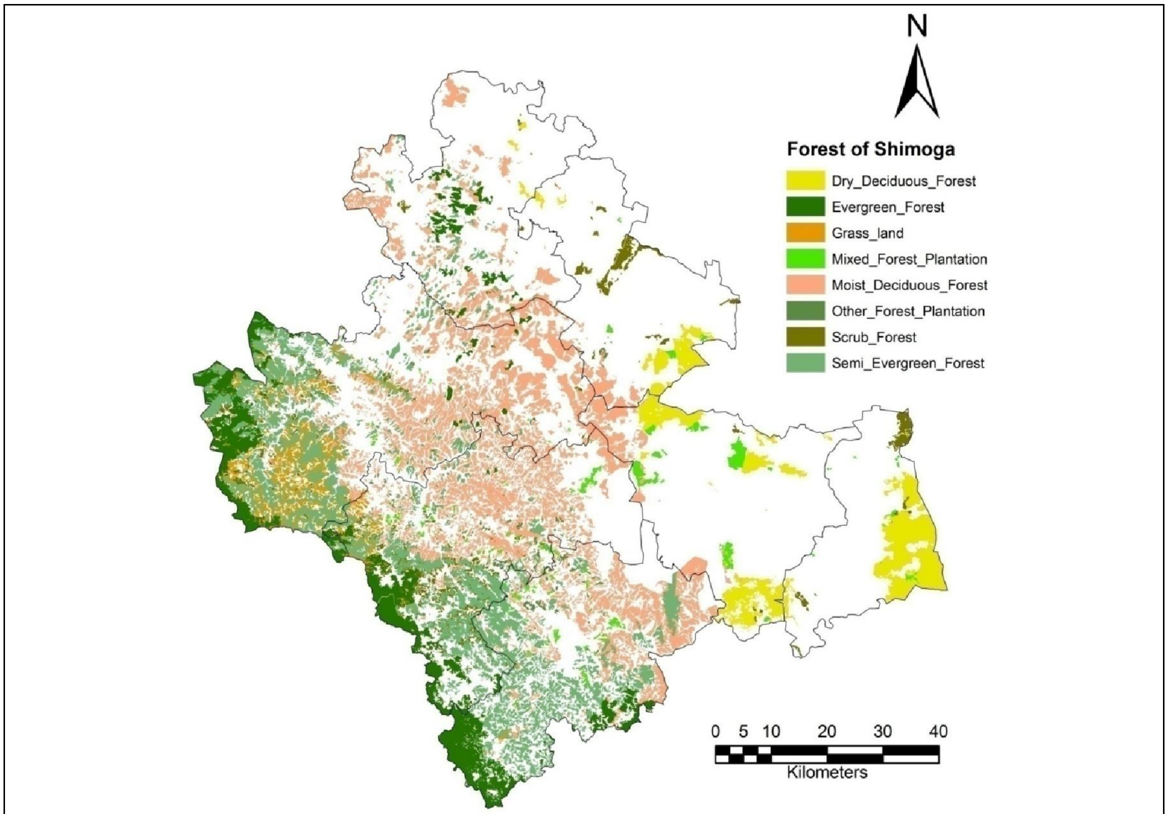



**Figure 19: Vegetation distribution of Shimoga district**(classification as per Champion and Seth, 1968)

**Table 6: Spatial extent of different classes of forests (Pascal et.al, 1982)**

| **Forest type** | **Area(Hectares)** |
|---|---|
| Evergreen | 139457.1 |
| Moist deciduous | 117369.79 |
| Dry deciduous | 83686.26 |
| Degraded | 46414.17 |
| **Total** | **386927.32** |

As per the revised classification of forest types of India by Champion and Seth (1968), the fol1owing forest types are occurring in Shimoga district (Figure 19) :-

(1) Southern tropical wet evergreen forests (Sub-group lA),
(2) Southern tropical semi-evergreen forests (Sub-group 2A),
(3) South Indian moist deciduous forests (Sub-group 3B),
(4) Southern tropical dry deciduous forests (Sub-group 5A),
(5) Southern tropical thorn forests (Sub-group 6A)

**Evergreen and Semi-evergreen belt:**The evergreen forest is confined to the west of the district with magnificent tree vegetation. Many of the hills are covered with heavy forests while valleys and ravines produce luxuriant trees known for their great height and size. Typical patches of evergreen and semi-evergreen forests occur in places like Hulikal, Kodachadri, Nittur, Nagavalli and Jog along the Western Ghats at an elevation upto 800 m receiving a rainfall of more than 200cm. Based on the average height attained by the floristic elements, the vegetation in these forests shows a 3-tiered arrangement (Ramaswamy et.al, 2001).

a) *Top canopy or emergent layer:* This layer consists of trees which are 25-40 m or more tall with their crown raised from the general canopy surface. Some of important species are *Dipterocarpus indicus, Vateria indica*, *Artocarpus hirsuta*, *Hopea parviflora*, *Mesua ferrea, Artocarpus integrifolia, Mangiferaindica*, *Machilus macrantha*, Michelia *champaca*, *Alstonia scholaris*, *Hopea wightiana*, *Diospyros ebonum*, *Lagerstroemia sp. Syzygium canarensis etc.*
b) *Middle canopy:*This is the second layer represented by medium sized trees of height of 12-20 m. They are adapted to sub-canopy conditions. Some of the important species in this layer are *Aporusa lindleyanea*, Chrysophyllum *roxburghii*, *Holigarna arnottiana*, *Stereospermum personatum*, *Strychnos nux-vomica, Vitex altissima* etc.
c) *Lower canopy:* This is the layer consisting of innumerable number of woody shrubs and small trees of average height of 3-12 m. The important floristic elements are *Clerodendrum viscosum*, *Callicarpa tomentosa*, *Grewia tiliifolia, Rauvolfia densiflora, Saraca asoca* etc.

**Moist deciduous forest belt:** The moist deciduous forest is found in the extreme north of Sorab taluk extending towards south.These types of forests are found in regions where the altitude ranges from 600-1000m and the annual rainfall varies from 150-350 cm. The width varies from belt 16 to 64 or 82 kms.It includes the timber producing forests and much sandalwood. In this belt, one can observe the Kans of Sorab and the rich fields of Sagar, Nagar and Tirthahalli. The prominent moist deciduous species of this belt are sagwvani (*Tectona grandis*, Linn. f.), beete (*Dalbergia latifolia*, Roxb.), honne (*Pterocarpus marsupium*, Roxb.), matti (*Terminaliatomentosa*, W. & A.), Jambe (*Xylia dolabriformis*, Benth.), hunal(*Terminalia paniculata*, Roth.) , Nandimara (*Lagerstroemia lanceoIata*, Wall.), bage (*Albizzia lebbeck*, Benth.), bilwara (*Albizzia odoratissima*, Benth.), tadasale (*Grewia tiliaefolia*, Vahl.), gandha-garige (*Toona ciliata*, Roem.), kadavala (*Anthocephalus eadamba*, Miq.), bileburuga (*Geiba pentandra*, Gaertn.), mashe (*Alseodaphne semicarpifolia*, Nees.), tare (*Terminalia bellerica*, Roxb.), kanagalu (*Dillenia indica*, Linn.), srigandha (*Santalum album*, Linn.), and others.The eastern limit of this belt commences near Anavatti in thenorth and runs south-east to half-way between Shikaripur and Honnali and thence due south to Sakrebyle from where it runs due east. Along the western confines, trees proper to the ever-green forests occur frequently(Ramaswamy et.al, 2001).

**Dry deciduous forest belt:** The dry deciduous forest belt lies to the east of the mixed Dry deciduous deciduous forest belt in the district. The tree vegetation in this belt part is much inferior and the trees are of smaller growth. Dry deciduous species met with in this area are dindiga (*Anogeissus latifolia*, Wall.), ippe (*Bassia longifolia*, Macbride.), kalnara (*Hardwickia binata*, Roxb.), bevu (*Azadirachta indica*, A .. Juss.), dale (*Terminalia chebula*, Retz.), nelli (*Emblica officinalis*, Gaertn.), srigandha (*Santalum album*, Linn.), and others. Among the thorny forest species are honge (*Pongamia pinnata*, Pirre.) ,seetaphala (*Anona squamousa*, Lin.), antavala (*Sapinduslaurifolias*, Vahl.), karigeru (*Semicarpus anacardium*, Linn. f.), hunase (*Tamarindus indica*, Linn.), kare (*Randia dumetornm*), urimullu (*Zizyphus oenoplia*), bilijali (*Acacia leucopholea*), karijali (*Acacia nilotica*) (Ramaswamy et.al, 2001)

**Scrub forests:** These types of forests are found in eastern part of the district, with a low rain fall (less than 75 cms). These forests consist of thorny species interspersed with a few malformed deciduous trees. In most places these types of forests are converted into agricultural lands. Some of the tree species of this forest are *Bauhinia racemosa*, *Casssia fistula*, *Catunaregam spinosa*, *Diospyros Montana*, *Flacourtia indica*, *Phyllanthus emblica*, *Santalum album, Zizipus sp, Asparagus racemosus, Blepharis asperrima, Hemidesmus indicus* etc **(**Ramaswamy et.al, 2001*)*. Table 7 lists the flora of Shimoga district based on Ramaswamy etal., 2001 and field work carried out during 2012. Table 8 lists endemic species of Shimoga district (Radhakrishna et.al, 1992)

**Table 7: Flora of Shimoga District (based on Ramasamy et.al, 2001 and field invetigations)**

| Family | Species | Place | Common name | Characteristics |
|---|---|---|---|---|
| Malvaceae | *Abelmoschus angulosus* | Kodachadri | M- Kattukasthuri | Erect plants; stem leaves and pedicels with long, yellowish bristly hispid hairs. Leaves sub-orbicular dentate, base subcordate; Epicalyx of 4 ovate persistent lobes, 3 - 4 cm long, hairy calyx included, spathaceous, splitting on one side; lobes 5. Stamens numerous, monadelphous stamina tube antheriferous throughout; anthers 1-celled. Ovary 5-locular ovules many. |
| Malvaceae | *Abelmoschus manihot* | Sampekatte, Nagara | K- Kaadubendkaai | Annual erect herbs, 45-60 cm tall, stem slender, greenish-white, prickly-hairy. Leaves alternate, palmately deeply 5-lobed, base subcordate, lobes lanceolate, dentate. Flowers yellowish with purple centre, in terminal |

| | | | | |
|---|---|---|---|---|
| | | | | racemes, pedicels 2-5 cm long. Epicalyx segments 4-6, ovate to oblong. Epicalyx lobes 4 or 5, ovate-lanceolate, 3 cm long, ciliate. |
| Papilionaceae | *Abrus precatorius* | Devagaru | K-Gurugunji M-Kunni | Woody, slender, twining shrubs. Leaves paripinnately compound, channelled above, slender. Leaflets less than 2 cm long; seeds llipsoid-globose, usually red with a black spot. Pod oblong, adpressed pubescent without, crowded on axillary racemes peduncles. |
| Malvaceae | *Abutilon persicum* | Induvalli | Bettadadendu gida | Erect slender undershrubs, 2-2.5 m tall. Corolla uniformly single coloured; carpels 5; staminal tube very short, densely hairy. Epicalyx absent. |
| Mimosaceae | *Acacia pennata* | Nittur | Mullu seege; Kaadu seege. | Large, prickly, climbing shrubs, prickles slightly curved branchlets glabrous or minutely pubescent. Leaves bipinnately compound. Pinnae 10-15 pairs; leaflets 40-60 pairs. Rachis 18-20 cm long, grooved, prickly, hairy, glandular, 1 gland oblong, at or above the middle of the petiole, another between terminal pairs of pinnae. Pinnae 12-13 pairs, 6 cm long, pubescent.flowers white, shortly pedicelled or subsessile. |
| Mimosaceae | *Acacia torta* | Bileshvara, Kodachadri, Nittur | Ingi | Large prickly climbing shrubs, branchlets, leaves and inflorescence pubescent. Leaves bipinnately compound. Leaflets attached at the centre; petiolar gland conical. Rachis 10-22 cm long, 1 gland near the base, 1-2 between the terminal pairs of pinnae on the rachis; pinnae 1-12 pairs, each 4-7 cm long. Pods thin, strap-like, brownish, apiculate. |
| Euphorbiaceae | *Acalypha brachystachya* | Nagara | - | Erect branched, monecious herbs to 60 cm tall; stem angular, grooved, and hairy. Leaves membranous, ovate, serrate-crenate, apex acute or shortly acuminate. Flowers in axillary spikes, peduncle to 1.5 cm long, male minute, clustered above, ebracteate, female 2-3 at base, bracteate. Disc absent. Bracts in |

| | | | | |
|---|---|---|---|---|
| | | | | female flower 3 or 4-lobed, linear. Capsule obscurely 3-gonous, hairy, seeds globose. |
| Euphorbiaceae | *Acalypha ciliata* | Ayanur | - | Erect unbranched monecious herbs, 20-30 cm long; stem gooved, hairy. Leaves alternate, ovate, crenate-serrate, apex acuminate, base rounded, glandular. Flowers in axillary spikes. Male flowers; few, placed above, very minute. Female flowers; several at base, each with a large, camapanulate, ribbed, laciniate bract; teeth hispid. Capsule glabrous, concealed by bracts. |
| Asteraceae | *Acanthospermum hispidum* | Nittur, Lingahalli | - | Erect, dichotomously branched herbs, stem hirsute. Leaves opposite, obovate or elliptic, serrate. Involucre in 2 whorls; outer foliaceous. Ray florets 5-8, ligulate; disc tubular. Anthers rounded at base. Achenes of ray florets fertile, radiate, 5 mm long, compressed, covered by stiff, hooked bristles and a pair of straight divergent spines at apex; achenes of disc sterile, glandular. Pappus absent. |
| Amaranthaceae | *Achyranthes aspera* | Hulical, Varahi | Uttarani | A stiff herb. Stem obscurely 4-angled, sulcate. Leaves ovate, elliptic-lanceate or orbicular-obovate, hairy or glabrous, obtuse, acute or acuminate. Mature spikes to 40 cm long. Staminodes of tufted appendages. |
| Amaranthaceae | *Achyranthes bidendatata* | Kodachadri hills | kaadu uttharaani | Erect or subscandent, branched herbs. Leaves very variable, usually lanceolate, acute at both ends, glabrous. Flowers green. Staminodes truncate or toothed |
| Commelinaceae | *Aclisia secundiflora* | Hulikal | E-Three-Stamen Pollia | Stout, erect or subscandent herbs, stem viscid. Leaves elliptic-lanceolate, apex caudate-acuminate. Panicles terminal, laxly branched. Flowers white or pale pink, 3-merous. Sepals 3, free. Petals 3, free, smaller. Staminodes 3. Fruit indehiscent, globose or ovoid, 3-celled. |
| Lamiaceae | *Acrocephalus hispidus* | Mattimane | - | Slender, simple or branched herbs, 20-30 cm tall, young parts hairy. Leaves ovate to lanceolate, |

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| | | | | coarsely serrate, apex subacute, base tapering into petiole, sparsely hairy and gland-dotted. Flowers pale pinkish-white, in terminal approximate whorls, forming globose or ovoid 6-7 mm across, heads, subtended by a pair of leaves. Calyx slightly enlarged in fruits, 2-lipped; upper lip large, entire; lower 4-lobed. Corolla obscurely 2-lipped; tube short, lip 4 lobed. Nutlet 1-1.5 mm long, ellipsoid, brownish. |
| Rutaceae | *Acronychi pedunculata* | Kundadri, Kargal, Nivane | Muttanari | Small trees to 8 m tall. Leaves 1-foliolate, opposite, leaflets elliptic-oblong or obovate. Flowers greenish-white, in axillary or terminal paniculately corymbose cymes.Drupe globose, apiculate. |
| Lauraceae | *Actinodaphne malabarica* | Yedur, Chakra, Hulical | - | Dioecious trees, upto 8 m tall, branches minutely hairy, tender branchlets rusty-tomentose. Leaves subvertioillate, in whorls of 3, at the ends of branchlets. Petiole thick to 2.5 cm long; leaf blade elliptic-lanceolate, acuminate, cuneate, to 21*6.5 cm fulvous-pubescent beneath when young; lateral nerves 8-11 pairs. Inflorescence of subracemose umbels, tawny-silky-pubescent. Perianth lobes ovate or oblong. Berry globose. |
| Boraginaceae | *Adelocaryum coelestinum* | Hulikal, Yedur | - | Large, erect, branched herbs, stem sparsely hairy above, hollow within. Leaves variable, smaller and sessile terminally, ovate, margin subentire. Fruit of 4 nutlets, prominently margined, sparsely glochidiate. |
| Passifloraceae | *Adenia hondala* | Hulikal, Nagodi, Sampekatte, Nagavalli | Muthukku, Karimuthukku | Stem pachpodous at base, climbing above. Leaves generally palmately lobed, glands rounded. Flowers unisexual, in axillary cymes, peduncle often produced into tendrils. Peduncle often produced into tendrils. Corona present, reduced to hairs. Disc of 5 small glands. Capsules with coriaceous pericarp, red when ripe. |
| Asteraceae | *Adenoon indicum* | Kodachadri hills | - | Erect, rigid herbs to 1m tall, stem ribbed, hispid. Leaves terminal |

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| | | | | smaller, obovate, irregularly. Achenes 3 mm long, cylindrical strongly 10-ribbed, granular between the ribs. |
| Asteraceae | *Adenostemma lavenia* | Hulikal, Varahi | - | Erect, branched herbs up to 1 m tall, branches somewhat glandular-pubescent or nearly glabrous. Leaves broadly ovate to ovate-lanceate, irregulary toothed, scabrid with short appressed hairs on both sides, subacute at apex, tapering at base. Flowers white, in terminal, pedunculate, corymbose heads 1-1.2 cm across. Achenes 3-5 mm long, compressed, trigonous, nearly glabrous, pappus of 3 shot, clavate hairs on a short ring. |
| Acanthaceae | *Adhatoda zeylanica* | Jog | K-Aadusoge T-Adathodai | Erect bushy shrubs 1-1.5 m tall, stems and brnaches grey-puberulous, terete. Leaves elliptic-lanceate, acuminate, dark-green above, pale beneath, glabrous on both sides, entire, base tapering. Flowers whitish, in axillary, dense, pedunculate spikes, bracts large, foliar, elliptic, subacute, glabrate. |
| Orobanchaceae | *Aeginetia indica* | Sampekatte | - | Leafless, erect parasitic herbs, stem rhizomatous, condensed, underground. Scapes to 25 cm long, brownish, 1 or many from rhizomes. Flowers solitary, terminal to the scape. Calyx 5-lobed, tube spathaceous, split on the lowers side to the middle. |
| Orobanchaceae | *Aeginetia pedunculata* | Savehaklu | - | Leafless, parasitic herbs; 10-15 cm tall; stem short, underground. Scape short, stout, usually many-flowered, rarely1-flowered; bracts large, ovate, obtuse; pedicels to 7 cm long. Calyx 5-lobed, united, 6 cm long, spathaceously split on oneside, fleshy, mucilaginous within. Corolla tube as long as calyx, yellowish; lobes 5, 2-lipped, bluish. Stamens 4, didynamous, included; filaments short; anthers 1-celled, anthers of lower pair with decurved horn-like spur. Ovary unilocular; ovules many on parietal placentate; style slender; stigma peltate. Flowering: September. |

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| Rutaceae | *Aegle marmelos* | Between Anandapura and Kumsi | Bilvapatre | Small, thorny, deciduous trees, thorns long, axillary, solitary or paired. Leaves 3-foliolate, alternate. Berry large, ovoid, dull green without, pinkish within, axillary. Seeds numerous. |
| Orchidaceae | *Aerides maculosum* | Sampekatte, Nagara | | Epiphytic herbs; stem slender or stout; root fleshy. Leaves 15-24 x 1.5-4 cm, coriaceous, strap-shaped, oblong, apex unequally 2-lobed, lobes rounded, base narrowed to a sheath, faintly channelled along the midrib. Flowers 2-3 cm across, in axillary racemes or panicles; peduncle to 35 cm long; pedicels with ovary 1.5-2 cm long, faintly ribbed; bracts small, ovate. Sepals 3, free, 12-15 x 8-9 mm, subequal, faintly 7-nerved, pinkish-white. Petals slightly smaller than sepals. Lip large, 3-lobed; lateral lobes 8 x 5 m, rounded; midlobe 2 x 1.5 cm purplish, margin irregularly lobed, with 2-lobed callus at base; spur 1.2-2 cm long, curved, hook-like. Column erect, stout, produced below into a foot. Anther 1, 2-celled; pollinia 1 in each cell, oblong; caudicle long with small gland. Stigmatic surface orbicular. Capsule 3 x 1 cm, obovoid, strongly ribbed. Flowering: June. |
| Gesneriaceae | *Aeschynanthus perrottetii* | Hosagadde | - | Epiphytic undershrubs, stems smooth, glabrous, rooting at nodes. Leaves broadly elliptic, elliptic-lanceate or oblanceate, fleshy, entire. Flowers large, scarlet, terminal, solitary or in fascicles. Capsules linear, papery, loclicidally 2-valved. |
| Asteraceae | *Ageratum conyzoides* | Hulikal | Oorala gida, Helukasa | Foetid smelling, annuals to 1 tall, stem hairy. Leaves opposite, or the upper alternate, broadly ovate, crenate. Involucral bracts 2-3-seriate, each 3-4 mm long, linear or oblong-lanceolate, apex acute, 2-3-nerved on the back, margin serrate. Receptacle flat, naked. Florets tubular. Pappus of 5, white scales, each 2-3 mm long, nearly equalling the corolla, |

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| | | | | lanceolate, apex aristate. |
| Meliaceae | *Aglaia anamallayana* | Varahi falls | - | Dioecious trees, 13 m tall. Leaves imparipinnate. Flowers in racemes, peduncle shorter than leaves, bud globose. Fruit obovate, greenish or yellowish-green, tomentose, 1-seeded. |
| Meliaceae | *Aglaia canarensis* | Kodachadri | - | Trees, to 12 m tall; branched, leaf-rachis, peduncle and calyx lepidote-scaly. Leaves imparipinnate; rachis 12-20 cm long; leaflets 9-11; laterals opposite, subopposite or alternate, reddish when young, each 12-15 x 4-5 cm oblong-lanceolate, obtusely acute at both ends, unequal-sided; petiolule 1-1.5 cm long. Flowers 3 mm long, orange-yellow, sessile, in axillary, 30 cm long panicles. Calyx united; lobe 5, rounded, ciliate. Petals 4, free. Stamens 5, united; staminal tube 5-lobed terminally; anthers included in staminal tube, 2-celled, apiculate, pistillode lepidote-scaly. Flowering: January. |
| Meliaceae | *Aglaia elaeagnoidea* | Yedur, Sampagod Kan | Pucche pajje | Small to medium-sized trees to 13 m tall, young branches. Leaves imparipinnate, rachis 9-16 cm long, shallowly grooved above, pubescent. Flowers yellowish, polygamous, in axillary, or extra-axilllary panicles. Beery globose orange-brown, lepidote. |
| Meliaceae | *Aglaia lawii* | Hulikal | - | Medium-sized trees, 15-25 m tall, young branches lepidote-scaly. Leaves pinnately compound. Flowers 4-merous; staminal tube minutely lobed; stamens 4-8. Pistillode present in male flowers. |
| Alangiaceae | *Alangium salvifolium* | Chakra, Mastikatte, Nittur | Ankole-mara, Ankaliga | Large shrubs or small trees, branches spreading, often thorny on the trunk. Leaves alternate, ovate-elliptic or oblong. Fruit ovoid, crowned by persistent, calyx, axillary, solitary or paired, seed 1, oblong. |
| Mimosaceae | *Albizia chinensis* | Nittur | Kalbaage | Medium-sized trees, to 17 m tall, branchlets, rachis and peduncle minutely pubescent. Leaves bipinnately compound. Pinnae more than 6 pairs; leaflets less than 1 cm long. Rachis to 20 cm |

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| | | | | long, glandular, one on the petiole and few in between the pairs of pinnae. Pinnae 13-15 pairs, to 6 cm long; Pod strap-shaped, reddish-brown, on axillary or terminal peduncles. |
| Mimosaceae | *Albizia lebbeck* | Sorab | Bage, Kalbaage San-Shireesha | Large deciduous trees to 25 m tall. Leaves bipinnately compound. Pinnae 2-3 pairs; heads in short corymbose racemes; flowers pedicelled. Rachis 12-30 cm long, pubescent, glandular, one gland near the base of petiole and another in between the uppermost pair of pinnae. Pinnae 2-5 pairs, 4-15 cm long. Pod flat, strap-shaped. |
| Sapindaceae | *Allophylus cobbe* | Kodachadri, Bileshvara, Savehaklu, Yedur, Sampekatte, Jog | Mooji Kabaru tappu | Erect, branched shrubs, branches lenticellate, rusty tomentose. Leaves 3-foliolate, alternate. Flowers polygamodioecious, in axillary racemes of interrupted clusters. Racemes unbranched, Peduncle unbranched or laxly few branched, as long as or longer than leaves. Disc hairy. Fruit globose, reddish, 1(or 2) seeded. |
| Poaceae | *Alloteropsis cimicina* | Bileshvara | Neeru sajjae hullu | Tufted grass to 25 cm tall; stem slender, striate, branched, erect or decumbent at base; nodes hairy. Leaves 1.5-2.5 x 0.3-0.8cm, ovate or lanceolate, apex obtuse or sub-acute, base cordate, margin ciliate with tubercle-based stiff hairs; sheaths striate, sparsely hairy; ligule of a row of hairs. Inflorescence of racemes, 3-10 digitately arranged on the top of a slender, glabrous, ca. 15 cm long, peduncle; rachis of raceme of 6 cm long, angular, scaberulous. Spikelets including awns to 5 mm long, ovate, solitary (or 2-3) on alternate pedicels of 2-3 mm long; pedicels cupular at tip (where the spikelet disarticulates). |
| Apocynaceae | *Alstonia scholaris* | Hulikal, Sampekatte, Jog | Mukampalei | Medium-sized trees, 13-30 m tall. Leaves whorled, 7 in each whorl, elliptic-ovate or oblanceolate, apex obtuse or acute. Flowers yellowish-green, fragrant, in terminal panicled cymes. Corolla tube 7 mm long; lobes 5, |

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| | | | | spreading, oblong, 2-5 mm long. Follicles paired, linear, cylindric, drooping, seeds linear-oblong, compressed. |
| Amaranthaceae | *Alternanthera sessilis* | Nagara fort, Sorab | Honaganne soppu | Prostrate or procumbent herbs. Leaves linear-elliptic, oblong, obovate, rounded, cuneate at base. Flowers heads globose, becoming cylindrical later. Tepals almost equal, glabrous. Stamens 3-5, alternating with filamentous staminodes. |
| Papilionaceae | *Alysicarpus vaginalis* | Nittur | - | Branched, prostrate herbs, stem nearly 3-angled. Diffuse herbs; racemes compact. Leaves 1-foliolate, stipules scarious. Pods compressed or sub-terete, joint 4-8, faintly reticulate. |
| Papilionaceae | *Alysicarpus tetragonolobus* | Savehaklu | - | Erect, procumbent, caespitose herbs, to 50 cm tall, branches slender, terete, striate, hairy. Leaves 1-foliolate, lanceolate, scarious, striate. Racemes axillary or terminal. Flowers pinklish, lower in distant pairs, upper approximate. Pods rugose; segments 4 angled. Pods jointed, tetragonally. |
| Amaranthaceae | *Amaranthus spinosus* | Nagara fort, savehaklu | Mullukeerai | Branched herbs. Leaves ovate-elliptic to lanceolate, 1-6*0.5-2.6 cm. axillary spines paired. Perianth segments 5. Seeds compressed, dark brown, shining. |
| Zingiberaceae | *Ammomum hypoleucum* | Hulikal | - | Rhizomatous herbs, rhizome slender, creeping. Leafy-shoot to 1.75 m tall. Leaves oblong-lanceolate, acuminate, adpressed-silky pubescent beneath, ligule short. Lateral staminodes small, tooth-like-labellum 3.5x2.3 cm, orbicular, narrowed at base, frilled, yellowish towards the centre with purple striations.flowers in dense, conelike spikes, produced directly from the root-stock. Capsule globose, smooth, dehiscing irregulary. |
| Zingiberaceae | *Ammomum muricatum* | Jog falls | - | Leafy-shoot to 1.7 m tall. Leaves petioled elliptic or oblong-lanceolate, acuminate, glabrous, ligule entire. Inflorescence at first sub-globose, densely flowered. Lateral staminodes minute, |

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| | | | | subulate. Labellum broadly ovate, deeply 3-lobed, mid-lobe emarginate, glabrous, yellow, with a broad band of red spot. Capsule globose, reddish, concave at top, densely echinate. |
| Vitaceae | *Ampelocissus tomentosa* | Kargal | - | Large climbing shrubs, stem striate, tendril arising from peduncle forked, young parts of stem, petiole and leaves beneath cinnamomeous-floccose-tomentose. Leaves simple, palmately 3-5-angled or lobed. |
| Menispermaceae | *Anamirta cocculus* | Hulical | Kagemari | Large woody, dioecious climbers. Stem longitudinally furrowed. Leaves alternate, broadly ovate, apex acute or obtuse truncate or cordate. Flowers in panicles, calyx hirsute without; petals absent; stamens numerous; anthers 2-celled, connate into a globose head, on a central column of united filaments. |
| Asteraceae | *Anaphalis marcescens* | Hulikal | | Woody, branched herbs, 60-80 cm tall. Leaves alternate, closely arranged towards base, coriaceous. Marginal florets female, fertile; inner florets mostly sterile. Corolla of ray florets 2.5 - 3 mm long, 2 - 4 toothed, of disc florets 2 - 3 mm long; lobes glandular-hairy. Achenes glaborus. |
| Ancistrocladaceae | *Ancistrocladus heyneanus* | Kargal, Hulical | - | Scandent shrubs with hooked branches. Leaves oblanceolate, acute at apex, narrowed at base to 46*16 cm. Sepals oblong, rounded at apex. Stamens 9-10. Fruiting sepals' spathulate, 3 longer and 2 shorter. |
| Acanthaceae | *Andrographis ovata* | Nittur, Induvalli | | Slender, erect herbs, simple or with 1-2 basal branches, stems 4-angled, pubescent below, internodes unequal. Leaves opposite, ovate, apex obtusely acute, base rounded, decurrent into long petiole. Flowers in terminal or axillary lax panicles. Capsules linear-oblong, glandular hairy, many-seeded. |
| Lamiaceae | *Anisomeles heyneana* | Nagavalli | | Erect, slender rigid, aromatic herbs or undershrubs, 1-1.5 m tall, stem and branches quadrangular, sparsely hairy. |

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| | | | | Hairs long, deflexed, internodes long. Leaves smaller terminally, opposite, ovate or ovate-lanceloate, crenate-serrate, apex acute, base acute or cuneate, hairy, densely along nerves beneath. Flowers few, white, tinged with pink, second, in axillary or terminal, paniculate cymes. Cymes few-flowered; corolla white; stem glabrous or sparsely hairy. Nutlet 2 mm long, shining. |
| Lamiaceae | *Anisomeles indica* | Sampekatte | | Erect aromatic undershrubs, stem quadrangular, hispid with recurved hairs. Leaves opposite, ovate, serrate-dentate, apex acute, base truncate or subcordate, densely hairy, nerves 4-5 pairs. Flowers pale purple, in dense, close, whorls of cymes, resembling spikes.Calyx 5-lobed, reticulate, glandular-hairy; tube ca. 7 mm long, companulate. 10 ribbed; lobes ca. 5 mm long, triangular. Corolla 1-1.2 cm long, 2-lipped; tube narrow, annular; upper lip entire; lowers longer 3-lobed. Nutlet to 3 mm long, ovoid with rounded outersurface, obtusely angular inner face, scar basal, polished black. |
| Apocynaceae | *Anodendron paniculatum* | Jog | | Large, woody, climbing or scandent shrubs, branchlets compressed, latex watery. Leaves opposite, oblong or oblong-lanceolate, apex shortly acuminate, base rounded or sub-truncate. Flowers yellowish, in long, slender, axillary, panicled-cymes. Calyx glabrous lobes ovate. Corolla tube enlarged above the base over the stamens, lobes linear. Follicles 11-12 cm long, divaricate, tapering to apex, seeds 8-12 each, compressed, come silky-white. |
| Rubiaceae | *Anthocephalus chinensis* | Yedur | Kadamba-vriksha | Small, delicate herbs with tuberous root, stem succulent. Leaves 2 pairs, approximate, opposite, unequal, membranous, ovate. Flowers in terminal umbels, peduncle 4-6 cm long, pedicels 1 cm long. Corolla tube |

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| | | | | 1 cm long, lobe slanceolate, acute |
| Euphorbiaceae | *Antidesma menasu* | Nagodi, Hulikal, Yedur | | Small, dioecious trees, branchlets, petiole and peduncle densely pubescent. Leaves alternate, elliptic-oblong, apex acuminate, base acute or slightly rounded, slightly rounded. Racemes terminal or axillary, unbranched or with 1-2 branches. Female flowers shortly pedicelled. Perianth lobes 4, hairy, persistent. Ovary 1-loculed, ovules 2. Drupe ovoid, reddish, 1-seeded. |
| Meliaceae | *Aphanamixis polystachya* | Jog | Rakta Rohita M-Chemmaram | Small to medium-sized trees, to 12 m tall, young branches pubescent. Leaves impairpinnate. Flowers polygamous, in axillary spikes. Capsules sub-globose, reddish, 3-valved, seeds 3. |
| Aponogetonaceae | *Aponogeton echinatus* | Between Sorab and Banavasi | | Tuberous, aquatic herbs, tubers cylindrical. Leaves floating, membranous, oblong-lanceolate, margin more or less undulate, apex acute, Young spike covered by spathaceous, deciduous sheath. Follicles in aggregates of 3, ovoid, tubercled, beaked, beak straight or slightly hooked at apex, dorsally ridged. |
| Euphorbiaceae | *Aporusa lindleyana* | Sampekatte, Yedur, Jog | Vetti | Small, dioecious trees, branchlets angular. Leaves alternate, coriaceous, elliptic-oblong, apex rounded or shortly acuminate. Male flowers yellowish-green, in axillary catkin-like spikes, to 8 cm long. Perianth lobes 4. Female flowers in ca. 1.5 cm long spikes, hairy. Capsule ovoid or subglobose, dehiscing irregularly from base above, style persistent, apex 2-lobed, seeds 3-4, ovoid, smooth. |
| Mimosaceae | *Archidendron monadelphum* | Sampekatte, Hulikal, Yedur | Kaadu kondemara | Small trees, young parts pubescent. Leaves bipinnately compound. Rachis to 15 cm long, glandular, one near the base of the petiole and other between terminal pair of pinnae. Pinnae 1-2 pairs, to 18 cm long, glandular between pairs of leaflets.pods flat, circinate, orange brown, seeds 1 cm, across, rounded, blackish. |
| Myrsinaceae | *Ardisia solanacea* | Bileshvara, Yedur, | - | Shrubs to small trees. Leaves alternate elliptic-oblanceolate, |

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| | | Hulikal,Savehaklu, Sampekatte | | acute-acuminate, attenuate. Racemes often corymbose or umbellate. Corolla pink, spotted. Berries blach when ripe. |
| Arecaceae | *Arenga wightii* | Hulikal | Alam panai | Monoecious trees, stem stout, clothed spirally with the remains of leaf-sheaths. Leaves pinnatisect, linear, margin sparsely toothed, base unequally auricled, whitish beneath. Flowers 3-merous, stamens numerous. Female flowers with or without staminodes. |
| Papaveraceae | *Argemone mexicana* | Ayyanur | Arasina dattura. | Prickly annual; leaves alternate, sessile, pinnatified. Flowers yellow; leaves semi-amplexicaul. Capsules to 4*2cm. |
| Rubiaceae | *Argostemma courtallense* | Hulikal | | Small delicate herbs with tuberous root, stem succulent. Leaves 2 pairs. Flowers in terminal umbels, peduncle 4-6 cm long. |
| Rubiaceae | *Argostemma verticillatum* | Hulikal | | Erect, delicate herbs, 10-15 cm tall. Leaves opposite, membranous, sessile or subsessile. Flowers white, 5-merous, in terminal few flowered umbels. |
| Convolvulaceae | *Argyreia elliptica* | Chakra | | Large, scandent or twining woody herbs, young stem pubescent. Leaves acute at base, ovate or elliptic-oblong, apex acute or obtuse, apiculate, hairy, mature nearly glabrous above. Flowers pink, in axillary corymbose or paniculate cymes, pubescent. |
| Convolvulaceae | *Argyreia hookeri* | Hulikal, Varahi | Ulibelli | Large, glabrous, climbing shrubs, stem grooved. Leaves subcordate at base subacute, prominent. Flowers bluish-purplish, in axillary, long-peduncled umbellate cymes. Berry across globose, yellowish-green, 4-seeded. |
| Convolvulaceae | *Argyreia involucrata* | Hulikal ghat | | Large climbing or creeping shrubs, stem white-pubescent. Leaves ovate - lanceolate rounded or cordate at base, densely appressed-pilose to subsericeous beneath; sepals lanceolate; acuminate, sparsely strigose. |
| Convolvulaceae | *Argyreia pilosa* | Sampekatte | | Large twiners; young branches pale reddish; stem, leaves, inflorescence, bracts and calyx |

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| | | | | hirsute; hairs white, bulbous-based. Leaves 7-10.5 x 7-9 cm, alternate, broadly ovate, apex acute, base subcordate; nerves 7-8 pairs; petiole 3-4.5 cm long. Flowers pink, in axillary, capitate heads; peduncle 2-3 cm long; bract 1-1.2 cm long, oblong-lanceolate. Calyx nearly free to base; lobes 5, subequal, each 6-8 mm long, oblong to lanceolate, acute. |
| Araceae | *Ariopsis peltata* | Hulikal | | Small tuberous herbs, tubers 1-3 cm across. Leaves solitary, membranous, eltate, nearly orbicular apex obtuse. Flowers unisexual; females secund on peduncle at base and males placed above. |
| Araceae | *Arisaema leschenaultii* | Hulikal | | Erect, cormous herbs, corm depressed-globose. Leaves solitary, palmately 6-foliolate, membranous, obovate or elliptic, margin wavy.spathe to 16 cm long, long-caudate, striped, spadix slightly erserted above the tube, appendix cylindric. |
| Araceae | *Arisaema tortuosum* | Hulikal | | Tall, cormous herbs 1 m tall, corm up to 10 cm across. Leaves 2-3 together, each 7-9-foliolate. Spadix with long exserted, tapering, sigmoidly curved appendix; spathe 10-15 cm long. Spadix sigmoid, staminate in smaller specimens and monoecious in larger specimens. |
| Aristolochiaceae | *Aristalochia tagala* | Hulikal | | Climbing shrubs, stem stout, glabrous, grooved. Leaves ovate or ovate-oblong, acute or acuminate at apex, glabrous, base corddate with a deep sinus. Flowers purple, several, in lax, puberulous racemes, usually only 1 fertile, others abortive. Capsules long, oblong-ellipsoid glabrous. |
| Annonaceae | *Artabotrys zeylanicus* | Hulical | | Climbing shrubs with hooked peduncles, internodes of branchlets zig-zag. Leaves oval-oblong; mature petals tomentose. |
| Poaceae | *Arthraxon hispidus* | Jog | | Tufted, branched herbs; branches slender, ascending, hairy at nodes. Leaves ca. 4 x 2 cm, ovate-lanceolate, apex acute, base rounded or subcordate, glabrous |

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| | | | | or sparsely hairy, margin ciliate towards base; sheath ribbed, ciliate; ligule ca. 2 mm long, membranous, ciliate. Inflorescence axillary or terminal spiciform panicles; peduncle naked or spathaceously sheathed; rachis articulated. Spikelets (excluding awns) 4-5 mm long, laterally compressed, both sessile and pedicelled spikelets alike, 1-flowered; pedicels ca. 3-4 mm long, often naked without spikelets. |
| Poaceae | *Arthraxon lanceolatus* | Chakra | | Slender, annual grass; stem often purple tinged; nodes hairy. Leaves 2-2.8 x 0.5-1 cm, ovate or ovate-lanceolate, apex-acute-acuminate, base cordate, amplexicaul, glabrous or sparsely hairy, margin scabrid and ciliate with tubercle-based hairs; sheaths striate, hairy with ciliate margin; upper sheath often spathaceous; ligule membranous, shortly ciliate. Inflorescence axillary or terminal, paired, spiciform racemes usually 2-3 cm long; rachis jointed; joints 4 mm long. Spikelets paired, one sessile and the other pedicelled; pedicels 2.5-4 mm long; both joints and pedicels densely villous with silky hairs. Sessile spikelets; 7-8 mm long, narrowly lanceolate. |
| Moraceae | *Artocarpus gomezianus* | Jog, Nittur | - | Dioecious, deciduous trees, young branches grey-pubescent, latex yellowish-white. Leaves entire; branchlets and leaves hairy; not cauliflorus; male inflorescence globose; syncarps smooth. Perianth 2-4-lobed, pubescent. |
| Poaceae | *Arundinella ciliata* | Savehaklu | | Annual, erect grass, 15-25 cm tall; stem slender. Leaves 3-6 x 0.3 cm, lanceolate, acute, ribbed, sparsely hairy; hairs soft, bulbous-based, more towards the margin; sheath ribbed, hairy; ligule a narrow fimbriate membrane. Panicle terminal, 4-8 cm long, branches in fascicles of 1-4, contracted, slender, erect. Spikelets 5-6 mm long (including |

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| | | | | 2.5-3 mm long awn), ovoid-lanceolate, the lower half with tubercle-based hairs; pedicels ca. 5 mm long, glabrous. Lower glume ca. 4 mm long, ovate, acuminate, 3-nerved, hairy. Upper glume ca. 5 mm long, elliptic or ovate, acuminate, 5-nerved. Lower lemma male, female or bisexual, ca. 3 mm long, ovate-lanceolate, subcoriaceous, 3-nerved, paleate. Upper lemma ca. 2 mm long, elliptic-oblong, awned; awn ca. 3 mm (rarely cq. 6 mm) long, lower half palebrown, twisted. |
| Poaceae | *Arundinella pumila* | Yedur | | Erect, solitary or tufted annual grass, 10-15 cm tall; internodes distant above. Leaves 3-8 x 0.4-1 cm, narrowly elliptic-lanceolate, acuminate, more or less scabrid, with long, slender hairs; sheaths prominently ribbed, ciliate and hairy; ligule narrow, membranous. Panicles to 8 cm long; branches ascending, but spreading at maturity; branchlets capillary, scaberulous. Spikelets 2 mm long, solitary on branchlets. Glumes 2, unequal; lower glume 1.5 mm long, ovate, acute, 3-nerved, glabrous or with few hairs on nerves. Upper glume to 2 mm long, ovate, acuminate, 3-nerved, lower lemma neutral (or male) 1 mm long, ovate, acute, membranous, faintly 3-nerved. Glabrous; palea hyaline. Upper lemma ca. 1 mm long ; membranous, scabrid, awned ; awn ca. 2.5 mm long ; palea small, hyaline. Lodicules 2. Stamens 3, styles 2, distinct. Flowering: October. |
| Poaceae | *Arundinella purpurea* | Kodachadri hills | | Perennial, erect grass, to 60 cm long; stem; striate, hairy, some what hispid. Leaves 10 x 0.8 cm or longer, lanceolate, apex acuminate, base rounded, hairy ; hairs tubercular-based ; sheath striate, pilose without ; ligule short hairy, membranous, inflorescence terminal, contracted panicles, to about 20 cm long ; |

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| | | | | branches angular, striate, hairy. Spikelets 3-4 mm long, ovate-lanceolate, solitary or unequally pedicellate pairs of 2 flowers; pedicels to 2.5 mm long. Glumes 2; lower 2-5 mm long, ovate, acute, 3-nerved; upper 3.5 mm long, ovate-lanceolate, acuminate, 5-nerved. Lower lemma empty, male or bisexual, similar to glume, ovate, blunt acute at apex, its palea linear, 2-2.5 mm long, membranous, 2-keeled ; upper lemma empty, male or bisexual, 1.5 mm long membranous, bifid at apex, with awn of ca. 3 mm long, arising from sinus ; its palea small, 2-keeled. Lodicules 2. |
| Asclepiadaceae | *Asclepias curassavica* | Chakra | Chadurangada-gida | Calyx connate, 3 mm long. Corolla reddish, deeply 5-lobed; lobes 5-6x2-2.5 mm, obovate, reflexed. Corona of 5 scales, adnate to staminal column above, orange, each with a horn-like process within. Stamens 5, adnate to the corolla near base; filaments connate; anthers with inflexed, membranous connectives; pollinia solitary in each cell, pendulous. |
| Liliaceae | *Asparagus gonoclados* | Hulikal, Varahi | | Cladodes 2 - 6 nate; racemes fascicled; pedicels jointed at the middle |
| Liliaceae | *Asparagus racemosus* | Between Sampekatte and Nittur | Shataavari, Halavu makkala taayi gida | Cladodes slightly compressed or triquetrous, less than 1 mm wide, Cladodes 2-6 in a cluster, up to 2.5 cm long, falcate, acute or acuminate. |
| Malpighiaceae | *Aspidopterys cordata* | Gajanur | - | Slender climbers, younger parts tomentose. Leaves hairy beneath; leaves cordate at the base. |
| Acanthaceae | *Asystasia dalzelliana* | Sampekatte, Nittur | | Straggling herbs or undershrubs, stem quadrangular, striate, swollen at nodes. Leaves opposite, unequal opvate or elliptic-lanceolate, apex acute or shortly acuminate, base cuneate or decurrent, sparsely hairy. Flowers blue or purplish, secund, in simple, axillary or terminal racemes. Corolla less than 2 cm long.<br>Calyx tube 2-2.5 mm long; lobes 5-6 mm long, linear, hairy without. Corolla 2.5-3 cm long. |

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| | | | | Capsule clavate, glangular-hairy, seeds4, flat, angular, rugose. |
| Rutaceae | *Atalantia racemosa* | Kundadri, Tenkbail, Nagavalli | | Small trees to 8 m tall, armed with long, straight thorns, sometimes unarmed. Leaves 1-foliolate, alternate. Filaments free. Flowers large 15-25 mm in diameter; twig usually with single axillary spines. |
| Rutaceae | *Atalantia wightii* | Chakra, Mastikatte | - | Large, woody shrubs or small trees, unarmed or with long, straight thorns. Leaves 1-foliolate, alternate. Flowers bud globose, white, in axillary racemes or corymbose cymes. |
| Papilionaceae | *Atylosia lineata* | Kundadri, Yedur, Kodachadri | | Erect shrubs, branches sulcate and densely tomentose. Leaves 3-foliolate, petiole 1-1.5 cm long, stipules lanceolate, terminal larger, rhomboidal or obovate. Flowers 1-4 together, in axillary cymes, each to 1.5 cm long. |
| Acanthaceae | *Barleria courtallica* | Hulikal | | Plants without spines; spikes not unilateral, glandular hairy.leaves opposite, elliptic, apex shortly acuminate or acute, base cuneate. Flowers blue in dense spikes, peduncle 5-6 cm long. Corolla with blue limb and yellow tube, Calyx lobes 4; subequal. Corolla tube white or yellow. Capsule oblong, pointed and pubescent at tip, seeds 4, black silky-hairy. |
| Acanthaceae | *Barleria involucrata* | Kodachadri hills | | Erect herbs, 1-2 m tall, stem quadrangular, adpressed hairy, swollen at nodes. Leaves elliptic, entire or irregulary crenate, apex acuminate, base cuneate. Flowers in simple cincinni, pedicels short. |
| Lecythidaceae | *Barringtonia racemosa* | Hulikal | Samudra phala, Samudra maapaala | Trees, 6 m tall, sometimes reaching to 15 m tall. Leaves elliptic-obovate, acuminate, narrowed at base. Calyx valvate; fruit not or only angled at basal portion; leaves toothed; fruit 4 cm broad.Calyx tube funnel-like, irregular, ovate, acute. Stamen filaments erect, spreading, pinkish. |
| Caesalpiniaceae | *Bauhinia malabarica* | Sagar, Arodi | | Small trees to 8 m tall, sometimes dioecious. Perfect stamens 10; flowered white or yellowish; Trees; calyx-tube cylindrical, tubinate; limb 5-toothed. Petal |

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| | | | | unequal, slightly exserted, hairy. Staminal filaments unequal, alternate longer, broad and hairy at base, all fertile. Seeds stalked, minutely pubescent. |
| Caesalpiniaceae | *Bauhinia phoenicea* | Herodi | | Large scandent shrubs, branches pubescent, lenticellate. Leaves alternate, ovate-oblong, apex deeply, bilobed, base sub-cordate, pubescent, especially beneath. Flowers scarlet-red, in axillary or terminal, few-flowered corymbs. Petals 5, ca. 2.5 cm long, unequal, long-celled, 5 mm long, oblong. Pods flat, thickened along one suture, reddish pubescent, seeds many. |
| Caesalpiniaceae | *Bauhinia racemosa* | Nittur | Mandara | Small crooked deciduous trees. Leaves not more than 15 cm across; calyx limb spathaceous, entire; fruit 12 - 20 seeded. Petiole channelled above, swollen at both ends, pubescent. |
| Begoniaceae | *Begonia integrifolia* | Kodachadri hills, Jog | - | Small, tuberous, herbs, stem short, reddish, succulent. Leaves alternate, ovate, irregularly serrate-dentate, apex acute, base cordate. Male flowers; pinkish with 4 perianth-lobes in 2 whorls; outer 2 orbicular, larger. Female flower to 8 mm long, with 5 perianth-lobes, free; inner 1 smaller. Fruit winged; capsule 2-celled. |
| Begoniaceae | *Begonia malabarica* | Hulikal, Savehaklu | - | Erect herbs, stem reddish, succulent. Leaves alternate, membranous, ovate, distantly serrate-dentate. Flowers white; wings of capsule subequal; leaf apex acuminate. Male flowers: pinkish with 2 perianth-lobes. Female flowers: with 2 perianth-lobes. Capsule winged, wings equal or subequal, reticulately veined. |
| Commelinaceae | *Belosynapsis vivipara* | Hulikal | | Epiphytes, stem slender, stoloniferous, hairy, root-stock small. Leaves in tufts on root-stocks, linear. Flowers white, umbellate, 3-4 together. Found epiphytic on *Hopea ponga* (Dennst.) |
| Oxalidaceae | *Biophytum sensitivum* | Sampekatte , Lingahalli | Nilamthengu | Erect, unbranched herbs, 6-10 cm tall, stem hispid-pubescent. |

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| | | | | Leaflets glabrous; seeds ridged; pedicels short.flowers yellow, 3 mm long, in terminal umbels. |
| Bixaceae | *Bixa orellana* | Gajanur | Bangaara kaayi, Rangumale | Small trees or large shrubs. Leaf blade to 14*9 cm, 5-nerved. Flowers pink. Sepals' obovate, concave, obtuse at tip, sometimes unequal, obovate. Capsules ovate, acute. |
| Euphorbiaceae | *Blachia calycina* | Kodachadri | | Monoecious shrubs or small trees, to 4 m tall, branchlets compressed. Leaves alternate, elliptic-oblong oor elliptic-subrhomboidal, apex obtusely acuminate.Calyx of female flowers persistent, enlarged and spreading in fruits. Male flower 4-5 mm across, yellowish, in few-flowered racemes, terminal; Female flowers 1-3 together. |
| Euphorbiaceae | *Blachia denudata* | Jog | | Large, monoecious shrubs, branchlets compressed. Leaves ovate or elliptic-oblong, apex obtusely acute or shortly acuminate. Male flowers; 2.5-3 mm across, few-flowered racemes, terminal; peduncle slender pedicels 2-3 mm long, thickened above the middle. Calyx 5-lobed, free; lobes membranous, suborbicular, 3-4 mm across. Corolla lobes 5, free, smaller. Disc of 5, scaly glands, alternating with corolla lobes. Stamens many, free; filaments short; anther cells at the margin of broad connective, tips confluent. Female flowers; 1-2 together; pedicels to 5 mm, long, thickened upwards. Calyx lobes deciduous. Corolla absent. Disc annualar. |
| Acanthaceae | *Blepharis asperrima* | Yedur, Kodachadri, Hulikal | | Erect or prostrate herbs, rooting at nodes, stems striate, glabrous, except a few hair at the nodes. Leaves ovate-lanceate, acute or aciminate at apex, entire or spinous-dentate, rough on both surfaces with short bulbous-based hairs, tapering or rounded. Flowers blue, solitary, sessil, axillary or in terminal spikes. |
| Asteraceae | *Blepharispermum subsessile* | Sampekatte | | Erect glabrous, much branched, aromatic shrubs or undershrubs, stem striate. Ray florets 2, fertile, |

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| | | | | female. Corolla tubular, 3-3.5 mm long; lobes 4, unequal, style exserted. Achenes faintly 2-ribbed on flattened surface villous, with long silky, yellowish hairs along ribs and margins. Disc florets bisexual or sterile. |
| Asteraceae | *Blumea belangeriana* | Hulikal | | Erect herbs to 40 cm tall, stem glabrous, below, long, white hairy upwards, branches axillary, short. Ray florets narrower, sterile. Disc florets fertile, bisexual, 2-3 mm long. Pappus of white hairs, 4 mm long, longer than corolla. Corolla tubular, glandular-hairy. Achenes less than 1 mm long, not or faintly ribbed, hairy. |
| Asteraceae | *Blumea lacera* | Hulikal | | Much branched, erect herbs, stem ribbed, densely villous some hairs with glandular apex. Leaves decreasing upwards, alternate, lower lyrate. Heads in corymbs; achenes subterete. Outer florets female or sterile, inner bisexual, to 3 mm long. Achenes small, less than 1 m long, slightly 4-angular, straight or curved, nearly glabrous or sparsely hairy when mature. |
| Asteraceae | *Blumea lanceolaria* | Hulikal | | Large, erect, aromatic herbs or under shrubs. Leaves alternate oblanceolate or elliptic-oblong, serrate-dentate, apex acute or shortly acuminate, tapering at base into short petiole often winged, dilated and appendaged at base. Heads to 1 cm across, heterogamous, yellowish, I n terminal large panicles. Ray florets sterile, with narrow corolla tube. Disc florets bisexual. Pappus 3.5-4 mm long, as long as corolla. |
| Asteraceae | *Blumea mollis* | Hulikal | | Erect branched, aromatic, herb; Upper leaves with 1 - 2 stipuliform lobes at the base, not decurrent. Ray florets female. Disc florets bisexual. Corolla of female florets 2.5 - 3.5 mm long; of bisexual florets 3 - 4 mm long. |
| Asteraceae | *Blumea oxyodonta* | Nagavalli | | Prostrate herb with a central rootstock and rqadiating branches. Aromatic, Ray florets female, 2 mm long, with narrow |

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| | | | | corolla tube, 2-lobed apically. Disc florets 3-3.5 mm long, bisexual. Achene of disc florets larger, ca.1 mm long, 5-angled, hairy. Receptacle flat or convex, areolate. |
| Asteraceae | *Blumea virens* | Hulikal | | Much branched tall herbs, stem grooved, glabrous or nearly so. Florets yellow, Leaves pubescent or glabrate; Panicle lax, diffusely branched. Outer florets female with narrow tubular corolla. Inner florets fertile, bisexual. |
| Hydrocharitaceae | *Blyxa echinosperma* | Hulikal | | Acaulescent herbs. Leaves variable in length, broad, membranous, narrowly linear, entire or minutely denticulate. Flowers white, bisexual, spathe 1-flowered. Seed echinate with rows of spines, long tailed on both sides. Scape 30-90 cm long. |
| Hydrocharitaceae | *Blyxa octandra* | Hulikal | | Dioecious ascaulent herbs. Leaves radical, membranous, linear, brownish-purple. Flowers white, clustered on distinct scapes, scapes in male plants straight. Flowers unisexual; stamens 9; seed tubercled, not or shortly tailed. Capsule seeds oblong-elliptic, white, spinous or prominently tubercled in 8 rows, not tailed. |
| Urticaceae | *Boehmeria glomerulifera* | Hulikal | | Large monoecious shrubs, to 5 m tall, branchlets and young leaves tomentose. Leaves alternate, equal or alternate ones smallers, ovate or ovate-lanceolate, serrate-crenate, apex acute or shortly acuminate. Male flowers: ca. 2 mm long, sessile, in axillary clusters. Perianth connate; lobes 4, ovate, acute. Stamens 4, opposite the perianth; filaments inflexed in bud; anthers 2- celled. Pistillode minute. |
| Urticaceae | *Boehmeria platyphylla* | Yedur, Hulikal | | Erect herbs or undershrubs, 1-2 m tall, stem angular, grooved, glabrous or hairy. Leaves opposite, unequal, broadly ovate, serrate-dentate. Flowers unisexual. In interrupted clusters, on slender, simple or branched spikes, axillary or terminal, hairy, bracts large, ovate. Male flowers: |

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| | | | | ca. 2 mm long. Perianth lobes 4, connate or free to base, hairy without. Stamens opposite the perianth; filaments inflexed; anthers 2-celled. Pistillode short, clavate. Female flowers; perianth tubular. Achene compressed, hairy. |
| Nyctaginaceae | *Boerhavia diffusa* | Hulikal | Mookkarattai, Adakaputtana gida. | Diffuse herbs with prostrate or ascending branches. Opposite pair of leaves unequal, leaf blade undulate along the margin, usually ovate, sometimes elliptic-lanceo;ate, rounded-cordate, scence a panicle of subcapitate umbels; umbels 4-8 flowered. Perianth long, white, red or pink. Stamens anthocarp clavate, glandular along the 5-ribs. |
| Zingiberaceae | *Boesenbergia pulcherrima* | Hulikal, Yedur, Between Nagara and Hosanagar | | Non rhizomatous, erect herbs, 25-30 cm long, roots fibrous, tuberous. Leaves sessile or petioled, elliptic, apex acute or shortly acuminate, base unequal. Labellum 2.5 x 1.5 cm, obovate, entire, white, tinged with pink; lateral. Flowers in spikes, enclosed in upper leaf-sheaths. |
| Bombacaceae | *Bombax ceiba* | Between Nagara and Hosanagara | Kempu booruga | Small to medium sized, deciduous trees to 12 m tall, trunk with conical, corky prickly, leaflets lanceolate; leaves crowded on branchlets, palmately 5-foliolate, filaments flattened; petiolule more than 1 cm long; flowers deep red, to 8 cm long. |
| Bombacaceae | *Bombax insigne* | Tenkbail, Nagavalli | - | Deciduous trees, to 17 m tall. Unarmed, branchlets prickly, sometimes prickly. Leaflets obovate; filaments filiform.flowers 13-14 cm long, sessile, pale orange-red, clustered on leafless woody branches. |
| Euphorbiaceae | *Breynia retusa* | Kodachadri | | Branched, monoecious shrubs, 1-1.5 m tall, branchlets angular. Leaves alternate, distichous, ovate or elliptic-oblong, apex obtuse or retuse, base rounded. Female flowers Calyx enlarged in fruits; fruits dehiscent. |
| Euphorbiaceae | *Breynia vitis-idaea* | Yedur, Savehaklu, Kargal | | Glabrous, monoecious shrubs, branches distichous, horizontal. Leaves alternate, distichous, ovate, apex obtuse or sub-acute. |

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| | | | | Male flowers small, yellowish-green, in axillary fascicles. Female flowers solitary Calyx not enlarged; fruit fleshy, indehiscent. |
| Euphorbiaceae | *Bridelia scandens* | Yedur, Hulikal | | Large scandent shrubs, shoots tomentose. Leaves much smaller on flowering branches, alternate, entire or indulate, Corolla lobes 5, smaller than calyx, obovate, apex emarginate, attached to cupular disc. Flowers unisexual, in axillary, sessile clusters. Male flowers greenish yellow. Stamens 5, on short gynadophore bearing pistillode at tip. |
| Anacardiaceae | *Buchanania lanzan* | Tagarthi | Charohli | Trees 15-20 m tall. Leaves broadly oblong, pilose beneath, panicles pilose, Disc Villous. Carpels reduced to short subulate styles. |
| Scrophulariaceae | *Buchnera hispida* | Kodachadri hills | | Erect, slender herbs, 60-70 cm tall, usually unbranched, black when dry, stem angular, hispid. Leaves opposite below, alternate above, sessile, elliptic-lanceolate or obovate, serrate above the middle, apex acute, narrow at base, upper linear-lanceolate, passing into floral bracts. Flowers pale-purple, in terminal long spikes. Corolla tube 6-8 mm long, slender, somewhat curved; lobes 5, ca. 2 mm long, spreading, obovate, slightly irregular. Capsules included within calyx, seeds minute, obovoid, truncate eat one end, longitudinally ridged. |
| Cyperaceae | *Bulbostylis densa* | Nagara | | Slender, tufted annuals, to 15 cm tall ; stem 3-gonous, leafy near the base. Leaves ca. 7 cm long, filiform, glabrous except long hairy at the mouth of sheath. Inflorescence an umbel ; rays terminating in spikelets, each ca. 1.5 cm long, unequal, sometimes branched below spikelets ; rachilla often winged ; involucral bracts 35, each ca. 6 mm long, scaly, ovate-lanceolate, caudate-acuminate, ciliolate. Spikelets 3-4 mm long. Flowers few, inconspicuous, in the axils of spiral glumes ; each glume 1-2 mm long, ovate, acute, often |

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| | | | | mucronate, dark brown with greenish keel. Stamens 2, style 3-lobed, exserted. Nuts 0.5-0.8 mm long, ovoid, 3-gonous, obscurely, transversely wrinkled, with hardened, persistent style base. |
| Papilionaceae | *Butea monosperma* | Sampagod Kan forest | Mutthuga | Small to medium-sized, deciduous trees. Leaves pinnately 3-foliolate, alternate, pulvinate. Flowers orange or salman coloured. Staminal tube campanulate; lobes acute, lowest smaller. Petals keel equal or slightly longer than standard. Stamens stalked, 1-2-ovuled |
| Caesalpiniaceae | *Caesalpinia mimosoides* | Jog | | Prickly climbing shrubs. Stipules not foliaceous; leaflets 10-20 pairs; less than 1.5 cm long; pods clothed with minute bristles. Rachis, pinnae, peduncle and pedicels reddish, prickly and bristly with glandular base. Rachis 26-30 cm long, prickles distant and curved; pinnae 15-17 pairs, to 4 cm long. |
| Arecaceae | *Calamus pseudotenuis* | Hulikal | | Armed, dioecious, slender, climbing shrubs, sheath, petiole and rachis with many, unequal, straight spines. Leaves pinnately compound. Male spadix ca.1m long, slender, decurved; peduncle branched. Female spadix with distant branched, armed with short, deflexed spines; spathe flattened, the lower elongate, tutublar. Drupe globose or ovoid, apiculate, brown, pericarp clothed with minute imbricate scales. |
| Alismataceae | *Caldesia parnassifolia* | Gajnur | | Erect herbs. Leaves basal, erect, orbicular-reniform, apex rounded, base deeply cordate. Flowers white, in terminal, long panicles. Achenes 3 mm long, black, with persistent styles. |
| Verbenaceae | *Callicarpa tomentosa* | Hulikal, Chakra | | Large shrubs or small trees, to 5 m tall, branches, leaves beneath, petiole and peduncle densely stellately-grey or fulvous-tomentose. Leaves variable, opposite, broadly ovate or ovate-elliptic, margin entire or denticulate, apex acuminate, base rounded or acute. Flowers purple, sessile or subsessile in axillary, |

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| | | | | divaricately branched, shortly-pedunculed cymes. Drupe globose, black, seated on persistent calyx. |
| Clusiaceae | *Calophyllum apetalum* | Hulical, near varahi falls | Holehonne | Trees 20 m tall. Leaves chartaceous, oblong-obovate, obtuse or retuse at apex. Petals absent; drupe elliptic, Nerves approximate. Drupe stalk 2-3 cm long. |
| Asclepiadaceae | *Calotropios gigantea* | Talguppa | Ekke | Calyx lobes 5, connate, 3 mm long, ovate, acute, pubescent without. Corolla 1.5 cm long, connate; lobes 5, ca. 1 x 0.5 cm, ovate, acute, spreading; coronal scales 5, laterally compressed, keel-shaped, adnate to staminal column. |
| Combretaceae | *Calycopteris floribunda* | Yedur | Enjir soppu | Large scandent shrubs, young branches .Leaves fulvous-tomemtose. Fruits clustered in terminal panicles. |
| Burseraceae | *Canarium strictum* | Hulikal | - | Large trees, to 20 m tall, young branches, raches, leaflets densely rusty-tomentose beneath, resin fragant. Leaflets denticulate-serrate; drupe single celled. Plants associated with Poicelomeuron indicum Bedd., Litsea floribunda (Bl.) Gamble. Resin fragrant. Rachis 30-35 cm long; disc prominent, slightly lobed margin hairy. |
| Papilionaceae | *Canavalia cathartica* | Sampekatte | | Large twiners, stem sparsely pubescent. Leaves pinnately 3-foliolate, rachis 3.5-6.5 cm long, hairy, stipules caduceus. Flowers white or pale pink, in axillary, pendulous racemes, naked behind. Pod 7-12 x 3-4.5 cm, oblong; wild. |
| Gentianaceae | *Canscora decurrens* | Chakra | | Erect branched herbs 30 cm tall, stem 4-winged. Leaves opposite, sessile, ovate to lanceolate. Flowers 8-10 mm long, pink or white, in axillary or terminal, lax, dichotomously branched cymes. Calyx not winged; corolla white |
| Gentianaceae | *Canscora diffusa* | Chakra | | Slender erect branched herbs to 40 cm tall, stem quardragular. Leaves opposite, sessile, ovate to elliptic, apex acute, base cuneate. Calyx tube not winged; corolla pink; stem 4 - angled; pedicels |

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| | | | | filiform. |
| Gentianaceae | *Canscora perfoliata* | Hulikal, Kavaledurga | | Erect branched herbs, 20 cm tall, stem winged. Leaves opposite, sessile, ovate-lanceolate, apex acute or acuminate, 3-nerved, perfoliate. Flowers pink, in terminal, dichotomously branched, lax cymes. |
| Rubiaceae | *Canthium augustifolium* | Yedur, Chakra | | Slender, armed, erect shrubs, branches 4-angled, hairy, spines axillary, recurved. Leaves opposite, ovate, apex acute or acuminate. Flowers greenish in axillary, few-floweres fascicles, pediceld 3 mm long. |
| Rubiaceae | *Canthium dicoccum* | Yedur, Hulikal | | Unarmed tree; branchlets 4-angled, flattened at the apices. Leaves opposite, coriaceous, elliptic or elliptic-oblong, apex acute or shortly acuminate. Flowers umbellate on a short peduncle. |
| Rubiaceae | *Canthium parviflorum* | | | Rigid, erect or subscandent, armed shrubs. Spines horizontal, straight, sharp. Leaves opposite, often fascicled on the young shoots. Flowers greenish-white, 4-merous, in axillary many-flowered fasicicles. Drupe obovoid or obcordate, compressed often bilobed at apex. |
| Capparaceae | *Capparis cleghornii* | Hulical, Chakra, Yedur | - | Large woody climbing shrubs, branches hoary-pubescent, spines stipular, recurved. Leaves oblong, glabrous; flowers 3.2 cm in diameter; corymbose. Gynophore-3-4.5 cm long in fruit, glabrous. Berry 3 x 2.5 cm, globose, umbonate. |
| Capparaceae | *Capparis moonii* | Verthekodlu | Mullukathari | Glabrous woody climbers, spines recurved. Corymbs terminal. Leaves oblong with a callous tip, glabrous.stamens numerous. Gynophores to 8 cm, glabrous. Fruits ellipsoid, beaked, smooth. |
| Capparaceae | *Capparis zeylanica* | Sakrebylu, Yedur | Anthundikai | Climbing shrubs, rusty grey-pubescent, glabrescent. Spines recurved. Leaves ovate-elliptic, callus-tipped or rarely retuse. Flowers 3.5 - 5 cm across, in supra-axillary rows. Berry ellipsoid. |
| Rhizophoraceae | *Carallia brachiata* | Mastikatte, Nivane, | | Medium-sized glabrous trees, to 14 m tall. Leaves opposite, |

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| | | Sampekatte | | coriaceous, midrib impressed. Flowers to 5 mm long, white, sessile, crowded in small heads, on axillary, short, trichotomously branched peduncles. |
| Sapindaceae | *Cardiospermum halicacabrum* | Gajanur | Agni balli | Slender climbing peduncle herbs, tendril-bearing, lowest pair of pedicels tendrillar. Stem furrowed, pubescent. Leaves 2-ternate, ovate. Calyx outer pair 1.5-2 mm long; inner pair larger, membranous. Petals inner pair slightly larger with larger scales at base within; outer smaller with crested scales with. Fruit broadly pyriform; |
| Lecythidaceae | *Careya arborea* | Savehaklu | Daddaala, Kavalu mara | Deciduous trees. Leaves obovate, slightly acuminate, cuneate at base. Inflorescence a short spike. Flowers sessile. Calyx lobes ovate, obtuse at apex. Petals yellowish-white. Stamens long. Beerry 5.5- 6.5 cm long, green. |
| Apocynaceae | *Carissa spinarum* | Bileshvara | | Erect, thorny shrubs, thorns to 2 cm long, straight or slightly curved at tip. Leaves opposite, ovate, apex obtusely acute. Berry globose, purplish-black, seeds 4, calyx persistent hairy. |
| Flacourtiaceae | *Casearia bourdillonii* | Sampagod Kan | - | Trees to 10 m in height. Leaves entire, elliptic-lanceolate, acuminate at apex, rounded or narrowed at base, glabrous. Panicles and tepals hairy. Filaments bearded, staminodes densely hairy. The plant is associated with Xylia xylocarpa (Roxb.) Taub. and Terminalia paniculata Roth. Capsule ovoid or subglobse, axillary, 3-valved, orange, stalk 5-8 mm long, angular, puberulous, articulate at base, persistent calyx lobes hairy without. |
| Flacourtiaceae | *Casearia elliptica* | Gajanur | - | Small trees; stipules minute, scale like. Leaves and calyx pubescent, calyx lobes elliptic. capsule 2*1.2 cm, oblong, 6-ribbed, solitary or paired at leafless axils, tomenntose, articulate at base. Calyx lobes 5, persistent, 5 mm long, ovate pubescent. |
| Flacourtiaceae | *Casearia rubescens* | Yedur, Hulical | - | Shrubs or trees, 3-17 m tall. Leaves alternate, subcoriaceous, |

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| | | | | elliptic-oblong, apex acuminate, base cuneate or acute. Flowers 5 mm across, greenish-white, in axillary clusters, pedicels minutely pubescent. Stamens in male flowers 1-2.5 cm long, ovoid, yellowish, 2-valved, pulp yellow. Fruits in axillary clusters, each ovoid, yellowish, 2-valved, pulp yellow. |
| Flacourtiaceae | *Casearia zeylanica* | Yedur, Chikar, Hulical | - | Small trees to 8 m tall, branchlets angular, glabrous. Leaves alternate, subcoriaceous, elliptic-oblong, apex acute or shortly acuminate. Flowers bisexual, greenish, in axillary fascicles. Stamens inserted at the base of calyx, alternating with scale-like, ciliate staminodes shorter than stamens; filaments pubescent. |
| Caesalpiniaceae | *Cassia auriculata* | Shikaripura | | Erect, branched shrubs, 1-1.5 m tall, stem brownish. Leaves paripinnately compound. Stipule foliaceous seeds more than 50 in each pod, Rachis and leaflets beneath fulvous-pubescent. Rachis 6-8 cm long. Flowers long, yellow, in terminal or axillary corymbs. Pod flat, stalked, pubescent, many seeded. |
| Caesalpiniaceae | *Cassia fistula* | Sampekatte, Sagar, Gajanur | Konde-mara | Small deciduous trees, to 8 m tall. Leaves paripinnately compound. Flowers yellowish, in drooping, panicles. Pod cylindrical, pendulous, black when dry. |
| Caesalpiniaceae | *Cassia laschenaultiana* | Nittur, Jayanagar | | Small herbs, branches diffuse, pubescent with recurved hairs. Leaves pinnately compound, rachis 1.8-2.8 cm long, pubescent, gland sessile at the top of the petiole, stipules triangular, long acuminate. Flowers 1 cm across axillary solitary. Pod 3 cm long, compressed, seeds 13-14. |
| Caesalpiniaceae | *Cassia sophera* | Nagara fort, Sagar | Kaadamarda | Erect shrubs or undershrubs, stem glabrous or young parts sparsely pubescent. Leaflets 6-10 pairs; elliptic-ovate. Flowers few in axillary or terminal corymbs. Pod compressed, glabrous, seeds many. |
| Caesalpiniaceae | *Cassia tora* | Nagara fort | Tagarai | Erect herbs, stem more or less pubescent. Leaves paripinnately compound, rachis 4-6 cm long, |

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| | | | | glands present on the petiole and between the lower 2-pairs of leaflets. Leaflets not sericeous, glabrous above, pubescent or glabrous beneath; pods 10-15 long, puberulous. Flowers 1 cm long, yellow, in axillary pairs. Pod linear apiculate, pubescent seeds many. |
| Zingiberaceae | *Catimbium malaccensis* | Agumbe, Hulikal | | Rhizomatous herbs. Leafy-stem 2-3 m tall. Leaves oblong-lanceolate, acuminate at both ends, pubescent beneath. Racemes terminal to 30 cm long. Cincinni of 2-3 flowers or reduced to a solitary flower. Labellum large, yellowish, variegated with red, ovate, emarginate; lateral staminodes slender, subulate. Capsule globose, orange-red when mature, pubescent. |
| Rubiaceae | *Catunaregam spinosa* | Bileshvara, Yedur, Kargal | Kaarekaayi-gida | Armed shrubs or small trees, spines axillary, straight, branchlets pubescent. Leaves opposite, suppressed branchlets, obovate, apex obtuse. Flowers solitary or paired at the ends of arrested branchlets. Corolla white, turning pale yellow; tube 1-1.2 cm long, narrow, lobes 5, spreading, 1 cm long. Berry ovoid, with persistent, calyx, seeds many. |
| Rubiaceae | *Catunaregam uliginosa* | Mastikatte | | Large shrubs or small trees, armed with few axillary, straight spines. Leaves broadly ovate, apex obtusely shortly acuminate. Berry 4 cm across, globose or ovoid solitary. |
| Vitaceae | *Cayratia mollissima* | Hulikal | | Softly villous, tendrillar climbers. Leaves 3-foliolate, alternate, ovate or obovate, apex shortly acuminate flowers greenish-white, axillary branched cymes. Berries 1 cm across, globose, fleshy, greenish-white. |
| Vitaceae | *Cayratia pedata* | Kodachadri | Sanna Kandadi beelu, Kaama patige balli | Large, slender climbers. Leaves pedately 7-9 foliolate, petiole 7-10 cm long, pubescent, middle larger, oblong-lanceolate or elliptic-lanceolate, serrate, apex acuminate, base unequal, acute or rounded, minutely hairy, |

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| | | | | especially along nerves. Berries 6-11 cm across, corymbose cymes. |
| Vitaceae | *Cayratia tenuifolia* | Yedur | Narale balli | Slender, tendril climbers. Leaves pedately 5-7-foliolate, terminal larger, ovate or elliptoc, margin sharply serrate, apex acute or shortly acuminate, narrowed to unequal. Flowers small, yellowish, axillary, branched lax, divaricating cymes. |
| Vitaceae | *Cayratia trifolia* | Lakkikoppa | | Climbing shrubs, stem ribbed, woody at base herbaceous above, densely pubescent. Leaves 3-foliolate, alternate, terminal larger, ovate or obovate, margin sub-inciso-serrate-dentate. Flowers white, in axillary, divaricartly branched cymes. Petals oblong or ovate, apex rounded, pubescent without. Disc adnate to ovary at base |
| Celastraceae | *Celastrus paniculatus* | Bileshvara, Sampekatte, Savehaklu, Yedur, Nagara, Gajanur | Cherupunna | Large, scandent or climbing shrubs, branches reddish with white lenticels. Leaves alternate, ovate or elliptic-oblong. Flowers yellowish, in terminal panicles peduncle slender. Capsules subglobose, turning orange-yellow, 3-valved. Seeds 2 in each cell, enclosed in reddish aril. |
| Ulmaceae | *Celtis timorensis* | Nagodi, Yedur, Hulical | | Small to medium-sized trees, 10-14 m tall, branchlets pale reddish, lenticellate, glabrous or hairy. Leaves alternate, ovate, entire or remotely serrate above the middle, apex shortly acuminate, base rounded, slightly or not oblique, prominently 3-nerved from base, veinlets transversely parallel, caduceus. Flowers minute, yellowish-green, unisexual, in axillary or extra-axillary cymes. Perianth 4-lobed in both male and female, free, ovate. Stamens 4, inserted around woolly torus. Drupe ovoid, beaked. |
| Apiaceae | *Centella asiatica* | Chakra Tenkbail | Ondelaga, Urage | Prostrate herbs, rooting at nodes. Leaves several together from root-stock, reniform, margins crenate. Fruit a schizocarp of 2 mericarps in axillary, sessile umbels. |

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| Poaceae | *Centotheca lappacea* | Chakra | | Tall, stout, perennial grass; stem erect or suberect, with stout root-fibres from woody root-stock. Leaves 6-10 x 1-2 cm or larger, oblong-lanceolate, apex acute-acuminate, base narrowed, asymmetrical, margin scabrid, prominently many-nerved tessellate, glabrous or nearly so; sheaths compressed, glabrous or ciliate; ligule membranous. Inflorescence terminal panicle of 20-25 cm long; peduncle angular, grooved hairy; branches distant, lax, slender, to 15 cm long, not jointed. Spikelets 3-4 mm long green, narrowly lanceolate, acute, on slend hairy pedicels, 1-flowered. Glumes distant; lower 2-2.5 mm long, ovate, acute, apiculate, 3-nerved; upper ca. 4 mm long, 3-5-nerved. Lower lemma 3-3.5 mm long, 5-7-nerved, broadly ovate, apiculate; palea shorter than lemma, 2-keeled. Upper lemma similar to lower lemma. Lodicules absent. |
| Scrophulariaceae | *Centranthera indica* | Nittur | | Erect herbs, roots yellowish, stem leaves and calyx covered with bulbous-based, hispid, jointed hairs. Leaves opposite, passing into alternate, foliar bracts above, sessile, linear-oblong, apex obtuse roa cute, narrowed at base. Flowers purple or white axillary, solitary or terminal racemes, subsessile or shortly pedicelled, solitary or in terminal racemes. Calyx 5 mm long, tube spathaceously split on one side; lobes 5, obscure or minute. Corolla 1-1.5 cm long; tube curved above; lobes 5, unequal, 2-lipped. Capsule ovoid, pubescent, seeds spirally striate. |
| Ceratophyliaceae | *Ceratophyllum demersum* | Sorab | E- Hornwort | Submerged, monoecious, fragile, slender, branched herbs. Leaves whorled, dichotomously segmented into filiform, minutely toothed lobes. Flowering: January. |
| Rubiaceae | *Chasalia ophioxyloides* | Sampekatte, Nittur, ulikal, | Vellakurinji | Erect shrubs to 2m tall, branchlets compressed. Leaves opposite membranous, elliptic. Flowes |

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| | | Chakra, Yedur, Savehaklu | | pinkish-white in terminal, branched cymes. Beery purplish, 5 mm across, globose. |
| Chenopodiaceae | *Cheuopodium album* | Savehaklu | - | A tall erect herb. Leaves ovate-rhomboid to oblong-lanceolate, irregularly lobed. Flowers green, in axillary and terminal leafy panicle. Seeds orbicular-compressed, margin bluntly keeled. |
| Apocynaceae | *Chilocarpus malabaricus* | Hulikal | | Glabrous, large climbing shrubs. Leaves opposite, subcoriaceous, oblong, apex obtusely caudate, base acute, pale green beneath. Flowers white, in trichotomously branched, axillary cymes, shorter than leaves. Fruit ellipsoid-oblong, seeds ellipsoid. |
| Oleaceae | *Chionanthus malabarica* | Kodachadri, Kundadri, Sampekatte, Jog | | Small trees, to 10 m tall. Leaves opposite, elliptic-oblong, or obovate, apex obtuse, base acute or cuneate. Flowers small, white, in sessile fascicles, on short axillary, unbranched or branched peduncles. Often associated with Symplocos racemosa Roxb., Terminalia paniculata Roth. |
| Liliaceae | *Chlorophytum orchidastrum* | Kargal | | Erect, perennial, scapigerous herbs, root-stock short, roots fibrous, often tuberous. Leaves radical, elliptic or elliptic-oblong. Flowers white, often in pairs, distinct, on elongated, angular peduncles. Capsule sharply trigonous, 3-loculed, locule 1-seeded, seed reniform. |
| Apocynaceae | *Chonemorpha fragrans* | Mastikatte, Sampekatte | | Large woody climbing shrubs, young branches hairy. Leaves opposite, broadly suborbicular or oblong, apex abruptly and shortly acuminate, apiculate, base cordate, tomentose beneath. Flowers large, white with yellowish tinge within, in terminal cymes. Corolla tube 2-3 cm long; lobes to 4 cm long, twisted to left. Stamens included, inserted at base of corolla tube ; filaments short, hairy ; |
| Asteraceae | *Chromolaena odorata* | Savehaklu | | Erect tall, slender, aromatic undershrubs or shrubs, stem faintly ribbed, pubescent. Achenes 5-angled, truncate. |
| Sapotaceae | *Chrysophyllum* | Hulikal | - | Tall evergreen trees, young |

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| | *lanceolatum* | | | branchlets rufous-tomentose. Petiole to 8 mm long, leaf blade oblong-lanceolate, acuminate at apex, acute at base, shining. Flowers 5-merous, pedicels to 4 mm long. Calyx lobes, orbicular, hairy without. Corolla white, lobes with minutely fimbriate margin. Ovary villous. Berry globose. |
| Poaceae | *Chrysopogon aciculatus* | Nagara fort, Sampekatte | | Perennial, tufted grass; root stock woody, creeping and branching; stem erect or ascending, 20-25 cm long, lower internodes short. Leaves 2.5-10 cm long, mostly clustered at the base of stem, linear; sheaths terete, slightly bearded at throat; ligule membranous. Inflorescence terminal panicle, 5-6 cm long, pale green or purplish ; branches in approximate whorls, slender, ascending, faintly striate, terminating usually in 1 sessile and 2 pedicelled spikelets. Sessile spikelets: 3-4 mm long, 2-flowered, dorsally compressed; callus nearly as long as glumes, decurrent on peduncle, laterally fulvous bearded. Lower glume 3-4 mm long, chartaceous, lanceolate, minutely bicuspidate, dorsally convex, obscurely 3-nerved, 2-keeled laterally; keels hairy. |
| Poaceae | *Chrysopogon hackelii* | Kodachadri | | Perennial, tufted grass; stem erect, to 2 m tall leaves long, margin scabrid; sheath compressed, broad, glabrous or silky-hairy; ligule a ridge of hairs. Inflorescence terminal panicles, to 15 cm long; branches in whorls of 6-10, slender, filiform, spreading or ascending, spikelets 3 at the ends of each branch: 1 sessile, 2 pedicelled, all deciduous together from thickened hairy ends of branches. Sessile spikelets: laterally compressed; 5-6 mm long; callus short, with long, yellowish-brown hairs. Lower glume 4-5 mm long, lanceolate, obtuse, glabrous, 4-nerved. Upper glume 4-5 mm |

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| | | | | long, apex bilobed, awned, ciliate; keel rounded, thickened; awn 7-8 mm long. Lower lemma linear-oblong, hyaline, obtuse, ciliate, empty. Upper lemma bisexual, narrow, 1-3-nerved; awn ca. 2.5 cm long, twisted; palea absent. Lodicules 2. Stamens 3. Styles 2, free, plumose. Pedicelled spikelets: 3.5-4 mm long, male or empty, shorter and narrower than sessile spikelet ; pedicel ca. 2 mm long, villous, with long, rufous hairs. Lower glume oblong, acute, 5-7 nerved, not awned. Upper glume narrower, 3-nerved. Lower lemma oblong 2-nerved, ciliate; upper lemma smaller, linear, 1-nerved, ciliate, awnless. |
| Lauraceae | *Cinnamomum malabatrum* | Hulikal, Tenkbail,Kogar | Kattu karuvapatai, Lavanga patra | Trees, 7-15 m tall, bark blackish, branchlets minutely, adpressed-pubescent. Leaves 9 - 20 cm long, opposite or sub-opposite, elliptic-oblong, ovate-lanceolate or oblong-lanceolate, apex acute or acuminate. Drying pale greenish; secondary lateral nerves 2 mm apart. Flowers yellowish-white, bisexual, in axillary or subterminal panicles. |
| Lauraceae | *Cinnamomum sulphuratum* | Hulikal | Pinga dalchini | Small trees, 8 m tall, branchlets compressed, minutely hairy. Leaves 9 - 15 cm long; drying brownish; secondary lateral nerves 4 mm apart. Berry oblong or ellipsoid, 1-seeded, in axillary panicles peduncle 4-5 cm long, fruiting pedicels 5 mm long, cup-like, lobes 5, ovate, obtuse pubescent. |
| Vitaceae | *Cissus discolor* | Hulikal, Yedur | Njerinjampuli | Slender climbers, tendril leaf-opposed, forked. Leaves blotched with white above and deep red or purple beneath. Disc 4-lobed, yellowish.flowers reddish, in leaf-opposed branched cymes. Berry 5-6 mm across, globose, 1-seeded, turning violet or blackish. |
| Vitaceae | *Cissus repens* | Nagodi | - | Climbing shrubs, stem week, furrowed, glabrous, tendril leaf-opposed, forked. Leaves dentate-crenate at margins, glabrous.Flowers conical in bud, |

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| | | | | orange-red in leaf-opposed corymbose compound umbels. |
| Rutaceae | *Clausena dentata* | Kargal | - | Medium-sized trees, 12-15 m tall, young parts pubescent, leaves imparipinnate, alternate, rachis 12-15 cm long, pubescent leaflets 11. Laterals alternate or emarginated, base acute, unequal, gland-dotted. Berry globose, green, turning white, gland-dotted, on axillary, racemose peduncle. Aromatic seeds. |
| Rutaceae | *Clausena indica* | Hulical, Kundadri | | Large shrubs or small trees, to 4 m tall. Aromatic. Branchlets pubescent. Leaves imparipinnate, alternate, rachis 8-12 cm long pubescent, leaflets usually 9, alternate. Flowers small, greenish-white, in terminal panicles to 7 cm long, pedicels short, pubescent as on peduncle. |
| Ranunculaceae | *Clematis gouriana* | Savehaklu | Nikitakodi, Thalejadari | Large hairy climbers, leaves pinnate or 2-pinnate with 2 ternate pinnae and 3 leaflets at the apex; petioles often twining. Perianth white, hairy exteriorly. Filaments glabrous, connective not prolonged. |
| Capparaceae | *Cleome viscosa* | Hulical | Kadusasive | Plants viscous with stalkes glands; flowers yellow. Sepals oblong-lanceolate. Petals Oblong-obovate. Ovary sessile or shortly stalked; stamens inserted on the disc. |
| Verbenaceae | *Clerodendrum serratum* | Sampekatte, Chakra, Savehaklu | | Erect shrubs, 1-2 m tall, stem quadrangular, glabrous or hairy. Leaves opposite or ternate, subsessile or shortly petioled, elliptic or obovate, margin sharply serrate above the base, apex acute or shortly acuminate, base cuneate.Cymes in terminal panicle. Corolla bluish purple. Calyx 5-lobed, united, 4-5 mm long, cup-shaped; lobes short, acute or rounded, ciliate. Corolla tube 5-7 mm long; lobes 5, unequal, to 1 cm long, elliptic, obtuse, lower shorter. Drupe 4-lobed, black when dry. |
| Verbenaceae | *Clerodendrum viscosum* | Hulikal | Thaggigida | Large shrubs to 3 m tall, branches quadrangular, softly tomentose. Leaves ovate, amrgin entire or deniculate, base cordate. Flowers |

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| | | | | white, in terminal paniculate cymes. Calyx 5-lobed, more or less free to base; lobes 10-12 x 5-6 mm, ovate, acute, 3-nerved, reddish and enlarged in fruit. Corolla tube ca. 1 cm long; lobes 5, slightly unequal, oblong, obtuse. |
| Menispermaceae | *Cocculus hirsutus* | Ayyanur | K-Dhagadiballi. | Slender, dioecious stragglers or climbers, stem striate, densely villous. Leaves ovate alternate, sub-deltoid, raely 3-lobed, apex obtuse, mucronate, base rounded or truncate, pubescent, densely beneath. Flowers pale yellow in panicles; sepals pubescent; drupe purple. Drupe reddish-black. |
| Poaceae | *Coelachne simpliciusculata* | Tenkbail, Jog | | Erect, tufted grass, ca.10 cm tall; stem slender, leafy up to the inflorescence, hairy at nodes. Leaves ca. 2.5 cm long, lanceolate, striate ; sheaths ca. 1 cm long ; ligule of a few hairs. Panicles of interrupted shortly branched, spiciform clusters. Spikelets 1.5-2 mm long, ovoid, sessile or shortly pedicelled; pedicels less than 0.5 mm long. Lower glume suborbicular, ca.1 mm long, membranous or herbaceous, 3-5-nerved; upper similar, slightly larger, concave. Lower lemma as long as the spikelet, bisexual, subcoriaceous, ovate, obtuse; palea similar to the lemma; upper lemma ca.1 mm long, stalked, bisexual or sterile, paleate, pubescent. |
| Lamiaceae | *Colebrookea oppositifolia* | Hulikal, kundadri | | Branched shrubs, 1-3 m tall, branches subquadrangular, grooved, verticillate, usually in threes, young shoots downy. Leaves crowded towards end of branches, opposite or verticillate, in three, oblong-lanceate, acute at apex. Flowers numerous, in paniculate, often ternately arranged spikes, calyx-teeth subulate, plumose with white hairs. Nutlets oblong-ovoid, pubescent hairy at tip. |
| Lamiaceae | *Coleus mollis* | Kodachadri hills | | Erect herbs, stem quadrangular, densely pubescent. Leaves opposite, broadly ovate, margin |

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| Araceae | *Colocasia esculenta* | Hulikal ghat | Kesu | Tall, rhizomatous herbs, often stoloniferous. Leaves large, ovate, cordate or sagittate, peltate. Spathe yellow, lower tube oblong. Spadix shorter than spathe, appendix short, cylindric. |
| Combretaceae | *Combretum latifolium* | Hulikal, Jog | | Large, scandent or climbing shrubs. Leaves opposite, ovate or elliptic, apex acute or obtuse, base acute, often puberluous. Flowers to 1.5 cm long, white, in axillary dense spikes or panicles. Calyx funnel-shaped, leaves laurel-shaped. Fruit 4-winged, reddish when young. |
| Connaraceae | *Connarus wightii* | Kodachadri slopes, Hulikal, Chakra, Yedur | Kurigil | A climbing shrub; follicles chestnut brown, strongly striate, shortly narrowed into the stalk. Rachis 7-15 cm long. Leaves alternate, pinnately compound. Follicle 2, ovoid compressed, striate, reddish, turning brown, long-stalked, seed 1, arillate. |
| Tiliaceae | *Corchorus capsularis* | Nagara | Senabu | Erect herbs or undershrubs, to 1 m tall. Leaves alternate, narrowly ovate-lanceolate, serrate. Capsule depressed-globose, ridged and muricate, 5-valved; valves woody. Capsule, 5-valved, muricate, axillary, solitary or paired; stalk 2-3 mm long. |
| Cordiaceae | *Cordia obliqua* | Gajnur | | Deciduous trees to 9 m tall, branchlets whitish, lenticellate, sparsely hairy. Leaves alternate, rarely opposite. Drupe ovoid or oblong, orange-yellow, in axillary, shortly branched cymes, 2-seeded. |
| Asclepiadaceae | *Cosmostigma racemosum* | Jog | Peru kujumbe | Twining shrubs, latex watery, stem faintly striate, hollow within, sparsely hairy when young. Leaves membranous, opposite, broadly ovate, apex acuminate, base subcordate or rounded. Glandular at base on upper surface, sparsely pubescent. Calyx 1.5 mm long; lobes 5, divided near to the base, ovate, ciliate, glandular within. Corollarotate, 8-10 mm across; tube short; lobes 5, each 4 mm |

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| | | | | long, ovate, yellowish-green with reddish-brown speckles. Coronal scales 5, membranous, erect 2 fid, adnate to staminal column at base, free above. |
| Costaceae | *Costus speciosus* | Hulikal, Sampekatte | | Erect herbs, root-stock, tuberous. Leaves subsessile, elliptic-oblong or elliptic-oblanceolate, apex acute or shortly acuminate. Flowers white, in terminal dense 5-10 cm long spike. Spike oblong on the leafy stem, Staminodes modified into labellum, others reduced or absent, labellum ca. 5 cm across, white with yellow centre. |
| Orchidaceae | *Cottania peduncularis* | Nittur, Sagar | | Epiphytic herbs, with stout adventitious roots; stem elongate, clothed with sheathing bases. Leaves 11-13 x 1.4-1.6 cm, alternate, coriaceous, lorate, sessile, elliptic-oblong, apex unequally 2-lobed with a broad, acute sinus in between, bases lightly narrowed and jointed at petiolar sheath, keeled beneath. Flowers few, yellowish-brown, mottled purple, in lax panicles ; peduncle to 50 cm long or longer, emerging through leaf-sheath, 2-3 branched, each bearing racemes terminally ; bracts minute ; pedicels with ovary 1.5 cm long. Sepals 3, free, 8 x 3 mm, obovate, apex rounded, 7-nerved. Petals narrowly obovate, 8 x 2.5 mm, 3-nerved. Lip 12 x 6 mm, fleshy, purple, margin villous, 3-lobed; lateral lobes small, fringed; midlobe large. Unequally 3-fid. Column broad, with 2 calli laterally just above the stigmatic surface. Anther 1, 2-celled, broadly retuse at apex; pollinia 2, ovoid; caudicle slender, ca. 1 mm long, with a small gland. |
| Asteraceae | *Crassoceiphalum crepidiodes* | Talaguppa | - | Erect herbs, to 50 cm tall, usually unbranched, stem ribbed, puberulous when young. Leaves alternate, elliptic-oblannceolate. Disc florets 10-12 mm long. |
| Capparaceae | *Crateva magna* | Hosamane | Nirvaala | Petiolules to 0.3-0.5 cm. leaflets acuminate, membranous to sub- |

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| | | | | coriaceous. Flowers many on leafy twigs. Pedicels to 6.5 cm. Sepals ascending. Petals 2.5*1.8 cm. stamens 5-5.5 cm. ovary oblong-ellipsoid, to 0.4 cm long. Stigma sessile. Berry subspherical. Seeds dorsally crested, tuberculate. |
| Papilionaceae | *Crotalaria albida* | Yedur, Ulikoppa | - | Much branched, prostrate or procumbent herbs. Leaves subsessile, simple, alternate. Stipules 0; plants exceeding 60 cm height.flowers yellow, in axillary or terminal 6-10-flowered, lax racemes. Pod oblong, glabrous, seeds 6-12. |
| Papilionaceae | *Crotalaria berteroana* | Devagaru | - | Erect, rigid, branched shrubs to 2.5 m tall. Leaves simple, alternate, oblanceolate, apiculate. Flowers yellowish, in axillary or terminal panicles, silky-hairy. Pod 2-seeds; leaf apex obtuse, sub-acute, standard silky on back; pods included. |
| Papilionaceae | *Crotalaria filipes* | Chakra | - | Plants diffuse or trailing; racemes 1-4-flowered. Stem clothed with long coarse silky yellow-brown hairs. Leaves subsessile, ovate or oblong, apex obtuse or acute, often mucronate, base cordate. Pods short stalked, light brown, oblong, glabrous. |
| Papilionaceae | *Crotalaria nana* | Nagara, Chakra | | Erect, branched or unbranched herbs, stem silky-hirsute, hair spreading. Leaves narrowly elliptic-oblong. Flowers in umbels or globose heads; 1-8-flowered. Keels longer than wing petals. |
| Papilionaceae | *Crotalaria pallida* | Yedur | | Erect, branched undershrubs, stem striate, appressed silky-hairy in juvenile parts. Leaves alternate, 3-foliolate. Stipules minute, filiform; pod c. 5 cm long. Flowers terminal racemes. |
| Papilionaceae | *Crotalaria retusa* | Yedur | Kilukilukki | Erect undershrubs. Leaves silky-pubescent beneath; stipules sobulate.flowers yellow, in terminal long racemes, peduncle to 30 cm long, hairy, pedicels 5-7 mm long, bracteoles 2, inserted at the middle of the pedicel. Pod linear, oblong, turgid, glabrous, stalked. |

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| Papilionaceae | *Crotalaria triquetra* | Chakra | | Slender, suffruticose, herbs, 25-35 cm long, branches ascending triquetrous, hairy along the angles. Leaves alternate, subsessile, elliptic-oblong or oblong-lanceolate, apex obtuse or subacute, rounded or subcordate at base, sparsely hairy beneath and along margins. Flowers yellow, terminal racemes. Pod to 1.5 cm long. |
| Euphorbiaceae | *Croton caudatus* | Kerekoppa | | Scandent shrubs, branchlets slender, scabrid. Leaves ovate, cordate at base; capsule 2 cm long. Capsule oblong, scabrid, with stellate hairs, in terminal racemes, valves 6, dehiscing from apex downwards. |
| Euphorbiaceae | *Croton gibsonianus* | Hulikal ghat | | Scandent shrubs, branchlets slender, scabrid, stellately-hairy.leaves alternate, ovate, irregulary denticulate, teeth glangular. Male flowers above, female at base. Male flowers; 2-2.5 mm across, yellowish, in fascicles of 1-4 to each minute bract; pedicels slender, 4-5 mm long. Calyx lobes 4, free to base, 2-2.5 x 1 mm, ovate, white-woolly at margin, sparsel stellate-hairy without. Petals 4, free, shorter than calyx. Disc of 5 glands. Stamens 10-12, on hairy receptacle; filaments incurved in bud; anthers 2-celled. Female flowers 3-4 mm long, solitary to each bract; pedicels 2-2.5 mm long, stout. Calyx lobes 5, free, 3 x 1 mm, stellately-hairy without. Petals absent. Disc saucer-like. Ovary globose, densely hairy; styles 3, each 2-lobed. |
| Periplocaceae | *Cryptolepis buchanani* | Nittur, Kattinakere | | Large, straggling shrubs. Leaves opposite, elliptic-oblong, apex abruptly short-acuminate or apiculate, base acute, green, shining above. Flowers yellowish-green, in axillary, short paniculate cymes.Calyx lobes 5, free near to the base, ovate, glabrous or ciliate at apex, with 5 scales within. Corolla tube 2-4 mm long; lobes 7-8 mm long; lanceolate, apex subacute, twisted |

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| | | | | to right in bud. Corona of 5 short, clavate scales, notched at apex, adnate to corolla tube. |
| Araceae | *Crytocoryne retrospiralis* | Mavinhole | | Aquatic or marshy herbs, rootstock creeping. Leaves basal, 7-40 cm long, erect, grass-like, linear-lanceolate, apex acute or acuminate. Spathe nearly as long as the leaves, green, streaked with purple, tube narrow, limb closey spirally twisted. |
| Hypoxidaceae | *Curculigo orchioides* | Nagara, Lakkikoppa | Nilapana | Herbs with tuberous, cylindrical, root-stocks. Leaves basal, elliptic-lanceolate, apex acute, narrowed at base. Flowers axillary, solitary. Perianth tube produced above the ovary into long, slender, hairy, stalk-like rostrum. |
| Zingiberaceae | *Curcuma oligantha* | Bileshvara, Savehaklu | | Perennial herbs, root-stock small, fibrous roots terminating in sub-globose or oblong-ellipsoid tubers, white within. Leaves 2 to 7 in a tuft, elliptic-oblong or ovate, apex, acute, narrowed at base into short petiole. Inflorescence arising before or with the developing leaves. Corolla tube to 3 cm long, white, pubescent; lobes 3, sub-equal, white or with a pink tinge; dorsal lobe apiculate. Labellum 2x2 cm, emarginate, white, with yellow spot at throat; lateral staminodes white. |
| Cuscutaceae | *Cuscuta chinensis* | Sagar and Jog | | Parasitic, leafless twiners, stem slender, yellowish. Flowers white, in dense cymes, pedicels short or absent, bracts membranous, scale-like. Leafless, Stem yellow. Corolla lobes 5, united; tube equalling the lobes; fimbriate scales present within the tube, opposite the stamens. |
| Commelinaceae | *Cyanotis cristata* | Nittur, Hulikal | | Prostrate herbs, stem glabrous or with a row of spreading hairs. Leaves sessile, ovate, apex acute. Flowers bluish, in terminal, arcuate cymes, bracts leafy, longer than cymes. Capsules 3-celled, seeds 2 in each cell, trigonous, striate, 2-pitted laterally. |
| Amaranthaceae | *Cyathula prostrata* | Hulikal | - | Slender prostrate herbs with ascending branches, rooting at |

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| | | | | llower nodes, stem angular, pubescent. Leaves ovate, elliptic or obovate, margin entire or distantly dentate-crenate, apex acute, base cuneate, pubescent. Racemes terminal, tomentose. Flowers 3-4 mm long, clustered 1-3 to each bract, 1 perfect, 2 sterile. Perianth of sterile flowers with hooked awns; fertile with unequal tepals; each 3-nerved, apiculate, fimbricate. |
| Menispermaceae | *Cyclea peltata* | Nagodi, Hulical, Jog | Haade balli, Paatala beru | Slender, dioecious twiners, stem pubescent, with spirally twisted grooves. Leaves alternate, peltate, ovate-hastate, apex acute, apiculate, base truncaye, palmately 7-nerved, glabrous above, densely hairy beneath. Calyx globose or campanulate; loves 1/4 of the tube; anther 6 - 8 celled. A common twinner on hedges and bushes. Male flowers in axillary panicles, female flowers in axillary racemes. |
| Orchidaceae | *Cymbidium aloifolium* | Bileshvara | | Robust, tufted, epiphytes, pseudobulbs 4-6 cm long, covered with closely overlapping, membranous shealths. Leaves coriaceous, strap-like, narrowly oblong. Lip trilobe, sidelobes erect, midlobe deflexed all 3 yellow with deep purple striations. Disc yellow with 2 S-shaped lamellae with clubbed tips. Lip slightly saccate at the base, column, arched, deep purple. Capsule ellipsoid, ribbed, stalked, lateral, drooping. |
| Asclepiadaceae | *Cynanchum callialata* | Savehaklu | | Twining herbs, stem striate. Leaves opposite, coriaceous, ovate-oblong, apex acute or abruptly short acuminate, base cordate. Flowers in axillary or subaxillary, umbellate cymes, peduncle 0.5-1 cm long, hairy. Follicle ovate-lanceolate, narrowly 2-winged on either side. |
| Poaceae | *Cynodon dactylon* | Bileshvara | | Perennial, slender grass, creeping by rhizomes or stolons, forming matted tufts; branches erect or ascending. Leaves 1-2 x 0.1-0.3 cm, distichous, linear, acute, glabrous, margins scabrid; |

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| | | | | sheaths compressed, generally bearded with tufts of long hairs at mouth; ligule a rim of white hairs. Inflorescence of 2-8 (4 in our specimen) spikes, umbellately radiating from the top of a slender peduncle, 2-3 cm long, green or purplish. Spikelets 2-2.5 mm long, sessile, ovate, laterally compressed, 1-flowered, unilateral, arranged alternately in 2 rows on compressed, angular, keeled rachis ; rachilla dis-articulating from base, produced beyond palea as a naked bristle, Glumes 2, unequal, lanceolate, keeled, 1-nerved ; lower ca.1 mm long ; upper ca.1.5 mm. Lemma 2-2.5 x 1.5 mm, obliquely oblong or semi-ovate, boat-shaped, 3-nerved, lateral nerves close to margins, keeled, hairy along the keel. Palea 1.5 mm long, folded, 2-keeled. Lodicules 2. |
| Boraginaceae | *Cynoglossum zeylanicum* | Hulikal, Yedur, Savehaklu | | Erect, branched herbs, branches more or less hispid with bulbous-based hairs. Leaves elliptic-lanceolate, margin ciliate, entire or obscurely dentate, apex acute, base cuneate or subacute. Fruits of 4 nutlets, adnate to conical carpophores, each nutlet 2-2.5 mm across, narrowly margined and glochoidicate. |
| Cyperaceae | *Cyperus articulatus* | Gajnur | | Robust, rhizomatous, perennial herbs, to 2 m tall; stem terete, striped, transversely septate. Leaves reduced to papery sheaths. Inflorescence a compound umbel; primary rays to 10, unequal, slender to 7 cm long, compressed; secondary rays sometimes present; spikelets spicate, 10-15 together, each ca. 1.5 cm long, linear, compressed, pale brownish ; rachilla of spikelets distinctly winged, membranous; bracts 5 or more, outer slightly larger, ca. 1.5 cm long, ovate-lanceolate, apex acute, broad at base. Glumes 2.5-3 x 1.5 mm, elliptic or ovate, apex acute, with narrow, green keel, nerves obscure, margin membranous. |

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| Cyperaceae | *Cyperus haspan* | Tenkbail | | Perennial, rhizomatous herbs; rhizome slender, creeping; stem compressed or trigonous, stripped. Leaves ca. 15 x 0.3 cm, basal, linear; sheath inflated. Inflorescence compound umbels; rays about 8, each 5-8 cm long, unequal; bracts usually 2-3, to 5 cm long, unequal, linear-lanceolate; spikelets in clusters of 5-8, stellately radiating; each ca. 12 mm long. Glumes 2 x 0.5 mm, distichous, ovate, obtuse, brown, with narrow green keel. Stamens 3; filaments 1-1.2 mm long, slender, inserted below ovary. |
| Cyperaceae | *Cyperus iria* | Bileshvara | | Erect annuals; stem triquetrous. Leaves 3-5 mm wide, linear, shorter than or as long as stem; sheath papery. Inflorescence of compound umbels ; primary rays many, erect ca. 2 cm long, with ocreate truncate sheath at base, bearing irregularly fascicled umbellules. Each umbellule formed of narrow, interrupted spikes of few-flowered spikelets; bracts about 5, unequal, leaf-like, ca. 12 cm long, the umbels. Spikelets erect, 5-15 mm long, 5 or more-flowered; rachilla not winged. Glumes alternate, ca. 1.5 mm long, obovate, obtuse, keeled, 3-5-nerved on back, sides hyaline, nerveless. Stamens 2 or 3. Nuts 1-1.5 mm long, as long as glumes, obovate, triquetrous; style much shorter than nut. Flowering: September. Fruiting: September. |
| Cyperaceae | *Cyperus pangorei* | Tenkbail | | Perennial, rhizomatous herbs; rhizomes stout, creeping; stem more than 60 cm tall, trigonous, striped. Leaves few, basal, linear, shorter than stem, sheaths papery, purple or brown. Inflorescence of compound umbels ; primary rays 5-10, approximate or spreading, unequal, each to 12 cm long ; bracts 3-5, unequal, leaf-like, the lowest longer than inflorescence ; umbellules corymbose, 2-3 cm long ; rachilla with ovate, dark brown, deciduous wings. Glumes distant, distichous, 3 mm long, |

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| | | | | elliptic, obtuse, faintly 3-5-nerved on back, reddish-brown laterally, nerveless. |
| Cyperaceae | *Cyperus pygmaeus* | Gajnur | | Dwarf, annual herbs, to 8 cm tall; stem trigonous. Leaves 4-5 cm long, all basal, linear; sheaths scaly, overlapping. Spikelets ca. 4 mm long, compressed, many, sessile, densely packed in terminal heads ; head ca. 1 cm across, greenish ; bracts about 6, leaf-like, unequal, ca. 8 cm long. Rachilla slender, not winged. Glumes distichous, 2 mm long, closely overlapping, oblong-lanceolate, cuspidate, hyaline, with brown streaks on back. Perianth absent. |
| Poaceae | *Cyrtococcum oxyphyllum* | Chakra | | Slender, perennial grass, creeping and rooting at lower nodes, with ascending branches; stem striate. Leaves 6-12 x 0.5-1 cm, oblong-lanceolate, apex acuminate, base unequal, rounded, sparsely hairy, scabrid along margins; sheath compressed, striate, ciliate ; ligule membranous, rounded. Inflorescence 8-12 cm long, terminal, contracted panicles; branches distant, erect, with fastigiate branchlets, scabrid, sometimes pilose. Spikelets 2 mm long, gibbous-obovate, laterally compressed, pilose at joints below the glumes; pedicels variable. Lower glume ca. 1 mm long, ovate, acute, 3-nerved; lateral nerves obscure, minutely hairy along the narrow keel. Upper glume ca. 1.5 mm long, ovate, concave, boat-shaped, acute-3-nerved. Lower lemma empty, ca. 2 mm long, broadly ovate, similar to upper glume, 5-nerved, epaleate. Upper lemma bisexual, ca. 1.5 mm long, chartaceous, white, boat-shaped, gibbous with linear, blackish protuberances on the back of rounded apex ; palea narrow. Lodicules 2. |
| Poaceae | *Dactyloctenium aegyptium* | Savehaklu | | Annuals 30-45 cm tall; stem branched, erect, prostrate or ascending, rooting at lower nodes. |

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| | | | | Leaves 3-15 x 0.3-0.5 cm, lanceolate, acuminate, strongly nerved, hispidly ciliate with bulbous-based hairs; sheaths compressed; ligules membranous, ciliolate. Inflorescence terminal, 2-4 spikes, hairy at base, digitately radiating, each 2 x 3 x 0.3-0.5 cm, compressed; rachis stout, trigonous, ending in a pointed tip. Spikelets 3-4 mm long, sessile, 2-5-flowered, all bisexual, densely imbricate, in 2 rows on one side of rachis; rachilla disarticulating above the lower glume. Glumes 2, subequal, keeled. Lower glume 3 mm long, ovate, acute. Upper glume ovate, awned or cuspidate, ca. 4 mm long, including 2 mm long cusp. Lemmas 2-5, all cuspidate, boat-shaped (cymbiform), keeled, hairy along, keel; the lowest ca. 3.5 mm long. Paleas hyaline, 2-keeled. Lodicules 2. |
| Papilionaceae | *Dalbergia horrida* | Devagaru, Induvalli, Kundadri | Anamullu | Climbing shrubs; plants armed with spines on the branches; pods finely pubescent. Petiolule 1-2 mm long. Calyx 2-2.5 mm long, hairy; lobes unequal. Petals 5 emarginate, wings and keels rounded at apex. Pod apex rounded, apiculate, reticulate, and densely hairy. |
| Papilionaceae | *Dalbergia lanceolaria* | Gajanur | M-Cheruveetti | Medium-sized deciduous tree to 16 m tall. Leaves pinnately compound. Standard 6 mm broad, with a callosity at the base of the limb. Petals standard as broad as or broader than long, 6 x 7 mm, emarginate with a callus above the claw; keel small. |
| Papilionaceae | *Dalbergia rubiginosa* | Lingadamuk hi | - | Scandent or straggling shrubs, stems blackish-white, lenticellate, faintly pubescent in juvenile parts. Leaflets 3-5; stamens monadephous; pod long; stalked. Staminal tube split dorsally, alternate filaments long. |
| Solanaceae | *Datura metal* | Sagar | Datturi, Ummatti | Large, erect herbs, branches divaricate. Leaves alternate, paired in upper nodes, 1 smaller, broadly ovate, apex acute, base unequal, rounded, minutely |

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| | | | | pubescent, more along nerves. Flowers solitary, pale purlish-white, erect, axillary. Corolla tube to 16 cm long, funnel-shaped, to 6 cm across near the mouth; lobes 5, acute with a short tail. Capsule with spines. |
| Urticaceae | *Debregeasia longifolia* | Kodachadri, Savehaklu, Hulikal | | Large dioecious or monecious shrubs or small trees, branches pubescent or tomentose. Leaves alternate, elliptic-lanceolate or oblong-lanceolate, serrate, apex acute or acuminate, glaucous, white-tomentose beneath. Flowers minute, greenish-white in axillary, dichotomously branched, cymose heads. Male flowers: sessile, perianth lobes 4, free. Stamens 4. Female flowers: perianth united, tubular, 4-lobed. Achenes orange-yellow, in globose heads of 3-4 mm across, stigma sessile, penicillate, persistent. |
| Orchidaceae | *Dendrobium barbatulum* | Kundadri, Jog, Nagavalli | | Tufted, erect or pendulous herbs; leafless during flowering; stem elongate, often swollen at base; nodes many, 1.5-2.5 cm apart; internodes striate. Flowers 1.5 cm long, white, few, in axillary or terminal racemes ; peduncle to 5 cm long, slender ; pedicels including ovary 1 cm long ; bracts scarious, ovate, acute, 2.5 mm long, 1-nerved. Sepals 3, free, 8 x 3 mm, lanceolate, acute, 5-nerved; dorsal sepal slightly narrower; mentum conical. Petals1.0.5 cm, ovate or obovate, 3-nerved. Lip 1 cm long, 3-lobed; lateral lobes 3-5 x 2 mm; midlobe 10 x 4 mm, obovate, yellowish-hairy towards base. Column short. Anther 1, 2-celled, pale yellow; pollinia 4; caudicle absent. Stigmatic surface broadly obovate-orbicular. Flowering: November-January. |
| Orchidaceae | *Dendrobium macrostachyum* | Nagara | | Epiphytic herbs ; stem pendulous, slender, simple, arising in tufts from pseuduobulbous base ; leafy stem short, to 6 cm long. Leaves 4-6 x 0.6-1 cm, sessile, narrowly lanceolate oroblong-lanceolate, |

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| | | | | apex acute, prominently 5-nerved; sheaths overlapping. Flowers 1.5-2 cm long, yellowish, solitary or in 2-3-flowered cymes, on 3-4 mm long, peduncle ; pedicels including ovary 12-15 mm long ; bracts 2-3 mm long, membranous, ovate, acute, 1-nerved. Sepals 3, free, 12-14 x 2.5-3 mm, oblong-lanceolate, 5-nerved; lateral sepals slightly longer, produced below with the column-foot into a mentum. Petals more or less similar to sepals. Lip 12-17 x 12 mm, 3-lobed; lateral lobes small, rounded, embracing the column; midlobe large, ovate or oblong, with fimbriate, ciliate margin; disc 3-nerved, yellowish-hairy. Anther 1, 2-celled; pollinia 4, sessile. Stigmatic surface ovoid, pale green. |
| Urticaceae | *Dendrocnide sinuata* | Hulikal | | Dioecious shrubs or undershrubs, internodes hollow, stinging hairs prominent only on petiole and peduncle. Leaves alternate, elliptic or elliptic-oblong, entire or crenulated, apex obtusely acute or shortly acuminate. Female flowers greenish-white, in axillary, lax paniculate cymes. Perianth lobes, 4, subequal, connate. Achene compressed, warted. |
| Loranthaceae | *Dendrophthoe falcata* | Humcha, Hulikal, Sagar | | Parasitic, bushy shrubs, stem terete, glabrous. Leaves opposite, sessile, coriaceous, ovate or oblong, apex obtuse, base cordate and amplexicaul. Flowers in axillary or lateral. Calyx 4 mm long, truncate; teeth obscure. Corolla 5-lobed, red, orange or white; tube 3-4 cm long, recurved, hairy within. |
| Loranthaceae | *Dendrophthoe pubescens* | Tagarthi | | Parasitic shrubs; branchlets terete, glabrous. Leaves alternate, coriaceous, elliptic, base acute; petiole 5-10 mm long. Flowers in axillary unilateral racemes; pedicels 4-5 mm long, bracts 2-3 mm long, ovate, oblique, cupular below the calyx peduncle, pedicel bract, calyx and corolla in bud hoary-pubescent. Calyx tubular |

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| | | | | shortly 5-toothed. Corolla 5-lobed; tube ca. 2.5 cm long, broadened above the middle, slightly curved whitish. Stamens 5, inserted at corolla throat; filaments 5 mm long, hairy upwards; anthers linear, 3 mm long. Ovary inferior 1-loculed, style exserted; stigma capitate. |
| Papilionaceae | *Derris brevipes* | Sampekatte | | Large, woody, climbers. Branches glabrous, lenticellate. Leaves alternate, pinnately compound. Pod persistently brown-silky, Rachis 5-10 cm long, striate. Pods inflated, narrowly winged along 1-suture; pericarp brown-tomentose; cotyledons massive. |
| Papilionaceae | *Derris scandens* | Kargal, Kattinakere | | Large climbing shrubs, stem reddish, lenticellate, branchlets pubescent. Leaves pinnately compound, alternate. Leaflets 5-19; pods narrow, ligulate, 1-4-seeded. Petals standard 4-6 mm long, winged and keels ciliate above the claw. Staminal filaments unequal. Stamens 10, monadelphous. Pods winged along one suture, turgid and reticulate against the seed, adpressed-pubescent. |
| Papilionaceae | *Desmodium alysicarpoides* | Nagara fort | | Herbaceous; pods indehiscent; leaves 1-and trifoliate intermixed. Pod flat, 4-6 segmented, indented more along lower suture; joints reticulate, pubescent when young. |
| Papilionaceae | *Desmodium heterocarpon* | Hulikal Ghat | M-Nilathuvara | Erect or suberect, woody, undershrubs, 1.5 m tall. Leaves 3-foliolate, Flowers pinkish in densely axillary or terminal racemes. Pods with reticulate joints; joints as broad as long. |
| Papilionaceae | *Desmodium heterophyllum* | Jog | | Much branched trailing herbs rooting at lowers nodes, stem with dense, spreading hairs. Leaves 3-foliolate. Flowers both 1-3 together axillary and 2-6 in small lax racemes; pedicels more than 1 cm long. |
| Papilionaceae | *Desmodium laxiflorum* | Kodachadri | | Erect branched undershrubs, stem quadrangular, densely adpressed-pubescent. Leaves pinnately 3-foliolate, alternate. Bracts not concealing the flowers; pods 25-50 mm long; 10 jointed. Calyx |

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| | | | | teeth longer than the tube. Petals wings and keels bluish. Pod 1 cm long, linear, scarcely constricted, hairy; hairs white, hooked. |
| Papilionaceae | *Desmodium triangulare* | Sampekatte, Savehaklu, Kundadri | | Erect undershrubs or shrubs, branches triquetrous, adpressed-hairy, internodes zig-zag. Leaves pinnately 3-foliolate. Flowers creamy-white, in short axillary pedunculate racemes. Leaflets 4-10 x 2-4.5 cm. Pods 1.5 x 0.3 cm, oblong, indented on both sutures, adpressed-pubescent. |
| Papilionaceae | *Desmodium triflorum* | Chakra, Hulikal | M-Nilamparanda | Trailing or prostrate herbs, branches slender, rooting at nodes, hirsute with long. Leaves 3-foliolate, alternate. Flowers all axillary, 1-3 together; pedicels less than 1 cm long. Keel petals longer than wings. |
| Papilionacea | *Desmodium triquetrum* | Chakra, Devagaru | M-Adakkapanel | Erect undershrubs, stem triquetrous, hairy along angles.Leaves 1-foliolate; petioles broadly winged. Flowers in terminal or axillary racemes. Pods oblong, flate, 6-8-jointed, indented on 1 suture, pubescent. |
| Annonaceae | *Desmos lawii* | Hulical, Yedur, Jog | | Large straggling shrubs, branchlets blackish, hairy, lenticellate. Leaves elliptic-oblong. Peduncle extra-axillary or leaf-opposed. |
| Cucurbitaceae | *Dicaelospermum ritchiei* | Kodachadri hills | - | Slender rigid climbers, tendril axillary, simple, faintly striate, stem scabrid, with recurved prickles. Leaves alternate, ovate-hastate. Fruit ovoid, umbilicate, dry, blackish-brown when mature, white-streaked, 1-celled, in axillary, sessile clusters. |
| Dichapetalaceae | *Dichapetalum gelonioides* | Yedur, Sampekatte, Nittur, Jog | | Large shrubs or small trees, to 5 m tall, branches minutely pubescent. Leaves transversely oblong; drupt with soft grey epicarp, scarlet fleshy mesocarp; fleshy cotyledons. Flowers unisexual or polygamous, few, in axillary or extra-axillary or terminal cymes. Drupe oblong or obcordate, compressed, bilobed, greyish-pubescent, transversely rugose. |
| Asteraceae | *Dichrocephala integrifolia* | Hulikal | | Annual, branched, procumbent herbs, rooting at lowers nodes, |

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| | | | | stem hairy. Leaves alternate, shortly petioled, lyrate or entire, ovate, serrate-crenate, hairy. Heads 5 mm across, heterogamous, orange-yellow in axillary or terminal loose panicles. Involucral bracts biseriate. Ray florets female, numerous, without or with deciduous pappus. Corolla tube slender, ca. 0.5 mm long, 2-3-toothed above. Disc florets bisexual, with pappus of 4-5 bristles. |
| Acanthaceae | *Dicliptera zeylanica* | Induvalli | | Slender, branched, subscandent herbs or undershrubs, branches more or less, 4-6-angled. Leaves opposite, ovate or elliptic-glabrous and slightly scabrid above. Flowers purplish, sessile in clustera of 1-3 of which 1 fertile. Capsule compressed, glandular-pubescent, 4-seeded, seeds suborbicular, compressed, glochidiate-tubercled at margin. |
| Commelinaceae | *Dictyospermum montanum* | Hulikal | | Subscandent herbs with long adventitious roots. Leaves alternate, aggregated upwards, elliptic-lanceolate, pubescent beneath. Flowers irregular, white in terminal lax panicles. Capsule 2-celled, globose, white, seeds oblong, rugose. |
| Commelinaceae | *Dictyospermum ovalifolium* | Hulikal,Ten kbail | | Erect or suberect herbs, stem stout, glabrous, with long internodes below, rooting from lower nodes. Leaves alternate, elliptic-oblong or elliptic-lanceolate, apex acuminate. Capsule subglobose 3-celled, white, in terminal panicles, dichotomously branched pubescent, fruiting pedicels 5-6 mm long, decurved, bracts ovate caduceus, seed 1 in each cell. |
| Commelinaceae | *Dictyospermum scaberrimum* | Hulikal | | Scandent herbs, rooting at nodes. Leaves base rounded or narrowed into short petiole, hispid above, pubescent beneath; sheath 2-2.5 cm long, loose, hispid; mouth ciliate. Petals 3, free, 5 x 3 mm, obovate, shortly clawed, hairy. Fertile stamens usually 3; filaments long, glabrous; anthers |

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| | | | | 2-celled, bluish; staminodes 2-3, with short, slender, hairy filaments and 2 globose sterile, yellowish anther lobes. |
| Poaceae | *Digitaria ciliaris* | Savehaklu | | Annual grass; stem ca. 10 mm long, tufted, usually ascending from prostrate base. Leaves ca. 0.3 cm or more, flat, lanceolate, scabrid along margins, glabrous or sparsely hairy at contracted and rounded base ; sheaths glabrous or with tubercle-based hairs ; ligules truncate, membranous. Inflorescence digitately 2-3-branched spikes, on slender, 5-10 cm long peduncle; rachis of spike 5-7 cm long, triquetrous, narrowly winged. Spikelets 3-3.5 mm long, oblong-lanceolate, adpressed, mostly paired on unequal pedicels, longer pedicels 2 mm, angular. Lower glumes less than 0.5 mm long, ovate-orbicular. Upper glumes equalling the spikelets or slightly shorter, lanceolate, 3-nerved, with long hairs between the nerves and margin. Lower lemma equalling the spikelets, 5-7-nerves, hairy, empty. Upper lemma subchartaceous, 3-nerved; palea equal to lemma. Lodicules 2. |
| Poaceae | *Digitaria longiflora* | Nagara, Bileshvara | | Tufted grass; stem slender, ascending or suberect, rooting at lower nodes. Leaves 1-2 x 0.2-0.4 cm, linear-lanceolate, acute, glabrous; sheath compressed; ligule ca. 1 mm long, membranous. Inflorescence terminal, digitately spreading paired racemes; rachis ca. 2.5 cm long, flat, with winged margins. Spikelets to 2 mm long, elliptic-oblong, usually in pairs, one short and the other long pedicelled articulated at the top of pedicel, adpressed on one side of rachis. Lower glume absent. Upper glume 2 mm long, 7-nerved, silky-hairy. Lower lemma similar to upper glume, 7-nerved, empty. Upper lemma slightly shorter than glumes, 1.8 mm long, elliptic, acute, subcharataceous, obscurely |

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| | | | | striate, margins incurved; palea similar to lemma, striate, without keels, with 2 infolded flaps at base. |
| Poaceae | *Digitaria ternata* | Nagara | | Annual, erect, tufted grass, to 15 cm tall; stem erect or decumbent below. Leaves 2-3 x 0.2-0.5 cm or larger, lanceolate, acute, base rounded, glabrous or sparsely hairy; sheath striate; mouth ciliate ; ligule membranous. Inflorescence of terminal racemes 2-7 (2 in our specimens), each ca. 3 cm long, erect or spreading, subdigitate on a common, 6-9 cm long axis; rachis slender, narrowly winged. Spikelets 2.5-2.8 mm long, elliptic-oblong, acute-apiculate, adpressed to rachis in pairs; pedicels unequal, tip cupuliform with hairs on rim and below. Lower glume absent. Upper glume membranous, 3-nerved, sides villous with clavate hairs. Lower lemma empty, similar to upper glume, 5-nerved, villous, epaleate. Upper lemma ca. 2 mm long, ovate-oblong, chartaceous, acute, dark brown, sides infolded, 3-nerved; palea similar to lemma with slightly folded margin. Lodicules 2. |
| Dilleniaceae | *Dillenia pentagyna* | Yedur | K- Kadu kanigala, Madathega. | Deciduous trees, 12 m tall, bark blackish. Leaves larger, crowded at the ends of te branchlets. Flowers yellow, clustered on nodes of the old wood, 2.5 cm across appearing before the leaves; leaves often 2 ft long. Defoliate during January - February. |
| Sapindaceae | *Dimocarpus longan* | Hulikal, Nagodi, Chakra, Savehaklu | M- Malampoovathi | Small trees, to 9 m tall, branches lenticellate. Leaves alternate, paripinnate. Flowers unisexual, whitish, in axillary or terminal panicles. Fruit a schizocarp with 1-2 cocci. |
| Euphorbiaceae | *Dimorphocalyx lawianus* | Hulikal | | Small, glabrous trees. Leaves alternate, subcoriaceous, elliptic-lanceolate or ovate-oblong, stipules small, triangular. Flowers greenish-white, monecious, bracteates. Male flower; solitary or fascicled on woody stem, 7-8 |

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| | | | | mm long; pedicels ca. 5 mm long. Calyx united, cup-like, 3-4 mm long; lobes 5, obscure or rounded, erect. Petals 5, free, erect ca. 7 x 2 mm, oblong, obtuse, imbricate. Disc of 5 glandular scales. Stamens 10, in 2 whorls, sometimes with an odd stamen in the centre; filaments unequal, those of the outer ca. 3.5 mm long, connate at base, of inner ca. 5 mm long, united into a column with short free portion; anthers 2-celled; connective cymes; pedicels 1-1.2 cm long. Calyx 5-lobed, divided almost to the base; lobes ca. 8 x 2 mm, oblong, obtuse or emarginate, greenish, enlarged in fruits, unequal, spreading. Petals 5, free, white, shorter than calyx, erect. Disc annular, hairy. Ovary densely hairy, 3-locular; ovules 1 ineach locule; styles 3, connate at base, apex bifid. |
| Dioscoreaceae | *Dioscorea bulbifera* | Between Sagar and Anandapura | M-Kaatukachil | Large, dioecious climbing shrubs, Stem unarmed; leaf base cordate; leaves alternate, broadly ovate, apex cuspidate-acuminate, base deeply cordate. Male flowers minute, sessile, in axillary pendulous, panicled spikes, bracts ovate, acuminate. Perianth 6-lobed, in 2 whorls, connate. Stamens 6. |
| Dioscoreaceae | *Dioscorea oppositifolia* | Bileshvara, Nagara, Yedur | | Large, dioecious, climibing shrubs, stem teret, twining to right, glabrous or pubescent. Leaves lanceolate to elliptic-oblong, acute or rounded at base; Stems neither winged nor conspicuously angled. |
| Dioscoreaceae | *Dioscorea wallichii* | Nagodi | | Large, prickly, dioecious twiners, Stems twining to the right; bulbils absent; leaves and stems glabrous. Male flowers globose, in axillary panicles, peduncle tomentose. Perianth lobes 6, connate. Stamens small, 3 fertile, staminodes 3, anthers small, globose. |
| Ebenaceae | *Diospyros angustifolia* | Yedur, Hulikal | - | Trees, branchlets fulvous-pubescent. Leaf blade elliptic-lanceolate, acute at apex, cuneate |

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| | | | | at base. Inflorescence of 1-3-flowered clusters, subsessile. Flowers 3-merous. Calyx lobes ovate, acute, hairy. Corolla white, hairy. Stamens 6-9, pistillode. Ovary 3-celled, hairy. Berry ellipsoid with persistent style. |
| Ebenaceae | *Diospyros candolleana* | Yedur | Kare mara | Trees branchlets glabrescent. Leaves more than 5 x 2.5 cm. Corolla 5-lobed; calyx distinctly lobed; fruit globose, seated on the cup-shaped, enlarged calyx. Corolla lobes 5, 7-10 mm long, tubular, tomentose without. |
| Ebenaceae | *Diospyros malabarica* | Jog | Holetupare | Rtees with spreading branches. Leaf blade oblong-lanceolate, obtuse or acute, coriaceous. Inflorescence 1-many-flowered cyme. Flowers 4-merous. Male flowers 3 - 6 in pedunculate cymes. Female flowers larger than in male. |
| Ebenaceae | *Diospyros montana* | Between Kargal and Jog | Balagunike | Trees. Petiole to 1 cm long. Leaf blade elliptic-oblong or obovate, obtusely acute or acuminate at apex, rounded or subcordate at base. Male flowers in cymes, pubescent, female solitary. Flowers 4-merous. Calyx lobes ovate in male, oblong in female. Corolla greenish-white, glabrescent, urceolate. Stamens 12-16 in subequal pairs, connate at base of corolla. Pistillode present. Ovary 8-celled. Berry globose. |
| Ebenaceae | *Diospyros oocarpa* | Nagodi | - | Trees. Petiole to 1 cm long, leaf blade elliptic or ovate-lanceolatee, bluntly acute or acuminate at apex, acute at base. Male flowers shortly pedicelled. Female flowers 1 - 3 together, larger than male.Fruit ellipsoid with truncate persistent calyx. |
| Ebenaceae | *Diospyros pruriens* | Hulikal | - | Trees. Leaves oblong-lanceolate or oblanceolate, acuminate, sub-cordate. Inflorescence of 3 male flowers in cymes, female flowers solitary. Flowers 4-merous. Calyx lobes linear. Corolla silky-hairy without, glabrous within. Stamens 13-14. Ovary 4-celled. Fruit ovate, bristly hairy. Fruiting calyx lobes linear. |

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| Ebenaceae | *Diospyros saldanhae* | Nagodi | - | Trees. Branchlets with soft hirsute hairs intermixed with bristles. Leaves subsessile, oblong-ovate, acute, rounded or subcordate at base, glabrous above, sparsely hirsute beneath, with prominent reticulation. Female flowers in clusters of 1-3. Fruits sessile or subsessile, ovate, bristly hairy. |
| Orchidaceae | *Diplocentrum congestum* | Savehaklu | | Epiphytic herbs; stem condensed, 1-1.5 cm long. Leaves 3-6 x 0.6-1cm, distichous, coriaceous, linear-oblong, apex unequally 2-lobed; lobes nearly rounded; slightly narrowed at base, jointed with imbricate sheaths. Flowers 6-8 mm long, yellowish-white, in lateral, many-flowered racemes; peduncle 6-10 cm long, straight, simple or few branched at base, arising from below the leaves onthe stem; pedicels including ovary 2.5-3 mm long, slightly curved; bracts ca.1 mm long, broadly ovate, acute. Sepals 3, free, ca. 3 x 1.5 mm, oblong, spreading; lateral sepals slightly larger and falcate. Petals ca. 2.5 x 1 mm, slightly shorter than sepals. Lip 4-5 mm long, pinkish-white, sessile broad and produced at base into 2 spurs; spur 2-3 mm long, oblong, rounded, slightly divergent. Column short, 2-auricled; disc fleshy. Stamen 1 anther 2-celled; pollinia 2; caudicle broad, membranous. Flowering: June. |
| Menispermaceae | *Diploclisia glaucescens* | Nagodi, Hulical, Savehaklu | M-Vattoli | Large, woody, dioecious climbers, branches striate and minutely pubescent. Leaves broader than long, alternate, ovate or sub-ordicular, apex obtuse; flowers yellow; drupe red, laterally compressed. |
| Scrophulariaceae | *Dopatrium junceum* | Hosagadde | | Slender, erect slightly succulent herbs, to 20 cm tall, Stem with few erect branches from base; internodes long above, rooting from lower nodes. Flowers lower sessile; upper pedicellate; pedicels 4-5 mm long, filiform; bracteoles absent. Calyx 1-1.5 |

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| | | | | mm long, divided to the middle; lobes oblong, obtuse. Corolla 2-lipped, 4-5 mm long. |
| Liliaceae | *Dracaena terniflora* | Hulikal,Chakra,Yedur | | Erect, unbranched shrubs, 1-1.5 m tall. Leaves spirally clustered near the apex, lanceolate or elliptiv-oblong. Flowers greenish-white, in terminal racemes, peduncle to 16 cm long, cataphyllous at base. Perianth united. Fruit globose or 2-3-lobed, orange, turning black. |
| Droseraceae | *Drosera burmannii* | Hulikal | - | Acaulescent herbs, to 15 cm, with a basal rosette of obovate or orbicular, stipules leave. Scape terminal, circinate few-many-flowered. Leaves round-spathulate, all in basal rosette. Leaves in a rosette, ca. 2.5 cm across, reddish, petiole flat. |
| Droseraceae | *Drosera indica* | Nagara, Sampekatte, Talaguppa | - | Slender, caulescent herbs to 20 cm with glandular-hairy stem. Leaves linear, alternate, cauline, estipulate. Inflorescence leaf-opposed. Flowers pink. Sepals 5, acute; petals pink, obovate. |
| Papilionaceae | *Dunbaria heynei* | Hulikal, Devagaru | | Twining herbs stem ribbed and clothed with spreading hairs. Leaves pinnately 3-foliolate. Flowers 1.5-2.5 cm long, pedicels 5-10 mm long. |
| Meliaceae | *Dysoxylum binecatariferum* | Jog | - | Small to medium-sized trees, to 15 m tall. Leaves pinnately compound. Calyx cup shaped, nearly half the length of the petals; leaflets reticulately nerved; ovary 3 -5 celled; capsule reddish. |
| Acanthaceae | *Ecbolium viride* | Hulikal | | Erect undershrubs or shrubs, 1-1.5 m tall, stem swollen and compressed at nodes. Leaves elliptic or ovate-elliptic, apex acute or acuminate, base cuneate, ciliate when young, greenish when dry. Capsule compressed, long-stalked. |
| Poaceae | *Echinochloa colonum* | Bileshvara | | Annual grass; stem shortly creeping below; branches erect or ascending; nodes glabrous or puberulous. Leaves 3-8 x 0.3-0.5 cm or more, linear-lanceolate, acuminate, base rounded, glabrous; sheath compressed, narrowed above, sharply keeled; ligule absent. Inflorescence of |

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| | | | | terminal panicles with 5 or more, suberect, distant racemes; peduncle slender, angular, 3-5 cm long; rachis of raceme 6-10 mm long. Spikelets 2.5-3 mm long; ovoid, shortly pedicellate. Lower glume 1 mm long, broadly ovate, or orbicular, acute or acuminate, 3-nerved, pubescent. Upper glume 2.5-3 mm long, as long as lower lemma, concave, cuspidate, 5-nerved, hispidulous, ciliate. Lower lemma empty, more or less similar and equal to upper glume, 5-nerved; its palea hyaline oblong. Upper lemma bisexual, 2 mm long, broadly ovate, turgid, boat-shaped, coriaceous, shining; palea oblong, obtuse. Lodicules 2. Stamens 3. Styles 2, free; stigmas plumose. |
| Asteraceae | *Eclipta prostrata* | Nittur, Chakra, Sorab | M-Kayyunni | Erect or suberect herbs with procumbent branches often rooting at nodes, stem reddish. Leaves opposite, subsessile, elliptic-lanceolate, distantly serrate, apex acute, base rounded or acute, adpressed-strigose as on the stem. Heads 5-8 mm across, heterogamous white, axillary or terminal, peduncled, solitary or paired, involucral bracts 8, greenish, biseriate, each 4-6 mm long. Ray florets female, numerous, ligulate; tube short, minutely hairy. Disc florets bisexual, few, paleaceous; paleae bristle-like. |
| Ehretiaceae | *Ehretia canarensis* | Sampekatte, Kargal | | Shrubs or small trees to 7 m tall, branchlets glabrous or pubescent, lenticellate. Leaves alternate, margin more or less recurved. Flowers white, in axillary or terminal dichotomonusly. |
| Elaeagnaceae | *Elaeagnus conferta* | Hulikal, Kundadri | | Scandent shrubs, often thorny at base, branchlets. Leaves alternate, elliptic-oblong, ovate-oblong or obovate, apex obtuse or acute, base rounded pr acute, midrib impressed above. Flowers sessile, in axillary clusters, covered with silvery-white and rusty scales. |
| Elaeocarpaceae | *Elaeocarpus serratus* | Sampekatte, Hulical, Jog | M-Karamavu, K-Beejada | Small trees, to 10 m tall, branchlets often pubescent. |

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| | | | mara. | Leaves alternate, elliptic or obovate, serrate, glandular at each serration. Anthers not terminated by an awn; anthers bearded; filaments short, straight; stone 2-celled, 2-seeded. Drupe 1-3 celled. |
| Elaeocarpaceae | *Elaeocarpus tuberculatus* | Yedur, Nagavalli | K- Dandele mara, E-Deccan Olive. | Large trees with buttressed trunks. Leaves more than 5 cm broad; clustered at ends of branches, petioles, obovate, glabrous, obtuse, retuse or slightly acute at apex. Racemes in axils of fallen leaves shorter than blades. Flowers facing downwards, over 2 - 2.5 cm across. Sepals linear-lanceolate. Petals with silky hairs on outer side, white. Anthers prominently aristate. Ovary sericeo-tomentose. Drupe oblong, smooth. |
| Urticaceae | *Elatostemma lineolatum* | Hulikal, Kodachadri base, Jog | | Erect herbs, stem angular, pubescent. Leaves alternate, membranous, sessile or subsessile, lanceolate, coarsely serrate-crenate above the middle. Flowers unisexual, crowded on sessile or shortly peduncled receptacles; receptacle 6-8 mm across. Cystoliths very crowded and conspicuous. |
| Cyperaceae | *Eleocharis geniculata* | Tenkbail | | Annual, erect herbs, ca.12 cm tall; stem slender, tufted, often leaf-like. Leaves reduced, triangular, membranous above the sheath. Spikelets ca. 5 x 3 mm, solitary, globose or ovoid, head-like, terminal to erect peduncle; bracts ca. 3.5 x 2 mm, many, involucral, membranous, ovate-oblong, apex obtuse. Glumes bract-like, spiral, orbicular-ovate, obtuse at apex, obscurely keeled or 3-nerved, lower empty, upper mostly fertile, bisexual. Fertile glumes with a pair of hypogynous bristles. Stamens 2; filaments short; anthers 2-celled, linear. Ovary flattened; style ca. 2 mm long, flat and broad at either ends; stigma 2-3-lobed, white-hairy. |
| Asteraceae | *Elephantopus scaber* | Chakra | Nelamuchhilu | Rigid herbs, root-stock short, stem subscapigerous, dichotomously branched, |

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| | | | | adpressed-strigose. Leaves mostly radical, rosette-loke, few ciliate, apex acute or rounded, tapering at base, hairy, glandular beneath. Heads homogamous, discoid 2-5 floweres. Pappus of 5 linear bristles, dilated at base. Corolla 8 mm long, purplish; tube narrow. |
| Poaceae | *Eleusine indica* | Nagara | | Erect, tufted herbs, 15 cm or more tall; stem slightly compressed. Leaves 12 cm long or longer, distichous, linear, acuminate, folded; sheath compressed; ligule short, membranous, hairy. Spikes 2-3 (or to 9) in terminal, sessile, umbellate whorls, each 3 x 0.6 cm, secund, compressed; rachis flattened. Spikelets 5 mm long, 3-6-flowered, ovoid, pointing forwards, in 2 rows on rachis. Glumes membranous, unequal, lower ca. 3 mm long, lanceolate, 1-nerved; upper slightly longer, ovate acute or apiculate, 3-7-nerved and keeled. Lemmas 3 mm long, ovate, glume-like, membranous; palea 2-keeled, ca. 2 mm long, Lodicules minute. Stamens 3. Styles 2, feathery. Caryopsis 2-2.5 x 1-1.5 mm, trigonous, faintly striate. |
| Apocynaceae | *Ellertonia rheedii* | Hulikal, Kaimara | | Climibing shrubs, branches reddish, white-lenticellate. Leaves 3-4-nately whorled, ovate or elliptic, apex acute or shortly acuminate, base acute. Flowers white, in terminal branched cymes. Corolla tube slender, inflated at the middle, reddish in bud; Stamens included filaments short. Follicles paired, divaricate, cylindric, arched. |
| Myrsinaceae | *Embelia ribes* | Hulikal | - | Scandent shrubs, stem with large tubercles at base. Leaves elliptic to oblanceolate, acute, entire. Inflorescence usually paniculate, minutely grey-pubescent. Flowers polygamous. Sepals hairy. Drupe. Associated with Calicarpa tomentosa (L.) Murray., Leea indica (Burm. f.) Merr |
| Myrsinaceae | *Embelia tsjeriam-cottam* | Bileshvara and Nagara | Vaayu vidanga | Small, much branched trees, stem dark brownish, marked by scars of fallen leaves. Leaves alternate, |

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| | | | | coriaceous, obovate, apex obtuse, apex obtuse or emearginate, narrowed at base. Flowers subsessile, spiral, in racemes clusters. Corolla lobes 5, free almost to the base, glandular without along the margin, papillose within. Stamens equal and opposite corolla lobes; filaments short, inserted on corolla at base. |
| Asteraceae | *Emilia exserta* | Nagara fort | | Suberect herbs with ascending branches. Leaves alternate, variable, lower lyrate, ending a large reniform or ovate terminal segment.heads 1-1.2 cm across, discoid, homogamous, solitary or 2-3 corymose, slender peduncled, axillary or terminal. Achenes narrow, 5-angled, pubescent along the angles. |
| Musaceae | *Ensete superbum* | Hulikal, Varahi | | Erect massive herbs, pseudostem 3-4 m tall, swollen at base, not stoloniferous. Leaves apex acute, narrowed to the base, petiole short. Inflorescence a terminal decurved spike with interrupted flower clusters. Flowers 20-30, in 2 rows, spathaceouslu split on on one side. Berries trigonous, seeds many angular. |
| Mimosaceae | *Entada pusaetha* | Sampekatte | | Large woody climbing shrubs, cirrhiferous. Leaves bipinnately compound, rachis 8 cm long, ending in a bifid tendril, grooved above. Flowers yellow, Rachis to 8 cm long, ending in a bifid tendril, grooved above. Pinnae 2 pairs, to 9 cm long. |
| Euphorbiaceae | *Epiprinus mallotiformis* | Hulikal | | Monoecious trees or large shrubs, to 8 m tall, young parts stellate-pubescent. Leaves alternate, elliptic or elliptic-oblong apex acute or shortly acuminate, base acute. Flowers small, in axillary or terminal, interrupted spikes. Blade elliptic. Calyx in male splitting into 4, subequal glabrous lobes, in female 6, unequal hairy. Capsule obovate, scabrous, seeds 3. |
| Gesneriaceae | *Epithema carnosum* | Hulikal | | Small succulent herbs, sometimes epiphytic, stems long, slightly branched, erect, sparsely hirsute. |

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| | | | | Leaves few, alternate or opposite, sessile or petiole, nearly as broad as long, broadly elliptic or ovate, obtuse or acute at apex. Flowers small, bluish, in dense, pedunculate, terminal or axillary scorpoid cymes, peduncles solitary, confluent with the petiole or leaf-base. Capsules membranous, globose, enclosed in the persistent calyx. |
| Poaceae | *Eragrostis atrovirens* | Nagara | | Perennial, tufted grass, stem slender, glabrous. Leaves strongly nerved; sheaths glabrous; ligule obscure. Inflorescence terminal panicle, 20 cm long or more; branches and branchlets slender, stright, spreading, scabrid. Spikelets 5-12 x 0.2-0.25 cm, linear-oblong, compressed, white, turning yellowish when dry; rachilla zig-zag. Glumes unequal, ovate, acute, 1-nerved, ca. 2 mm long. Lemmas many, distichous, 2 x 2 mm, broadly ovate, acute, 3-nerved, minutely ciliate, deciduous ; paleas 2 mm long, broad, 2-keeled, ciliate or scabrid along keels, sub-persistent, not deciduous with lemmas. Lodicules minute or absent. Stamens 3. Styles 2; stigmas plumose. Caryopsis 0.5-1 mm long. oblong or ovoid, compressed, brownish, faintly longitudinally rugose or tubercled. |
| Poaceae | *Eragrostis japonica* | Jog | | Perennial, erect grass, ca.1 m tall. Leaves ca. 30 x 0.3 cm, lanceolate, apex acuminate, striped; sheath striped; ligule a ridge of minute hairs. Spikelets in terminal ca. 30 cm long, scabrid panicles; branches in interrupted whorls, erect or erecto-patent with numerous branchlets. Spikelets ca. 2 mm long, ovate-lanceolate or linear, few-flowered; pedicels ca. 2 mm long. Glumes less than 1 mm long, ovate, obtuse. Lemmas 2-4, lanceolate, obtuse; nerves slender. Palea keeled. Stamens 2. |
| Poaceae | *Eragrostis* | Bileshvara | | Tufted annual grass, 12 cm tall; |

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| | *santapaui* | | | stem slender; nodes glabrous. Leaves 2.5 cm long or longer, linear, acute, usually pilose above, especially towards base, glabrous beneath; sheaths bearded at mouth; ligule a pubescent ridge. Inflorescence terminal panicle, to 20 cm long; peduncle glabrous, except bearded branch axils. Spikelets 5-6 x 2-2.5 mm, oblong, compressed; pedicels 1-2 mm long; rachilla persistent. Glumes 2, ovate-lanceolate, acute,1-nerved; lower 1-1.5 mm long; upper ca. 3 mm long. Lemmas many, alternate, distichous, breaking up from base above, each 2 mm long, ovate, subacute, 3-nerved; paleaa 1.5 mm long, oblong, curved not separating with lemma, 2-keeled at sides, scabrid along keels. Lodicules 2. Stamens 3. Caryopsis 0.5-0.8 mm long, ovoid or oblong, slightly compressed, base laterally apiculate, brownish, minutely tubercled or rugose. |
| Poaceae | *Eragrostis tenuifolia* | Nagara | | Perennial, tufted grass, 40-50 cm tall; rhizome short; stem erect, slender. Leaves 3-20 x 0.2-0.3 cm, linear; sheaths glabrous; ligule obscure or of a hairy rim. Inflorescence terminal panicle, to 20 cm long; branches spreading, slender, distant, solitary or in pairs; axils of branches and branchlets often with hairy brownish glands; branchlets (pedicels) with glandular bands. Spikelets 8-19 x 1.5-2 mm, compressed, 5-15-flowered, breaking up from below upwards; rachilla persistent. Glumes unequal, nerveless; lower ca.1 mm long, narrowly oblong, acute; upper ca. 1.5 mm long, truncate or acute or apex. Lemmas distichous, each 2.5-3 mm long, ovate, acute, greenish; lateral nerves obscure, deciduous. Paleas 1.5-2 mm long, 2-keeled, scabrid on keels, persistent. Stamens 3, styles2; stigmas plumose, whitish. Caryopsis 1.2-1.5 x 0.5-0.6 mm, |

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| | | | | oblong, brownish, compressed, dorsally grooved. |
| Poaceae | *Eragrostis unioloides* | Bileshvara | | Erect, annual, tufted grass, to 60 cm tall; rhizome short; stem slender, geniculately ascending. Leaves 5-15 x 0.3-0.4 cm, lower shorter, linear-lanceolate, acute prominently nerved, glabrous; sheaths striate, ligules obscure or a narrow, ciliate membrane. Inflorescence terminal, slender panicle, to 25 cm long; branches filiform, scabrid, often spreading, with terminal spikelets. Spikelet 4-6 x 2.5-3 mm, green to purplish-red, ovate or ovate-oblong, compressed, with distichous flowers; rachilla zig-zag. Flowers many, shortly pedicelled. Glumes 2, unequal; lower glume 1-1.5 mm long, narrowly keeled and 1-nerved; upperglume ca. 2.5 mm long, sometimes 3-nerved, deciduous. Lemmas many, fertile, bisexual, imbricate, 2-2.5 mm, long, broadly ovate, acute, punctate, 3-nerved; paleas 2-keeled, deciduous with lemmas. Stamens 3; anthers 2-celled, short. Styles 2; stigmas plumose. Caryopsis 0.5-0.8 mm long, ellipsoid, compressed. |
| Orchidaceae | *Eria dalzelli* | Sampekatte | | Epiphytic herbs, pseudobulbs 7-10 mm across, discoid, nerves fan-like. Leaves 2-5, usually 2 to each pseudobulb, margin minutely papilose, apex obtuse. Racemes arising between the leaves, flowers second or subsecund. Capsule oblong or obovate, faintly ribbed. |
| Orchidaceae | *Eria mysorensis* | Hosagadde | | Epiphytic herbs, pseudobulbs 3 cm long, ovoid. Leaves 4-5 at the top of pseudobulb, lower 2 smaller, each 10-15 x 1.8-2 cm, oblong-lanceolate, apex acute, base tapering. Flowers yellow, in axillary racemes ; peduncle 6-10 m long, slender, densely hairy ; pedicels including ovary to 10 mm long ; bracts 10 x 2 mm, elliptic-lanceolate, 3-nerved, unequal, dorsal longer. Petals |

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| | | | | little shorter than sepals, lanceolate, 2-nerved. Lip oblong, constricted at middle, 3-lobed; lateral lobes narrow. Staminal column short, at right angles to foot. Anthers 2-celled; pollinia 8, in 2 groups of 4, with slender membranous caudicle. Ovary to 5 mm long, sparsely hairy. |
| Tiliaceae | *Erinocarpus nimmonii* | Gajanur | Kadve bende | Deciduous trees, to 13 m tall, bark fibrous, branchlets stellately-pubescent. Leaves suborbicular, cordate, glandular-dentate, nearly glabrous above, stellate-pubescent beneath. Flowers yellow, inflorescence lax panicles. Tree is associated with Tectona grandis L. |
| Eriocaulaceae | *Eriocaulon cuspidatum* | Hosagadde | | Marshy, erect herbs, stem condensed, discoid. Leaf apex rounded and cuspidate; male petals equal or subequal, never produced beyond the floral bracts. Scapes 1-many togehter, each 15-30 cm long, grooved; sheath to 10 cm long, obliquely split. Male flowers ca. 1.5 mm long. Female flowers 1.5-2 mm long |
| Eriocaulaceae | *Eriocaulon odoratum* | Between Hosnagar and Humcha | | Tufted, erect herbs to 9 cm tall, stem condensed. Leaves basal, linear-lanceolate, apex acuminate, minutely hairy at margin. Scapes 6-9 cm long, many, unequal, slender, grooved, spirally twisted. Male flowers : sepals 3, ca. 1 mm long, free or connate into a spathe, split in front; lobes obovate, cuneate at base, hairy on back. Corolla 0.5 mm long, united; tube narrow; lobes 3, unequal, 1 slightly larger, hairy, black-glandular. Female flowers: shortly stalked. Sepals variable, 2 or 3, larger than petals, lanceolate, acute. Petals 3, free, unequal, glandular, linear, clawed, hairy. |
| Eriocaulaceae | *Eriocaulon stellulatum* | Kodachadri, Hosagadde | | Small, erect herbs, 7-8 cm tall. Leaves basal radical, lanceolate, apex acute. Heads terminal, peduncles 5-6 mm long, spirally ribbed, hairy, 1-many together, receptacles hairy. Flowers 2.5-3 mm long, sessile, unisexual. Male |

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| | | | | flowers calyx lobes 3, free. Female flowers calyx lobes 2, free. |
| Eriocaulaceae | *Eriocaulon thomasi* | Hebbegeri | | Erect, tufted herbs, 8-10 cm tall. Leaves less than 5 mm broad; involucral bracts more or less similar to floral bracts, orbicular. Scape terminal, thickened below the head, 6-9 cm long, covered by leafy sheath to the middle. Receptacle broad, globose, hairy. Seeds with white, striate, minute papillae. |
| Eriocaulaceae | *Eriocaulon xeranthemum* | Between Hosnagar and Humcha | | Small, tufted herbs. Leaves basal, lanceolate, apex acute. Scapes 1.5-3.5 cm long, compressed; sheath nearly as long as the scape. Receptacle flattened, glabrous. Floral bracts ca. 1 mm long, obovate, truncate, ciliate at apex. Sepals 3, free, slightly shorter than floral bracts, narrowed to base, equal or unequal in female. Petals 3, free, linear, hairy and glandular at apex. |
| Apocynaceae | *Ervatamia heyneana* | Hulikal, Nagodi, Humcha | | Small trees or shrubs. Leaves opposite, elliptic, apex acuminate base acute, gland-dotted beneath, stipules axillary. Flowers white, in terminal or axillary, long-peduncled, corymbose or umbelliform cymes.follicles paired, boat-shaped, apex beaked, orange-yellow when ripe, seeds few, with orange or red aril. |
| Convolvulaceae | *Erycibe paniculata* | Yedur, Hulikal,Kun dadri | | Large, woody, scandent shrubs, branches and inflorescence rusty-tomentose. Leaves alternate, coriaceous, elliptic-oblong or obovate, apex abruptly ahortly acuminate, base acute. Flowers white, or cream coloured, numerous, in axillary or terminal panicles. Panicles with reddish-browm tomentum. Sepals' 1.5 - 2 mm ong, Ovate, brown tomentose. |
| Erythropalaceae | *Erythropalum populifolium* | Chakra, yedur, Hulical | | Tendrillar climbing shrubs, tendrils axillary, shortly bifid. Leaves alternate, ovate, apex acute or shortly acuminate, base rounded, truncate. Flowers yellowish, in axillary lax cymes. Drupe oblong, reddish, 1-seeded |

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| | | | | crowned with remains of calyx. |
| Myrtaceae | *Eugenia macrosepala* | Hulikal | | Large shrubs or small trees to 5 m tall. Tomentose. Leaves oblong-lanceolate, apex obtuse or acuminate. |
| Celastraceae | *Euonymus indicus* | Yedur, Sampekatte | - | Small evergreen trees to 8 m tall. Leaves opposite subcoriaceous, ovate or elliptic apex obtusely acute. Capsule obovoid, 5-angled or narrowly 5-winged, 5-valved, orange-red, axillary, solitary. Flowers red, peduncled umbellate cymes. |
| Euphorbiaceae | *Euphorbia hirta* | Savehaklu | | Erect rigid-herbs, branches ascending,stem terete below, angular above. Leaves opposite, less than 4 cm long; Cocci not winged.<br>Cyathia crowded in axillary, small cymes. Involucre with 4 stalked glands. |
| Euphorbiaceae | *Euphorbia prostrata* | Savehaklu | | Much branched, prostrate, herbs, stem pubescent. Leaves opposite, oblong, obovate, serrate-crenate. Floral leaves smaller. Cyathia 2-3 mm long, axillary. Capsules 3-valved, cocci with spreading hairs along the promnant keels. |
| Euphorbiaceae | *Euphorbia pycnostegia* | Kodachadri hills, Kundadri | | Erect, dichotomously branched herbs, stem often reddish, glabrous, except few long hairs at or near the swollen nodes. Leaves opposite, sessile or shortly-petioled. Floral leaves smaller, distichous, with long hairs within, fimbriate; glands 4, with transversely oblong, unequal, white or pink limbs. Capsule trigonous, cocci obtusely keeled, glabrous, seeds 4-angled, transversely rugose and furrowed. |
| Euphorbiaceae | *Euphorbia thymifolia* | Yedur | | Small, prostrate herbs, branches hairy. Leaves opposite, shortly petiolate, obliquely ovate-pubescent beneath, stipules minute, fimbriate. Cyathia in axillary clusters. Involucral glands 4, stipitate. Capsule tetragonous, transversely furrowed. |
| Lamiaceae | *Eusteralis tomentosa* | Nittur | | Procumbent 12-20 cm tall, herbs with tufts of short, erect branches, stem densely greyish-hairy. Leaves sessile, linear, margin |

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| | | | | recurved apex bluntly dense.flowers pink, dense, I terminal spikes, peduncle 4-7 cm long, tomentose bract linear. |
| Rutaceae | *Evodia lunu-ankenda* | Hulical, Yedur | | Dioecious trees, 12-15 m tall. Leaves aromatic, opposite, 13-foliolate. Flowers fragrant, white, 4-merous, in axillary paniculate cymes. Female flowers with 4 staminodes. Fruit of 4 coriaceous, 2-valved, 1-seeded cocci. |
| Convolvulaceae | *Evolvulus alsinoides* | Kaimara, Holekoppa | | Plants ascending to trailing, not rooting at the nodes; corolla blue, Calyx connate; lobes 3-4 mm long, ovate-lanceolate. |
| Convolvulaceae | *Evolvulus nummularius* | Sagar | | Plants prostrate and rooting at the nodes; corolla white. Rooting at nodes. Corolla 5-6 mm long; lobes 5, spreading. |
| Gentianaceae | *Exacum bicolor* | Nittur, Sampekatte, Kodachadri, Savehaklu | | Erect herbs, to 60 cm tall, stem quadrangular. Leaves opposite, sessile, elliptic-lanceolate or ovate-lanceolate, apex acute, base rounded. Calyx winged; corolla more than 1 cm |
| Gentianaceae | *Exacum carinatum* | Hulikal | | Erect, unbranches herbs, 12-14 cm tall, stem quadrangular.Leaves less than 2 cm long; leaves 5-nerved from base; calyx wings broad, prominently reticulate. Flowers blue, 1-few, in terminal cymes, pedicels erect to 1.5 cm long. |
| Gentianaceae | *Exacum pedunculatum* | Sampekatte, Bileshvara, Hebbegeri, Savehaklu | | Erect, herbs, 10-15 cm tall, unbranched or with few branches. Stem 4-angled. Leaves sessile, opposite, elliptic. Flower blue, in terminal, 1-few flowered cymes. |
| Gentianaceae | *Exacum sessile* | Yedur, Hebbegeri | | Erect herbs, to 14 cm tall, branches few, opposite, short, stem angular. Leaves opposite, sessile, ovate, apex acute. Flowers blue, solitary, terminal, shortly pedicelled. Calyx wingless, Calyx 4- lobed, connate, 2 cm long; Corolla tube ca. 2 mm long; lobes 4, 4-5 mm long; spreading. |
| Loganiaceae | *Fagraea ceilanica* | Nittur, Nagodi | Vallerei, Omal | Small epiphytic tress. Leaves opposite coriaceous, elliptic or obovate, apex acute or obtuse. Flowers white, in terminal corymbose cymes. Berry ovoid or ellipsoid, many-seeded. |

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| Euphorbiaceae | *Fahrenheitia zeylanica* | Hulikal | | Trees, young shoots pubescent. Leaves alternate, broadly elliptic or elliptic oblong, serrate, apex acute or obtuse. Female flowers in terminal, pendulous panicles. Calyx 5-lobed, unequal, shorter than corolla. Corolla lobes 5, free, yellowish. Disc villous. Capsule globose, 3-valved, seeds 3. |
| Moraceae | *Ficus arnottiana* | Kodachadri, Hulikal | Kallashvatha | Small trees. Leaves ovate - cordate, caudate at apex; figs in pairs or clusters, usually in the axils of fallen leaves. Receptacles 4 mm long, depressed-globose, axillary, solitary, or paired, shortly stalked, basal bracts 3. |
| Moraceae | *Ficus benghalensis* | Tenkbail | Aladamara | Small to medium-sized trees, young branchlets pubescent. Leaves pubescent or tomentose; obtuse at apex, lateral nerves 4 - 6 pairs; fig red when ripe. Receptacles 1.5-2 cm across, axillary, sessile, solitary or paired, reddish when ripe, silky-pubescent. |
| Moraceae | *Ficus callosa* | Hulikal ghat | Neeruvate, Thagadu golimara | Trees, 8-15 m tall, branchlets hoary, warted. Leaves alternate, coriaceous, elliptic. Receptacles subglobose, yellow when ripe, axillary, solitary. Basal bracts 3, ovate or orbicular. Figs solitary, 2.5 cm in diameter |
| Moraceae | *Ficus drupacea* | Gajnur | Bili Goli | Medium-sized trees, to 13 m tall, branchlets and petiole grey or brown-hairy. Leaves ovate, elliptic, obtuse to acuminate at apex; figs solitary, 2.5 cm in diameter. Bud scale 1.5 cm long, ovate-lanceolate. Receptacles 2x1.5 cm, ovoid, sessile in axillary pairs. |
| Moraceae | *Ficus exasperata* | Hulikal, Yedur | Gargatti | A small tree to 8 m tall, young shoots scabrid. Leaves alternate, ovate, oblong or obovate, serrate, apex obtuse or shortly acumnate, base rounded or acute, unequal, scabrid. Receptacles 1.5 cm across, globose, axillary, solitary, yellow, turning reddish, pubescent; peduncle 0.6-1 cm long. |
| Moraceae | *Ficus hispida* | Hulikal | Olapatha, Medi | Large shrubs or small trees, 4-5 m tall, young parts hispid, internodes hollow. Leaves |

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| | | | | opposite, ovate or oblong, margin entire or dentate, apex abruptly shortly acuminate. Figs cauliflorous; leaves opposite. Receptacles 0.6-1 cm across, obovoid, fascicled on tubercle-like peduncle on woody stem. |
| Moraceae | *Ficus microcarpa* | Kodachadri base | - | Small trees, to 12 m tall, latex yellowish-white. Leaves not caudate at apex; petioles less than 2 cm long. Receptacles 1 cm across, sessile, in axillary pairs, yellowish when ripe. Basal bracts 3, ovate, persistent. |
| Moraceae | *Ficus nervosa* | Yedur | - | Large trees, to 20 m tall, young parts pubescent. Leaves alternate, ovate or ovate-oblong. Figs in pairs, less than 2 cm, figs with small bracts at the base of the peduncle; stigma bifid. Receptacles 2.5 cm across, globose, green with whitish lenticels, in axillary pairs. Basal bracts 3. |
| Moraceae | *Ficus religiosa* | Lingadahalli | Ashwatha, Arali | Medium-sized trees, 15-17 m tall. Leaves glabrous, caudate at the apex; leaves rounded or truncate at the base, cusp 2.5 - 9 cm long; figs in axillary pairs.Receptacles small, 5 mm long, sessile, in axillary pairs.basal bracts 3, orbicular, spreading. |
| Moraceae | *Ficus talbotii* | Nittur, Kalekoppa | - | Large trees, to 23 m tall; bark smooth, white. Leaves 9-14 x 4-6 cm, alternate, oblong, apex shortly caudate-acuminate, acumen 1-1.5 cm long, base acute or cuneate, 3-5-nerved from base; petiole 2-3 cm long. Receptacles 5-6 mm long, obconic, depressed above, axillary, sessile, solitary or paired. Basal bracts 3, small. |
| Moraceae | *Ficus tinctoria* | Govardhana giri | K-Gudumittermar a | Epiphytic shrubs with copious interlacing and anastomosing aerial roots enclosing the host. Leaves alternate, oblong or elliptic-rhomboidal, unequal-sided, gibbous on one side. Figs distinctly peduncled, Receptacles in axillary pairs or clustered, 6-7 mm across, globose, minute apical scales around orifices, scabrid. |

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| Moraceae | *Ficus tsjahela* | Nittur, Nivane | K-Bilibasuri, Boviyamara | Medium-sized trees, to 15 m tall, bark blackish without, pale reddish within. Leaves not caudate at apex; petioles more than 2 cm long; figs 5 - 7 mm across, in clusters of 2 - 6, on short tubercles in the axils of present or fallen leaves. Receptacles 8 mm across, in sessile clusters, crowed on short tubercles, axillary or at the scars of fallen leaves, yellowish-white. Common in moist deciduous forests |
| Moraceae | *Ficus virens* | Yedur | Basarimara | Trees, to 12 m tall, branchlets, pubescent. Leaves alternate, base rounded, glabrous nerve, 6-8 pairs, prominent beneath. Figs in pairs, less than 2 cm in diam; figs with small bracts at the top of the peduncle; stigma simple. Receptacles 1.5 cm across, axillary, solitary or paired; peduncle 4-5 mm long. Basal below the receptacle. Fruiting: May. |
| Cyperaceae | *Fimbristylis aestivalis* | Gajnur | | Tufted, erect annuals, 5-10 cm tall; stem slender, trigonous striate, pubescent. Leaves ca. 4.5 cm long, usually shorter than stem, crowded at base, linear, eligulate, densely pubescent; sheath broad, membranous, pubescent. Inflorescence terminal umbel ; rays 10-12, unequal, to 1.5 cm long ; secondary rays when present 4-5, unequal, 5 to 6 mm long ; bracts many, filiform, broad at base, hairy, unequal, the longest larger than inflorescence. Spikelets 3-5 mm long, elliptic-oblong; rachilla often winged. Glumes ca. 2 mm long, ovate or oblong, keeled ; keel green and produced into a mucro, sides membranous, nerveless, pubescent, brown-spotted; lowest 2 glumes sterile. Stamen 1, inserted at the base of ovary; filament 2 mm long, flattened; anther 2-celled. Nuts ca. 0.5 mm long, obovoid, compressed, biconvex, stramineous, semitransparent; style 2-fid, broad |

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| | | | | at base, papillose or pubescent, mostly at base. |
| Cyperaceae | *Fimbristylis bisumbellata* | Near Gajnur | | Tufted, annual herbs, ca. 6 cm tall; stem compressed, striate. Leaves ca. 6 cm long, as long as or longer than stem, linear, many-nerved, hairy beneath; sheath broad, membranous, red-spotted, hairy without; ligule a fringe of hairs. Inflorescence of terminal compound or decompound umbels; rays 10, unequal, ca. 6 mm long, compressed, striate; bracts many, unequal, outer 1 or 2 longer, leaf-like, hairy, broad at base; secondary rays ca. 2 mm long. Spikelets ca. 4 x 1.5 mm, ovoid. |
| Cyperaceae | *Fimbristylis dichotoma* | Bileshvara | | Perennial, rhizomatous, tufted herbs, 20 to 60 cm tall; rhizome short; stem slender, trigonous. Leaves to 20 cm long, usually shorter than stem, linear; ligule a fringe of hairs; sheath membranous, hairy, brown-spotted. Inflorescence terminal, simple compound umbels; rays 6-8, ca. 3.5 cm long, unequal; bracts about 5; the largest ca. 5 cm long, equal or longer than umbels, broad at base. Spikelets 4-5 mm long, ovoid. |
| Cyperaceae | *Fimbristylis dipsacea* | Gajnur | | Tufted annuals, 3 to 5 cm tall; stem slender, compressed, striate. Leaves ca. 2.5 cm long, shorter or as long as stem, filiform; sheath broad, membranous, striate. Inflorescence terminal, simple or compound, dense, sessile, umbellate clusters, sometimes basal ; bracts ca. 2.5 cm long, unequal, linear, filiform, broad at base, hairy. Spikelets 2-3 mm long, sub-globose, echinate. Glumes 2.5-3 mm long, loosely spiral, lanceolate, prickly hairy, aristate, greenish except membranous sides near base. Stamen 1, style short, 2-fid, glabrous. Nuts ca. 1 mm long, clavate, terete or slightly biconvex, striolate, glabrous or with 2 lateral rows of stalked glands, pale brown. |

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| Cyperaceae | *Fimbristylis ovata* | Bileshvara | | Perennial, rhizomatous herbs; rhizome short; stem often tufted, ca. 16 cm tall, slender, angled, striate, swollen at base. Leaves to 12 cm long, shorter or as long as stem, linear, crowded at stem base; sheaths with scarious margins. Inflorescence of solitary (or 2) spikelets; bracts absent (or 1, erect). Spikelet 5-10 x 3-5 mm, compressed, ovate, acute; rachilla winged. Lower glumes distichous, upper spiral. Glumes 5 mm long, broadly triangular-ovate, cuspidate, keeled, greenish along keel, membranous at sides; lowest pair sterile, long-cuspidate. Stamens 3, inserted at the base of ovary; filaments ca. 1.5 mm long, broad at base; anthers equal to filaments in length, linear, 2-celled. Style flattened, pubescent, base conical, broad; stigma 3-lobed, pubescent. Nuts 2-2.5 mm long, globose pyriform, trigonous, white or pale yellow, densely tubercled. |
| Flacourtiaceae | *Flacourtia indica* | Yedur, Sampekatte, Kodachadri base | Jeide, Mullthare. | Shrubs or small trees; leaves 2-10 cm long glabrous beneath; tepals 4, united below. Anthers versatile. Berry fleshy, globose and size of a pea, dark purple when ripe. |
| Flacourtiaceae | *Flacourtia montana* | Nagavalli, Kundadri | Champe hannu, Abluka | Trees, often armed, thorns simple, branchlets densely pubescent. Leaves 12-8 cm long, midrib pubescent beneath; flowers unisexual, in axillary fascicled cymes. Fruits size of a cherry, reddish when ripe. |
| Papilionaceae | *Flemingia bracteata* | Savehaklu | | Erect shrubs, 1.5-2m tall. Leaves 1-foliolate, alternate. Flowers in axillary or terminal simple or branched racemes. Lateral nerves 4 - 6 pairs, lower; bracts softly hirsute with long hairs, slightly marginated. Flowers pinkish, in axillary or terminal simple or branched racemes. |
| Papilionaceae | *Flemingia macrophylla* | Savehaklu | | Erect undershrubs, 2-2.5 m tall, stem obtusely 3-angular, faintly ribbed, adpressed tawny-tomentose. Leaves 3-foliolate; erect shrubs; flowers in axillary |

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| | | | | or terminal congested racemes.Calyx tube short; lobes 7-8 mm long; mid-lower-lobe longer; red resinous-glandular and tomentose without. |
| Papilionaceae | *Flemingia strobilifera* | Kodachadri | | Erect, branched shrubs, to 1.5 m tall, stem more or less terete, densely silky-brown hairy. Leaves 1-foliolate. Flowers white, in axillary or terminal, branched racemes. |
| Orchidaceae | *Flickingeria macraei* | Kodachadri slopes, Hosagadde | | Epiphytic herbs; rhizome creeping, annulate, profusely branched; pseudobulbs 3.5 x 1.5 cm, at regular intervals on branches, oblong or fusiform, compressed, furrowed, yellowish when dry. Leaves 10-12 x 2 cm, solitary and sessile on pseudobulbs, coriaceous, oblong-elliptic, apex acute, obtuse or rarely retuse, base abruptly narrowed; nerves parallel, prominent on both surfaces. Flowers ca. 1 cm long, white, 1-3 from leaf base. Pedicels with ovary 6-8 mm long, ensheathed by several scarious bracts at base. Sepals 3; lateral sepals adnate to column-foot, forming amentum, obscurely 5-nerved. Petals equal to or slightly shorter and narrower than sepals, 3-nerved. Lip 3-lobe; midlobe elongated and expanded above the lateral lobes into 2-winged, erect structures. Column oblong. Anther 1, 2-celled; pollinia 4, in 2 pairs; caudicle absent. Stigmatic surface broad. |
| Commelinaceae | *Floscopa scandens* | Hulikal | | Sub-erect or spreading herbs, rooting at nodes; internodes long, hairy, hairs in a line with the margin of leaf-sheath. Leaves 3-5 x 0.6-1 cm, alternate, elliptic-lanceolate, apex acute, base narrowed into short petiole; sheath tubular, mouth oblique, with long hairs. Flowers secund, on the branches of terminal panicles; peduncle short, villous. Calyx lobes 3, free; lobes 3 x 1.5 mm, obovate, obtuse, 3-nerved, hairy. Petals 3, free, purplish. Stamens 6 (or 5), dimorphic; 3 |

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| | | | | stamens with broad connectives, 3 normal; anthers 2-celled, globose, yellowish. Capsule 2 x 2.5 mm, broader than long, suborbicular, abruptly acute at both ends, 2-valved; seeds 2, glaucous, transversely rugose on dorsal side. |
| Agavaceae | *Furcraea foetida* | Tenkbail | | Perennial shrubs, stem short, rhizomatous. Leaves larger, alternate, basal, coriaceous, ovate- lanceolate. Flowers 3-4 cm long, greenish-white, in terminal, large panicles, on stout scapes, pedicels minute. Perianth lobes 6, free, elliptic-oblong. |
| Clusiaceae | *Garcinia gummi-gutta* | Kargal | Upaagi mara | Medium-sized trees, 15 m tall. Branches horizontal. Male flowers fascicled, pale white or pale green. Stamens 12 -20 inserted on a prominent receptacle. Female flowers 1 - 3 together. Berries 6-10-grooved. |
| Clusiaceae | *Garcinia morella* | Mastikatte | Ardala, Murinahuli, Devanahuli. | Small trees, 10 m tall, branches horizontal, branchlets angular. Leaves coriaceous, opposite, ovate or elliptic-obovate, apex obtuse or subacute, base cuneate, midrib prominent beneath. Anthers peltate, with circumscissile dehiscence; stigmas 4; berries 1.8-2.5 cm in diam. |
| Clusiaceae | *Garcinia talboti* | Hulical | - | Branchlets angular. Leaves coriaceous, broadly oblong, obtuse, rounded at base; prominent on both surfaces, anastomosing. Staminate flowers congested in short racemes on old wood. Sepals 5, petals 5, greenish white. Stamens in 5 phalanges, opposite petals, anthers 2-celled. Pistillode absent. Pistillate flowers fascicled on old wood. Ovary globose, berry oblong, 4-6 cm across. |
| Clusiaceae | *Garcinia xanthochymus* | Between Chakra and Mastikatte | Jaarige, Devejaarige | Trees more than 10 m tall. Leaves coriaceous, opposite, oblong or oblong-lanceolate, margin recurved, apex irregular. Flowers 5-merous; leaves linear-oblong. Midrib prominent beneath; nerves irregular. Male flowers pedicellate. Sepals 5. Petals 5. |

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| | | | | Female flowers fascicled on old wood, staminodes in 5 phalanges. |
| Rubiaceae | *Gardenia gummifera* | Bilesvara, Nittur, Nagara | Bukki gida | Branched, unarmed, resinous, shrubs. Leaves opposite, subsessile. Flowers white, terminal , in fascicles of 1-3, subsessile or shortly pedicelled. Berry ovoid pr ellipsoid, woody, crowned by persistent calyx teeth, 1-celled. |
| Poaceae | *Garnotia tenella* | Hulikal, Jog | | Tufted annuals; stem slender, ribbed, nodes often hairy; branches ascending from base, rooting from lower nodes. Leaves 3-10 x 0.2-0.5 cm, linear-lanceolate, acuminate, narrowed at base, scabrid; sheath glabrous; ligules less than 1 mm long, membranous, truncate, ciliate. Inflorescence panicled, to 25 cm, long; peduncle slender, 3-angled, scabrid; branches in distant fascicles, ca. 6 cm long, angular or flattened, scabrid. Spikelets 3-3.5 mm long, lanceolate, compressed, solitary, often geniculate on unequal pedicels, 1-flowered. Glumes 2, slightly unequal 3.5 mm long, membranous, lanceolate, acuminate-cuspidate or shortly awned, 3-nerved, minutely hairy along nerves. Lemma 1, membranous, 2.5-3 mm long, awned; awn slender, ca. 8 mm long; palea as long as lemma. Stamens 3, styles 2; stigmas plumose. |
| Papilionaceae | *Geissaspis cristata* | Hulikal | | Much branched, diffuse herbs, stem angular. Leaves pinnately compound, rachis 5-7 mm long, bristle-tipped. Flowers shorter than bracts; bracts orbicular, ciliate with many long stiff brown hairs, Leaflets 5-8 x 4-5 mm. Stipule peltate ciliate. Bracts arranged in 2 rows concealing flowers. Calyx deeply 2-lipped; upper entire; lower minutely 3-toothed. |
| Orchidaceae | *Geodorum densiflorum* | Kattinkere | | Terrestrial, erect herbs. Pseudobulbs tuberous, globose or ovoid, partly exposed, persistent. Leaves 2-3, elliptic-oblong or |

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| | | | | elliptic-lanceolate, apex acute, base tapering into petiole. Lip-obscurely trilobed, sidelobes erect on either side of column, central bilobed, with shallow sinus.Lip fleshy pink with purple striations inside & with patch of yellow. Column short produced in foot. Lip pale purple, ventricose at the base, subpundurate. Pollinia 2. |
| Rubiaceae | *Geophila repens* | Nittur, Yedur, Sampekatte, Kowri | | Slender creeping herbs, rooting at nodes. Leaves opposite, orbicular-reniform. Flowers white, in terminal or axillary, solitary or 2-3-flowered umbels. Fruit 1 cm long, ovoid, fleshy, reddish when ripe, crowned by persistent calyx lobes, seeds 2. |
| Urticaceae | *Girardinia diversifolia* | Savehaklu | | Erect herbs, stem furrowed, with long stinging hairs. Leaves alternate, ovate, serrate-dentate, apex acute, base subcordate or truncate, bristly-hairy on both surfaces. Flowers unisexual, in axillary spikes, males in lowers and females in upper axils, male spikes slender. Male flowers greenish-white. Perianth lobes 4, free to base, hairy without. Stamens 4, filaments inflexed in bud. Female flowers slightly larger. Perianth 3-lobed. |
| Molluginaceae | *Glinus lotoides* | Hulikal | | Prostrate and spreading herbs, stem softly villous with white-stellate hairs. Leaves opposite or ternate, subequal. Flowers pinkish-white, in axillary fascicles of 3-8, subsessile or shortly pediceeled. Capsules 5-valved. |
| Zingiberaceae | *Globba marantina* | Lekkikoppa, Sagar | | Stem erect, to 20 cm tall. Leaves sessile or shortly petioled, oblong-lanceolate or elliptic-lanceolate, apex acuminate, acute at base. Spike slender, terminal, to 10 cm long. Bubils ovoid, at the base of the spike. Labellum deeply bifid; lateral staminodes oblong, slightly longer than corolla lobes. Capsule oblong. |
| Zingiberaceae | *Globba ophioglossa* | Hulikal | | Erect herbs, to 90 cm tall. Leaves sessile, elliptic-lanceolate, acuminate, glaucous and pubescent beneath, ligule short, |

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| | | | | sheath pubescent. Flowers in terminal panicles, peduncle slender, sub-sessile flowers. Labellum yellow, deeply bifid; lateral. Capsule 1.5 cm long, oblong. |
| Euphorbiaceae | *Glochidion ellipticum* | Nagodi | | Small, glabrous trees, branchlets angular, internodes more or less zig-zag. Leaves alternate, elliptic-lanceolate or elliptic-oblong, apex acuminate, triangular. Male flowers; yellowish; pedicels slender, to 1 cm long. Perianth connate; lobes 6, 2-2.5 mm long, oblong. Stamens 3; anthers 1 mm long, sessile, slightly connate; connective short. Female flowers; sessile. Perianth lobes 6, united, hairy without. Ovary densely hairy; style more or less conical, glabrous. |
| Euphorbiaceae | *Glochidion malabaricum* | Nagavalli forests | | Glabrous trees, 7-8 m tall, branchlets more or less 3-angled. Leaves alternate, elliptic-oblong, apex acuminate, base cuneate or acute, unequal, greenish when dry. Flowers in axillary fascicles; ovary and capsule pubescent; style shortly lobed; stipule lanceolate. |
| Euphorbiaceae | *Glochidion neilgherrense* | Hulikal | | Small, glabrous trees; branchlets angular, often zig-zag. Leaves 6-11 x 2.2-3.5 cm, alternate, chartaceous, falcately elliptic or oblong-lanceolate, apex obtusely acuminate, base acute or cuneat, unequal; nerves 6-9 pairs; petiole 5-8 mm long; stipules minute, triangular, erect. Flowers unisexual, male and female together, in axillary clusters. Male flowers; few; pedicels to 1 cm long, stout above. Perianth lobes 6, free to the base, yellow, linear-oblong, 5 x 1 mm, glabrous. Stamens 3; anthers united, sub-sessile, connective prolonged. Female flowers; sessile. Perianth lobes 4, small, united into a cup; lobes minute, unequal. Ovary small; style glabrous, stout, 4-6-lobed above, persistent. Capsule 0.5 x 1 cm, depressed-globose, 4-6-celled or more. Flowering: |

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| | | | | January, Fruiting: January. |
| Euphorbiaceae | *Glochidion velutinum* | Bileshvara, Kargal | | Small trees, young branches, leaves beneath, petiole and inflorescence clothed with velvety pubescence. Leaves alternate, elliptic-oblong, apex obtuse or acute, base rounded or acute. Flowers yellow, unisexual, male and female togehter, in axillary clusters. Male flowers pedicels 5-6 mm long, hairy. Perianth 6-lobed, free, 2-3 mm long, yellowish, hairy without. Capsule depressed-globose, 6-lobed, pubescent, seeds reddish. |
| Euphorbiaceae | *Glochidion zeylanicum* | Chakra, Kargal | | Small glabrous trees, branchlets angular, shallowly grooved. Leaves alternate, elliptic-oblong or ovate-lanceolate, apex obtuse or obtusely acuminate, base rounded, unequal, stipules small, triangular. Flowers in axillary umbellate cymes, Male flowers perianth lobes 6, in 2 whorls; each lobe 2 x 1 mm, oblong, outer little longer. Stamens 8, united, connective prolonged. |
| Liliaceae | *Gloriosa superba* | Sampekatte, Bileshvara | Gowrihoo, Huli uguru | Climbing herbs, leaf tip tendrillar. Leaves alternate, sessilr, ovate-lanceolate, base rounded. Flowers axillary, solitary. Perianth 6-lobed, free, linear, margin undulate, reflexed when mature, reddish terminally. Capsules 3 cm long, oblong. |
| Rutaceae | *Glycosmis arborea* | Hulical, Yedur | | Erect, branched shrubs, branches minutely pubescent. Leaves pinnately compound, alternate. Leaflets crenate-serrate; ovary sessile. Flowers white, in axillary panicles. Berry 1 cm across, white. |
| Poaceae | *Glyphochola forticulata* | Kodachadri | | Tufted, annual grass, to 15 cm tall; stem slender, erect or ascending; internodes close near base, villous. Leaves 3.5-10 cm long, linear, densely hairy, upper shorter; sheath compressed, upper spathaceous, often villous with tubercle-based hairs; ligules membranous. Inflorescence 3-5 cm long spiciform racemes, on axillary branches ; joints of rachis subclavate, compressed, ca. 2.5 |

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| | | | | mm long, with a tuft of long hairs at the outer angles of their tips. Spikelets of 2 types, sessile and pedicelled; pedicels flat, equal to joints. Sessile spikelets: 5-8 mm long including awns, with glabrous callus. Lower glume 6-8 mm long, coriaceous, 5-6-nerved, 4-6 transverse echinate ridges below the middle without ; the tips of echinae curved upwards; apex of glume cleft, bearing 2 lateral wings, each ca. 3.5 mm long, membranous, inner margins of wings produced into 2 divergent, barbellate awns of 4-6 mm long. |
| Thymelaeaceae | *Gnidia glauca* | Kodachadri Kundadri, Hulikal | | Much branched, large shrubs or small trees, branchlets pale reddish when dry. Leaves simple, alternate, shortly petioled or subsessile, oblanceolate or elliptic-oblong, apex acute, apiculate, base narrowed and rounded, midrib impressed. Flowers yellow sessile, in dense, terminal heads to 2 cm across, involucres of bracts imbricate. Corolla of 5, small scales, attached to calyx tube, alternating with the lobes. Stamens 10, inserted in calyx tube in 2 rows; upper row slightly exserted; filaments short or absent; anthers 2-celled. Disc annular. |
| Icacinaceae | *Gomphandra tetrandra* | Yedur, Kargal | | Large shrubs or small trees, 5 m tall. Branches puberulous somewhat zig-zag. Leaves thin, appery; inflorescence axillary; filaments with long hair.Drupe oblong or obconic, with the remants of persistant stigma. |
| Amaranthaceae | *Gomphrena serrata* | Jog, Sorab | Kempu kuntala | Prostrate herbs with procumbent branches, stem villous. Leaves opposite, elliptic oblong, obovate or spathulate, apex acute, narrowed to base, usually sessile, hairy. Flowers 5-6 mm long, white, bisexual, in terminal, sessile heads or short spikes. Perianth lobes 5, free, cottony-pilose without. |
| Annonaceae | *Goniothalamus cardiopetalus* | Kowri | | Large, erect shrubs or small trees, branchlets black when dry. |

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| | | | | Leaves thick, coriaceous, faintly reticulate; petals green, brown pubescent. |
| Rhamnaceae | *Gouania microcarpa* | Kundadri, Hulikal, Chakra | | Large climbing shrubs, tendrils axillary or from base of the peduncles. Leaves ovate or ovate-oblong. Flowers white, polygamous, in axillary and terminal. |
| Asteraceae | *Grangea maderaspatana* | Hulikal | | Profusely branched erect or prostrate, aromatic herbs. Bracts few-seriate, outer herbaceous; receptacle convex or conical. Outer ray florets female; inner disc florets bisexual. Corolla of ray florets filiform, 2-4-fid, of disc florets 4-5-lobed. |
| Tiliaceae | *Grewia abutilifolia* | Sacrebylu range Gajanur | - | Scandent shrubs to small trees, harshly tomentose. Leaves elliptic to orbicular-ovate. Umbels many flowered, peduncle shorter than petiole; drupe lobed.<br>Peduncle 1-3 together, shorter than petiole, hairy; pedicels longer than peduncle. |
| Tiliaceae | *Grewia disperma* | Sampekatte, Bileshwara, Kundadri, Nagara | - | Small tree; leaves lanceolate, alternate, ovate-lanceolate or elliptic, serrate, apex. Flowers 1.5 cm long, bud ovoid white, 3-6 in axillary umbels. Drupes didymous. |
| Tiliaceae | *Grewia heterotricha* | Hulical | - | Straggling shrubs, young parts clothed with ferruginous stellate hairs. Nerves 3 from base, 3-4 pairs from midrib. Drupe deeply 4-lobed, lobes almost free at maturity. Torus ca. 9 mm long, villous. |
| Tiliaceae | *Grewia nervosa* | Bileshvara, Chakra, Nittur, Sorab | - | Large shrubs, young parts stellately pubescent. Leaves alternate, broadly ovate-lanceolate or elliptic-oblong, entire or distantly crenate-serrate, apex acute or acuminate base rounded, slightly oblique. Calyx of 5 free lobes. Petals 5, free, yellowish, with ciliate gland at base within. Torus 1-2 cm long. Stamens numerous, filaments slender, anthers 2-celled. |
| Tiliaceae | *Grewia tiliifolia* | Nagodi, Gajanur | M-Chadachi | Small to medium-sized trees, branches tomentose. Leaves |

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| | | | | glaucous, hoary beneath; flowers in axillary umbels; drupe lobed. Torus hairy. Stamens numerous; filaments slender.Drupe bilobed, reddish, turning black when dry. |
| Tiliaceae | *Grewia umbellifera* | Hulical | - | Large scandent shrubs, branches rusty, stellately pubescent. Leaves alternate, elliptic-oblong or glandular-serrate-crenate, apex obtuse, acute or shortly acuminate, base unequal, rounded or subcordate, 3-nerved from base. Flowers bud oblong, white, in axillary umbellate cymes. |
| Podostemaceae | *Griffithelia hookcriana* | Nagavalli | | Minute herbs, attached to rocks in running water. Thallus polymorphic, fucoid or lichenoid; secondary shoots marginal or on central parts, short with included axis, ultimately exserted. Leaves distichous. Flowers irregular, naked, emerging from tubular spathe, irregularly spilt at tip. Capsule spherical of irregularly lobed. |
| Asclepiadaceae | *Gymnema sylvestre* | Bileshvara, Nittur, Mastikatte, Chakra, Savahaklu, Kargal, Jayanagara | | Calyx 1.5-2 mm long; connate; lobes 5, ovate, obtuse, pubescent, eglandular. Corolla ca. 2.5 mm long, connate to the middle; lobes 5, ovate, valvate or imbricate. Corona of 5 fleshy scales, inserted on corolla tube, projected above, alternating with the lobes. |
| Asclepiadaceae | *Gymnema tingens* | Hulikal, Yedur | | Large climbing shrubs, stem and inflorescence tomentose. Leaves opposite, ovate or ovate-oblong. Flowers yellowish, in axillary or lateral umbellate cymes. Follicle solitary or paired, lanceolate, narrowed to acute apex. |
| Acanthaceae | *Gymnostachyum latifolium* | Kodachadri hills | | Erect undershrubs. Leaves opposite, unequal, broadly ovate, apex acute or abruptly shortly acuminate, base rounded or truncate. Flowers yellowish, in axillary panicles, peduncle to 12 cm long, pedicles short, bract and bracteoles linear. |
| Asteraceae | *Gynura lycopersicifolia* | Yedur | | Erect herbs, 30-45 cm tall, roots often tuberous, stem angular, nearly glabrous. Leaves alternate, membranous, ovate, irregularly dentate. Heads 1.5 cm across, discoid, orange-red, |

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| | | | | homogamous, in alx panicles, peduncle slender, long. Achenes ribbed, hairy in between, receptable pitted. |
| Orchidaceae | *Habenaria crinifera* | Hulikal, Kowri | | Terrestrial, tuberous herbs, rarely epiphytic, to 10 cm tall; tubers 1.5x1 cm, oblong. Leaves 4-5.5 x 0.6-1.2 cm, 2-3, clustered at the base, thin, oblong-elliptic, apex acute, base tapering, sheathing the stem. Flowers large, white, few, in terminal racemes; peduncle with large, sterile leafy bracts below; floral bracts ovate, acuminate; pedicels short. Sepals 3, free, 1x0.3 cm ovate, obtuse, or acute at apex, 3-nerved. Petals narrower, linear, 1-nerved. Lip to 1.5 cm long, 3-lobed; lateral lobes curved outwards, outer margin dentate and produced into a long, slender tail; mid-lobe cleft into 2, each with a long caudate apex; spur 2.5-3 cm long, longer than ovary, clavate at apex. |
| Orchidaceae | *Habenaria elwesii* | Hosagadde | | Erect. Terestrial herbs, 15-30 cm tall; tubers 2x1 cm, horizontal. Leaves 4.5 x 1.5 cm, spiral. Flower yellowish-green, in terminal spikes or racemes; bracts long, ovate, acuminate, ciliate at margin, sheathing, Sepals 3, free, ovate, acuminate. Lateral petals narrower, densely villous along margin. Lip narrowly 3-lobed; Stamen 1; pollinia 2. Ovary inferior, 2 cm long; stigmatic lobes 2; column erect. Flowering: September. Fruiting: September. |
| Orchidaceae | *Habenaria grandifloriformis* | Bileshvara, Sampekatte | | Terrestrial herbs, to 12 cm long. Tuber solitary, 1.8 x 1 cm, ovoid. Leaves 2-3 x 1.5-3 cm, usually single, radical, lying flat on the ground, coriaceous, sessile, ovate or sub-orbicular, apex obtuse or acute, cordate at base. Flowers white, 1-4, in terminal racemes; scape with 1 or 2 sheaths at base; pedicels including ovary to 3 cm long; bracts 1-1.5 cm long, ovate, acuminate. Sepals 3, free, unequal, ovate; dorsal short, 3-nerved; laterals longer, 5-7-nerved. Petals white; upper |

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| | | | | segment ovate, equal to sepals; lower narrowly linear. Lip 3-lobed. |
| Orchidaceae | *Habenaria heyneana* | Nittur, Chakra, Hulikal,Sampekatte, Savehaklu | | Erect terrestrial herbs, to 30 cm tall; tubers 1 or 2, 1 x 0.6 cm, ovoid. Leaves 2-5 x 0.5-0.8 cm, alternate, spiral, oblong-lanceolate or lanceolate apex acute, mucronate, base narrowed to a sheath; lower leaves reduced. Flowers white, insecund, terminal spikes; bracts 1.5-2 x 0.4-0.5 cm, erect, ovate, acuminate, sheathing the ovary. Sepals 3, unequal; dorsal 8 x 5 mm, broader, laterals 10 x 4 mm, 1-nerved, greenish-white. Petals narrower an little shorter than sepals, 1-nerved. Lip 3-lobed; midlobe longer and broader than the lateral lobes, oblong, apex acute |
| Orchidaceae | *Habenaria longicorniculata* | Nagara | | Terrestrial, erect herbs, to 60 cm tall; tubers 1-2, unequal; stem short. Leaves 4-10 x 1.5-2 cm, 6, clustered near the base of stem, variable in size, 2-3 larger, elliptic-oblong or elliptic, apex obtuse or acute, base narrow, sheathing. Flowers 1-4, white, at the top of long, slender peduncle, covered by sheathing bracts; floral bracts cover the ovary, pedicellate. Sepals 3, free, unequal, 5-7-nerved. Petals 1 x 0.4 cm, subfalcate, 3-nerved. Lip 3-lobed, |
| Rubiaceae | *Haldina cordifolia* | Holekoppa, Lakkikoppa | Anavu | Large trees to 20 m tall. Leaves opposite, ovate-orbicular, apex shortly. Flowers orange, small, long, obovate or orbicular, caducous. |
| Sapindaceae | *Harpullia arborea* | Kundadri | | Tall trees with straight trunck. Leaves imparipinnate, leaflets 4-5 pairs. Capsules in lax, drooping, axillary panicles, 2-valved bright orange-red, tipped with long persistent style. |
| Rubiaceae | *Hedyotia auricularia* | Yedur, Nagodi | | Prostrate or diffuse herbs, sometimes suberect. Leaves sessile or shortly petioled. Flowers white, in axillary cluster or cymes. Capsules indehiscent |
| Rubiaceae | *Hedyotis caerulea* | Kaimara | | Erect, shortly branched herbs to 20 cm tall, stem 4-angled, |

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| | | | | minutely pubescent. Leaves opposite, sessile, linear, margin recurved. Flowers blue, in axillary or terminal cymes. Capsule 2-valved, seeds numerous, angular. |
| Rubiaceae | *Hedyotis erecta* | Sagar | | Erect branched herbs to 12 cm tall, stem 4-angled. Leaves opposite, sessile, linear-lanceolate, apex acute, narrow at base. Flowers white, in axillry 1-3-flowered cymes. Ccapsule slightly compressed, crown produced little above the calyx tube, dehiscent only at apex, seeds many, trigonous, pale brown. |
| Rubiaceae | *Hedyotis herbacea* | Yedur | | Erect herbs to 50 cm tall, branches slender, short, stem 4-angled. Leaves sessile, opposite, linear, margin. Flowers axillary, usuallt solitary. Pedicels slender, 5 mm long, elongating in fruit; calyx. ca. 2 mm long; tube rounded, enlarged in fruit lobes 4, equal to tube in flower. Corolla 4-lobed; tube narrow, ca 3 mm long; lobes small. |
| Rubiaceae | *Hedyotis nitida* | Hulikal | | Prostrate or erect, slender herbs, branches ascending. Leaves thick, margin recurved, lateral veins indistinct.flowers solitary, sometimes 1-4 axillary, sessile. Capsule ovoid, crustaceous, hard, flat at the dehiscing apex. |
| Sterculiaceae | *Helicteres isora* | Sampekatte, Kodachadri, Kundadri, Kargal | Yedamuri | Erect, branched shrubs, stem stellately-tomentose. Leaves serrate; flowers red, fading to lead colour, followed by spirally twisted cylindric, pubescent fruit. |
| Heliotropiaceae | *Heliotropium indicum* | Gajnur | Chelubalada gida | Erect, branched herbs, 30-50 cm tall, branches erect, with spreading hairs. Leaves alternate, rarely opposite, ovate, margin undulate-crenate, apex acute, base subcordate and abruptly decurrent into petiole. Flowers white, terminal simple or forked, monochasial scorpoid cymes. Nutlets 4, each 5 mm long, separating in pairs, beaked at apex, 4-ribbed on back. |
| Loranthaceae | *Helixanthera intermedia* | Yedur | | Parasitic shrubs, stem lenticellate. Leaves opposite or alternate, |

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| | | | | coriaceous, ovate, apex obtuse, base acute or cuuneate, rarely rounded. Petiole 1 cm long. Flowers in racemes, peduncle to 6 cm long, often 1-many fascicled nodes, pedicels 3 mm long, bracts small. |
| Loranthaceae | *Helixanthera wallichiana* | Jog | | Parasitic shrubs, stem densely lenticellate. Leaves opposite and alternate, coriaceous, ovate or elliptic, apex obtuse, acute at base. Flowers in racemes, peduncle 2-5 cm long, often 1-30fascicled at leafless nodes. Calyx ca.1 mm long; trucate. Corolla 4-lobed, reddish ca. 5 mm long; tube angular; lobes ovate. |
| Periplocaceae | *Hemidesmus indicus* | Nagara, Bileshvara, Kowri | Naamadaberu, Naanariber | Slender twining herbs, root-stock aromatic, stem faintly ribbed, thickened at nodes, sparsely pubescent. Leaves opposite, shortly petioled, variable in shape from linear-lanceolate to elliptic-oblong, apex acute, apiculate, base rounded, pale beneath. Flowers yellowish, small, few to many, crowded. Calyx 1 mm long; lobes 5, free to base, ovate, acute, ciliate. Corolla 5-6 mm long ; tube short ; lobes ovate, shortly acuminate, corona corolline, of 5 short scales at corolla throat, alternating with the lobes. |
| Acanthaceae | *Hemigraphis latebrosa* | Induvalli | | Diffuse, weak herbs or undershrubs, branches procumbent, stem densely white-hairy. Leaves opposite, ovate, crenate-serrate. Flowers in axillary or terminal, shortly peduncled, few-flowered, capitates spikes. Capsules linear-oblong, minutely pubscent, 6-seeded. |
| Apiaceae | *Heracleum pinda* | Kodachadri | | Erect, branched herbs, stem striate, clothed with weak, white flate hairs. Lower leaves pinnately compound, upper 3-foliolate, often reduced into sheaths. Most of the pedicels with sterile flowers; mericarps ridged; vittae 6-8; 2-4 in the commissure, 4-6 on the back; all descending from the stylopodium, not |

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| | | | | reaching the base, 1 or each furrow. Schizocarps compressed, orbicular or obovate, broadly winged, thickened at marin, mericarps ridged, vittae 6-8. |
| Sterculiaceae | *Heritiera papilio* | Kodachadri | - | Small trees, branchlets and inflorescence clothed with rusty-stellate tomentum. Leaves elliptic-ovate, abruptly acuminate, with rusty scales when young, nerves 4-5 pairs. Panicles stellate-pubescent. Flowers 5-(-6) merous. Calyx lobed to nearly middle. Pistils stellate-pubescent. Follicles ellipsoid, wing deltoid to 5 cm long. |
| Poaceae | *Heteropogon contortus* | Kodachadri | | Perennial, slender, tufted grass, to 60 cm tall; stem erect or decumbent below, leafy chiefly at base. Leaves 10-15 x 0.3-0.35 cm or larger, linear, apex acute or shortly acuminate, base rounded, often ciliate with bulbous-based hairs towards base, sometimes sparsely hairy above; sheaths compressed, narrowly keeled, striate; ligules truncate. Inflorescence terminal spiciform racemes, to 8 cm long, covered partly by spathaceous, leafybract. Spikelets closely imbricating, subsecund, in pairs, 1sessile, the other pedicelled. Lower 2-6 or more sessile spikelets awnless, male or neural |
| Malvaceae | *Hibiscus aculeatus* | Hulical | Betta bende, Huli gauri. | Rambling undershrubs, densely pubescent. Stipules obliquely lanceolate. Leaves 3-5-lobed, cordate to truncate at base, densely strigose, prickly on nerves beneath. Capsule 5-celled, calyx not membranous, not inflated, involucral bracts branched or with leafy appendages, stipules not semicordate and noor auricled; stipules lanceolate; calyx enlarged in fruits. |
| Malpighiaceae | *Hiptage benghalensis* | Nittur | Sanskrit-Maadhavi latha | Large, woody, branched, climbing shrubs, young branchlets and inflorescence adpressed silky-tomentose. Leaves 4-9 in. long; flowers 0.7 - 1 in across; wings of samaras 1.5 |

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| | | | | in. long. Stamens 10, filaments connate. Ovary villous, 3-locular. |
| Apocynaceae | *Holarrhena antidysenterica* | Bileshvar, Nivane, Sagar, Holekoppa, Gajnur | | Large shrubs or small trees to 3 m tall. Leaves opposite, ovate or elliptic, apex obtuse or shortly acuminate, base rounded. Flowers white, axillary or terminal corymbose cymes. Follicles paired, slender, cylindric. Seeds many, linear-oblong, compressed, with deciduous coma. |
| Anacardiaceae | *Holigarna arnottiana* | Hulikal, Yedur, Tagarthi | Chera, Holigar | Medium-sized trees, to 17 m tall. Leaves up to 25 cm long, oblanceolate, acute at apex; inflorescence with golden-brown pubescence. Drupe oblong, pale brownish. |
| Anacardiaceae | *Holigarna ferruginea* | Hulikal | Chera | Large trees, 30-33 m tall. Leaves up to 20 cm long, obovate or sub-acute at apex; inflorescence with dark brown pubescence. Drupe ovoid, black when ripe. |
| Anacardiaceae | *Holigarna grahamii* | Hulikal | | Trees to 25 m tall. Leaves alternate, crowded at the ends of branchlets, rusty pubescent beneath. Flowers unisexual, in terminal rusty-tomentose panicles, male panicles to 30 cm long, female to 15 cm. Drupe exserted from the torsus. |
| Flacourtiaceae | *Homalium zeylanicum* | Hulical ghats | Kala | Trees. Leaves elliptic, acuminate, narrowed at base, crenate. Fascicles of flowers collected into axillary racemes. Flowers white, with offensive smell. Sepals 4, ciliate along margin, petals glabrous. Stamens 4, alternating with glandular staminodes. Ovary globose, pubescent. |
| Euphorbiaceae | *Homonoia riparia* | Kodachadri | | Erect, rigid dioecious shrubs, branchlets pubescent. Leaves linear - oblong or linear - lanceolate, acute at apex. Emale flowers bract 1, bracteoles 2. Perianth lobes 5, free to base, subequal, brownish-hairy. |
| Dipterocarpacea e | *Hopea ponga* | Nittur, Near Hosanagar | Kalmara, Hiribbogi, Karimara | Large trees, 15-20 m tall, branchlets pubescent. Leaves without domatia; panicles glabrous. Petals ovate-lanceolate, pubscent outside. Wings of samara green, turning red when mature. |

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| Gentianaceae | *Hoppea dichotoma* | Nittur | | Herbs, 4-6 cm tall, branches divaricate, stem quadrangular or narrowly winged. Leaves opposite, sessile, ovate or orbicular. Flowers white, sessile, in terminal or axillary. Capsules. |
| Asclepiadaceae | *Hoya ovalifolia* | Kugwe | | Epiphytic shrubs, stem with long internodes. Leaves often clustered on lateral branchlets, coriaceous, elliptic-lanceolate, apex obtuse or sub-acute, base acute, reticulation distinct. Flowers pale straw-coloured, in axillary umbels.Corolla tube short; lobes 5 x 2.5 mm long, ovate, acute, pubescent within. Corona of 5 large scales attached to staminal column, radiating, pointed outside, concave on upper surface, with a cuspidate point inside. |
| Asclepiadaceae | *Hoya pauciflora* | Sagar | | Slender, apparently epiphytic climbers, leafy branchlets much condensed. Leaves less than 1 cm broad, opposite, coriaceous, linear-lanceolate, apex obtuse or acute, base rounded, midrib prominent, channelled, glaucous beneath, apex acute or obtuse |
| Asclepiadaceae | *Hoya retusa* | Sagar, Hulikal | | Epiphytic glabrous herbs. Leaves opposite, clustered on branchlets, fleshy, linear, gradually broadened, above the middle, apex deeply emarginated, midrib impressed, nerves obscure. |
| Asclepiadaceae | *Hoya wightii* | Bileshvara, Mastikatte | | Large, climbing shrubs, rooting at nodes. Leaves coriaceous, elliptic or elliptic-lanceolate, margin recurved, apex acuminate, base attenuate, subcordate and sub-peltate, nerves indistinct. Flowers white, in axillary umbels. Corona of 5, fleshy, stellately spreading scales, adnate to staminal column at base, obovate, 2-2.5 mm long. |
| Poaceae | *Hubbardia heptaneuron* | Jog falls | | Tufted, erect, annual, 15 --45 cm high. Leaf blades 10 - I5 cm long, linear, bulbous hairy on both surfaces. Inflorescence sub digitate, racemes 1-5, simple; peduncles capillary with whorl oblong hairs in the axils. Sessile spikelets 3.0- 3.5 mm long; lower. |
| Flacourtiaceae | *Hydnocarpus* | Sampekatte, | Toratti, Chaal | Trees, 8-17 m tall, branchlets |

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| | *pentandra* | Kattinakere, Induvalli | mogra yenne mara | minutely pubescent. Leaves subentire to distinctly serrate; petals as long as sepals. Nerves 6-9 pairs, prominent beneath. Petal scales fimbriate. Berry axillary, solitary, globose, ring hard, brownish, minutely tmentose, 1-locular, seeds many. |
| Podostemaceae | *Hydrobryopsis sessile* | Herodi | | Small, green herbaceous plants, closely attached to rocks. Thallus to 10 mm wide, branched; pinnules acropetal, flowering shoots numerous, at the fringe of thallus; each in the axil of the branches with 5-6 bracts, of which the uppermost 1-1.5 mm across, spathaceous, boat-shaped. Pedicels 1.5-2 mm long. Tepals 2, narrow, linear, as long as ovary. Capsule obovoid or subglobose, ribbed, obliquely dehiscing. |
| Apiaceae | *Hydrocptyle javanica* | Hulikal, Sacv | | Prostrate, branched herbs, rooting at nodes. Leaves variable in size, reniform, irregularly lobed, crenate, base cordate, 6-7 nerved, hairy along nerves, petiole slender, stipules scarious. Flowers sessile or shortly pedcelled, crowded, in axillary, globose heads. Schizocarp compressed, meriicarps 3-ribbed, styles 2, persistent recurved. |
| Acanthaceae | *Hygrophila auriculata* | Tenkbail | | Stout thorny herbs, stems 4-angled, or somewhat rounded, hairy. Leaves opposite, 3 pairs at each node, lanceate, entire, acute at both ends, hispid, thorns brownish-yellow, straight. Flowers blue, in axillary whorls of 8 flowers each, hispid, yellowish-hairy, lanceate. |
| Acanthaceae | *Hygrophila polysperma* | Gajnur | | Procumbent branched herbs, rooting at nodes. Leaves less than 4 cm long, elliptic-obovate, apex or rarely emarginated, base narrowed, hairy beneath. Spikes terminal, bracts leafy, 2-3 flowered, bracteoles linear-oblong, ciliate. Capsule narrowly oblong, furrowed, glabrous with apical tuft of hairs, seeds discoid. |
| Acanthaceae | *Hygrophila salicifolia* | Sorab | | Unarmed, erect, herbs 30-45 cm tall, stem reddish jointed at nodes nearly glabrous. Leaves opposite |

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| | | | | linear-elliptic or lanceolate, acute, hairy along the midrib and margins shortly petioled. |
| Rubiaceae | *Hymenodictyon obovatum* | Chakra, Hulikal | | Small trees, epiphytic when young, young stem and leaves reddish. Leaves opposite, unequal, elliptic-oblong or obovate. Floral leaves large, white, long-petioled, bullate, attached at base of peduncle. Corolla tube 1 mm long; lobes 2 mm long, ovate, acute. |
| Hypericaceae | *Hypericum japonicum* | Nagodi | - | Slender, erect herbs, unbranched or with few short opposite branches.Leaves sessile, opposite. Sepals entire; stamnes monodelphous, ovary 1-celled.flowers few, yellowish, in terminal dichotomous cymes. |
| Lamiaceae | *Hyptis suaveolens* | Nittur | | Erect, rigid aromatic herbs, stem quadrangular, hispid, inetrnodes hollow. Leaves ovate, irregularly serrate-dentate, apex, acute, base cordate, tomentose, densely beneath, gland-dotted. Flowers blue, in axillary cymose whorls on floral branches, pediceld short. Corolla 2-lipped; tube 3-4 mm long, narrow; upper lip 2-lobed; lower 3-lobed. |
| Apocynaceae | *Ichnocarpus frutescens* | Kodachadri, Kundadri | Gauriballi, Koogalballi | Slender, woody, tiwnng shrubs, young branches rusty-tomentose. Leaves opposite, elliptic or Corolla tube 3-4 mm long; lobes 3.5-4 mm long; ovate, acuminate, twisted to the right, hairy. Stamens included near the middle of the corolla tube ; filaments short ; anthers arranged around stigma 2-celled, cells spurred at base; connective prolonged. |
| Balsaminaceae | *Impatiens agumbeana* | Hulical | - | Plants acaulescent; epiphytic; 4-8 cm tall. Spur broad, less than 1 cm long. Leaves radical, membranous, ovate, orbicular or elliptic, entire or glandular crenate-serrate, apex rounded, mucronate, abruptly narrowed at base, into slender, flattened. Flowers 1-1.5 cm long, pinkish-white, in terminal racemes at the ends of scapes. |
| Balsaminaceae | *Impatiens gardneriana* | Hulical | - | Slender, erect herbs, 30-40 cm tall. Plants caulescent; leaves |

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| | | | | whorled or opposite. Flowers 1 cm long, pinkish, axillary, solitary, pedicels 1.5-3 cm long.capsule oblong, glabrous. |
| Balsaminaceae | *Impatiens herbicola* | Kodachadri hills | - | Slender erect herbs to 35 cm tall, stem reddish, glabrous, with long internodes. Leaves opposite, membranous. Flowers orange, in axilllary pairs. Capsule ovoid, narrowed at both ends, seeds few. |
| Balsaminaceae | *Impatiens kleinii* | Sampekatte, Mastikatte | - | Slender erect herbs, 10-15 cm tall. Leaves opposite; spur less than 1.5 cm long. Flowers 6-8 mm long, pink or white, usually axillary, solitary. |
| Balsaminaceae | *Impatiens oppositifolia* | Nagara, Hebbigeri | - | Small, erect or pubescent, ranched herbs, often rooting at nodes 10-15 cm tall. Leaves opposite, obovate or ovate-oblong, distantly spinous-serrate, apex rounded, sometimes mucronate. Lip with very short spur. |
| Balsaminaceae | *Impatiens scapiflora* | Hulical | - | Plants acaulescent; terrestrial; spur slender to 3 cm long. Scape to 20 cm long.leavs all radical, membranous, ovate or ovate-oblong, entire or crenate, apex obtuse or subacute, base subcordate to acute. Flowers pinkish, few, in racemes, peduncle slender. Petals free, standard smaller, wings large, 3-lobed. |
| Papilionaceae | *Indigofera trifoliata* | Nagara fort | - | Erect or diffuse herbs, branches often trailing. Leaves 3-foliolate. Reddish resinous-glandular and glaucous beneath. Flowers 2-4 mm long, pinkish-red, in axillary clusters. Pods 15 - 20 mm long, 5-7 seeded. |
| Liliaceae | *Iphigenia pallida* | Kattinkere | - | Erect herbs, 8-12 cm tall, corm oval or pear-shaped, Pedicels less than 3 cm long in fruit, perianth white or pale violet. Flowers white, pedicel 2 cm long in fruit. Capsule 5 mm long, obovoid, seeds many. |
| Liliaceae | *Iphigenia indica* | Nagara | - | Erect herbs, 8-10 cm tall, corm subglobose. Leaves alternate, sessile, linear, apex acute-acuminate, sheathing at base. Flowers solitary, axillary or terminal. Pedicels 5 cm long; in |

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| | | | | fruit; perianth purple. Capsule oblong, 3-grooved, many seeded. |
| Liliaceae | *Iphigenia sahyadrica* | Hulikal | | Herbs, 8-10 cm tall, globose, with membranous tunics. Leaves few, grass-like, linear or linear-lanceolate, apex acute. Inflorescence mostly a 2-flowered corymb. Flowers pale violet; pedicel 3 cm long in th fruit; capsule few seeded, Pedicels 3 cm long in fruit, ascending, grooved; ridges dotted with papillae. |
| Convolvulaceae | *Ipomoea bracteata* | Kundadri | | Twining or trailing slender, strigose herbs, hairs long, white, bulbous-based. Leaves alternate, pedately or palmately 3-5-lobed. Flowers purplish, axillary pedunculate heads. |
| Convolvulaceae | *Ipomoea campanulata* | Hulikal | | Large twiners rarely prostrate, stem striate puberulous or glabrous. Leaves alternate, ovate, apex acuminate and apiculate, base subcorde. Flowers pink, few, in axillary, peduncle cymes peduncle 2-3 cm long. |
| Convolvulaceae | *Ipomoea hederifolia* | Nittur | Nakshatra hoovu | Slender twiners, stem glabrous, grooved. Leaves alternate, broadly ovate, entire or slightly dentate, apex acute-acuminate, base cordate, 7-nerved from base. Flowers scarlet-red, in axillary, few-many-flowered cymes. Corolla salver shaped with a long and narrow tube; sepals distinctly awned at or below the apex; corolla scarlet or purplish; 4.5 cm long, open all day or most of the day; leaves ovate,entire or lobed |
| Convolvulaceae | *Ipomoea lanciniata* | Savehaklu | | Slender, creeping herbs, stem angled and twisted. Leaves palmately 3 - 7 lobed, bracts not involucrate. Flowers white, axillary usually solitary, pedicels 3-4 cm long, variable, thichened upwards in fruit. |
| Convolvulaceae | *Ipomoea staphylina* | Shikaripura | Tamil-Onankodi | Large, straggling or climbing shrubs, branches longitudinally grooved and spirally twisted, glabrous. Leaves simple, alternate, ovate. Flowers numerous, in axillary, 7-14 cm long panicles. |
| Poaceae | *Ischaemum* | Kodachadri | | Annuals, clums to 50 cm tall, |

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| | *impressum* | | | tufted, erect or suberect, branching upwards, nodes glabrous. Leavea oblong-lanceolate, apex acute, base subcordate or cuneate, hispid with bulbous-based hairs on both surfaces. Both spikelets deciduous from the joints or pedicels. Sessile spikelets oblong, obtuse, dorsally compressed, with short, bearded callus. Lower lemma empty, hyaline, ciliate, 3-nerved. |
| Poaceae | *Ischaemum indicum* | Nagara fort | | Tufted grasses; stem slender, erect or ascending, sometimes creeping at base, rooting at lower nodes; usually bearded. Leaves 6-8 x 0.4-0.6 cm or larger, linear-lanceolate, apex acute, base rounded or narrowed, hairy; hairs bulbous-based, margin scabrid; sheath compressed, glabrous or hirsute, auricled above; ligules membranous, ciliate. Inflorescence of 2 racemes or spikes, to 6cm long, adpressed to each other, enclosed partly in leafyspathe; rachis fragile, stout. Spikelets green or purplish, inpairs, one sessile, the other pedicellate; pedicels ca. 4 mm long, trigonous, broad above, hairy. Sessile spikelets: ca. 8 mm long; callus bearded. Lower glume ca. 5 mm long, coriaceous at base, papery above, apex 2-toothed 2-keeled, margins inflexed, often auricled at base, sides broadly 2-winged near the apex; wings ciliate. |
| Poaceae | *Ischaemum rugosum* | Nagara fort, Tenkbail | | Annual, erect grasses; nodes glabrous or bearded. Leaves 6-12 x 0.4-0.7 cm or larger, lanceolate, apex acuminate, base rounded, hairy, margin seabrid, subsessile; sheath loose, compressed, hairy, mount auricled; auricles confluent with 4 mm long ligule. Inflorescence of 2 racemes or spikes, adpressed, yellowish, 6-8 cm long, partly enclosed in spathaceous, leafy bract; rachis stout, jointed. Spikelets in pairs, one sessile and the other pedicelle |

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| | | | | ; pedicels ca.1 mm long, more or less trigonous, slightly concave on the inner face, hairy, confluent with bristly, thick callus of sessile spikelet. Sessile spikelets: 6-8 mm long. Lower glume cartilaginous, yellowish, two thirds of the length from base concave with 3-6 deep transverse ridges, flattened above, membranous, apex obtuse, margin incurved, the outer margin narrowly winged, with many green nerves. |
| Poaceae | *Ischaemum semisagittatum* | Kodachadri | | Annuals to 40 cm tall; stem slender, decumbent and ascending; nodes glabrous. Leaves 4-10 x 0.6-1 cm or larger, oblong or lanceolate, apex acuminate base deeply cordate or sagittate, margins scabrid, sparsely bulbous-based hairy; lower leaves long-petioled; petiole slender, to 3 cm long; sheath loose, keeled; keel articulating with petiole above, sparsely hairy, those of the uppermost leaves spathiform ; ligules membranous. Inflorescence of paired spiciform racemes, ca. 5 cm long, villous, with long, white hairs; rachis jointed, trigonous. Spikelets in pairs, 1 sessile, the other pedicelled; pedicels1-1.5 mm long, much shorter than spiketlet. Sessile spikelets: 5-8 mm long. |
| Rubiaceae | *Ixora brachiata* | Hulikal, Jog, Govardhana giri | | Small trees; panicles not corymbose.leaves opposite, subcoriaceous, elliptic-oblong. Flowers white, sessile or subsessile in terminal paniculate cymes. Corolla tube 5-6 mm long, narrow, palered ; lobes ca. 2 mm long, oblong, deflexed, white, glabrous or puberulous without. |
| Rubiaceae | *Ixora coccinia* | Nagara | M-Thechi | Erect, shrubs, branches minutely pubescent. Leaves opposite, coriaceous, sessil or subsessile, oblong, apex obtusely acute. Flowers scarlet-red, in terminal, dense, shortly peduncled, corymbose cymose. Corolla tube 3 cm long, red, glabrous. |

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| Rubiaceae | *Ixora malabarica* | Savehaklu, Devagaru | | Erect branched shrubs, stem 4-angled, branchlets compressed, broader, jointed at nodes. Leaves to 10 cm long, secondary veins 18 - 13 pairs. Flowers creamy-white, in terminal panicles of corymbose, cymes. |
| Rubiaceae | *Ixora nigricans* | Hulikal, Yedur, Mastikatte, Hosagadde, Kodachadri | | Erect shrubs, to 3 m tall. Entire plant turns black when dry. Leaves opposite, elliptic-lanceolatye. Flowers white, in terminal, branched cymes. Drupe. |
| Rubiaceae | *Ixora polyantha* | Hulikal | | Shrubs. Leaves obovate, elliptic-oblong or oblong-lanceate, acute or acuminate at apex, coriaceous, glabrous on both sides, midrib raised beneath, margins entire or slightly wavy, stipules broadly ovate, cuspidate. Flowers white, cymes in corymbiform open or globose heads, branches of the cyme densely clothed with white hairs. |
| Poaceae | *Jansenella griffithiana* | Yedur, Hulikal | | Annuals, 8-12 cm tall; stem slender, erect. Leaves 1.8-4 x 0.25-0.35 cm, ovate-lanceolate, apex acute, flat strongly nerved, scabrid above, with amplexicaul and pectinately ciliate, auricled base ; sheath striate, naked or ciliate in the upperpart ; ligules 2-3 mm long, membranous, adpressed to leaf-base. Inflorescence terminal 1.5-2 cm compact panicles, ovoid oroblong ; branches 5-6 mm long, compressed, hairy. Spikelets subsessil, 6-7 mm long, oblong-lanceolate, setose, shortly aristate, 3-nerved. Upper glume 6-7 long, elliptic-lanceolate, setose, long aristate, 5-nerved. |
| Oleaceae | *Jasminum azoricum* | Yedur, kundadri | Kaadu mallige | Large, glabrous, climbing or scandent shrubs. Leaves 3-foliolate, sometimes twisted, terminal large, ovate or oblong-lanceolate, apex acuminate, base rounded. Flowers in axillary, lax, cup-like, 3 mm long. |
| Oleaceae | *Jasminum cordifolium* | Hulikal | | Large, climbing shrubs stem spirally twisted, glabrous. Leaves simple, broadly ovate, truncate or sub cordate at base; calyx lobes glabrous. Flowers white, in |

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| | | | | terminal, compact, paniculate cymes, branches lanceolate. |
| Oleaceae | *Jasminum malabaricum* | Bileshvara, Savehaklu | Kaadu mallige | Scandent shrubs. Leaves broadly ovate, truncate or sub-cordate at base, calyx lobes densely hairy. Fruit ovoid, drying black, single or paired in terminal or axillary, trichotomously branched cymes. |
| Oleaceae | *Jasminum rottlerianum* | Hulikal | | Large, climbing shrubs, branches densely villous. Leaves opposite, ovate. Flowers in terminal cymes. Berry usually paired, ovoid, erect. |
| Acanthaceae | *Justicia japonica* | Hulikal, Nagara fort, Yedur | | Erect or procumbent herbs, simple or branched, stem quadrangular, green hairy. Leaves ovate or ovate-elliptic, apex acute or obtuse, base acute, raphides scattered. Flowers pinkish, in terminal spikes, peduncle to 5 cm long. Bracts without green nerves; calyx 4-lobed, spike continuous. Capsule 4 mm long, 4-seeded, seeds 1 mm across, compressed, rugose. |
| Acanthaceae | *Justicia santapani* | Hulikal | | Erect herbs or undershrubs. Leaves opposite, elliptic-lanceolate or oblanceolate, apex acute or shortly acuminate, narrowed at base, green beneath when dry. Flowers white, in axillary or terminal panicles, with interrupted clusters towards base. Capsule 2.5 cm long, clavate, pubescent, seeds 4, rugose. |
| Acanthaceae | *Justicia trinervia* | Hulikal, Savehaklu,Yedur | | Small, procumbent herbs, branches ascending. Leaves upper sessile, elliptic or ovate, apex obtuse. Flowers dull white with blue tinge, terminal spikes, bracts lanceolate, leafy, white, green nerved. Calyx 5 mm long, pubescent. Corolla ca. 10mm long; lobes unequal, lower tailed. Capsule clavate or subglobose, pubescent, seeds usually 4, densely clothed with tubercles. |
| Acanthaceae | *Justicia wynaadensis* | Nagavalli | | Slender, scandnt herbs or undershrubs. Leaves opposite, elliptic, entire or distantly crenate, acuminate at both ends and base acute, glabrous or sparsely hairy, hairs jointed. Flowers in axillary or terminal spikes, glandular-pubescent, as on bracts, |

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| | | | | bracteoles and calyx. Capsule long, clavate, stalked, villous, constricted between seeds, seeds 4, sparsely tubercled. |
| Crassulaceae | *Kalanchoe pinnata* | Kargal | Kaadubasale | Branches terete, reddish speckled with white. Leaves simple or pinnately 2-5-lobed, elliptic-oblong, crenate-serrate, obtuse, rounded or narrowed at base. Calyx gamosepalous, lobes shorter than tube. Corolla constricted below moddle to 5 cm long. Stamens inserted below middle of corolla. |
| Bignoniaceae | *Kigelia africana* | Umblebylu | | Medium-sized trees, 10-12 m tall. Leaves ternate, imparpinnate, laterals opposite, undulate, apex, obtusely acute. Fruits cylindrical, pale brownish, drooping, periocarp hard. |
| Euphorbiaceae | *Kirganelia reticulata* | Shimoga and Lakkavalli, Gajnur | Tamil-Poola | Large, much branched, monecious, shrubs. Branchlets slender, glabrous, lenticellate. Leaves alternate, elliptic-oblong or obvate, apex rounded, obtuse or acute. Male flowers; stamens 5, inner 3 connate into a column, outer 2 free, shorter; anthers 2-celled. Female flowers; with scale-like disc glands alternating with perianth lobes. Berry axillary, globose, purplish-black. |
| Myristicaceae | *Knema attenuata* | Nittur, Hulikal,Yedur, Sampekatte | Raktamara | Small to medium-sized dioecious trees, 8-13 m tall, young stem and leaves tawny-furfuraceous-tomentose. Leaves alternate, elliptic-oblong, apex acute or shortly acuminate, base rounded or sub acute, glaucous beneath, petiole 0.8-2 cm long, twisted. Male flowers ca.1 cm across. Perianth 3-lobed, deeply divided; lobes 5x3 mm, ovate, rusty stellate-tomentose without. Aril reddish, uniform. |
| Rubiaceae | *Knoxia mollis* | Sampekatte, Nagara | | Erect, slender herbs, to 1 m tall. Leaves opposite, elliptic or elliptic-lanceolate. Cymes. |
| Malvaceae | *Kydia calycina* | Nagodi, Kundadri | M-Vellachadachi | Small trees, to 10 m tall, young branches stellately pubescent. Leaves alternate, ovate-orbicular. Flowers pink or white, corolla clawed. Epicalyx lobes 4, each ca. 6x3 mm, oblong, persistent. |

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| | | | | Capsule ellipsoid, 4-angled. |
| Cyperaceae | *Kyllinga brevifolia* | Bileshvara | | Rhizomatous herbs; rhizomes slender, creeping, covered by scales; stem to 20 cm tall, slender, compressed or trigonous above, striate. Leaves linear, 1-1.2 mm across, shorter than stem; sheath scarious, striate. Spikes 4 x 5 mm, of capitate cluster of many spikelets, solitary, ovoid, compressed; bracts 3-4, unequal, ca. 5 cm long; each spikelet with 1 fertile flower. Glumes 2-3 distichous, each 2-2.5 x 1 mm, ovate, mucronate, 3-4-nerved laterally; keel greenish, usually glabrous. Stamens 3, included; filaments slender |
| Araceae | *Lagenandra meeboldii* | Hulikal | | Rhizomatous, aquatic herbs., rhizome thick, adventitious roots, fleshy, long. Leaves elliptic-oblong, apex acute, base rounded, emarginated densely pubescent near margin on the upper surface. |
| Lythraceae | *Lagerstroemia microcarpa* | Sampekatte, Yedur, Kattinkere, Gajnur | Nandi mara | Medium-sized trees, 15-18 m tall, bark peeling off, barnchlets pubescent. Leaves opposite or alternate above, elliptic. Leaves 6-10 cm long; petioles up to 1.3 cm long. Flowers white, in axillary or terminal panicles. Capsule 3-valved, seeds many, winged. |
| Lythraceae | *Lagerstroemia parviflora* | Kattinkere | | Small to medium-sized deciduous trees to 15 m tall. Leaves opposite, elliptic. Capsule 3-valved, persistent calyx lobes 5, seeds many whorled. |
| Lythraceae | *Lagerstroemia reginae* | Jog | | Deciduous trees. Leaves opposite elliptic or elliptic-oblong, apex shortly acuminate, apex shortly. Capsule subglobose, apiculate, 6-valved, in terminal panicles. Fruiting calyx long, ribbed without, triangular, spreading or slightly recurved. |
| Anacardiaceae | *Lannea coroandelica* | Gajanur | Godda | Deciduous trees to 14 m tall. Leaves alternate, imparipinnate. Drupe ovoid, compressed in terminal panicles on leafless branches. |
| Verbenaceae | *Lantana camara* | Kargal | Kaadugulaabi, Chitrangi | Rambling, aromatic shrubs, stem with recurved prickles and hairs. Leaves opposite, ovate, margin |

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| | | | | serrate-crenate, apex acute, base cuneate or sub-cordate, scabrid on upper surface, pubescent on both surfaces. Flowers orange-red, in terminal pedunculate, capitates spikes, pubscent, broad above. Drupe 4 mm across, globose, black when mature, seeds 2. |
| Leeaceae | *Leea asiatica* | Savehaklu | - | Erect shrubs, stem angular, swollen above the nodes, internodes, petiole and peduncle usually with narrowed crisped wings. Leaves 1-pinnate; anthers free,<br>Stem swollen above the nodes; internodes. Calyx teeth 5, obscure, often glandular-tipped. Petals 5, connate, 2-3 mm long, ovate, acute. Staminal tube 5-lobes, 2-celled. Ovary inserted on the disc. |
| Leeaceae | *Leea indica* | Kodachadri, Hulikal, Sampekatte, Yedur, Kargal | Andilu | Shrubs, 4-5 m tall. Leaflets glabrous, bipinnate or tripinnate, Nerves 10-14 pairs, parallel, arched and forked near the margin. |
| Lamiaceae | *Leonotis nepetifolia* | Sagar | | Erect herbs, to 2 m tall, stem stout, quadrangular, pubescent. Leaves opposite, ovate, serrate-crenate, apex acute, base cuneate, pubescent. Flowers orange or brick red, dense, in axillary, globose verticillaster, to 6 cm across, bracts many, 1 cm long, tubular, broad and incurved above, 10 ribbed, reticulate, mouth oblique. Corolla more than 2 cm long, 2-lipped.nutlet 3 mm long, trigonous, base narrow, apex truncate with a pit. |
| Piperaceae | *Lepianthes umbellata* | Savehaklu | M-Attanaari | Usually erect shrubs with succulent branches. Leaves to 30 cm across, suborbicular, pubescent on nerves. Petiole about 20 cm long. Peduncle 3-6 cm long. Flowers small, bisexual, in axillary dense, subumbellate spikes, bracts small, stalked, thick, peltate. Perianth absent. |
| Acanthaceae | *Lepidagathis cuspidata* | Kodachadri hills, Jog | | Erect or undershrubs, branches ascending or spreading, stem glandular pubescent, nearly 4-angled. Leaves opposite, ovate- |

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| | | | | lanceolate or elliptic-lanceolate, entire or undulate-crenate, apex acute or shortly cauminate, mucronate, base decurrrent into petiole, pubescent. Flowers 15 mm long; spike 8 cm long, white with purple streaks, in axillary or terminal spikes long. |
| Acanthaceae | *Lepidagathis incurva* | Hulikal ghat | | Diffuse or prostrate herbs. Leaves variable, elliptic or elliptic-lanceolate, entire or obscurely crenate, apex acute, decurrent at base into the petiole. Flowers white, in axillary or terminal, 1-sided, long spikes, bracts 5 mm long, oblong-lanceolate, spinous-tipped, 3-nerved. Corolla white, with purple or brown spots. Capsule oblong-lanceolate, acute at tip, seeds 4. |
| Sapindaceae | *Lepisanthes tetraphylla* | Hulikal | M-Kalpoovathi | Small trees, to 8 m tall. Leaves alternate, pinnately compound. Rachis 28-30 cm long, pulvinate. Flowers polygamous, white, in panicles, on woody branches. Male flowers ca. 1 cm long. Disc unilateral. |
| Lamiaceae | *Leucas biflora* | Bileshvara, Hulikal | | Procumbent branched herbs, to 15 cm long, stem quadrangular, pubescent, hairs deflexed. Leaves ovate or elliptic, distantly serrate, apex acute or obtuse, base acute, pubescent. Flowers white, axillary, solitary, pedicels to 2.5 mm long, bracts linear, hairy. Calyx 8-10 mm long, campanulate, tube 5-6 mm long, 10-ribbed, hairy along ribs. Corolla 2-lipped, tube 3-4 mm long, annular-upper lip entire, hairy without. |
| Lamiaceae | *Leucas ciliata* | Hulikal, Nagodi, Chakra | | Erect, branched herbs or undershurbs, stem quadrangular, hirsute, with deflexed, jointed bulbous-based hairs. Leaves opposite, ovate, serrate, bristly bulbous-hairy. Flowers in whorls, terminal or aillary to terminal 1-2 nodes. Nutlets 3.5-4 mm long, oblong, angular on inner face , rounded on outer face. |
| Lamiaceae | *Leucas eriostoma* | Chakra | | Much branched undershrubs. stem quadrangular, branchlets subterete, densely hairy. Leaves |

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| | | | | opposite, subcoriaceous, subsessile, linear-lanceolate, serrate, apex subacute. Flowers in axillary 2-2.5 cm across whorls, bracts, 5-7 mm long, linear, plumose. |
| Lamiaceae | Leucas *lamifolia* | Kodachadri | | Densely hairy shrubby herbs 2.5-3 m tall. Leaves margin serrate-crenate, apex acute, nerves impressed. Flowers whorls 3-4 cm across, flowers 1.5-1.8 cm long, bracts linear-lanceolate, equal the calyx. |
| Lamiaceae | *Leucas marrubioides* | Bileshvara, Sampekatte | | Straggling stout herbs, stems 4-angled, simple or sparingly branched, appressedly-tomentose. Leaves sessile or shortly petioled, thick, crenate-serrate, ovate acute, ooften rugose above, white-tomentose beneath, base truncate or rounded. Flowers white, axillary, dense whorls, woolly or silky. |
| Lamiaceae | *Leucas stelligera* | Hulikal, Yedur | | Erect branched herbs, stem 4-angular, hairy, hairs erect and spreading. Leaves opposite, elliptic-lanceolate, serrate, apex obtuse or subacute, base tapering into the petiole, nerves impressed. Flowers in dense axillary or terminal whorls. Calyx 5-8 mm long, pubescent; throat villous with erect hairs; teeth ca. 2 mm long, ciliate, stellately spreading. Corolla ca. 1.2 cm long; tube ca. 5 mm long, annular within; lips nealy equal; upper wooly with long white hairs; midlobe of lower lip shortly 2-fid. |
| Lamiaceae | *Leucas zeylanica* | Nittur, Sagar, Anandapura | | Erect branched herbs, stem 4-angled, hispid, internodes long, grooved. No silvery white tomentose beneath leaves. Flowers white, whorled, axillary to terminal 1-3 nodes, pedicels 1-2 mm long, bracts 4-6 mm long. Nutlets 3 mm long, obovoid-oblong, apex rounded, scar basal. |
| Oleaceae | *Ligustrum perrottetii* | Nagara | | Large, glabrous shrubs, setm densely lenticellate. Leaves opposite, elliptic-lanceolate, apex obtusely short-acuminate, base acute or cuneate. Flowers white, terminal panicles, peduncle to 8 |

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| | | | | cm long, nearly glabrous, branches subquandrangular, sparsely lenticellate. Corolla tubes twice the length of calyx; lobes 1.5-2 mm long, spreading. |
| Oleaceae | *Ligustrum walkeri* | Nagodi, Chakra, Hulikal, Yedur | | Small trees, 5-8 m tall, branches and peduncle densely lenticellate. Leaves opposite, elliptic or elliptic-lanceolate, apex shortly acuminate, base acute. Flowers long, variable, white, in terminal panicles. |
| Scrophulariaceae | *Limnophila chinensis* | Jog | | Erect, hirsute herbs, 20-25 cm long, rooting at lower nodes. Leaves pinantely nerved; multifid lower leaves absent. Flowers purple, in axillary, solitary cyme, pedicels 6 mm long in flower, to 1.5 cm in fruit. Capsule enclosed in calyx, seeds angular, truncate, tubercled. |
| Scrophulariaceae | *Limnophila indica* | Hulikal, Induvalli | | Erect herbs, Stem up to 20 cm high, upper leaves frequently absent, corolla pale yellow. Flowers pedicelled, Corolla 8-10 mm long; tube broad; lobes 5, 2-lipped. Capsule subglobose, seeds angular. |
| Scrophulariaceae | *Linderina antipoda* | Nittur, Jog | | Prostrate or diffuse herbs, branches ascending. Leaves opposite, sessile, narrowly elliptic-oblong or obovate, serrate, apex obtuse or acute, narrowed to base.flowers blue, in terminal, difarious racemes.Calyx deeply divided; lobes 5-6 mm long, lanceolate. Corolla tube 8 mm long; lobes 5, unequal 2-lipped; upper lip little longer, entire; lower with 3-broader lobes. Capsule cylindrical, seeds small, pitted. |
| Scrophulariaceae | *Linderina cillata* | Nagara, Hulikal | | Erect herbs, 3-4 cm tall, unbranched or diffusely branched, stem angular. Leaves aristate-serrate; penninerved, apex acute-aristate, narrowed at base. Flowers bluish or pink, terminal, solitary or few in lax racemes. Calyx 5-lobed, connate, 5 mm long, linear, aristate. Corolla tube narrow; lobes unequal, 2-lipped; upper emarginate; lower 3-lobed. Capsules oblong, acute or |

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| | | | | apiculate, seeds small. |
| Scrophulariacea e | *Linderina crustace* | Nagara, Hulikal | | Erect, branched or unbranched herbs to 6 cm tall, stem angular, glabrous or sparsely hairy. Leaves opposite, ovate, serrate, apex subacute, base cuneate, glabrous or hairy along nerves beneath and margin. Flowers to 8 mm long, bluish or pale pink, axillary or terminal solitary. Corolla tube cylindrical, broad above; lobes 5, unequal, 2-lipped, upper erect, bifid, lower 3-lobed. Capsule ovoid, included in calyx, seeds ellipsoid. |
| Scrophulariaceae | *Linderina hyssopioides* | Hulikal | | Erect herbs to 4-6 cm tall. Leaves opposite, in distant pairs, sessile, narrowly oblong-lanceolate or elliptic, entire or minutely serrate-crenate, apex obtuse or acute, base rounded. Flowers blusih-white, axillary, solitary, fruiting pedicels 1.2-1.5 cm long, deflexed. Capsule ovoid, seeds small. |
| Linaceae | *Linum mysorense* | Nagara fort, Chakra | - | Slender, erect, branched herbs, to 45 cm tall. Stem striate. Leaves alternate, sessile, linear or narrowly obovate, apex acute, tapering at base. Flowers small 0.8 cm in diameter., yellow |
| Lauraceae | *Litsea coriacea* | Hulikal, Yedur | M-Maravetti thalai | Small trees, 10 m tall, young parts of stem, petiole and leaves beneath minutely pubescent. Leaves elliptic-obovate or lanceate, cuneate at base, glaucous beneath; lateral nerves 6-7 pairs, obscure. Inflorescence subsessile. Umbellules pubescent without, in sessile or subsessile clusters, fruiting peduncle to 5 mm long. Fruit ovoid, paex obtuse seated on persistent, copular, truncate perianth tube. |
| Lauraceae | *Litsea floribunda* | Hulikal, Nagodi.Chakra, Yedur | - | Small, diocious trees, to 10 m tall, young stem, leaves beneath and peuncle fulvous-tomentose. Leaves alternate, rarely opposite or subopposite, penninerved, rarely triple-nerved, leaf-buds naked or scaly. Umbellules globose, stalked, in axillary racemes or apnilces. Flowers 3 mm long in bud, sessile, 6-8 in |

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| | | | | each umbellule, bracts 3 pairs, outer hairy. Perianth lobes 6. Berry ovoid, seated on capular, truncate perianth-tube. |
| Lauraceae | *Litsea ghatica* | Sampekatte, Savehaklu, Kodachadri | - | Dioecious shrubs or small trees, young shoots tomentose, elongsting through terminal scales. Leaves subverticillate; umbellules solitary. Flowers unisexual, 4-5 in solitary umbels, peduncle 5-8 mm long, cauliferous, bracts ovate, usually in pairs, tomentose without. |
| Lauraceae | *Litsea wightiana* | Hulikal, Yedur, Jog | - | Trees, 8-20 m tall, young shoots, beneath and inflorescence fulovs-tomentose. Petiole to 1.5 cm long; leaf blade elliptic-lanceolate, acute, 8*3.5 cm, nearly glabrous when mature; lateral nerves much impressed above; transverse nervules not prominent. |
| Campanulaceae | *Lobelia nicotianifolia* | Chakra | M-Kattupukayila | Subshrubs; stem pubescent, hollow within, branches short. Leaves alternate, sessile, narrowly oblong-lanceolate, serrate, apex acute, base rounded or subacute, pubscent. Flowers in long, terminal racemes. |
| Hippocrateaceae | *Loeseneriella bourdillonii* | Nagavalli | | Large climbing shrubs, branches often twisted. Leaves opposite, coriaceous, ovate-oblong, margin minutely glandular serrate. Flowers ovoid, acute in bud, yellowish-green, in axillary or terminal paniculate cymes. |
| Celastraceae | *Lophopetalum wightianum* | Yedur, Vartekodalu | | Glabrous trees, to 20 m tall, branchlets compressed. Leaves opposite, rarely alternate, coriaceous, oblong or oblong-lanceolate, apex. Flowers pale reddish, in axillary or terminal panicles, of corymbose cymes. Capsules 3-gonous, 3-valved. Seeds many compressed, winged around. |
| Onagraceae | *Ludwigia adscendens* | Anandapura | | Aquatic herbs; stems floating with white aerophores. Flowers 5-merous. Floating aquatic herbs, with whitish spongy floats at nodes; branches ascending, solitary axillary. |
| Onagraceae | *Ludwigia hyssopifolia* | Nagara fort | | Erect, terrestrial herbs; stems erect, without aerophores. Flowers 4-merous; stamens 8. |

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| | | | | Capsules linear, terete, more than 1 cm long. |
| Onagraceae | *Ludwigia octovalvis* | Tenkbail | M-Kattukarayambu | Erect branched herbs, 0.5-1 m tall, stem subterete or angular, striate, villous upwards. Leaves hirsute, acute. Flowers yellow; flowers pedicelled. Capsule 4-5 cm long, linear, more or less angular, 8-ribbed, villous, dehiscing between the ribs. |
| Onagraceae | *Ludwigia perennis* | Hulikal | M-Neerkarayambu | Paludose, erect, branched herbs. Leaves alternate, submembranous, obovate.flowers yellow, axillary, solitary, pedicels 1-4 mm long. Capsule subcylindric 4-5-valved. |
| Rutaceae | *Luvunga sarmentosa* | Hulikal, Savehaklu | - | Large, armed, scandent shrubs, spines axillary. Leaves palmately 3-foliolate, alternate. Flowers greenish-white, black when dry, in axillary racemes or panicles. Berry obovoid or ellipsoid gland-pitted, black when dry. |
| Solanaceae | *Lycianthes laevis* | Chakra, Savehaklu, Kodachadri top, Nagodi | | Erect herbs, branches divaricate, stem stellately pubescent. Leaves lowers alternate, upper opposite pairs unequal, membranous. Flowers white or purplish-white, axillary, solitary or paired. Berry. |
| Euphorbiaceae | *Macaranga peltata* | Kodachadri, Hulikal, Yedur | K-Uppaligana-mara | Dioecious, resinous trees, to 10 m tall, young parts pubescent. Leaves alternate, peltate, orbicular or broadly ovate, entire or minutely dentate, apex acute or acuminate. Flowers in axillary, long panicles, male minute, numerous, clustered in the axils of large bracts with dentate apex. Capsules globose, 2-valved, seed 1, rounded, blackish. |
| Sapotaceae | *Madhuca neriifolia* | Hulical | Holehippe | Evergreen trees. Stipules linear to 7 mm long, leaf blade acute to obtuse at apex, usually cuneate at base, glabrous. Corolla white, pubescent. Stamens 16, in 2 whorls, hirsute. Ovary glabrous. Berry fusiform, beaked to 3 cm long. |
| Myrsinaceae | *Maesa indica* | Kodachadri base, Savehaklu, Hulikal | - | Branchlets and leaves densely rusty-tomentose to glabrous. Leaves elliptic-ovate, serrate-dentate, chartaceoud, often paler beneath. Calyx lobes obtuse or acute at apex. Stigma 3. Beery to |

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| | | | | 0.5 cm across. |
| Orchidaceae | *Malaxis rheedii* | Nagodi | | Terrestrial, erect herbs; stem swollen at base, with membranous sheaths around. Leaves 3-5, upper 2 larger, to 10x3 cm, elliptic-lanceolate, apex acute, base narrowed into sheaths, plicate, 7-nerved. Capsule including stalk 2x0.5 cm, obovate, twisted at base, in terminal 14 cm long, angular racemose scapes; bracts persistent, ca. 5 mm long, lanceolate. Fruiting: September |
| Euphorbiaceae | *Mallotus ferrugineus* | Nagodi, Hulikal | | Small to medium-sized dioecious trees to 17 m tall, branchlets petiole, leaves beneath and inflorescence clothed with tawny-stellate tomentum. Leaves alternate or opposite, unequal when opposite, broadly ovate, entires or slightly wavy. Flowers in terminal or axillary panicles, male in interrupted clusters, small, globose. Capsule echinate. |
| Euphorbiaceae | *Mallotus philippensis* | Yedur, Nivane, Hulikal, Umblebylu | M-Manjana | Small, dioecious trees, branchlets stellately-pubescent. Leaves variable, crowded near the top, alternate, ovate or ovate-lanceolate, apex acute or shortly acuminate. Male flowers small, globose, yellowish in axillary or terminal paniculate –spikes, 2 or more flowers to bract. Perianth lobes 4. Stamens numerous, free. Capsules red – glandular, globose. |
| Euphorbiaceae | *Mallotus repandus* | Kargal, Hosagadde | | Large straggling, dioecious shrubs, stem lenticellate, tawny-stellate pubescent as on leaves beneath and inflorescence. Leaves alternate, ovate or rhomboidal, entire or repand-toothed, apex acute or shortly acuminate, base rounded or truncate. Male flowers globose, in terminal, slender 10 cm long, pedunculate panicles. Perianth 3-lobed, free to base, pubescent without. Stamens numerous, filaments free, anthers 2-celled. |
| Euphorbiaceae | *Mallotus stenanthus* | Kodachadri, Kattinkere | | Monoecious shrubs or small trees, branches pubescent or glabrous, branchlets compressed. Leaves |

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| | | | | opposite, unequal, elliptic or ovate-lanecolate. Flowers in racemes or spikes, male and female on separate axils. Male flowers yellowish, ovoid in buds. Capsule sparsely spiny, yellow resinous - glandular, as on leaves beneath |
| Euphorbiaceae | *Margaritaria indica* | Kattinkere | | Branched, dioecious, deciduous trees, to 15 m tall, lenticels white, bark yellowish-white within. Leaves alternate, broadly elliptic-obovate, apex obtuse or abruptly shortly acuminate, base acute. Perianth lobes 4, persistent. Capsule globose, 3-valved, faintly reticulately rugose, in axillary clusters. Seed white-arillate |
| Cyperaceae | *Mariscus maderaspatanus* | Hulikal | | Slender, annual herbs to 8 cm long. Leaves few, basal, filiform, nearly as long as stem. Inflorescence in simple, umbellate, spikelets; rays 3-4, each ca. 1.5 cm long; bracts leafy, few, unequal, much longer than rays; rachis narrowly winged. Spikelets with 15-20 distichous glumes, the lowest 2 small, empty. Fertile glumes ca. 3 mm long, narrowly oblong, keeled; keel strong, green, excurrent in a recurved arista; sides membranous, strongly 3-5-nerved. Stamen 1, Nuts ca. 1.5 mm long, oblong, slightly curved, acute, trigonous, brown, puncticulate; style base persistent. |
| Cyperaceae | *Mariscus paniceus* | Hulikal | | Erect, rhizomatous herbs; rhizomes slender, stoloniferous; stem to 30 cm long, slender, trifonous upwards, compressed below, striate, usually thickened at base. Leaves to 25 cm long, shorter or longer than the stem, filiform; sheath broad, striate, not thickened. Inflorescence in umbellate spikes; rays 3-7; bracts 4-6, unequal, leaf-like, the longest to 20 cm long. Spikes 1-1.2 cm long, lax; rachis triangular, narrowly winged. Spikelets 3-3.5 mm long; glumes usually 4, the lowest 2 small, 1-2 mm long, empty, persistent, the third fertile, |

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| | | | | ca. 3.5 mm long, elliptic or ovate-lanceolate, the fourth empty, lanceolate. Stamens 3; filaments slender; anthers 2-celled, linear, exserted. Styles 3-lobed, exserted. Nuts ca. 3 x 0.5 mm oblong-ellipsoid, often slightly curved, trigonous. |
| Loranthaceae | *Marosolen capitellatus* | Gajnur, Hulikal | | Glabrous, parasitic shrubs. Leaves opposite, coriaceous, ovate-lanceolate or elliptic-lanceolate, apex obtuse or acuminate, base acute, decurrent into short petiole. Flowers greenish-red, few, in condensed axillary spikes, peduncle stout. |
| Loranthaceae | *Marosolen parasiticus* | Yedur | | Parasitic shrubs, stem thickened at nodes, lenticellate. Leaves opposite, ovate-lanceolate or oblong-lanceolate, apex acuminate, base rounded. Flowers few, sessile, in short, axillary spikes, peduncle to 1 cm long, bracts ovate. Berry ovoid, green with persistent calyx tube. |
| Cornaceae | *Mastixia pentandra* | Yedur | | Moderate-sized trees, to 15 m tall. Leaves alternate or subopposite, elliptic-oblong or ovate, apex abruptly shortly acuminate, base rounded or subacute, unequal. Drupe ellipsoid in terminal panicles. |
| Celastraceae | *Maytenus rothiana* | Mastikatte, Hulikal, Kundadri | | Armed or unarmed erect shrubs. Leaves alternate, subcoriaceous, ovate-oblong. Flowers greenish-white, in fascicles of short cymes at leafless nodes. Ripe capsules red; peduncles short |
| Scrophulariacea e | *Mecardonia procumbens* | Chakra | | Prostrate or sub-erect herbs with ascending branches rooting at lower nodes. Leaves opposite, sessile or subsessile, ovate or elliptic, serrate-crenate above the middle, apex obtuse, narrowed at base, gland-dotted. Flowers yellow, axillary, solitary or paired.Corolla to 1 cm long; tube broad above, hairy at throat; lobes 5, 2-lipped. Capsule ellipsoid, seeds many, small, reticulate. |
| Melastomatacea e | *Medinilla beddomei* | Kodachadri | | Epiphytic to Vateria indica L. epiphytic large shrubs, rooting at nodes, stem succulent, minutely white-scaly. Leaves opposite, |

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| | | | | succulent, oavet-orbicular, apex obtuse or rounded. |
| Annonaceae | *Meiogyne pannosa* | Hulical, Jog falls | | Shrubs or small trees, 5-7 m tall, young parts tomentose. Leaves alternate, ovate or elliptic-lanceolate. Flowers yellowish-green, densely tomentose, axillary, solitary sessile. Fruitlets ovoid or globose with rounded beak, hairy. |
| Melastomatacea e | *Melastoma malabathricum* | Nagodi | Nekkarika; Nekkare, Dodda Nekkare | Erect, much branched shrubs 2-2.5 m tall, branches, petiole, nerves densely covered with adpressed lanceloate scales. Leaves opposite, elliptic or ovate-oblong, acute, 5-nerved from base. Flowers purplish, in terminal clusters. |
| Sterculiaceae | *Melochia corchorifolia* | Savehaklu | - | Erect branched herbs; leaves ovate-oblong, often shallowly lobed, cordate to round at base, crenate-serrate. Flowers arranged in terminal clusters. Bracts and bracteoles ciliate. Calyx 5 toothed. Capsules globose, 0.5 cm across. |
| Melastomatacea e | *Memecylon talbotianum* | Hulikal, Nittur, Jog, Kattinkere | | Trees or large shrubs, branchlets terete or slightly compressed. Leaves opposite, ovate or elliptic, margin slightly revolute, apex obtuse. Berries bright yellow when ripe; drying leaves yellow. |
| Melastomatacea e | *Memecylon terminale* | Hulikal | | Erect shrubs, 1-1.5 m tall, stem terete or quadrangular. Leaves opposite, sessile, ovate-lanceolate. Flowers hairy at base. |
| Melastomatacea e | *Memecylon wightii* | Hulikal | | Shrubs or small trees, dichotomous, quadrangular, narrowly winged. Leaves opposite, coriaceous, subsessile or shortly petioled, ovate-oblong. Fruiting pedicel, fruit-clusters to 2 cm across. Berry reddish with persistent, truncate calyx. |
| Convolvulaceae | *Merremia umbellata* | Hulikal | | Large, straggling or climbing shrubs, branches longitudinally grooved and spirally twisted, glabrous.Leaves entire, crenate or 3-lobed, linear-lanceolate, lobes 1 to several toothed. Flowers numerous, in axillary. Corolla 1-2 cm, pale yellow. Capsule globose or ovoid, black, seeds 4, black, densely clothed with long hairs. |

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| Convolvulaceae | *Merremia vitifolia* | Hulikal | | Large twiners, hairs when young, glabrous on age. Leaves palmately 5 - 7 lobed. Flowers yellowish, in axillary, 1 to few flowered cymes, capsule subglobose, 4-valved, seeds 4. |
| Myrtaceae | *Metereomyrtus wynaadensis* | Nittur, Chakra, Hulikal, Kundadri | | A small tree or shrub, Leaves rather thin; lateral nerves indistict above, slender beneath and uniting into a continuos one within the margin; pedancles supra-axillary, calyx lobes lanceolate acuminate a little longer than the corrolla, bracts 2 linear much longer than the flowers, stamens inserted round the edge of the disk |
| Caesalpiniaceae | *Mezoneuron cucullatum* | Hulikal | | Large, prickly climbing shrubs, prickles on corky tubercles, curved. Leaves 2-pinnate, rachis 30 cm long, pinnae 2-5 pairs, leaflets opposite. Flowers yellow, streaked with crimson, in axillary or terminal panicles.Sepals cucullate; pods thin. Rachis ca. 30 cm long; pinnae 2-5 pairs, each 10 cm long. Pod reddish-brown, flat, oblong, winged along the upper suture, 1-seeded. |
| Celastraceae | *Microtropis latifolia* | Varahi | | Shrubs or small trees, 4-6m tall, stem blackish. Leaves opposite, coriaceous, elliptic, apex blunt, acute or obtuse. Flowers in sessile clusters, in axillary or extra-axillary. |
| Mimosaceae | *Mimosa pudica* | Savehaklu | Naachige-mullu | Diffuse prickly herbs, stem sparingly prickly and bristly, leaves bpinnately compound, stipules linear, long ciliate. Pinnae 1-2 pairs, arranged palmately, Rachis 2-4 cm long; stipules linear, long ciliate. Pinnae 1-2 pairs, to 5 cm long. Flowers small, sessile, pinkish-white. Pod 3-5-jointed, bristly. |
| Icacinaceae | *Miquelia dentata* | Hulikal | | Dioecious climbing shrubs, branches glabrous. Leaves alternate, obruptly acuminate, base rounded. Drupe ovoid, more or less compressed, yellowish, 1-seeded. |
| Rubiaceae | *Mitracarpus verticiliatus* | Kaimara, Jayanagara, Jog | | Erect, simpe or sparingly branched, rigid herbs to 40 cm tall, stem 4-angled, hairy, |

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| | | | | internodes long. Leaves opposite, subsessile, elliptic. Corolla tube 2.5 mm long, narrow; lobes 4, each 0.5 mm long. Capsule 1 mm across, 2-locular, circumcissile below the middle, seeds 2. |
| Rubiaceae | *Mitragyna parviflora* | Kattinkere | Kongu | Small, trees, to 10 m tall, branchlets compressed, broad at nodes, glabrous, or pubescent. Leaves rounded or obtuse at apex, veins 5 - 7 pairs, Calyx with pair of leafy bract. Corolla 6 mm long; lobes acute. Plant associated with Terminalia paniculata Roth and Tectona grandis. L. |
| Annonaceae | *Mitrephora grandiflora* | Hulical ghat | | A large tree. Leaves with woolly tufts in the forks of the nerves beneath; stigma club-shaped. Flowers outer petals white with inner crimson spotted |
| Hypoxidaceae | *Molineria trichocarpa* | Savehaklu | | Erect herbs, root-stocks cylindric, stout. Leaves basal, papery, elliptic-oblong or elliptic-lanceolate, apex acuminate, base acute. Flowers few, in terminal corymbs. Perianth 6-lobed, in 2 whorls, free, outer longer, 1-nerved, hairy without. |
| Molluginaceae | *Mollugo pentaphylla* | Kattinkere | | Annual, slender, erect herbs, to 12 cm tall, stem angular, glabrous. Leaves simple, in whorls of 2-5 membranous, obovate or linear-lanceolate. Flowers brownish or white, in terminal corymbosely branched cymes. Capsule membranous, included in the perianth, 3-valved |
| Cucurbitaceae | *Momordica dioica* | Nagara, Chakra, Sampekatte | Kaaduhaagala | Plants dioecious; roots tuberous, tendril simple, leaf-opposed. Leaves alternate, membranous, broadly ovate. Male flowers bracteate near the top of the peduncle; calyx-lobes linear-laceolate, acute.fruit ovoid, fleshy, 3-valved, muricate, seeds flattened, sculptured. |
| Pontederiaceae | *Monochoria hastaefolia* | Anandapura | Te-Nir-tamara | Aquatic herbs; root-stock creeping clothed with adventitious roots and remains of leaf sheaths. Leaves large, long-petioled; petiole 35-70; blade 16 x 7 cm or more, sagittate or hastate, apex acuminate, deeply cordate at base; petioles of floral |

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| | | | | leaves tumid above, spathe-like, embracing the short, stout peduncle. |
| Caesalpiniaceae | *Moullava spicata* | Chakra, Sampekatte | Vagati, Gajjiga balli | Large, prickly, climbing shrubs, stem, leaves and peduncle pubescent. Leaves bipinnately compound, rachis 20-25 cm long, prickly, pinnae 6 pairs. Inflorescence spicate racemes; sepals scarlet. Pods swollen above the seeds and constricted between them. |
| Papilionaceae | *Mucuna monosperma* | Nagavalli | M-Malanthalli | Large woody twiners, branches slender, grooved, pubescent, glabrous with age. Leaves pinnately 3-foliolate.flowers in axillary racemes, white-pubescent. Pod as long as broad, 1-seeded |
| Papilionaceae | *Mucuna pruriens* | Kodachadri | Naaisungu | Large annual twiners, branches tomentose, glabrous with age. Leaves alternate, 3-foliolate. Pod neither winged nor transversely plaited, Pod S-shaped, turgid, covered with yellow brown stinging hairs. |
| Commelinaceae | *Murdannia lanuginosa* | Savehaklu | | Erect or suberect, branched herbs, fibrous roots often tuberous, slightly thickened, stem angular, glabrous or hairy. Leaves cauline, alternate, oblong-lanceolate or lanceolate, margin undulate, apex acute or shortly acuminate. Flowers 5-6 mm long, 1-2, axillary to the upper leaf-sheaths. Capsule oblong, trigonous, cuspidate with persistent style, 3-celled, seedsd 3 or more, angular, pitted. |
| Commelinaceae | *Murdannia pauciflora* | Yedur | | Tufted, erect, slender herbs to 8 cm tall, stem condensed. Leaves basal, linear, acute or acuminate, broad at base. Flowers brownish yellow, in axillary 1 - 4 flowered. cymes; fruiting pedicels decurved |
| Commelinaceae | *Murdannia semiteres* | Nagara | | Small, erect herbs, branched from base, branches decumbent, rooting at nodes, roots fibrous. Leaves cauline, approximate near base, distant and smaller upwards. Flowers purple, blue or white, in terminal corymbs or panicles; seeds 2-seriate in each cell; leaves filiform, narrowly linear or |

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| | | | | subulate-semiterete. Fertile stamens with naked filaments. |
| Commelinaceae | *Murdannia simplex* | Savehaklu, Yedur | | Slender, erect herbs, roots fibrous, elongate often tuberous, stem suberect with long internodes. Leaves basal, tufted and a few cauline, linear-lanceolate, apex acute or shortly acuminate, scabrid at margin. Flowers slightly irregular, blue. In terminal lax panicles. Capsules oblong, 3-valved, seeds 1-2 in each valve, obscurely rugose. |
| Commelinaceae | *Murdannia spirata* | Yedur | | Small, erect herbs, branched from base, branches decumbent, rooting at nodes, roots fibrous. Leaves cauline approximate near base, distant and smaller upwards, lower broadly linear-lanceolate. Flowers in axillary or terminal, few flowered dichotomously branches panicles. Capsule ovoid, oblong, trigonous, mucronate, smooth, 3-valved, fruiting pedicels 6-8 mm long, erect, seeds uniseriate, 3 in each cell, cubical or angular, rugose. |
| Rubiaceae | *Mussaenda laxa* | Mastikatte, Yedur, Nagara fort | Bellante-Gida | Large scandent shrubs, compressed, divaricate, adpressed-hairy, glabrous with age. Leaves opposite, ovate-orbicular or ovate, apex shortly acuminate, base cuneate. Berries obovoid, black when dry. |
| Myristicaceae | *Myristica dactyloides* | Hulikal | M-Adakkapayin | Medium-sized dioecious trees, to 13 m tall. Leaves alternate, coriaceous, elliptic oblong, apx obtusely acute, base acute or cuneate, pale glaucous beneath nerves 12-17 pairs, impressed above. Male flowers: 5-8 mm long, ovoid in bud, rusty-tomentose. Associated with Elaceocarpus tuberculatus L. perianth 3-lobed, united below, glabrous within. |
| Myristicaceae | *Myristica malabarica* | Hosur | M-Panampalka | Large trees, to 26 m tall. Leaves alternate, chartaceous or subcoriaceous, elliptic-lanceolate or obovate, apex obtuse or blunt acute, base subacute, pale brownish beneath when dry, nerves slender to 10 pairs. Fruit often 2-valved; sutures |

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| | | | | prominent, longitudinally grooved on 2 sides, rusty-tomentose; aril yellowish. Associated with Hydnocarpus laurifolia (Dennst.) Slender |
| Ranunculaceae | *Naravelia zeylanica* | Hulical, Savehaklu, Tagarthi | - | Young parts softly tomentose. Leaves opposite, 3-foliolate, petioles long, leaflets ovate, acute, 5-ribbed, glabrous above, downy beneath. Tendril 10-12 cm long. Fruit a head of twisted achenes ending in twisted feathery tail. |
| Meliaceae | *Naregamia alata* | Hulikal | - | Stunted shrubs or undershrubs, 15-45 cm tall. Leaves 3-foliolate, alternate, leaflets middle larger, sessile, obovate, apex rounded or obtuse, base cuneate. Flowers longer than leaves, white, solitary, axillary, pedicellate. Fruits 3-valved capsule, truncate at either end, muricate. |
| Rubiaceae | *Neanotis foetida* | Nagara, Hulikal, Jayanagara | | Slender, erect herbs, 10-20 cm long, simple or branched, stem 4-angled. Leaves linear-lanceolate, sessile. Flowers subsessile, in clusters. Capsule broader than long, 2-valved, dehiscing from the top, seeds locule, excavated and pitted on black. |
| Rubiaceae | *Neanotis quadrilocularis* | Hulikal, Chakra | | Erect, divaricately branched herbs, rooting at lower nodes, stem slender, 4-angled, internodes long. Leaves opposite, membranous, ovate, apex acute, apiculate. Flowers pinkish, sessile, axillary or in terminal pedunculate, enlarged in fruits. Capsule small, 4-valved, dehiscing from top; seeds 1 or more in each locule, convex, excavated and pitted on outer surface. |
| Rubiaceae | *Neanotis rheedii* | Kodachadri | | Erect, slender, branched annual herbs, stem glabrous, internodes long. Leaves ovate, petioled; flowers with filiform pedicels, in lax cymes. Capsule compressed, dehiscing from the top, appearing like 4 connate cups, seeds 2, rugose, style arms 2. Feathery. |
| Acanthaceae | *Nelsonia campestris* | Hulikal ghat | | Trailing villous herbs. Leaves variable, lower large, 10-20 cm long with long petioles, the upper |

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| | | | | smaller with short petioles. Flowers purplish spikes. Capsules ovoid, glabrous, seeds 8-10, ellipsoid, brownish, granular. |
| Lauraceae | *Neolitsea scrobiculata* | Hulikal,Jog, Yedur | | Small, dioecious shrubs or trees to 5 m. Petiole 3-6 cm long. Leaf blade elliptic-ovate, minutely pitted, coriaceous. Umbels subsessile. Flowers 3-5 mm long, sessile, greenish-white, 5-7-flowered umbellules, in axillary clusters, involucral bract 4, silky-hairy. Berry globose, to 1 cm across. |
| Rubiaceae | *Neonauclea purpurea* | Hulikal | | Small to medium-sized tress, 8-13 m tall. Leaves opposite, unequal, elliptic or obovate. Flowers small, sessile, in terminal. |
| Orchidaceae | *Nervilia discolor* | Nittur | | Hysteranthous terrestrial, tuberous herbs; tubers 2 cm across, globose or ovoid with root-let knobs and often with transverse bands. Leaves 3.5-6 cm across, solitary, ovate-orbicular, apex acute, base cordate, prominently 13-nerved, pale reddish-brown, hairy; hairs 1-2 mm long; petiole short; sheaths 3-4, each to 2.5 cm long. Scape to 8 cm long. Flowers 2, terminal and at right angles to the scape; pedicels short; bracts ovate. |
| Orchidaceae | *Nervilia prainiana* | Sampekatte | | Hysteranthous terrestrial tuberous herbs; tubers to 1 cm across. Leaves solitary, flat, greenish, 2.5-3.5 x 3.5-5 cm, orbicular or reniform, margin entire or crenulate, base cordate, 11-nerved from base, prominent beneath, densely hairy above; petiole to 2.5 cm long, with few sheaths at base. Flowering: September. |
| Rubiaceae | *Neurocalyx calycinus* | Hulikal, Varahi | | Woody, annual herbs, 25 cm tall. Leaves opposite, mostly crowded at the ends of branches, sessile. Flowers 15-16 mm across, 5-merous, white, in axillary racemes. |
| Acanthaceae | *Nilgirianthus barbatus* | Hulikal | | Erect shrubs or undershrubs, stem and branches 4-winged. Leaves opposite, broadly elliptic, obovate, serrate-crenate. |
| Acanthaceae | *Nilgirianthus* | Sampekatte, | | Small shrubs, stems hirsute |

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| | *heyneanuss* | Chakra, Yedur, Kodachadri, Nagavalli | | upwards. Leaves acuminate closely crenate-serrate, hairy above, with short, stiff, bulbous-based hairs, softly hairy on the nerves beneath, base tapering. Flowers bluish, in axillary, simple or branched spikes, peduncles short, bracts membranous, broadly elliptic, rounded at apex, concave. |
| Icacinaceae | *Nothapodytes nimmoniana* | Chakra, Yedur, Hulikal | Durvaasane mara | Small trees, to 8 m tall, branchlets compressed lenticellate. Leaves alternate, broadly ovate-oblong, apex acute-acuminate or obtuse. Flowers yellowish-white, foetid, in terminak paniculate cymes. Drupe ovoid, purple, 1-seeded. |
| Anacardiaceae | *Nothopegia racemosa* | Way to Govardhana giri | | Small trees, to 5 m tall. Leaves alternate, subcoriaceous, glaucous beneath. Flowers unisexual, male 3 mm long, more or less sessile, in clusters of 3, on slender, axillary 2 cm long, rusty-pubescnt peduncle. |
| Nymphaeaceae | *Nymphaea nouchali* | kattinakere | Naidile, K-Neela thavare | Perennial aquatic herbs, root-stock cylindrical, straight. Leaves floating and glabrous beneath, entire or obtusely sinuate-dentate. Carpels enclosed in hollow receptacle, loosely united, stigma sessile, many, linear. |
| Nymphaeaceae | *Nymphaea pubescens* | Basavani | Naidile, Kannaidile | Perennial aquatic herbs, root-stock cylindrical, straight. Leaves floating. Leaves densely pubescent beneath, sharply dentate. Petals in many whorls, free, anthers 2-celled, linear, connective hood-like. Carpels many, enclosed in hollow receptacle, loosely united. |
| Menyanthaceae | *Nymphoides indica* | Kattinkere, Induvalli | | Aquatic herbs, rhizomes very short, erect, with long petiole-like branches, reaching the surface of water. Only floating leaves; Corolla more than 12 mm across; lobes 5 -7; Corolla lobes densely fimbriate on inner surface.Seeds few, biconvex, thickened at margin, glandular-pitted. |
| Orchidaceae | *Oberonia chandrasekharanii* | Nagodi | | Pendulous epiphytes, to 20 cm tall. Leaves to 13 x 1 cm, distichous, ensiform, apex acute. Flowers to 4 mm long, yellowish-green or pale brownish, shortly |

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| | | | | pedicelled, in approximate whorls of terminal spicate racemes ; peduncle ca. 14 cm long, adnate to the uppermost leaf at base ; ovary with pedicels to 3 mm long, broadened upwards ; bracts slightly longer than ovary, ovate, acute or acuminate, fringed along margin. Sepals 3, free, ca. 1 x 1 mm, ovate-oblong, obtuse, deflexed. Petals 1 x 0.5 mm, slightly narrower than calyx-lobes, linear, toothed at apex. |
| Orchidaceae | *Oberonia verticillata* | Sampekatte | | Pendulous, epiphytic herbs, without distinct stem. Leaves 2-9 x 0.5-1 cm, coriaceous, ensiform, oblong, apex acute. Flowers ca. 1.5-2 mm long, pale yellowish, in whorls of spiciform racemes ; peduncle slender, to 12 cm long, curved or nearly straight, not jointed to the uppermost leaf ; pedicels short ; bracts 1.5-2 mm long, slightly longer than flowers, lanceolate acuminate, sepals 3, free ca. 0.8 mm long, subequal, lateral lobes slightly long. Petals smaller than sepals, ovate, apex sub-obtuse, 1-nerved. Lip 1.5-2 mm long, obovate, cuneate at base, 3-lobed, lateral lobes minute, indistinct ; midlobe broadly obovate, 2-lobuled ; lobules crenate dentate. Staminal columnshort. |
| Olacaceae | *Olax wightiana* | Jog | - | Large unarmed climbers. Leaves alternate, oblong or oblong-lanceolate, apex obtuse, base rounded, midrib impressed above. Flowers greenish-white, in axillary, compact racemes. Drupes 15-18 mm long. |
| Oleaceae | *Olea dioica* | Hulikal, Kodachadri, Jog, Nagavalli | | Small to medium-sized, dioecious trees, branchlets compressed. Leaves opposite, subcoriaceous, elliptic or elliptic-lanceloate, entire or distantly serrate-dentate, apex abruptly acuminate, Male flowers: creamy-white, in extra-axillary, slender, paniculate cymes; peduncle 4-4.5 cm long; pedicels 2-3 mm long. |
| Haemodoraceae | *Ophiopogon indicus* | Kodachadri hills | | Scapigerous herbs; root-stocks short; roots stout, long. Leaves |

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| | | | | radical, grass-like, linear, apex acute, narrowed at base, greenish dorsally, pale beneath, petiole rigid. Scape ca. 25 cm long, slender. Fruits pseudo-berries, few, crowded at the ends of the scapes; seeds ca, 5 mm across. Globose, fleshy, 1-3, bursting through the pericarp during ripening and rest at the base of withered pericarp. Fruiting: October. |
| Rubiaceae | *Ophiorrhiza harrissiana* | Hulikal, Jog | | Erect or suberect herbs with ascending branches, rooting at lowers nodes, stem minutely hairy. Leaves opposite, elliptic or ovate-elliptic, apex obtusely acute. Flowers 5-6 mm long, white, terminal second, dichotomous cymes.Corolla tube constricted 1 mm above the base. Capsule obcordate, compressed, glabrous or minutely pubescent. |
| Rubiaceae | *Ophiorrhiza hirsutula* | Sampekatte | | Erect or suberect herbs, woody at base, stem hairy. Leaves opposite, elliptic or ovate-lanceolate, apex acute or acuminate, base acute or cuneate. Flowers white, in terminal, few-flowered, dichotomous cymes. |
| Poaceae | *Oplismenus compositus* | Yedur | | Tall, slender, branched grass; stem striate, creeping and rooting from nodes below, with ascending branches, more or less hairy. Leaves 4-11 x 1-1.6 cm, ovate-lanceolate, apex acute, margin scabrid, base narrowed and rounded, auricled on one side, hairy ; sheaths striate, hairy, ciliate; ligules membranous, hairy. Inflorescence terminal panicle, ca. 25 cm long; peduncle triangular, hairy; branches 5-9 cm long, distant, angular, hairy. Spikelets 3.5-4 mm long, excluding awn, usually in distant pairs, ovate-lanceolate, subsessile or one of the pairsshortly-pedicelled, often hairy at base. |
| Poaceae | *Oryza rufipogon* | Bileshvara | | Erect, semi-aquatic herbs, to 80 cm tall, stem ribbed. Leaves linear-lanceolate, acuminate, scabrous, striate, sheath striate, glabrous. Spikelets 1-flowered, |

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| | | | | oblong, compressed. Lodicules 2, membranous. Caryopsis oblong, compressed, free within lemma, style 2, stigmas plumose. |
| Melastomatacea e | *Osbeckia truncata* | Nagara, Chakra, Jayanagara | | Erect annual herbs 10-30 cm tall, unbranched or with few opposite branches, stem quadrangular with long spreading hairs. Leaves opposite, elliptic or ovate, entire or serrulate. Flowers in terminal clusters often with 2 pairs of leaves below. Calyx cup not veined; fruit ovoid. Capsule 4-valved, dehiscing terminally, seeds many, minutely tubercled. |
| Santalaceae | *Osyris quadripartita* | Nittur, Kundadri | | Erec shrubs, branchlets angular. Leaves alternate, subsessile or shortly petioled, elliptic-oblong, apex acute or mucronate, base acute or cuneate. Flowers yellowish, polygamous, males in axillary or terminal panicled cymes, bisexuals solitary. Fruits globose, orange when mature. Seed 1. |
| Oxalidaceae | *Oxalis corniculata* | Near Jog | - | Trailing slender herbs, rooting att nodes, stem densely pubescent. Creeping weed; trifoliate leaves with obcordate leaflets; flowers yellow; slender peduncles. |
| Asclepiadaceae | *Oxystelma esculentum* | On way to Anavatti | | Slender, twining undershrub, stem faintly striped. Leaves opposite, linear or linear-lanceolate, apex acute, base rounded, glabrous or nearly so. Flowers in lateral, drooping, lax, sub-umbellate or racemiform cymes. Corona 2-seriate, staminal; outer cupular, inner 5-lobed, ovate-lanceolate, apex narrow, acuminate, free |
| Bignoniaceae | *Pajanelia longifolia* | Between Sampekatte and Kodachadri base | | Small trees, to 4 m tall. Leaves imparipinnately compoubd, alternate, clustered near the apex. Rachis 50-60 cm long, trigonous, lenticellate. Flowers pale purplish, in terminal, erect, long panicles. Corolla broadly campanulate; tube to 6 cm long, lobes 5, unequal, ca. 3 x 2 cm, pubescent, especially along crisped margin. |
| Poaceae | *Panicum* | Bileshvara | | Annual, tufted grass; stem |

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| | *psilopodium* | | | slender, erect or ascending, simple or branched. Leaves 6-10 x 0.5-0.6 cm, lanceolate, acuminate, base rounded, glabrous or with few spreading hairs at base; sheath compressed, striate, mouth hairy; ligules a narrow row of hairs. Inflorescence terminal, ca.12 cm long panicles; branches slender, more or less spreading. Spikelets ca.3 mm long, distant, glabrous; pedicels 2-6 mm long, usually longer than spikelets |
| Rutaceae | *Paramignya monophylla* | Kundadri, Jog, Nagavalli | Kaadu Kithale | Erect or straggling shrubs with spreading branches. Young branches pubescent. Leaves 1-foliolate, alternate, twisted, pubescent, joints obscure. Calyx softly woolly. Branches with sharp recurved axillary spines. Berry axillary or terminal, solitary; stalk 1-1.2 cm long. Disc columnar, 5 mm long |
| Asteraceae | *Parthenium hysterophorus* | Ayanur | | Erect, slender, branched herbs, stem angular, pubescent. Leaves alternate, sessile, variable in size. Outer ray florets 5, female, 3 mm long, supported by 2 hyaline scale-like wings at base. Achenes dorsally compressed. |
| Poaceae | *Paspalidum flavidum* | Kattinkere | | Spikelets 3 mm long, 2-flowered, whitish, subglobose or ovoid, sessile, arranged in 2 rows, secund to flattened rachis. Lower glume 1 x 1.5 mm, suborbicular, obtuse, broad at base, 3-nerved. Upper glume 2-2.5 mm long, broadly ovate, obtuse, 7-nerved. Lower lemma male (or empty), ca. 2.5 mm long, membranous, ovate, 5-nerved; palea slightly narrower, 2-keeled. Lodicules 2, stamens 3. Upper lemma ca. 3 mm long, white, ovate, mucronate, convex, striate-punctate; palea broadly ovate, with thickened infolded margins, texture similar to lemma. Lodicules 2. |
| Poaceae | *Paspalum scrobiculatum* | Yedur, Hulikal, Bileshvara, Savehaklu | | Erect, tufted annual or perennial herbs, to 30 cm tall, rhizome short, erect, leafy from lower part. Leaves 5-12 x 3-4 mm, |

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| | | | | lanceolate, margin entire or serrulate, apex acuminate; sheath broad, compressed, mouth hairy; ligules short, membranous, less than 1 mm long. Spikes usually 2 (or 6), alternate, spreading, 1.5-3.5 cm long; rachis flattened with minutely ciliate, curved margins. Spikelets 2.5 x 1.5 mm, ovate-oblong, apex obtuse, secund, in 2 rows on the rachis, brown or white, shortly pedicellate. Lower glume absent. Upper glume as long as the spikelet, membranous, 3-nerved. |
| Passifloraceae | *Passiflora foetida* | Kerekoppa | Kukkeballi | Climbing herbs, stem striate, silky-hairy, some with glandular. Tendrils axillary, simple. Leaves alternate, ovate, obscurely 3-lobes entire. Flowers bisexual, white, axillary, solitary.Bracts bipinnately pectinate with glandular hairs. Corona cup-like with many fimbriate appendages |
| Rubiaceae | *Pavetta bengalensis* | Hulikal | | Undershrubs or shrubs, stem 4-angled. Leaves opposite, membranous. Flowers shhot not corky, branched, pubescent, corymbose cymes. |
| Rubiaceae | *Pavetta indica* | Bileshvara, Sampekatte, Chakra, Nagara fort | | Erect branched undershrubs or shrubs. Branchlets tomentose. Leaves opposite, axpex acute or obtuse. Flowers white un terminal paniculate cymes. |
| Rubiaceae | *Pavetta thomsonii* | Hulikal | | Glabrous undershrubs to 1 m tall, flowering shoot green. Leaves membranous, elliptic-obovate, apex acuminate, base acute. Flowers creamy-white, in terminal condensed, trichotomously branched. |
| Haemodoraceae | *Peliosanthes tota* | Hulikal | | Scapigerous herbs, root-stock creeping, root fleshy, long. Leaves basal, elliptic-lanceolate, acute at both ends, venation striate. Scapes 20 cm long, erect. Fruits beery-like, many in racemes on the scapes upwards. |
| Urticaceae | *Pellionia heyneana* | Kodachadri base | | Erect or suberect, monoecious herbs, stem ribbed. Leaves alternate, with opposite, cordate nanophylls. Subfalcately elliptic-lanceolate or elliptic-oblong. Flowers in axillary, peduncled, |

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| | | | | open or contracted cymes, peduncle slender, compressed, sometimes elongate to 10 cm, dichotomously branched at apex. Perianth 5-lobed in male and female, free or connate. Achene ovoid, compressed, tubercled. |
| Poaceae | *Pennisetum pedicellatum* | Savehaklu | | Branches from leaf and above leafy. Erect grass, to 1 m tall; stem stout, branched from base. Leaves to 18 cm long or longer than 6-10 mm wide, linear-lanceolate, glabrous or sparsely hairy, scabrid along margins; sheaths glabrous; ligule a ciliate membrane. Inflorescence spike-like, contracted, densely-flowered, cylindrical racemes, to 12 cm long, on short axillary branches; rachis slender, hairy, notched. Spikelets arranged in sessile involucre. |
| Piperaceae | *Peperomia portulacoides* | Nagodi, Hulikal | | Erect, tufted herbs, rooting at lower nodes; stem and leaves succulent, glabrous. Leaves 2-3 x 1-1.6 cm. opposite or whorled. Ovate or obovate, apex rounded or emarginate, base cuneate. Spikes 2-6 cm long, slender, terminal; orbicular, membranous and scaly at the margins. Fruit small, ovoid, reddish-brown. |
| Orchidaceae | *Peristylus aristatus* | Yedur | | Slender, erect herbs, to 60 cm tall; tubers 2, each 2x1.5 cm, ovoid. Leaves 4-6, clustered near the middle, 5-8.5 x 1-2.2 cm, membranous, elliptic or elliptic-lanceolate, margin ciliate, apex acute, narrowed at base, faintly 5-nerved; lower part of stem naked or with few reduced leaves. Flowers few, greenish, in terminal lax spikes; bract ca. 1.5 cm long, shorter than ovary, lanceolate. Sepals 3, free; laterals 8x4 mm, larger than dorsal, ovate, acute, slightly falcate, faintly 3-nerved; dorsal 6x3 mm. Petals 7x0.5 mm, narrowly linear. |
| Orchidaceae | *Peristylus plantagineus* | Between Nagara and Hosnagar | | Erect, terrestrial herbs; tubers paired, 2-2.5 cm long, ovoid or oblong. Leaves 3-4, clustered at about the middle of stem, each 8-12x2.2-4.8 cm, elliptic-oblong, |

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| | | | | margin papillose, apex acute, narrowed at base, 5-7-nerved from base, prominent beneath; lower part of stem ensheathed by long sheaths. Flowers white, ca. 5 mm long, in terminal, dense spikes; bracts 1x0.2 cm, erect, lanceolate, acuminate, longer than flowers. |
| Orchidaceae | *Peristylus secundus* | Nittur, Sampekatte | | Erect, slender, terrestrial orchids, 25-30 cm tall; tuber small. Leaves 5-7, spiral, each 4.5-6 x 0.4-0.6 cm, linear-lanceolate or narrowly elliptic-lanceolate, apex acute. Flowers ca. 1 cm long, yellowish-green, in terminal spikes; bracts lanceolate, acuminate, shorter than flowers. Sepals 3, free, ca. 4 mm long, linear-lanceolate, 1-nerved. Petals as long as or slightly shorter than sepals, oblong. |
| Lauraceae | *Persea macrantha* | Kogar | Kurma | Medium to large trees, more than 15 m tall, bark blackish. Leaves alternate, clustered near the ends of branchlets, subcoriaceous, elliptic or oblong, acute or rounded at both ends, more or less glaucous beneath, midrib impressed. Petiole to 4 cm long; leaf blade elliptic-oblong or elliptic-lanceolate, 6-19*3-8 cm, glaucous beneath. Peduncle branched to 29 cm long, sparsely pubescent. Perianth greenish-yellow, pubescent without. Stamens hairy. Berry globose, smooth, 2 cm across. |
| Acanthaceae | *Phaulopsis imbricata* | Hulikal | | Erect or suberect herbs, 20-35 cm tall, rooting at lower nodes of nodes, stem with deflexed hairs. Leaves opposite, unequal, ovate or ellipticv-lanceolate, undulate or dentate, apex acute or shortly acuminate, base cuneate or tapering. Flowers white, second, in terminal dense 2 cm long spikes, bracts imbricate. Calyx 5-lobed, hairy, divided to base; 1 lobe leaf-lke, 10x5 mm, rest linear. Corolla tube 6-7 mm long ; lobes 5, rounded, unequal. |
| Arecaceae | *Phoenix humilis* | Savehaklu | | Erect, woody shrubs or small trees, stem short or absent when |

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| | | | | young, columnar later, unbranched. Leaves pinnately compound rachis compressed, broad at base. Drupe oblong, orange, turning black, in terminal spadix, vertically grooved. |
| Orchidaceae | *Pholidota pallida* | Kargal | | Epiphytic herbs, stems pseudobulbs, pseudobulb 3-5 cm long.leaves solitary on the top of pseudobulb, coriaceous, sub-plicate, elliptic or oblanceolate. Lip with a cup-shaped hypochile & a two lobed epichile, with a deep sinus in between the two lobes.Lobes orbicular.The two deep orange ridges running the length of hypochile inside the cup.Column broad winged. Stamen 1, anther 2-celled, pollinia 4, in 2 pairs, sessile, stigmatic surface broad. |
| Euphorbiaceae | *Phyllanthus emblica* | Humcha | Nellimara | Small to medium-sized, deciduous tree; leaves linear-oblong, apex obtuse or acute, base truncate or sub-cordate, stipules triangular. Fruit a berry, more than 1 cm, axillary, solitary. |
| Euphorbiaceae | *Phyllanthus lawii* | Kuppigadde, Tenkbail | | Erect, monecious, glabrous shrub; branchlets slender, 1-3-fascicled on tubersles, with 2 small stipuliferous blunt spines. Flowers small, axillary, 1-few, in fascicles. Perianth lobes filaments united at base. Capsule, less than 0.5 cm across; capsule smooth. |
| Euphorbiaceae | *Phyllanthus urinaria* | Sampekatte, Nagara | | Slender, erect, monoecious herbs, branchlets narrowly winged. Leaves alternate, sub-sessile, linear-oblong or obovate, apex rounded. Male flowers in axillary fascicles, long pedicelled. Perianth lobes 6, free or slightly connate. Stamens 3, filaments united into a column, arising from disc. Female flowers solitary, shortly pedicelled. Perianth lobes 6, persistent. Capsule verrucose, 3-lobed, seeds striate. |
| Asteraceae | *Phyllocephalum scabridum* | Nagara fort | | Erect, branched herbs to 50 cm tall, stem grooved, minutely bristly, often purplish. Leaves alternate, sessile, shortly petiolate. Achene 3 mm long, oblong, deeply 10-ribbed. |

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| Solanaceae | *Physalis minima* | Hulikal, Savehaklu | | Erect herbs, 30-45 cm tall. Leaves alternate, membranous, ovate, margin entire, sinuate or distantly toothed, unequal. Flowers yellow, often with brown spot within, axillary, solitary. Berry globose, enclose in calyx. |
| Urticaceae | *Pilea microphylla* | Sagar | | Slender glabrous herbs with prostrate branches, stem with rapides and reddish glandular outgrowth. Leaves opposite, unequal, subsessile, obovate or spathulate, apex rounded, raphides transverse, prominent beneath. Achene ovoid in axillary clusters. |
| Apiaceae | *Pimpinella heyneana* | Kodachadri, Hulical, Kundadri | | Erect, slender herbs 30-45 cm tall, stem striate. Leaves 3-foliolate, lateral leaflets usually ternate. Flowers white, in terminal compound umbels. Mature fruit glabrous and smooth; bracts present |
| Apiaceae | *Pimpinella wallichiana* | Sampekatte | | Erect, branched herbs, root tuberous, fusiform, stem glabrous, striate. Lower leaves trifoliolate orbicular; involucre and involucel absent. Flowers white, polygamous, in terminal compound umbels. Schizocarp ovoid, crowned by 2-fid disc. |
| Arecaceae | *Pinanga dicksonii* | Hulikal,Yedur | | Slender, monecious trees, to 7 m tall, stem annulate. Leaves pinnatisect, crowned, linear. Spadix few, branched, clothed with imbriacting flower-clusters, each cluster with a female flowers between 2 male flowers. Male flowers 3 quetrous, 3-merous. Stamens many. Female flowers staminodes 6. Ovary 1-locular, 1-ovuled. |
| Piperaceae | *Piper argyrophyllum* | Sampekatte, Yedur, Jog | - | Stem striated, slender. Petiole glabrous; blade membranous, 5-ribbed from base, covered with closely arranged silvery scales on lower surface, to 10*5 cm. Spikes glabrous, to 20 cm long in fruit. Bracts oblong, glabrous, sessile, adnate to axis. Stigmas 5. |
| Piperaceae | *Piper galeatum* | Yedur | | Large woody climber. Leaves 3-ribbed from the base and with a pair of pinnate nerves above, coriaceous, elliptic-ovate, |

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| | | | | acuminate, 17*8.5 cm. spike glabrous, to 6 cm long. Flowers distant, in cups of connate bracts. Berry yellow whn ripe, to 0.7 cm across. |
| Piperaceae | *Piper hookeri* | Yedur | | Stem robust. Petioles hirsute. Leaf slightly coriaceous, ovate, acute to acuminate, subcordate at base, sparsely hirsute beneath, 5-7-ribbed. Spikes slender with hairy peduncles. Bracts orbicular, peltate, with spreading hairs. Fruiting spike often interrupted. |
| Piperaceae | *Piper nigrum* | Kodachadri slopes | Karimenasu, Olle menasu | Glabrous climbing shrubs, stem ribbed. Leaves alternate, ovate, apex acuminate, base rounded, gland-dotted, nerves 5 from the base, a pair higher up on the midrib. Male spikes more than 7 cm long, slightly interrupted, slender, pendulous. |
| Pittosporaceae | *Pittosporum dasycaulon* | Yedur, Hulical, Kargal, Sampekatte | Boogri | Small trees, young shoots generally tomentose. Young branches and inflorescence pubescent; capsule size of a cherry, tomentose. |
| Orchidaceae | *Platanthera susannae* | Between Kargal and Kogar | | Terrestrial, erect, tuberous herbs, 1 m tall, tuber oblong. Leaves cauline, sessile, alternate, ovate-oblong or elliptic-oblong, acute, upper leaves passing into leafy bracts. Flowers white, in terminal 3-6-flowered, racemes sepals 3, free, unequal. Petals linear, acute. Lip 3-lobed; lateral lobes ca. 3x2 cm, apex pectinate, midlobe 2-2.5 cm long, narrowly linear, dilated below; spur ca. 12 cm long, more than twice as long as the ovary, pointed at the apex. Staminal column erect, ca. 2 cm long; pollinia 2; caudicle slender; gland viscid |
| Lamiaceae | *Plectranthus mollis* | Hulikal, Lingarahalli | | Erect aromatic herbs or undershrubs, stem angular, pubescent. Leaves opposite, ovate, serrate-crenate, apex acute, base cordate, densely pubescent and gland-dotted beneath. Flowers pale blue, in terminal panicles with pubescent, pedicels 5-6 mm long. Calyx 2-lipped, to 8 mm long in fruits, lobes reticulate, lanceolate. Corolla tube |

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| | | | | 4-5 mm long; lobes 2-lipped. Nutlet 2-2.5 mm long, sub-globose, dotted with reddish-brown spots. |
| Lamiaceae | *Plectranthus stocksii* | Chakra, Kodachadri | | Slender branched herbs, stem angular, procumbent, pubescent. Leaves red-glandular beneath, ovate, serrate-dentate, apex acute, base truncate, subcordate, or cuneate, sparsely crispate hairy. Flowers 5-6 mm long, white, in terminal long panicles, slender glandular-pubescent. calyx 3 mm long in fruit; lobes of both lips rounded. Corolla 2-lipped, tube narrow, straight. Nutlet 0.7*0.5 mm oblong. |
| Plumbaginaceae | *Plumbago zeylanica* | Ayanur | M-Vellakoduveli, K-Bili chitra mula, E-White lead wort. | Erect herbs or undershrubs, stem ribbed. Leaves alternate, ovate, apex obtuse, base abruptly attenuate into short petiole and amplexicaul with stipule-like auricles. Flowers white, in terminal racemes, peduncles glandular. Rachis glandular. Corolla-tube 2 - 2.5 cm long; lobes obovate, apiculate, Flowers white. |
| Clusiaceae | *Poeciloneuron indicum* | Hulical | - | Leaves elliptic-oblong, acuminate, rounded at base. Flowers in terminal panicles, yellowish-white. Sepals 5. Petals 5. Anther cells lobulate on the margins. Anthers lobulate on the margins. Capsule to 4 cm across, ribbed. |
| Lamiaceae | *Pogostemon panliculatus* | Kundadri, Kodachadri hills | | Erect branched herbs, stem angular, hairy, internodes zig-zag. Leaves in unequal opposite pairs, sessile or subsessile, ovate irregular inciso-serrate, apex acute, base cuneate, adpressed hairy. Flower clusters semilunate, one sided in spikes. |
| Lamiaceae | *Pogostemon purpurascens* | Savehaklu | | Aromatic erect or suberect branched herbs to 20 cm tall, stem 4-angled, hairy long, spreading, sometimes glandular. Leaves in unequal, opposite pairs, ovate, irregularly doubly serrate, apex acute, base cuneate, densely adpressed-hairy. Flowers whitish in approximate whorls of elongate spikes, bracts 6 mm long, ovate- |

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| | | | | lanceolate, acute, slightly falcate, prominently nerved, hairy and ciliate. |
| Caryophyllaceae | *Polycarpon prostratum* | Hulical | - | Prostrate, branched herbs, more or less pubescent. Leaves whorled linear-oblong or spathulate, apex acute. Flowers in cymes, blue; capsules enclosed in sepals |
| Polygalaceae | *Polygala elongata* | Sampekatte, Jayanagara | - | Erect, rigid, branched or unbranched herbs, angular, minutely pubescent. Leaves alternate, linear-lanceolate or oblanceolate, apex obtuse, mucronate, base narrowed to very short petiole, pubescent. Flowers yellowish, in lax, extra-axillary racemes. Capsule oblong; filaments connate in bundles of 3 each,<br>Outer sepals lanceolate acuminate wings very oblique. |
| Polygonaceae | *Polygonum chinense* | Chakra, Kodachadri, Hulikal | K- Bili konde.<br>T-Yerumainakku chedi | Straggling or erect herbs, stem glabrous or sparsely pubescent, densely at nodes, oreate. Acuminate and cleft above. Leaves alternate, elliptic-oblong, apex acute or shortly acuminate. Flowers white; in heads; ocreate long acuminate, cleft above. Stem ocreate; ocreae 2.5-3 cm long, acuminate and cleft above. Petiole ca. 1 cm long, auricled at base; auricles sometimes caducous. Nut 3*2 mm, trigonous. |
| Polygonaceae | *Polygonum glabrum* | Hulikal | K- Nirusanne soppu, Niru kanigalu. | Erect herbs, stem ocreate, ocreae 3 cm long, tubular, nearly truncate above. Leaves alternate, linear-lanceloate or narrowly elliptic-lanceolate, acute at both ends, gland-dotted beneath, midrib reddish. Flowers pinkish in terminal panicles. Perianth 5-lobed, connate. |
| Polygonaceae | *Polygonum hydropiper* | Jog | - | Slender, erect, branched, angular, gland-dotted, ocreate, tubular, truncate, ciliae of few bristly hairs at mouth. Leaves less than 1 cm broad, linear-lanceolate, apex acute, narrowed at base, glabrous except hairy margins. Flowers pinkish-white, clustered in the axils of distant ocreate bracts, in axillary or terminal, slender racemes. Perianth 5-lobed, |

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| | | | | glandular. |
| Orchidaceae | *Polystachya flavescens* | Nagodi,Hosagadde | | Epiphytes. Pseudobulbs many, approximate, ovate, usually 2-3-noded, with dense fibrous roots. Leaf nerves prominent beneath. Scape terminal, compressed, pubescent, covered by 3-4 large sheaths at base. Sepals 3, subequal, ca. 3 x 2 mm, hairy; dorsal little broader, faintly 5-nerved; laterals slightly narrowers, ovate, 3-nerved.flowers yellow, not resupinate, few in racemes, terminal to the scapes; bracts, ovate. Sepals 3, subequal. Petals narrowly linear, in curved. |
| Apiaceae | *Polyzygous tuberosus* | Hebbigere | | Erect glabrous herbs 40-50 cm tall. Roots tuberous, fusiform. Leaves decompound, petiole 5-6 cm long with broad sheathing base. |
| Papilionaceae | *Pongamia pinnata* | Anandapura | Honge-mara | Often planted as an avenue tree. Leaves imparipinnately compound. Pods in axillary racemes, oblong, compressed, oblique, minutely beaked, seed 1. |
| Orchidaceae | *Porpax jerdoniana* | Sampekatte | | Small, epiphytic herbs, pseudobulbs 5-6 mm across, flat, discoid, covered by rigid net-like sheaths. Leaves green, striped with brown. Capsule trigonous or ovoid, tomentose, 1 or 2 from pseudobulb between leaves. |
| Portulacaceae | *Portulaca oleracea* | Sorab | Goli soppu, Doddagoni soppu | Diffuse or prostrate, branched herbs, stem and leaves alternate or sub-opposite, obovate, apex rounded or truncate, narrowed to short petiolate at base, hairy at axils. Flowers yellowish, few, in sessile, terminal clusters. Petals 5 free, stamens 8-12 inserted at the base of petals, anthers 2-celled. Ovary semi-inferior, 1-locular, ovules many basal. Capsules ovoid dehiscence transverse. |
| Araceae | *Pothos scandens* | Mastikatte, Chakra,Yedur | M-Paruvakodi | Climbing, branche shrubs with aerial roots. Leaves distichous, ovate-lanceolate or elliptic-lanceolate, apex acute.spadix axillary or terminal, globose or ovoid, stipitate, terminal. Spathe 3-4 mm long ovate or concave; cataphylls ovate, acute. |

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| Urticaceae | *Pouzolzia wighti* | Nagara fort | | Monoecious, erect, rigid herbs, stem compressed, hoarsely tomentose or scabrid. Leaves reduced upwards, merging into floral bracts, opposite-decussate or alternate. Flowers in axillary, sessile clusters of leafy bracts, male and female together. Male flowers: ca. 1.5 mm across. Perianth 4-lobed, free, inflexed, hairy at tip; bud truncate. Female flowers: slightly shorter than male. Perianth tubular. Achene ovoid, ribbed, exserted above perianth. |
| Urticaceae | *Pouzolzia zeylanica* | Nagara fort | | Slender, monoecious trailing or erect herbs, variable on habit, stem hirsute upwards. Leaves alternate or lowers opposite, ovate or ovate-lanceolate, apex obtuse or acute. Flowers in axillary, sessile clusters, both male and female together. Male flower: ca. 1 mm long. Female flowers: ca. 2 mm long; perianth tubular, 2-fid at apex, accrescent, ribbed. |
| Verbenaceae | *Premna coriacea* | Yedur | | Climbing shrubs, Calyx 11-1.5 x 1.5-3 mm, cup-like, truncate, pubescent without. Leaves opposite usually unequal, coriaceous, ovate or elliptic, apex shortly acuminate, base variable, rounded, acute, truncate or subcordate. Panicles terminal, corymbose cymes, peduncle pubescent. Drupe oblong, black when mature, 1-seeded. Associated with Hopea ponga (Dennst.) MAbberly, AMesa indica (Roxb.) DC. and Entada pusaetha DC. |
| Rosaceae | *Prunus ceylanica* | Between Kogar and Tumri | - | Trees, 15-20 m tall. Petiole 0.7-1.5 cm long. Leaf blade entire, elliptic-ovate or oblong-lanceolate, acuminate at apex. Flowers sessile; pericarp indehiscent; calyx 8 - 12 lobed. Drupe 0.8*1.8 cm, 2-seeded. |
| Poaceae | *Pseudanthistiria hispida* | Nagara fort | | Leaves strongly nerved; sheaths sparsely hairy in the upper part, glabrous below, strongly ribbed; ligules membranous, 3 mm long, much divided intonarrow segments. Panicles to 25 cm long, |

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| | | | | terminal, much branched; branches to 8 cm long, often in pairs, clothed by leafy, common spathe of ca. 3.5 cm long (proper spathe ca. 1.2 cm long, lanceolate, acuminate); all spathes with tubercle-based setae, margin hairy. |
| Acanthaceae | *Pseuderanthemum malabaricum* | Hulikal | | Undershrubs to 1 m tall, stem 4-angled or slightly compressed. Leaves opposite, ovate or elliptic, undulate or crenate, apex acuminate. Flowers white in opposite interrupted clusters of 1-3. Capsules. |
| Rubiaceae | *Psychotria canarensis* | Yedur | | Erect glabrous shrubs to 2 m tall. Leaves opposite, ovate, obovate or elliptic-oblong.cymes terminal. Drupe ovoid or ellipsoid, mostly curved, ridged along the back. |
| Rubiaceae | *Psychotria dalzelli* | Jog | | Erect shrubs or undershrubs, branchlets flattened, faintly striate. Leaves opposite, coriaceious, obovate-oblong or oblanceolate, apex obtuse or acute. Flowers white, sessil, 2-5 together at the ends of branches, in terminal, peduncled cymes. Corolla tube short, throat villous, lobes ovate - oblong, acute. |
| Rubiaceae | *Psychotria flavida* | Nagodi, Jog | | Shrubs, stem 4-angled. Leaves opposite, coriaceous, elliptic-oblong or elliptic-oblanceolate, apex obtusely acute or shortly acuminate, narrowed at base. Cyme-branches mostly opposite, bright yellow in fruit. Drupe subglobose, compressed, narrowly on back, blackish when dry with truncate or minutely toothed persistent calyx. |
| Rubiaceae | *Psychotria nigra* | Hulikal | | Glabrous undershrubs, branches compressed above. Leaves opposite, oblanceolate or elliptic, apex shortly acuminate, petioled elliptic obtusely acuminate shining, nerves 5-7 pair.flowers white, in capitates clusters on cyme-branches, interspersed with rufous hairs. |
| Rubiaceae | *Psychotria truncata* | Kodachadri | | Stout, erect, branched shrubs, branchlets flattened. Leaves opposite, coriaceous, ovate-oblong or obovate. Flowers white, |

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| | | | | shortly pedicelled, in dense, terminal, branched cymes. Drupe globose or ovoid, crowned by truncate calyx. |
| Sterculiaceae | *Pterospermum diversifolium* | Hulical, Nagodi, Nagavalli | Muchukunda | Trees to 20 m. Minutely rusty-pubescent. Stipules entire; petiol usually under 2 cm. Bracteoles and stipules entire or bifid. Petals 10 cm long, Ovary inserted within the top of staminal column on the gynophore. Staminodes alternating with phalanges. |
| Sterculiaceae | *Pterospermum reticulatum* | Kargal | - | Trees to 8 m. leaves elliptic-obovate, toothed near apex, cuneate to obliquely subcordate at base, prominently reticulate and rusty-toemntose beneath. Bracteoles pinnatisect with linear segments. Petals 2 cm long. The plant is rarely associated with Macaranga peltata (Roxb.) Muell. Staminal filaments connate in lower half of the phalanges. Capsules ovoid, rough, with rusty stellate hairs. |
| Cyperaceae | *Pycreus diaphanus* | Nagara | | Tufted, erect herbs, stem slender, trigonus. Leaves linear, usually shorter than stem. Inflorescence a terminal umbel of 3 unequal rays. Rachilla zig-zag, narrowly winged. Glumes 2 mm long, distichous, boat-shaped, ovate, obtuse, green, keeled on back; sides reddish-brown, nerveless. Style 2-fid. Nuts 0.5-0.6 mm across, globose, apiculate, whitish (young) with transverse, undulating lines or reticulate. Fruiting: September. |
| Cyperaceae | *Pycreus polystachyos* | Between Sampekatte and Nittur | | Perennial, erect, tufted herbs, stem 20-40 cm tall, slender trigonous, thickened slightly at base. Leaves basal, shorter than stem, linear. Inflorescence terminal, umbellate. Glumes distichous, ovate, mucronulate, boat-shaped, narrowly keeled, obscurely 3-nerved, margin hyaline, membranous. |
| Cyperaceae | *Pycreus pumilus* | Nagara, Bileshvara | | Tufted, annual herbs, to 6 cm tall; stem slender, trigonous striate. Leaves about 5 to the stem, basal, shorter than stem, linear, 1-1.2 mm wide, midrib prominent. |

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| | | | | Inflorescence terminal, spicate or simple umbels (or sub-umbellate); rays about 5, unequal, arising slightly at different points; each ray trigonous, 1.5 cm long, covered by sheath at base, often branched; bracts, 3-4, unequal, leaf-like, the lowest longer than inflorescence, ca. 7 cm long. |
| Cyperaceae | *Pycreus stramineus* | Hulikal, Bileshvara, Nagara | | Tufted herbs, to 30 cm tall; stem slender, trigonous. Leaves filiform, usually shorter than stem, basal or spiral from little above the base. Inflorescence spicate, reduced to 1-rayed spike with 5-12 spikelets; bracts 1 or 2, leaf-like, longer than inflorescence, sometimes 1 or 2 above, subtending the next spikelet. Spikelets 5 to 10 mm long (2-2.5 mm wide), linear-oblong, compressed, stramineous or purplish; rachilla winged. |
| Scrophulariaceae | *Ramphicara longiflora* | Nagara, Hulikal, Chakra | | Erect, glabrous, parasitic herbs to 10 cm tall, turning black when dry. Leaves 2 cm long, opposite, pinnately dissected, lobes linear. Flowers white, axillary, solitary, pedicels short. Capsules ovoid, oblique, compressed, beaked. |
| Rubiaceae | *Randia rugulosa* | Hulikal, Yedur | | Unarmed, scandent herbs, branches drooping, 4-angled. Leaves opposite, elliptic-oblong. Flowers white, fragrant, in leaf-opposed, paniculate persistent. |
| Myrsinaceae | *Rapanea wightiana* | Kodachadri | - | Small, much branched trees, stem dark brownish, marked by scars of fallen leaves. Leaves alternate, coriaceous, obovate, apex obtuse or emarginated, narrowed at base, blackish above when dry, brown beneath. Petiole to 0.5-0.7 cm.leaf blade oblanceolate. Flowers subsessile, spiral, in racemes clusters, on 5 mm long tubercular peduncles, at the axils of fallen leaves. Pedicels 0.2-0.3 cm. corolla lobes obtuse, connate at base, with prominent striations. |
| Apocynaceae | *Rauvolfia densiflora* | Nagodi, Sampekatte, Yedur | | Large shrubs to 5 m tall. Leaves opposite, or whorled, ovate-elliptic or obovate, apex acuminate, base cuneate or tapering, pale beneath. Flowers in |

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| | | | | lax cymes; corolla tube 0.7 cm long, stout, Associated with Chasalia ophioxyloides (Wall.) Craib., Dichapetalum gelonoides (Roxb.) Engl., and Xantolis tomentose (Roxb.) Raf. Drupe paired, ovoid, purplish-red when ripe, seeds usually solitary. |
| Apocynaceae | *Rauvolfia serpentina* | Kattinakere, Jayanagara | | Erect undershrubs or shrubs. Leaves ternate or rarely alternate below, membranous, elliptic or obovate, apex acuminate, base acute or tapering into petiole, pale beneath. Flowers white, tinged with violet, in terminal, ocngested, corymbose cymes. Drupe ovoid, distinct or connate. |
| Euphorbiaceae | *Reidia macrocalyx* | Between Nagara and Hosnagar, Kundadri | | Monoecious, undershrubs, 1-1.5 m tall, branchlets reddish. Leaves simple, alternate, ovate, apex acute, apiculate base ronded. Flowers axillary, solitary. Male flowers; in lower axils, 3-5 mm across; pedicels slender, 7-10 mm long. Perianth lobes 4, free to base; lobes 2-3 x 1.5-2 mm, ovate-orbicular distantly denatate, reddish. Disc 4-lobed, fleshy. Stamens 4, united in pairs, anthers transverse; pistillode small. Female flowers ; large, to 2 cm across, greenish, in upper axils ; pedicels 2 cm long, thickened upwards. Perianth lobes 6, 16 x 7 mm, persistent, enlarged in fruit. Disc cup-like, Capsule 3-celled |
| Hippocrateaceae | *Reissantia grahamii* | Hulikal | - | Large climbing shrubs, branchlets lenticellate. Leaves coriaceous, ovate or ovate-oblong, entire or minutely serrate. Flowers yellowish-green , in axillary panicles, peduncle to about 12 cm long, often fascicled at leafless nodes. Fruits 10 cm long; anthers sub-sessile. |
| Hippocrateaceae | *Reissantia indica* | Hulikal, Kargal | - | Large climbing shrubs, branches often coiled, stem 4-angled, glabrous, lenticellate. Leaves opposite, elliptic-oblong or ovate. Flowers yellowish, in axillary corymbosely branched. Fruits 4 cm long; filaments longer than the anthers. |

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| Araceae | *Remusatia vivipara* | Sampekatte | Marakesu | Cormous, epiphytic herbs, corm to 3.5 cm across. Bulbiferous shoots to 30 cm long, erect, bearing clusters of bulbils at nodes. Peduncle short, enclosed in cataphylls. Spathe up to 12 cm long, yellow above. |
| Araceae | *Rhaphidophora laciniata* | Hulikal | | Large root climbers; stem cylindric, stout, greenish. Leaves 28x11 cm or larger, ovate, apex acuminate, base rounded or sub-truncate, perfoliate with elliptic holes, pinnately nerved, midrib prominent; mature leaves laciniately lobed towards the midrib; petiole 12 cm or more long, chanelled above, sheathing at base. |
| Acanthaceae | *Rhinacanthus nasutus* | Gajnur forest area | | Erect or straggling, branched undershrubs, branchlets densely tomentose, stem obtusely 4-angled, striped. leaves ovate or elliptic, apex acute, base cuneate, often decurrent on to petole, hairy when young, glabrous except on nerves beneath when mature. Flowers long, white, in axillary or terminal, divaricately branched cymes, peduncle glandular-pubescent. Calyx tube 1 mm long; lobes 5, lanceolate. Corolla 2-lipped; glandular-hairy. Disc cupular. Capsule clavate, long stalked, seeds 4, glabrous. |
| Caesalpiniaceae | *Homboldtia brunonis* | Hulikal | | Small evergreen trees, to 7 m tall. Leaves compound, stipules green, erect, with large orbicular appendages at base. Flowers irregular, in axillary racemes, pubescent, gland-dotted, persistent. |
| Gesneriaceae | *Rhynchoglossum notoniatum* | Hulikal | | Succulent, erect, herbs, 30-40 cm tall, stem striped. Leaves alternate, membranous, ovate or elliptic, sinuate or entires, apex acute or shortly acuminate, base acute and rounded on unequal sides. Racemes terminal or leaf-opposed, bracteole minute. Corolla ca. 2 cm long, blue; tube 8-10 mm long; limb 2-lipped. |
| Gesneriaceae | *Rhynchoglossum obliqum* | Hulikal | | Succulent, glabrous, herbs, variable in size, 5-50 cm tall. Leaves alternate, membranous, |

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| | | | | elliptic-oblong. Flowers blue, 10 cm long racemes. |
| Orchidaceae | *Rhynchostylis retusa* | Bileshvara, Between Sampekatte and Nagara | | Epiphytic herbs , stem short, stout. Leaves distichous, coriaceous, lorate, apex unequally lobed and toothed, articulate with leaf-sheath, channelled dorsally. Flowers pinkish-white, in long, drooping, densely-flowered racemes. Lip oblong-obovate, clawed, 3-lobed; lateral lobes obscure; base saccate and spurred; spur 5-6 x 4-5 mm, laterally compressed, hairy within. Column ca. 5 mm long; rostellum produced into a beak. Stamen 1; anther 2-celled; pollinia 2, globose, with short caudicle. |
| Gesneriaceae | *Rhynchotechum permolle* | Hulikal, Varahi | | Silky-villous, woody herbs or undershrubs. Leaves alternate, oblanceolate, serrate, acute. Flowers white, axillary, spreading cymes. Beery long ovoid, white. |
| Cyperaceae | *Rhyncospora wightiana* | Between Sampekatte and Nittur | | Tufted erect herbs, to 25 cm tall, stem slender, rigid, trigonous, striate. Leaves many, basal, broad, shorter than the stem, linear, acuminate. Inflorescence terminal, in reddish-brown. Glumes 6-7, elliptic-lanceolate, acute, membranous, the lowest 3-4 small, to 1 mm long, empty, the next one fertile, bisexual, 5-7 mm long, larger than other gluems, the upper rudimentary or male. Perianth represented by 6 hypogynous bristles, slightly unequal, ca. 6 mm long, brownish, scabrid or plumose. Stamen 1; filament long, exserted; anther 2 mm long, 2-celled. Ovary linear-oblanceolate, sparsely scaly; style ca. 4 mm long, undivided, base conical |
| Lythraceae | *Rotala densiflora* | Hosagadde | | Aquatic, divaricately branched herbs, rooting at basal nodes. Leaves rounded or suborbicular; Flowers in close terminal spikes with cordate floral leaves. Capsules 3-valved, seeds few, hemispherical. |
| Lythraceae | *Rotala macrandra* | Induvalli | | Creeping or diffuse herbs, rooting at lowers nodes, branches |

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| | | | | ascending, stem succulent. Leaves sessile; petals narrowly obovate; stamens exserted. Flowers pinkish, in spicate-racemes, terminal or from upper axis. Capsule enclosed within aclyx, 4-valved, dehiscing from top. 1 valve with persistent style, seeds many, rounded dorsally, raphe present on ventral face. |
| Lythraceae | *Rotala rotundifolia* | Nittur | | Creeping or sub-erect herbs, 10-14 cm long, rooting at lower nodes, stem succulent, reddish, nearly 4-angled, ribbed. Leaves rounded or suborbicular. Flowers in close terminal spikes with cordate floral leaves. Capsules 4-valved |
| Ehretiaceae | *Rotula auatica* | Tenkbail | | Calyx lobes 5-6 mm long, inner 2 shorter, ovate-lanceolate, ciliate. Corolla to 8 mm long; tube short; lobes 5, twice as long as the tube, oblong, apex rounded or truncate. |
| Connaraceae | *Rourea minor* | Jog, Kargal | | Large scandent shrubs, branches twisted. Leaflets shining; carpels curved, falcate, not broad at the base. Follicle ovoid, slightly curved, orange, finely striate, in axillaryy or terminal, long panicles, seed 1, erect, arillate. |
| Rubiaceae | *Rubia cordifolia* | Hulikal, Kodachadri, Savehaklu | Manjatti | Slender, much branched climbing herbs, stem 4-angular, scabrid often minutely prickly. Leaves whorls of 4. Flowers yellowish-green, in axillary or terminal trichotomonusly branched, paniculate cymes. |
| Rosaceae | *Rubus fockei* | Nagodi | - | Straggling or climbing, velvely shrubs. Leaves simple, stipules pectinately laciniate, blade ovate, serrulate, acute at apex. Bracts pectinatelly laciniate. Panicle fulvous-tomentose except corolla. Druplets reddish, aggregated on the receptacle. |
| Acanthaceae | *Rungia pectinata* | Hulikal | | Erect, slender herbs, 15-30 cm tall, branches few at base, often rooting at lower nodes, stem pubescent. Leaves opposite, elliptic-lanceolate or linear-elliptic, apex obtuse or acute, raphides scattered. Flowers 3-4 mm long, blue, second, in 2-rows, usually in axillary spikes. Calyx |

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| | | | | to 3 mm long, connate; lobes 5, linear, hairy. Corolla 2-lipped; tube narrow. Capsule 1.5-2.5 mm long, long, desiscing elastically, seeds 4, orbicular, compressed, verrucose. |
| Poaceae | *Sacciolepis indica* | Tenkbail | | Leaf sheath striate, hirsute; ligules membranous. Inflorescence terminal, spiciform panicles to 4 cm long, continuous, cylindric, densely flowered; branches slender, very short; pedicels 0.5-0.8 mm long. Spikelets 2-2.5 mm long, ovate-lanceolate, acute, straight or slightly curved. Lower glume ca.1.5 mm long, membranous, broad at base, apex acute, 3-nerved. Upper glume 2-2.5 mm long, ovate, acute, 7-9-nerved, often hairy. |
| Poaceae | *Sacciolepis interrupta* | Induvalli | | Leaf sheath striate, reddish, glabrous; ligules 2-3 mm long, membranous. Inflorescence terminal, spike-like panicles, to 15 cm long, cylindric, interrupted below; branches slender, short, to 5 mm long. Spikelets 4-5 mm long, ovate-lanceolate, green, shortly pedicelled; pedicels ca.1 mm long. Lower glume 1.5-2 mm long, broadly ovate, obtuse, 3-5 nerved. Upper glume 4-5 mm long, ovate-oblong, obtuse, 9-nerved. Lower lemma male or empty, along as upper glume, oblong, 9-nerved; palea 2.5 mm long, hyaline |
| Poaceae | *Sacciolepis myosuroides* | Nagara fort | | Leaf sheath striate, coloured at leaf-base ; ligule absent. Inflorescence terminal, spiciform panicles, 10-20 cm long, cylindric, densely flowered, erect ; branches ca. 5 mm long ; peduncle grooved, long, erect. Spikelets 1.5-2 mm long, ovoid ; pedicels 0.5-0.6 mm long, thickened above. Lower glume 1-1.2 mm long, ovate, acute, broad at base 3-nerved. Upper glume ca. 2 mm long, subacute, glabrous or sparsely hairy near margins, 5-9-nerved. |
| Annonaceae | *Sageraea* | Jog | | Medium-sized, evergreen trees, to |

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| | *laurifolia* | | | 14 m tall, bark blackish outside, yellowish within, stem lenticellate. Leaves alternate, coriaceous, narrowly oblong or oblong-lanceolate. Flowers subglobose, greenish in bud, in fascicles on short tubercles of woody stem. Sepals orbicular. Petal sorbicular, ciliate. |
| Hippocrateaceae | *Salacia macrosperma* | Hulikal | | Climbing shrubs, branchlets often coiled at base, lanticelllate. Leaves opposite, coriaceous, elliptic-oblong, apex obtuse. Flowers yellowish-green, fascicled, on axillary or extra-axillary tubercles. Flowers numerous. |
| Salicaceae | *Salix tetrasperma* | Mavinhole and Jog | Niravanji | Dioecious, deciduous trees, 7-13 m tall, young shoot puberulous. Leaves ovate-lanceolate, acute or acuminate, glaucous below. Flowers in drooping, 5-8 cm long catkins, peduncle silky-villous, bacts ovate. Perianth absent in both. Disc of 2 yellow glands in males, annular, or of yellow 1-sided scale in female. Stamens 5-10, anthers 2-celled, yellowish. Ovary sessile or stalked, fusiform, 1-loculed. |
| Polygalaceae | *Salomonia ciliata* | Nittur | - | Slender, unbranched, erect herbs. Stem furrowed, somewhat angular. Leaves alternate ovate or elliptic-oblong, margin minutely bristly-dentate in the upper half, apex acute. Petals pink; didymous fruit with setose-dentate margins. |
| Santalaceae | *Santalum album* | Sampekatte, Nagara | Sreegandha | Small branched trees. Leaves usually opposite, elliptic or elliptic-lanceolate, acute. Flowers small, bisexual, in axillary or terminal short cymes. Perianth 4-lobed, united, campanulate, lobes triangular. Stamens 4, anthers 2-celled. Disc of 4 fleshy, reddish-brown scales, alternating with the stamens. Fruit (immature) subglobose or ovoid, black when dry. |
| Sapindaceae | *Sapindus laurifolia* | Between Kargal and Jog | Antuvaaladakai | Small trees, young parts of stem. Leaves acute at the apex, Leaflets rounded or emarginate at the apex, Rachis and inflorescence rusty-pubescent. Rachis 11-22 cm |

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| | | | | long; nerves 9-11 pairs; petiolule 5 mm long. Male flowers: 2-3 mm across in bud, shortly pedicelled. Disc concave, with a raised fleshy hirsute edge. Pistillode clavate. Fruit trigonous, rusty-tomentose, 2-3-celled; stalk 6-8 mm long; seed 1 in each cell. |
| Euphorbiaceae | *Sapium insigne* | Nagavalli, Chakra | | Small, deciduous trees, juice milky. Leaves opposite, crowded at the ends of branchlets and usually leafless during floering, elliptic or elliptic-lanceolate, crenate-serrate. Flowers small, unisexual, in terminal 7-9 cm long, pedinculate, stout, spikes, with a whorl of linear scales at the base. Male rounded clusters, female solitary. |
| Rubiaceae | *Saprosma glomerata* | Yedur | | Erect, much branched, foetid shrubs, branches dichotomous. Leaves opposite, unequal, subsessil or shortly petioled, elliptic or elliptic-oblong, acute or shortly acuminate, base rounded, black when dry, stipules small, broad at base. Flowers white, in terminal, congested cymes between the uppermost leaf pair. |
| Caesalpiniaceae | *Saraca asoca* | Jog, Nagavalli | Ashoka | Small trees, branches spreading. Leaves pinnate, Rachis 14 cm or more long, leaflets 3-6 pairs. Flowers in axillary, dense, corymbose panicles. |
| Orchidaceae | *Sarcanthus pauciflorus* | Sampekatte, Mastikatte, Hosagadde | | Epiphytic herbs; roots slender, long, emerging through leaf-sheaths; stem elongate, pendulous; internodes 1 cm long, covered byleaf-sheaths. Leaves 8-12.5 x 0.8-1 cm, alternate, coriaceous, linear-oblong, acuminate, slightly constricted below the sharp apex, narrowed at base. Fruit 2 x 0.5 cm, oblong, ribbed, shortly stalked on axillary or leaf-opposed drooping, ca. 5.5 cm long peduncle. |
| Icacinaceae | *Sarcostigma kleinii* | Yedur | | Large, woody, dioecious, climbing shrubs. Leaves coriaceous, alternate, elliptic-oblong, apex abruptly shortly acuminate, base acute or rounded, reticulations prominent on oth surfaces. Flowers in axillary or |

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| | | | | extra-axillary spikes, peduncle slender, puberulous, pendulous fascicled. Pistillode conical, hairy on the disc. |
| Araliaceae | *Schefflera venulosa* | Kodachadri, Yedur | | Large straggling shrubs or small trees, sometimes epiphytic. Leaves alternate, digitately 5-6-foliolate. Flowers pinkish-white, 5-merous, in terminal or sub-terminal, long paniculate umbels. Fruit narrowly 5-winged. |
| Araliaceae | *Schefflra wallichiana* | Hulikal | | Arborescent, epiphytic shrubs or trees. Leaves foliolate, robust, coriaceous elliptic or oblong, apex acute, base rounded. Flowers 3-5 mm across, 6-merous, in large panicles. Disc enlarged, prominent. |
| Sapindaceae | *Schleichera oleosa* | Bileshvara, Gajanur | Chakota, Chendaala | Small trees, to 10 m tall. Leaves alternate, apripinnate, rachis 6-15 cm long. Rachis 6-15 cm long. Nerves 18-20 pairs, prominent beneath. Fruit dry, crustaceous with persistent style base and few prickles near the apex, in axillary racemes; stalk to 1 cm long. |
| Cyperaceae | *Schoenoplectus articulatus* | Tagarthi,Gajnur | | Tufted, glabrous herbs, 50-90 cm tall; stem robust, terete, striate, greenish, spongy, transversely white septate. Leaves reduced; sheaths membranous of pseudo-lateral, capitate clusters of spikelets, often arising from some distance above the mouth of the sheath. Bracts solitary, continuous with stem. Spikelets 5-18 mm long, ovoid or cylindrical-oblong, green or purplish. Glumes broadly ovate, acute, apiculate, keeled near the apex. Stamens 3; anthers linear, 1.5 mm long; filaments as long as anthers. |
| Marantaceae | *Schumannianthus virgatus* | Yedur | | Rhizomatous herbs, to 3 m tall. Leaves alternate, oblong or oblong-lanceolate, apex acuminate, base rounded. Flowers white, in terminal lax panicles, branches slender, terminating in clums. Ovary hairy, 3-locular, style long, stigma 3-lobed. |
| Cyperaceae | *Scleria corymbosa* | Hulikal | | Perennial robust herbs, to 3 m tall; rhizome horizontal, woody; stem sharply 3-gonous. Leaves |

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| | | | | ca. 52 cm long or longer, 1.2-1.6 cm wide, cauline, alternate, lanceolate, margin scabrous, apex acute; sheaths triquetrous, glabrous, with tongue-like contraligule opposite the blade. Inflorescence of spikelets, in axillary or terminal, long, corymbose panicles; peduncle branches spreading, 3-gonous, hairy and scabrous in the terminal branchlets; bracts lanceolate, broad at base, hairy. Spikelets 5-7 mm long, solitary or clustered, ovate-lanceolate, unisexual, stramineous or brownish |
| Cyperaceae | *Scleria levis* | Bileshvara | | Perennial, rhizomatous herbs; rhizomes nodulose; stem 3-quetrous, striate, sparsely hairy. Leaves 12-20 x 0.3-0.7 cm, linear, apex acute, sparsely hairy beneath, scabrid along margin; sheath narrowly winged. Inflorescence axillary or terminal, slender, lax 10 cm long (upto 30 cm) panicles; primary bract foliaceous; secondary filiform, ciliate. Spikelets 5-6 mm long, solitary or clustered, all unisexual, usually 1 male and 1 female spikelet together. |
| Cyperaceae | *Scleria terrestris* | Jog | | Large erect herbs; stem trigonous, scabrid, leafy throughout. Leaves 20-25 x 1.2-1.5 cm, flat, oblong-lanceolate apex acuminate, margin scabrid, prominently 3-nerved; sheath broad, narrowly 2-winged; contra-ligule brown, with ciliate, membranous margin. Panicles axillary and terminal; peduncle purplish, hairy. Spikelets numerous, unisexual; male and female scattered; females few ; bracts linear. Male spikelets 2.5-3 mm long |
| Santalaceae | *Scleropyrum pentandrum* | Sampekatte, Kundadri | | Small trees, often throny below. Leaves alternate, coriaceous, elliptic or oblong, apex obtuse or subacute. Flowers small, orange, polygamous, males in catkin-like spikes at leafless nodes. Perianth 5-lobed, united at base, tufted hairy within. Stamens 5, inserted at the base of the perianth tube. |

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| | | | | Female flowers in compact racemes. Drupe brown, pyriform, on long stalk, perianth persistant at the top, seed 1, globose. |
| Flacourtiaceae | *Scolopia crenata* | Yedur | Kodali mara | Trees, often with branching spines at base of trunk. Leaves elliptic-lanceolate, cuneate at base, acute at tip, often with crenations. Inflorescence racemose. Sepals 5, ciliate. Petals 5. Drupe ovate, nearly globose. |
| Scrophulariacea e | *Scoparia dulcis* | Nagara | | Erect, rigid, branched herbs or undershrubs 50-60 cm tall, stem angular, minutely hairy. Leaves opposite or ternate, sessile or shortly petioled, narrowed elliptic or oblanceolate, distantly serrate above the middle. Flowers white, in axillary fascciles of 1-3. Calyx 4-lobed, ca. 2 mm long; lobes ovate, apex obtuse, ciliate. Corolla rotate, ca. 3 mm long, densely villous at throat; lobes 4, subequal, ovate, obtuse. Capsule subglobose, seeds angular pitted. |
| Loranthaceae | *Scurrula parasitica* | Hulikal, Yedur | | Parasitic shrubs, stem terete, lenticellate. Leaves opposite, elliptic-oblong, apex obtuse, base rounded or subtruncate, rusty with stellate, scale, like tomentum on both surfaces when young. Flowers in axillary, subracemose fascicles, pedicels 3 mm long, bract 1. Calyx 2-3 mm long, not produced above the middle in bud, to 1.5 cm long, rusty-tomentose; tube slender, split on one side; lobes broad, acute. Found parasitic on Archidendron monadelphum (Roxb.) Nielson. |
| Lamiaceae | *Scutellaria colebrookiana* | Near Gajnur | | Straggling herbs, stems much branched, pubescent. Levaes cauline, deltoid, repand-crenate, minutely tomentose, acute at apex, truncate at base. Flowers pinkish-violet, in elongate, bracteates, terminal racemes. |
| Euphorbiaceae | *Securinega leucopyrus* | Nittur | | Large, dioecious shrubs or small trees, throny at base, branchlets short, angular, spine-like, bearing leaves and flowers. Leaves alternate, obovate, apex emarginated base acute or cuneate, stipules minute, |

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| | | | | triangular. Male flowers small, white, frangant, in axillary clusters. Perianth lobes 5, free. Stamens 5 free, filaments linear, curved. Disc of 5 glands, alternating with filaments. Pistillodes 3, erect, hook-like. |
| Euphorbiaceae | *Securinega virosa* | Jog | | Large shrubs or small trees, branchlets angular, long. Leaves alternate, obovate or elliptic, apex emarginate, base acute. Perianth lobes 5, persistent. Fruit globose, fleshy, white, in axillary clusters, seeds 3 or 6. |
| Anacardiaceae | *Semecarpus anacardium* | Bileshvara, Kattinakere, between Hosanagar and Sagar | - | Small trees, to 8 m tall, branchlets slightly compressed, tomentose. Leaves above brown, minutely pubescent beneath. Young parts petiole leaves beneath and panicle clothed with a fine pale pubescence. |
| Asteraceae | *Senecio belgaumensis* | Nagara fort, Kundadri | | Erect or sub-erect, branched or unbranched herbs, 30-50 cm tall, stem hairy. Leaves alternate, lower petioled, upper sessile, ovate, 2 auricled, distantly toothed, apex acute, base tapering into petiole, white-cottony beneath between the nerves. All florets without pappus. |
| Asteraceae | *Senecio corymbosus* | Kodachadri hills | | Large climbing shrubs; stem longitudinally grooved, floccose-tomentose. Leaves alternate, ovate, dentate, apex acute, base truncate or slightly rounded, glabrous above, cinnamomeus-tomentose beneath. Homogamous in axillary or terminal panicles of corymbose cymes. Invulucral bracts 8, uniseriate, elliptic. Ray florests absent. |
| Asteraceae | *Senecio edgeworthi* | Kodachadri hills | | Erect herbs; stem and branches angled, pubescent or glabrous. Leaves alternate, ovate or elliptic-lanceolate, irregularly serrate-dentate, apex acute. Heads heterogamous, in axillary or terminal, dichotomously forked cymes, peduncle slender, cottony-pubescent with linear, scattered bracts. Achenes ribbed, sparsely hairy along ribs. |
| Asclepiadaceae | *Seshagiria sahyadrica* | Between Nagara and | | Large twiners. Leaves opposite, ovate-oblong, entire, acuminate, |

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| | | Hosanagar | | base deeply cordate, glandular above at base. Follicle ovate-lanceolate, apex acute, muricate with warty protuberances. |
| Poaceae | *Setaria pallid-fusca* | Bileshvara, Nagara fort | | Leaf sheaths compressed, glabrous; ligule a ridge oflong white hairs. Inflorescence terminal, cylindric continous or capitate, spike-like racemes, 1-7 cm long; rachis of spike pubescent. Spikelets 3 mm long, ovoid or ellipsoid, 2-flowered, shortly-pedicelled, with 6-10, yellow or reddish-brown involucral bristled attached to pedicels ; spikelets deciduous above the bristles; bristles unequal, ca. 5 mm long, barbed. Glumes 2, slightly unequal. |
| Papilionaceae | *Shuteria vestita* | Hulikal | | Slender, climbing herbs. Leaves pinnately 3-foliolate, petiole 3.5-6.5 cm long, more or less or less hairy, terminal rhomboid-obovate, laterals slightly smaller, ovate-oblong or elliptic. Flowers purple-red or violet, in axillary racemes. Pod linear, slightly curve hairy. |
| Malvaceae | *Sida acuta* | Yedur | Bheemana kaddi, Dodda bindige gida. | Erect herbs, nearly glabrous. Stipules of each pair dissimilar, one linear to lanceolate and other linear to filiform. Calyx lobes triangular, acute. Cocci 7, shortly awned. |
| Malvaceae | *Sida alba* | Gajanur | | Erect branched undershrubs, branchlets greenish with minute stellate hairs. Leaves alternate, elliptiv or elliptic-oblong, crenate-serrate, apex abruptly acute, base beneath, glabrous or nearly so above. Petiole with one or two short spines at the base. |
| Malvaceae | *Sida rhombifolia* | Yedur, Chakra | Bannegarugugi da | Slender, suffruticose, erect, stellate-pubescent herbs. Stipules linear, petiole 0.7 cm long; leaves obovate to rhomboid, rounded to obtuse at apex. Mericarps 6 reticulate, shortly awned. |
| Smilacaceae | *Smilax zeylanica* | Kodachadri baseHulikal, Yedur, Chakra,Nag ara, Bileshvara | | Large, dioecious, climbing shrubs with tendrillar sheath attached to petiole, stem often prickly, faintly ribbed.leaves alternate, broadly ovate or elliptic-oblong, apex abruptly acuminate. Flowers |

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| | | | | greenish-white, in axillary umbels, male flowers perianth base of perianth lobes. |
| Papilionaceae | *Smithia bigemina* | Nagara fort, Yedur | | Diffuse herbs with procumbent branches. Leaves pinnately compound. Pods 6-8 jointed joints reticulate and tubercled. Flowers in racemes; leaflets 2 pairs. Calyx dichotomously nerved, bristly 2-lipped; lower 3-lobed; upper slightly emarginate. Corolla 4-8 mm long, twice the length of calyx. |
| Papilionaceae | *Smithia conferta* | Yedur, Chakra | | Much branched, diffuse herbs, leaves pinnately compound. Flowers in pairs at the upper leaf axils. Flowers 1-4, axillary. Pod 6-7-jointed, joints turid, minutely tubercled. |
| Papilionaceae | *Smithia hirsuta* | Kodachadri, Talguppa | | Slender, erect herbs, 30-35 cm long, leaves pinnately compound, scarious, peltate. Flowers yellow, in terminal few-flowered, secund, compact racemes. Lower lip of calyx entire; upper lip of calyx larger than the lower. |
| Papilionaceae | *Smithia purpurea* | Hulikal | | Erect, branched, slender herbs. Leaves pinnately compound. Flowers purple, in axillary, second, 6-12-flowered lax racemes. Pods 10-12 jointed joints orbicular reticulate. |
| Papilionaceae | *Smithia setulosa* | Kodachadri hills | | Erect, branched herbs to 1 mm tall, branches faintly striate, bristly-hairy yellow. Stems bristly, hairy. Pod 8 or more jointed. Flowers yellow, usually in terminal second panicles, bracts caduceus. Pod 8 or more jointed, joints turgid, reticulate, folded within the calyx. |
| Rhamnaceae | *Smythea bombaiensis* | Hulikal, Jog | | Large climbing shrubs, branches angular, pubescent. Leaves alternate, elliptic or elliptic-lanceolate. Flowers yellowish-green in axillary fascicles. |
| Solanaceae | *Solanum giganteum* | Kodachadri base | | Erect shrubs to 3 m tall, stem armed with small, triangular, pointed prickles, branches, leaves beneath and inflorescence, clothed with dense, white, stellate tomentum. |
| Solanaceae | *Solanum indicum* | Tirthahalli, Hulikal | | Armed undershrubs or shrubs up to 4 m tall, branches sparsely |

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| | | | | stellately-hairy in younger parts, glabrate and somewhat shining in older. Leaves ovate or ovate-oblong, sinuately to deeply lobed, sparsely stellately hairy above, densely stellately hairy beneath, acute at apex, acute, rounded or subequal at base, prickly especially on nerves. Flowers blue in extra-axillary, racemose cymes. Berries globose, orange-yellow when ripe, shining. |
| Solanaceae | *Solanum nigrum* | Nagara fort | Ooruganige | Erect, glabrous or sparsely pubescent branched herbs. Leaves ovate-lanceate, membranous, acute at apex, entire or sinute, base tapering into the petiole. Flowers white, small, in supra-axillary, subumbellate cymes. Berries globose, smooth, shining, red or yellow when ripe. |
| Solanaceae | *Solanum seaforthianum* | Ayanur | | Glabrous climbing shrubs. Stem faintly striped. Leaves deeply pinnately dissected, almost into leaflets. Flowers blue, in terminal or lateral, paniculate cymes. |
| Solanaceae | *Solanum stramoniifolium* | Kodachadri base, Yedur | Aane sunde gida | Stout straggling herbs, 1-1.5 m tall, stems densely clothed with long coase often stalked, usually stellate tomentose hairs and copiously armed with straight slender prickles. Leaves usually 2 at a node and unequal, broadl elliptic, pinnately cut into few triangular lobes, softly stellately-tomentose on both surfaces, armed with long, erect, yellow, slender prickles on the nerves on both sides, base cordate, truncate or more or less acute. Flowers white, 2-6-flowered, axillary, leaf-opposed, densely hairy cymes. Berries globose, densely covered with long, fulvous hairs, obscurely rugose with concentric rings. |
| Solanaceae | *Solanum torvum* | Nagodi, Mastikatte, Banavasi | Kudane | Erect, stellately-tomentose shrubs. Leaves alternate, ovate, margin sinuate or deeply lobed, 1-2 prickles on te mdrib beneath. Flowers white, in extra-axillary, corymbose cymes. Berry globose, yellowish when ripe, seeds many, small, smooth. |

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| Cucurbitaceae | *Solena amplexicaulis* | Hulikal, Yedur | - | Dioecious. Leaves highly variable in shape, membranous, often clasping at base, margin entire or remotely denticulate. Fruit not distinctly angular. Berry ovoid to elliptic-rostrate, smooth to distinctly ribbed, seeds emarginated to marginate. |
| Anacardiaceae | *Solenocarpus indica* | Jog | - | Small trees or large shrubs. Rachis 15-16 cm long, pubescent. Midrib pale reddish beneath; nerves approximate. Epiphytic on Xantolis campanulata. Leaflets subopposite, sessile, long petiolulate. |
| Melastomatacea e | *Sonerila rheedii* | Sampekatte, Hulikal | | Plants with distinct stem weak, sparsely hairy. Leaves opposite or fascicled, membranous, ovate, margin bristly serrate, apex acute, base cordate, sparsely hairy. Flowers pinkish, in terminal, compact, scropoid cymes, peduncles to 10 cm long, pedicels 3-4 mm long. |
| Scrophulariacea e | *Sopubia delphiniifolia* | Kodachadri hills, Nittur | | Erect, branched herbs, 60-70 cm long, branches short, erect, angled, minutely pubescent. Leaves opposite, pinnatisect, lobes slender, filiform, pubescent. Flowers axillary, solitary, purplish, 1-1.5 cm long. Calyx 5-lobed, 4-5 mm long, united to the middle, lobes linear. Corolla to 1.5 cm long; tube dilated above, hairy without; lobes 5, subequal, rounded. |
| Rubiaceae | *Spermacoce articularies* | Sampekatte, Bileshvara, yedur | | Prostrate of diffuse herbs, stem 4-angled, often hispidly-hairy, intenodes long. Leaves sessile,, elliptic or obovate, acute, hispid on both surfaces. Flowers pink, in axillary, few flowered, sessile clusters. Corolla tube 3-4 times longer than lobes, Calyx tube 2 mm long, hairy without ; lobes 4, as long as tube. Corolla tube narrow, to 8 mm long; lobes 4, ca. 3 mm long, spreading, ovate. Capsule 4 mm long, oblong, more or less hispid, mericarps 2, seeds 2, oblong. |
| Rubiaceae | *Spermacoce mauritiana* | Nagara, Bileshvara, Yedur | | Erect of diffuse herbs to 12 cm tall, stem slender, distinctly 4-winged, especially near the apex, |

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| | | | | margin hairy. Leaves opposite, ovate or elliptic, apex acute, base narrowed to short petiole, glabrous except minutely hairy or scabrid on margin. Flowers small, white, in axillary, sessile, capitates clusters. Calyx 2 lobed; leaves ovate or elliptic, opposite. Stipules pectinately lobed, side-lobes short, forming a sheath with leaf base. Corolla lobes 4, hardly longer than calyx lobes. |
| Rubiaceae | *Spermacoce pusilla* | Nagara, Sampekatte, Jayanagara | | Small, erect herbs, usually branched, stem rigid, 4-angled, scabrid with minutely prickly hairs as on leaves beneath. Leaves sessile, opposite, linear, margin recurved, apex acute, base forming. Flowers white, in dense, axillary or terminal clusters. |
| Rubiaceae | *Spermacoce verticillata* | Savehaklu | | Erect, much branches rigid herbs or under shrubs, woody at base, stem 4-angled. Leaves in apparent whorls sessile, obovate or oblanceolate, apex obtusely acute, narrowed to base, midrib impressed above, nerves obscure, stipules pectinate, connate with leaf-base into a sheath. Flowers white, in terminal or axillary, globose heads of 1 cm across. Corolla tube 1 mm long with a ring of hairs at throat; lobes 4, spreading, longer than tube. |
| Asteraceae | *Spilanthes calva* | Kodachadri hills | | Sub-erect herbs; leaves opposite, ovate, distantly serrate, apex acute or obtuse, tapering at base into the petiole, 3-nerved from base, sparsely hairy. Ray florests absent. Disc florests yellow. Involucral bracts in 2 whorls. Palae scale-like. Achenes glabrous, |
| Asteraceae | *Spilanthes paniculata* | Savehaklu | | Erect, glabrescent herbs, 40-50 cm tall, rooting at lowers nodes. Leaves opposite, membranous, ovate lanceolate, entire or crenate-serrate, apex obtusely acute, base narrowed and decurrent into petiole, 3-nerved from base. Paleae as long as disc florets. Pappus of 2 long bristles. Corolla of disc florets, 2 mm long. Achene blackish, of outer |

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| | | | | florests trigonous, inner compressed, ciliate, often verrucose. |
| Poaceae | *Sporobolus diander* | Bileshvara | | Perennial, erect grass, 15-45 cm tall, internodes distant above. Leaves linar, glabrous, rolled, sheaths compressed, ribbed, glabrous, ligule a fringe of hairs. Spikelet ca. 2 mm long, 1-flowered, ovate-lanceolate. Glumes 2, unequal. Lower glume less than ca. 0.6 mm long, membranous, hyaline, nerveless. Upper glume larger than lower, 1-1.2 mm long, ovate-oblong, hyaline, 1-nerved. |
| Poaceae | *Sporobolus piliferus* | Nagara | | Stem tufted, erect, roots fibrous. Leaf margins serrulate, often with bulbous based ciliate hairs at lower part; sheaths hairy at mouth; ligules a narrow line of hairs. Inflorescence a narrow panicle, greenish-white, to 6 cm long; branches short, to 5 mm long, erect. Spikelets ca. 2 mm long, ovate-lanceolate on 1 mm long pedicels. |
| Verbenaceae | *Stachytarpheta indica* | Mastikatte | | Erect, branched herbs or undershrubs, 0.5-1 m tall, branches quadrangular, nearly glabrous. Leaves opposite, elliptic, serrate, apex acute, base cuneate and decurrent to 1-2 cm long petiole. Flowers blue in terminal spikes, glabrous bracts 5 mm long, lanceolate, adpressed to peduncle. |
| Menispermaceae | *Stephania japonica* | Nagodi, Hulical, Sampekatte | - | Slender, dioecious twiners, branches striate, grooved, spirally twisted. Leaves alternate, peltate, ovate, apex acute or acuminate. Inflorescence glabrous, condyle not perforate. Male flowers in umbelled heads, Male flowers sepals 6-8, obovate, petals 3-4, synandrium 1mm long. Female flowers petals 3-4, ovate |
| Sterculiaceae | *Sterculia quttata* | Hulical, Yedur, | Hulithardu | Deciduous trees, to 12 m tall, bark fibrous. Branchlets stellately-pubescent. Leaves simple, alternet. Flower buds globose; stipules ensiform, not striate.<br>Flower colour yellow spotted |

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| | | | | with purple. Male and hermophrodite flowers are present. |
| Bignoniaceae | *Stereospermum personatum* | Nittur, Kattinkere | | Trees, to 17 m tall, stem soft. Leaves alternate, impariipinnate, rachis 26 cm long. Capsule in terminal, long, drooping panicles, linear, curved, tetragonous, 2-valved, septum cylindrical, seeds many 2-winged. Associated woth Terminalia paniculata ROth, Syzygium caryophyllatum (L.) Alston. |
| Moraceae | *Streblus asper* | Bileshvara | Mittemara. | Small unarmed trees, branchlets tomentose. Leaves elliptic-obovate, acuminate at apex, cuneate at base. Male flowers with globose heads, female axillary. Drupe globose with persistent perianth. |
| Scrophulariacea e | *Striga angustifolia* | Bileshvara | | Small, erect, unbranched parasitic herbs, to 15 cm tall, stem leaves and calyx scabrid, often minutely prickly-hairy, stem faintly ribbed. Leaves opposite below, alternate upwards, sessile, linear, midrib prominent beneath. Flowers white, sessile or shortly pedicelled, in distant terminal spikes or racemes. Capsules ovoid, included in calyx tube, seeds 0.5 mm long, oblong, faintly striate. |
| Scrophulariacea e | *Striga asiatica* | Nagara, Hulikal, Sampekatte | Berumari gida | Erect, slender, parasitic herbs, 20-30 cm tall, stems simple or branched, strigose. Lewer leaves opposite, upper alternate, simple, sessile, ridig, linear, acute, narrow, entire, hirsute. Flowers white, axillary, solitary, passing on to terminal leafy spikes, bracts longer than calyx, lateral nerves of the calyx-lobes ending in the sinus. Capsules oblong, loculicidal. |
| Scrophulariacea e | *Striga gesnerioides* | Kodachadri hills | | Erect, glabrous, reddish, parasitic herbs o 25 cm tall, often branched from base, stem ribbed. Leaves 5 mm long, scale-like alternate below, opposite upwards. Flowers purple. Sessile, in terminal distant spikes, bracts large, ovate, scaly, bracteoles 2, ciliate, in upper part |

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| | | | | as in bracts. Corolla pink to purple. Calyx 5-lobed, united, 5 mm long; tube 5-ribbed; lobes acute with bristly tips, ciliate. Corolla tube narrow, curved, to 8 mm long; lobes 5, unequal, 2-lipped. Capsules oblong, with persistent style base, seeds small, oblong. |
| Loganiaceae | *Strychnos dalzelli* | Yedur, Hulikal,Kundadri,Hosagadde | | Large climbing shrubs with hooked, clavate tendrils. Sometimes thorny at base. Leaves opposite, coriaceous. Flowers yellowish-green in axillary cymes. Berry globose, black when dry, many seeded. |
| Loganiaceae | *Strychnos nux-vomica* | Hirekoppa | Kaasarkana-mara, Kaasarka | Medium-sized, thorny, deciduous trees, thorns 2-3 cm long. Leaves opposite, ovate-lanceolate or ovate-oblong. Fruits globose, terminal, orange-red when ripe. |
| Gentianaceae | *Swertia corymbosa* | Nittur, Savehaklu | | Erect, annual herbs to 70 cm tall, stem quadrangular, narrowly winged. Leaves opposite, sessile, ovate-lanceolate, apex acute or obtuse, apiculate. Cymes terminal, in paniculate corymbs. Capsule 2-valved, seeds compressed, reticulate. |
| Symplocaceae | *Symplocos cochinchinenssi* | Kowri, Kargal | Changa | Trees to 15 cm. branchlets glabrous or sparsely appressed-pubescent, glabrescent. Leaves elliptic-lanceolate, acute-acuminate, cuneate. Spikes axillary, branched.calyx lobes often ciliate and minutely pubescent. Ovary glabrous. |
| Symplocaceae | *Symplocos racemosa* | Nagodi, Kundadri, Hulikal | Bala doddli | Trees to 15 m. branchlets glabrous. Leaves elliptic-oblong, acute-acuminate, cuneate to rounded, glabrous. Racemes axillary 8-18 cm. calyx lobes ovate, obtuse, glabrous or sparsely ciliate and appressed-pubescent. Drupe glabrous, ellipsoid to ovoid, usually 2-celled, endocarp smooth. |
| Asteraceae | *Syneedrella nodiflora* | Nagara fort, Anavatti | | Erect, branched herbs, stem grooved, adpressed-hairy. Leaves opposite, ovate-elliptic or ovate-lanceolate, crenate-serrate, apex acute, base decurrent into petiole, 3-nerved from base. Outer ray florets female; inner disc florets |

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| | | | | bisexual. Ray achenes compressed with marginal lacerate wings; disc achenes narrow, 2-3-angled. |
| Myrtaceae | *Syzygium caryophyllatum* | Nittur, Bileshvara, Mastikatte, Hulikal, Yedur | Kuntu-nerale, Kuntangila | Small, evergreen trees, branchlets terete or slightly compressed. Leaves obovate or oblanceolate, obtuse or bluntly subacuminate at apex; calyx-tube urceolate, c. 2 mm long. Flowers white, sessile or subsessile in terminal corymbose panicles. Berry globose, purple. |
| Myrtaceae | *Syzygium cumini* | Sagar | Nerale-mara | Trees 16 m tall. Leaves coriaceous opposite, variable in shape, ovate or elliptic-oblong, apex obtuse or acuminate, base subacute. Petals calyptrate; flowers in compound trichotomous cymes on old wood; calyx-tube turbinate.fruit varying in size, to 4 cm long, purple, crowned with truncate, calyx-limb. |
| Myrtaceae | *Syzygium laetum* | Hulikal, Yedur | | Small trees, to 10 m tall. Leaves opposite, elliptic-oblong, apex subacute or shortly acuminate, base acute. Calyx tube slender, conical; pedicels few flowered.flowers 3-4 cm across, axillary or terminal, solitary or in paired cymes. |
| Myrtaceae | *Syzygium lanceolatum* | Hulikal | | Trees, 5-12 m tall, branchlets slender, terete. Leaves elliptic-oblong or obovate, apex abruptly acuminate, base tapering.Petals free; flowers in short few-flowered axillary cymes or on the leafless branches; calyx-tube elongate. Midrib impressed, nerves numerous, parallel, faint. Petals as many as 12, calyptrate. Fruit tapering to a slender base, crowned with the thickened calyx lobes and persistent style |
| Myrtaceae | *Syzygium rubicundum* | Hulikal | | Small, evergreen trees, branchlets terete or slightly compressed leaves opposite, subcoriaceous. Flowers white, in terminal or axillary, paniculate cymes, sometimes umbellate at the ends of the branchlets. |
| Myrtaceae | *Syzygium zeylanicum* | Hulikal | Jogi-mara | Much branched shrubs or small trees 4 m tall. Leaves opposite, |

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| | | | | ovate-lanceolate, ovate-lanceolate, apex acuminate, base rounded or subacute. Calyx-tube c. 5 mm long, funnel shaped; petals free; berry sub-globose, white; wild trees, Calyx tube elongate, turbinate, lobes 4-5, conspicuous. Petals calyptrate. Berries white, 1-seeded. |
| Loranthaceae | *Taxillus cuneatus* | Hosagadde | | Parasitic shrubs, branches long, slender, lenticellate. Leaves alternate, sometimes fascicled, obovate, apex rounded, base cuneate, decurrent into a short petiole. Flowers few, in axillary sessile or pedunculate fascicles, bract solitary, shorter than caylx. Calyx ca. 5 mm long, hairy. Corolla ca. 3 cm long, greenish-yellow; tube ca. 2 cm long, straight or slightly curved, 5-ribbed, split down on one side, gibbose above the middle; lobes 5, spreading or recurved. |
| Asclepiadaceae | *Telosma pallida* | Sagar | | Twining under shrubs, stem slender, densely pubescent. Leaves opposite, ovate-oblong, apex shortly acuminate, base cordate, pubescent, densely on nerves. Flowers pale cream-coloured, lateral many, umbellate cymes. |
| Papilionaceae | *Tephrosia pulcherrima* | Kodachadri | | Erect undershrubs, branches angular, fulvous-hairy. Leaves alternate, compound, silvery-tomentose beneath. Flowers few, orange, in axillary or terminal congested racemes at the ends of peduncle to 6 cm long than leaflets. Pod flat, adpressed, silky-hairy, style persistent. |
| Papilionaceae | *Teramnus labialis* | Sampekatte | | Slender adpressed hairy twiners. Leaves pinnately 3-foliolate, stipules ovate-lanceolate, 3-nerved, su;-persistent, stipellate. Rachis ca. 4 cm long. Flowers small, 2-6-fascicled, pinkish, bracts and bracteoles, ovate-lanceolate, sriate. Calyx lobes equal to the tube, lower middle lobe longer; upper 2 lobes broad. Petals standard longer than wings and keels. Seeds smooth; pods glabrous, |

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| Combretaceae | *Terminalia bellirica* | Kattinalere, Ullur, Gajnur | Shaanti-mara | Medium-sized trees, to 15 m tall. Leaves alternate, clustered at the extremities of branchlets, obovate, margin pellucid, apex rounded, subacute or shortly acuminate. Flowers pale yellowish-white, in axillary or terminal spikes. Fruits otherwise; wild; petioles more than 3.5 cm long; fruits globular, tomentose |
| Combretaceae | *Terminalia chebula* | Nivane, Ullur, | Anile | Small to moderate-sized trees, to 15 m tall. Leaves opposite or sub-opposite, ovate or elliptic-oblong, rounded at both ends, glaborus or nearly so when mature. Petioles less than 2 cm long; fruits obovoid or oblong-ellipsoid, glabrous, A pair of sessile glands near the apex of leaf. Drupe 3-4 x 2.5-3 cm, ovoid 5-ribbed, sessile, on terminal long drooping panicles. |
| Combretaceae | *Terminalia crenulata* | Kodachadri, Humcha, Savehaklu | Kari-mathi | Small to medium-sized trees, glabrous, bark blackish without. Leaves opposite, rarely alternate, oblong or elliptic-oblong. Flowers white, axillary or terminal panicles. Fruits with 5 equal wings. Nerves 10-20 pairs; glands 2, stalked, on midrib beneath Stamens in 2 whorls, inserted outside the disc; filaments erect, exserted. Disc hairy. ovules 2-3; style 3-3.5 mm long. Fruit 5-winged; wings unequal, broad, transversely striated. |
| Combretaceae | *Terminalia paniculata* | Sampekatte, Kodachadri, Tagarthi | Mathi | Medium to large-sized trees, 15-18 m tall, bark blackisk without, glabrous. Leaves opposite, sub-opposite, or alternate, oblong or elliptic-oblong. Flowers pale brownish, in axillary or terminal branched spikes. Fruits with 3-5 longitudinal wings; fruits with 3 unequal wings, 1 long and 2 short. |
| Vitaceae | *Tetrastigma gamblei* | Hulikal | - | Climbing dioecious shrubs stem teret, striate, glabrous, tendrils simple. Leaves 3-foliolate, alternate.flowers greenish-white, in axillary, short umbellate cymes. Berry single seede; seeds striate. |
| Acanthaceae | *Thelepapale* | Nagavalli | | Much branched, aromatic bushy |

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| | *ixiocephala* | forest area | | shrubs, stem viscid, glandular-hairy, swollen above the nodes. Leaves opposite, unequal, elliptic-lanceolate, crenate, apex acuminate, base cuneate or decurrent, scabrid on uppers urface, hairy along the nerves beneath. Flowers white or pale blue, in axillary or terminal condensed spikes. Style broad at middle, pubescent upwards |
| Poaceae | *Themeda tremula* | Nagara fort | | Perennial grass; stem erect or ascending from creeping rootstock, to 1.25 m tall. Leaves 25-30 x 0.6-0.8 cm, lanceolate, acuminate, margin scabrid ; sheaths compressed, narrowly keeled ; ligule a narrow membrane, inflorescence terminal or axillary, racemiform, flexuous panicles, to 30 cm long, fascicles of racemes 1-2 cm wide; branches 1-2 together. Bracts spathaceous, outer spathe to 6 cm long, tubercle based hairy, leaf-like; proper spathe 1.2-1.6 cm long. Each proper spathe encloses 2 pairs of involucral spikelets, slightly superposed, enclosing 2 sessile, bisexual spikelets and 3 pedicelled spikelets. Involucral spikelets: ca. 8 mm long, oblong-lanceolate, male or empty. Lower glume 8 x 2.5 mm, lanceolate, apiculate, many-nerved, margin inflexed, bulbous-based bristly without ; upper glumes lightly shorter, 3-nerved, membranous, margin ; inflexed. Lower lemma 5 mm long, hyaline, 1-nerved; palea absent. |
| Poaceae | *Themeda triandra* | Nagara fort, Kodachadri | | Perennial, tufted, grasses, to 1 m tall; stem erect orgeniculately ascending, simple or branched. Leaves 15-20 x 0.5-0.6 cm, linear, margin scabrid, apex acuminate; sheath compressed, narrowly keeled; ligules 3 mm long, ciliolate. Inflorescence axillary, sparingly branched, distant, racemiform panicles ; branches solitary or the upper 2-3-nate, filiform ; fascicles of racemes drooping, fan-shaped; |

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| | | | | bracts spathaceous; outer spathe to 8 cm long; proper spathe to 1.5 cm long, glabrous or ciliate with tubercle-based hairs. Lowest 2 pairs of spikelets of each raceme sessile, male or neutral, forming involucre, approximately whorled, awnless, 7 mm long, oblong-lanceolate, usually persistent. Glumes ciliate with tubercule-based hairs; the upper 1-3 pairs of spikelets, each consists of a sessile bisexual spikelet and a pedicelled male spikelet, the latter resembling the involucral spikelet. Bisexual sessile spikelets: 6-8 mm long; callus bearded; ca. 6 mm long, stiff. |
| Aristolochiaceae | *Thottea siliquosa* | Hulikal, Nagavalli | Chakranike | Erect undershurbs, young parts stellately-hairy, stem swollen at nodes, internodes zig-zag. Leaves papery, alternate, ovate-lanceolate or oblong-lanceolate, apex acute, base rounded or bluntly acute, 3-nerved from base, with an inconspicuous pair near the margin. Flowers violet-brown in axillary racemes. Perianth 3-lobed, connate. Capsule to 18 cm long, linear, somewhat angular, seeds trigonous, pitted. |
| Acanthaceae | *Thunbregia fragrans* | Sampekatte, Bileshvara | | Climbers, stem pubescent. Leaves opposite, ovate-hastate, entire or dentate, apex acute, base truncate or subcordate, 3-5-nerved from base. Flowers axillary, soliatry or in pairs; calyx 12 - 16 toothed, Calyx enclosed; tube cup-like; teeth 14. Corolla 2.5 cm long, narrow. Capsule 2-valved, globose, below, beaked, seeds 4. |
| Acanthaceae | *Thunbregia mysorensis* | Hulikal | | Large twiners, stem grooved, angular. Leaves opposite, elliptic-lanceolate or ovate-lanceolate, entire or serrate-dentate, apex acuminate, base rounded or acute, 3-nerved from base. Flowers orange-yellow, in long, drooping panicles, pedicels 2-4 cm long. |
| Menispermaceae | *Tinospora cordifolia* | Karigudda | Amrutaballi | Dioecious, climbing shrubs, bark corky. Leaves smaller 5 - 10 cm, glabrous. Leaves with a broad sinus. Flowers yellow, in axillary, |

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| | | | | long racemes.sepals and petals 3 each in both sexes. Male flowers fascicled, female flowers solitary. |
| Rutaceae | *Toddalia asiatica* | Nagodi, Sampekatte, Kodachadri, Humcha, Yedur | | Large scandent or climbing, aromatic shrubs, armed with recurved prickles. Leaves 3-foliolate, alternate, sessile. Petals 5. Male flowers; stamens 8, filament slightly longer than petals; anther 2-celled; pistillode cylindric. Flowers unisexual, in axillary or terminal panicled cymes. Fruit 3 - 7 celled; Fruit 1 cm across, sub-globose, gland-pitted, 4-6-locular; seeds 1 in each cell. |
| Loranthaceae | *Tolypanthus lagenifer* | Kargal | | Parasitic shrubs, stem lenticellate. Leaves opposite, reddish when young, ovate or ovate-oblong, apex obtuse or acute, base rounded. Flowers subsessile, fascicled on woody stem, subtended by reddish, campanulate, 5-lbed, 2-3 cm long involucres. Corolla 5-lobed, reddish; tube dilated above the middle; loss 5, short. Found parasitic on Hopea ponga (Dennst.) Mabberly and Erratamia heyneana (Wall.) Cooke. |
| Scrophulariacea e | *Torenia bicolor* | Hulikal, Yedur | | Prostrate herbs, rooting at nodes, stem angular, glabrous. Leaves opposite, ovate, serrate, apex obtuse or acute, base truncate, rounded or cuneate, sparsely hairy. Flowers purplish-blue, or bluish-white, axillary, solitary, pedicels to 3.5 cm long, stout upwards. Calyx 5-lobed, united; tube narrow, 1 cm long, ridged; ridges decurrent on the pedicel; lobes unequal. Corolla 2-lipped; tube to 1 cm long, broad above; upper lip with 1 purplish, rounded lobe, lower with 2 white or purplish, rounded lobes. |
| Scrophulariacea e | *Torenia cordifolia* | Nagara, hulikal, Yedur | | Erect or sub-erect herbs, 10-25 cm tall, stem 4-angled, often trichotomously branched, young parts pubescent. Leaves oppositye, serrate, apex acute, cuneate at base, hairy chiefly along nerves on both surfaces. |

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| | | | | Flowers 1 cm long, axillary, solitary. Capsules oblong, acute, enclosed in calyx tube. |
| Asclepiadaceae | *Toxocarpus kleinii* | Kodachadri | | Twining shrubs, stem terete, swollen at nodes, rusty-tomentose. Leaves elliptic-oblong or lanceolate or obovate, apex acute or shortly acuminate, base acute. Flowers in axillary or lateral, paniculate or dichotomous cymes. Pollinia globular-oblong, 2 in each anther-lobe; caudicle membranous; corpusculum light brown. Stylar apex pentangular. |
| Euphorbiaceae | *Tragia hispida* | Chakra, Yedur,Naga valli | | Slender, twining herbs, stem hispid with stinging hairs. Leaves ovate, serrate, apx shortly acuminate, base cordate, long hairy. Flowers in axillary, pedunculate racemes, females few below, male small, many upwards. Perianth lobes 5, united at base. Stamens 3, free or connate at base. Fruiting calyx lobes 6, pinnately 4-toothed, ciliate, glabrous within. Ovary pubescent, 3-loculed. |
| Trapaceae | *Trapa natans* | Kattinakere | | Floating, aquatic herbs, stem tufted hairy near nodes. Leaves dimorphic, submerged opposite, root-like, pinnatipartite. Flowers white, axillary, solitary, pedicels 2.5 c m long. Drupe 4-angled, 2 or all angles spiny, seed 1. |
| Ulmaceae | *Trema orientalis* | Savehaklu, Chakra | Kiruhale | Dioecious, small trees or shrubs, young branchlets and stipules white pubescent. Petiole to 1.5 cm long; leaf blade ovate-lanceolate, acuminate at apex, obliquely subcordate at base, serrate, canescent beneath, scabrid above.Stamens opposite the perianth. |
| Euphorbiaceae | *Trewia polycarpa* | Nagodi, Hulikal | | Dioecious trees to 12 m tall, young branches stellately pubescent. Leaves opposite, unequal, broadly ovate, apex acuminate, base sub-cordate or truncate. Flowers small, in axillary, simple or branched racemes. Male flowers sessile, female flowers many flowered. |
| Orchidaceae | *Trias stocksii* | Bileshvara | | Epiphytic small herbs; rhizome creeping, pseudobulbous. |

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| | | | | Pseudobulbs 1 cm across, ovoid or disc-like. Leaves 2-3.5 x 1-1.2cm, coriaceous, erect and solitary to each pseudobulb, ovate orelliptic-oblong, apex acute, base tapering, midrib impressed. Scape 5 mm long, inserted laterally on the pseudobulb. Capsule 1 cm across, globose. Fruiting: June. |
| Meliaceae | *Trichilia connaroides* | Hulical, Kodachadri | | Small trees to 8 m tall. Leaves imparipinnate. Rachis 18-27 cm long, pulvinate. Flowers long, white, hairy, in axillary corymbosely branched panicles. Capsules ovoid, 2-valved.aril white. |
| Asteraceae | *Tricholepis galberrima* | Kodachadri hills | | Erect rigid herbs. Stem angular, ribbed. Leaves alternate, sessile or subsessile, linear-oblong or lanceolate, spinous-serrate, apex acute, base often auricled, scabrid and prominently nerved beneath. Heads homogamous, purplish, discoid, terminal, solitary. Involucral bracts in many whorls, linear-lanceolate, apex aristate, ciliolate. Florets disc like, bisexual. |
| Cucurbitaceae | *Trichosanthes cucumerina* | Hulikal | Padavala kaayi | Slender, monoecious climber. Leaves membranous, palmately 3-5-lobed, broadly ovate or suborbicular, denticulate. Male flowers in axillary, solitary or short racemes. Female flowers solitary or paired. Fruit ovoid-conical, to 6*4 cm. seeds ovate-oblong, compressed, with undulate margin. |
| Cucurbitaceae | *Trichosanthes lepiniana* | Yedur, Hulikal | - | Large dioecious climber. Tendril rigid and angular at base coiled and forked above; Leaves generally membranous. Male flowers 8 cm long, white, few, in axillary, solitary or short, slender racemes. Anthers sub-sessile ca. 1.2 cm long enclosed in calyx tube, 2 with 2 cells, 1 monothecous. Fruit ovoid-conical, beaked. |
| Asteraceae | *Tridax procumbens* | Nagara fort wall | | Procumbent, hirsute herbs, hairs stout, glandular, branches creeping or ascending. Leaves opposite, ovate or elliptic, deply inciso-dentate at both ends. |

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| | | | | Outermost whorl of 5 bracts herbaceous, ca 5 x 3 mm, ovate, acuminate, ribbed, hairy without; inner bracts slightly larger, oblong, apiculate, scarious, striped, glabrous or sparsely hairy. Ray florets ca. 8 mm long, female. Corolla tube 3-3.5 mm long, narrow, hairy; ligule ca. 5 mm long, 3-lobed. Disc florets, 6-8 mm long, bisexual, tubular. Corolla tube 5-6 mm long. |
| Tiliaceae | *Triumfetta annua* | Hulical | - | Much branched undershrubs, branches hispid, hairs in rows. Leaves entire, subcordate at base. Capsule including hooked bristles 1.5 cm long, 3-4-valved, 1-3 clustered on axillary or extra-axillary peduncles; bristles 5 mm long globose, minutely hairy at base, glabrous above. |
| Tiliaceae | *Triumfetta rhomboidea* | Chakra, Hulical | Urki | Woody, branched herbs or undershrubs, branches slender, stellately-hairy, more or less hispid. Leaves tomentose beneath; lower leaves 3-5 lobed. Flowers 5-6 mm long, orange-yellow in terminal or leaf-opposed cymes. Bristles of fruit glabrous. Stamens 8-15. Pericarp tomentose. Fruit globose. |
| Orchidaceae | *Tropidia angulosa* | Sampekatte | | Terrestrial, erect herbs, to 25 cm long; root-stock short, woody, with rigid adventitious roots; aerial stem simple or branched, clothed with broad, strongly nerved leaf-sheaths. Leaves 11-12 x 3.5-4 cm, broadly elliptic or ovate-lanceolate, apex acuminate, base rounded, plicate, strongly 6-8-nerved. Flowers greenish-white, in terminal, dense spikes; peduncle 5-8 cm long; bracts ca. 1.5 cm long, narrowly lanceolate, acuminate, 3-ribbed. Sepals connate nearly to the tip. Petals shorter, ovate-lanceolate. Lip as long as petals, oblong, apex obtuse, reflexed. Column short; rostellum long, horn-like, 2-fid. Anther 1, 2-celled; pollinia 2, with long caudicle and linear gland. Ovary to 1 cm long, cylindrical, faintly ribbed. |

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| | | | | Flowering: September. |
| Staphyleaceae | *Turpinia malabarica* | Hulikal, Yedur | | Medium-sized trees, 15-17 m tall, branches compressed. Leaves imparipinnately compound. Flowers white in axillary or terminal panicles of corymbose cymes. Fruit 1.5-3 cm across, globose. Seeds 3. |
| Meliaceae | *Turraea villosa* | Jog | | Shrubs; juvenile parts villous. Leaves simple, alternate, elliptic, ovoate or obovate. Flowers axillary, solitary or in 2-3-flowered cymes. |
| Asclepiadaceae | *Tylophora dalzellii* | Hulikal, Yedur | | Twining herbs, stem pubescent. Leaves opposite, elliptic or oblong-lanceolate, apex acute, base rounded pr subcordate, hairy. Flowers reddish-purple, in axillary or lateral, simple or panicled umbellate cymes. Pedicels glabrous, Corona of 5, fleshy lobes, adnate to staminal column, gibbous at base, truncate at apex. |
| Asclepiadaceae | *Tylophora fasciculata* | Nittur, Sampekatte | | Erect rigid herbs to 25 cm tall, simple or branched, often branches arising base. Leaves less than 4 cm long. Flowers in axillary or lateal umbellate or paniculate cymes. Coronal scales 5, broadly ovoid below, radiating from staminal column, pollinia one in each cell, more or less transverse; connective prolonged into membranous tip above the style apex. |
| Asclepiadaceae | *Tylophora indica* | Hulikal, Yedur | | Pubescent or glabrous twining herbs; sap yellow, watery. Leaves more than 4 cm long, ovate-lanceolate or elliptic-oblong, apex acute or acuminate, apiculate, base rounded or cordate. Flowers greenish with reddish-purple centre in axillary or lateral umbellate cymes, pedicels hairy, Corolla ca. 5mm long; lobes oblong, acute. Corona staminal, gibbous below, abruptly narrowed at apex. |
| Asclepiadaceae | *Tylophora pauciflora* | Hulikal, Kundadri | | Glabrous, twining herbs often with waatery sap. Leaves opposite, membranous, triangular-ovate or ovate-lanceolate, apex acute or |

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| | | | | acuminate, base sub-cordate. Flowers yellowish-green with purple centre, in lateral umbellate cymes, peduncle slender. Coronal lobes 5, fleshy, globose, adnate to staminal column, pollinia 1 in each cell, horizontal; connective produced into terminal, membranous tip. Styles apex flattened. Follicle ovate-lanceolate. |
| Malvaceae | *Urena lobata* | Kodachadri, Savehaklu | | Erect herbs or undershrubs, stem densely hairy, hairs often clustered. Leaves angled or shallowly lobed; epicalyx cupular in fruit.<br>Leaves 7-nerved from base; midrib glandular beneath. Epicalyx of 5 lobes, connate, 4-6 mm long as long as calyx or slightly longer, hairy. Capsule depressed-globose, 5-lobed, glochidiate. |
| Lentibulariaceae | *Utricularia aurea* | Kattinkere | | Aquatic, submerged, floating herbs. Leaves in whorls of 4, pinnately divided into slender, filiform segments, pinnae with globose bladders near the base and highly dissected. Flowers yellow; scapes 4 - 8 flowered; seeds prismatic with sharp angles and slightly winged margins. Capsule globose, 1-celled, seeds many, angular. |
| Lentibulariaceae | *Utricularia praeterita* | Nagara, Hulikal | | Slender, erect herbs, roots branched. Leaves few, membranous, linear-oblonbg or obovate or spathulate, apex rounded, cuneate at base. Flowers bluish, 1-6, racemes, pedicels 1.5-3 mm long, erect or slightly curved. Fruiting pedicel erector slightly curved; spur conical, not sickle-shaped. Scapes 4-8 cm long, slender; greenish with few scales at base. |
| Lentibulariaceae | *Utricularia purpurascens* | Hebbegere | | Small, erect scapigirous, herbs to 10 cm tall, roots slender, branched. Leaves membranous, deciduous, linear-spathulate, apex rounded. Flowers 5-6 mm long, bluish. Capsule globose, enclosed in enlarged calyx, 1-celled, seeds many, oblong. |

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| Lentibulariaceae | *Utricularia striatula* | Hulikal | | Small, slender, epiphytic herbs, stolons filiform, creeping, bearing leaves and bladders. Leaves orbicular, long-petioled. Flowers white, on slender, erect, scapes. Lower lip of corolla unigibbous at base; pedicels more or less erect in fruit. Traps globose. Scapes 2 - 10 cm long, filiform. Sepal unequal, lower lobes smaller. Corolla upper lip suborbicular, emarginate.capsules subglobose, 1-celled, seeds many, on free-central placenta, pale-brownish, oblong, glochidiate. |
| Annonaceae | *Uvaria narum* | Jog | Kariballi | Large, woody climbing on scandent shrubs. Leaves alternate, elliptic-oblong-lanceolate, apex acute or shortly acuminate, base acute. Fruitlets 15-17, on terminal peduncles, cylindrical or slightly constricted orange or scarlet red, turning black, 1-few-seeded. |
| Hydrocharitaceae | *Vallisneria spiralis* | Between Yedur and Mastikatte | | Submerged, dioecious, aquatic herbs, roots slender, fibrous. Leaves variable in length, grass-like, membranous, lanceolate, apex acute. Capsule included in spathe, many seeded, slender, filiform. |
| Dipterocarpaceae | *Vateria indica* | Between Sampekatte and Kodachadri | Dhoopa, Chandalika | Trees to 20 m tall. Leaves elliptic-oblong, coriaceous, glabrous, acuminate; lateral nerves to 15 pairs. Stipules thick, linear-oblong, caduceus. Panicles to 12.5 cm long. Flowers white. Stamens nearly 50; anthers linear. Capsules fleshy, oblong, obtuse. |
| Rutaceae | *Vepris bilocularis* | Kodachadri, Nagodi, Yedur | - | Unarmed, medium-sized, dioecious trees, to 15 m tall. Leaves 3-foliolate, alternate, elliptic or elliptic-oblong. Flowers white, in terminally lax panicles. Male flowers: calyx minute, saucer-shaped. Petals 2, free. Female flowers: calyx and petals same as in male. |
| Asteraceae | *Vernonia ornata* | Agumbe, Kodachadri | | Erect herbs or undershrubs, stem striate young parts hairy. Leaves alternate, membranous, elliptic, obovtae. Achenes 3-3.5 mm long, 10-ribbed, minutely hairy, slightly curved above the base. |
| Papilionaceae | *Vigna mungo* | Kodachadri | Uddu | Twining herbs, stem, leaves and |

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| | | | | inflorescence hirsute, with long, spreading, bulbous-based deflexed hairs. Leaves pinnately 3-foliolate. Pods hirsute; seeds with a raised rim-aril around hilum. Keels longer than wings, twisted upwards. Pod villous, valves twisted after dehiscence. Aril rim raised around hilum. |
| Papilionaceae | *Vigna umbellata* | Chakra | | Twining herbs, stem slender with long deflexed hairs. Leaves pinnately 3-foliolate, leaflets membranous, terminal large, rhomboid or ovate-lanceolate, apex shortly. Leaflets entire or shallowly lobed at the base; pods compressed, reflexed. Petals standard emarginate at apex, laterally adpressed to wings; keels longer than wings, often twisted. Pod to 6 cm long, compressed, minutely pubescent, seeds about 12. |
| Loranthaceae | *Viscum angulatum* | Bileshvara | | Leafless, slender, parasitic shrubs; stem green, dichotomously branched; internodes 4-angled. Flowers minute, sessile, 2 or more in whorls at nodes; bract 1; bracteoles 2, persistent. Fruits ovoid, green, 1-seeded. Flowering: June, Fruiting: June. |
| Verbenaceae | *Vitex altissima* | Nagodi, Savehaklu, Sagar | | Small to medium-sized trees, to 17 m tall, branchlets quadrangular, pubescent. Leaves opposite, palmately 3-foliolate, petiole 4-8 cm long, channelled above. Flowers long, bluish-white, in interrupted clusters along the branches of terminal or axillary panciles. Cymes in termianl panicles; petioles angular or winged with an auricled base.Calyx 5-lobed, ca. 3 mm long, cup-like; teeth minute. Corolla tube short, hairy within; limb 2-lipped; upper lip with 2 lobes; lower 3-lobed; mid-lobe twice longer than laterals. Drupe globose or ovoid, turning reddish when ripe. |
| Verbenaceae | *Vitex negundo* | Bileshvara | | Shrubs or small trees; branchlets angular, finely tomentose. Leaves 1 - 3 foliolate, opposite, |

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| | | | | palmately 3-5-foliolate petiole 4-6 cm long, leaflets sessile. Flowers more than 5 mm long, bluish-purple, in terminal or axillary paniculate cymes. Corolla tube short; limb 2-lipped; upper lip with 2 lobes; lower 3-lobed. Drupe 4-5 mm across, globose. |
| Asclepiadaceae | *Wattakaka volubillis* | Savehaklu, Kodachadri | Hegala balli | Twining shrubs, latex watery, branches green, lenticellate. Leaves opposite, ovate, apex acuminate, base cordate or rounded, glands few on upper surface at base, minutely hairy. Flowers greenish, on axillary umbels. Corolla rotate; lobes 5-6 mm long. Corona of 5, fleshy scales, adnate to staminal column at base, free, truncate above. |
| Rubiaceae | *Wendlandia thyrsoidea* | Kodachadri hills | | Large, branched shrubs or small trees to 5 m tall, stem terete or obtusely 4-angled, densely pubescent. Leaves ternately whorled, rarely opposite in puuer nodes, elliptic, acute or obtusely shortly acuminate. Flowers small, white, in terminal panicles.Corolla tube narrow, 4 mm long, sparsely hairy within, glabrous without lobes 5, ca. 1 mm long. |
| Apocynaceae | *Wrightia arborea* | Gajnur | Kaadu kanagilu, Benki gida | Small trees to 8 m tall, young branches, leaves and inflorescence softly tomentose, branches divaricate, compredded. Leaves tomentose on both sides, follicles rough with prominent lenticels. Flowers yellowish, in terminal corymbose cymes, peduncle 4 cm long, pedicels 8 mm long. |
| Apocynaceae | *Wrightia tinctoria* | Sagar, Gajnur | Kare kodasiga | Deciduous trees, 8-10 m tall. Leaves glabrous, opposite, membranous, elliptic-lanceolate or oblong-lanceolate, apex acuminate, base acute, glabrous, pale beneath. Flowers white; corona of many, linear scales. Corona of numerous tubular scales in 2 rows. Stamens inserted on the corolla tube at the throat; filaments short, dilated below. |
| Sapotaceae | *Xantolis tomentosa* | Chakra, Yedur, | Hudigullu, Kampale. | Small to medium-sized trees, to 14 m tall; trunk often thorny, |

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| | | Hulikal | | formed by modified twigs; young branchlets hairy, lenticellate. Leaves 6-10 x 3.5-6 cm, alternate, sometimes sub-opposite, elliptic, or obovate, apex obtuse or bluntly acute, base cuneate or acute, often unequal; petiole 5-10 mm long. Flowers white, in axillary fascicles; pedicels 1 cm long, thickened above, often curved, hairy. Calyx 5-lobed, greenish, connate; lobes imbricate, 5x3 mm, ovate, acute; outer 2 larger, hairy without. Corolla lobes 5, united; tube campanulate, 2 mm long, broad; lobes 4 mm long, lanceolate. |
| Mimosaceae | *Xylia xylocarpa* | Nivane, Near Gajnur | Malayalam-Kadamaram, Tamil-Irul | Medium-sized deciduous trees, to 16 m tall, young parts pubescent. Leaves bipinnately compound, rachis 2-5 cm long, glandular between pinnae. Rachis 2-5 cm long, more or less grooved above, Pinnae 1-pair, to 10 cm long. Flowers sessile or subsessile, yellowish-white, in axillary, long-peduncled, globose heads. Pod flate, falcate, woody, stalked, seeds many. |
| Rutaceae | *Zanthoxylum ovalifolium* | Bileshvara, Hulikal, Nagara | Tulu-Are maapaala | Erect, branched shrubs. Leaves trifoliolate, alternate, sessile. Flowers white, polygamous, in terminal panicles , pedicels pubescent. Filaments 2-2.5 mm long; anthers 2-celled. Pistillode present in male flower. Capsule 5-8 mm across, globose, 2-valved, seed 1. |
| Rutaceae | *Zanthoxylum rhetsa* | Mastikatte, Kattinakere | Gaamate mara, Aramaadala | Aromatic trees, to 10 m tall, stem hollow, with conical, straight prickles. Leaves pinnate. Capsule dehiscing ventrally.flowers yellowish-white polygamous, in terminal or subterminal, large panicles, in terminal or subterminal. |
| Cucurbitaceae | *Zehneria maysorensis* | Yedur, Hulikal | - | Slender monoecious climber; leaves membranous, ovate, suborbicular or oblong.flowers subumbellate or pistillate flowers solitary, sub-sessile, sometimes staminate and pistillate flowers coaxillary. Fruit ellipsoid. |
| Orchidaceae | *Zeuxine* | Hulikal, | | Terrestrial herbs; stem slender, |

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| | *longilabris* | Yedur | | creeping and ascending, 15-25 cm tall. Leaves 2.5-4 x 0.8-1.2 cm, ovate or ovate-oblong, apex acute, base rounded, 7-nerved from base; sheath inflated. fLowers greenish-white, in lax few-flowered spikes, terminal to slender, erect scape; floral bracts as long as the ovary, lanceolate. Sepals 3, ca. 6 mm long, oblong, apex obtuse. Petals white, adpressed to the dorsal sepal forming a hood. |
| Zingiberaceae | *Zingiber cernuum* | Hulikal | | Rhizomatous, aromatic herbs, leafy stem to 1.5 m tall. Leaves elliptic-oblong or oblong-lanceolate, acuminate, narrowed at base, sessile, glabrous or pubescent beneath, ligule membranous, bifid. Peduncle condensed; spike scarcely appearing above the ground. Capsule pale pinkish-yellow or reddish, 4.5 cm long, ellipsoid, seeds red, aril white. |
| Zingiberaceae | *Zingiber neesanum* | Hulikal, Savehaklu, Kargal | | Rhizomatous herbs, rhizome short, yellowish within inside, with fleshy roots ending in globose tubers. Leaves oblong-lanceolate, more than 5 cm wide, pubescent beneath. Bracts obovate, acute or cuspidate at apex; labellum spotted.capsules 1.5 cm long, obovoid, reddish, pubescent, seeds black, aril white. |
| Rhamnaceae | *Ziziphus oenoplta* | Nittur, Kargal | | Scadent shrubs, often with straggling branches. Leaves alternate, ovate or ovate-lanceolate. Flowers in axillary cymes or fascicles; petals present. |
| Rhamnaceae | *Ziziphus rugosa* | Hulikal | Kotte hannu | Large, armed straggling shrubs, young parts pubescent, stem lenticellate. Leaves alteranet, ovate-oblong margin serrate with callus. Flowers in peduncled cymose terminal panicles; petals absent. Calyx lobes ovate, acute. Petals absent. Disc 5-lobed. Stamens 5, inserted at the periphery of disc ; filaments short |
| Rhamnaceae | *Ziziphus xylopyrus* | Nivane, Nittur, Kargal, Gajanur | | Large shrubs or small trees, rarely to 8 m tall, branches often straggling. Leaves hairy; prickles present, fruit woody with a large |

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| | | | | stone. Fruit 2-2.5 cm in diameter, globose, hard, 2-3-seeded. |
| Papilionaceae | *Zornia gibbosa* | Nittur, Savehaklu, Kundadri | | Small, diffuse herbs, branches ascending or prostrate. Leaves alternate, 2-foliolate, petiole to 1 cm long, stipules greenish, lanceolate, peltate, sessile or subsessile, lanceolate or ovate. Flowers yellow, in axillary spikes, bracts paired, foliaceous, produced below, ciliate, black glandular. Pods partly exposed outside the bracts, not entirely enclosed in the bracts. Leaflets 0.8-2 x 0.2-0.4 cm, sessile or sub-sessile. |

**Table 8: Endemic species of Shimoga district (Radhakrishna et.al, 1992)**

| Species | Occurance |
|---|---|
| *Adelocaryum coelestinum* | Yedur |
| *Adenoon indicum* | Kodachadri hills |
| *Aeschynanthus perrottetii* | Hosagadde |
| *Aglaia canarensis* | Kodachadri |
| *Aglaia lawii* | Hulikal |
| *Andrographis ovata* | Nittur, Induvalli |
| *Anisomeles heyneana* | Nagavalli |
| *Aporusa lindleyana* | Sampekatte, Yedur, Jog |
| *Argostemma courtallense* | Hulikal |
| *Argyreia pilosa* | Sampekatte |
| *Asystasia dalzelliana* | Sampekatte, Nittur |
| *Atylosia lineata* | Kundadri, Yedur, Kodachadri |
| *Blachia denudata* | Jog |
| *Blepharis asperrima* | Yedur, Kodachadri, Hulikal |
| *Blepharispermum subsessile* | Sampekatte |
| *Blumea belangeriana* | Hulikal |
| *Chrysopogon hackelii* | Kodachadri |
| *Cinnamomum malabatrum* | Hulikal, Tenkbail,Kogar |
| *Crotalaria filipes* | Chakra |
| *Dendrobium barbatulum* | Kundadri, Jog, Nagavalli |
| *Derris brevipes* | Sampekatte |
| *Desmos lawii* | Hulical, Yedur, Jog |
| *Diospyros saldanhae* | Nagodi |
| *Ellertonia rheedii* | Hulikal, Kaimara |

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| *Ensete superbum* | Hulikal, Varahi |
| *Eria dalzelli* | Sampekatte |
| *Eriocaulon cuspidatum* | Hosagadde |
| *Eriocaulon stellulatum* | Kodachadri, Hosagadde |
| *Ervatamia heyneana* | Hulikal, Nagodi, Humcha |
| *Erythropalum populifolium* | Chakra, yedur, Hulical |
| *Euonymus indicus* | Yedur, Sampekatte |
| *Eusteralis tomentosa* | Nittur |
| *Garcinia gummigutta* | Kargal |
| *Goniothalamus cardiopetalus* | Tenkbail |
| *Griffithelia hookcriana* | Nagavalli |
| *Gymnostachyum latifolium* | Kodachadri hills |
| *Habenaria elwesii* | Hosagadde |
| *Habenaria grandifloriformis* | Bileshvara, Sampekatte |
| *Habenaria heyneana* | Nittur, Chakra, Hulikal,Sampekatte, Savehaklu |
| *Habenaria longicorniculata* | Nagara |
| *Hedyotis erecta* | Sagar |
| *Helixanthera intermedia* | Yedur |
| *Helixanthera wallichiana* | Jog |
| *Heritiera papilio* | Kodachadri |
| *Holigarna arnottiana* | Hulikal, Yedur, Tagarthi |
| *Holigarna ferruginea* | Hulikal |
| *Holigarna grahamii* | Hulikal |
| *Hopea ponga* | Nittur, Hulikal, Nagodi |
| *Hymenodictyon obovatum* | Chakra, Hulikal |
| *Impatiens agumbeana* | Hulical |
| *Impatiens gardneriana* | Hulical |
| *Impatiens herbicola* | Kodachadri hills |
| *Impatiens kleinii* | Sampekatte, Mastikatte |
| *Ischaemum impressum* | Kodachadri |
| *Ixora brachiata* | Hulikal, Jog, Govardhanagiri |
| *Ixora malabarica* | Savehaklu, Devagaru |
| *Ixora polyantha* | Hulikal |
| *Jasminum cordifolium* | Hulikal |
| *Justicia santapani* | Hulikal |
| *Justicia wynaadensis* | Nagavalli |
| *Knema attenuata* | Nittur,Yedur, Nagodi |
| *Lagerstroemia microcarpa* | Sampekatte, Yedur, Kattinkere |
| *Litsea coriacea* | Hulikal, Yedur |
| *Mallotus stenanthus* | Kodachadri, Kattinkere |
| *Medinilla beddomei* | Kodachadri |
| *Memecylon terminale* | Hulikal |
| *Metereomyrtus wynaadensis* | Nittur, Chakra, Hulikal |
| *Moullava spicata* | Chakra, Sampekatte |
| *Mussaenda laxa* | Mastikatte, Yedur, Nagara fort |
| *Myristica malabarica* | Hosur |

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| *Nilgirianthus barbatus* | Hulikal |
| *Nilgirianthus heyneanuss* | Sampekatte, Chakra, Yedur, Kodachadri, Nagavalli |
| *Oberonia chandrasekharanii* | Nagodi |
| *Pittosporum dasycaulon* | Yedur, Hulical, Kargal, Sampekatte |
| *Plectranthus stocksii* | Chakra, Kodachadri |
| *Poeciloneuron indicum* | Hulical |
| *Polyzygous tuberosus* | Hebbigere |
| *Porpax jerdoniana* | Sampekatte |
| *Pouzolzia wighti* | Nagara fort |
| *Psychotria canarensis* | Yedur |
| *Ramphicara longiflora* | Nagara, Hulikal, Chakra |
| *Reidia macrocalyx* | Kundadri |
| *Reissantia grahamii* | Hulikal |
| *Rubus fockei* | Nagodi |
| *Salacia macrosperma* | Hulikal |
| *Scutellaria colebrookiana* | Gajnur |
| *Seshagiria sahyadrica* | Nagara |
| *Smithia setulosa* | Kodachadri hills |
| *Smythea bombaiensis* | Hulikal, Jog |
| *Strychnos dalzelli* | Yedur, Hosagadde |
| *Swertia corymbosa* | Nittur, Savehaklu |
| *Tetrastigma gamblei* | Hulikal |
| *Thelepapale ixiocephala* | Nagavalli forest area |
| *Thottea siliquosa* | Hulikal, Nagavalli |
| *Tolypanthus lagenifer* | Kargal |
| *Trewia polycarpa* | Nagodi, Hulikal |
| *Trias stocksii* | Bileshvara |
| *Turpinia malabarica* | Hulikal, Yedur |
| *Vateria indica* | Kodachadri |
| *Vernonia ornata* | Agumbe, Kodachadri |
| *Zingiber neesanum* | Hulikal, Savehaklu, Kargal |

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| *Aporosa lindleyana* | *Argostemma courtallense* |
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| *Ixora brachiata* | *Knema attenuate* |

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| *Myristica malabarica* | *Vateria indica* |
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| *Holigarna grahamii* | *Holigarna arnottiana* |
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| *Impatiens gardeneriana* | *Euonymus indicus* |

*Habenaria longicorniculata*

*Lagerstroemia microcarpa*

*Ervatamia heyneana*

*Desmos lawii*

*Crotolaria filipes*

*Tolypanthus lagenifer*

## 2.0 LANDSCAPE DYNAMICS IN SHIMOGA

Landscape refers to a portion of heterogeneous territory composed of sets of interacting ecosystems and is characterized essentially by its dynamics that are partly governed by human activities (Ramachandra et al., 2012a). Human induced land use and land cover (LULC) changes have been the major drivers for the changes in local and global environments. Analyses of changes in land uses provide a historical perspective of land use and give an opportunity to assess the spatial patterns, correlation, trends, rate and impacts of the change, which would help in better regional planning and good governance of the region (Bhatta et al., 2010, Ramachandra, et al., 2012a, Ramachandra et al., 2012b).

Humans are influencing the forested landscape through many interventions fragmenting it into patches. Fragmentation is the breaking up of a landscape, habitat, ecosystems, or land use types into smaller parts (Forman, 1995 &1997), which results in the decreased size of the continuous landscape and lost connectivity between populations and the similar ecosystems (Griffiths et al. 2000).

Forest fragmentation is a process which results in loss of biodiversity and natural forest ecosystems through human influence. Fragmentations of landscape have been quantified by change in spatial characteristics and configuration of remaining patches (Saunders et al. 1987). Various ecological effect of forest fragmentations are loss of species populations, increased isolation of remnant populations, inbreeding (Laurance et al. 1998, Boyle 2001), enhanced human-animal conflicts, decline in ecosystem goods and services, etc.This necessitates understanding of the causes of forest and habitat fragmentations, in order to evolve effective management strategies for conservation.

Remote sensing (RS) data acquired through space borne sensors available post 70’s at regular intervals can be used as one of the major tools to understand LULC dynamics and quantify the extent of forest fragmentation (Gustafson 1998; Turner & Gardner 1991). Remotely sensed(RS) data in conjunction with geographic information systems have been successfully utilized to quantify forest loss as well as forest fragmentation (Jha et al., 2005).Temporal analysis of the spatial data provides an idea of the extent of changes happening in the landscape. Land use details derived from temporal RS data offer potential for assessing the changes in land uses, forest fragmentation and its impact on ecology and biodiversity (Ramachandra et al., 2011). Categorization and understanding of forest fragmentation using spatial data (RS data) provides a picture of the degree and extent of fragmentation, which are useful for conservation of the affected habitat fragments (O’Neill et al.,1997).

Numerous measures of forest fragmentation and forest connectivity using spatial data include average forest patch size, mean forest patch density, number of forest patches, forest patchiness, forest continuity, and proportion of forest in the largest forest patch (Vogelmann, 1995; Trani and Giles, 1999; Wickham et al.1999). Quantification of pf and pff has effectively helped in assessing the process of fragmentation (Ramachandra et al., 2011). This section assesses the LULC dynamics in Shimoga and examines the extent of forest fragmentation in Shimoga landscape.

**Material**

The spatial data acquired from Landsat Series Multispectral sensor (57.5m) and thematic mapper (28.5m) IRS LISS III sensors for the period 1979 to 2010 were downloaded from public domain as indicated in Table 1. Survey of India (SOI) topographic maps of 1:50000 and 1:250000 scales were used to generate base layers of city boundary, etc.

| DATA | Year | Purpose |
|---|---|---|
| Landsat Series Multispectral sensor(57.5m) | 1973 | Land cover, Land use analysis and Fragmentation analysis |
| Landsat Series Thematic mapper (28.5m) | 1990 | Land cover, Land use analysis and Fragmentation analysis |
| IRS LISS III | 2001, 2010 | Land cover, Land use analysis and Fragmentation analysis |
| Survey of India (SOI) toposheets of 1:50000 and 1:250000 scales | | To Generate boundary and Base layer maps. |
| Field visit data –captured using GPS | | For geo-correcting and generating validation dataset |
| Google earth and Bhuvan | | For digitizing various attribute data and as validation input |

Table 1: Data used in the Analysis

## METHOD

**Landscape Dynamics**: Assessment of landscape dynamics involved (i) land use and land cover assessment considering temporal remote sensing data, (ii) quantification of fragmentation of natural forests, (iii) assessment of extent of fragmentation due to encroachment (and subsequent changes in land uses).The procedure followed to assess landscape dynamics is outlined in Figure 1.

The spatio-temporal changes in land use and land cover (LULC) of the study region were studied using temporal RS data with geospatial techniques. Spatial data acquired through space borne sensors at regular intervals since 1970's aid in monitoring of large areas and enable the change analyses at local, regional scales over time (Wilkie and finn, 1996). Remote sensing data along with field data collection using pre-calibrated GPS (Global Positioning System) help in the effective land use analysis (Ramachandra et al., 2012a).

The remote sensing data obtained were geo-referenced, rectified and cropped pertaining to the study area. Geo-registration of remote sensing data (Landsat data) has been done using ground control points collected from the field using GPS and also from known points (such as road intersections, etc.) collected from geo-referenced topographic maps published by the Survey of India.

Remote sensing data requires preprocessing like atmospheric correction and geometric correction in order to enable correct area measurements, precise localization and multi-source data integration (Ramachandra and Bharath, 2012b**,** Buiten, 1994)**.** Geometric correction is the process of referencing an image to a geographic location (real earth surface positions) using GCP's (ground control points). GCP's were collected from the toposheet (SOI) as well as from field using hand held pre-calibrated GPS. This helped in geometrically correcting the distorted remote sensing data.Landsat satellite 1973 data have a spatial resolution of 57.5 m x 57.5 m (nominal resolution) were resampled to 28.5m comparable to the 1989 - 2010 data which are 28.5 m x 28.5 m (nominal resolution).

## 2.1 LAND COVER ANALYSIS:

Spatiotemporal change detection process involves determining the changes associated with LULC properties with reference to geo-registered multi temporal remote sensing data.

The monitoring of land cover involves the computation of vegetation indices. The land cover analysis was done using NDVI (Normalized Difference Vegetation Index). Among all techniques of land cover mapping, NDVI is most widely accepted and applied (Zhanget al., 2007, Jensen et al., 1982, Nelson et al,. 1983)**.**Calculation of NDVI for multi-temporal data is advantageous in areas where vegetation changes rapidly. The capability of capturing changes in land cover and extracting the change information from satellite data requires effective and automated change detection techniques (Ramachandra et al., 2009, Roy et al., 2002). NDVI is calculated by using visible Red and NIR bands of the data reflected by vegetation. Healthy vegetation absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Sparse vegetation reflects more visible light and less near-infrared light. NDVI for a given pixel always results in a number that ranges from -1 to (+1), using Equation1

$$\mathrm{NDVI} = \left( {}^{\mathrm{NIR\text{-}R}}\!/_{\mathrm{NIR}+\mathrm{R}} \right) \qquad \ldots (1)$$

## 2.2 LAND USE ANALYSIS:

This involved i) generation of False Color Composite (FCC) of remote sensing data (bands – green, red and NIR). This helped in locating heterogeneous patches in the landscape ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15% of the study area and uniformly distributed over the entire study area, iii) loading these training polygons co-ordinates into pre-calibrated GPS, iv) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field, v) supplementing this information with Google Earth vi) 60% of the training data has been used for classification, while the balance is used for validation or accuracy assessment.

The land use analysis was carried out with training data using supervised classification technique based on Gaussian Maximum Likelihood algorithm. The supervised classification approach preserves the basic land use characteristics through statistical classification techniques using a number of well-distributed training pixels. Gaussian Maximum Likelihood classifier (GMLC) is appropriate and efficient technique based on "ground truth" information for classifier learning. Supervised training areas are located in regions of homogeneous cover type. All spectral classes in the scene are represented in the various subareas and then clustered independently to determine their identity. The following classes of land use were examined: built-up, water, cropland, open space or barren land, and forest. Such quantitative assessments, will lead to a deeper and more robust understanding of land-use changes for an appropriate policy intervention. ***GRASS GIS*** *(Geographical Analysis Support System)*, a free and open source software having the robust support for processing both vector and raster files accessible at http://wgbis.ces.iisc.ernet.in/grass/index.phpis used for the analysis.

**Accuracy assessments** decide the quality of the information derived from remotely sensed data. The accuracy assessment is the process of measuring the spectral classification inaccuracies by a set of reference pixels.These test samples are then used to create error matrix (also referred as confusion matrix), kappa ($\kappa$) statistics and producer's and user's accuracies to assess the classification accuracies. Kappa is an accuracy statistic that permits us to compare two or more matrices and weighs cells in error matrix according to the magnitude of misclassification.

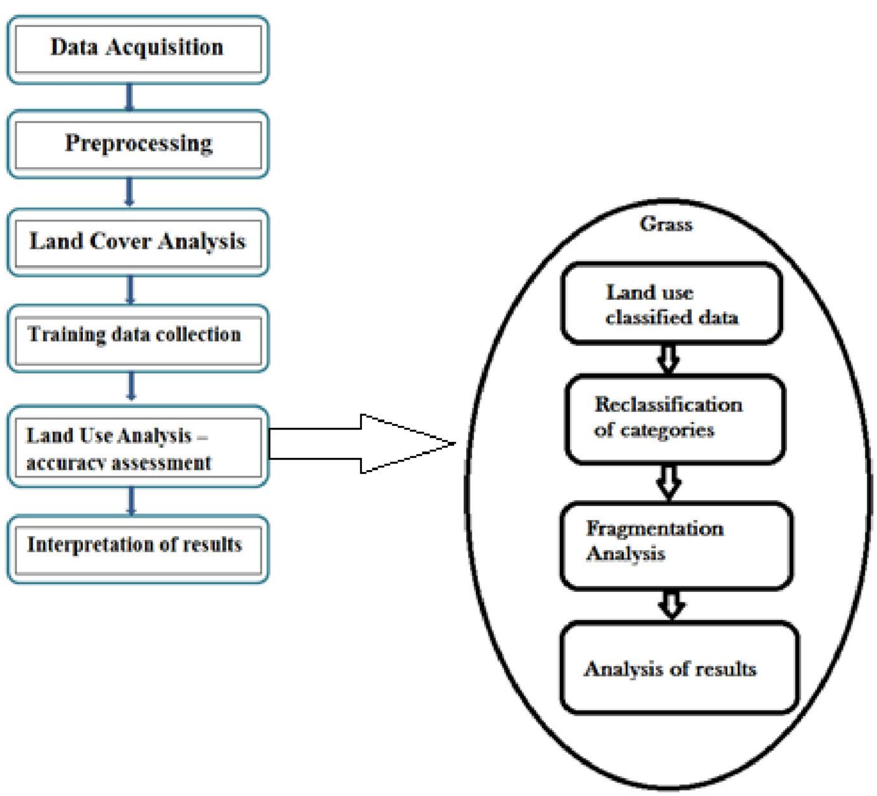


Figure 1:LULC and fragmentation analysis

## 2.3 FRAGMENTATION ANALYSIS:

Forest fragmentation analysis was done to evaluate the extent of fragmentation through quantification of - patch, transitional, edge, perforated, and interior forests using temporal classified land use data of Shimoga district.

Forest fragmentation statistics pf and pff is computed using fixed-area kernel (3x3) considering the current pixel and its neighborhood (Ritters et al., 2000, Ramachandra et al., 2011). The result is stored at the location of the center pixel. Forest fragmentation category at pixel level is computed through Pf (the ratio of pixels that are forested tothe total non-water pixels in the window) and Pff (the proportion of all adjacent (cardinal directions only) pixel pairs that include at least one forest pixel, for which both pixels are forested). Pff estimates the conditional probability that given a pixel of forest, its neighbour is also forest. Based on the knowledge of Pf and Pff, six fragmentation categories derived (Figure 2) are (i) interior, when Pf= 1.0; (ii) patch, when Pf< 0.4; (iii) transitional, when 0.4 < Pf< 0.6; (iv) edge, when Pf> 0.6 and Pf– Pff> 0; (v) perforated, when Pf> 0.6 and Pf – Pff < 0, and (vi) undetermined, when Pf> 0.6 and Pf= Pff.

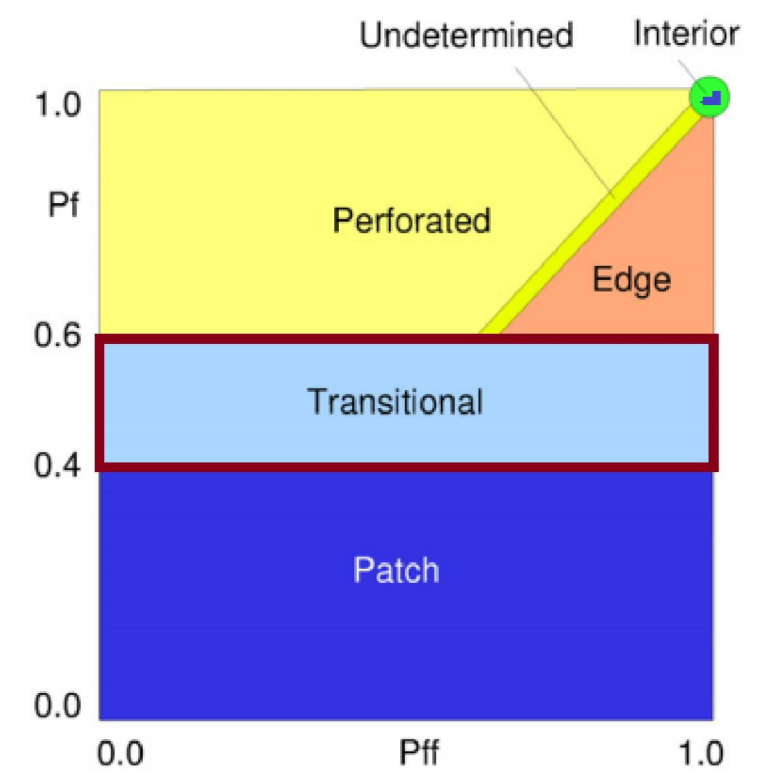


Figure 2: Forest Fragmentation using PF and PFF

# RESULTS

***Land cover analysis:*** Land cover analysis through NDVI shows the percentage of area under vegetation and non-vegetation. NDVI is based on the principle of spectral difference based on strong vegetation absorbance in the red and strong reflectance in the near-infrared part of the spectrum. Figure 3 and Table 2 illustrates the spatio-temporal changes in the land cover of the region, which highlight the decline of vegetation cover from 96.57 (1973) to 91.72%.

| Land Cover (%) | | |
|---|---|---|
| | Vegetation | Non-Vegetation |
| 1973 | 96.57 | 3.43 |
| 1990 | 96.43 | 3.57 |
| 2002 | 93.84 | 6.16 |
| 2012 | 91.72 | 8.28 |

Table2: Extent of vegetation cover during 1973, 1990, 2002 and 2012

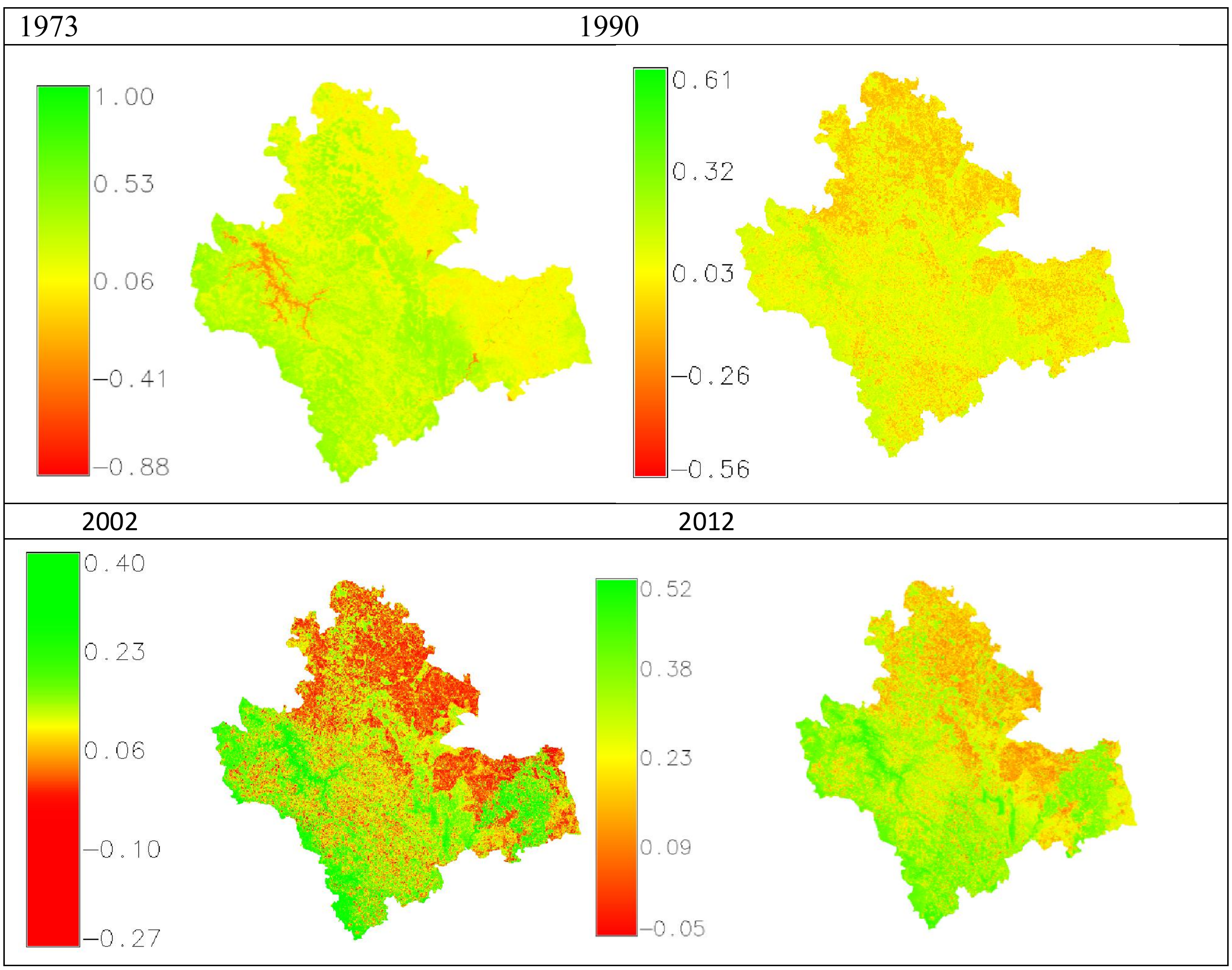


Figure 3: Vegetation dynamics in Shimoga

***Land use analysis:*** Figure 4 highlight changes in land uses at landscape level during 1973 to 2012. Table 3 illustrates the changes in land uses: built-up increased from 0.63% (1973) to 2.32% (2012) and forest vegetation decreased from 43.83% (1973) to 22.33% (2012). The results highlight conversion of forests to agricultures, industrial and cascaded developmental activities acted as major driving forces of degradation.Table 4 lists Kappa statistics and overall accuracy.

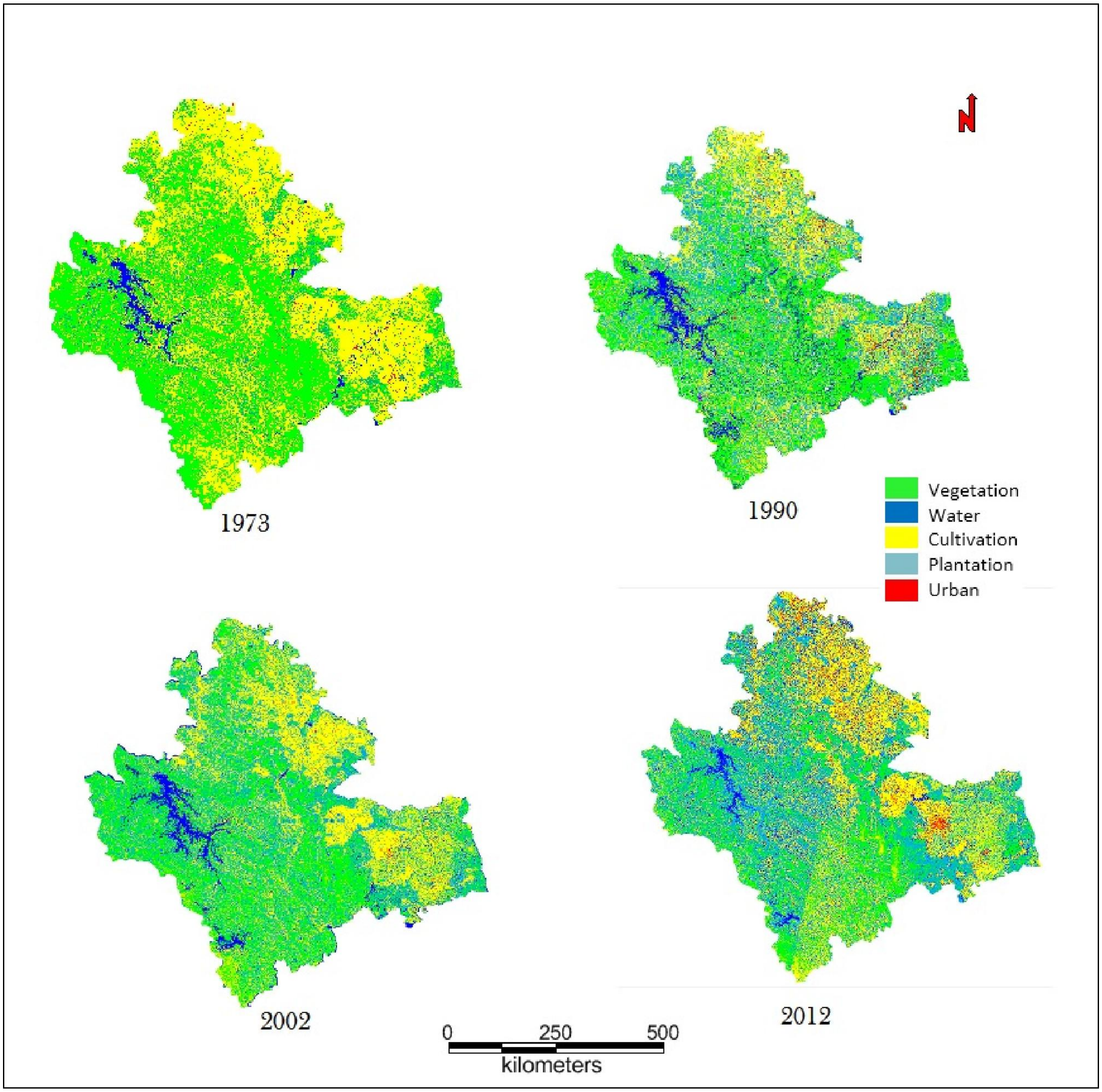


Figure 4. Land use changes during 1973 to 2012 in Shimoga

| Land use categories (%) | | | | | |
|---|---|---|---|---|---|
| Years | Urban | Vegetation | Water | Cultivation and open area | Plantation |
| 1973 | 0.63 | 43.83 | 1.91 | 44.14 | 9.46 |
| 1990 | 0.74 | 39.90 | 4.53 | 29.68 | 25.15 |
| 2002 | 1.08 | 37.78 | 4.57 | 30.21 | 26.36 |
| 2012 | 2.32 | 22.33 | 6.09 | 34.56 | 34.69 |

Table3: Land use statistics

| Year | Kappa coefficient | Overall accuracy (%) |
|---|---|---|
| 1973 | 0.82 | 74.68 |
| 1990 | 0.89 | 86.31 |
| 2002 | 0.83 | 92.23 |
| 2012 | 0.91 | 91.48 |

Table4: Kappa and overall accuracy

**Fragmentation analysis**

Land use data (classified data with 4 classes) were used as input to the fragmentation analysis and the analysis was done at district and division levels. Figure 5 illustrates the extent of forest fragmentations while Table 5 provides the summary statistics.

| Type of fragments | **1973** | **1990** | **2001** | **2012** |
|---|---|---|---|---|
| Patch | 3.95 | 5.00 | 3.31 | 2.05 |
| Transitional | 6.65 | 8.91 | 6.08 | 3.72 |
| Edge | 1.30 | 1.93 | 0.94 | 0.98 |
| Perforated | 12.79 | 9.89 | 15.73 | 8.19 |
| Interior | **18.55** | 14.01 | 9.37 | **6.88** |
| Undetermined/other category | 56.76 | 60.26 | 64.56 | 78.17 |

Table 5: Extent of forest fragmentation during 1973 to 2012

Applying forest fragmentation analysis to a time series of land use data provided a quantitative assessment of the pattern and trends in forest fragmentation. The analysis indicated that domination of forests receded during post 90’s with the formation of patch and edge forest in all 3 divisions. Land use changes from forests to non-forests with intensified human interference had been very high especially in Bhadravathi division. Interior forest decreased by 12% during 4 decades.

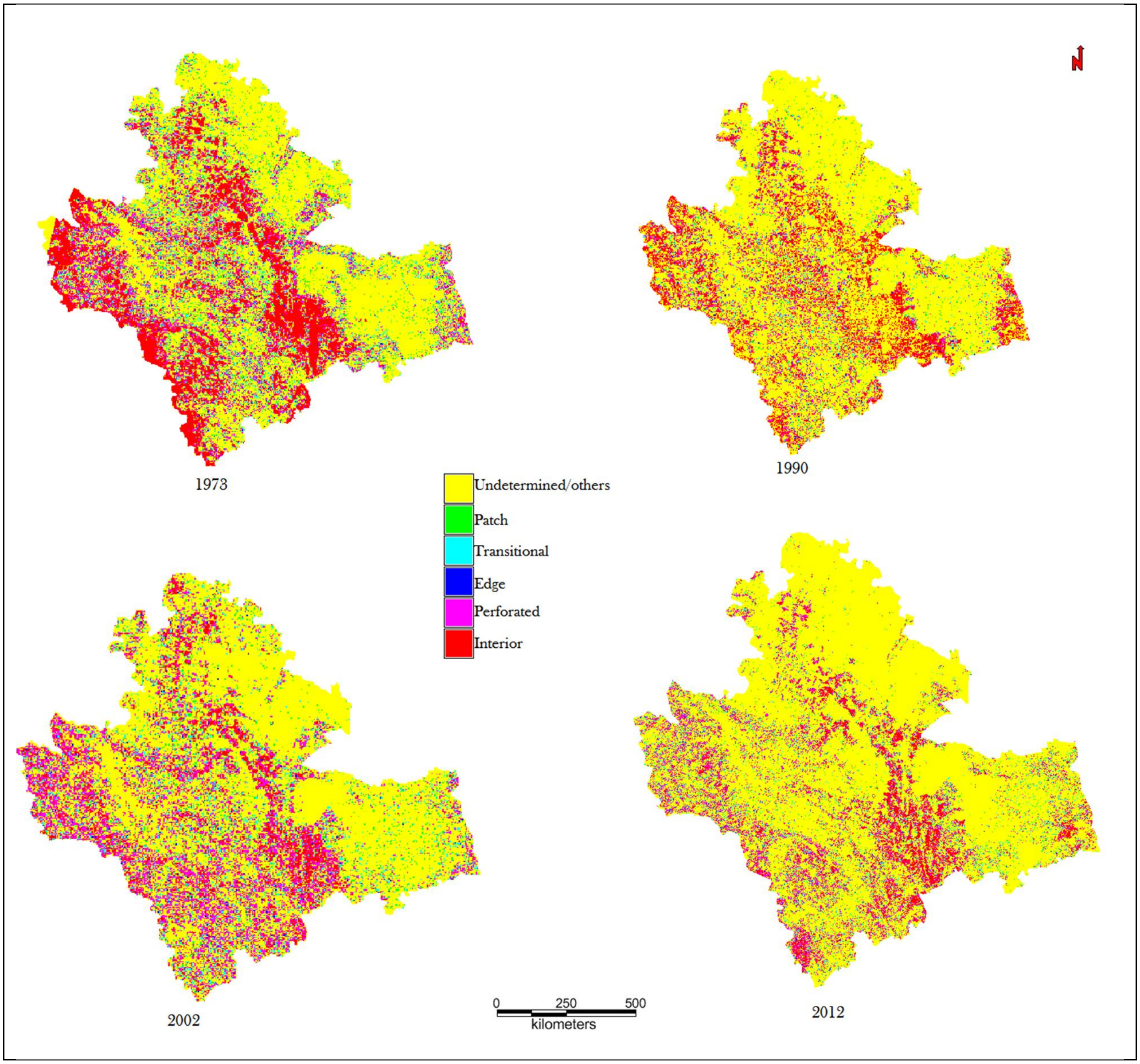


Figure 5: Fragmentation of forests in Shimoga

Forests in Shimoga district are administered through three divisions – Shimoga, Bhadravathi and Sagar. The quantification of extent of forest fragmentation has been done division-wise for the past four decades to enable the respective division administration to undertake appropriate forest restoration measures to minimize fragmentation of ecologically important ecosystems. Figure 6 illustrates spatially the extent of forest fragmentation in Shimoga. Similarly Figures 7 and 8 depicts the extent of fragmentation in Bhadravathi and Sagar divisions respectively.

The extent of interior forests ranges from 12.91 (Shimoga) followed by 4.76 (Sagar) and 3.79 % (Bhadravathi). During the last four decades the interior forest declined from 22.9 (1973) to 13 % (2012) in Shimoga, and 15.90 (1973) to 4.76% (2012) in Sagar, and 4.10 (1973) to 3.79 %

(2012) in Bhadravathi divisions emphasizing the need for an immediate eco-restoration measures to arrest fragmentation and consequent impacts.

**Shimoga division**

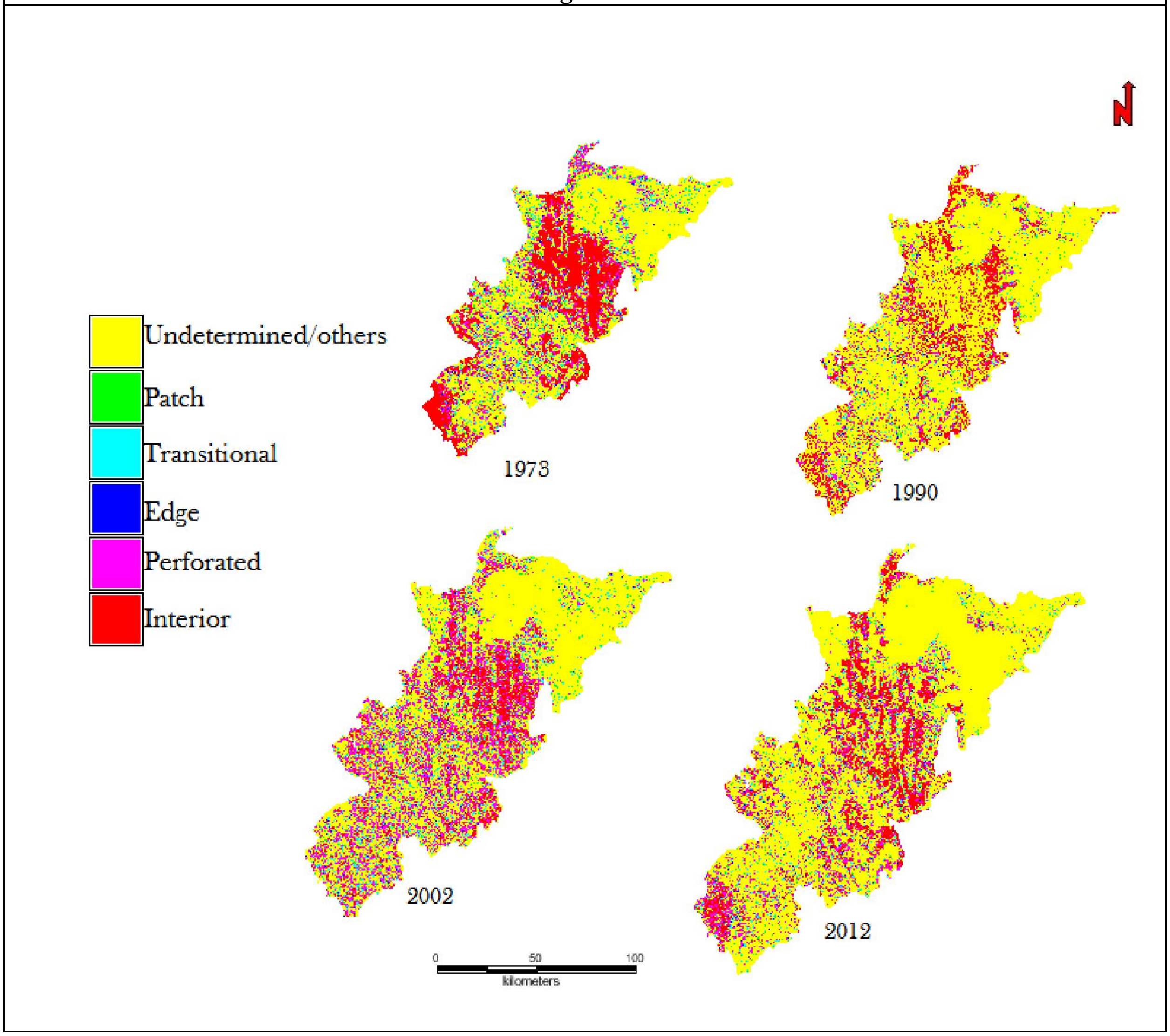


Figure 6: Spatial extent of forest fragmentation in Shimoga division during 1973 to 2012

| Shimoga division | | | | |
|---|---|---|---|---|
| Type of fragments | 1973 | 1990 | 2002 | 2012 |
| Patch | 3.68 | 1.95 | 3.05 | 2.13 |
| Transitional | 6.23 | 8.05 | 6.73 | 4.26 |
| Edge | 1.44 | 1.04 | 1.10 | 1.23 |
| Perforated | 11.89 | 18.00 | 17.06 | 10.49 |
| Interior | 22.90 | 14.20 | 13.83 | 12.91 |
| Undetermined/other category | 53.86 | 56.76 | 58.23 | 68.97 |

Table 6: Quantification of forest fragmentation in Shimoga division

Bhadravathi division

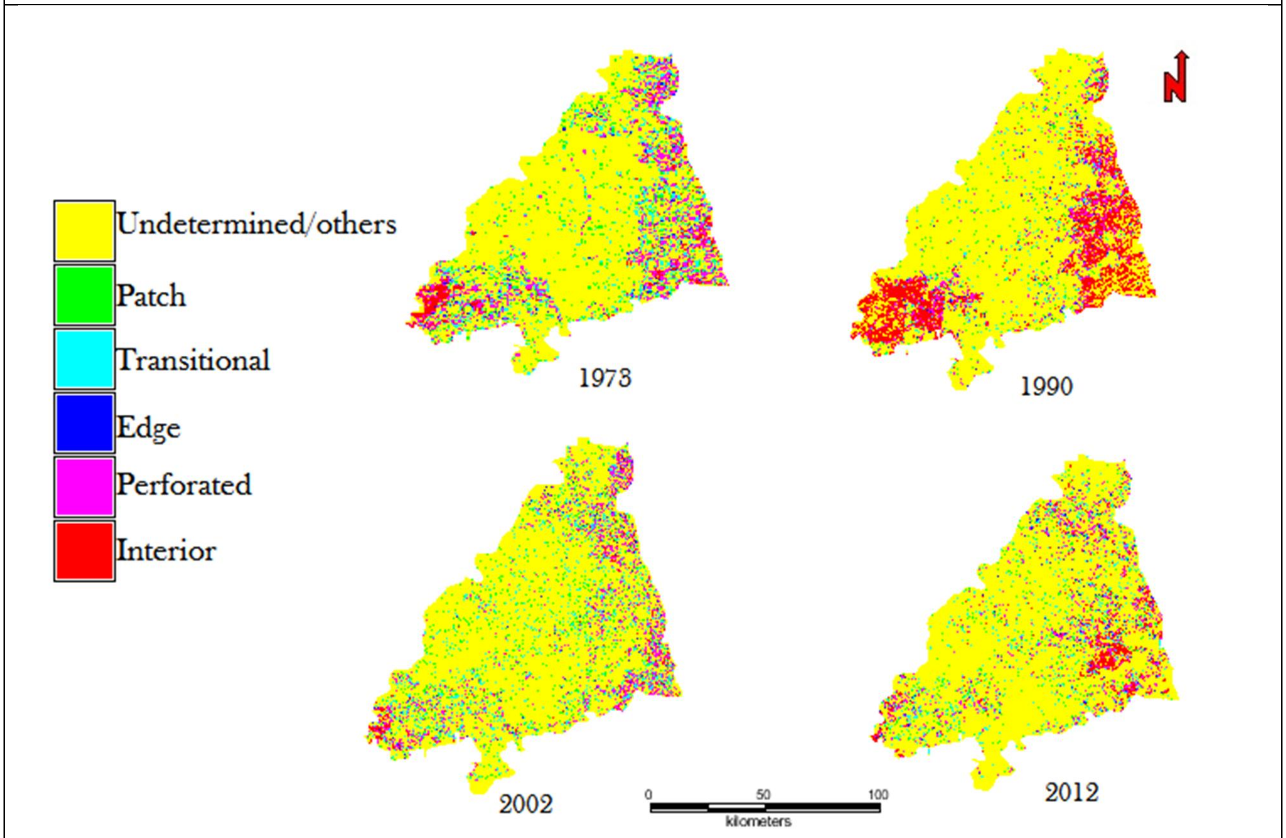


Figure 7: Spatial extent of forest fragmentation in Bhadravathi division

| Bhadravathi division | | | | |
|---|---|---|---|---|
| Type of fragments | 1973 | 1990 | 2002 | 2012 |
| Patch | 5.57 | 4.52 | 4.12 | 3.15 |
| Transitional | 6.62 | 6.82 | 5.03 | 4.42 |
| Edge | 0.90 | 0.93 | 0.58 | 0.91 |
| Perforated | 7.15 | 7.35 | 6.57 | 5.42 |
| Interior | 4.10 | 3.58 | 2.58 | 3.79 |
| Undetermined/other category | 75.66 | 75.74 | 80.12 | 82.31 |

Table 7: Quantification of forest fragments in Bhadravathi division

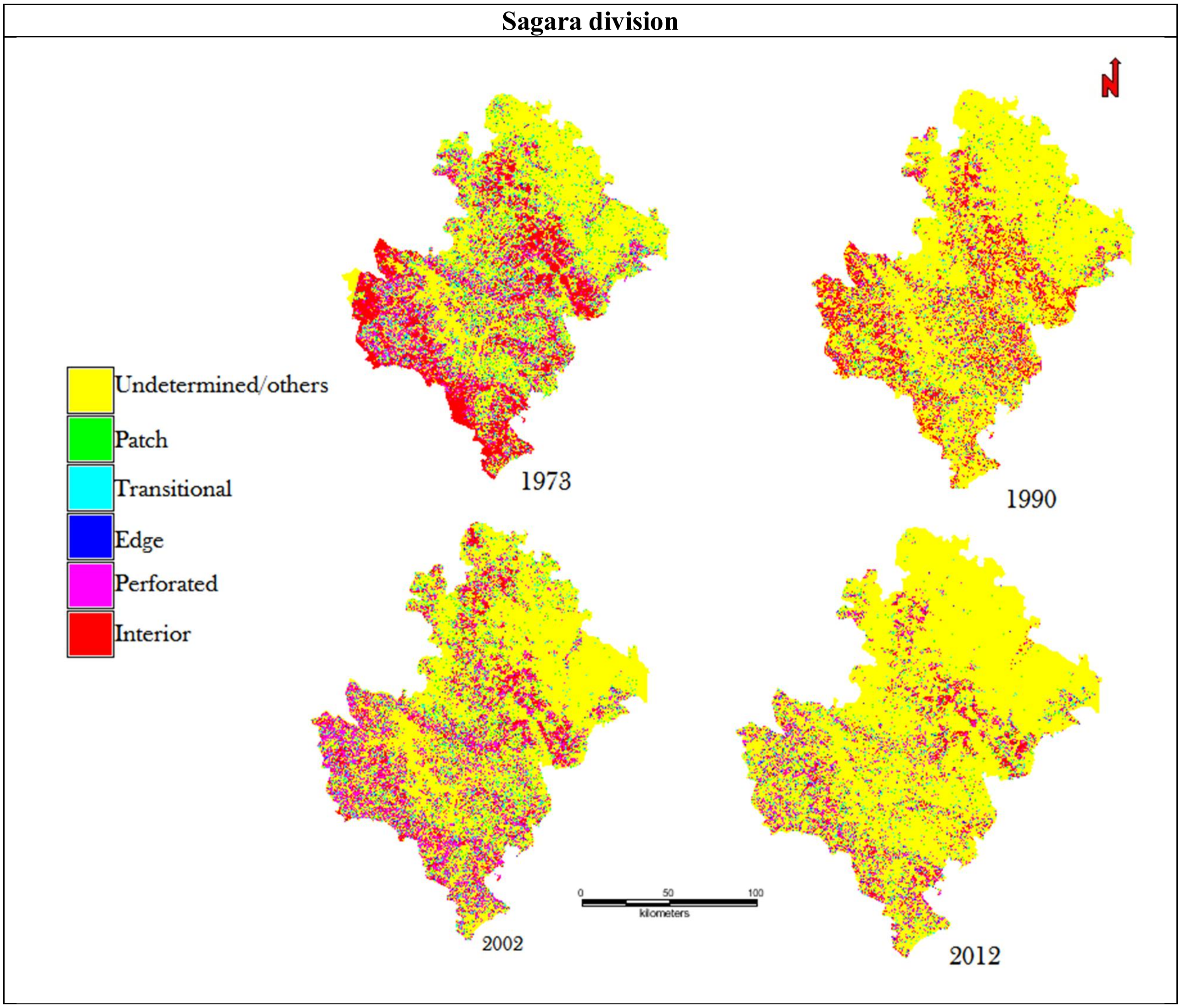


Figure 8: Spatial extent of forest fragmentation in Sagara division

| Sagar division | | | | |
|---|---|---|---|---|
| Type of fragments | 1973 | 1990 | 2001 | 2010 |
| Patch | 3.12 | 2.02 | 3.12 | 1.80 |
| Transitional | 5.82 | 2.96 | 5.82 | 3.34 |
| Edge | 0.93 | 0.92 | 0.93 | 0.87 |
| Perforated | 9.66 | 15.10 | 13.90 | 7.65 |
| Interior | 15.90 | 13.99 | 9.66 | 4.76 |
| Undetermined/other category | 64.57 | 65.01 | 66.57 | 81.58 |

Table 8: Quantification of forest fragments in Sagar division

## CONCLUSION

Spatio-temporal changes in land cover highlight the decline of vegetation cover from 96.57 (1973) to 91.72 % ( 2012). Built-up has increased from 0.63% (1973) to 2.32% (2012) and forest vegetation decreased from 43.83% (1973) to 22.33% (2012). The results highlight conversion of forests to agriculture, industrial and cascaded developmental activities acted as major driving forces of degradation.Forest fragmentation analysis indicated that domination of forests receded during post 90's with the formation of patch and edge forest in all three divisions. Land use changes from forests to non-forests with intensified human interference had been very high especially in Bhadravathi division. Interior forest decreased by 12% during 4 decades. The extent of interior forests ranges from 12.91 (Shimoga) followed by 4.76 (Sagar) and 3.79 % (Bhadravathi). During the last four decades the interior forest declined from 22.9 (1973) to 13 % (2012) in Shimoga, and 15.90 (1973) to 4.76% (2012) in Sagar, and 4.10 (1973) to 3.79 % (2012) in Bhadravathi divisions emphasizing the need for an immediate eco-restoration measures to arrest fragmentation and consequent reduction in goods and services apart from the increase of human animal conflicts.

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## 3.0 FOREST ENCROACHMENTS IN SHIMOGA DISTRICT

As per Section 32 of the National Forestry and Tree Planting Act (NFTPA) of 2003 encroachment is the entry of people with their activities into forest reserves without permission. The entry can be deliberate or unknowingly for the purpose of grazing cattle, cultivation, settlement, construction or any other human activities (National Forestry Authority http://www.nfa.org.ug). At present forest encroachment is the major threat to biodiversity because it not only causes the habitat loss of species but also results in the more devastating effects through fragmentation. The encroachment of forest land for agricultural purposes is mainly because of relatively rich and virgin forest soils. However leaching in forest soils is much faster when exposed to the high temperatures and heavy rainfall of the tropical region and gets exhausted much faster. These factors force the encroachers to open new land annually. Forest encroachment will result in several ecological and economic effects. The ecological effects of forest encroachment will include; reduction in the forest cover, forest fragmentation, reduction in forest biodiversity, changes in vegetation type (composition and abundance), curtailment of natural regeneration of the forest, spread of invasive alien species, destruction of ecosystems/habitats, species extinction, etc. The economic effects of forest encroachment will include reduction in the quality and quantity of products from forests, reduction in the Total Economic Value (TEV) of the forests, increases the cost of forest management

Forest vegetation decreased from 43.83% (1973) to 22.33% (2012). The results highlight conversion of forests to agriculture, industrial and cascaded developmental activities acted as major driving forces of degradation.Forest fragmentation analysis indicated that domination of forests receded during post 90's with the formation of patch and edge forest in all three divisions. Land use changes from forests to non-forests with intensified human interference had been very high especially in Bhadravathi division. Interior forest decreased by 12% during 4 decades. The extent of interior forests ranges from 12.91 (Shimoga) followed by 4.76 (Sagar) and 3.79 % (Bhadravathi). During the last four decades the interior forest declined from 22.9 (1973) to 13 % (2012) in Shimoga, and 15.90 (1973) to 4.76% (2012) in Sagar, and 4.10 (1973) to 3.79 % (2012) in Bhadravathi divisions. Encroachment of forest land (36105 hectares) and conversion to agricultural land is the principal cause of degradation at local levels apart from land releases for major developmental activities. Table 1 lists talukwise encroachment of forest land in Shimoga. Bhadravathi taluk has highest number of encroachments (26.36%), followed by Shikaripur (18.77), Shimoga (15.42), Sagar (13.92), Sorab (11.66%), Hosanagar (8.35%), and Teerthahalli (5.51%). Figure 1 depicts the locations of encroachment in the district (talukwise) while Figure 2 provides the spatial distribution of divisionwise encroachment.

| | Total Encroachment | |
|---|---|---|
| **Taluk** | **Acres** | **Hectares** |
| Teerthahalli | 4917.15 | 1990.75 |
| Hosanagar | 7448.09 | 3015.42 |
| Sorab | 10399.12 | 4210.17 |
| Shimoga | 13751.08 | 5567.24 |
| Shikaripur | 16738.40 | 6776.68 |
| Sagar | 12416.79 | 5027.04 |
| Bhadravathi | 23508.72 | 9517.7 |
| **Total** | 89179.35 | 36105.00 |

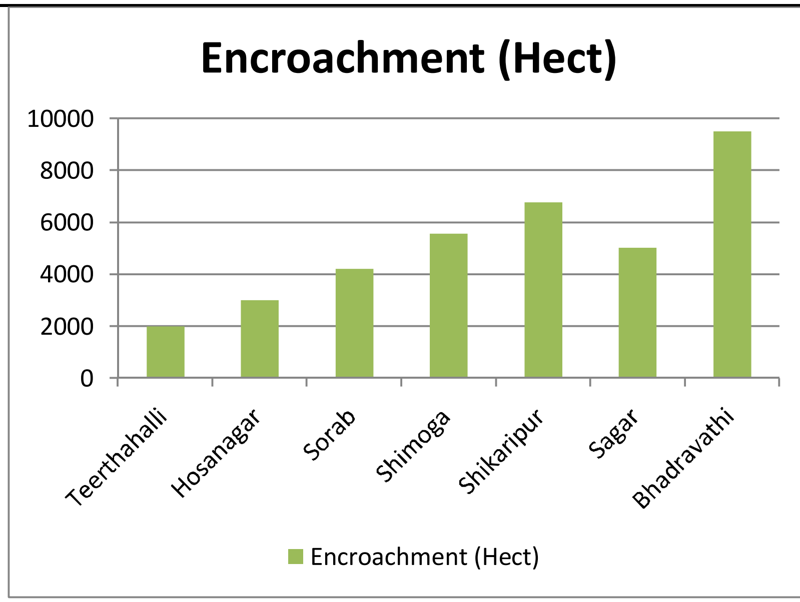



Figure 1: Spatial distribution of forest encroachments in Shimoga

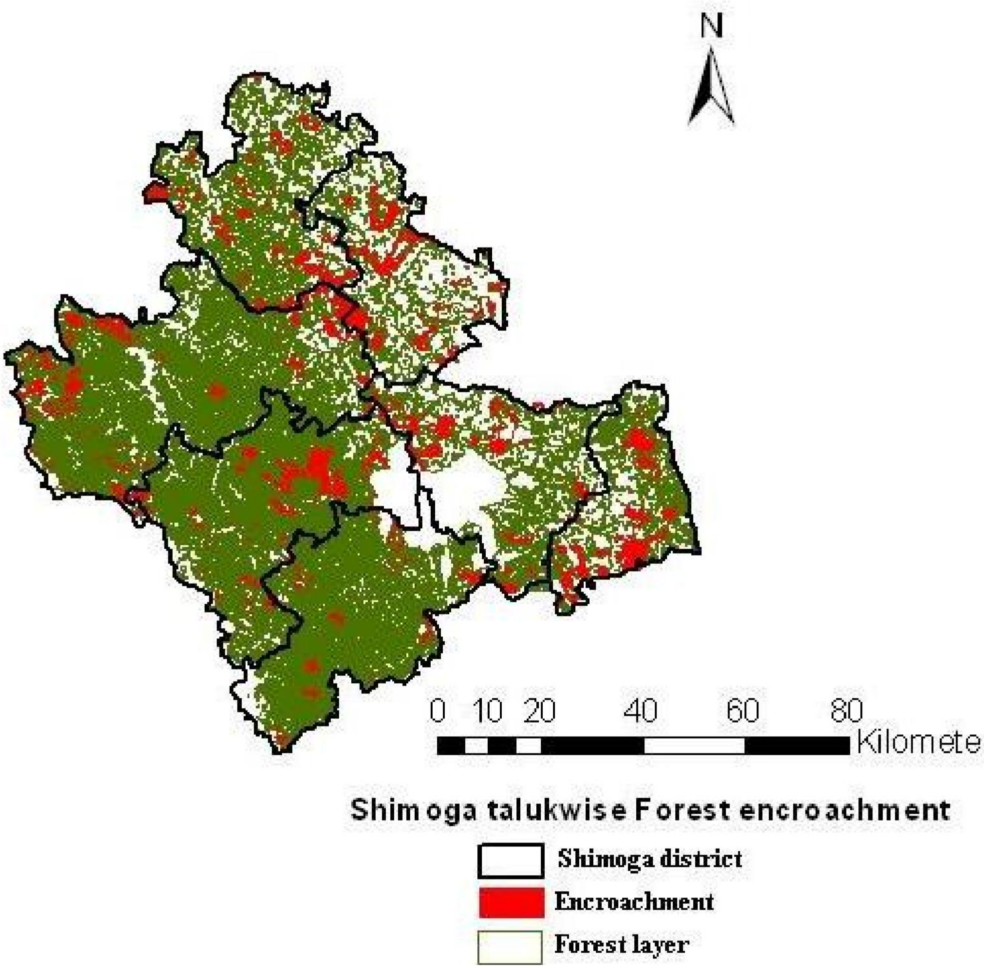
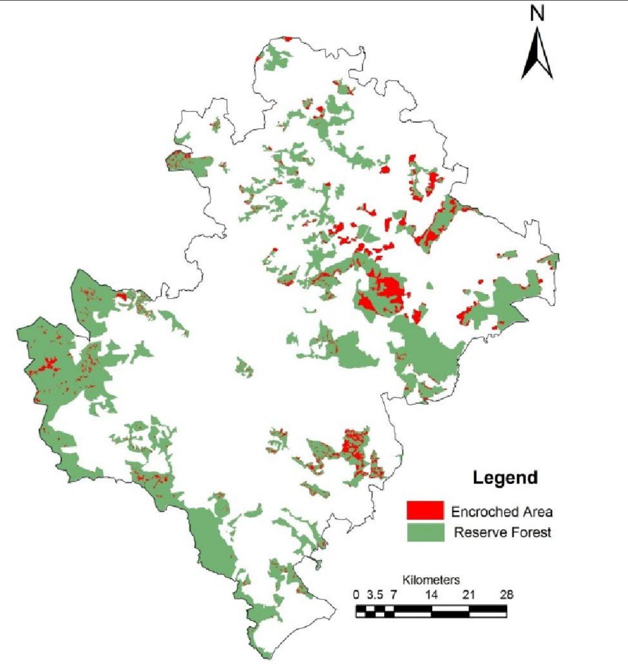
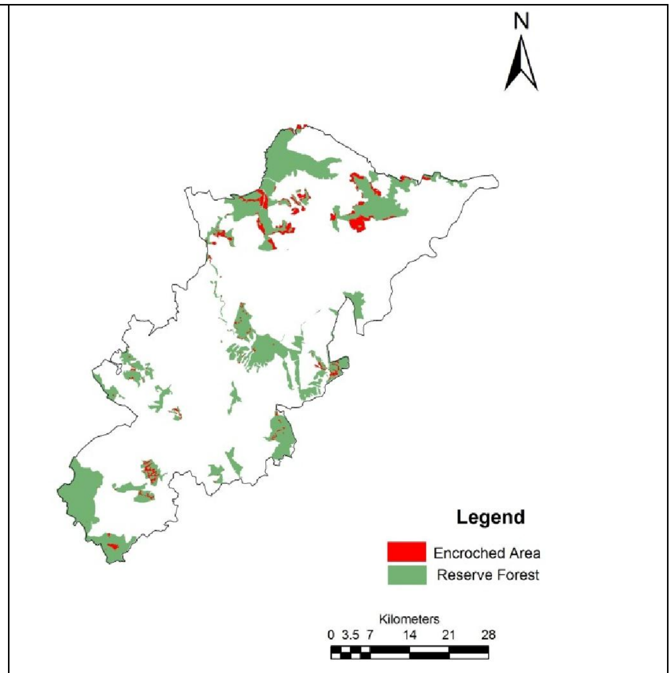
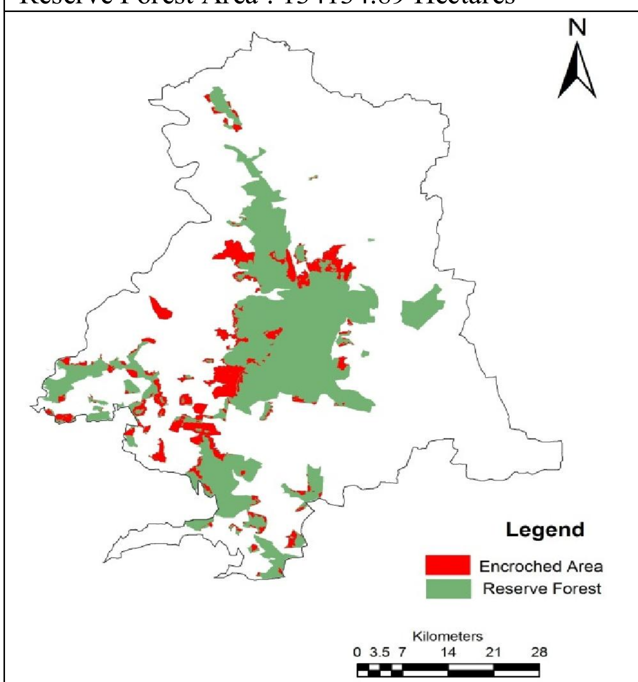
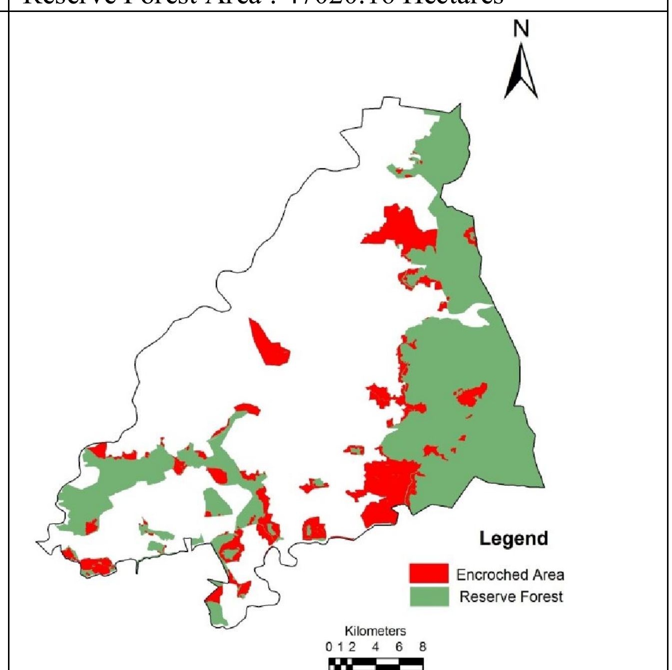


**Figure 2: Division-wise Reserve forest encroachments**

| | |
|---|---|
|   |   |
| Sagara division RF Encroachment Area : 18445.5 Hectares<br>Reserve Forest Area : 134134.89 Hectares | Shimoga division RF Encroachment Area : 6687Hectares<br>Reserve Forest Area : 47020.16 Hectares |
|   |   |
| Bhadravathi division RF Encroachment Area : 14472 Hectares }<br>Reserve Forest Area : 87439.88 Hectares | Bhadravathi taluk Reserve Forest Shimoga District<br>Encroachment area : 10973 Hectares<br>Reserve Forest Area : 60640.14 Hectares |

Total Encroachment of Reserve forest in the 3 divisions of Shimoga district boundary: 36105.5 Hectares

## 4.0 FOREST MANAGEMENT IN SHIMOGA

Forests are a precious gift of nature, meant to be intensively exploited and simultaneously tended and cultured so that they go on giving a sustained or even an increasing yield every year. This is because forests provide array of goods such as timber, firewood, industrial raw materials for making paper, rayon and minor forest produce like honey, wax, soap nut, medicinal plants etc. The Forest resources have an important bearing on the environmental or ecological security and well being of the country and its people. Forest ecosystems preserve the physical features, minimize soil erosion, prevents floods, check the flow of subsoil water and help to maintain the productivity of cultivated lands.

## 4.1 FOREST MANAGEMENT: PRESENT STATUS

Karnataka with the geographical area of 191,791 km$^2$, in southern peninsular India has forest area of 38,284 km$^2$ (19.96% of geographical area). Reserved forests (India State of Forest report 2011) constitute a major share (74.94%) followed by protected forests (10.72%) and un-classed forests (14.79%). Administratively, the State is divided into 13 Forest Territorial Circles, 40 Territorial Divisions (**Karnataka forest department Annual Report, 2010**).

**Shimoga circle:** As per Mysore government order G.5034.5.FT. 101-27.3 dated 11 November 1927, Shimoga circle was constituted in 1927 consisting of Shimoga, Bhadravathi, Sagar, Koppa and Chikmaglur divisions of Shimoga and Chikmaglur revenue district (Upto 30-11-2001). Subsequently, the Koppa and Chikmaglur divisions are removed from Shimoga circle and included in Chikmaglur circle (with effect from 1-12-2001) and Shimoga wildlife division was added to the Shimoga circle (**Annual report, Shimoga Circle 2012**).

The administration of the Forest Department in the district is under the charge of the Conservator of Forests (CF), Shimoga Circle, Shimoga. The district has been divided into three Forest Divisions, namely, Shimoga, Bhadravati and Sagar Divisions (Figure 1), each headed by a Divisional Forest Officer (DFO). There are thirty three forest ranges corresponding to the seven revenue taluks of the district. Each forest range is placed under the charge of a Range Forest Officer (RFO). The ranges are further divided into sections, and each section is under the charge of a Forester. Further, each section is sub-divided into beats, and each beat is under the charge of a Forest Guard who is assisted by a Watcher. Thus, there are thirty three Range Forest Officers (in the district under the administrative control of the three Divisional Forest Officers. And they are assisted by 12 Assistant Conservator of Forests ACF), 33 Range Forest Officers; in all three Forest Divisions **(Annual report, Shimoga circle 2012)**.

Area under forest constitutes 51.99% of the geographical area (8477 sq.km). Table 1 lists forest cover under different categories as per FSI (Forest Survey of India) during 1991 to 2011. Table 2 lists categorywise area under forests during 1990-91 to 2009-10. Current area under forests is about 78% (with the inclusion of 2305 sq.km unclass forests). Table 3 lists the area under forests for each division. Sagar division with 30.79% (1217 sq.km) leads the area under forests in Shimoga circle, followed by Bhadravathi (22.26%; 870 sq.km), Shimoga (22.02%; 1038 sq.km), Wildlife division (20.99%; 827 sq.km). Categorywise forests are listed in Table 4; Area under reserve forests constitute 43.3%, followed by unclassified forests (35.35%) and protected forests (18.2%). Table 5 list type wise forests which include evergreen (45.8%), moist deciduous (25.7%), semi-evergreen (13.7%), Shola (9%), etc.

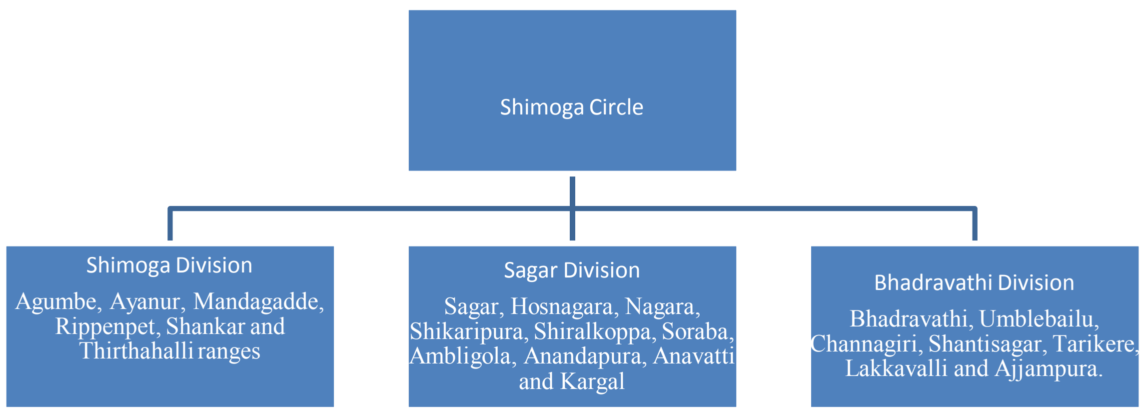



Figure 1: Forest administrative framework in the district

**Table 1: Forest cover in Shimoga district (FSI 1991-2011)**

| Year | Geographical area(sq.km) | Forest cover (sq.km) | | | | % of forest cover to geographical area | Scrub |
|---|---|---|---|---|---|---|---|
| | | Dense | Open | Mangrove | Total | | |
| 1991 | 10553 | 4036 | 885 | 0 | 4921 | 46.63 | |
| 1993 | 10553 | 4009 | 909 | 0 | 4918 | 46.6 | |
| 1995 | 10553 | 4012 | 911 | 0 | 4923 | 46.65 | |
| 1997 | 10553 | 4026 | 888 | 0 | 4914 | | 168 |
| 1999 | 10553 | 4009 | 891 | 0 | 4900 | | 179 |
| 2001 | 8477 | 3117 | 1356 | 0 | 4473 | 52.77 | 36 |
| 2003 | 8477 | 3075 | 1401 | 0 | 4476 | 52.8 | |
| 2005 | 8477 | 3075 | 1402 | 0 | 4477 | 52.81 | 23 |
| 2007 | 8477 | 3014 | 1394 | 0 | 4408 | 52 | 23 |
| 2011 | 8477 | 3013 | 1394 | 0 | 4407 | 51.99 | 23 |

**Table 2: Forest Area of Shimoga district (Karnataka State Forest Department)**

| Year | Geographical Area(sq. km) | Forest Area (sq.km) | | | | | | Percentage of Forest Area to Geographical Area |
|---|---|---|---|---|---|---|---|---|
| | | Reserved | Protected | unclassed | Village | Private | Total | |
| **1990-91** | 10576 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 30.92 |
| **2000-01** | 8465 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 38.63 |
| **2001-02** | 8465 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 38.63 |
| **2002-03** | 8465 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 38.63 |
| **2003-04** | 8465 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 38.63 |
| **2005-06** | 8465 | 1945.72 | 1298.28 | 21.57 | 13.59 | - | 3270.16 | 38.63 |
| **2006-07** | 8465 | 3127.66 | 1190.99 | 2305.35 | 7.44 | - | 6631.44 | 78.34 |
| **2008-09** | 8477 | 3127.66 | 1190.99 | 2305.35 | 7.44 | - | 6631.44 | 78.34 |
| **2009-10** | 8477 | 3127.66 | 1190.99 | 2305.35 | 7.44 | - | 6631.44 | 78.34 |

**Table 3: Area of Forests of different divisions in Shimoga circle (**New proforma 1, KFD)

| Divisions | Forest Area in Hectares | | | | | |
|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Sagar | 121460 | 121759.5 | 121759.5 | 121759.5 | 121759.5 | 121759.5 |
| Shimoga | 75101.58 | 75101.58 | 75101.58 | 81782 | 81782 | 87073.01 |
| Bhadravathi | 103297.1 | 103297.1 | 103430.3 | 103216 | 103875.3 | 103875.3 |
| WLDnShimoga | 82756.7 | 82707.44 | 82707.44 | 82707.43 | 82707.43 | 82707.43 |
| Total | **382615.38** | 382865.6 | 382998.8 | **389465** | **390124.3** | **395415.3** |

**Table 4: Area of different class of forests in Shimoga circle as per Form 23 KFD**

| Class of forests | Area as on April 2005 (Ha) | Area as on April 2006 (Ha) | Area as on April 2007 (Ha) | Area as on April 2008 (Ha) | Area as on April 2009 (Ha) | Area as on April 2010 (Ha) |
|---|---|---|---|---|---|---|
| Reserved forest | 292685.5 | 293027.79 | 293460.55 | 302353.16 | 302357.61 | 302347.37 |
| Protected forest | 85091.95 | 85091.95 | 85091.95 | 119098.63 | 119098.63 | 119098.66 |
| Village forest | 743.95 | 743.95 | 743.95 | 743.95 | 743.86 | 743.86 |
| Unclassified forest | 3256.29 | 3256.29 | 3256.29 | 230534.92 | 230534.92 | 230534.92 |
| Deemed forest | 23578.79 | 23578.79 | 23578.79 | 0 | 0 | 0 |
| Others | 18138.85 | 18138.85 | 18138.85 | 0 | 0 | 0 |
| District forest | 10432.8 | 10432.8 | 10432.8 | 0 | 0 | 0 |
| Total | **433928.13** | **434270.42** | **434703.18** | **652730.66** | **652735.02** | **652724.81** |

**Table 5: Forest Area by types (Proforma 2) for Shimoga circle**

| Type of Forests | Area in Hectares | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | % |
| Evergreen | 59119.62 | 69459 | 69458.56 | 161477.12 | 161477.12 | 176056.5 | 45.8 |
| Semi evergreen | 57643.11 | 88135 | 88135.41 | 52792.15 | 52792.15 | 52792.17 | 13.7 |
| Moist deciduous | 68363.66 | 130612 | 130611.7 | 101790 | 98740.7 | 98740.7 | 25.7 |
| Dry deciduous | 50130.52 | 109539 | 109677.6 | 2625 | 2625 | 2625 | 0.7 |
| Shola | 89493.79 | 24111 | 24111.26 | 31070.4 | 34559.4 | 34559.4 | 9.0 |
| Grassy blank | 5209.87 | 5103 | 10898.97 | 5840.35 | 5840.35 | 4226.31 | 1.1 |
| Others | 980.91 | 7557 | 1760.614 | 5107.14 | 5107.14 | 5107.14 | 1.3 |
| | | 0 | | 6282.72 | 6282.72 | 6282.72 | 1.6 |
| | | | | 2591.36 | 2591.36 | 4205.96 | 1.1 |
| **TOTAL** | **330941.48** | **434516** | **434654.1** | **369576.24** | **370015.94** | **384595.9** | 100 |

**Shimoga Division**

Shimoga division located between 13°21' to 14° 8'N and 75 °5' to 75° 45' E (Figure 2), is the old division established during the year 1920. It borders Davangere district in the north, Chikmagalore district in the south and south west, Dashina Kannada and Udupi districts in the west. The forests of the division almost entirely lie within Shimoga district extending over major parts of Shimoga and Thirthahalli taluks and a small part of Hosanagara taluk. A very small part of Honalli taluk of Davangere district is also included in the division. The rivers Kumudvathi and Kushavathi border the state forest boundaries of Masrur, Arasalu and Kumsi in the East. Tunga and Tungabhadra rivers bound the division in the northwest.

The total forest area coming under the Shimoga as per working plan 2001 is 67551.44 hectares of which 26388.52 hectares are State forests and 35843.36 hectares are minor forests.The forest consists of about 13,000 hectares of evergreen and semi-evergreen forests about 23,000 hectares of closed deciduous forests about 12,500 hectares of plantations and about 19,000 hectares of degraded and open forest lands in the division. The forests of Shimoga division can be classified as following types:

- **Southern tropical wet evergreen forests**: These types of forests occur in Agumbe state forest and Balehalli state forest of Agumbe range.
- **Southern tropical semi evergreen forests:** These forests mostly occur in Thirthahalli, Mandagadde and Sacrebyle ranges besides the borders of moist deciduous forests of Shanker and Rippanpet ranges in places of high elevations having moderate to heavy rainfall.
- **South tropical moist deciduous forests:** The forests of Purdal, Anesara, Shankar, Sacrebyle, Hangere, Bommenahalli, Mugudthi, Kumsi, Sudur, Part of Kudi, Masrur, Arasalu part of Kumudvathi and Burve are typical representatives of this type.
- **Southern tropical dry deciduous forests:** The mixed dry deciduous forests are found mostly in areas with rainfall of 30" to 50" in Shimogataluk in Ayanur range. These are also spread over in other ranges in the minor and district forests of the division. These

forests contain shrubby growth and also scattered miscellaneous species such as Mathi, Nandi, Hunal, Honne, Yethiga, Beete, Dindiga, Neralu, Jambe, Buruga, Thare and Teak but is of poor quality.

- **South tropical Scrub forests:** These types of forests are found in northern portion of Ayanur, Shankar and Honnali ranges.

The entire forests of Shimoga division form the catchment and are distributed towards the left of Tunga and Tungabhadra rivers. At present Shimoga forest division has three sub divisions, six territorial ranges attached with small depots to range headquarters and one major timber depot and one sandal koti. There are six ranges in the division, namely Agumbe, Ayanur, Mandagadde, Rippenpet, Shankar and Thirthahalli ranges. (**Working plan Shimoga division, 2001**).

**Sagar Division**

Sagar division is located at 13º 36' to 14º 38' N and 74º 38' to 75º 32' E (Figure 3), in Shimoga revenue district and comprises of Sagar, Hosnagar, Shikaripura and Soraba taluks. Sagar division became a separate administrative unit in 1916 and has 3 sub-divisions with headquarters at Sagar, Hosnagar and Shikaripura. There are 10 ranges namely Sagar, Hosnagara, Nagara, Shikaripura, Shiralkoppa, Soraba, Ambligola, Anandapura, Anavatti and Kargal. Sagar Forest Division has the total Forest area of 1,47,829.40 ha of forests. The total extent of forest area transferred from Sagar territorial division to Shimoga Wildlife division is 21400.86 ha. Besides 6,396.77 hectares and 3,494.50 hectares of forestland have been transferred to the Karnataka Forest Development Corporation (KFDC) limited and the Mysore Paper Mills (MPM) limited respectively for raising plantations. Total extent of forest area in the division is about 1, 16,754.27 ha. (Working Plan, Sagar division, 2003). The forests of Sagar division occurring in Hosnagara, Nagara, Kargal and Sagar ranges are:

**Evergreen Forests:**

**Southern tropical wet evergreen forests**

**Southern tropical semi evergreen forests**

The deciduous types are spread over in all the other ranges of the division.

**Deciduous forests:**

**South tropical moist deciduous forests**

**Southern tropical dry deciduous forests**

**Bhadravathi Division**

Bhadravathi division is located at 13º 30' to 14º 21'N and 75º 30' to 76º 7' E (Figure 4) and comprises of Bhadravathi, Channagiri, Tarikere, Shimoga and Honnali taluks. This division came into effect from 1-7-1962. It has 4 sub divisions with 7 ranges namely Bhadravathi, Umblebailu, Channagiri, Shantisagar, Tarikere, Lakkavalli and Ajjampura. The forests stretch from Kakanahosudi State forest on the west to Tuppadalli State forest on the east and from Yelavadalli State forest on the north to Bababudangiri State forest on south.

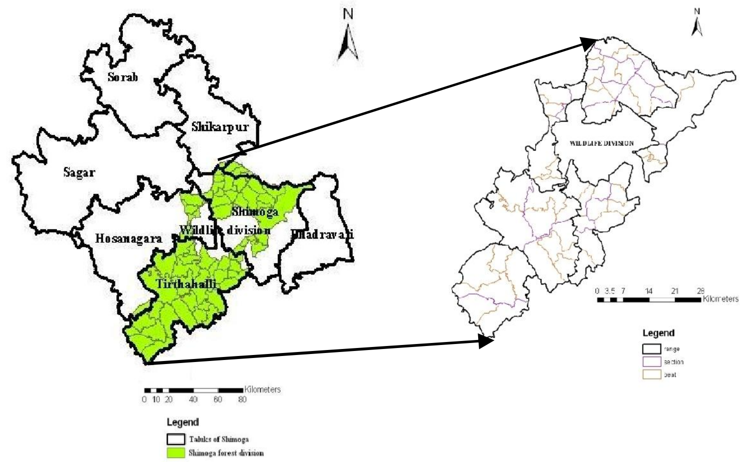



**Figure 2: Shimoga division with range, section and beats**

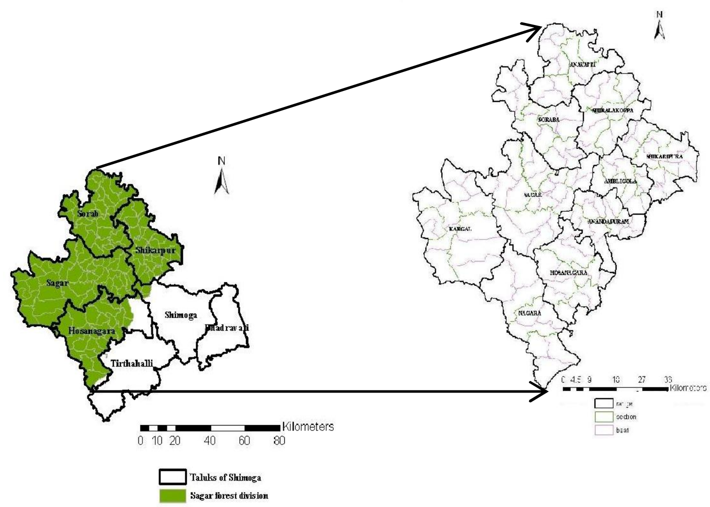



**Figure 3: Sagar division with range, section and beats**

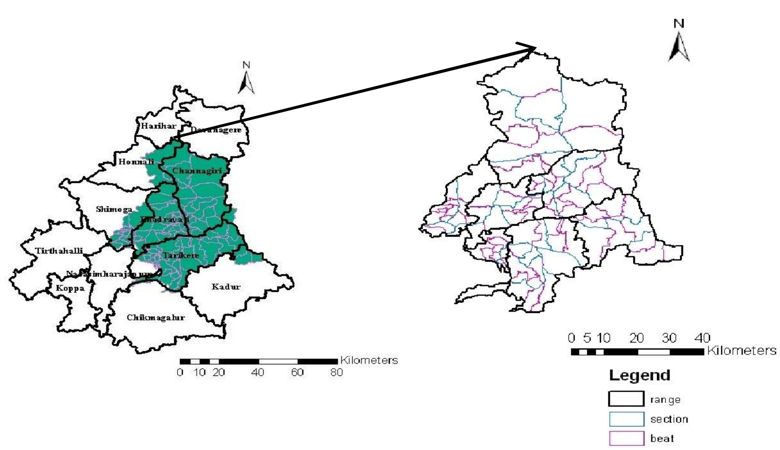



**Figure 4: Bhadravathi division with Range, section and beats**

Bhadravathi forest division with a total geographical area of 5106.13 Sq.km is spread over about 80 km in north south direction about 65 km in the east-west direction. The forest types of division are as follows:

**Southern moist mixed deciduous forest**: This type of forest is seen in parts of KukwadaUbrani, Antharagange, Chornedehalli and Kakanahosudi state forests.

**Southern tropical dry teak bearing forest:** Forests of this type are seen in Eastern part of Kukwada Ubrani State forest, Northwestern part of Kakanahosudi state forest, Western part of Rangainagiri state forest, central and south part of Bhadrapura state forest, northern part of Antharagange state forest, Tyagadabagi state forests, Tammadihalli, Umblebyle state forests and southwestern part of Gangur state forest (Working Plan Bhadravathi division, 2003).

**Dry deciduous scrub:** These types can be seen in Udev state forest, Jedikatte and Gangur state forests and all minor forests of the division.

Before 1920, the forests included in the present Bhadravathi division constituted parts of Shimoga and Kadur forest divisions. In 1920-21 these forests were included in Tarikere and Benkipura (Bhadravathi) firewood supply divisions that were created to meet the huge fuelwood requirements of Iron and Steel industry setup at Bhadravathi during 1916. The Bhadravathi firewood supply division was abolished in 1962 and Bhadravathi division came into effect from 1-7-1962. During 1992, parts of Lakkavalli, Tarikere, Bhadravathi and Umblebyle range coming under Bhadravathi wildlife Sanctuary are separated and included under Bhadra Wildlife division. The trend in areas of Bhadravathi forest division from 1920-1956 is given in table 6.1.

The total area of state forests, Reserved forests, Minor forests and other types of forests such as wooded blocks, kaval lands and Sandal reserves of Bhadravathi division as per 2003 Working plan is 1, 14,102.92 ha comprising 89,568.14 ha of state forests, 20,184.28 ha of minor forests, 169.69 ha of reserved forests 2,368.97 ha of reserved lands 572.14 of sandal reserves 1,211.38 ha of wooded block and 28.32 ha of plantation. The total extent of forest area transferred from Bhadravathi territorial division to Bhadra wildlife division is 18494.34 hectares. Besides this 2679.61 ha and 5796.16 ha of forest lands have been transferred to the Karnataka Forest Development Corporation (KFDC) and Mysore Paper Mills (MPM) respectively for raising plantations (**Working Plan Bhadravathi division, 2003**). The area of Bhadravathi forest division from 2006 to 2011 is given in Table 3.

### 4.2 HISTORY OF FOREST MANAGEMENT

**Mysore forest department:** The Mysore forest department was formed in 1864. In the past, the importance was given mainly to selection felling and improvement felling with the primary objective of revenue collection. Timber was mainly brought to the depots for sale.

**Trends of forest areas in Mysore presidency:** Land utilization trends have changed dramatically in Mysore presidency during the post-Forest Act period. Available data indicates an increase in forest cover from 36.35 lakh hectares (in 1893–1894) to 52.55 lakh hectares (in 1915–1916). It has further gone up to 53.45 lakh hectares in the subsequent decade. It remained more or less the same for the rest of colonial period. In other words, the proportion of forest area has witnessed a marginal increase from 15.57 per cent of the total geographical area in 1884–1885 to 16.40 per cent in 1946–1947. Land not available for cultivation which has risen from 44.92 lakh hectares in 1884–1885 to 96.07 lakh hectares in 1910–1911, however, this has declined in the subsequent decades. In 1946–1947, it has come down to 56.88 lakh hectares (Mysore Forest Administrative Report, 1893-1956). ). Table 6 lists area under state and reserve forests during 1893 to 1915 in Shimoga district.

Table 6: Area under state and reserve forests during 1893 to 1915 in Shimoga district **(Mysore forest administrative report)**

| Year | Area of State forest (Hectares) | Reserved Forests (Hectares) | Plantations (Hectares) |
|---|---|---|---|
| 1893 | 91944.65 | | |
| 1894 | 91944.65 | | |
| 1895 | 90131.65 | 230.51 | |
| 1896 | 90131.65 | 230.51 | |
| 1897 | 90131.65 | 230.51 | |
| 1901 | 89769.05 | | |
| 1902 | 89769.05 | | |
| 1904 | 88836.66 | | |
| 1906 | 89095.66 | 39626.85 | |
| 1907 | 95829.63 | 41180.84 | |
| 1908 | 110851.6 | | |
| 1909 | 120952.5 | 46101.82 | 1036 |
| 1910 | 124578.5 | | |
| 1911 | 124578.5 | 82361.68 | 1036 |
| 1912 | 124578.5 | 82620.68 | 1036 |
| 1913 | 135456.5 | 70447.73 | 1036 |
| 1914 | 138435 | 67080.74 | 1036 |
| 1915 | 139631.5 | 65526.75 | 1036 |

**Expansion of agriculture**

Expansion of agriculture was notable in the Mysore Presidency during the post-Forest Act period. Despite an increase in current fallows, the net sown area has gone up progressively during this period. For instance, in 1884–1885, 86.33 lakh hectares of land was the net sown area and it has shot up to 125.59 lakh hectares in 1946–1947. In other words, the proportion of net sown area, which was 37 per cent of the total geographical area in 1884–1885, had risen to 39.05 per cent in 1946–1947. This highlights that more and more land was brought under the cultivation during the late nineteenth century and early twentieth centuries in the Mysore Presidency (Mysore Forest Administrative Report, 1893-1956.

## 4.3 PAST MANAGEMENT IN SHIMOGA FOREST DIVISIONS

**Bhadravathi:**

**The pre-working plan period:** This period refers to management of forests prior to 1898 when there were no systematic working plans. After formation of the forest department in 1864 various forest areas were placed under the protection of forest department. The valuable forests of Lakkavalli and Chornedehalli were the first to be placed under protection of forest department in Bhadravathi division **(Working Plan Bhadravathi division, 2003).** During that time little attention was paid to protection and regeneration of forests. Col. Campbell Walker ordered for preparation of working plans for some of the important forests of Bhadravathi division. Seetharamaiah drew up first working plan in 1900 for Kukwada Ubrani State Forest **(Working Plan Bhadravathi division, 2003)**.

In 1902 a provisional working scheme based on silvicultural principles was drawn up and applied to all the forests of Bhadravathi division. The provisional plan provided for fire protection, climber cutting, planting, sowing, coppicing, etc. in order to improve the growing stock.

In 1907 regular working plan for the first time for Kukwada Ubrani forest was worked out. During 1910 working plan was prepared for Lakkavalli and Thyagadabagi. Working plan for Kakanhosudi, Aldhara, Umblebyle and Chornedehalli forests were prepared during 1916 and Kukwada, Ubrani, Rangainagiri, Hadikere and Gurupura forests during 1919.

**Period of firewood supply from 1919 to 1935:** This period has brought a lot of changes in the working of forests. After the introduction of tramways for transport of firewood to Bhadravathi Iron factory, rearrangement of working plan areas was made and heavy exploitation was carried out in forest areas adjacent to the tramways. The extraction of fuel wood till 1923 was mainly controlled by old working plans with modification and addition of district forest areas to the extent of 7360 areas.

During 1924, in addition to state forests 10240 acres of district forests were also covered since the district forest were often nearer to the tramways than the state forests **(Working Plan, Bhadravathi division, 2003)**. In 1943 Mysore Iron and Steel Works factory started transporting charcoal from distant forests.In 1962 another working plan was written for supply of firewood and charcoal to MSIL and bamboo to MPM. The trend in areas of Bhadravathi forest division from 1920-1956 is given in table 7.1.

**Table 7.1: Areas of Forests in Bhadravathi division from (1920-1956)**

| Year | Area of state forests (Hectares) | Plantations (Hectares) | Reserve lands (Hectares) | Minor Forests (Hectares) |
|---|---|---|---|---|
| 1921 | 63304.54 | 118.98 | 11719.71 | |
| 1922 | 63304.54 | 85.47 | 12696.14 | |
| 1923 | 63304.54 | 85.47 | 12696.14 | |
| 1924 | 113330.2 | 85.47 | 18471.81 | |
| 1925 | 114355.8 | 85.47 | 24669.65 | |
| 1928 | 124498.2 | 85.47 | 19147.8 | |
| 1931 | 126065.2 | 85.47 | 13755.44 | 36314.25 |
| 1933 | 126065.2 | 85.47 | 13755.44 | 36314.25 |
| 1934 | 126065.2 | 85.47 | 14099.91 | 36314.25 |
| 1936 | 126065.2 | 85.47 | 14099.91 | 36368.64 |
| 1937 | 134221.1 | 85.47 | 6627.78 | 36368.64 |
| 1938 | 134221.1 | 85.47 | 7622.34 | 36368.64 |
| 1939 | 134221.1 | 85.47 | 7622.34 | 36368.64 |
| 1941 | 135140.5 | 85.47 | 6930.81 | 36231.37 |
| 1943 | 136453.6 | 85.47 | 5337.97 | 36231.37 |
| 1944 | 136453.6 | 85.47 | 5337.97 | 36231.37 |
| 1945 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1948 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1949 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1950 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1951 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1952 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1955 | 138732.8 | 85.47 | 2900.79 | 36231.37 |
| 1956 | 138732.8 | 85.47 | 2900.79 | 36231.37 |

**Post working plan period - Recent management:** After the expiry of above working plans, forests were exploited for extraction of fuel and timber. In 1960's some areas were clear felled to raise Eucalyptus. During the year 1971-72, in Bhadravathi division, 2679.61 hectares of area were leased to KFDC for raising Eucalyptus plantation for supply to West-coast paper mills, Harihar Polyfibres and Mysore Paper Mills Ltd. Bhadravathi. 5796.16 hectares of area were leased to Mysore paper Mills Ltd. Bhadravathi for raising captive plantations for paper pulp. (**Working Plan, Bhadravathi division, 2003**). Joint forest planning and management (JFPM) has been adopted as a departmental strategy to regenerate and restock the degraded forest areas with the help and cooperation of all the stakeholders. Total area of 6957.62 hectares was leased to JFPM in Bhadravathi division up to 1998-99.

*Encroachment:* Encroachment of forest land for extension of cultivation has caused considerable damage to the forests. After the formation of Bhadra irrigation channels, forest areas adjacent to the channels were occupied for unauthorized cultivation. As per the stock maps prepared based on the inventory, the extent of forest areas encroached is **12916.01 hectares**. The details of areas leased to MPM, JFPM, KFDC and area under encroachment are summarized in the table 7.2.

Table 7.2: Forest area details in Bhadravathi division

| Sl. No | Range | Extent (Ha) | Area released to MPM (Ha) | Area released to KFDC (Ha) | Area released to JFPM (Ha) | Area under encroachment (Ha) | Balance wooded area(Ha) |
|---|---|---|---|---|---|---|---|
| 1 | Ajjampura | 995 | | 46.15 | 483.6 | | 465.25 |
| 2 | Bhadravathi | 13271.09 | 1428.01 | 664.35 | 2128.63 | 2882.62 | 6167.48 |
| 3 | Channagiri | 27522.86 | 646.5 | 617.79 | 1606.43 | 2381.01 | 22271.13 |
| 4 | Lakkavalli | 21737.85 | | 305.25 | 458.97 | 1637.04 | 16418.11(2918.48 ha submerged) |
| 5 | Shantisagar | 13222.45 | 1589.48 | | 631 | 3006.46 | 7995.51 |
| 6 | Tarikere | 21011.05 | 1844.41 | 133.59 | 914.9 | 2397.37 | 15708.78(12 ha submerged) |
| 7 | Umblebyle | 16342.62 | 287.76 | 912.48 | 734.09 | 611.51 | 11051.7(2745.08 ha submerged) |
| 8 | **TOTAL** | **114102.92** | **5796.16** | **2679.61** | **6957.62** | **12916.01** | **80077.96(5675.56 ha submerged)** |

**Shimoga:**

Before the formation of the Forest Department in 1864, Sandalwood was collected through the "Amildars" of the taluk, who employed on their own responsibility men called "Mangers" who felled, prepared and collected the wood in small local stores called "Pattadis" scattered all over the taluk (**Working Plan, Shimoga division, 2003**).

Untill 1910, Agumbe and Balehalli state forests were brought under reserve forest category, coffee and cardamom planting were practiced by the colonial planters, who made dense Malanad their home. It is reported that kumri cultivation (Shifting cultivation) was in practice in those days in Balehalli state forest and Agumbe state forest (**Working Plan, Shimoga division,**

**2003**). Table 8.1 lists forest type (state, reserve, plantation, etc.) wise and year wise area under forests during 1917 to 1956.

**Table 8.1: Areas of Forests in Shimoga division from (1917-1956)**

| Year | Area of state forests (Hectares) | Plantations (Hectares) | Reserve lands (Hectares) | Minor Forests (Hectares) |
|---|---|---|---|---|
| 1917 | 79660.32 | 647.5 | 27453.89 | |
| 1918 | 79660.32 | 647.5 | 37295.86 | |
| 1919 | 81973.18 | 647.5 | 37280.32 | |
| 1921 | 58153.05 | 517.99 | 10144.99 | |
| 1922 | 61227.36 | 517.99 | 5615.1 | |
| 1923 | 61227.36 | 616.42 | 5615.1 | |
| 1924 | 61227.36 | 631.96 | 6920.45 | |
| 1925 | 61227.36 | 631.96 | 7417.73 | |
| 1928 | 62519.77 | 593.11 | 2675.46 | |
| 1931 | 62703.66 | 593.11 | 2766.11 | 15343.1 |
| 1933 | 62703.66 | 593.11 | 2766.11 | 34780.98 |
| 1934 | 62701.07 | 593.11 | 2766.11 | 34780.98 |
| 1936 | 62701.07 | 593.11 | 2766.11 | 34780.98 |
| 1937 | 62701.07 | 593.11 | 2766.11 | 34768.03 |
| 1938 | 63503.96 | 593.11 | 1748.24 | 34768.03 |
| 1939 | 63503.96 | 593.11 | 1748.24 | 34768.03 |
| 1941 | 63503.96 | 593.11 | 1748.24 | 34768.03 |
| 1943 | 63506.55 | 593.11 | 1748.24 | 34768.03 |
| 1944 | 63506.55 | 593.11 | 1748.24 | 34768.03 |
| 1945 | 63506.55 | 593.11 | 1748.24 | 34768.03 |
| 1948 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1949 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1950 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1951 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1952 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1955 | 65578.55 | 593.11 | 1748.24 | 34768.03 |
| 1956 | 65578.55 | 593.11 | 1748.24 | 34768.03 |

*Balagi pole supply period: (History from 1922 - 1932):* This period is marked by supply of Balagi poles to the electrical department. In 1928 the cresolting plant (Wood preservation plant) was started at Bhadravathi which opened a new era in utilisation of Dhuma timber for railway sleepers. The treated Dhuma timber was accepted as a sleeper wood by Mysore railways. As a result large-scale exploitation of this timber was started. During 1933 summer for the first time about 80,000 Cft of timber was felled for conversion into sleepers. The forests of Agumbe and Balehalli were not brought under any systematic treatment until 1921 when the first working plan based on sound silvicultural principles came into force.

Shankar and Sacrebyle Ranges: Prior to 1902 these forests were reserved as timber forests at the time when the forest conservancy was introduced in the state in the year 1863. Between 1902 and 1917, a provisional working scheme was drawn up and regulated working was introduced in 1902. A regular working plan was drawn up and brought to effect from 1917-18. According to this plan the forests were divided into three types based on quality and girth of teak and felling was prescribed for 20 years. The revised working plan was brought into force in 1933 for a period of 10 years. In order to attain continuity felling cycle was fixed for 20 years. *Purdal state forest* was constituted during 1893.

*Arasalu and Harohitlu state forests*: Provisional working scheme was introduced during 1923 for these forests. A regular working plan was introduced in 1928-29 which prescribed selection and improvement feelings on a rotation of 20 years.

*Kumsi state forest:* Recognised during 1865-66 and included in reserved forest. In the absence of regular system of felling, a great deal of damage was done to this forest. Provisional scheme was introduced during 1903. Teak sleepers were supplied to Mysore Railways from these forests during 1914-16.

After the expiry of the above plans and schemes, no working plan has been revised or written for Shimoga division. Forests were worked on ad-hoc basis for extraction for fuel and timber. During the year 1971-72, **2533.89 hectares** of area were leased to KFDC for raising Eucalyptus plantation for supply to West-coast paper mills, Harihar Polyfibers and Mysore Paper Mills Ltd., Bhadravathi (Table 8.2). Besides, **6825.62 hectares** of area were leased to Mysore Paper Mills Ltd., Bhadravathi for raising captive plantations for Paper pulp (Table 8.3). The Karnataka Cashew development Corporation limited (KCDC) has been managing the cashew plantations in Teerthahalli and Rippanpet ranges. These plantations were earlier raised by the forest department and were handed over to the corporation on 13-1-1999. The total area handed over to KCDC was **1214.05 hectares** (Table 8.4). With the introduction of the Western Ghats forestry project during 1996, most of the areas having density less than 0.25 are covered under Joint Forest Planning and Management (JFPM) programme. Total area of **1006.5 hectares** was leased for plantations under JFPM.

During 1980's protection of natural forests and Social forestry had gained importance. During 1991-2000, 3400 hectares of miscellaneous plantations have been raised in Shimoga division (**Working Plan, Shimoga division, 2003**). Due to diversion of forest areas for non-forestry purposes, 339.25 hectares of compensatory plantations have been raised in Shimoga division. Apart from this, 118 hectares of school forestry and 89 hectares of roadside plantations and 180.85 hectares of urban plantations have been raised during 1991-2000.

*Encroachment:* Encroachment is more common in the deciduous forests than in Evergreen forests. Ragi, Jowar, Maize, Ginger and rubber are grown on the encroached lands. It has caused considerable damage to the forests. The total encroachment as per 30-11-2000 is **3766.63 hectares.**

Table 8.2: Extent of forest area diverted to KFDC

| **Sl. No.** | **Name of the Range** | **Name of the locality** | **Area (Extent in Ha) transferred as per list appended to the agreement dated: 26.03.1988** | **Date of transfer** | **Cumulative total** |
|---|---|---|---|---|---|
| 1 | Ayanur | Muttinakoppa Sandal Reserve, Siddapura 1966 | 40.48 | 22.02.1989 | 40.48 |
| 2 | - do - | 1970 - Guddinakoppa | 25.10 | - do - | 65.58 |
| 3 | - do - | 1971 - Guddinakoppa | 18.62 | - do - | 84.20 |
| 4 | - do - | 1968 - Kempinakoppa | 18.62 | - do - | 98.37 |
| 5 | - do - | 1971 - Kempinakoppa | 14.17 | - do - | 127.51 |
| 6 | - do - | 1968 - Kumsi S.F. | 29.14 | - do - | 157.87 |
| 7 | - do - | 1947 - Kumadwathi | 30.36 | - do - | 160.70 |
| 8 | - do - | 1971 - Kumadwathi | 2.63 | - do - | 178.51 |
| 9 | - do - | 1961 - Sudur | 17.81 | - do - | 186.51 |
| 10 | - do - | 1962 - Sudur | 30.76 | - do - | 217.36 |
| 11 | - do - | 1962 - Belaguthi (Sowlanga Unit) | 10.12 | - do - | 227.48 |
| 12 | - do - | 1963 - Belaguthi | 10.12 | - do - | 237.6 |
| 13 | - do - | 1964 - Belaguthi | 10.12 | - do - | 247.72 |
| 14 | - do - | 1958 - 64 Mallapura | 74.89 | - do - | 322.61 |
| 15 | - do - | 1962 - 98 Suthukote | 141.70 | - do - | 464.31 |
| 16 | - do - | 1963 - 68 - Kallapura | 40.48 | - do - | 504.79 |
| 17 | - do - | 1965 - 67 - Devabalu | 26.31 | - do - | 531.10 |
| 18 | - do - | 1956 - 68 - Bikkonahalli Series | 212.55 | - do - | 743.65 |
| 19 | - do - | 1970 - Haramaghatta | 40.48 | - do - | 784.13 |
| 1 | 2 | 3 | 4 | 7 | 8 |
| 20 | - do - | 1971 - Haramaghatta | 40.48 | - do - | 824.61 |
| 21 | Hanagere | 1966 - Shankar S.F. | 9.31 | - do - | 833.92 |
| 21 a. | - do - | 1967 - Shankar S.F. | 40.48 | - do - | 874.40 |
| 22 | - do - | 1946 - Kudi | 7.28 | - do - | 881.68 |
| 23 | - do - | 1964 - Shankar | 42.51 | - do - | 924.19 |
| 24 | - do - | 1962 - Kudi Chinmane | 25.62 | - do - | 949.81 |

| | | | | | |
|---|---|---|---|---|---|
| 25 | - do - | 1958 - Kudi Chinmane | 10.12 | - do - | 959.93 |
| 26 | Arasalu | 1971 - Masarur | 20.54 | - do - | 980.47 |
| 27 | - do - | 1971 - Harohithlu | 6.07 | - do - | 986.54 |
| 28 | - do - | 1952 - Masarur | 22.67 | - do - | 1009.21 |
| 29 | Arasalu | 1949 - Masarur | 10.12 | - do - | 1019.33 |
| 30 | - do - | 1967 - Burve | 40.48 | - do - | 1059.81 |
| 31 | - do - | 1968 - Burve | 41.7 | - do - | 1101.51 |
| 32 | - do - | 1969 - Burve | 40.48 | - do - | 1141.99 |
| 33 | Shankar | 1969 - Shankar | 9.71 | - do - | 1151.7 |
| 34 | - do - | 1969 - Shankar | 45.34 | - do - | 1197.04 |
| 35 | Sacrebyle | 1968 - Sacrebyle | 24.29 | - do - | 1221.33 |
| 36 | - do - | 1967 - Sacrebyle | 20.24 | - do - | 1241.57 |
| 37 | - do - | 1963 - Basavapura | 34.41 | - do - | 1275.98 |
| 38 | - do - | 1964 - Basavapura | 39.67 | - do - | 1315.65 |
| 39 | - do - | 1965 - Basavapura | 60.72 | - do - | 1376.37 |
| 40 | - do - | 1967 - Basavapura | 40.48 | - do - | 1416.85 |
| 41 | - do - | 1968 - Basavapura | 55.46 | - do - | 1472.31 |
| 42 | - do - | 1968 - Bedanakalmatti | 72.87 | - do - | 1545.18 |
| 43 | - do - | 1971 - Sacrebyle | 17.4 | - do - | 1562.58 |
| 44 | - do - | 1966 - Kudugalamane | 82.99 | - do - | 1645.57 |
| 45 | - do - | 1966 - Kudugalamane | 24.29 | - do - | 1669.86 |
| 46 | Mandagadde | 1962 - Ubbur - Savemakki | 52.63 | - do - | 1722.49 |
| 47 | - do - | 1962 - Bommenahalli | 10.12 | - do - | 1732.61 |
| 48 | - do - | 1965 - Bommenahalli | 40.48 | - do - | 1773.09 |
| 49 | - do - | 1961 - Bommenahalli | 24.29 | - do - | 1797.38 |
| 50 | - do - | 1960 - Ubbur | 24.29 | - do - | 1821.67 |
| 51 | - do - | 1961 - Ubbur | 24.29 | - do - | 1845.96 |
| 52 | - do - | 1968 - Hegalathi | 40.48 | - do - | 1886.44 |
| 53 | Thirthahalli | 1968 - Hosagadde | 323.08 | - do - | 2209.52 |
| 54 | - do - | 1965 - Aralapura | 121.45 | - do - | 2330.97 |
| 55 | - do - | 1966 - Bharathipura - Nellisara | 202.42 | - do - | 2533.89 |

**Table 8.3: Plantations raised by Mysore Paper Mills Ltd. in Shimoga division**

| Sl.No. | SF/MF | Village | Survey No. | Area (Ha) | Year | Type of Plantation |
|---|---|---|---|---|---|---|
| 1 | MF | Shriambakapura | 35 | 32.8 | 1981 | Acacia |
| 2 | SF | Devabalu | 26,58 | 80 | 1981 | Casuarina |
| 3 | -"- | Devabalu II | 26,58 | 62 | 1982 | Eucalyptus |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | -"- | Kunchenahalli | 52,109 | 89.44 | 1982 | -"- |
| 5 | -"- | Devabalul | 26,58 | 55.5 | 1982 | -"- |
| 6 | MF | Malleshwaral & II | 1,11 | 55.5 | 1982 | Casuarina |
| 7 | -"- | Nonabur | 113,15,35 | 80.4 | 1982 | Acacia |
| 8 | -"- | Shirigar | 181,194, 18 | 60 | 1982 | -"- |
| 9 | -"- | Hadigal | 161,54 | 86 | 1982 | -"- |
| 10 | -"- | Kandike | 25,316,84 | 86.16 | 1983 | -"- |
| 11 | -"- | Nartur | 48 | 10 | 1983 | Pines |
| 12 | -"- | Dyamlapur | 160,172, 173,174 | 36.4 | 1983 | -"- |
| 13 | -"- | Kalammanagudi | 53 | 74.1 | 1983 | Acacia |
| 14 | -"- | Muniyoor | 47,51, 98, 30, 31, 32 | 58 | 1983 | Casuarina |
| 15 | -"- | Aralapura | 1, 18, 27 | 94.12 | 1983 | Acacia |
| 16 | -"- | Devabalu | 26, 28 | 80 | 1983 | -"- |
| 17 | SF | Devabalul | | 55.5 | 1983 | -"- |
| 18 | -"- | Kunchenahalli | | 65.2 | 1983 | -"- |
| 19 | -"- | Harmaghatta | 52,199 | 130 | 1983 | -"- |
| 20 | -"- | Devabalull | 41,31 | 73 | 1984 | Eucalyptus |
| 21 | -"- | Devabalul | 26,58 | 92 | 1984 | -"- |
| 22 | -"- | Kunchenahalli | 52,100 | 45 | 1984 | -"- |
| 23 | -"- | Harmaghatta | 41,31 | 75 | 1984 | -"- |
| 24 | -"- | Beenarakere | 24 | 58 | 1984 | -"- |
| 25 | MF | Ambuteertha | 19,16 | 105 | 1984 | -"- |
| 26 | SF | Navaturu | | 10 | 1984 | -"- |
| 27 | MF | Beede | | 23 | 1984 | -"- |
| 28 | -"- | Kittanduru | 70,29,30 | 41 | 1984 | Eucalyptus |
| 29 | -"- | Aklapura | | 30 | 1984 | -"- |
| 30 | -"- | Gangadharagudda | | 46 | 1984 | -"- |
| 31 | -"- | Koduru | | 23 | 1984 | -"- |
| 32 | -"- | Muniyoor | 47,98 | 33 | 1984 | -"- |
| 33 | -"- | Bharatipur | 81,78 | 32 | 1984 | -"- |
| 34 | -"- | Aralipura | 111 | 24 | 1984 | -"- |
| 35 | -"- | Sarala | 72,6 | 59 | 1984 | -"- |
| 36 | -"- | Maragalale | 22,12 | 27 | 1984 | -"- |
| 37 | SF | Devabalul | | 79 | 1985 | -"- |
| 38 | -"- | Devabalull | | 76 | 1985 | -"- |

| | | | | | | |
|---|---|---|---|---|---|---|
| 39 | -"- | Puradalu | | 110 | 1985 | -"- |
| 40 | MF | AnupinakatteÖ | | 110 | 1985 | -"- |
| 41 | SF | Haramaghatta | | 55 | 1985 | -"- |
| 42 | -"- | Kukova | | 70 | 1985 | -"- |
| 43 | SF | Beeranakere | | 50 | 1985 | -"- |
| 44 | MF | BK gudda | 39 | 40 | 1985 | Acacia |
| 45 | -"- | Dyamlapura | 61 | 31 | 1985 | Casuarina |
| 46 | -"- | Agalabagilu | 19 | 41 | 1985 | -"- |
| 47 | -"- | Dyamlapura | 70 | 18 | 1985 | -"- |
| 48 | -"- | Udukere | 35,16 | 28 | 1985 | -"- |
| 49 | -"- | Muniyoor | 47,48, 69, 81 | 27 | 1985 | -"- |
| 50 | -"- | Karadiga | 53 | 39 | 1985 | -"- |
| 51 | -"- | Bharatipura | 18,110 111 | 26 | 1985 | -"- |
| 52 | -"- | Bharatipura | 82, 154 | 37 | 1985 | -"- |
| 53 | -"- | Jambetallur | 138, 139, 129, 132 | 67 | 1985 | -"- |
| 54 | -"- | Aralapura | 72 | 23 | 1985 | -"- |
| 55 | -"- | Hosakoppa | 1 | 35 | 1986 | Eucalyptus |
| 56 | C CLASS | Malakovi | 29 | 68 | 1986 | Casuarina |
| 57 | -"- | Kudumallige | 86 | 45 | 1986 | -"- |
| 58 | -"- | BK gudda | 45 | 23 | 1986 | -"- |
| 59 | C CLASS | Triambakapura | 105, 24 | 46 | 1986 | -"- |
| 60 | -"- | Dattaranjapura | 5 | 37 | 1986 | -"- |
| 61 | -"- | Shankarapura | 193 | 31 | 1986 | -"- |
| 62 | -"- | Beesu | 21 | 29 | 1986 | -"- |
| 63 | -"- | Beede | 268 | 20 | 1986 | -"- |
| 64 | -"- | Hadigallu | 101 | 80 | 1986 | -"- |
| 65 | C CLASS | Kandaka | 76, 26, 28 | 40 | 1986 | -"- |
| 66 | C CLASS | Hunchadakatte | 10 | 20 | 1986 | Casuarina |
| 67 | C CLASS | Jambetalluru | 77 | 31 | 1986 | -"- |
| 68 | MF | Tyaranduru | 23 | 24 | 1986 | -"- |
| 69 | -"- | Balagaru | 11 | 30 | 1986 | -"- |
| 70 | C CLASS | Virupapura | 23,388, 74, 256 | 91 | 1986 | -"- |
| 71 | SF | Devabalu | 26, 28 | 37 | 1987 | Eucalyptus |
| 72 | MF | Anupinakatte | 124, 125, 126 | 28 | 1987 | -"- |
| 73 | -"- | Suttukote | 29 | 26 | 1987 | -"- |
| 74 | -"- | Bikkonahalli | 11,8 | 25 | 1987 | -"- |

| | | | | | | |
|---|---|---|---|---|---|---|
| 75 | C CLASS | Kakkikoppa | 109, 110 | 48 | 1987 | -"- |
| 76 | C CLASS | Guddakoppa | 116, 38,55 | 66 | 1987 | Acacia |
| 77 | MF | Agasadi | 5 | 26 | 1987 | Casuarina |
| 78 | C CLASS | Virupapura | 256, 288 | 37 | 1987 | -"- |
| 79 | -"- | Malalimatt | 127 | 39 | 1987 | -"- |
| 80 | -"- | -"- | 107 | 24 | 1987 | -"- |
| 81 | SF | Heggaru | 42 | 20 | 1987 | -"- |
| 82 | MF | Kudumallige | 43 | 33 | 1987 | -"- |
| 83 | C CLASS | Mulkere | 29 | 27 | 1987 | -"- |
| 84 | -"- | Hirekalahalli | 16 | 29 | 1987 | -"- |
| 85 | -"- | Beede | 9, 11 | 20 | 1987 | -"- |
| 86 | MF | Bikkukoppa | 23, 24 | 24 | 1987 | -"- |
| 87 | C CLASS | Udukere | 105,16 | 29 | 1987 | -"- |
| 88 | -"- | Beesu | 29, 91, 99 | 24 | 1987 | -"- |
| 89 | -"- | Yanaralli | 7, 80 | 21 | 1987 | -"- |
| 90 | -"- | Hoskere | 19 | 14 | 1987 | -"- |
| 91 | -"- | Tanigebailu | 7,16, 22, 23, 123 | 38 | 1987 | -"- |
| 92 | C CLASS | Gagadharagudda | 1 | 23 | 1988 | Acacia, Pines |
| 93 | -"- | Nekkaragonda | 1,41 | 28 | 1988 | -"- |
| 94 | -"- | Shankarapura | 193 | 11 | 1988 | -"- |
| 95 | MF | Hoskere | 109,173, 80 | 32 | 1988 | -"- |
| 96 | C CLASS | Bharathipura | 110 | 24 | 1988 | -"- |
| 97 | MF | Kalahatti | 9 | 54 | 1988 | -"- |
| 98 | -"- | Kukke | 86 | 28 | 1988 | -"- |
| 99 | -"- | Malligesara | 22 | 21 | 1988 | -"- |
| 100 | -"- | Guddenakoppa | 38 | 30 | 1988 | -"- |
| 101 | -"- | Seeke | 53 | 10 | 1988 | -"- |
| 102 | -"- | Balebailu | 6, 84, 85, 86 | 40 | 1988 | -"- |
| 103 | -"- | Kudumallige | 86 | 18 | 1988 | -"- |
| 104 | -"- | Survikoppa | 54, 64 | 50 | 1988 | -"- |
| 105 | -"- | Hosakoppa | 1 | 30 | 1988 | -"- |
| 106 | -"- | Suruvali | 1 | 21 | 1988 | -"- |
| 107 | -"- | Sarala | 6 | 12 | 1988 | -"- |
| 108 | SF | Puradalu | 1 | 107 | 1988 | Nilgiri |
| 109 | -"- | Devabalu | 1 | 122 | 1988 | -"- |
| 110 | -"- | Siddlipura | 27, 28, 6 | 55 | 1988 | -"- |
| 111 | -"- | Goggur | 82 | 50 | 1988 | -"- |
| 112 | -"- | Kunchenahalli | 52, 109 | 10 | 1988 | -"- |

| | | | | | | |
|---|---|---|---|---|---|---|
| 113 | -"- | Sutkote | 29 | 25 | 1988 | -"- |
| 114 | -"- | Devabalu | 2, 4 | 22 | 1988 | -"- |
| 115 | SF | Gangavvanasara | 18 | 66 | 1989 | -"- |
| 116 | MF | Anupinakatte | 124, 125, 126 | 17 | 1989 | -"- |
| 117 | SF | Devabalu | | 41 | 1989 | -"- |
| 118 | MF | Siddlipura | 27, 28 | 53 | 1989 | -"- |
| 119 | SF | Kunchenahalli | 52, 119 | 44 | 1989 | -"- |
| 120 | C CLASS | Jogisara | 17 | 15 | 1989 | Acacia, Pines |
| 121 | MF | Balesetta | 38, 43 | 30 | 1989 | -"- |
| 122 | MF | Andagere | 53, 57, 24 | 15 | 1989 | -"- |
| 123 | C CLASS | Kadur | 91 | 11 | 1989 | Acacia |
| 124 | -"- | Shankarapura | 193 | 13 | 1989 | -"- |
| 125 | MF | Makkimane | 56 | 10 | 1989 | -"- |
| 126 | C CLASS | Kiranagere | 36, 37 | 30 | 1989 | -"- |
| 127 | -"- | Nallisara | 35 | 10 | 1989 | -"- |
| 128 | -"- | Virupapura | 135 | 28 | 1989 | -"- |
| 129 | -"- | Shripati | 11, 12, 13 | 15 | 1989 | -"- |
| 130 | -"- | Nallisara | 31, 32 | 10 | 1989 | -"- |
| 131 | MF | Mulubagilu | 26 | 15 | 1990 | -"- |
| 132 | -"- | -"- | 38 | 12 | 1990 | -"- |
| 133 | -"- | Mulubagilu | 14 | 6 | 1990 | -"- |
| 134 | -"- | Totadakoppa | 15 | 24 | 1990 | -"- |
| 135 | -"- | -"- | 15 | 6 | 1990 | -"- |
| 136 | -"- | -"- | 173 | 35 | 1990 | -"- |
| 137 | -"- | Kittanduru | 105 | 19 | 1990 | -"- |
| 138 | -"- | Dabbanagadde | 166 | 33 | 1990 | -"- |
| 139 | MF | Kodinakoppa | 72, 73 | 23 | 1990 | Acacia |
| 140 | -"- | Siddlipura | 27, 28, 6 | 13 | 1991 | -"- |
| 141 | -"- | Kiranagere | 57, 35 | 18 | 1991 | -"- |
| 142 | -"- | Totadakoppa | 112 | 8 | 1991 | -"- |
| 143 | SF | Makkimane | 55 | 14 | 1991 | -"- |
| 144 | -"- | Herambapura | 55, 56 | 25 | 1991 | -"- |
| 145 | SF | Jogisara | 17 | 8.5 | 1991 | -"- |
| 146 | C CLASS | Hardi | 36, 37 | 12 | 1991 | -"- |
| 147 | SF | Hadaginamakki | 10 | 17 | 1991 | -"- |
| 148 | MF | Shankarapura | 193 | 26 | 1992 | -"- |
| 149 | -"- | Patlamane | 1 | 15 | 1992 | -"- |
| 150 | -"- | -"- | 1 | 8 | 1992 | -"- |
| 151 | -"- | Buklapura | 170 | 37 | 1992 | -"- |
| 152 | Kan | Mannekere | 51, 52 | 43 | 1992 | -"- |

| | | | | | | |
|---|---|---|---|---|---|---|
| 153 | -"- | Kiranagere | 36, 37 | 12 | 1992 | Bamboo, Acacia |
| 154 | MF | Virupapura | 135, 136 | 42 | 1992 | -"- |
| 155 | -"- | Jattinagadde | 126, 42 | 27 | 1992 | Bamboo, Acacia |
| 156 | -"- | Anagere | 209, 212 | 7 | 1992 | -"- |
| 157 | sSoppinabett a | Kalvaru | 82 | 30 | 1993 | Acacia |
| 158 | | -"- | 77 | 20 | 1993 | -"- |
| 159 | | Hunasuvalli | 96 | 32.5 | 1993 | -"- |
| 160 | MF | Melina Kuruvallî | 88 | 19 | 1993 | -"- |
| 161 | Soppinabetta | Balagatta | 43 | 27.5 | 1993 | -"- |
| 162 | Kan | Holekoppa | 102 | 20 | 1993 | -"- |
| 163 | MF | Kudumallige | 119, 113 | 20 | 1993 | -"- |
| 164 | -"- | Haradavalli | 135 | 10 | 1993 | -"- |
| 165 | -"- | Ganigadde | 85 | 10 | 1993 | -"- |
| 166 | -"- | Kanukoppa | 288 | 24 | 1993 | -"- |
| 167 | -"- | Hadikallgadde A | 6, 9 | 30 | 1993 | -"- |
| 168 | -"- | Hadikallgadde B | 6, 7 | 23 | 1993 | -"- |
| 169 | C CLASS | Jogisara | 17 | 9 | 1993 | Acacia |
| 170 | SF | TungaBhadra | 14,6, 413 | 41 | 1993 | -"- |
| 171 | -"- | -"- | 14, 6, 413 | 41 | 1994 | -"- |
| 172 | -"- | -"- | -"- | 31 | 1994 | -"- |
| 173 | -"- | -"- | -"- | 34 | 1994 | -"- |
| 174 | -"- | Haluvani | -"- | 27 | 1994 | -"- |
| 175 | -"- | -"- | 12, 345 | 24 | 1994 | -"- |
| 176 | -"- | -"- | | 38 | 1994 | -"- |
| 177 | -"- | Melina Kuruvallî | | 29 | 1994 | -"- |
| 178 | -"- | Kumarakoppa | | 12 | 1994 | -"- |
| 179 | -"- | Lakkunda | | 10 | 1994 | -"- |
| 180 | -"- | Kuruvalli | 57, 78, 42 | 20 | 1995 | -"- |
| 181 | -"- | Mahishi | 83, 84 | 27 | 1995 | -"- |
| 182 | -"- | -"- | 83, 84 | 21 | 1995 | -"- |
| 183 | -"- | Sarvavinakoppa | 105 | 13 | 1995 | -"- |
| 184 | MF | Bandya | 64 | 46 | 1995 | -"- |
| 185 | -"- | Teerthamattur | 67, 102 | 12 | 1995 | -"- |
| 186 | Soppinabetta | Mahishi | 72 | 28 | 1995 | -"- |

| | | | | | | |
|---|---|---|---|---|---|---|
| 187 | -"- | Hunasuvalli | 96 | 15 | 1995 | -"- |
| 188 | -"- | Shedgar | 58 | 23 | 1995 | -"- |
| 189 | -"- | -"- | 58 | 23 | 1995 | -"- |
| **TOTAL** | | | | **6825.62** | | |

Table 8.4: Cashew plantations handed over to KCDC by Shimoga forest division

| Sl No | Name of the Cashew Plantation | Year | Area in Ha |
|---|---|---|---|
| **Thirthahalli Range** | | | |
| 1 | Thrithahalli Anandapura road left side plantation | | 20.24 |
| 2 | Maragalale Cashew plantation | | 202.35 |
| 3 | Araga Sankarali road near Kandaka Primary School | | 20.24 |
| 4 | Kalkoppa Plantation (Kalakoppa) | 1943 | 28.33 |
| 5 | Jayapura-Aralapura Bharathi Nagara Plantation | 1965 | 242.82 |
| 6 | Aralapura Hospital nearby plantation | | 24.23 |
| 7 | Malali Matha nearby plantation | | 12.14 |
| 8 | Aralapura Plantation | 1968 | 12.95 |
| 9 | Jayapura-Aralapura road left and right side plantation | | 24.28 |
| 10 | Aralapura yadehalli shirupathi plantation | | 323.76 |
| 11 | Yadegudde school nearby plantation | | 24.28 |
| 12 | Anandapura Thirthahalli road left and right side plantation | | 24.28 |
| 13 | Ambuthirtha Plantation | 1978 | 24.28 |
| 14 | Tirallebilu Plantation | 1965 | 24.28 |
| 15 | Aralapura Plantation | 1963 | 20.24 |
| 16 | Mallesara Plantation | | 24.28 |
| 17 | Mookadhamane Plantation | 1938 | 31.57 |
| 18 | Nellisara Plantation | 1967 | 24.28 |
| | | | **1108.83** |
| **Rippenpet Range** | | | |
| 1 | Kittendur MF | 1966 | 40.47 |
| 2 | Kittendur MF | 1967 | 40.47 |
| 3 | Cashew Plantation | 1985 | 24.28 |
| | | | **105.22** |
| | | **Grand Total** | **1214.05** |

**Sagar:**
Before 1977 there was no composite working plan for the whole of Sagar forest division. *Karadibetta:* This was reserved during 1895 and is the oldest to come under protection. Even before that, the forest was worked heavily in accessible localities for Teak, Honne and Mathi timber and the timber was supplied to forest depots at Shikaripur and Ayanur. In 1903, the Belandur forest was brought under a provisional working scheme, which fixed the exploitable girths of timber species and prescribed half of the exploitable stocks to be removed during the felling cycle of 30 years. In 1903, the *Belandur* forest was brought under a provisional working scheme, which fixed the exploitable girths of timber species and prescribed half of the exploitable stocks to be removed during the felling cycle of 30 years. Mr. H.S. Narayan Rao's working plan prescribed improvement felling with a felling cycle of 20 years commencing from July 1918.

*Goverdhanagiri S.F*: This was notified as state forest in June 1908.

Shri.P.Krishna Swmy Rao's working plan (WP) for *Gilalgundi Forest* came into force from July 1922. It prescribed "Improvement fellings" with a felling cycle of 20 years and the removal of only unsound or over mature stocks. Minimum exploitable girths were prescribed for useful timbers. Working Plan for all the State Forests of Sagar Division was written by Shri N.G Veerappa and was for a period of 10 years from June 1977 to June 1987. Not much emphasis was laid on the implementation of the plan because of the policy changes in the State such as clear felling ban on natural forests issued by the Government of Karnataka in 1983 and emphasis on the afforestation and Social forestry.

Timber and other marketable produce have been removed in the past. Due to the increased activities under Five year plans, large-scale extraction of timber and other forest produce have been done. Softwoods were extracted from evergreen and Semi-evergreen forests to feed the industries like Indian Plywood manufacturing Company, the Mysore Commercial Union, WIMCO, etc. Supply of Charcoal to Vishweshvaraiah Iron and Steel Works Ltd., Bhadravathi was also undertaken from regeneration and Sharavathi valley hydroelectric project submersion areas. Firewood has also been supplied to Sandal Oil factory from regeneration areas. In the past large-scale extraction of timber, to feed various Government departments and to meet the requirement of public was undertaken. 31,080.53 ha of forest area were clear felled for the SVHEP (Sharavathi Valley HydroElectric Project), which was subsequently called MGHEP (Mahatma Gandhi Hydro Electric Project), which is now called KPC Ltd (Karnataka Power Corporation Ltd). Table 9 lists area of forests during 1917 to 1956.

After the expiry of the above Plan, working plan has not been revised or written for Sagar division. During the eighties, protection of natural forests and social forestry had gained importance in the State. Clear felling of natural forest for the purpose of taking up afforestation had been stopped in 1983. Felling of green trees from evergreen and semi-evergreen forests was banned from 1987. This was followed by a ban on felling of green trees from any type of natural forests. With the State Government's policy to ban clear felling and felling of green trees, forestry operations in the division have been conservation oriented.

*Diversion of forest land:* In compliance with the Government order, the 22000-acre or **8903.27 hectares** of forest land were transferred to M/s MPM Ltd from Sagar division. In addition to the above lands, an additional area of **949.59 ha** of forest lands was transferred to the MPM Ltd on 28.9.1996. As per Government order. No FFD/12/FAD/71 dated 2.7.1976 and AHFF/93/FDC/77 dated 10.4.1987, the Karnataka Forest Department has transferred 25,373.75 hectares of Eucalyptus plantations raised over the years to the KFDC Ltd, which was earlier called Plantation Corporation Ltd, on lease basis. Of the 25,373.75 ha of plantations **2127.12 ha** plantations raised by the KFD was handed over from Sagar Division. Besides, **5682.06 ha** plantations have been raised by the KFDC Ltd.

**Table 9: Areas of Forests in Sagar division during 1920-1956**

| Year | Area of state forests (Hectares) | Plantations (Hectares) | Reserve lands (section 4 &35) (Hectares) | Minor Forests (Hectares) |
|---|---|---|---|---|
| 1917 | 81393.03 | 517.99 | 28334.49 | |
| 1918 | 90571.95 | 517.99 | 31520.18 | |
| 1919 | 93299.21 | 517.99 | 29007.89 | |
| 1921 | 88960.98 | 517.99 | 24667.06 | |
| 1922 | 90929.37 | 445.48 | 22867.02 | |
| 1923 | 90929.37 | 445.48 | 24299.29 | |
| 1924 | 90929.37 | 445.48 | 23571.5 | |
| 1925 | 92480.77 | 437.71 | 22126.28 | |
| 1928 | 97564.92 | 437.71 | 16625.15 | |
| 1931 | 98720.06 | 437.71 | 16133.05 | 20087.96 |
| 1933 | 98720.06 | 437.71 | 16133.05 | 20087.96 |
| 1934 | 98720.06 | 437.71 | 16368.74 | 24690.37 |
| 1936 | 100841.3 | 437.71 | 16368.74 | 24690.37 |
| 1937 | 101118.4 | 437.71 | 17003.28 | 24690.37 |
| 1938 | 101118.4 | 437.71 | 17003.28 | 24690.37 |
| 1939 | 101118.4 | 437.71 | 17003.28 | 24690.37 |
| 1941 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1943 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1944 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1945 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1948 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1949 | 110040.9 | 437.71 | 5677.26 | 24485.77 |
| 1950 | 111626 | 437.71 | 5677.26 | 24485.77 |
| 1951 | 111626 | 437.71 | 5677.26 | 24485.77 |
| 1952 | 111626 | 437.71 | 5677.26 | 24485.77 |

| | | | | |
|---|---|---|---|---|
| 1955 | 111626 | 308.21 | 5677.26 | 24485.77 |
| 1956 | 111626 | 308.21 | 5677.26 | 24485.77 |

*Encroachment:* Encroachment to forest land for extension of cultivation has caused considerable damage to the forests. Cultivation of cotton, rubber and pineapple has attracted people of surrounding villages to encroach upon forest lands. As per the stock maps prepared based on inventory by the forest department, the extent of forest areas encroached is **18213.23 Hectares.**

**5.0 FAUNA**

**Mammals:** The Shimoga district is rich in fauna with varied mammals due to diverse forests of tropical evergreen, moist deciduous and dry forests. Elephants, Indian bison, antelopes, sambar, Indian tigers, panthers, leopards, barking deer, wild pigs, black monkeys, jungle cats, bears, red squirrels and porcupines are found in the high forested area of Shimoga and Sagar taluks. The wild boar, destructive to crops, is predominant in Channagiri, Nagar and other parts (**working plan, 2003**)

**Birds:** A good number of species of birds are found in the woods of Shimoga district. Among the important species are parrot, vulture, kite, green pigeon, rock pigeon, peafowl, jungle fowl, partridge, wood-pecker, myna, tailor bird, sparrow, swallow, king fisher, etc. Teals, ducks and wild geese are found in the tanks of Shimoga and Channagiritaluks. The district is also noted for game birds such as tree pie, jungle crow, gray tit, yellow-cheeked tit, parrots, peacocks, herons and storks.

**Reptiles:** Crocodiles are found in the Tunga and Bhadra rivers. Among the other species of reptiles are tortoise, chameleon and python found in the high forested areas. Snakes are found in large numbers in the malnad areas. Green snake, krait, cobra and viper are met with in all parts of the district.

**Amphibians:** Green frog, bull frog and tree frog are common among the amphibians.

**Fishes:** Among the fishes, the important kinds noticed in the district are black cat fish, scorpion fish, mashur and murrel fiddler.

**5.1 FOREST WORKING PLANS**

In the fast changing world of today the demand for traditional wooded products has come down considerably because of various reasons. In the 19th century and early 20th century, besides a few selected timber species, sandalwood and firewood there was not much in demand for other forest products. But by the middle of the 20th century due to rapid population growth and consequent increase in the demand several tree species and other forest products became marketable. This caused tremendous pressure on the forests and, at many places resulted in their depletion and degradation (**KFD Annual report**).

**Timber:** In the past Bhadravathi was an important source of timber supply to the market. The trees were sold after extraction, conversion, transportation and classification in the depots. From the depot timber is supplied to various departments and to bonafide users on retail sales and rest is auctioned periodically (**Working Plan, Bhadravathi division**). In Shimoga division, various kinds of timber from dead and fallen trees and teak poles are removed toGovernment timber depots. From the depots timber is supplied to Government departments and public at retail price fixed and revised from time to time. Timber left after making these supplies is auctioned periodically **(Working Plan, Shimoga division).**The kinds of timber in demand are Teak, Beete, Honne, Mathi, Hunal, Nandi, Surhonne, Hebbalasu, Yethyaga, Bilidevdar and Neralu. Table 10 lists the quantity of timber extracted during 1909 to 1955.

**Firewood:** Firewood extracted from forests is sold to public from various depots through Karnataka State Forest Industries Corporation in Bhadravathi town. There is a demand for firewood from distant places like Davanagere,Chitradurga, etc. The firewood requirement is met partly from harvest of *Acacia auriculiformis* plantations of the department and partly from the harvest of captive plantations of the MPM Ltd **(Working Plan, Shimoga division).**The MPM Ltd., as per the agreement conditions of the lease, concedes 12.5 % of the harvested produce to the Forest Department as lease rent for the land. Lops and tops of the plantations after harvest and removal of firewood and pulpwood are used by the neighbouring villagers. Figure 5 illustrates the major forest produces (teak, fuelwood, etc.) during 2005-06 to 2010-11.

**Table 10: Timber operations in Shimoga district (Mysore forest administration report. 1909-1954)**

| Year | Quantity cut in forests (cft) | | | |
|---|---|---|---|---|
| | Shimoga | Sagar | Bhadravathi | Total |
| 1909-10 | | | | 1,91,500 |
| 1910-11 | | | | 1,62,272 |
| 1911-12 | | | | 1,86,574 |
| 1912-13 | | | | 1,55,767 |
| 1923-24 | 3,83,033 | 84,756 | 2,99,083 | 7,66,872 |
| 1924-25 | 3,16,142 | 82,780 | 1,69,404 | 5,68,326 |
| 1926-27 | 1,81,163 | 79,877 | 3,88,973 | 6,50,013 |
| 1927-28 | 2,38,567 | 93,211 | 2,96,791 | 6,28,569 |
| 1928-29 | 2,63,134 | 61,869 | 2,45,051 | 5,70,054 |
| 1936-37 | 2,01,492 | 38,384 | 2,47,324 | 4,87,200 |
| 1949-50 | 1,06,445 | 52,999 | 1,44,602 | 3,04,046 |
| 1954-55 | 1,91,847 | 1,21,960 | 2,61,768 | 5,75,575 |

**Bamboo:** The dead and dry bamboos were removed for the supply to Mysore Paper Mills Ltd. Green big and small bamboos are supplied to local Medars and for bonafide users from various depots.In order to meet requirement of local people and others, greenbamboo is removed as per silvicultural principles. Figure 6 depicts the quantum of bamboo extracted during 2005-06 during 2010-11.

**Sandalwood:** Dead and fallen sandalwood trees are extracted from forests, departmentally and supplied to government sandalwood depot. Supplies to various agencies are made from the sandalwood depot. Table 11 provides the details of sandalwood collected from Shimoga during 1909 to 1925.

**Table 11: Sandalwood from Shimoga district (Mysore forest administration report-1909-1954)**

| Year | Quantity of rough wood collected (tons) | | | |
|---|---|---|---|---|
| | Shimoga | Sagar | Bhadravathi | Total |
| 1909-10 | | | | 665 |
| 1910-11 | | | | 766 |
| 1911-12 | | | | 1213 |
| 1912-13 | | | | 777 |
| 1921-22 | 105 | 27 | | 132 |
| 1922-23 | 224 | 58 | | 282 |
| 1923-24 | 222 | 71 | 107 | 400 |
| 1924-25 | 265 | 238 | 506 | 1009 |
| 1926-27 | 347 | 206 | 218 | 771 |
| 1927-28 | 381 | 218 | 263 | 862 |
| 1928-29 | 362 | 169 | 340 | 871 |

Bamboo and sandalwood extracted from forests during the last decade is given in Table 12.

**Table 12: Bamboo and Sandalwood extracted from Shimoga district (KFD Annual report)**

| **Year** | **Bamboo(tons)** | **Sandalwood (kg)** |
|---|---|---|
| 2000-01 | 995.3 | 10.211 |
| 2001-02 | 552.330 | 110.807 |
| 2002-03 | 6039.04 | - |
| 2003-04 | 0 | 2498 |
| 2005-06 | 11605.23 (cum) | 38407 |
| 2006-07 | 1527.79(cum) | 189 |
| 2008-09 | 170421(nos) | 309.5 |
| 2009-10 | 150067.3(cum) | 0.00 |

**Minor forest products**

Non-timber forest products are important forest products. In Karnataka, forests play animportant role in the socio-economic development of the state. Forests help in maintaining a stable environment conducive to sustained development of agriculture. Forests meet a large share of the energy needs of the population, more so in the rural areas. A significant portion of the fodder needs of the vast cattle population is also met from the forest. Forest products, in addition to contributing to the state's income, also play a very important role in the rural and tribal economy. Many of the forest products, including non-timber forest products (NTFPs), provide sustenance to the rural and tribal people, who collect a large part of their dailynecessities, including food and medicines, from the forests. Most of these products represent a direct subsidy to the rural poor, and constitute an integral element of the factors alleviating their poverty. For landless and marginal farmers living in the vicinity of forests, forest-related activities generate their primary source of income. (**Panchamukhi et.al)**

In Karnataka, collection of non-timber forest produce is being entrusted mainly to Tribal Societies. There are 19 such Tribal Societies in Karnataka. Wherever the societies do not exist the NTFP collection leases are granted through tender-cum-auction sales. Firewood is sold at fixed rates at the depots for domestic consumption. Canes and bamboos are provided by the department on payment basis against the quantity allotted to private artisans (**Govt of Karnataka, 1996**). These officially extracted NTFPs are included in the estimation of the state domestic product. The value of NTFPs collected by the local populationis not included in the estimation of SDP. Failure to take these resources into account means neglecting a considerable source of wealth, at least locally. This also prevents optimal resource allocation.

Forests of Shimoga produce a variety of products such as leaves, fruits and flowers that are used locally or traded. The common minor forest produces are soapnut, tamarind fruits, tanning barks, honeybee wax, seeds, non-edible oil seeds, etc. These products are of great economic value, and are known as Minor Forest Produce (MFP). This also includes different varieties of medicinal plants which are highly valuable. Due to over exploitation and unscientific way of harvesting, some medicinal plants have become extinct. For better regeneration, protection and management of these resources, these products should be harvested in controlled and scientific manner. Figure 7.1 and 7.2 provides the quantity of MFP during 2005-06 to 2010-11.

**Present method of Harvesting**

At present, Minor forest products are sold through tender-cum-auction sale once in two years taking range as a unit. Since there is no proper knowledge available for collection of products, contractors use very crude methods for collection of MFP. This results in large-scale destruction of the resource base. There is no regulation by the Department (KFD) on the intensity of collection of MFP. The payment to the workers is based on quantity of produce collected. So the workers(unskilled, skilled) extract maximum quantity within short time.

The evergreen forests yield timber which was used for electric transmission poles and railway sleepers. The felled areas are being tended for getting the natural regeneration of valuable species. The deciduous forests supply timber, firewood, charcoal, bamboos, matchwood and plywood. Plantations of teak, silver oak (*Gravillearobusta*), matchwood and other valuable species are raised in the clear-felled areas for improving the potential of the forests and for meeting the demand for certain species **(Shimoga Gazeteer, 1975).** Dry deciduous forests are useful for firewood and charcoal. Suitable areas in the district are afforested with eucalyptus and other forest growing species under various plan schemes. Dry scrub Forests are afforested as a measure of soil conservation under relief works such as drought relief, famine relief and rural employment programme. The Mysore forest department had a commitment of supplying 36000 tons of firewood per year to Mysore Iron and Steel, and 50000 tons of air dry bamboo to Mysore Paper mills **(Mysore forest administration report)**. Table 13 provides the timber and major forest produce in Shimoga circle during the last decade.

**Table 13: Timber and Major Forest Produce (Shimoga circle) (KFD Annual report)**

| Year | Rosewood (cum) | Teakwood (cum) | Sawn Timber (cum) | Other kinds of timber (cum) | Nilgiri (cum) | Match wood (cum) | Timber in round poles(cum) | Firewood (cum) | Softwood |
|---|---|---|---|---|---|---|---|---|---|
| 2009-10 | 853.76 | 935.01 | 1239.98 | 2649.43 | 146.18 | | 900.5 | 1267.36 | 0.00 |
| 2008-09 | 227.661 | 240.738 | 3933.47 | 3541.66 | 19.44 | | 8763.66 | 1791.88 | 0.00 |
| 2006-07 | 236.170 | 150.740 | 36.630 | 2805.85 | 383.11 | | 4158.00 | 2529.76 | 0.00 |
| 2005-06 | 146.27 | 84.19 | 28.4 | 1598.6 | 284.32 | | 475.69 | 909.81 | 0.00 |
| 2003-04 | 122.19 | 140.72 | 41.05 | 1119.34 | 12.85 | 0.00 | 320.95 | 1740.42 | 808.00 |
| 2002-03 | 158.949 | 105.770 | 36.355 | 437.522 | 85 | - | 17.633 | 5369.528 | 2238.054 |
| 2001-02 | 337.97 | 157.658 | 53.803 | 1563.45 | 1.958 | - | 78 597 | 13,475.357 | 128.867 |
| 2000-01 | 201.743 | 149.311 | 43.213 | 1263.96 | 584.17 | .830 | 2,925.31 | 11,585.1 | 20.368 |

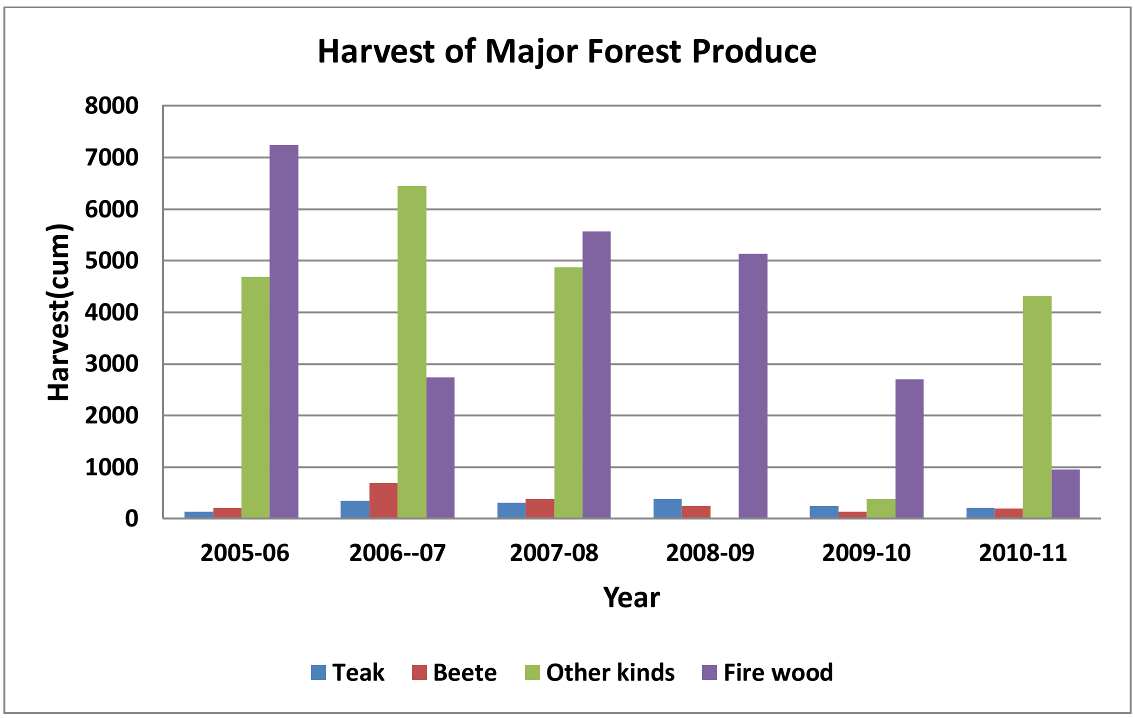



**Figure 5: Major forest produces in Shimoga circle from 2005-2006 to 2011-2011**

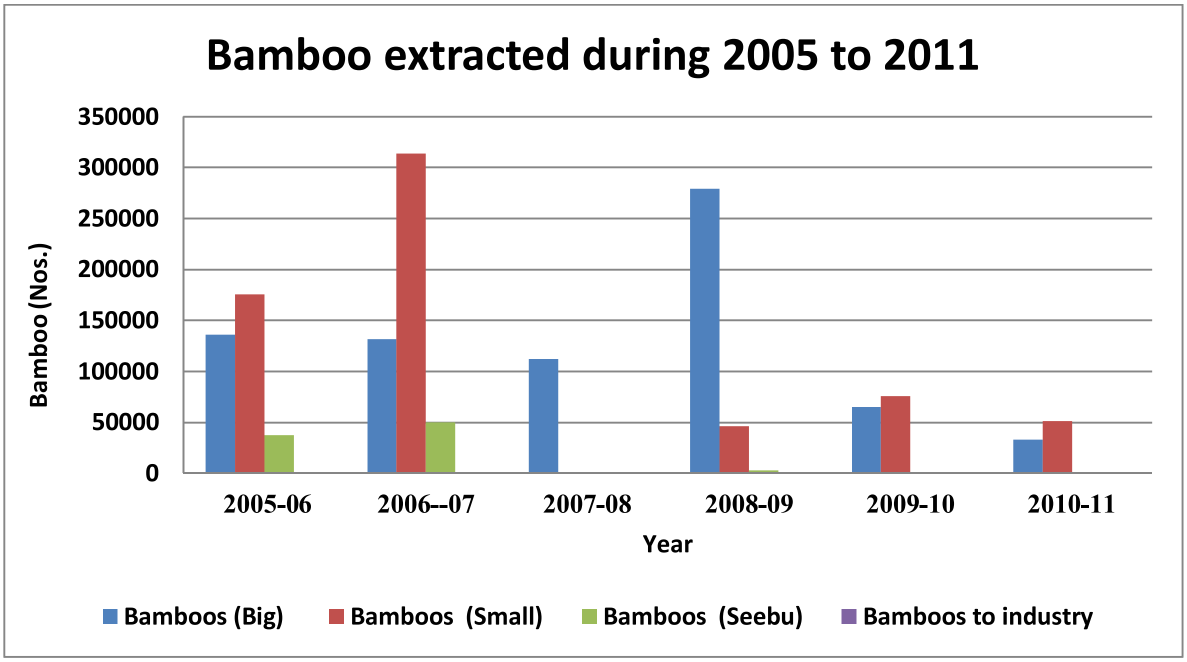



**Figure 6: Bamboo extracted in Shimoga circle during 2005-2006 to 2010-2011**

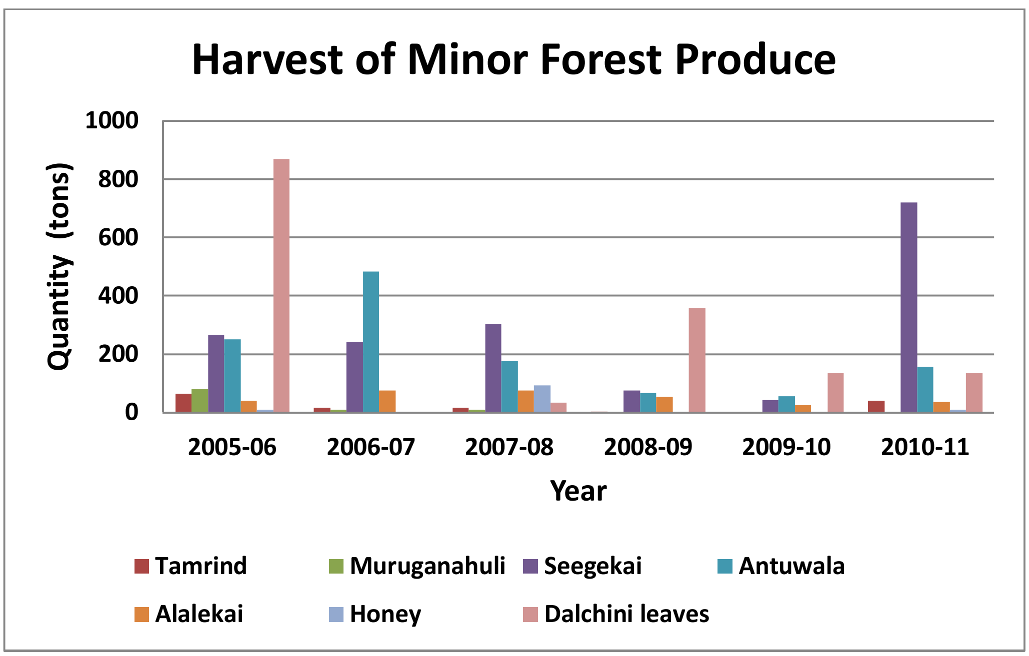



**Figure 7.1: Minor Forest Produce in Shimoga circle during 2005-2006 to 2010-2011**

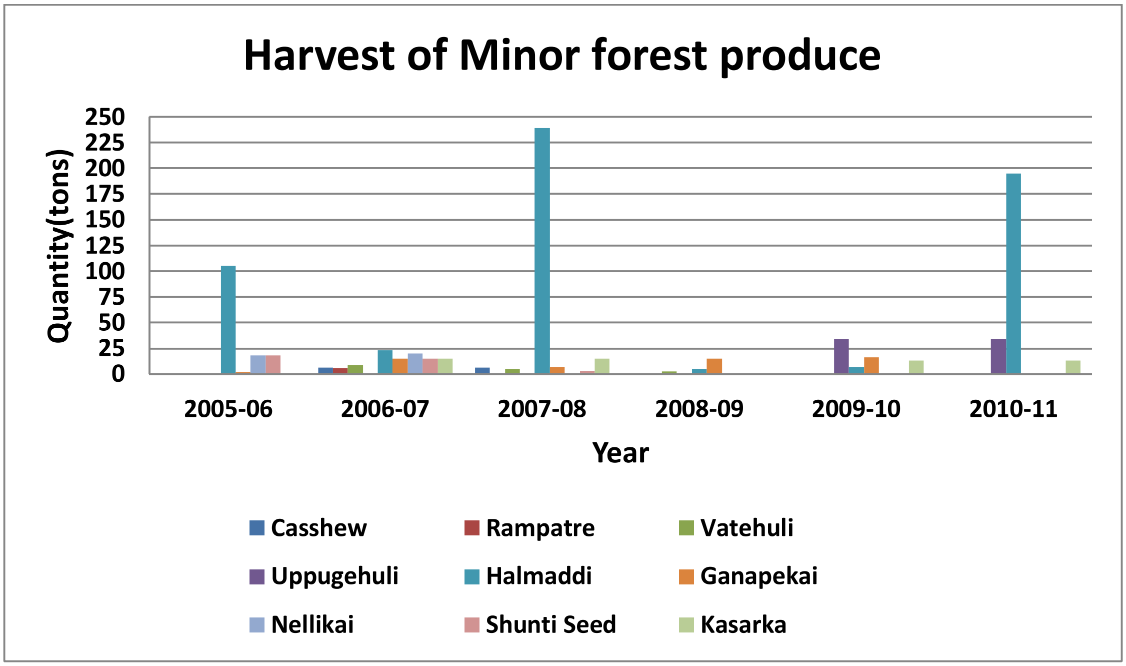



**Figure 7.2: Minor Forest Produces in Shimoga circle during 2005-2006 to 2010-2011**

## 5.2 FOREST ALLOTMENT FOR NON-FORESTRY PURPOSES

### Hydroelectric and irrigation Projects (River valley projects)

There are, 4 irrigation projects (Tunga, Ambligola and Anjanapur and Jampadahalla projects), irrigation and power (Bhadra reservoir) and one power (The Sharavathi Valley Hydroelectric Project) project in the district. The very well wooded area submerged in these development projects are given below:(**Working Plan, 1962**).

| | |
|---|---|
| Sharavathi valley Hydroelectric Project- | 318.57 sq.km |
| Bhadra Reservoir Project- | 112.66 sq.km |
| Tunga Reservoir Project- | 13.31 Sq.km |
| Ambligola Reservoir- | 4.35 Sq.km |
| Jampadahalla Reservoir- | 1.6 Sq.km |

These projects have a serious bearing on the forest percentage, forest management and yields from the forests. Before these river valley projects were taken up, the hill districts of Shimoga had a forest percentage of 23.8 and over 90% constituted dense wood land with growing stock upto 5000 c. ft. and more per acre (360m$^3$/ha) (**Working Plan,1962**).

In addition to the permanent loss of forest land by submersion, the water spread disrupts and destroys land communications to other valuable forests, making them useless pockets. The area submerged under Sharavathi project is largely of the semi evergreen type. The areas submerged under Bhadra, Tunga, Ambligola and Jampadahalla reservoirs include the finest natural teak bearing areas (**Working Plan, 1962**).The big reservoirs bring about changes in the surrounding areas and even in composition of nearly forest, making them moister. Table 14 details the extent of forest area released for non-forestry purposes in Shimoga circle and Table 15 provided the details for the period 2008 to 2011.

**Table14: Forest area released for non forest purposes (since formation of divisions to 2007-08) in Shimoga circle**

| Sl. No. | Circle | Division | Range | Location (Sy. No) | Extent of Area in Ha | G.O.No. & Date | Project / Purposes | Remarks |
|---|---|---|---|---|---|---|---|---|
| **Bhadravathi Division** | | | | | | | | |
| 1 | Shimoga | Bhadravathi | Bhadravathi | Bullapura Sy. No. 55 | 215.220 | No. C1 192 11W 50 Dt. Bangalore | For VISL township | |
| | | | | Anekoppa Sy.No.44 | 147.210 | 25/26-9-1959 &FFD FGL 73, Bangalore | | |
| | | | | Ujjanipura Sy.No.05 | 34.230 | 11/2/1980 | | |
| | | | Tarikere | Kemmana gundi | 80.000 | AHFF 83 FTM 90 dt.23-4-91 | For removal Iron ore. | Land leased period expired ( Area handed over to Bhadra wild life Division) |
| | | | Bhadravathi | Siddarahalli&Chammanahalli | 860.000 | MC 624/30-7-68 | manganese ore. | Proposal rejected in higher authorities |
| | | | Umblebyle | Bilikalbetta | 81.340 | ML 1910/27-9-83 | Granite stone | Not in Operation |
| | | | Channagiri | Bandigudda | 40.120 | ML 1966/28-2-85 | Lime stone | Mining lease renewed by MOEF. |
| | | | Bhadravathi | Antharaganga SF & MF | 47.600 | GO 1850-95-FC dt.15-5-1996 | Agriculture purpose | Prior to 1978 encroachment yet to be released process is going on. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Umble byle | Umblebyle SF &Hunsekatte MF | 11.980 | - | - | - |
| | | | Channa giri | Basapura SF Laxmipur MF, Kaggi MF. | 106.840 | - | - | - |
| | | | Nallur | Bhadrapura SF | 78.690 | - | - | - |
| | | | Lakkav alli | Gurupura, Kundur& Tyagadabagi MF | 17.570 | - | - | - |
| | | | Umble byle | Halalakka valli No 19 | 223.900 | No.8-30-97-FC dt : 1-10-03 | Project Purposes | Hon'ble supreme court central Govt. agrees in Principal for division |
| | | | | Chornadihalli 37,45 | | | | |
| | | | **Total** | | **1944.700** | | | |
| **Shimoga Division** | | | | | | | | |
| | Shimo ga | Shimo ga | Ayanur | Kumsi | 526.100 | Agreement on dated:30-7-69 | Mining | Renewal proposal has been submitted to government. |
| | | | G.T.D. Alkola | Sy.No.1 of SrigandaKavalu | 1.210 | FEE 59 FGK 93 05-07-1994 | Ring Road Project | |
| | | | Shankar Range | Sy. No.1,2 | 22.260 | FEE 89 FGL/94 dt: 13-1-05 | Upper Tunga Project | |
| | | | Manda gadde Range | Sy No. 14,18,40,41, 55 & 56 | 143.230 | | | |
| | | | **Total** | | **692.800** | | | |
| **Sagar Division** | | | | | | | | |
| | | | Nagara KPC | Varahi Project | 2668.000 | - | Project | |
| | | Sagar | | Chakra --,,-- | 1325.000 | - | --,,-- | |
| | | | | Savehaklu --,,-- | 853.000 | - | --,,-- | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | KPTCL | Kararibylu to M.K. Byle road | 600.000 | - | Projected (Road) | |
| | | | KPC | ChannalCutting | 400.000 | | Channal | |
| | | | KPC | Under submerssion | 24460.000 | -- | | |
| | | | Hosanagar | Under submerssion | 7760.000 | | Submerssion | |
| | | | Sagar | Under submerssion | 8840.000 | | Submerssion | |
| | | | KPTCL | Sagar to Sorab 110 K.V. Line | 39.000 | FEE 106 FGL-941 Dtd: 7-11-1995 | Submerssion construction of 110 K.W. line | |
| | | | Shikaripura | Under submerssion | 743.000 | - | Submerssion | |
| | | | Soraba | --Nil-- | --Nil-- | -- | | |
| | | | KPC Kargal | Under submerssion | 51.150 | G.O.No. 53, FGL. 2000 Hydro Electro Project at 6-10-2000 | | |
| | | | | 220 K.V. Line From S.T.R.P.T.O. Talaguppa | 20.600 | | | |
| | | | Shikaripura | Hosur Mines | 17.500 | G.O.No. FEE.78.FFM. 96. Dt 12-11-2001 | | |
| | | | Kargal | Talakalale Sy.No. 118, 151 | 7.100 | FEE-253-FGL/2000/13-5-2002 | Mahatma Gandhi Hydro electric tail race | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Chordi | Konehosu rSy.No. 47 &Gilalgun diSy.No. 4 | 3.200 | FEE-297-FGL/298/ 03/26-3-2003 | Kollibac halluHall a | |
| | | | Anavat ti | Constructi on of first grade collage in Sy. No. 10 of Anavatti | 1.600 | FEE-321-FGL-2000 dated : 19-10-01 | Construct ion of first grade collage | |
| **Total** | | | | | **47789.15** | | | |
| **Wildlife Division Shimoga** | | | | | | | | |
| 1 | Shimo ga | Wildlif e | Sacreb yle | Shettihalli wildlife sanctuary | 49.260 | FEE-89-FGL-1994 dated : 13-01-06 | For Construct ion of Upper Tunga Project | Released on 30-3-06 |
| **S. F. Division Shimoga** | | | | | | | | |
| 1 | Shimo ga | S.F.Dn | | Nil | - | - | | |
| | | | **Circle Total** | | **50426.65** | | | |

**Table 15: Forest area released for non forestry purpose from 2008-2011**

| Division | Area in Hectares | | |
|---|---|---|---|
| | 2008-09 | 2009-10 | 2010-11 |
| **Bhadravathi** | 709.12 | 317.34 | 389.867 |
| **Sagar** | 9.401 | 0 | |
| **Shimoga** | 3351.32 | 3351.32 | 7.374 |
| **Shimoga wildlife** | 0 | 0 | |
| **Total** | **4069.844** | **3668.66** | **397.241** |

### 5.4 PLANTATIONS

Some of the areas of forest divisions are leased out to 1) Mysore Paper Mills (MPM) limited, 2) Karnataka Forest Development Corporation (KFDC) limited and 3) Karnataka Cashew Development Corporation (KCDC). Divisionwise extent of plantations for the period 2005 to 2011 is given in Table 16.

**Table 16: Plantations raised during 2005-2010 in Shimoga circle**

| Division | Plantation extent in hectares | | | | | |
|---|---|---|---|---|---|---|
| | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 |
| Wildlife Division Shimoga. | 0 | 277.5 | 250 | 10 | 0 | 45.00 |
| Bhadravathi | 734.50 | 1018 | 2240 | 2918 | 2375.00 | 2375.00 |
| Social Forestry Shimoga | 359.50 | 241 | 14 | 96.5 | 117.90 | 10.00 |
| Shimoga Division | 1267.50 | 1092 | 1930.87 | 1980.12 | 2699.00 | 2845.00 |
| Sagar Division | 949.00 | 1319.24 | 3080.00 | 2872 | 1825.00 | 1445.00 |
| Circle total | 2576.00 | 3947.740 | 7514.870 | 7876.62 | 7016.9 | 6720 |

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## 6.0 STATUS OF WILDLIFE

Wild fauna diversity is one of the most gracious gifts of nature to the region. Wildlife has been diminishing at an alarming rate during recent years, particularly during the last 20-25 years as a result of deforestation, fragmentation of animal habitats, etc. Wildlife and wildlife habitat play a vital role in the ecological and biological processes that is essential to life itself. The functioning of the biosphere, and hence the maintenance and enhancement of human life, depends on countless inter actions among plants, animals and micro organisms. These ecological processes are essential for agriculture, forestry, fisheries and other endeavours necessary to human life. They also help maintain environmental quality by degrading and otherwise removing some pollutants and by preventing waste accumulation. Some of the biological processes in which wild species play a key role are pollination, germination seed dispersal, soil generation, nutrient cycling, predation, habitat maintenance, waste break down and pest control. Wildlife habitat regardless of whether it is upland or wetland habitat, is significant because of a number of functions it performs to support wildlife. Wildlife needs adequate space and habitat for the basic life requirements **(Sameer Ali et.al 2007)**.

The primary step taken towards conservation and management measures is to preserve a small proportion of forest and declare it as bioreserve, wildlife sanctuary or national park. The criteria followed in this regard, involved prioritising regions based on naturalness, diversity, rarity and or uniqueness, and size. Such planned actions were aimed at preserving and conserving biodiversity and natural resources of a region/nation or at larger scale contributing to global biodiversity. At the same time, it helps in improving local biodiversity and the environment in and around such areas in a natural and protected environment **(Sameer Ali et.al 2007).** The areas having significant conservation value are declared as national parks and wildlife sanctuaries under the Wildlife (Protection) Act, 1972, which was amended in 1991. The Act specifies that, the state governments are empowered to declare any area as a sanctuary or a national park as per the procedures, for the purpose of protecting, propagating or developing wildlife or its environment. The National Parks and Wildlife Sanctuaries have been studied for ecological significance and to implement measures to conserve endemic and endangered species of flora and fauna.

There are two wildlife sanctuaries and one bird sanctuary in Shimoga forest circle.

1) **Shettihalli Wildlife Sanctuary**
2) **Sharavathi Valley Wildlife Sanctuary**
3) **Gudavi Bird Sanctuary**

## 6.1 SHETTIHALLI WILDLIFE SANCTUARY

Shettihalli wildlife Sanctuary with a spatial extent of 395.6 Sq.km is spread over parts of three taluks of Shimoga district: Shimoga, Hosnagara and Thirthahalli taluks (Figure 1). It is situated between 13° 40' to 14° 5' N and 75° 10' to 75° 35' E (**Karnataka forest department, 2006**). The vegetation in the region mainly consists of dry deciduous, moist deciduous and semi evergreen types. This Sanctuary was constituted under the government notification No.Afd.47.F.W.L.74 dt 31st October 1974. After declaration of Shettihalli wildlife Sanctuary, protection and development activities towards better management of wildlife had been initiated by wildlife wing of forest department.

The Karnataka Forest Act, 1963 and Rules 1969 regulate working in the forest areas. The State has 5 National Parks and 22 Wildlife Sanctuaries covering an area of 6576.76 sq. kms, which forms nearly 15.17% of the total forest area as protected area (http://karnatakaforest.gov.in). Wildlife (Protection) Act was enacted during 1972 by Government of India to provide for the protection of wild animals, birds and plants and with a view to ensuring the ecological and environmental security of the country.

North: From Ayanur along the southern portion of Ayanur-Hosnagara road upto Rippenpet running from East to West.

South: From Konandur the boundaries of Riponpet, Hanagere and Thirthahalli range forest area upto Mandagadde running from West to East.

West: From Ripponpet along eastern portion of Ripponpet-Tirthahalli road including Mugudthi state forest upto Konandur which runs north to South.

South-East: From Mandagadde along the western portion of Shimoga running from South to

North-East: Starting from Shimoga, the line runs along the western portion of Bangalore-Honnavar road upto Ayanur (**Karnataka forest Department, 2006**)

Figure 1: Shettihalli wildlife sanctuary, Shimoga

The overall area of the sanctuary is plain to undulating with a few pockets consisting of very steep and undulating terrains and hillocks. These consist of perennial nalas and a number of small streams. The highest peak is Shankaragudda with an altitude of 1031 meters. The Sanctuary receives rainfall from south west monsoon. The intensity of rainfall is more during

June to September with an average rainfall of 2000 mm. The average minimum and maximum temperatures are 12° C and 38º C respectively (**Karnataka forest Department, 2006**).

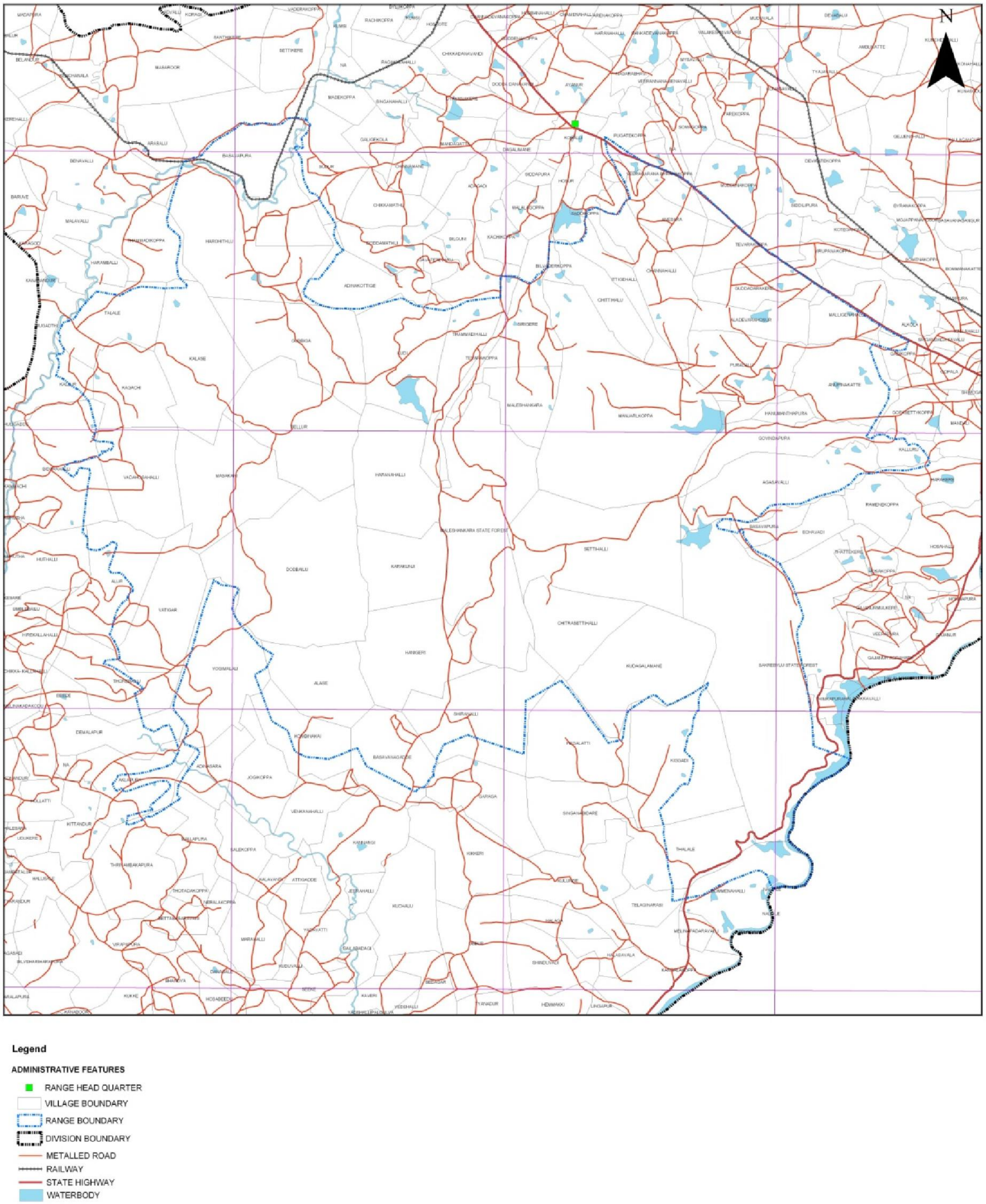


**Figure 1: Shettihalli Wildlife Sanctuary**

**History**

During early 20th century the forest within Sanctuary were under the control of Previously State of Mysore. For better management of forests and wildlife these forests were declared as 'protected forests' during 1905-1920. Table 1 details the spatial extent of forests in Shettihalli Wildlife Sanctuary.

**Table 1: Forests in Shettihalli wildlife sanctuary**

| Name of Forest | Extent (in Ha) |
|---|---|
| Hanagere RF | 6755.0 |
| Kudi RF | 2730.0 |
| Harohitlu RF | 1795.00 |
| Masaruru RF-Block vii 1,2,3,6,7,8,9 | 1060.0 |
| Kumadhwathi RF | 3817.0 |
| Baruve RF- vii 12 to 14 | 807.0 |
| Mugudthi RF | 194.0 |
| Anesara RF | 1819.0 |
| Puradal RF | 2591.0 |
| Shankar RF | 9330.0 |
| Sacrebyle RF | 3886.0 |
| Arakere MF | 368.0 |
| Anupinakatte MF | 497.0 |
| Basavapure MF-XII 1 | 317.0 |
| Bedankalmatti MF-XII 2,3 | 693.0 |
| Keegadi MF-XIII 20 | 144.0 |
| Talale MF-XIV13 | 242.0 |
| Kullunde MF-XIV14 | 204.0 |
| Halasavala MF- XIV10 | 325.0 |
| Kanagalakoppa MF- XIV11 | 150.0 |
| Mandagadde MF-XIV8 | 223.0 |
| Bommenahalli XIV15 | 50.0 |
| Mandagatta MF | 942.0 |
| Kittanduru MF VIII23 | 294.0 |
| Bide MF VIII24 | 209.0 |
| Muniyur MF VIII 25 | 332.0 |
| Anupinakatte Pltn | 87.0 |
| Sacrebyle Pltn | 100.0 |
| **TOTAL** | **39560.00** |

During 1960-1965 Linganamakki reservoir was constructed in Sharavathi river valley, which led to submersion of many villages. The people affected by this Hydro-Electric project were shifted from protected area and allowed to settle in Shettihalli Wildlife Sanctuary. In this way more settlements of rehabilitated village come into existence in the sanctuary leading to encroachments and clearing of forests. The animals found in this sanctuary are Tiger, Panther, Wild elephant, Bison, Sambar, Spotted Deer, Barking deer, Mouse deer, wild pig, Porcupine, Sloth bear, Wild Cats etc. In Shettihalli Wildlife Sanctuary there are both natural forests and artificial plantations. It consists of 11 reserve forests, 14 minor forests and 3 plantation areas (**Karnataka forest Department, 2006**).

**Vegetation:**

**Forest types:**

i). **Southern tropical dry deciduous type:** This type of forests is seen in Puradal, Anesara, Sacrebyle, Shankargudda, Kudi and part of Hanagere state forest. The top canopy consists of *Terminalia tomentosa*, *Terminalia bellerica*, *Tectona grandis*, *Anogeissus latifolia*, *Lagerstroemia lanceolata* etc. The second canopy consists of *Wrightia tinctoria*, *Zizyphus zuzuba*, *Santalum album*, *Emblica officinalis*, *Cassia fistula*, *Shorea talura*, *Randia domatorum* and bambbos etc. The ground floor consists of grassy patches.

ii). **Southern tropical moist deciduous type:** This type of forest is seen on the western side of the sanctuary i.e, part of Hanagere state forest, Kumadwathi state forest, Mugudthi state forest etc. *Bambusa aurundanasea* and *Dendrocalamus strictus* occur throughout the area. *Terminalia tomentosa*, *Tectona grandis*, *Lagerstroemea lanceolata*, *Adina cardifolia*, *Dalbergia latifolia*, *Xylia xylocarpa*, *Grewia tiliafolia* are the other species.

iii). **Semi evergreen type:** This type of forests is seen in parts of Hanagere state forests and Kumadwathi state forests. The important species found are Dipterocarpus, Hopea, Terminalia, Hopea, Xylia, Michelia and Bambusa species.

**Plantations:** The sanctuary has about 6000 Ha of Teak plantations.

**Aquatic habitat:** The Tunga reservoir bordering the sanctuary has a good population of otter, fish, and some crocodiles, water birds like Cormorants and Snake birds visit the river island near Mandagadde.

The **butterfly diversity** investigations in Tiger-Lion safari Thyaverekoppa, revealed the presence of 57 species of butterflies, representing 5 families **Pramod Kumar et.al, 2007**. Papilionidae is represented by 5 genera and 10 species; Lycaenidae by 8 genera each with one species. Nymphalidae by 21 genera with 28 species; Pieridae by 7 genera and 8 species and hesperidae by 3 genera each with one species. The checklist of all species observed is given in **Table 2.**

**Table 2: Butterflies along with their status in the Tiger-Lion safari, Thyavarekoppa**

| Sl.No. | Scientific name | Common name | Status |
|---|---|---|---|
| | Family Papilionidae | | |
| 1 | *Graphium agamemnon* (Linnaeus) | Tailed Jay | C |
| 2 | *Graphium nomius* (Esper) | Spot Swordtail | C |
| 3 | *Graphium sapedon* (Linnaeus) | Common Blue Bottle | R |
| 4 | *Pachlioopta aristolochiae*(Linnaeus) | Common Rose | R |
| 5 | *Pachlioopta hector* (Linnaeus) | Crimson Rose* | VC |
| 6 | *Pachlioopta pandiyana* (Moore) | Malabar Rose* | R |
| 7 | *Papilio demoleus* (Linnaeus) | Lime Butterfly | VC |
| 8 | *Papilio polymnestor* (Cramer) | Blue Mormon** | R |
| 9 | *Papilio polytes* (Linnaeus) | Common Mormon | C |
| 10 | *Troides minos* (Cramer) | Southern Birdwing* | R |
| | Family : Lycaenidae | | |
| 11 | *Alphnaeus vulcanus* (Fabricius) | Common Silverline | R |
| 12 | *Arhopala amantes* (Hewitson) | Large Oak Blue | R |
| 13 | *Castalius rosimon* (Fabricius) | Common Pierrot | VC |
| 14 | *Discolampa ethion* (Westwood) | Banded Blue Pierrot | C |
| 15 | *Jamides bochus* (Stoll) | Dark Cerulean | C |
| 16 | *Lampides boeticus* (Linnaeus) | Pea blue | C |
| 17 | *Talicada nyseus* (Guerin-Meneville) | Red Pierrot | C |
| 18 | *Zizeeria karsandra* (Moore) | Common dark Grass Blue | VC |
| | Family: Nymphalidae | | |
| 19 | *Acraea violae* (Fabricius) | Tawny Coster | VC |
| 20 | *Ariadne merione* (Cramer) | Common Castor | R |
| 21 | *Byblia ilithyia* (Drury) | Jocker | C |
| 22 | *Cupha erymanthis* (Drury) | Rustic | C |
| 23 | *Danaus chrysippus* (Linnaeus) | Plain Tiger | R |
| 24 | *Danaus genutia* (Cramer) | Striped Tiger | C |
| 25 | *Euploea core*(Cramer) | Common Indian Crow | VC |
| 26 | *Hypolomnas bolina* (Linnaeus) | Great Eggfly | R |
| 27 | *Hypolomnas misippus*(Linnaeus) | Danaid eggfly** | C |
| 28 | *Junonia almana* (Linnaeus) | Peacock Pansy | R |
| 29 | *Junonia atlites* (Linnaeus) | Gray Pansy | R |
| 30 | *Junonia hierta* (Fabricius) | Yellow Pansy | C |

| | | | |
|---|---|---|---|
| 31 | *Junonia iphita* (Cramer) | Chocolate Pansy | C |
| 32 | *Junonia lemonias* (Linnaeus) | Lemon Pansy | VC |
| 33 | *Junonia orithya* (Linnaeus) | Blue Pansy | C |
| 34 | *Lethe rohria* (Fabricius) | Common tree brown | R |
| 35 | *Melanitis leda* (Linnaeus) | Common Evening Brown | VC |
| 36 | *Moduza procris* (Cramer) | Commander | R |
| 37 | *Mycalesis patnia* (Moore) | Glade eye Bush brown** | R |
| 38 | *Mycalesis perseus* (Fabricius) | Common Bush brown | C |
| 39 | *Neptis hylas* (Moore) | Common Sailer | VC |
| 40 | *Orsotrioena medus(* Fabricius) | Nigger | C |
| 41 | *Phalanta phalantha* (Drury) | Common Leopard | VC |
| 42 | *Polyura athamas* (Drury) | Common Nawab | R |
| 43 | *Symphaedta nais* (Forster) | Baronet** | VC |
| 44 | *Tanaecial lepidea* (Butler) | Grey Count | R |
| 45 | *Tellewo limniace* (Cramer) | Blue Tiger | VC |
| 46 | *Ypthima baldus* (Fabricius) | Common Four Ring | VC |
| | Family: Pieridae | | |
| 47 | *Anaphaeis aurota* (Fabricius) | Pioneer | VC |
| 48 | *Catopsilia pomona* (Fabricius) | Common Emigrant | C |
| 49 | *Catopsilia pyranthe*(Linnaeus) | Mottled Emigrant | VC |
| 50 | *Colotis danae* (Fabricius) | Crimson Tip | R |
| 51 | *Delias eucharis* (Drury) | Common Jezebel** | R |
| 52 | *Eurema hecabe* (Linnaeus) | Common Grass Yellow | VC |
| 53 | *Hebomoea glaucippe* (Linnaeus) | Great Orange Tip | R |
| 54 | *Valeria valeria* (Joicey & Talbot) | Common Wanderer | C |
| | Family : Hesperiidae | | |
| 55 | *Borbo cinnara* (Wallace) | Rice Swift | C |
| 56 | *Gangara thyrsid* (Fabricius) | Gaint Red Eye | R |
| 57 | *Spialia galba* (Fabricius) | Indian Skipper | R |
| VC - Very Common; C-Common; R- Rare | | | |
| * - Endemic to Western Ghats; ** - Endemic to Peninsular India and Sri Lanka. | | | |

**Animals** (**Karnataka forest Department, 2006):** 22 species of mammals (Table 3), 42 birds (Table 4), 10 reptiles (Table 5), 6 Amphibians (Table 6) and 16 fishes (Table 7) have been reported from the Sanctuary **(Source:** Shimoga wildlife division**).**

- **Prey animals:** Spotted deer, Sambar, Indian Gaur, Indian wild Boar, Indian porcupine, Hare and common langurs.
- **Predators:** Panthers, Tigers, Indian wild dogs, Pythons and King Cobras, Jackals, Hyenas and vultures.
- **Other Animals:** Elephants, Sloth bear, Malbar Squirrel, Monkeys, Tortoise.

**Table 3: Mammals of Shettihalli wildlife Sanctuary**

| Sl. No. | Species name | Common names |
|---|---|---|
| 1 | *Macaca sinica* | The Bonnet monkey |
| 2 | *Pithecus entellus* | Hanuman monkey |
| 3 | *Loris lydekkerianus* | Slender loris |
| 4 | *Felis affinis* | The tiger |
| 5 | *Felis affinis* | The Jungle cat |
| 6 | *Acinonyx venaticus* | The hunting leopard |
| 7 | *Mangos mungo mungo* | Indian mungoose |
| 8 | *Canis indicus* | The Indian Jackal |
| 9 | *Lutra lutra* | The common Otter |
| 10 | *Melurus ursinus* | The sloth bear |
| 11 | *Tragullus meminna* | Mouse deer |
| 12 | *Pteropus giganteus* | The Indian flying fox |
| 13 | *Lyroderma lyra lyra* | Vampire bat |
| 14 | *Petaurista philippensis* | South Indian flying squirrel |
| 15 | *Seiurus malabaricus* | The Malabar Squirrel |
| 16 | *Seirus* | The Bison |
| 17 | *Muntiacus vaginalis* | The barking deeer |
| 18 | *Rosa unicolor* | The sandbur |
| 19 | *Axis* | The spotted deer |
| 20 | *Sues cryostats* | The Indian Wild Boar |
| 21 | *Hystrix leucra* | The Indian Porcupine |
| 22 | *Manis crassicaudata* | The Indian Pangolin |

**Table 4: Birds of Shettihalli Wildlife Sanctuary**

| Sl. No. | Species name | Common Name |
|---|---|---|
| 1 | *Corvus macrorhynchos* | Jungle Crow |
| 2 | *Palaeornis torquatus* | Common Indian parrot |
| 3 | *Neopharon ginginianus* | Vulture |
| 4 | *Haliastur indus* | Brahminy kite |
| 5 | *Crocopus chlorogaster* | Green pigeon |

| | | |
|---|---|---|
| 6 | *Columba intemedia* | Blue rock pigeon |
| 7 | *Pavo cristatus* | Pen fowl |
| 8 | *Gallus sonnerati* | Gray jungle fowl |
| 9 | *Gallooerdix spadicea* | Red Sour Fowl |
| 10 | *Francolinus pondicerians* | Gray patridge |
| 11 | *Sarkidiornis melanotos* | Comb Duck |
| 12 | *Dendrocygna javanica* | The Whistling teal |
| 13 | *Nettium crecea* | Common teal |
| 14 | *Gallus bankiva murgi* | Red jungle fowl |
| 15 | *Dendrocitta rufa* | Tree pie |
| 16 | *Dumetia hyperithra* | The Rufous-Hellied Babbler |
| 17 | *Otocompusa jocose fascucaudata* | Southern Red Whiskered Bul Bul |
| 18 | *Saxicolodes cambaiensis* | India Robin |
| 19 | *Pycnonotus luteolus* | White browed bulbul |
| 20 | *Terpsiphone paradisi* | Paradise flycatcher |
| 21 | *Cyornis tickellioe* | Blue flycatcher |
| 22 | *Tephrodornis pondiceriana* | common woodshrike |
| 23 | *Pericocotus speciosus* | The Scarlet minivet |
| 24 | *Dicururus macrocerus* | The king Crow |
| 25 | *Dissemurus sctorius* | The Rocket tailed drongo |
| 26 | *Orthotomus sctoricus* | The Tailor Bird |
| 27 | *Acredotheres trestis* | The Common myna |
| 28 | *Gymnoris xanthocolis* | Yellow throated Sparrow |
| 29 | *Hirindo rustica* | The Common Sallow |
| 30 | *Hirundo filifera* | Wire tailed Swallow |
| 31 | *Dicoem erythrorthyncum* | Tikells Flower peacker |
| 32 | *Leopicus blanfordil* | Yellow frinted pied wood pecker |
| 33 | *Centropus parroti* | Southern crow pheasant |
| 34 | *Alcedo benghalensis* | Common king fisher |
| 35 | *Sarcogyps calvus* | Black Vulture |
| 36 | *Astur dussumier* | The Indian shikhara |
| 37 | *Oenopopelia transquebarica* | The red turtle dove |
| 38 | *Amauromis phoenicurus* | The white breasted water hen |
| 39 | *Bulbulcus coromandus* | Cattle egret |
| 40 | *Nettion crecca* | The common teal |
| 41 | *Demdrocygna javanica* | common whistling teal |
| 42 | *Niroca rufa* | The white Bye |

**Table 5: Reptiles found in Shettihalli Wildlife Sanctuary**

| Sl. No. | Species name | Common Name |
|---|---|---|
| 1 | *Crocodilus palustris* | The Mugger |
| 2 | *Testudo elegans* | The land Tortoise |
| 3 | *Gonotodes mysorenisi* | The Monitor lizard |
| 4 | *Calotes versicolor* | |
| 5 | *Chameleon calcaratus* | Chameleon |
| 6 | *Python molures* | Python |
| 7 | *Tropidinotus stolatus* | Common Green Snake |
| 8 | *Bugarus coeruleus* | Krait |
| 9 | *Naja tripudians* | Cobra |
| 10 | *Vipera resselli* | Viper King cobra |

**Table 6: Amphibians of Shettihalli Wildlife Sanctuary**

| Sl. No. | Species name | Common Name |
|---|---|---|
| 1 | *Rana hexadactyla* | Green tank frog |
| 2 | *Rana tigrina* | Bull frog |
| 3 | *Rana cyanophlyctis* | Skipper frog |
| 4 | *Rana malabarica* | The Tree frog |
| 5 | *Rhacophorus pleuroxtictus* | Tree frog |
| 6 | *Rana verrucosa kalloula* | The Plantain frog |

**Table 7: Fishes of Shettihalli Wildlife SanctuarySanctuary**

| Sl. No. | Species name | Common Name |
|---|---|---|
| 1 | *Clarias batrachus* | The Black cat fish |
| 2 | *Saccobranchus fossillis* | Scorpin fish |
| 3 | *Wallago attu* | |
| 4 | *Callichrous bimaculatus* | Butter fish |
| 5 | *Pseudotropius atheronoides* | Lady fish |
| 6 | *Macrones vittatus* | Pidler |
| 7 | *Macrenes ao* | |
| 8 | *Macrenes kelitius* | |
| 9 | *Barbus tor* | |
| 10 | *Barbus neilli* | |
| 11 | *Berbus sarana* | |
| 12 | *Labeo kontius* | |
| 13 | *Labeo boga* | |
| 14 | *Mastocembalus armatus* | |
| 15 | *Ophioce halus puntatus* | |
| 16 | *Oleucopunctatus gachua* | |

**Social Aspects:** The sanctuary has 32 enclosures and 70 villages inside the sanctuary. The size of the revenue enclosure varies from few house hold to a maximum of 110 household.95% of the people are dependent on agriculture. There are about 383 families and 616.18 Ha of encroachment before 1978 and 1292 families and 989.43 Ha after 1978 within the sanctuary, totally occupying 1605.61 Ha of the forest. (**Karnataka forest Department, 2006**).

**Encroachment:** There are about 383 families and 616.18 Ha of encroachment before 1978 and 1992. 989.46 Ha after 1978 within the sanctuary who occupied 1605.61 Ha. **(Karnataka forest Department, 2006**)

**Park Zonations:** The Sanctuary is classified into zones as per the norms, for better management of the sanctuary. The details of Zonations are as follows:

- **Core Zone:** This Zone comprises part of Hanagere state forest and part of Shankar state forest, excluding the enclosures. The area of core zone is 100.60 Sq.Km.
- **Buffer Zone:** This Zone includes Purdal state forest, part of Anesara and Shankar state forest, entire Sacrebyle, Kudi and Kumadwathi state forests, Harohithlu, Masarur, Baruve, Mugudthi state forests. Excluding enclosure the total area of buffer zone is 237.4 Sq.Km.
- **Tourism Zone:** It includes parts of Shankar, Kudi, Sacrebyle and Kumdwathi state forests. Tourism zone also includes Lion safari at Thyavarekoppa, Elephant camp at Sacrebyle and Bird Sanctuary at Mandagadde. The total area is 57.60 Sq.Kms.

**Tourism:** The following are the existing tourism facilities:

i. Tiger and Lion safari, Thyavarekoppa: Tiger and lion Safari was established in the year 1988 at Thyavarekoppa. A safari park is a place of education, enterainment and enlightment and a breeding place of endangered species. The total extent of safari is 195.0 hectares.

ii. Sacrebyle elephant camp: It is situated on Shimoga-Mangalore highway and it is 14 Kms from Shimoga city. There are 19 elephants and 2 calves at present.

iii. Mandagadde Bird Sanctuary: It is about 30 Kms from Shimoga on the left side of Shimoga-Tirthahalli main road.This is an island in Thunga River and 1.14 Acre in extent. This ia a place for the migratory birds which come for breeding and feeding.

## 6.3 SHARAVATHI VALLEY WILDLIFE SANCTUARY

Geographically Sharavathi Valley Wildlife Sanctuary located between 13° 54' to 14° 12' North and 74° 38' to 75° 00' East in central Western Ghats region of Karnataka state (Figure 2). Sharavathi Valley Wildlife Sanctuary was notified vide Government order No. AFD70/FWL71/ Dated 20.04.1972 and has an area of 431.23 Sq. Kms. with a final notification No. AFD/12/FWL/74 Dated 27.06.1974. It is spread over in the Sharavathi River Valley of Sagar Taluk in Shimoga District**.** The area of the Sanctuary is 431.23 Sq. Kms out of which an area of 123.63 Sq. Kms is under the water spread of Sharavathi Reservoir. The Sanctuary lies in the Western Ghats, mainly covered with evergreen and semi-evergreen forests in the valleys and grassy patches on hill tops, and are immensely rich in flora and fauna both in variety and diversity. The boundaries of the sanctuary are as follows: Jog S.F., Thalakalale Reservoir and Karagal S.F. form the northern boundary of the Sanctuary. Eastern boundary of Sharavathi Reservoir forms the Eastern boundary of the Sanctuary. The southern part consists of Mukambika Wildlife Sanctuary and North Canara District boundary. Common boundary of Shimoga and North Canara district forms Western boundary of the Sanctuary. The area is highly undulating with altitudinal range of 94 mts. MSL at Nagavalli to 1102 mts. MSL at Edigudda and consists of valleys and hillocks. The area is marked by perennial nalas and a large number of small streams. The forests are rich with evergreen and semi evergreen species and dense undergrowth.The climate is of monsoon type. The intensity of rain fall is more during June to September by the regular south west monsoon. The break of the monsoon is attended by high velocity wind. The temperature varies from 11° C to 38° C depending upon the factor of elevation. The rainfall, particularly during monsoon, is very heavy. The sanctuary is exposed to torrential showers during April, May and October with heavy showers in June, July and August. The erosive action of the torrential rain can be noticed in open areas. In areas devoid of vegetation cover the, top soil gets washed out with water resulting in unproductive, barren lateritic surfaces. The average rainfall of the area is 4500 mm.

**Brief history**

This sanctuary area previously came under the control of the princely State of Mysore. The Mysore Kingdom had shown keen interest towards the protection of forests, and for better management of forests and wild-life, all the forest areas had been declared as State Forests during 1905-1940. Since then, these forests have been managed in a systematic way for fulfilling the needs of people. During 1964-65, Linganamakki dam was constructed across the Sharavathi River which led to submersion of many villages and forest areas. The people affected by this hydro-electric project were shifted from the project area and allowed to settle in various other places. After the submersion of forest area many big and small Islands has created. The study of these Islands shows good vegetation due to least biotic pressure and inaccessible. There are 31 Islands found in the sanctuary **(Karnataka forest Department, 2006**).

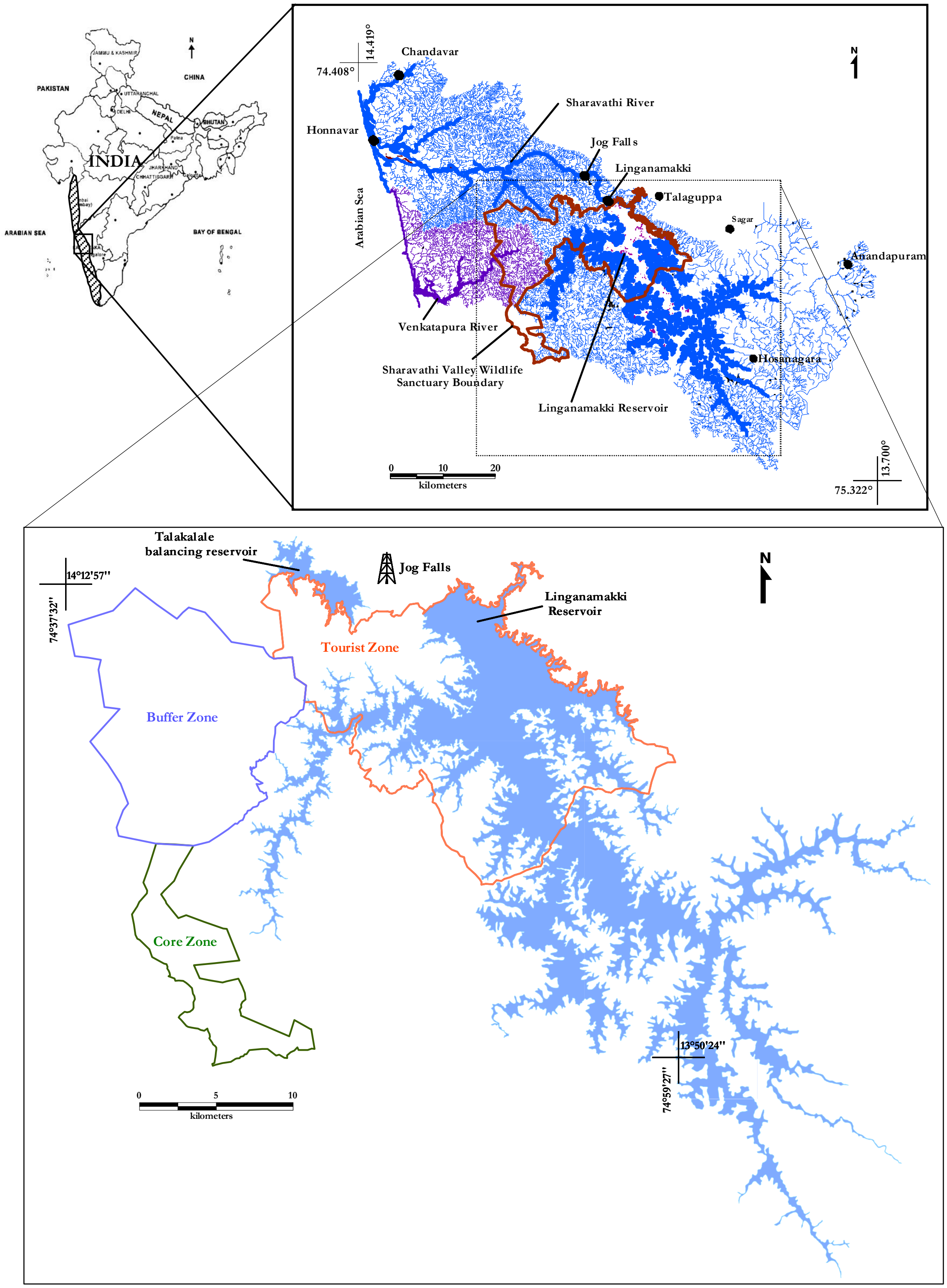


Figure 2.1: Sharavathi Valley Wildlife Sanctuary

After the enactment of the Wildlife (protection) Act, 1972 and Forest Conservation Act, 1980, more emphasis has been given for protection of wildlife and in creating awareness among the people about the need to conserve wildlife. Then onwards the protection and development activities towards the better management of wildlife in the sanctuary were commenced and continued by the wildlife wing of the Forest Department. With the handing over of the sanctuary areas to the wildlife wing by the territorial wing, these activities have been further intensified in a systematic way. The wildlife division has been functioning independently since 01.08.1993 after taking over of 6 State Forests, submersion area and islands, from Sagar Territorial Division. Details of State Forests and other areas coming under Sharavathi Valley Wildlife Sanctuary are given in Table 81.

**Table 8.1: Details of forests in Sharavathi valley wildlife sanctuary**

| Sl. No. | Name of the forest | Legal status | Block No. | Compartment No. | Area in Ha. |
|---|---|---|---|---|---|
| 1 | Govardhanagiri | SF | XX | 1–34 (34) | 13473.68 |
| 2 | Karini | SF | XXI | 1-17 (17) | 5102.53 |
| 3 | Muppane Bl. A | SF | XIX | 4,5,6,7 (4) | 961.77 |
| 4 | Muppane Bl. B | SF | XIX | 8,9,10,11 (4) | 629.16 |
| 5 | Channagonda (part) | SF | XIX | 13 (part) | 701.05 |
| 6 | Attigodu | SF | XIX | 1,2,3 (3) | 763.70 |
| 7 | Submerged area | | | | 12363.00 |
| 8 | Islands | | | | 507.00 |
| 9 | Others | | | | 8621.11 |
| | **TOTAL** | | | | **43123.00** |

Land-use analysis was done using maximum likelihood classifier and percentage compositions of various categories of land-use are listed in Table 8.2; the same is depicted in Figure 2.2. The forest cover in the sanctuary is about 49.5% and 17.6% is water body at full level of the reservoir.

**Table 8.2:** Land-use analysis (%area) in SVWS.

| **Classification** | **Area (%)** |
|---|---|
| Built-up | 8.62 |
| Evergreen to semi-evergreen | 35.63 |
| Moist-deciduous | 13.84 |
| Plantation (*Areca/Acacia/Casuarina*) | 15.27 |
| Water body | 17.64 |
| Agriculture | 2.66 |
| Open land | 6.35 |

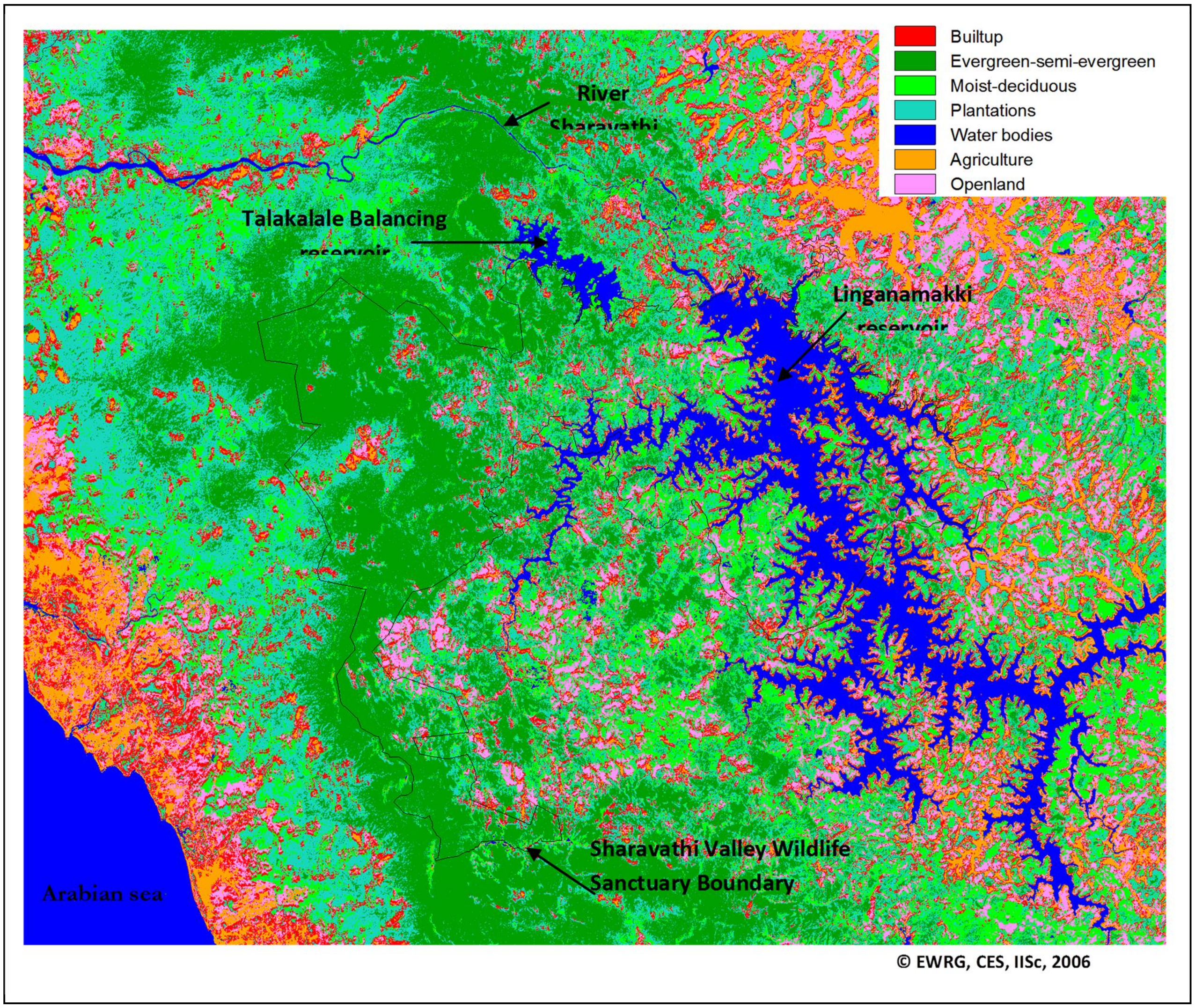


**Figure 2.2:** Land-use in Sharavathi Valley Wildlife Sanctuary.

Vegetation types inside the sanctuary area including islands (in the reservoir) vary from grassland to evergreen forest. The vegetation type in the core zone and buffer zone varies from moist-deciduous to evergreen forest. But in few places, grasslands, especially on hill tops, are interspersed with evergreen forests. Scrub jungles to semi-evergreen forests are more prevalent in the tourist zone of the sanctuary. The species richness suggests that semi-evergreen forests have more species due to the combined presence of both evergreen and deciduous species. The evergreen forest in the sanctuary area is more fragmented and disturbed and this is clearly depicted in the Shannon's diversity index. The percentage evergreenness and endemic plants are more in the evergreen forest area.

The sanctuary has a variety of habitats that support rich flora of herbs, shrubs and climbers of which about 215 species have been recorded. Evergreen to semi-evergreen forests and grasslands of the Western Ghats have the largest congregations of endemic herbs. Some of the herbs are exclusive to specialised habitats like tree trunks and wet rocks. The increasing human impact and openings in forest canopy as well as over grazing are posing threats to many of these rare plants.

Evergreen to semi-evergreen forests are the major source of perennial waters. On the other hand in the deciduous tract, the streams mostly dry up in the summer months. Therefore conservation of evergreen forests and restoration of such forests are of paramount importance. Bulk of the water flow into reservoir comes from natural forests. Unfortunately, in some parts of the sanctuary area, monoculture plantations have been raised causing the drying up of streams and impoverishment of the ecosystems as a whole. Since the plantations do not yield any fodder or NTFP, the rural population is put to great hardship. Therefore such land-uses are not desirable in the sanctuary area. The numerous streams and the banks of Sharavathi and Venkatapura rivers and their tributaries in the evergreen to semi-evergreen forest belt are lined with characteristic riparian vegetation of which the notable tree species are *Calophyllum apetalum, Elaeocarpus tuberculatus, Mastixia arborea, Hydnocarpus laurifolia, Madhuca neriifolia,* etc. Towards the drier forests, water bodies are lined with tree species such as *Pongamia pinnata*, *Madhuca neriifolia, Hopea wightiana, Bambusa* sp., etc. The riparian vegetation plays a crucial role in protecting the water bodies from siltation, creating shade conditions to maintain appropriate temperature regime for sustaining populations of endemic fishes, amphibians, phytoplankton, zooplankton and aquatic insects. Of late there has been numerous instances of misuse of the banks of streams and rivers in the catchment area causing severe upsets in the characteristic biota associated with them. Stream waters are often diverted to newly created horticultural farms, thereby, affecting the water flow into the reservoir. During field observations, it was noticed that the endemic vegetation patches were associated with perennial streams. The estimated basal area per hectare is highest for evergreen forests and is decreasing from semi-evergreen to scrub. But higher Shannon diversity for semi-evergreen compared to evergreen, may be due to disturbances and canopy openings, which pave way for the addition of some pioneers and other secondary species. Plant species of the sanctuary are listed in Table 8.3 and the percentage evergreens and percentage endemics range from evergreen towards moist deciduous (Table 8.4).

**Table 8.3: Plant species in SVWS**

| Species name | Family | Habit | Distribution |
|---|---|---|---|
| ***Abrus pulchellus*** | Faboideae | Climber | Oriental and Paleotropic |
| *Abutilon persicum* | Malvaceae | Shrub | Oriental-Indomalaysia |
| *Acanthospermum hispidum* | Asteraceae | Herb | Neotropic |
| *Achyranthus aspera* | Amaranthaceae | Herb | Pantropical |
| *Acronychia pedunculata* | Rutaceae | Tree | Oriental-Indomalaysia |
| *Actinodaphne hookeri* | Lauraceae | Tree | Oriental-W. Ghats |

| | | | |
|---|---|---|---|
| *Adhatoda zeylanica* | Acanthaceae | Shrub | Oriental-Indomalaysia |
| *Aeginetia indica* | Orobanchaceae | Herb | Indomalaysia to Japan |
| *Aerides maculosum* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Aeschynomene aspera* | Faboideae | Herb | Paleotropics |
| *Aganosma cymosa* | Apocynaceae | Climber | Oriental-India, Sri Lanka |
| *Aglaia anamallayana* | Meliaceae | Tree | Oriental-W. Ghats |
| *Aglaia roxburghiana* | Meliaceae | Tree | Oriental-Indomalaysia |
| *Aglaia* sp (bark not red) | Meliaceae | Tree | |
| *Aglaia* sp (red bark big leaf) | Meliaceae | Tree | |
| *Alangium salvifolium* | Alangiaceae | Straggler | Oriental-W. Ghats |
| *Allophylus cobbe* | Sapindaceae | Shrub | Oriental-S. India, Sri Lanka, |
| *Alpinia malaccansis* | Zingiberaceae | Herb | Oriental-Indomalaysia |
| *Alseodaphne semicarpifolia* | Lauraceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Alstonia scholaris* | Apocynaceae | Tree | Oriental to Australian |
| *Alysicarpus bupleurifolius* | Faboideae | Herb | Indomalaysia, China |
| *Ammannia baccifera* | Lythraceae | Herb | Paleotropics |
| *Amoora polystachia* | Meliaceae | Tree | Oriental-India, Sumatra |
| *Amorphophallus bulbifer* | Araceae | Herb | India, Burma |
| *Anamirta cocculus* | Menispermaceae | Climber | Oriental-Indomalaysia |
| *Ancistrocladus heyneanus* | Ancistrocladaceae | Climber | Oriental-W. Ghats |
| *Andrographis ovata* | Acanthaceae | Herb | |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Angelonia biflora* | Scrophulariaceae | Herb | S America |
| *Anisomeles indica* | Lamiaceae | Undershrub | Indomalaysia, China |
| *Annonaceae member* | Annonaceae | Climber | |
| *Antidesma menasu* | Euphorbiaceae | Tree | Oriental-W. Ghats |
| *Apama siliquosa* | Aristolochiaceae | Shrub | Oriental-W. Ghats, Sri Lanka |
| *Aphyllorchis montana* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Ardisia solanacea* | Myrsinaceae | Shrub | Oriental-Peninsular India |
| *Arenga wightii* | Arecaceae | Palm | Oriental-W. Ghats |
| *Argostemma courtallense* | Rubiaceae | Herb | Oriental-W. Ghats |
| *Argostemma verticillatum* | Rubiaceae | Herb | Oriental-India |
| *Arisaema tortuosum* | Araceae | Herb | Oriental- Himalayas, W.Ghats |
| *Aristolochia indica* | Aristolochiaceae | Climber | Oriental-India, Sri Lanka |
| *Artabotrys zeylanicus* | Annonaceae | Sca.shrub | Oriental-W. Ghats, Sri Lanka |
| *Artocarpus gomezianus* | Moraceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Artocarpus heterophyllus* | Moraceae | Tree | Oriental-W. Ghats |
| *Artocarpus hirsutus* | Moraceae | Tree | Oriental-W. Ghats |
| *Asclepiadaceae* member_1 | Asclepiadaceae | Climber | |
| *Asclepias curassavica* | Asclepiadaceae | Herb | Neotropic |
| *Asparagus racemosus* | Liliaceae | Climber | Palaeotropics |
| *Asystasia crispata* | Acanthaceae | Herb | |

| | | | |
|---|---|---|---|
| *Atalantia wightii* | Rutaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Bacopa monnieri* | Scrophulariaceae | Herb | Tropics |
| *Bambusa arundinaceae* | Poaceae | Reed | Oriental-Throughout India |
| *Bauhinia racemosa* | Faboideae | Tree | Oriental-Indomalaysia, China |
| *Begonia integrifolia* | Begoniaceae | Herb | Oriental-W. Ghats |
| *Begonia malabarica* | Begoniaceae | Herb | Oriental-W. Ghats |
| *Beilschmiedia fagifolia* | Lauraceae | Tree | Oriental-W. Ghats |
| *Bhidea burnsiana* | Poaceae | Herb | Oriental-Peninsular India |
| *Bidens biternata* | Asteraceae | Herb | Asiatic |
| *Biophytum sensitivum* | Oxalidaceae | Herb | Western peninsular India, Sri Lanka |
| *Bischofia javanica* | Euphorbiaceae | Tree | Oriental-Indomalaysia |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Blachia denudata* | Euphorbiaceae | Shrub | Oriental-W. Ghats |
| *Blepharis asperrima* | Acanthaceae | Herb | Western India |
| *Boehmeria glomerulifera* | Urticaceae | Climber | Oriental-Indomalaysia |
| *Boehmeria platyphylla* | Urticaceae | Herb | South west India, Sri Lanka |
| *Boesenbergia pulcherrima* | Zingiberaceae | Herb | Oriental-W. Ghats |
| *Bombax ceiba* | Bombacaceae | Tree | Oriental-Indomalaysia |
| *Breynia retusa* | Euphorbiaceae | Shrub | Oriental-India, Sri Lanka |
| *Bridelia scandens* | Euphorbiaceae | Shrub | Oriental-W. Ghats |
| *Buchanania lanzan* | Anacardiaceae | Tree | Oriental-India, Myanmar |
| *Burmannia coelestis* | Burmanniaceae | Herb | Oriental-Indomalaysia |
| *Butea monosperma* | Faboideae | Tree | Indomalaya |
| *Calamus* sp. | Arecaceae | Climber | Oriental-W. Ghats |
| *Calicopteris floribunda* | Combretaceae | Climber | Oriental-Indomalaysia |
| *Callicarpa tomentosa* | Verbenaceae | Tree | Oriental-South India |
| *Calophyllum apetalum* | Clusiaceae | Tree | Oriental-W. Ghats |
| *Calophyllum tomentosum* | Clusiaceae | Tree | Oriental, Paleoarctic |
| *Calotropis gigantea* | Asclepiadaceae | Climber | Tropical Asia |
| *Calycopteris floribunda* | Combretaceae | Straggler | Oriental-Indomalaysia |
| *Canarium strictum* | Burseraceae | Tree | Oriental-W. Ghats |
| *Canscora decurrens* | Gentianaceae | Herb | Oriental-W. Ghats |
| *Canscora decussata* | Gentianaceae | Herb | Tropical Africa, Madagascar, India |
| *Canscora perfoliata* | Gentianaceae | Herb | Oriental-W. Ghats |
| *Canthium dicoccum* | Rubiaceae | Tree | South India, Myamnar |
| *Canthium parviflorum* | Rubiaceae | Shrub | Oriental-W. Ghats |
| *Capparis rheedei* | Capparaceae | Sca.shrub | Oriental-W. Ghats |
| *Carallia brachiata* | Rhizophoraceae | Tree | Oriental to Australian |
| *Careya arborea* | Lecythidaceae | Tree | Oriental-Himalayas to Sri Lanka |
| *Carissa inermis* | Apocynaceae | Sca.shrub | Oriental-Peninsular India |
| *Caryota urens* | Arecaceae | Tree | Oriental-W. Ghats |
| *Casearia* Sp. | Flacourtiaceae | Tree | |

| | | | |
|---|---|---|---|
| *Caseria rubescens* | Flacourtiaceae | Tree | Oriental-W. Ghats |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Cassia fistula* | Faboideae | Tree | Oriental-China, Indomalaysia |
| *Cassia mimosoides* | Faboideae | Herb | Tropics |
| *Cassia tora* | Faboideae | Herb | Tropics |
| *Cassine glauca* | Celastraceae | Tree | Oriental-Indomalaysia |
| *Cayratia trifolia* | Vitaceae | Climber | India, Ceylon, Malacca |
| *Celosia argentea* | Amaranthaceae | Herb | Tropics |
| *Celtis cinnamomea* | Ulmaceae | Tree | Oriental-Indomalaysia |
| *Centella asiatica* | Apiaceae | Herb | Tropics |
| *Centranthera indica* | Scrophulariaceae | Herb | Oriental-Indomalaysia |
| *Cestrum nocturnum* | Solanaceae | Sca.shrub | West Indies |
| *Chasalia ophioxyloides* | Rubiaceae | Shrub | South India, Sri Lanka |
| *Chlorophytum orchidastrum* | Liliaceae | Herb | India, Tropical Africa |
| *Chrysophyllum roxburghii* | Sapotaceae | Tree | Oriental-Indomalaysia |
| *Cinnamomum macrocarpum* | Lauraceae | Tree | Oriental-W. Ghats |
| *Cinnamomum zeylanicum* | Lauraceae | Tree | Oriental-Indomalaysia |
| *Cissus discolor* | Vitaceae | Climber | Oriental-Indomalaysia |
| *Cissus repens* | Vitaceae | Climber | Indomalaysia, Nepal to Taiwan, Java |
| *Cleidion javanicum* | Euphorbiaceae | Tree | Oriental-Indomalaysia |
| *Cleisostoma tenuifolium* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Clerodendrum paniculatum* | Verbenaceae | Shrub | Oriental-Indomalaysia |
| *Clerodendrum serratum* | Verbenaceae | Shrub | Oriental-India, Sri Lanka |
| *Clerodendrum viscosum* | Verbenaceae | Shrub | Oriental-Indomalaysia |
| *Coldenia procumbens* | Boraginaceae | Herb | Pantropical |
| *Combretum latifolium* | Combretaceae | Climber | Oriental-Indomalaysia |
| *Commelina benghalensis* | Commelinaceae | Herb | Paleotropics |
| *Connarus wightii* | Connaraceae | Sca.shrub | Oriental-W. Ghats |
| *Corchorus trilocularis* | Tiliaceae | Herb | Oriental-Tropical India |
| *Costos speciosus* | Costaceae | Herb | Oriental-Indomalaysia |
| *Cottonia peduncularis* | Orchidaceae | Herb | Oriental-W. Ghats, Sri Lanka |
| *Crotolaria filipes* | Faboideae | Herb | Oriental-W. Ghats |
| *Crotolaria pallida* | Faboideae | Shrub | Oriental,Paleotropic, Neotropic |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Crotolaria retusa* | Faboideae | Shrub | Oriental,Paleotropic, Neotropic |
| *Crotolaria verrucosa* | Faboideae | Herb | Oriental,Paleotropic, Neotropic |
| *Croton gibsonianus* | Euphorbiaceae | Shrub | Oriental-W. Ghats |
| *Curculigo orchioides* | Liliaceae | Herb | India, Java |
| *Curcuma neilgherrensis* | Zingiberaceae | Herb | Oriental-W. Ghats |
| *Cyathocline purpurea* | Asteraceae | Herb | Oreintal-India, Myamnar |
| *Cyathula prostrata* | Amaranthaceae | Herb | Paleotropics |
| *Cyclea peltata* | Menispermaceae | Climber | Oriental-W. Ghats |

| | | | |
|---|---|---|---|
| *Cymbidium aloifolium* | Orchidaceae | Herb | Oriental-Indomalaysia, Indochina |
| *Cynoglossum zeylanicum* | Boraginaceae | Herb | Oriental-South India, Sri Lanka |
| *Cyrtococcum oxyphyllum* | Poaceae | Herb | Oriental-Indomalaysia |
| *Dalbergia* Sp. | Faboideae | Climber | |
| *Dalbergia sympathetica* | Faboideae | Climber | Oriental-W. Ghats |
| *Dendrobium macrostachyum* | Orchidaceae | Herb | Oriental-India, Sri Lanka |
| *Dendrobium nanum* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Dendrobium ovatum* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Derris canarensis* | Faboideae | Climber | Oriental-W. Ghats |
| *Desmodium laxiflorum* | Faboideae | Shrub | Oriental-Indomalaysia |
| *Desmodium triflorum* | Faboideae | Herb | Tropics |
| *Desmodium triquetrum* | Faboideae | Shrub | Indomalaysia, China |
| *Desmos lawii* | Annonaceae | Straggler | Indomalaysia, China |
| *Dichapetalum gelonioides* | Dichapetalaceae | Shrub | Oriental-W. Ghats |
| *Dictyospermum ovalifolium* | Commelinaceae | Herb | Oriental-W. Ghats |
| *Dillenia pentagyana* | Dilleniaceae | Tree | Oriental- China to Indomalaysia |
| *Dimocarpus longan* | Sapindaceae | Tree | Oriental-Tropics |
| *Dimorphocalyx beddomei* | Euphorbiaceae | Tree | Oriental-W. Ghats |
| *Dioscorea bulbifera* | Dioscoreaceae | Climber | Oriental-India, Sri Lanka |
| *Dioscorea oppositifolia* | Dioscoreaceae | Climber | Oriental-India, Sri Lanka |
| *Diospyros assimilis* | Ebenaceae | Tree | Oriental-W. Ghats |
| *Diospyros buxifolia* | Ebenaceae | Tree | Oriental-Indomalaysia |
| *Diospyros candolleana* | Ebenaceae | Tree | Oriental-W. Ghats |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Diospyros crumenata* | Ebenaceae | Tree | Oriental-Western Karnataka, Sri Lanka |
| *Diospyros melanoxylon* | Ebenaceae | Tree | Oriental-Peninsular India, |
| *Diospyros montana* | Ebenaceae | Tree | Oriental to Tropical Australia |
| *Diospyros nigrescens* | Ebenaceae | Tree | Oriental-W. Ghats |
| *Diospyros pruriens* | Ebenaceae | Tree | Oriental-W. Ghats |
| *Diospyros* Sp. | Ebenaceae | Tree | |
| *Dipterocarpus indicus* | Dipterocarpaceae | Tree | Oriental-W. Ghats |
| *Dopatrium junceum* | Scrophulariaceae | Herb | Oriental-Indomalaysia |
| *Dracaena terniflora* | Agavaceae | Herb | Oriental-India, S.E. Asia |
| *Drosera burmanii* | Droseraceae | Herb | West Africa to North east Africa |
| *Drosera indica* | Droseraceae | Herb | Tropical Africa to Australia |
| *Duranta repens* | Verbenaceae | Shrub | South America |
| *Dysoxylum glandulosum* | Meliaceae | Tree | Oriental-W. Ghats |
| *Ecbolium ligustrinum* | Acanthaceae | Shrub | Oriental-India, Sri Lanka |
| *Eclipta alba* | Asteraceae | Herb | Pantropical |
| *Elaeagnus conferta* | Elaeagnaceae | Tree | Oriental-Indomalaysia |
| *Elaeocarpus serratus* | Elaeocarpaceae | Tree | Oriental-India |
| *Elaeocarpus tuberculatus* | Elaeocarpaceae | Tree | Oriental-Indomalaysia |

| | | | |
|---|---|---|---|
| *Elatostema cuneatum* | Urticaceae | Herb | Oriental-India, Sri Lanka |
| *Elatostema lineolatum* | Urticaceae | Herb | Oriental-India |
| *Elephantopus scaber* | Asteraceae | Herb | Pantropical |
| *Emblica officinalis* | Euphorbiaceae | Tree | Palaeotropics |
| *Emilia sonchifolia* | Asteraceae | Herb | Pantropical |
| *Entada pursaetha* | Faboideae | Climber | Oriental-Western India, |
| *Epaltes divaricata* | Asteraceae | Herb | W Peninsular India, China, Myanmar |
| *Epipogium roseum* | Orchidaceae | Herb | W Africa, Indomalaysia |
| *Epithema carnosum* | Gesneriaceae | Herb | Oriental-W. Ghats |
| *Eria dalzelli* | Orchidaceae | Herb | Oriental-W. Ghats |
| *Eriocaulon stellulatum* | Eriocaulaceae | Herb | Oriental-W. Ghats |
| *Eriocaulon xeranthemum* | Eriocaulaceae | Herb | Tropical Africa, Oriental-India |
| *Ervatamia heyneana* | Apocynaceae | Tree | Oriental-W. Ghats |

| **Species name** | **Family** | **Habit** | **Distribution** |
|---|---|---|---|
| *Euodia lunu-ankenda* | Rutaceae | Tree | Oriental-India to S. E. Asia |
| *Euonymus indicus* | Celastraceae | Tree | Oriental-W. Ghats |
| *Eupatorium odoratum* | Asteraceae | Herb | Neotropic |
| *Euphorbia hirta* | Euphorbiaceae | Herb | Pantropical |
| *Euphorbia notoptera* | Euphorbiaceae | Herb | Oriental-W. Ghats |
| *Euphorbia thymifolia* | Euphorbiaceae | Herb | Tropics |
| *Evolvulus alsinoides* | Convolvulaceae | Herb | Paleotropics |
| *Evolvulus nummularius* | Convolvulaceae | Herb | Tropical America |
| *Exacum bicolor* | Gentianaceae | Herb | Oriental-Peninsular India |
| *Exacum carinatum* | Gentianaceae | Herb | Oriental-Central India, W. Ghats |
| *Exacum lawii* | Gentianaceae | Herb | Oriental-W. Ghats, Sri Lanka? |
| *Exacum pedunculatum* | Gentianaceae | Herb | Oriental- India |
| *Ficus arnottiana* | Moraceae | Tree | Oriental-Deccan Peninsula, Sri Lanka |
| *Ficus asperrima* | Moraceae | Tree | Oriental-India, Sri Lanka |
| *Ficus heterophylla* | Moraceae | Tree | Oriental-India, Sri Lanka, |
| *Ficus hispida* | Moraceae | Tree | Oriental-Indomalaysia |
| *Ficus nervosa* | Moraceae | Tree | Oriental-India to Vietnam |
| *Ficus* Sp. | Moraceae | Tree | |
| *Fimbristylis camplanata* | Cyperaceae | Herb | Pantropical |
| *Flacourtia montana* | Flacourtiaceae | Tree | Oriental-W. Ghats |
| *Flemingia strobilifera* | Faboideae | Shrub | Oriental-Indomalaysia |
| *Garcinia gummi-gutta* | Clusiaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Garcinia indica* | Clusiaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Garcinia morella* | Clusiaceae | Tree | Oriental-Indomalaysia |
| *Garcinia talbotii* | Clusiaceae | Tree | Oriental-W. Ghats |
| *Geissaspis cristata* | Faboideae | Herb | Oriental-W. Ghats |
| *Geophila reniformis* | Rubiaceae | Herb | Oriental-India, Sri Lanka |
| *Globba marantina* | Zingiberaceae | Herb | Oriental- India, Sri Lanka, Malaya |

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| *Glochidion* sp. | Euphorbiaceae | Tree | |
| *Glochidion zeylanicum* | Euphorbiaceae | Tree | Oriental-Indomalaysia |
| *Gloriosa superba* | Liliaceae | Climber | Paleotropics |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Glycosmis pentaphylla* | Rutaceae | Shrub | Oriental-S. India, Sri Lanka |
| *Gnetum ula* | Gnetaceae | Climber | Oriental-South India |
| *Gnidia glauca* | Thymelaeaceae | Shrub | Palaeotropics |
| *Goniothalamus cardiopetalus* | Annonaceae | Tree | Oriental-W. Ghats |
| *Gordonia obtusa* | Theaceae | Tree | Oriental-W. Ghats |
| *Grangea maderaspatana* | Asteraceae | Herb | Paleotropics |
| *Grewia disperma* | Tiliaceae | Tree | Paleotropics, Oriental-India, Myanmar |
| *Grewia microcos* | Tiliaceae | Tree | Oriental-Asia |
| *Grewia tiliifolia* | Tiliaceae | Tree | Tropical Africa, Tropical |
| *Grewia umbellifera* | Tiliaceae | Sca.shrub | Oriental-Central and Peninsular India |
| *Grewilia robusta* | Gymnosperm | Tree | |
| *Gymnema sylvestre* | Asclepiadaceae | Climber | Paleotropics, Oriental |
| *Gymnosporia rothiana* | Celastraceae | Shrub | Oriental-W. Ghats |
| *Gymnostachyum latifolium* | Acanthaceae | Shrub | Oriental-W. Ghats |
| *Habenaria crinifera* | Orchidaceae | Herb | Oriental- W. Ghats, Sri Lanka |
| *Habenaria grandifloriformis* | Orchidaceae | Herb | Oriental-Deccan, W Peninsular India |
| *Habenaria longicorniculata* | Orchidaceae | Herb | Oriental- W. Ghats |
| *Harpullia imbricata* | Sapindaceae | Tree | Oriental-Indomalaysia |
| *Hedyotis caerulea* | Rubiaceae | Herb | Oriental- South India |
| *Hedyotis corymbosa* | Rubiaceae | Herb | |
| *Hedyotis herbacea* | Rubiaceae | Herb | Paleotropic |
| *Hedyotis nitida* | Rubiaceae | Herb | Oriental- W. Ghats, Sri Lanka |
| *Helicteres isora* | Sterculiaceae | Shrub | Oriental- Indomalaysia |
| *Heliotropium indicum* | Boraginaceae | Herb | Pantropical |
| *Heliotropium marifolium* | Boraginaceae | Herb | Indomalaysia |
| *Hemidesmus indicus* | Asclepiadaceae | Climber | Oriental-India, Sri Lanka |
| *Hibiscus furcatus* | Malvaceae | Sca.shrub | Tropical Africa, Tropical Asia |
| *Hippocratea indica* | Hippocrataceae | Climber | Oriental-Indomalaysia |
| *Holarrhena antidysenterica* | Apocynaceae | Tree | Oriental-India, Malaya |
| *Holigarna arnottiana* | Anacardiaceae | Tree | Oriental-W. Ghats |
| *Holigarna beddomii* | Anacardiaceae | Tree | Oriental-W. Ghats |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Holigarna ferruginea* | Anacardiaceae | Tree | Oriental-W. Ghats |
| *Holigarna grahamii* | Anacardiaceae | Tree | Oriental-W. Ghats |
| *Hopea parviflora* | Dipterocarpaceae | Tree | Oriental-W. Ghats |
| *Hopea wightiana* | Dipterocarpaceae | Tree | Oriental-W. Ghats |
| *Hoya ovalifolia* | Asclepiadaceae | Herb | Oriental- Peninsular India, Sri Lanka |
| *Hoya retusa* | Asclepiadaceae | Herb | Oriental- W. Ghats |

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| *Hybanthus enneaspermus* | Violaceae | Herb | Africa to Australia |
| *Hydnocarpus laurifolia* | Flacourtiaceae | Tree | Oriental-W. Ghats |
| *Hydrocotyl javanica* | Apiaceae | Herb | Tropical Africa-Indomalaysia |
| *Hydrocotyl sibthorpioides* | Apiaceae | Herb | Tropical Africa-Indomalaysia |
| *Hygrophila auriculata* | Acanthaceae | Herb | Oriental-India, Sri Lanka |
| *Hypoxis aurea* | Hypoxidaceae | Herb | Oriental-India, S.E. Asia |
| *Hyptis suaveolens* | Lamiaceae | Herb | Tropical America |
| *Ichnocarpus frutescens* | Apocynaceae | Climber | Indomalaysia, Australia |
| *Impatiens balsamina* | Balsaminaceae | Herb | Indomalaysia, China |
| *Impatiens oppositifolia* | Balsaminaceae | Herb | Oriental- W. Ghats, Sri Lanka |
| *Impatiens scapiflora* | Balsaminaceae | Herb | Oriental- W. Ghats |
| *Impatiens trichocarpa* | Balsaminaceae | Herb | Oriental- W. Ghats |
| *Iphigenia indica* | Liliaceae | Herb | Oriental-Indomalaysia |
| *Ipomoea hederifolia* | Convolvulaceae | Twiner | Tropical America |
| *Ischaemum indicum* | Poaceae | Herb | Oriental-South India |
| *Ixora arborea* | Rubiaceae | Tree | Oriental-W. Ghats |
| *Ixora brachiata* | Rubiaceae | Tree | Oriental-W. Ghats |
| *Ixora coccinea* | Rubiaceae | Shrub | Oriental-W. Ghats, Sri Lanka |
| *Ixora polyantha* | Rubiaceae | Shrub | Oriental- W. Ghats |
| *Jasminum malabaricum* | Oleaceae | Climber | Oriental-W. Ghats |
| *Jasminum ritchiei* | Oleaceae | Climber | Oriental-W. Ghats, Sri Lanka |
| *Jasminum rottlerianum* | Oleaceae | Climber | Oriental-W. Ghats |
| *Jerdonia indica* | Gesneriaceae | Herb | Oriental- W. Ghats |
| *Justicia betonica* | Acanthaceae | Herb | Tropical Africa, India, Sri Lanka, Malaysia |
| *Justicia simplex* | Acanthaceae | Herb | E Africa, India, Malaysia |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Knema attenuata* | Myristicaceae | Tree | Oriental-W. Ghats |
| *Knoxia sumatrensis* | Rubiaceae | Herb | Oriental-Indomalaysia |
| *Lagenandra meeboldii* | Araceae | Herb | Oriental- W. Ghats |
| *Lagerstroemia microcarapa* | Lythraceae | Tree | Oriental-W. Ghats |
| *Lagerstroemia parviflora* | Lythraceae | Tree | Oriental-W. Ghats, Myanmar |
| *Lannea coromandelica* | Anacardiaceae | Tree | Oriental-India, Sri Lanka |
| *Leea indica* | Leeaceae | Shrub | Oriental- India, China to Australia |
| *Lepisanthes tetraphylla* | Sapindaceae | Tree | Oriental-W. Ghats, Sri Lanka, Myanmar |
| *Leucas biflora* | Lamiaceae | Herb | Oriental-W Peninsular India, Sri Lanka |
| *Leucas ciliata* | Lamiaceae | Herb | Oriental-India |
| *Leucas hirta* | Lamiaceae | Herb | Oriental-South India |
| *Leucas lavandulifolia* | Lamiaceae | Herb | Oriental-Indomalaysia |
| *Leucus marrubioides* | Lamiaceae | Herb | Oriental-W. Ghats, Sri Lanka |
| *Limnophila aromatica.* | Scrophulariaceae | Herb | Tropical India, N Australia |
| *Limnophila indica* | Scrophulariaceae | Herb | Paleotropics |
| *Lindernia anagallis* | Scrophulariaceae | Herb | Oriental-Indomalaysia |

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| *Lindernia antipoda* | Scrophulariaceae | Herb | Oriental-Indomalaysia |
| *Lindernia ciliata* | Scrophulariaceae | Herb | Oriental-Indomalaysia |
| *Lindernia hyssopoides* | Scrophulariaceae | Herb | Oriental-India, Sri Lanka |
| *Lindernia nummulariifolia* | Scrophulariaceae | Herb | Oriental-India, Myanmar |
| *Lindernia procumbens* | Scrophulariaceae | Herb | Temperate to tropical Eurasia |
| *Lindernia pusilla* | Scrophulariaceae | Herb | Paleotropics |
| *Lindernia rotundifolia* | Scrophulariaceae | Herb | Oriental-W and S. India, Sri Lanka, Madagascar |
| *Linociera malabarica* | Oleaceae | Tree | Oriental-W. Ghats |
| *Litsea laevigata* | Lauraceae | Tree | Oriental-W. Ghats |
| *Litsea* sp. | Lauraceae | Tree | |
| *Lobelia alsinoides* | Campanulaceae | Herb | Oriental-S and S.E. Asia |
| *Lobelia nicotianifolia* | Campanulaceae | Herb | Oriental-Indomalaysia |
| *Lophopetalum wightianum* | Celastraceae | Tree | Oriental-Indomalaysia |
| *Ludwigia perennis* | Onagraceae | Herb | Indomalaysia, E Africa, Iran, Sri Lanka |
| *Luvunga sarmentosa* | Rutaceae | Shrub | Oriental-Java, Sri Lanka |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Macaranga peltata* | Euphorbiaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Madhuca latifolia* | Sapotaceae | Tree | Oriental- India, Myanmar |
| *Malaxis acuminata* | Orchidaceae | Herb | Oriental-Indomalaysia |
| *Malaxis rheedii* | Orchidaceae | Herb | India, Thailand, China |
| *Mallotus philippensis* | Euphorbiaceae | Tree | China, Indomalaysia to Australia |
| *Mangifera indica* | Anacardiaceae | Tree | Oriental-W. Ghats |
| *Mastixia arborea* | Cornaceae | Tree | Oriental-W. Ghats |
| *Mecardonia procumbens* | Scrophulariaceae | Herb | Neotropic |
| *Melastoma malabathricum* | Melastomataceae | Shrub | Oriental-India |
| *Melochia corchorifolia* | Sterculiaceae | Herb | Tropics |
| *Memecylon* sp. | Melastomataceae | Shrub | |
| *Memecylon talbotianum* | Melastomataceae | Tree | Oriental-W. Ghats |
| *Memecylon terminale* | Melastomataceae | Shrub | Oriental-W. Ghats |
| *Memecylon umbellatum* | Melastomataceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Memecylon wightii* | Melastomataceae | Shrub | Oriental-W. Ghats |
| *Menispermaceae member* | Menispermaceae | Climber | |
| *Mesua ferrea* | Clusiaceae | Tree | Oriental-Indomalaysia |
| *Mimosa pudica* | Faboideae | Herb | Tropical America |
| *Mimusops elengi* | Sapotaceae | Tree | Oriental-Indomalaysia |
| *Mitraphora heyneana* | Annonaceae | Tree | Oriental-W. Ghats |
| *Mollugo pentaphylla* | Molluginaceae | Herb | Paleotropics |
| *Monochoria vaginalis* | Pontederiaeae | Herb | Paleotropics |
| *Moullava spicata* | Faboideae | Sca.shrub | Oriental- W. Ghats |
| *Murdannia pauciflora* | Commelinaceae | Herb | Oriental-S. India, Malaya |
| *Murdannia semiteres* | Commelinaceae | Herb | Africa, S. India |
| *Murdannia simplex* | Commelinaceae | Herb | Paleotropics |

| Species name | Family | Habit | Distribution |
|---|---|---|---|
| *Murraya koenigii* | Rutaceae | Tree | Oriental-India, Sri Lanka |
| *Murraya paniculata* | Rutaceae | Shrub | Oriental-Indomalaysia |
| *Mussaenda bellila* | Rubiaceae | Sca.shrub | Oriental-Peninsular India |
| *Myristica dactyloides* | Myristicaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Myristica malabarica* | Myristicaceae | Tree | Oriental-W. Ghats |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Naravelia zeylanica* | Ranunculaceae | Climber | Oriental-India, Sri Lanka, Java |
| *Naregamia alata* | Meliaceae | Herb | Oriental-India, Angola |
| *Neanotis foetida* | Rubiaceae | Herb | Oriental- W. Ghats |
| *Neolitsea scrobiculata* | Lauraceae | Tree | Oriental-Western India |
| *Nothapodytes nimmoniana* | Icacinaceae | Tree | Oriental-China, Indomalaysia |
| *Nothopegia colebrookeana* | Anacardiaceae | Tree | Oriental-W. Ghats |
| *Nymphaea nouchali* | Nymphaeaceae | Herb | Tropics |
| *Nymphaea pubescens* | Nymphaeaceae | Herb | Tropics |
| *Nymphoides aurantiaca* | Menyanthaceae | Herb | Oriental-S. India, Sri Lanka |
| *Nymphoides indica* | Menyanthaceae | Herb | Oriental-Indomalaysia |
| *Oberonia brunoniana* | Orchidaceae | Herb | Oriental- W. Ghats |
| *Oberonia santapaui* | Orchidaceae | Herb | Oriental- W. Ghats |
| *Olax wightiana* | Olacaceae | Sca.shrub | Oriental- W. Ghats, Sri Lanka |
| *Olea dioica* | Oleaceae | Tree | Oriental-N E India, S W India |
| *Ophiorrhiza hirsutula* | Rubiaceae | Herb | Oriental-W. Ghats |
| *Osbeckia truncata* | Melastomataceae | Herb | Oriental- W. Ghats |
| *Oxalis corniculata* | Oxalidaceae | Herb | Pantropical |
| *Pajanelia longifolia* | Bignoniaceae | Tree | Oriental-India, Myanmar |
| *Palaquium ellipticum* | Sapotaceae | Tree | Oriental-W. Ghats |
| *Pandanus* Sp. | Pandanaceae | Shrub | |
| *Paramignya monophylla* | Rutaceae | Climber | Oriental-India, Sri Lanka |
| *Paspalum scrobiculatum* | Poaceae | Herb | Oriental- India |
| *Passiflora subpeltata* | Passifloraceae | Climber | Native of Madagascar |
| *Pavetta indica* | Rubiaceae | Shrub | Oriental-South India |
| *Pennisetum pedicellatum* | Poaceae | Herb | India, Tropical Africa |
| *Peperomia pellucida* | Piperaceae | Herb | S America |
| *Peperomia portulacoides* | Piperaceae | Herb | Madagascar to S W India |
| *Peristylus aristatus* | Orchidaceae | Herb | Oriental-India, Sri Lanka |
| *Peristylus secundus* | Orchidaceae | Herb | Oriental-S. India |
| *Persea macarantha* | Lauraceae | Tree | Oriental-South India, Sri Lanka |
| *Phaulopsis imbricata* | Acanthaceae | Herb | India, Africa, Sri Lanka, Madagascar |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Phoebe cathia* | Lauraceae | Tree | Oriental-W. Ghats, C Himalayas to Myanmar |
| *Phoenix humilis* | Arecaceae | Palm | Oriental-W. Ghats |
| *Pholidota pallida* | Orchidaceae | Herb | Oriental-Indomalaysia |
| *Phyllanthus debilis* | Euphorbiaceae | Herb | India, Tropical Africa |

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| *Phyllanthus niruri* | Euphorbiaceae | Herb | Tropics except Australia |
| *Phyllanthus urinaria* | Euphorbiaceae | Herb | Tropics |
| *Pinanga dicksonii* | Arecaceae | Palm | Oriental-W. Ghats |
| *Piper nigrum* | Piperaceae | Climber | Oriental-E and W. Ghats |
| *Plantanthera susannae* | Orchidaceae | Herb | Oriental-Indomalaysia |
| *Plectranthus mollis* | Lamiaceae | Herb | Oriental-India |
| *Plectranthus stocksii* | Lamiaceae | Herb | Oriental-Central and S. India |
| *Plumbago zeylanica* | Plumbaginaceae | Herb | Tropics |
| *Poeciloneuron indicum* | Clusiaceae | Tree | Oriental-W. Ghats |
| *Polyalthia fragrance* | Annonaceae | Tree | Oriental-W. Ghats |
| *Polygonum chinense* | Polygonaceae | Herb | Oriental-Indomalaysia |
| *Polystachya flavescens* | Orchidaceae | Herb | Oriental-Indomalaysia |
| *Porpax jerdoniana* | Orchidaceae | Herb | Oriental- W. Ghats |
| *Porpax reticulata* | Orchidaceae | Herb | Oriental- W. Ghats |
| *Portulaca oleracea* | Portulacaceae | Herb | Tropics |
| *Pothos scandens* | Araceae | Climber | Oriental-India, Sri Lanka, |
| *Pouzolzia zeylanica* | Urticaceae | Herb | China through Indomalaysia |
| *Prunus ceylanica* | Rosaceae | Tree | Oriental-South India to S.E. Asia |
| *Psychotria canarensis* | Rubiaceae | Shrub | Oriental-W. Ghats |
| *Psychotria dalzellii* | Rubiaceae | Shrub | Oriental-W. Ghats |
| *Psychotria flavida* | Rubiaceae | Shrub | Oriental-W. Ghats |
| *Psychotria truncata* | Rubiaceae | Shrub | Oriental-W. Ghats |
| *Pterocarpus marsupium* | Faboideae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Pterospermum acerifolium* | Sterculiaceae | Tree | Oriental-Indomalaysia |
| *Pterospermum diversifolium* | Sterculiaceae | Tree | Oriental-W. Ghats, Java, Philippines, Malaysia |
| *Ramphicarpa longiflora* | Scrophulariaceae | Herb | Oriental- W. Ghats |
| *Randia rugulosa* | Rubiaceae | Sca.shrub | Oriental- W. Ghats, Sri Lanka |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Randia uliginosa* | Rubiaceae | Shrub | Oriental-India, Myanmar |
| *Rauvolfia serpentina* | Apocynaceae | Shrub | India, Sri Lanka, Java |
| *Rhynchoglossum notonianum* | Gesneriaceae | Herb | Oriental- W. Ghats, Sri Lanka |
| *Rhynchospora wightiana* | Cyperaceae | Herb | Oriental- W. Ghats |
| *Rhynchostylis retusa* | Orchidaceae | Herb | Oriental-Indomalaysia |
| *Rotala densiflora* | Lythraceae | Herb | Oriental-Indomalaysia |
| *Rotala macrandra* | Lythraceae | Herb | Oriental-S. India |
| *Rubia cordifolia* | Rubiaceae | Climber | Palaeotropics |
| *Rungia pectinata* | Acanthaceae | Herb | Oriental-India, Sri Lanka, Myanmar |
| *Sageraea laurifolia* | Annonaceae | Tree | Oriental-W. Ghats |
| *Salomonia ciliata* | Polygalaceae | Herb | India, Sri Lanka, Malaya, Australia |
| *Santalum album* | Santalaceae | Tree | Oriental-South India |
| *Saraca asoca* | Faboideae | Tree | Oriental-Indomalaysia |
| *Sarcostigma kleinii* | Euphorbiaceae | Climber | Oriental-Eastern & W. Ghats |

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| *Schefflera venulosa* | Araliaceae | Tree | Oriental-India, Myanmar, |
| *Schleichera oleosa* | Sapindaceae | Tree | Oriental-Indomalaysia |
| *Scoparia dulcis* | Scrophulariaceae | Herb | Neotropic |
| *Scutia myrtina* | Rhamnaceae | Shrub | Oriental-Myanmar, India |
| *Sebastania chamaela* | Euphorbiaceae | Herb | Paleotropics |
| *Sida acuta* | Malvaceae | Herb | Pantropical |
| *Sida cordifolia* | Malvaceae | Herb | Pantropical |
| *Sida rhombifolia* | Malvaceae | Herb | Oriental-Indomalaysia |
| *Smilax zeylanica* | Smilacaceae | Climber | Oriental-South E. Asia to |
| *Smithia conferta* | Faboideae | Herb | Oriental-Indomalaysia |
| *Smithia hirsuta* | Faboideae | Herb | Oriental- W. Ghats |
| *Solanum americanum* | Solanaceae | Herb | Temperate and Tropical |
| *Solanum surattense* | Solanaceae | Herb | Indomalaya, Tropical Australia, Polynesia |
| *Solanum violaceum* | Solanaceae | Herb | Tropical Africa, Indian subcontinent |
| *Sophubia delphinifolia* | Scrophulariaceae | Herb | Oriental-S. India, Sri Lanka |
| *Spermacoce articularis* | Rubiaceae | Herb | Oriental-Indomalaysia |
| *Spermacoce mauritiana* | Rubiaceae | Herb | Pantropical |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Spermacoce pusilla* | Rubiaceae | Herb | Paleotropics |
| *Spermacoce verticillata* | Rubiaceae | Herb | Pantropical |
| *Stachytarpheta indica* | Verbenaceae | Herb | Tropical America |
| *Sterculia guttata* | Sterculiaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Steriospermum personatum* | Bignoniaceae | Tree | Oriental-India, Myanmar, |
| *Striga angustifolia* | Scrophulariaceae | Herb | Oriental-Indomalaysia |
| *Striga asiatica* | Scrophulariaceae | Herb | Paleotropics |
| *Striga densiflora* | Scrophulariaceae | Herb | Oriental-Central and S. India |
| *Strobilanthus barbatus* | Acanthaceae | Shrub | Oriental-W. Ghats |
| *Strobilanthus heyneanus* | Acanthaceae | Shrub | Oriental-W. Ghats |
| *Strobilanthus integrifolius* | Acanthaceae | Shrub | Oriental-W. Ghats |
| *Strombosia ceylanica* | Olacaceae | Tree | Oriental-W. Ghats |
| *Strychnos dalzelli* | Loganiaceae | Climber | Oriental-Peninsular India |
| *Swertia corymbosa* | Gentianaceae | Herb | Oriental- W. Ghats |
| *Symplocos racemosa* | Symplocaceae | Tree | Oriental-W. Ghats |
| *Syzygium caryophyllatum* | Myrtaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Syzygium cumini* | Myrtaceae | Tree | Oriental-Indomalaysia |
| *Syzygium gardnerii* | Myrtaceae | Tree | Oriental-W. Ghats, Sri Lanka |
| *Syzygium laetum* | Myrtaceae | Tree | Oriental-W. Ghats |
| *Syzygium macrocephala* | Myrtaceae | Tree | Oriental-W. Ghats |
| *Syzygium* Sp.1 | Myrtaceae | Tree | |
| ***Syzygium* Sp.2** | Myrtaceae | Tree | |
| *Tarenna asiatica* | Rubiaceae | Shrub | Oriental-Indomalaysia |
| *Tephrosia pulcherrima* | Faboideae | Herb | Oriental-W. Ghats, Sri Lanka |

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| *Terminalia alata* | Combretaceae | Tree | Oriental-India |
| *Terminalia bellirica* | Combretaceae | Tree | Oriental-Indomalaysia |
| *Terminalia chebula* | Combretaceae | Tree | Oriental-India, Myanmar |
| *Terminalia paniculata* | Combretaceae | Tree | Oriental-Peninsular India |
| *Tetrameles nudiflora* | Datiscaceae | Tree | Oriental-India, Sri Lanka, |
| *Thunbergia mysorensis* | Acanthaceae | Climber | Oriental-W. Ghats |
| *Toddalia asiatica* | Rutaceae | Climber | Oriental-South India |
| **Species name** | **Family** | **Habit** | **Distribution** |
| ***Tolypanthus lagenifer*** | Loranthaceae | Shrub | Oriental- W. Ghats |
| *Toona ciliata* | Meliaceae | Tree | India to Australia |
| *Torenia bicolor* | Scrophulariaceae | Herb | Oriental- W. Ghats |
| *Tragia hispida* | Euphorbiaceae | Twiner | Oriental-Peninsular India |
| *Trapa natans* | Trapaceae | Herb | Oriental-India, Sri Lanka |
| *Trewia nudiflora* | Euphorbiaceae | Tree | Oriental-India, Sri Lanka |
| *Tricalysia apiocarpa* | Rubiaceae | Tree | Oriental-W. Ghats |
| *Tricholepis glaberrima* | Asteraceae | Herb | Oriental-India |
| *Triumfetta rhomboidea* | Tiliaceae | Herb | Tropical Africa, Asia |
| *Turnera ulmifolia* | Turneraceae | Herb | |
| *Turraea villosa* | Meliaceae | Shrub | Western peninsular India, Java |
| *Tylophora indica* | Asclepidiaceae | Climber | Oriental-Indomalaysia |
| Unidentified (from Chikmattur) | | Tree | |
| Unidentified (from Karni) | | Tree | |
| Unidentified (from Mayyalli) | | Tree | |
| Unidentified (from Talgani) | | Tree | |
| *Urena lobata* | Malvaceae | Herb | Pantropical |
| *Utricularia aurea* | Lentibulariaceae | Herb | Oriental and Australian |
| *Utricularia praeterita* | Lentibulariaceae | Herb | Oriental-S. India |
| *Utricularia reticulata* | Lentibulariaceae | Herb | Oriental-India, Sri Lanka |
| *Utricularia striatula* | Lentibulariaceae | Herb | Paleotropics |
| *Uvaria narum* | Annonaceae | Climber | Oriental-W. Ghats, Sri Lanka |
| *Vangueria spinosa* | Rubiaceae | Tree | Oriental-Indomalaysia |
| *Ventilago madraspatana* | Rhamnaceae | Climber | Oriental-W. Ghats, Sri Lanka, Java |
| *Vepris bilocularis* | Rutaceae | Tree | Oriental-W. Ghats |
| *Vernonia cineria* | Asteraceae | Herb | Paleotropics |
| *Vitaceae member* | Vitaceae | Climber | |
| *Vitex altissima* | Verbenaceae | Tree | Oriental- South India |
| *Vitex negundo* | Verbenaceae | Shrub | Oriental-Asia |
| *Vitis auriculata* | Vitaceae | Climber | Oriental- India |
| *Wendlandia thyrsoidea* | Rubiaceae | Tree | Oriental-S. India, Sri Lanka |
| **Species name** | **Family** | **Habit** | **Distribution** |
| *Xantolis tomentosa* | Sapotaceae | Tree | Oriental-India,China |
| *Xylia xylocarpa* | Faboideae | Tree | Oriental-Indomalaysia |

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| *Xyris pauciflora* | Xyridaceae | Herb | Oriental-Indomalaysia |
| *Zanthoxylum ovalifolium* | Rutaceae | Shrub | Oriental-Singapur |
| *Zanthoxylum rhetsa* | Rutaceae | Tree | Oriental-Indomalaysia |
| *Zingiber cernum* | Zingiberaceae | Herb | Oriental-W. Ghats |
| *Zingiber neesanum* | Zingiberaceae | Herb | Oriental-W. Ghats |
| *Ziziphus oenoplia* | Rhamnaceae | Sca.shrub | Pantropics |
| *Ziziphus rugosa* | Rhamnaceae | Straggler | Oriental-India, Sri Lanka |
| *Zornia gibbosa* | Faboideae | Herb | Tropics |

Sca.shrub-Scandent Shrub

Table 8.4: Details of different landscape elements sampled and their diversity indices, basal area, percentage evergreens and percentage endemics.

| Vegetation type | Total transects | Total quadrats | Total area sampled (ha.) | Total individuals | Total species | Estimated basal area/ha. | Species richness | Shannon's diversity | Simpson's diversity | % Evergreens | % Endemics |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Evergreen | 20 | 96 | 11.8 | 1818 | 128 | 35.3 | 17 | 3.94 | 0.96 | 95.8 | 56.7 |
| Semi-evergreen | 16 | 82 | 3.3 | 1916 | 138 | 31.1 | 18 | 4.03 | 0.97 | 77.1 | 40.9 |
| Moist deciduous | 3 | 18 | 0.7 | 318 | 58 | 19.8 | 10 | 3.44 | 0.95 | 43.6 | 19.7 |
| Scrub | 2 | 5 | 0.2 | 6 | 4 | 0.6 | 2 | 1.24 | 0.67 | 0.0 | 0.0 |

**Lichens**

Lichens are unique groups of plants exhibiting symbiotic association of fungi and algae, but represented as a single organism. Because of their sensitivity to microclimatic changes in environment, lichens aid as bioindicators. They require specific conditions in the environment and respond critically to any changes in it. Hence, they are widely used in air pollution, geochemical and geothermal emission, and biomonitoring studies. They play various roles as pioneers in successionaland climax ecosystems and could as well indicate the age and ecological continuity of a forest. Apart from this, they also can be used as tools in determining the age of an unknown rock surface (lichenometry) and soil formation (pedogenesis) during plant succession. Western Ghats harbour 800 species of lichens in which, 161 species are endemic to this region. The study in SVWS shows the presence of 46 species of lichens in the SVWS (in semi-evergreen forest of Holebagilu, Honnemaradu Island, Karumane, Muppane and Siganduru) representing 5% from the Western Ghats of Karnataka. (Table 8.4). However, lichen studies need to be carried out more intensively. Table 8.5 gives Simpson's and Shannon-Weiner's diversity indices. Holebagilu and Karumane are highly diverse, while Honnemaradu (Island) is least diverse in lichen composition.

Table 8.4: Lichen species recorded in SVWS

| Taxa | Growth form | Holebagilu | Siganduru | Muppane | Karumane | Honnemardu (I) | *Substrata* |
|---|---|---|---|---|---|---|---|
| **Arthoniaceae** | | | | | | | |
| *Cryptothecia lunulata* (Zahlbr.) Makhija & Patwardhan | C | + | + | | + | | 16,27,33,41 |
| *C. phyctidiforme* (Müll. Arg.) Awasthi & K Singh | C | | | + | | | 1,4,47 |
| *C. stirtonii* A.L. Smith | C | + | | | | + | 5,13,34 |
| *C.subnidulans* Stirton | C | | | | | + | 5,11,34,39,41 |
| **Arthopyreniaceae** | | | | | | | |
| *Arthopyrenia indusiata* Müll. Arg. | C | + | | | | | 1,12,24,27,31,35,39,51 |
| *A. subnexa* (Nyl.) Müll. Arg. | C | + | | | | | 1,5,24,27,30 |
| *A. terminata* (Nyl.) Müll. Arg. | C | + | + | | + | | 4,8,14,27, |
| **Bacidiaceae** | | | | | | | |
| *Bacidia incongruens* (Stirton) Zahlbr. | C | | | | + | | 2,22,39 |
| *B. subletorum* (Schreber) Lettau | C | | | + | | | 36 |
| *Brigantiaea leucoxantha* (Sprengel) Half. In Half & Bellem | C | + | | | | | 15,25,48 |
| **Caliciales (Order)** | | | | | | | |
| *Heterocyphelium leucompyx* (Tuck.) Vainio | C | + | | | | | 1,6 |
| **Catilariaceae** | | | | | | | |
| *Catilaria pulverea* (Borrer) Lattau | C | | | | | + | 1,6,8,9,18,19,45,48 |
| **Coccocarpiaceae** | | | | | | | |
| *Coccocarpia erythroxyli* (Sprengel) Swinsc and Krog. | F | | + | | + | + | 2,4,5,14,20,22,23,27,32, 37,39,40,41, 44,48,50 |
| **Collamataceae** | | | | | | | |
| *Leptogium aurstro-americanum* (Malme) Dodge | F | | + | | + | | 3,4,7,20,37,39,41,44,46, 47,50, |
| *L. denticulatum* Nyl. | F | | | + | + | | 2,3,10,41,42,44,50 |
| **Graphidaceae** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Graphina petricosa* (Krempelh) A. Zahlbr. | C | | | | + | | 2,4,39,41 |
| *Graphis nakanishiana* Patwardhan & Kulkarni | C | | | + | | + | 4,10,14,18,20,39,44,49 |

| **Taxa** | **Growth form** | **Holebagilu** | **Siganduru** | **Muppane** | **Karumane** | **Honnemardu (I)** | *Substrata* |
|---|---|---|---|---|---|---|---|
| *Xylographa vitiligo* (Ach.) Laundon | C | | | + | + | + | 2,4,10,14,16,20,27,28,30, 41,44 |
| **Lecanoraceae** | | | | | | | |
| *Lecidia* sp1 | C | + | | | | | 2,12 |
| *Lecidia* sp2 | C | | | + | | | 2,4 |
| *Lecidia* sp3 | C | | | | + | | 4,45 |
| *Lecidia* sp4 | C | + | | + | | + | 2,13,16,27,34,45,46 |
| **Letrouitiaceae** | | | | | | | |
| *Letrouitia trangressa* (Malme) Half. & Bellem | C | | | + | | | 2,4,36,48 |
| **Opegraphaceae** | | | | | | | |
| *Opegrapha subvulgata* Nyl. | C | + | | | | | 6 |
| **Pertusariaceae** | | | | | | | |
| *Ochrolechia androgyna* (Hoffm.) Arnold | C | | + | | | | 23 |
| *O. subviridis* (Hoeg) Erichsen | C | + | | | | | 6,27,40 |
| *Pertusaria albescens* (Huds.) M. Choisy & Werner | C | | | + | | | 2,42 |
| *P. multipunctata* (Turner) Nyl. | C | | | + | | | 2 |
| **Phyllosporaceae** | | | | | | | |
| *Phyllospora manipurensis* (Müll. Arg.) Sch. | F | + | | + | | | 2,27 |
| *P. parvifolia* (Pers.) Müll. Arg. | F | + | + | + | | | 2,12,23,31,37,38,43 |

| **Taxa** | **Growth form** | **Holebagilu** | **Siganduru** | **Muppane** | **Karumane** | **Honnemardu (I)** | *Substrata* |
|---|---|---|---|---|---|---|---|
| **Physciaceae** | | | | | | | |
| *Physcia aipolia* (Ehrh. in Humb.) Furnr | F | + | | | | | 13,31 |
| *P. dimidiata* (Arn.) Nyl. | F | | + | | | | 1,2,18,29 |
| **Pilocarpaceae** | | | | | | | |
| *Byssoid* sp1 | C | + | + | | + | | 1,2,4,12,14,20,21,25,27,32,38,39,41,50 |
| **Pyrenulaceae** | | | | | | | |

| Taxa | Growth form | Holebagilu | Siganduru | Muppane | Karumane | Honnemardu (I) | *Substrata* |
|---|---|---|---|---|---|---|---|
| *Pyenula mamillana* (Ach.) Trevisan | C | + | + | | | | 2,8,5,17,27 |
| *Pyrgillus* sp. | C | | + | | | | 41 |
| **Teloschistaceae** | | | | | | | |
| *Caloplaca ferruginea* (Huds.) Th. Fr. | C | + | | + | | | 2,10,13,15,27,39,44 |
| **Thelotremataceae** | | | | | | | |
| *Ocellularia allosporoides* (Nyl.) Patwardhan and Kulkarni | C | | + | | | | 2,4,6,24,25,27,31,35,40,50, |
| *O. groenhartii* Hale | C | + | | | | | 1,12,14,15,16,19,23,27,30, 36,38,39,40 |
| *Thelotrema leprocarpum* (Nyl.) Tuck. | C | | + | + | | + | 5,14,18,34,44,45,48 |
| **Trichotheliaceae** | | | | | | | |
| *Porina interestes* (Nyl.) Harm | C | + | + | | | | 1,8,27,31,44 |
| *P. internigrans* (Nyl.) Müll. Arg. | C | + | + | | + | | 2,4,13,15,30,39,41,44 |
| *P. subcutanea* Ach. | C | + | | | | | 17,27,38 |
| *P. subhibernica* Upreti | C | + | | + | | + | 4,5,6,10,11,12,13,16,17,20, 21, 23,24,26,27,29,31, 37,40,44,50,51,52 |
| **Trypthilliaceae** | | | | | | | |
| *Trypthelium tropicum* (Ach.) Müll. Arg. | C | | | | | + | 11 |

**Note: C – Crustose, F – Foliose**

Substratum of the Lichen Species

| No. | Substratum | No. | Substatum | No. | Substratum |
|---|---|---|---|---|---|
| 1 | Fallen twig | 2 | Unidentified tree | 3 | Rock |
| 4 | *Aglaia elaegnoidea* | 5 | ***Aporosa lindleyana*** | 6 | ***Artocarpus integrifolius*** |
| 7 | *Artocarpus* Sp. | 8 | ***Canarium strictum*** | 9 | ***Careya arborea*** |
| 10 | *Cinnamomum* Sp. | 11 | ***Diospyros condollena*** | 12 | *Diospyros crumenata* |
| 13 | *Diospyros microphylla*. | 14 | *Diospyrus* Sp. | 15 | *Dysoxylun* Sp. |
| 16 | *Elaeagnus latifolia*. | 17 | ***Elaeocarpus serratus*** | 18 | ***Ervatamia heyneana*** |
| 19 | *Ficus asperrima*. | 20 | *Ficus* Sp. | 21 | ***Garcinia morella*** |
| 22 | *Garcinia talbotii* | 23 | *Holigarna arnottiana* | 24 | ***Holigarna grahamii*** |
| 25 | *Holigarna* Sp. | 26 | *Homalium zeylanicum* | 27 | ***Hopea wightiana*** |
| 28 | *Ixora brachiata*. | 29 | ***Ixora parviflora*** | 30 | *Ixora* Sp. |
| 31 | *Knema attenuata* | 32 | *Lagestroemia lanceolata* | 33 | *Linociera malabarica* |
| 34 | *Litsea laevigata* | 35 | ***Mangifera indica*** | *36* | ***Memecylon terminale*** |
| 37 | *Mimusops elengi* | 38 | ***Myristica malabarica*** | *39* | ***Olea dioica*** |
| 40 | *Polyalthia* Sp. | 41 | ***Pterospermum reticulatum*** | 42 | Salle (Kannada name) |
| 43 | *Strychnos nux-vomica* | 44 | *Syzygium* Sp. | 45 | ***Terminalia arjuna*** |
| 46 | *Terminalia chebula* | 47 | *Terminalia* Sp. | 48 | ***Terminalia tomentosa*** |

| | | |
|---|---|---|
| 49 *Toddalia asiatica* | 50 *Ventalago maderaspatana* | 51 *Vepris* Sp. |
| 52 *Ziziphus jujuba* | | |

**Table 8.5** Simpson's (D) and Shannon-Weiner's (H') indices for the lichens of studied localities

| Locality | D | H' |
|---|---|---|
| Honnemaradu (Island) | 1.26 | 1.397 |
| Muppane | 1.21 | 1.548 |
| Karumane | 1.14 | 1.675 |
| Holebagilu | 1.11 | 1.969 |
| Siganduru | 1.08 | 1.502 |

**RANGE OF WILDLIFE, STATUS, DISTRIBUTION AND HABITAT**

**Forest type and cover:** The biotic facing and edaphic variations have played a dominant role in determining the nature of the forests growing in the sanctuary. This sanctuary consists of multitiered vegetation that belongs to tropical evergreen type to moist deciduous type with lower, middle, top canopies, under growth and climbers. There are few areas where human interference is very low. On the fringes of villages the forest area has been degraded due to human interference as well as cattle pressure. Two types of forests are mainly found in sanctuary are:

i). **Southern Tropical evergreen type:** This type is seen in Nagavalli, Kannor Kote, part of Biligar and Kattinkar areas. The top canopy consists of *Depterocarpus indicus, Calophyllum tomentosum, Machilus mecarantha, Acrocarpus, fraxinopolius, Bischfia Javanica, Syzigium Species, Alstonia scholaris, Mangifera indica*. Second canopy consists of *caryota urens, Aporasa lindleyana* etc.

ii). **Southern Tropical Semi-Evergreen type:** This type of forest is seen in parts of Muppane, Attigodu Satate Forests. The important species found are, *Lagertroemia lanceolata, Careya arborea, Emblica officinalis*, *Randia species*, *Syzygium species*, *Terminalia species*, *Vitex altisima*, *Mangifera indica*, *Artocarpus species* and Bamboos in patches.

**Animals:** There are several kinds of animals in the sanctuary including carnivores, herbivores, omnivores and aquatic animals. The following are the important wild animals found in the sanctuary.

- **Carnivores:** Tiger (*Panthera tigris*), Panther (Normal and Black) (*Panthera pardus*), Wild Dogs (*Cuon alpines*), Wild cats (*Felis chaus*), Malabar civets (*Viverricule indica*), Hyena (*Hyena hyena*)

- **Herbivores:** Sambar (*Cervus unicolor*), Barking Deer (*Muntiocus muntjack*), Spotted Deer (*Axis axis*), Zusk Deer (*Moschus moschiferus*), Black naped hare (*Lepus nigricolis*), The gaur (Bision) (*Bos gaurus*), Mouse Deer (*Tragulus meninna*).
- **Scvangers:** Jackal (*Canis aurus*)
- **Reptiles:** Land monitor lizard (*Veranus grisens*), Python (*Python molurus*), King Cobra (*Naja naja*), Tortoises (*Geochelone elegars*)
- **Other Animals:** Flying Squirrel (*Refuta indica*), Giant malabar squirrel (*Benus hylopetus*), Indian Porcupine (*Hystrix indica*), Common langur (*Presbytis enstellus*), Bonnet monkey (*Macaca radiate*), Lion tailed maeaque (*Macaca slenus*), Sloth bear (*Melursus ursinus*), Wild bear (*Sus scrofa*).

**Butterflies**

The Western Ghats comprises 330 species belonging to 166 genera and five families. It includes the largest butterfly, the Southern Birdwing (*Troides minos*) with a wingspan of about 140-190mm to the smallest, the Grass Jewel (*Freyeria trochylus*) and Tiny Grass Blue (*Zizula hylax*) with wingspan only 15-22 mm and 16-24 mm respectively. Nymphalidae and Lycaenidae are the major families that contribute to the entire Western Ghats butterfly species diversity. SVWS comprises five butterfly families with 173 species (Table 9.3). The family composition and the conservation status of the butterflies in Western Ghats are cited in Table 9.4.

Most of the Swallotails (Family; Papilionidae) show habitat preferences and hence can be used as indicators of ecosystem health. For instance, Spot Sword tail is found only in the thick evergreen forest and its larval host plants are *Thottea siliquosa*, etc., are found in the core and buffer zone of the sanctuary. The swallowtails are also found puddling near the streams.

The Brush-footed butterflies of the family Nymphalidae are represented by 65 species in the sanctuary. They are well distributed in the sanctuary area and some are habitat specific in nature. The Map Butterfly, Blue Nawab and Malabar Tree Nymph are found only in the moist and shady places. Blue Nawab is an endangered species encountered in Banukuli locality. Indian Sunbeam is found in moist places within the sanctuary area. Family Hesperiidae, popularly known as the family of “Skippers” comprises of tiny butterflies found throughout the sanctuary. Spotted Small Flat is endemic species found only in few localities.

**Table 9.3: Butterflies species in SVWS**

| Species | Common Name |
|---|---|
| **Family: Papilionidae** | |
| Papilionidae: Papilioninae: Troidini | |
| *Troides minos* Cramer | Southern Birdwing (WG) |
| *Pachliopta pandiyana* Moore | Malabar Rose (WG) |

| | |
|---|---|
| *Pachliopta aristolochiae* Fabricius | Common Rose |
| *Pachliopta hector* L., | Crimson Rose (PI&SL)* |
| **Papilionidae: Papilioninae: Leptocircini** | |
| *Graphium sarpedon* L., | Common Bluebottle |
| *Graphium doson* C&R Felder | Common Jay |
| *Graphium agamemnon* L., | Tailed Jay |
| *Graphium nomius* Esper | Spot Sword Tail |
| *Graphium antiphates* Cramer | Fivebar Swordtail |
| **Papilionidae: Papilioninae: Papilioninii** | |
| *Papilio clytia* L., | Common Mime |
| *Papilio demoleus* L., | Lime Butterfly |
| *Papilio liomedon* Moore | Malabar Banded Swallow Tail (WG)* |
| *Papilio dravidarum* Wood-Mason | Malabar Raven (WG) |
| *Papilio helenus* L., | Red Helen |
| *Papilio polytes* L., | Common Mormon |
| *Papilio polymnestor* Cramer | Blue Mormon (PI&SL) |
| *Papilio paris* L., | Paris Peacock |
| *Papilio buddha* Westwood | Buddha Peacock |
| *Papilio crino* Fabricius | Common Banded Peacock |
| **Family: Pieridae** | |
| Pieridae: Coliadinae: Coliadini | |
| *Catopsilia pomona* Fabricius | Common Emigrant |
| *Catopsilia pyranthe* L., | Mottled Emigrant |
| *Eurema brigitta* Cramer | Small Grass Yellow |
| *Eurema laeta* Boisduval | Spotless Grass Yellow |
| *Eurema hecabe* L., | Common Grass Yellow |
| *Eurema blanda* Boisduval | Three-spot Grass Yellow |
| *Eurema andersoni* | One spot Grass Yellow |

| **Species** | **Common Name** |
|---|---|
| **Pieridae: Pierinae: Pierini** | |
| *Delias eucharis* Drury | Common Jezebel (PI & SL) |
| *Leptosia nina* Fabricius | Psyche |
| *Pieris canidia* L., | Indian Cabbage White |
| *Cepora nerissa* Fabricius | Common Gull |
| *Anaphaeis aurota* Fabricius | Caper White or Pioneer |
| *Appias indra* Moore | Plain Puffin |
| *Appias libythea* Fabricius | Striped Albatross |
| *Appias albina* Boisduval | Common Albatross |
| *Colotis etrida* Boisduval | Small Orange Tip |
| *Colotis eucharis* Fabricius | Plain Orange Tip |
| *Colotis danae* Fabricius | Crimson Tip |
| *Ixias marianne* Cramer | White Orange Tip |
| *Ixias pyrene* L., | Yellow Orange Tip |
| **Pieridae: Pierinae: Euchlocini** | |
| *Pareronia valeria* Cramer | Common wanderer |
| *Pareronia ceylanica* C&R Felder | Dark Wanderer (PI&SL) |
| *Hebomoea glaucippe* L., | Great Orange Tip |
| Family: Nymphalidae | |
| **Nymphalidae: Satyrinae: Melanitini** | |
| *Melanitis leda* L., | Common Evening Brown |
| *Melanitis zitenius* Herbst | Great Evening Brown |
| *Melanitis phedima* Stoll | Dark Evening Brown |
| **Nymphalidae: Satyrinae: Elymniini** | |
| *Elymnias hypermenstra* L., | Common Palmfly |
| *Lethe europa* | Bamboo Tree Brown |

| | |
|---|---|
| *Lethe rohria* | Common Tree Brown |
| *Mycalesis anaxias* Hewitson | White-bar Bushbrown |
| *Mycalesis mineus* L., | Dark-brand Bushbrown |
| *Mycalesis perseus* Fabricius | Common Bushbrown |
| *Mycalesis subdita* Moore | Tamil Bushbrown |
| *Mycalesis patnia* Moore | Glad-eye Bushbrown (PI&SL) |
| *Orsotrioena medus* Fabricius | The Nigger |
| *Zipoetis saitis* | Tamil Catseye (WG) |

| Species | Common Name |
|---|---|
| **Nymphalidae: Satyrinae: Satyrini** | |
| *Ypthima asterope* Klug | Common Three-ring |
| *Ypthima hiiebneri* Kirby | Common Four-ring |
| *Ypthima baldus* Fabricius | Common Five-ring |
| *Ypthima sp.* | Ring |
| **Nymphalidae: Charaxinae: Charaxini** | |
| *Polyura athamas* Drury | Common Nawab |
| *Polyura schreiber* | Blue Nawab (PI&SL)* |
| *Charaxes bernardus* | Tawny Rajah |
| *Charaxes dolon* Fabricius | Black Rajah |
| **Nymphalidae: Heliconiinae: Acraeini** | |
| *Acraea violae* Fabricius | Tawny Coster |
| **Nymphalidae: Heliconiinae: Heliconiini** | |
| *Cethosia nietneri* C&R Felder | Tamil Lacewing (PI&SL) |
| *Vindula erota* Fabricius | Cruiser |
| **Nymphalidae: Heliconiinae: Argynnini** | |
| *Cupha erymanthis* Drury | Rustic |
| *Phalanta phalantha* Drury | Common Leopard |
| *Cirrochroa thais* Fabricius | Tamil Yeoman (PI&SL) |
| *Argyreus hyperbius* L., | Indian Fritillary |
| **Nymphalidae: Aparturinae** | |
| *Euripus consimilis* | Painted Courtesan |
| **Nymphalidae: Limenitinae: Neptini** | |
| *Neptis jumbah* Moore | Chestnut-streaked Sailer |
| *Neptis hylas* Moore | Common Sailer |
| *Pantoporia hordonia* Stoll | Common Lascar |
| **Nymphalidae: Limenitinae: Limetini** | |
| *Athyma perius* L., | Common Sergeant |
| *Athyma nefte* | Colour Sargeant |
| *Athyma ranga* Moore | Blackvein Sergeant |
| *Limenitis procris* Cramer | Commander |
| **Nymphalidae: Limenitinae: Parthenini** | |
| *Parthenos sylvia* Cramer | Clipper |
| **Nymphalidae: Limenitinae: Euthaliinii** | |
| *Tanaecia lepidea* Butler | Grey Count |
| *Euthalia aconthea* Cramer | Common Baron |
| *Euthalia nais* Forster | Red Baron or Baronet (PI&SL) |

| Species | Common Name |
|---|---|
| *Dolpha evelina* Stoll | Red-spot Duke |
| **Nymphalidae: Limenitinae: Biblini** | |
| *Byblia ilithyia* | Joker |
| *Ariadne merione* Cramer | Common Castor |
| *Ariadne ariadne* L., | Angled Castor |

| | |
|---|---|
| **Nymphalidae: Limenitinae: Marpesiini** | |
| *Cyrestis thyodamas* | Map |
| **Nymphalidae: Libytheinae** | |
| *Libythea lepita* Moore | Common Beak |
| **Nymphalidae: Nymphalinae: Nymphalini** | |
| *Junonia hierta* Fabricius | Yellow Pansy |
| *Junonia orithya* L., | Blue Pansy |
| *Junonia lemonias* L., | Lemon Pansy |
| *Junonia almana* L., | Peacock Pansy |
| *Junonia atlites* L., | Grey Pansy |
| *Junonia iphita* Cramer | Chocolate Pansy |
| *Kaniska canace* | Blue Admiral |
| *Cynthia cardui* L., | Painted Lady |
| *Hypolimnas bolina* L., | Great Eggfly |
| *Hypolimnas misippus* L., | Danaid Eggfly (PI&SL)* |
| *Doleschallia bisaltide* | Autumn Leaf |
| *Kallima horsfieldi* Kollar | South Indian Blue Oak Leaf (WG) |
| **Nymphalidae: Danainae: Danaini** | |
| *Parantica aglea* Stoll | Glassy Blue Tiger |
| *Tirumala limniace* Cramer | Blue Tiger |
| *Tirumala septentrionis* Butler | Dark Blue Tiger |
| *Danaus chrysippus* L., | Plain Tiger |
| *Danaus genutia* Cramer | Striped Tiger |
| **Nymphalidae: Danainae: Euploeini** | |
| *Euploea core* Cramer | Common Indian Crow |
| *Idea malabarica* Moore | Malabar Tree Nymph (WG) |
| Family: Lycaenidae | |
| **Lycaenidae: Riodininae: Riodinini** | |
| *Abisara echerius* Stoll | Plum Judy |
| **Lycaenidae: Miletinae: Spalgini** | |
| *Spalgis epius* WestWood | Apefly |

| **Species** | **Common Name** |
|---|---|
| Lycaenidae: Polymmatinae: Polymmatini | |
| *Castalius rosimon* Fabricius | Common Pierrot |
| *Caleta caleta* Hewitson | Angled Pierrot |
| *Discolampa ethion* Doubleday & Hewitson | Banded Blue Pierrot |
| *Leptotes plinius* Fabricius | Zebra Blue |
| *Azanus ubaldus* | Bright Babul Blue |
| *Everes lacturnus* Godart | Indian Cupid |
| *Actolepis puspa* Horsfield | Common Hedge Blue |
| *Neopithecops zalmora* Butler | Quaker |
| *Pseudozizeeria maha* Kollar | Pale Grass Blue |
| *Zizeeria karsandra* Moore | Dark Grass Blue |
| *Zizina otis* Fabricius | Lesser Grass Blue |
| *Zizula hylax* Fabricius | Tiny Grass Blue |
| *Chilades laius* Stoll | Lime Blue |
| *Freyeria trochylus* Freyer | Grass Jewel |
| *Lampides boeticus* L., | Pea Blue |
| *Jamides bochus* Cramer | Dark Cerulean |
| *Jamides celeno* Cramer | Common Cerulean |
| *Jamides alecto* Felder | Metallic Cerulean |
| *Nacaduba pactolus* | Large four line blue |
| *Nacaduba hermus* | Pale-4 line Blue |
| *Prosotas nora* C & R Felder | Common Lineblue |

| | |
|---|---|
| *Prosotas dubiosa* | Tailless Lineblue |
| *Talicada nyseus* Guerin-Meneville | Red Pierrot |
| Lycaenidae: Theclinae: Arhopalini | |
| *Arhopala amantes* Hewitson | Large Oakblue |
| *Thaduka multicaudata* Moore | Many-tailed Oakblue |
| **Lycaenidae: Theclinae: Amblypodiini** | |
| *Iraota timoleon* Stoll | Silverstreak Blue |
| *Amblypodia anita* Hewitson | Leaf Blue |
| **Lycaenidae: Theclinae: Aphnaeini** | |
| *Spindasis vulcanus* Fabricius | Common Silverline |
| **Lycaenidae: Theclinae: Loxurini** | |
| *Loxura atymnus* | Yamfly |
| **Lycaenidae: Theclinae: Horagini** | |
| *Rathinda amor* | Monkey Puzzle |

| Species | Common Name |
|---|---|
| Lycaenidae: Theclinae: Hypolycaenini | |
| *Zeltus amasa* | Fluffy tit |
| **Lycaenidae: Theclinae: Deudorigini** | |
| *Deudorix epijarbas* | Cornelian |
| *Deudorix isocrates* | Common Guva Blue |
| *Rapala manea* Hewitson | Slate Flash |
| *Rapala varuna* Moore | Indigo Flash |
| Lycaenidae: Curetinae | |
| *Curetis thetis* | Indian Sunbeam (PI&SL) |
| **Family: Hesperiidae** | |
| Hesperiidae: Coeliadinae | |
| *Bibasis sena* Moore | Orange Tail Awl |
| *Hasora chromus* Cramer | Common Banded Awl |
| *Hasora badra* Moore | Common Awl |
| *Badamia exclamationis* Fabricius | Brown awl |
| **Hesperiidae: Pyrginae** | |
| *Celaenorrhinus leucocera* Kollar | Common Spotted Flat |
| *Celaenorrhinus ambareesa* Moore | Malabar Spotted Flat |
| *Tagiades japetus* Cramer | Common Snow Flat |
| *Tagiades litigiosa* Moschler | Water Snow Flat |
| *Tagiades gana* Moore | Immaculate or Suffused Snow Flat |
| *Pseudocoladenia dan* Fabricius | Fulvous Pied Flat |
| *Coladenia indrani* Moore | Tricolor Pied Flat |
| *Sarangesa dasahara* Moore | Common Small Flat |
| *Sarangesa purendra* Moore | Spotted Small Flat (WG) |
| *Odontoptilum angulatum* C&R Felder | Chestnut or Banded Angle |
| *Spialia galba* Fabricius | Indian Grizzled Skipper |
| **Hesperiidae: Hesperiinae** | |
| *Ampittia dioscorides* | Bush Hopper |
| *Halpe porus* | Moore's ace |
| *Lambrix salsala* Moore | Chestnut Bob |
| *Notocrypta paralysos* Wood-Mason & de Niceville | Common Banded Demon |
| *Notocrypta curvifascia* C & R Felder | Restricted Demon |
| *Udaspes folus* Cramer | Grass Demon |
| *Suastus gremius* Fabricius | Indian Palm Bob |
| *Suastus sp.* | Bob |

| Species | Common Name |
|---|---|
| *Gangara thyrsis* Fabricius | Giant Redeye |
| *Taractrocera maevius* Fabricius | Common Grass Dart |
| *Talicota colon* Fabricius | Pale Palm Dart |

| | |
|---|---|
| *Borbo cinnara* Wallace | Rice Swift |
| *Pelopidas mathias* | Small branded swift |

Note: * indicates Endangered species (Wildlife Protection Act, 1972)

**WG – indicates Western Ghats endemic**

PI&SL – indicates Endemic to Peninsular India and Sri Lanka.

**Table 9.4:** Butterfly family composition in SVWS.

| Family | India | Western Ghats | Inside the sanctuary | | | |
|---|---|---|---|---|---|---|
| | | | **Total species** | **Endangered** | **Western Ghats Endemics** | **Shared Endemics (Western Ghats and Sri Lanka)** |
| Papilionidae | 107 | 19 | 19 | 2 | 5 | 3 |
| Pieridae | 109 | 33 | 23 | | | 2 |
| Nymphalidae | 520 | 96 | 65 | 2 | 3 | 6 |
| Lycaenidae | 450 | 101 | 38 | | | 1 |
| Hesperiidae | 320 | 81 | 28 | | 1 | |

## Molluscs

Molluscs are one of the most diverse groups of invertebrates - both in form and habitat. They have figured prominently in palaeobiological and biological studies, and have served as study organisms in numerous evolutionary, biomechanical, ecological, physiological, and behavioural studies. Many species of freshwater mussels and snails are threatened or endangered throughout the world. Twenty-one species belonging to 7 families were recorded from different localities. The list of species collected has been given in Table 9.5. The plight of freshwater mussels is a prime example of the decline of aquatic habitats and the species that inhabit them. If trends are not reversed and stream degradation and loss of habitat continues many of the interesting and beautiful molluscs will be lost forever.

**Table 9.5: Mollusc species in SVWS**

| Family | Genera/Species |
|---|---|
| Cyclophoridae | Alycaeus expatriatus |
| Cyclophoridae | Cyclophorus jerdoni |
| Cyclophoridae | *Theobaldius* Sp. |
| Cyclophoridae | *Craspedoptris* Sp. |
| Cyclophoridae | *Cyathophoma* Sp. |
| Diplommatinidae | Nicida liricincta |
| Diplommatinidae | Ophisthosoma deccanense |
| Ariophantidae | Ariophanta immerita |
| Ariophantidae | Ariophanta canarica |
| Ariophantidae | *Ariophanta* Sp. |
| Ariophantidae | *Euplecta* Sp. |
| Ariophantidae | *Macrochalmys* Sp. |
| Helixarionidae | *Kaliella* Sp. |
| Helixarionidae | Kaliella sigurensis |
| Streptaxidae | Streptaxis canarica |
| Subulinidae | *Glessula* Sp. *a* |

| | |
|---|---|
| Subulinidae | *Glessula* Sp. *b* |
| Subulinidae | *Glessula* Sp. *c* |
| Subulinidae | *Glessula* Sp. *d* |
| Subulinidae | *Opeas* Sp. |
| Vertiginidae | *Pupisoma* Sp. |
| Unidentified | Unidentified |

**Reptiles**

157 species of reptiles including a crocodile *Crocodulus palustris* is known from the Western Ghats. Out of 157 species 97 are endemics and majority of them are snakes. Twenty-three species of reptiles were recorded in the present study (Table 10.1). Three endemic species, viz., skink, malabar pit viper and bamboo pit viper were also recorded. Tortoises are commonly found in the reservoir. Crocodile (*Crocodulus palustris)* was recorded from reservoir at Madenur and Muppane area during the study. Two juveniles were caught in the nets of the fishermen at Holebagilu. There was an instance of livestock death due to crocodile at Muppane. King cobra is found in shady places and in the riparian vegetation dominated by *Ochlandra* sp. Malabar pit viper is found in between the buttresses of the huge trees of species like, *Ficus nervosa*, *Syzigium gardneri* and on the medium height shrubs. Hump nosed pit viper is found concealing in the litter cover.

**Table 10.1: Reptiles of SVWS**

| Common Name | Scientific Name | IUCN Status |
|---|---|---|
| Crocodile | *Crocodylus palustris* | VU |
| Common Indian Monitor Lizard | *Varnus bengalensis* | VU |
| Flapshell turtles | *Lissemys punctata* | Lr-lc |
| Indian Chameleon | *Chameleon zeylanicus* | VU |
| House Gecko | *Hemidactylus frenatus* | Lr-lc |
| Gunther's Supple Skink | **Lygosoma guentheri* | Lr-nt |
| King Cobra | *Ophiophagus hannah* | Lr-nt |
| The Cobra | *Naja naja* | Lr-nt |
| The Krait | *Bungarus caeruleus* | Lr-nt |
| Russell's Viper | *Daboia russelli* | Lr-nt |
| Hump-nosed Pit Viper | *Hypnale hypnale* | Lr-nt |
| Saw Scaled Viper | **Echis carinatus* | Lr-nt |
| Malabar Pit Viper | **Trimersurus malabaricus* | Lr-nt |
| Bronzebacked Tree Snake | *Dendrelaphis tristis* | Lr-lc |
| The Vine Snake | *Ahaetulla nasuta* | Lr-nt |
| Flying Snake | *Chrysopelea ornata* | Lr-nt |
| Trinket Snake | *Elaphe helena helena* | Lr-nt |
| Checkered Keelback | *Xenochrophis piscator piscator* | Lr-lc |
| Montane Keelback | **Amphiesma monticola* | Lr-nt |
| Common Sand Boa | *Eryx conicus conicus* | Lr-nt |
| Shieldtail | **Uropeltis sp.* | |
| The Rat Snake | *Ptyas mucosus* | Lr-nt |
| Python | *Python molurus* | Lr-nt |

Note: * Western Ghats endemic
VU – Vulnerable, LR-lc – Lower risk least concerned, LR-nt – Lower risk near threatened.

**Avifauna**

Birds are a unique group of vertebrates and can indicate the quality of habitat or environment. In the ecosystem studies, birds play a pivotal role as predators of lower organisms and prey to higher vertebrates. The bird diversity of an area not only indicates its health but also stability. A total of 122 bird species were sighted in the sanctuary area during the study period (Table 10.2). Inside the sanctuary, few localities are very important in bird diversity like, Muppane, Kanur and Govardhanagiri state forest. Muppane nature camp is an important area for bird watching as it is surrounded by heterogenous habitats from Scrub jungle to Semi-evergreen forest and also reservoir. The presence of some of the endemic and endangered species like, Malabar Grey Hornbill, and Great Indian Hornbill found in these areas signifies the presence of primary forest remnants. During the study, a flock of great Indian hornbill with 14 individuals were found in the Govardhanagiri forest. Apart from that, in some of the islands, malabar grey and Malabar Pied Hornbill are encountered which in turn shows the presence of endemic tree species, like, *Myristica malabarica*, *Knema attenuata*. In some of the forest enclosures the presence of green pigeons, hornbills and parakeets signifies also the presence of their foraging plant species.

**Table 10.2: Birds of SVWS**

| Family | Sub-family | Common name | Scientific name |
|---|---|---|---|
| Podicipitidae | | Little grebe | *Podiceps ruficollis (Pallas)* |
| Phalacrocoracidae | | Large cormorant | *Phalacrocorax carbo L.,* |
| | | Little cormorant | *Phalacrocorax niger Vieillot* |
| | | Darter | *Anhinga rufa (Daudin)* |
| Ardeidae | | Night heron | *Nycticorax nycticorax L.,* |
| | | Purple heron | *Ardea purpurea L.,* |
| | | Grey heron | *Ardea cinerea L.,* |
| | | Paddy bird | *Ardeola grayii (Sykes)* |
| | | Cattle egret | *Bubulcus ibis L.,* |
| | | Median egret | *Egretta intermedia (Wagler)* |
| | | Little egret | *Egretta garzetta L.,* |
| Ciconiidae | | White necked stork | *Ciconia episcopus (Boddaert)* |
| Threskiornithidae | | White ibis | *Threskiornis aethiopica (Latham)* |
| Accipitridae | | Pariah kite | *Milvus migrans (Boddaert)* |
| | | Brahminy kite | *Haliastur indus (Boddaert)* |
| | | Shikra | *Accipiter badius (Gmelin)* |
| | | Tawny eagle | *Aquila vindhiana Franklin* |
| | | Crested serpent eagle | *Spilornis cheela (Latham)* |
| | | Indian griffon vulture | *Gyps fulvus (Hablizl)* |
| Phasianidae | | Grey jungle fowl | *Gallus sonneratii Temminck* |
| | | Red spurfowl | *Galloperdix spadicea (Gmelin)* |
| | | Common pea fowl | *Pavo cristatus L.,* |
| Rallidae | | White breasted waterhen | *Amaurornis phoenicurus (Pennant)* |
| Jacanidae | | Bronzewinged jacana | *Metopidius indicus Latham* |
| Charadriidae | Charadriinae | Spotted sandpiper | *Tringa glareola L.,* |
| | | Little ringed plover | *Charadrius dubius Scopoli* |
| | | Redwattled lapwing | *Vanellus indicus (Boddaert)* |

| | | | |
|---|---|---|---|
| | | Yellowwattled lapwing | *Vanellus malabaricus (Boddaert)* |
| Laridae | | River tern | *Sterna aurantia J.E.Gray* |
| Columbidae | | Orangebreasted green pigeon | *Treron pompadora (Jerdon)* |
| **Family** | **Sub-family** | **Common name** | Scientific name |
| | | Greyfronted green pigeon | *Treron pompadora (Gmelin)* |
| | | Green imperial pigeon | *Ducula aenea L.,* |
| | | Blue rock pigeon | *Columba livia (Gmelin)* |
| | | Spotted dove | *Streptopelia senegalensis (Scopoli)* |
| | | Emerald dove | *Chalcophaps indica L.,* |
| Psittacidae | | Roseringed parakeet | *Psittacula krameri (Scopoli)* |
| | | Blossomheaded parakeet | *Psittacula cyanocephala (L.,)* |
| | | Lorikeet | *Loriculus vernalis (Sparrman)* |
| | | Bluewinged parakeet | *Psittacula columboides (Vigors)** |
| Cuculidae | | Cuckoo | *Cuculus canorus L.,* |
| | | Indian cuckoo | *Cuculus micropterus Gould* |
| | | Koel | *Eudynamys scolopacea L.,* |
| | | Sirkeer cuckoo | *Taccocua leschenaultii Lesson* |
| | | Crow-pheasant | *Centropus sinensis Stephens* |
| Strigidae | Striginae | Forest eagle-owl | *Bubo nipalensis Hodgson* |
| Trogonidae | | Southern trogon | *Harpactes fasciatus (Pennant)* |
| Alcedinidae | | Small blue kingfisher | *Alcedo atthis L.,* |
| | | Whitebreasted kingfisher | *Halcyon smyrnensis L.,* |
| | | Small blue kingfisher | *Alcedo atthis (L.,)* |
| | | Pied kingfisher | *Ceryle rudis L.,* |
| Meropidae | | Chestnutheaded bee-eater | *Merops leschenaulti (Vieillot)* |
| | | Small green bee-eater | *Merops orientalis (Latham)* |
| Upupidae | | Hoopoe | *Upupa epops L.,* |
| Bucerotidae | | Common grey hornbill | *Tockus birostris (Scopoli)* |
| | | Malabar grey hornbill | *Tockus griseus Latham* |
| | | Great pied hornbill | *Buceros bicornis L., ** |
| | | Malabar pied hornbill | *Anthracoceros malabaricus Boddaert ** |
| Capitonidae | | Crimson throated barbet | *Megalaima rubricapilla Gmelin* |
| | | Small green barbet | *Megalaima viridis Boddaert* |
| | | Large green barbet | *Megalaima zeylanica Gmelin* |
| Picidae | | Indian goldenbacked threetoed woodpecker | *Dinopium javanense (Ljungh)* |
| | | Great black woodpecker | *Dryocopus javensis (Horsfield)* |
| | | Heartspotted woodpecker | *Hemicircus canente L.,* |
| | | Great black woodpecker | *Dryocopus javensis (Horsfield)* |
| Alaudidae | | Crested lark | *Galerida cristata (L.,)* |
| **Family** | **Sub-family** | **Common name** | Scientific name |
| Hirundinidae | | Swallow | *Hirundo rustica L.,* |
| | | Wiretailed swallow | *Hirundo smithii Leach* |
| Oriolidae | | Golden oriole | *Oriolus oriolus L.,* |
| | | Blackheaded oriole | *Oriolus xanthornus L.,* |
| Daniidae | | Rufousbacked shrike | *Lanius schach L.,* |
| Dicruridae | | Black drongo | *Dicrurus adsimilis (Bechstein)* |
| | | Racket-tailed drongo | *Dicrurus paradiseus L.,* |
| Sturnidae | | Brahminy myna | *Sturnus pagodarum (Gmelin)* |
| | | Rosy pastor | *Sturnus roseus L.,* |
| | | Indian myna | *Acridotheres tristis L.,* |
| | | Jungle myna | *Acridotheres fuscus (Wagler)* |
| | | Hill myna | *Gracula religiosa L.,* |

| | | | |
|---|---|---|---|
| | | Bank myna | *Acridotheres ginginianus (Latham)* |
| Corvidae | | House crow | *Corvus splendens Vieillot* |
| | | Tree pie | *Dendrocitta vagabunda (Latham)* |
| Campephagidae | | Scarlet minivet | *Pericrocotus roseus (Forster)* |
| Irenidae | | Iora | *Aegithina tiphia L.,* |
| | | Goldmantled chloropsis | *Chloropsis cochinchinensis (Gmelin)* |
| | | Fairy bluebird | *Irena puella (Latham)* |
| Pycnonotidae | | Redvented bulbul | *Pycnonotus cafer L.,* |
| | | Rubythroated bulbul | *Pycnonotus melanicterus gularis Gould* |
| | | Greyheaded bulbul | *Pycnonotus priocephalus Jerdon* |
| | | Redwhiskered bulbul | *Pycnonotus jocosus L.,* |
| | | Yellowbrowed bulbul | *Hypsipetes indicus (Jerdon)* |
| Muscicapidae | Timaliinae | Common babbler | *Turdoides caudatus (Dumont)* |
| | | Rufous babbler | *Turdoides subrufus (Jerdon)* |
| | | Blackheaded babbler | *Rhopocichla atriceps* |
| | | Jungle babbler | *Turdoides striatus (Dumont)* |
| | | Slatyheaded scimitar babbler | *Pomatorhinus horsfieldii Sykes* |
| | Muscicapinae | Paradise flycatcher | *Terpsiphone paradisi L.,* |
| | | Redbreasted flycatcher | *Muscicapa ruficauda Swainson* |
| | | Verditer flycatcher | *Muscicapa thalassina Swainson* |
| | Sylviinae | Indian greatreed warbler | *Acrocephalus stentoreus (Hemprich & Ehrenberg)* |
| | Turdinae | Magpie-robin | *Copsychus saularis L.,* |
| **Family** | **Sub-family** | **Common name** | Scientific name |
| | | Indian robin | *Saxicoloides fulicata L.,* |
| | | Blue chat | *Erithacus brunneus (Hodgson)* |
| | | Blue rock thrush | *Monticola solitarius L.,* |
| | | Malabar whistling thrush | *Myiophonus horsfieldii (Vigors)* |
| | | Orangeheaded ground thrush | *Zoothera citrina (Latham)* |
| Paridae | Parinae | Yellowcheeked tit | *Parus xanthogenys Vigors* |
| Sittidae | Sittinae | Velvetfronted nuthatch | *Sitta frontalis Swainson* |
| Motacillidae | | Forest wagtail | *Motacilla indica Gmelin* |
| | | Yellow wagtail | *Motacilla flava L.,* |
| | | Yellowheaded wagtail | *Motacilla citreola Pallas* |
| | | Grey wagtail | *Motacilla cinerea Tunstall* |
| | | White wagtail | *Motacilla alba L.,* |
| | | Large pied wagtail | *Motacilla maderaspatensis* |
| Dicaeidae | | Thickbilled flowerpecker | *Dicaeum agile (Tickell)* |
| Nectariniidae | | Purplerumped sunbird | *Nectarinia zeylonica L.,* |
| | | Small sunbird | *Nectarinia minima (Sykes)* |
| | | Purple sunbird | *Nectarinia asiatica (Latham)* |
| Zosteropidae | | White-eye | *Zosterops palpebrosus (Temminck)* |
| Ploceidae | Passerinae | House sparrow | *Passer domesticus L.,* |
| | Ploceinae | Baya weaver bird | *Ploceus philippinus L.,* |
| | Estrildinae | Spotted munia | *Lonchura punctulata L.,* |
| | | Blackheaded munia | *Lonchura malacca L.,* |
| | | Whitebacked munia | *Lonchura striata L.,* |

* Endemic birds of the region

## Mammals

Mammals are the group of animals that have reached a pinnacle during the evolution of life. In wildlife conservation, prioritisation is mainly given to mammals, because of their direct relevance to human beings. Their presence in the wild is an indication of the health of that habitat. The study area harbours many mammalian species as listed in Table 11**.** Of the 43 mammals recorded from the sanctuary, Tiger and Lion-tailed Macaque are endangered, and leopard is vulnerable. Table 11 also lists the bats (flying mammals) found in this region. The endemic and endangered lion tailed macaque is sighted in the Karani area. Reports indicate their presence in Kogar, Gurta, Kodachadri and Sharavathi valley area. Now its population is on the decline due to the destruction and fragmentation of habitat and hunting for its skin and meat.

Tigers (*Panthera tigris tigris)* inhabit mostly in the evergreen and moist deciduous forests. According to forest department 7 leopard and 2 tigers were found in the sanctuary and its immediate surroundings (Figure 2.3). In the sanctuary area tiger was sighted near Shashichowka, Kogar, Karumane and Karani. Linganamakki catchment area has records of 4 leopards and 6 tigers.

**Table 11: Mammals of SVWS**

| Common Name | Scientific Name | IUCN Status |
|---|---|---|
| Slow Loris | **Loris tardigradus** | Lr-nt |
| Bonnet Macaque | *Macaca radiata* | Lr-lc |
| Lion-tailed Macaque | **Macaca silenus* | EN |
| Hanuman Langur | *Semnopithecus entellus* | |
| Indian Jackal | *Canis aureus* | Lr-lc |
| Indian Fox | *Vulpes bengalensis* | Lr-nt |
| Wild Dog or Dhole | **Cuon alpinus* | Lr-nt |
| Sloth Bear | *Melursus ursinus* | VU |
| Common Otter | *Lutra lutra* | NE |
| Jungle Cat | *Felis chaus* | Lr-nt |
| Fishing Cat | *Felis viverrina* | VU |
| Brown Palm Civet | **Paradoxurus jerdoni* | VU |
| Small Indian Civet | *Viverricula indica* | Lr-nt |
| Common Indian Mongoose | *Herpestes edwardsi* | Lr-lc |
| Small Indian Mongoose | *Herpestes auropunctatus* | |
| Three-striped Palm Squirrel | *Funambulus palmarum* | Lr-lc |
| Jungle striped Squirrel | **Funambulus tristriatus* | Lr-nt |
| Indian Giant Squirrel | **Ratufa indica* | VU |
| Common Giant Flying Squirrel | *Petaurista petaurista* | Lr-nt |
| Indian Porcupine | *Hystrix indica* | Lr-lc |
| Indian Pangolin | *Manis crassicaudata* | Lr-nt |
| Black-naped Hare | *Lepus nigricollis* | Lr-lc |
| Leopard | *Panthera pardus* | VU |
| Tiger | *Panthera tigris* | EN |
| Wild Boar | *Sus scrofa cristatus* | Lr-lc |
| Indian Spotted Chevrotain or Mouse Deer | *Tragulus meminna* | Lr-nt |
| Barking deer or The Muntjac | *Muntiacus muntjak* | Lr-lc |
| Spotted Deer or Chital | *Axis axis* | Lr-lc |
| Sambar | *Cervus unicolor* | Lr-lc |

| | | |
|---|---|---|
| The Gaur or Indian Bison | *Bos gaurus* | VU |
| **Common Name** | **Scientific Name** | **IUCN Status** |
| Fulvous fruit bat | **Rousettus leschnaulti** | Lr-lc |
| Black-bearded tomb bat | *Taphozous melanopogon* | Lr-nt |
| Pouch bearing bat | *Saccolaimus saccolaimus* | DD |
| Greater false vampire | *Megaderma derma* | |
| Lesser false vampire | *Megaderma spasma* | DD |
| Blyth's horse-shoe bat | *Rhinolophus lepidus* | Lr-nt |
| Fulvous leaf-nosed bat | *Hipposideros fulvus* | Lr-nt |
| Kantor's leaf-nosed bat | *Hipposideros* Sp. | |
| Schneider's leaf-nosed bat | Hipposideros speoris | *Lr-nt* |
| Kelaart's leaf-nosed bat | *Hipposideros lankadiva* | VU |
| Burmese whiskered bat | *Myotis montivagus* | DD |
| Least pipistrelle | *Pipistrellus tenuis* | Lr-lc |
| Kelaart's pipistrelle | *Pipistrellus ceylonicus* | Lr-lc |

Note: * Western Ghats endemic
VU – Vulnerable, EN – Endangered, LR-lc – Lower risk least concerned, LR-nt – Lower risk near threatened, NE - Not evaluated.

**Wildlife census data in the Kogaru and Kargal range in 1997**

| **Animals** | **Kogaru range** | **Kargal range** | |
|---|---|---|---|
| | Block counting | Line transect | Block counting |
| Gaur | 52 | 65 | 61 |
| Spotted deer | 68 | 30 | 36 |
| Sambar | 13 | 18 | 13 |
| Wild Boar | 42 | 60 | 64 |
| Urial | 7 | 3 | 4 |
| Dhole | | 9 | 17 |
| Langur | 122 | 40 | 57 |
| Sloth Bear | 4 | | |
| Monkey | 170 | 25 | 39 |
| Red giant squirrel | 64 | 14 | 7 |
| Peacock | 80 | 17 | 10 |
| Indian Hare | | 6 | 3 |
| Jungle fowl | | 10 | 16 |
| Barking deer | | 5 | 3 |
| Hornbill | | 6 | 2 |
| Owl | | 2 | 2 |
| Monitor lizard | | 4 | 4 |
| Tiger | | 1 | |
| Leopard | 4 (male – 3, female – 1) | 1 (male –1) | |

Source: Tiger, Leopard and other wildlife census of 1997. Office of the Deputy Conservator of Forest, Shimoga Wildlife Division, Shimoga

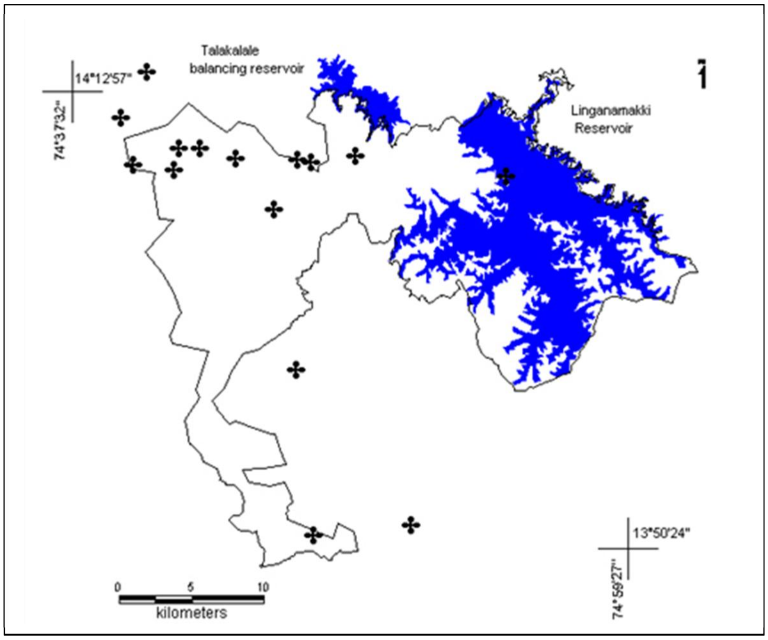



**Figure 2.3:** Tiger and leopard distribution in SVWS.

## Aquatic Ecosystem

Aquatic ecosystems contribute to a large proportion of the planet's biotic productivity as about 30% of the world's primary productivity comes from plants living in the ocean. These ecosystems also include riverbanks, wetlands located at lakeshores, the ocean shoreline, and any habitat where the soil or vegetation is submerged for some duration. These ecosystems have been subjected to various levels of stresses, due to unplanned developmental activities in the last century. Anthropogenic activities involving changes in land use ultimately affects the receiving water in that drainage. Activities include unplanned agricultural practices, unscientific usage of inorganic fertiliser, pesticides and herbicides applied to crops, silt washed away because of vegetation removal, or even due to atmospheric deposition, or disposal of solid and liquid wastes. The Linganamakki reservoir (in eastern part) and Talakalale reservoir (northern side) form a part of the lacustrine ecosystem in SVWS, while many first and second order streams of river Sharavathi and Venkatapura forms the lotic ecosystem in the sanctuary.

### Phytoplankton

Phytoplankton are the microscopic suspended algae that occur in different forms such as unicellular, colonial or filamentous, which are mainly photosynthetic in nature. They are one of the most rapid detectors of environmental change and are regarded as the primary producers in aquatic food chain. The family, genus and species composition of phytoplankton is listed in Table 12.1. Species list is given in Table 12.2

**Table 12.1:** Familywise composition of phytoplankton.

| Family composition | I-collection | II-collection | III -collection |
|---|---|---|---|
| Desmidials | 50 | 51 | 48 |
| Bacillariophyceae | 12 | 25 | 22 |
| Cyanophyceae | 4 | 6 | 6 |
| Chlorococcales | 3 | 9 | 8 |
| Dinophyceae | 2 | 2 | 4 |
| Chrysophyceae | | 1 | 4 |
| Total no. of genera | 44 | 64 | 61 |
| Total no. of species | 71 | 94 | 92 |

Qualitative dominance of the phytoplankton was in the order of Desmidials > Bacillariophyceae > Cyanophyceae >Chlorococcales > Dinophyceae in the first sampling. In this collection population of Desmidial member *Staurastrum multispiniceps* was highest (58,944/L) in Muppane of the reservoir. While, in the second sampling, qualitative dominance was in the order of Desmidials > Bacillariophyceae > Chlorococcales > Cyanophyceae > Dinophyceae >Chrysophyceae. Similarly in the third collection, it was in the order of Desmidials > Bacillariophyceae > Chlorococcales > Cyanophyceae > Dinophyceae = Chrysophyceae. Table 12.3 reveals diversity and diversity indices calculated in various sampling localities.

**Table 12.2: Phytoplankton species in SVWS**

I. Muppane

| **Bacillariophyceae (Diatoms)** | **Collections** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| *Cymbella chandolensis* Gandhi | | + | |
| *Gyrosigma attenuatum* (Kuetz.) Rabh. | | + | |
| *Melosira islandica* O. Muell v. helvetica O. Muell | | + | + |
| *M. granulata* (Ehr.) Ralfs. v. mazzanensis Meister | | | + |
| *Navicula pygmaea* Kuetz. v. indica Skv | + | | |
| *N.viridula* Kuetz. V. capitata Mayer | | + | + |
| *Nitzschia philippinarum* Hustedt | + | | |
| *Pinnularia streptoraphe* Cleve | | | + |
| *Synedra ulna* (Nitz.) Ehr. v. danica Kuetz. Grun. | | | + |
| **Desmidials** | | | |
| *Arthrodesmus curvatus* Turn | + | | |
| *A. psilosporus* (Nodrdst. & Lofg.) De Toni Formae | + | | + |
| *Cosmarium contractum* Kirchn | | + | + |
| *C. ordinatum* (Borges) West & West var.borgei Scott Gronbl. | + | | |

| | | | |
|---|---|---|---|
| *C. lundellii* Delp var circulare (Reinch) Krieg | + | | |
| *C. spinuliferum* West & West | | | + |
| *Desmidium baileyi* (Ralfs) Nordst fa.longiprocessum | + | | |
| *D. baileyi* (Ralfs) Nordst fa. tetragonum Nordst | | + | |
| *Euastrum gnathophorum* West & West | | | + |
| *Spondylosium planum* (Wolle.) West & West | + | | |
| *Staurastrum cerastes* Scott.& Presc. | + | | |
| *S. euprepes* | + | | |
| *S. freemanii* West & West var.nudiceps Scott & Presc. | + | + | + |
| *S. limneticum* Schm. Var. burmense West & West | + | + | + |
| *S. multispiniceps* | + | | + |
| *S. peristephes* | | + | + |
| *S. prionotum* | | + | + |
| *S. sexangulare* Lund var.productum Nordst | + | | |
| *S. tauphorum* West & West | + | | |
| *S. thienemannii* Krieg | | | + |
| *S. tohopekaligense* Wolle var. insigne West & West Formae | + | | + |
| *Triploceros gracile* Bail fa. curvatum | + | + | + |
| *T. gracile* Bail fa. undulatum Scott & Presc. | | | + |
| *Xanthedium hastiferum* Turn. Var. javanicum (Nordst.) Turn. fa. Planum Turn | | | |
| *X. perissacanthum Scott. & Presc. Var. minus.* | + | + | |
| **Chlorococcales** | | | |
| *Ankistrodeimus falcatus* (Corda) Ralfs | + | | + |
| **Cyanophyceae** | | | |
| *Aphanocapsa rivularis* (Carm) Rabenhorst | | | + |
| *Chroococcus limneticus* var.elegans G. M. Smith | + | | |
| *Microcystis aeruginosa* Kuetz, emend, Elenkin | | + | |
| **Dinophyceae** | | | |
| *Ceratium hirundinella* (O.F. Muell) Dujardin | + | | |
| **Chrysophyceae** | | | |
| *Dinobryon sertularia* Ehrberg. | | | |

## II. Talakalale

| **Bacillariophyceae (Diatoms)** | **Collections** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| *Cymbella powaiana* Gandhi | | | + |
| *Gomphonema longiceps* Ehr. v. subclavata Grun | | + | + |
| *Melosira islandica* O. Muell v. helvetica O. Muell | | + | + |
| *Navicula cari* Ehr. | | + | |
| *N.viridula* Kuetz. V. capitata Mayer | | + | |
| *Pinnularia maharashtrensis* | | | + |
| *Synedra ulna* (Nitz.) Ehr. v. danica Kuetz. Grun. | | + | |
| **Desmidials** | | | |
| *Arthodesmus psilosporus* (Nodrdst. & Lofg.) De Toni Formae | + | | + |
| *Cosmarium contractum* Kirchn | | + | + |

| | | | |
|---|---|---|---|
| *C. subturgidum* (Turn.) Schm. Fa. minus Schm | | + | |
| *Desmidium baileyi* (Ralfs) Nordst | + | | |
| *D. baileyi* (Ralfs) Nordst fa. tetragonum Nordst | | + | |
| *Euastrum gnathophorum* West & West | | + | + |
| *Spondylosium planum* (Wolle.) West & West | + | | |
| *Staurastrum freemanii* West & West var.nudiceps Scott & Presc. | + | + | + |
| *S. limneticum* Schm. Var. burmense West & West | + | + | |
| *S. longibrachiatum* (Borge) Gutz. | + | | |
| *S. multispiniceps*. | + | | |
| *S. peristephes* | + | + | + |
| *S. prionotum* | | + | + |
| *S. sexangulare* Lund var.productum Nordst | + | | |
| *S. rosei* Playf. var. stemmatum | | | + |
| *S. thienemannii* Krieg fa. triradiatum | | | + |
| *Triploceros gracile* Bail fa. curvatum | | + | |
| *X. perissacanthum Scott. & Presc. Var. minus.* | + | | |
| **Chlorococcales** | | | |
| *Ankistrodeimus falcatus* (Corda) Ralfs | | | + |
| *Eudorina elegans* Ehrenberg | + | | |
| *Scenedesmus acuminatus* (Lag) Chodat | | | + |
| *S. dimorphus* (Turp.) Kuetzing | | + | |
| *S. opoliensis* var contacta Prescott | | | + |
| **Cyanophyceae** | | | |
| *Aphanocapsa rivularis* (Carm) Rabenhorst | | + | |
| *Chroococcus limneticus* var.elegans G. M. Smith | + | | |
| *Coelosphaerium dubium* Grunow | | | + |
| **Dinophyceae** | | | |
| *Ceratium hirundinella* (O.F. Muell) Dujardin | + | + | + |

## III. Reservoir centre

| **Bacillariophyceae (Diatoms)** | **Collections** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| *Cymbella ventricosa* Kuetz. | | + | |
| *Gomphonema lanceolatum* Her | | + | |
| *G. longiceps* Ehr. v. subclavata Grun | + | | + |
| *Gyrosigma attenuatum* (Kuetz.) Rabh. | | + | |
| *Melosira islandica* O. Muell v. helvetica O. Muell | | + | + |
| *Navicula cari* Ehr. | | | + |
| *N.viridula* Kuetz. V. capitata Mayer | | + | + |
| *N. subdapaliformis* Gandhi | + | | |
| *Pinnularia lundii* Hustedt | | | + |
| **Desmidials** | | | |
| *Arthodesmus psilosporus* (Nodrdst. & Lofg.) De Toni Formae | | + | + |
| *Cosmarium contractum* Kirchn | | + | |
| *C. margaritatum* (Lund) Roy & Biss var sublatum (Nordst.) Krieg | | + | |
| *C. scabrum* Turn | | + | |

| | | | |
|---|---|---|---|
| *Desmidium baileyi* (Ralfs) Nordst fa.longiprocessum | + | | |
| *Euastrum ansatum* Ehr. v. Triporum | + | | |
| *E. gnathophorum* West & West var.bulbosum | | + | + |
| *Pleurotaenium ehrenbergi* (Breb.) De Bary v. undulatum Schaarschm | | | + |
| *Spondylosium planum* (Wolle.) West & West | + | | |
| *Staurastrum cerates* Lund var pulchrum Scott & Gronbl. fa | | + | |
| *S. freemanii* West & West var.nudiceps Scott & Presc. | + | + | + |
| *S. limneticum* Schm. Var. burmense West & West | + | + | |
| *S. longibrachiatum* (Borge) Gutz. | + | | |
| *S. multispiniceps* | + | | |
| *S. peristephes* | + | + | |
| *S. prionotum* | | + | + |
| *S. sexangulare* Lund var.productum Nordst | + | | |
| *S. thienemannii* Krieg fa. triradiatum | | + | |
| *X. perissacanthum Scott. & Presc. Var. minus.* | + | | |
| **Chlorococcales** | | | |
| *Ankistrodeimus falcatus* (Corda) Ralfs | | | + |
| *Pediastrum simplex* Meyen | | + | |
| *Scenedesmus acuminatus* (Lag) Chodat | | | + |
| **Cyanophyceae** | | | |
| *Chroococcus limneticus* var.elegans G. M. Smith | + | | |
| *C. turgidus* (kuetz.) Naegeli | | + | |
| *Microcystis aeruginosa* Kuetz, emend, Elenkin | | + | + |
| **Dinophyceae** | | | |
| *Ceratium hirundinella* (O.F. Muell) Dujardin | | | + |

## IV. Yennehole

| **Bacillariophyceae (Diatoms)** | **Collections** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| *Eunotia praerupta* Ehr. | + | + | |
| *Gomphonema gracile* Ehr. v. intricatiforme Mayer | + | | |
| *G.lanceolatum* Her | | + | |
| *Melosira islandica* O. Muell v. helvetica O. Muell | | | + |
| *M. granulata* (Ehr.) Ralfs. v. mazzanensis Meister | | | + |
| *Navicula cuspidata* Kuetz.f.brevirostrata Gandhi | + | | |
| *N. laeta* A. Mayer | + | | |
| *N. viridula* Kuetz. | + | | |
| *Nitzschia closterium* W. Smith | + | | |
| *N. obtusa* W. Smith v. scalpelliformis Grun | + | | |
| *Pinnularia gracioloides* Hustedt | | | + |
| *Synedra acus* Kuetz. | + | | |
| ***Desmidials*** | | | |
| *Arthrodesmus constrictus* G. M Smith var.longispinus Gronbl. | | + | + |
| *A.curvatus* Turn.var.latus | + | | |
| *Closterium ehrenbergii* Menegh | | + | |
| *C. porrectum* Nordst | + | | |

| | | | |
|---|---|---|---|
| *C. ralfsii* Breb var.hybridrum Rab | | + | |
| *Cosmarium askenasyi* Schm.fa.latum Scott & Presc | | | + |
| *C. contractum* Kirchn | | + | |
| *C. decoratum* West & West | | | + |
| *C. pseudoconnatum* Nordst | + | | |
| *C. punctulatum* Breb.var.sub punctulatum (Nordst.) Borges | + | | |
| *Desmidium baileyi* (Ralfs) Nordst fa.longiprocessum | | + | |
| *D. bengalicum* Turn | + | | |
| *D. quadratum* Nordst | | + | |
| *Euastrum gnathophorum* West & West var.bulbosum | | + | |
| *E. sinuosum* Lenorm. var. parallelum Krieg | + | | |
| *Gonatozygon aculeatum* Hastings | | + | + |
| *Hyalotheca dissiliens* (Smith) Breb. var. hains Wolle | + | | |
| *Micrasterias foliacea* Bail var. quadrinflata | | + | |
| *M. mahabuleshwarensis* Hobs.var.chauliodon | + | | |
| *M. quadridentata* (Nordst.) Gronbl.fa, indonesinsis | | | + |
| *Staurastrum anceps* Her. | | + | |
| *S. anceps* Ehr. v. hyalina Brun. et.Perag | | | + |
| *S. freemanii* West & West var.nudiceps Scott & Presc. | + | | + |
| *S. limneticum* Schm. Var. burmense West & West | + | | + |
| *S. multispiniceps* | + | | |
| *S. peristephes* | | + | |
| *S. sebaldi* Reinsch var.ornatum Nordst | | | + |
| *S. tohopekaligense* Wolle var. trifurcatum West & West | + | | |
| *S. wildmanii* Gutw. | | + | |
| **Chlorococcales** | | | |
| *Ankistrodeimus falcatus* (Corda) Ralfs | + | | + |
| *A. spiralis* (Turner) Lemmermann | + | | |
| *Gomphosphaeria aponina* var. delicatula virieux | | + | |
| *Kirchnerilla lunaris* (Krich.) Moebius | + | | |
| *Muogeotia punctata* Wittrock | | + | |
| *Pediastrum simplex* Meyen | | | + |
| *Scenedesmus bijuga* (Turp.) Lagerheim | | + | |
| **Cyanophyceae** | | | |
| *Microcystis aeruginosa* Kuetz, emend, Elenkin | + | + | + |
| *Gomphosphaeria aponina* var. cordiformis Wolle | | | + |
| **Dinophyceae** | | | |
| *Ceratium hirundinella* (O.F. Muell) Dujardin | | | + |
| **Chrysophyceae** | | | |
| *Dinobryon calciformis* Bachmann | | | + |
| *D. divergens* Imhof | | + | |
| *D. sertularia* Ehrbg. | | | + |

## V. Madenur

| **Bacillariophyceae (Diatoms)** | **Collections** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| *Cymbella laevis* Naeg | | + | |

| | | |
|---|---|---|
| *C. ventricosa* Kuetz. | + | |
| *Gomphonema lanceolatum* Her | + | |
| *G. longiceps* Ehr. v. subclavata Grun | + | + |
| *Gyrosigma attenuatum* (Kuetz.) Rabh.(Nordst & Lofg.) De Toni | + | |
| *Melosira granulata* (Ehr.) Ralfs. v. mazzanensis Meister | | + |
| *M. islandica* O. Muell v. helvetica O. Muell | + | + |
| *Navicula viridula* Kuetz. V. capitata Mayer | + | + |
| *Nitzschia obtusa* W. Smith v. scalpelliformis Grun | + | |
| *N. radiosa* Kuetz. | + | |
| ***Desmidials*** | | |
| *Arthodesmus psilosporus* (Nodrdst. & Lofg.) De Toni Formae | + | + |
| *Cosmarium contractum* Kirchn | | + |
| *Desmidium bengalicum* Turn fa.quadratum | + | |
| *Euastrum gnathophorum* West & West var.bulbosum | + | + |
| *Onychonema laeve* Nordst. var. latum West & West | | + |
| *Staurastrum cerates* Lund var pulchrum Scott & Gronbl. fa | + | |
| *S. emaciatum* | + | |
| *S. freemanii* West & West var.nudiceps Scott & Presc. | + | + |
| *S. gralile* Ralfs fa. Kriegeri | | + |
| *S. limneticum* Schm. Var. burmense West & West | + | + |
| *S. multispiniceps* | + | |
| *S. prionotum* | + | + |
| *S. tohopekaligense* Wolle var. insigne West & West Formae | + | |
| *S. sebaldi* Reinsch var.ventriverrucosum | | + |
| *Triploceros gracile* Bail fa. undulatum Scott & Presc. | | + |
| *Xanthedium perissacanthum Scott. & Presc. Var. minus.* | + | |
| **Chlorococcales** | | |
| *Muogeotia punctata* Wittrock | + | |
| *Spirogyra rhizobrachialis* Jao | + | + |
| **Cyanophyceae** | | |
| *Chroococcus turgidus* (kuetz.) Naegeli | + | |
| *Gomphosphaeria lacustris* Chodat | | + |
| *Microcystis aeruginosa* Kuetz, emend, Elenkin | + | |
| **Dinophyceae** | | |
| *Ceratium hirundinella* (O.F. Muell) Dujardin | | + |
| **Chrysophyceae** | | |
| *Dinobryon calciformis* Brachmann | | + |

**Table 12.3:** Diversity indices at various sampling localities.

| **Parameter** | *Collection* | **Muppane** | **Talakalale** | **Reservoir Centre** | **Yenne holé** | **Madenur** |
|---|---|---|---|---|---|---|
| Total individual | 1 | 10339 | 2770 | 3414 | 820 | - |
| | 2 | 49 | 96 | 33 | 437 | 74 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 232 | 59 | 88 | 585 | 175 |
| | 1 | 21 | 13 | 14 | 23 | - |
| Total species | 2 | 15 | 18 | 18 | 19 | 24 |
| | 3 | 21 | 17 | 15 | 20 | 19 |
| | 1 | 2.16 | 1.51 | 1.59 | 3.27 | - |
| Species richness | 2 | 3.59 | 3.72 | 4.86 | 2.96 | 5.34 |
| | 3 | 3.67 | 3.92 | 3.12 | 2.98 | 3.48 |
| | 1 | 1.96 | 1.85 | 2.24 | 2.69 | - |
| Shannon-diversity | 2 | 2.43 | 2.11 | 2.75 | 1.97 | 2.85 |
| | 3 | 1.57 | 2.45 | 2.21 | 1.57 | 2.21 |
| | 1 | 0.2 | 0.22 | 0.12 | 0.09 | - |
| Simpson-dominance | 2 | 0.11 | 0.23 | 0.07 | 0.24 | 0.07 |
| | 3 | 0.4 | 0.12 | 0.14 | 0.38 | 0.15 |
| | 1 | 0.79 | 0.77 | 0.87 | 0.9 | - |
| Simpson-diversity | 2 | 0.88 | 0.76 | 0.92 | 0.75 | 0.92 |
| | 3 | 0.59 | 0.87 | 0.85 | 0.61 | 0.84 |

Abrupt variations in total number of individuals indicate that the growth and distribution patterns of phytoplankton are not uniform. High total number of individuals during I-collection compared to other two can be attributed to the rains during the month of September just prior to I-collection during October, which might have added nutrients to the waters along with run-off water from the catchment.

In order to apply biological means of determining the trophic status, Shannon and Weiner's species diversity values were calculated. The degrees of pollution is categorized based on the ranges of Shannon and Wiener's species diversity as 'slight' (species diversity range of 3.0 – 4.5), 'light' (2.0 – 3.0), 'moderate' (1.0 – 2.0) and 'heavy' (0.0 – 1.0).

From Table 12.3 it is clear that in general, species diversity values are in the range of moderate or light pollution level. From Shannon's diversity indices it is clear that the waters of sanctuary area are of oligotrophic nature.

A total of 109 species are collected from the SVWS; 28 species of diatoms, 58 species of desmidials, 12 species of chlorococales, 7 species of cynophyceae, 3 species of chrysophyceae and a species of dinophyceae represent total number. The biological examination of the stream and reservoir ecosystems showed a rich and diverse phytoplankton population. Desmids predominated in reservoir waters while diatoms in streams.

**Zooplankton**

Zooplankton are the primary consumers of an aquatic ecosystem, which feed on phytoplankton. Rotifera, Cladocera and Copepoda are the major groups among freshwater zooplankton. A detailed knowledge about zooplankton composition and their seasonal fluctuations is essential for proper management of water bodies. To study the zooplankton diversity in aquatic systems of the SVWS water samples were collected at Muppane, Talakalale, Reservoir center and Yenneholé. Majority of rotifers inhabits freshwater but some genera also occur in brackish water and marine environment. Most species are free-living while some are epizoic or parasitic. Generally the size of the rotifera range from 400 µm to 0.2 mm. Six species belonging to two families are recorded in the present study. Number of species belonging to rotifers, cladocerons and copepoda are given in Table 12.4.

**Table 12.4:** Zooplankton of SVWS

| Groups | Family | Muppane | Talakalale | Reservoir Centre | Yenneholé |
|---|---|---|---|---|---|
| Rotifera | Brachionidae | 1 | 0 | 1 | 1 |
| | Lecanidae | 1 | 2 | 1 | 3 |
| Cladocera | Sididae | 1 | 0 | 0 | 0 |
| | Daphnidae | 1 | 1 | 0 | 0 |
| | Moinidae | 1 | 0 | 1 | 0 |
| | Macrothricidae | 0 | 0 | 0 | 1 |
| | Chydoridae | 1 | 0 | 0 | 1 |
| Copepoda | Cyclopidae | 0 | 0 | 0 | 1 |
| | Diaptomidae | 1 | 1 | 1 | 0 |

Cladocerans are ubiquitous in distribution, *i.e.,* they are found in the Arctic to Antarctic, in temperate and tropical latitudes. Recently they were also reported from ground water (Dumont, 1987; Negrea 1983). The size ranges from 0.2 mm to 18 mm. Like other Zooplankton cladocerans are excellent food for zooplanktivorous fish. Six species belonging to five families are recorded in the present study (Table 12.4). Copepods are the very ancient arthropods. In inland waters copepods are well known, up to family level, but numerous species are yet to be discovered. Of the three groups of zooplankton, Copepoda was least represented in terms of diversity with only three species (Table 12.4).

In the present study, 15 species of zooplankton were recorded from four localities along the River Sharavathi, showing a typical tropical assemblage. Table 12.5 lists locality-wise species list. Large zooplankton species were absent in this river system, probably due to high predatory pressure.

**Table 12.5: Zooplankton diversity in SVWS**

Rotifers

| Species | Sites | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Family: Brachionidae** | | | | |
| *Brachionus quadridentatus* Hemann, 1783 | | | + | |
| *B. falcatus* (Zacharias, 1898) | + | | | |
| *Keratella tropica* (Apsein, 1907) | | | | + |
| **Family: Lecanidae** | | | | |
| *Lecane bulla* (gosse, 1888). | + | + | + | + |
| *L. lateralis* sharma, 1978. | | | | + |
| *Lecane* sp. | | + | | + |

Cladocerans

| Species | Sites | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Family: Sididae** | | | | |
| *Diaphanosoma sarsi* Richard, 1895 | + | | | |
| **Family: Daphniidae** | | | | |
| *Ceriodaphnia cornuta* Sars, 1885 | + | + | | |
| **Family: Moinidae** | | | | |
| *Moina micrura* Kurz, 1874 | + | | + | |
| **Family: Macrothricidae** | | | | |
| *M. odiosa* (Gurney, 1907) | | | | + |
| **Family: Chydoridae** | | | | |
| Sub-family: Chydorinae | | | | |
| *Ephimeroporus barrosi* (Richard, 1894) | + | | | |
| **Sub-family: Aloninae** | | | | |
| *Alona verrucosa* (Sars, 1901) | | | | + |

Copepodans

| Species | Sites | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Family: Cyclopidae** | | | | |
| **Sub-family: Cyclopinae** | | | | |
| *Microcyclops varicans* Sars, 1863 | | | | + |
| **Family: Diaptomidae** | | | | |
| *Heliodiptomus cinctus* (Gurney, 1907) | | | + | |
| *Allodiaptomus mirabilipes* (Kiefer, 1936) | + | + | | |

**Ichthyofauna**

The Western Ghats records 288 species belonging to 12 orders, 41 families and 109 genera, of which 118 species are endemic and 51 are unique. This diverse fish fauna composition aptly demonstrates the hotspots status of the Western Ghats. A major portion of the Linganamakki reservoir falls under the SVWS. The ichthyological studies gain importance, as it helps to adopt appropriate conservation strategies for sustainable management of the aquatic ecosystem. Several rivers in the Western Ghats are being exploited for fisheries and there is hardly any information available on its effect on such a pristine resource stock of the region. This necessitates a detailed investigation on fish and fisheries.

We have recored from SVWS 60 species of fishes (Table 13.1). Considering the IUCN status of these species, there are about 16.6% (10 species) endangered, 18.3% (11 species) vulnerable, 16.6% (10 species) data deficient, 33.2% (20 species) are with lower risk and the status of 3 species is unknown. There is about 16 endemic fish species in the reservoir. Compared to the Western Ghats this value is relatively low, which could be attributed to the formation of the reservoir that has lead to the flourishing of generalist species and diminishing of sensitive endemic species. Also, the introduction of the exotic species into the reservoir has increased the species richness while decreasing the endemism. About 16.6% (10 species) are restricted to peninsular India and 41.6% (25 species) have their distribution all over India.

**Table 13.1: Fish species in SVWS**

| Family | Species | Distribution | IUCN status |
|---|---|---|---|
| Bagridae | *Batasio sharavatiensis* | Endemic to Sharavathi | DD |
| Bagridae | *Mystus malabaricus* | Endemic to Western Ghats | EN |
| Balitoridae | *Nemacheilus anguilla* | Endemic to Western Ghats | LR |
| Balitoridae | *Schistura semiarmatus* | Endemic to Western Ghats | VU |
| Cyprinidae | *Barilius bakeri* | Endemic to Western Ghats | VU |
| Cyprinidae | *Barilius canarensis* | Endemic to Western Ghats | DD |
| Cyprinidae | *Barilius gatensis* | Endemic to Western Ghats | DD |
| Cyprinidae | *Garra gotyla stenorhynchus* | Endemic to Western Ghats | EN |
| Cyprinidae | *Gonoproktopterus dubius*? | Endemic to Western Ghats | EN |
| Cyprinidae | *Gonoproktopterus kolus* | Endemic to Western Ghats | EN |
| Cyprinidae | *Labeo kontius* | Endemic to Western Ghats | LR |
| Cyprinidae | *Osteocheilichthys nashii* | Endemic to Western Ghats | VU |
| Cyprinidae | *Puntius arulius* | Endemic to Western Ghats | EN |
| Cyprinidae | *Puntius sahyadriensis* | Endemic to Western Ghats | DD |
| Cyprinidae | *Salmostoma boopis* | Endemic to Western Ghats | LR |
| Sisoridae | *Glyptothorax lonah* | Endemic to Western Ghats | LR |

| | | | |
|---|---|---|---|
| Cichlidae | *Oreochromis mossambica* | Exotic | |
| Bagridae | *Mystus bleekeri* | India | VU |
| Bagridae | *Mystus cavesius* | India | LR |
| Balitoridae | *Acanthocobitis botia* | India | LR |
| Belonidae | *Xenentodon cancilla* | India | LR |
| Chandidae | *Chanda nama* | India | VU |
| Chandidae | *Parambassis ranga* | India | DD |
| Channidae | *Channa marulius* | India | LR |
| Channidae | *Channa orientalis* | India | VU |
| Claridae | *Clarias batrachus* | India | VU |
| Cyprinidae | *Amblypharyngodon mola* | India | LR |
| Cyprinidae | *Barilius bendelisis* | India | LR |
| Cyprinidae | *Oreichthys cosuatis* | India | DD |
| Cyprinidae | *Puntius chola* | India | VU |
| Cyprinidae | *Puntius sophore* | India | LR |
| Cyprinidae | *Puntius ticto* | India | LR |
| Cyprinidae | *Rasbora daniconius* | India | LR |
| Cyprinidae | *Tor mussullah* | India | EN |
| Gobidae | *Glossogobius giuris* | India | LR |
| Mastacembelidae | *Mastacembelus armatus* | India | LR |
| Schilbeidae | *Pseudeutropius atherinoides* | India | EN |
| Siluridae | *Ompok bimaculatus* | India | EN |
| Siluridae | *Ompok pabo*? | India | DD |
| Siluridae | *Wallago attu* | India | EN |
| Cyprinidae | *Brachydanio rerio* | India | LR |
| Claridae | *Clarias dussumieri* | India | VU |
| Aplocheilidae | *Aplocheilus lineatus* | Southern India | LR |
| Bagridae | *Mystus keletius* | Southern India | DD |
| Balitoridae | *Schistura denisonii densisonii* | Southern India | VU |
| **Family** | **Species** | **Distribution** | **IUCN status** |
| Belontidae | *Pseudophromenus cupanus* | Southern India | DD |
| Cobitinae | *Lepidocephalus thermalis* | Southern India | LR |
| Cyprinidae | *Cirrhinus fulungee* | Southern India | LR |
| Cyprinidae | *Danio aequipinnatus* | Southern India | LR |
| Cyprinidae | *Puntius fasciatus* | Southern India | EN |
| Cyprinidae | *Puntius filamentosus* | Southern India | DD |
| Cyprinidae | *Tor khudree* | Southern India | VU |
| Balitoridae | *Schistura* sp. | | |
| Balitoridae | *Schistura* sp. | | |
| Cyprinidae | *Catla catla* | introduced | |
| Cyprinidae | *Cirhinus mrigala* | introduced | |
| Cyprinidae | *Cyprinus carpio communis* | Exotic | |
| Cyprinidae | *Cyprinus carpio* | Exotic | |
| Cyprinidae | *Cyprinus carpio specularis* | Exotic | |
| Cyprinidae | *Labeo rohita* | introduced | |

Large-scale fishery began in this reservoir with the commissioning of the dam. This commercialisation of inland fishery that took place over a few decades has led to transformation of the subsistence fishing into commercial fishing in the wildlife sanctuary area of the Linganamakki reservoir. The introduction of exotic and alien species in to the Linganamakki reservoir has been practiced since 1965. Fingerlings of *Catla catla, Labeo rohita, Cirhina mrigala, Cyprinus carpio* and *Oreochromis mossambica* are introduced haphazardly into the reservoir on yearly basis.

The commercial fish catch of the reservoir is dominated by species belonging to Cyprinidae (54%). The other major families are Bagridae (23%) and the Siluridae (15%). When biomass is considered, the fast growing Indo-gangetic carps, popularly known as Indian major carps, occupy a prominent place namely *Catla catla* (21%), *Labeo rohita* (8.4%) and *Cirhina mrigala* (6.32%). These fishes are introduced to fulfill the commercial fish requirement along with the exotic species (*Cyprinus carpio* 21%). The native fishes with significant biomass are *Gonoproktopterus kolus* (11.5%), *Ompok bimaculatus* (10%) and *Wallago attu* (9%).

Data on fish catch of the selected five localities (Table 13.2) show that at the center of the reservoir (Holebagilu), the yield variation is very high compared to other regions. During monsoon season, the central region yields the introduced species in bulk. In the peripheral localities (Muppane, Konjavalli, Melmanji and Kogar) variation in catch during two seasons is less.

**Table 13.2:** Fish-catch observed at different locations during the year 2003-04

| **Locality** | **Catch per unit effort (Kg/boat/day)** | |
|---|---|---|
| | **Non-monsoon** | **Monsoon** |
| Holebagilu | 1.34 | 39.4 |
| Muppane | 7.93 | 16.5 |
| Konjavalli | 6.2 | 16.5 |
| Melmanji | 6.8 | 24.2 |
| Kogar | 8.2 | 28.5 |

The fish biomass composition (Table 13.3) in the central region is dominated by introduced species (Holebagilu - 55.8%) during monsoon season. Among the indigenous population, *Ompok bimaculatus* has shown significant biomass in these localities. Whereas in other localities without any introduced species, their catch includes indigenous commercial fishes like *Gonoproktopterus kolus, Wallago attu, Mastacembelus armatus* and *Ompok bimaculatus*. Apart from *G. kolus*, the market value for all indigenous fishes is higher than the introduced species.

**Table 13.3:** Percentage catch composition of various species during monsoon season

| Species name | Percentage biomass | | | | |
|---|---|---|---|---|---|
| | **Holebagilu** | **Muppane** | **Konjavalli** | **Melmanji** | **Kogar** |
| *Catla catla* | 25.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cyprinus carpio* | 12.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Labeo rohita* | 10.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cirhina mrigala* | 7.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Cirhinus fulungee* | 0.0 | 12.7 | 5.4 | 2.5 | 3.2 |
| *Gonoproktopterus kolus* | 0.0 | 39.0 | 43.4 | 38.9 | 43.2 |
| *Mastacembelus armatus* | 8.1 | 9.7 | 12.1 | 4.9 | 8.4 |
| *Mystus bleekeri* | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| *Mystus cavacius* | 9.1 | 7.2 | 1.4 | 0.6 | 0.5 |
| *Mystus malabaricus* | 1.7 | 2.7 | 1.4 | 0.6 | 2.1 |
| *Ompok bimaculatus* | 24.0 | 23.9 | 15.9 | 8.1 | 37.1 |
| *Ompok pabo* | 0.0 | 1.3 | 2.6 | 0.9 | 1.5 |
| *Osteocheilichthys nashii* | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| *Pseudeutropius atherinoides* | 0.0 | 0.2 | 0.3 | 0.1 | 0.2 |
| *Puntius filamentosus* | 0.0 | 1.1 | 1.4 | 1.5 | 3.8 |
| *Tor khudree* | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| *Tor mussullah* | 0.0 | 0.0 | 0.9 | 0.6 | 0.0 |
| *Wallago attu* | 0.0 | 0.0 | 15.1 | 41.2 | 0.0 |
| *Xenentodon cancilla* | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 |

During summer season, catch is mainly represented by *Mystus cavecius, M. malabaricus* and *Mastacembelus armatus* in almost all the localities (Table 13.4). This shows the absence of any introduced species in these localities. At the peripheral localities *Gonoproktopterus kolus* shows significant catch whereas its catch is negligible at the central region.

**Table 13.4:** Percentage catch composition of various species during non-monsoon season

| Species name | Percentage biomass | | | | |
|---|---|---|---|---|---|
| | **Holebagilu** | **Muppane** | **Konjavalli** | **Melmanji** | **Kogar** |
| Native | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| *Gonoproktopterus kolus* | 0.0 | 28.4 | 28.9 | 13.3 | 11.0 |
| *Cirhina fulungee* | 5.6 | 8.5 | 8.4 | 2.2 | 4.6 |
| *Garra gotyla stenorhynchus* | 0.0 | 1.5 | 0.6 | 0.0 | 0.0 |
| *Mastacembelus armatus* | 0.0 | 25.2 | 19.3 | 17.8 | 19.5 |
| *Mystus cavecius* | 16.8 | 3.8 | 6.0 | 8.9 | 14.6 |
| *Mystus malabaricus* | 22.4 | 5.7 | 7.2 | 7.8 | 10.1 |
| *Ompok bimaculatus* | 32.8 | 8.3 | 14.1 | 39.1 | 29.5 |
| *Ompok pabo* | 0.0 | 13.9 | 10.6 | 9.8 | 10.7 |
| *Oreochromis mossambica* | 0.0 | 1.0 | 2.4 | 1.1 | 0.0 |
| *Puntius arulius* | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Puntius filamentosus* | 17.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Tor khudree* | 0.0 | 3.8 | 2.4 | 0.0 | 0.0 |
| *Xenentodon cancilla* | 4.5 | 0.0 | 0.0 | 0.0 | 0.0 |

The fish catch composition shows variations between different sites as the composition in the peripheral regions of the sanctuary like Holebagilu is of introduced species while Yenneholé tributary is of native species.

Fishery in the sanctuary is being practiced illegally and continued overharvesting proves to be unsustainable. Yenneholé tributary has witnessed a self-preserving fishery within the biological limits of its resource's productivity, through a limited seasonal uptake, while ensuring future harvests. On the other hand, Holebagilu region, which supplies the fish requirements of the nearby urban centers has large number of fishermen and wider access and has led to illegal fishing activities.

The fortunes of the fishermen at the central parts of the reservoir like Holebagilu and the Hasaramakki seem to have touched bottom during recent years. During the winter and the summer seasons, the catch kg/per person/day is around one, which fetches about 25 rupees. During monsoon season, they get the introduced species. The competition for food and space between the exotic and indigenous has also led to the decline in the latter.

**Variable fishing pressure:** Monsoon is the peak fishing period with 3.4 times fish catch per person per day compared to non-monsoon period and accounts for 86.7% of the total fish-catch. Increased fishing pressure is noticed with migratory fishermen (accounting to 63% of the total) from various parts of peninsular India and the density of fishermen increases to 2.75 times the native fisher folk. During the initial monsoon season, the reservoir attains the minimum water spread area. It is observed that most of the fishermen get concentrated in the central regions like Holebagilu leading to overexploitation of fish resource.

Muppane, Konjavalli, Melmanji and Kogar represent the peripheral localities of the western region. The biomass composition of this region shows that in these localities, the catch is formed by the native species. These are the flood plains where majority of the fish species breed during monsoon season. Huge quantities of fish catch in these localities during monsoon season poses severe threat to their population. It is evident that the catch per unit effort increases at the periphery than the other localities.

**Fish translocation from other basins:** Details on the pattern of introduction clearly reveal that no scientific approach has been adopted before determining the quantity of introduction. Seeds have been introduced depending on the availability. This unscientific approach has resulted in an artificial system of fishing wherein the indigenous fishing population has to rely on an external source to increase the fishing stock. The low catches during non-monsoon season affect the permanent fishermen of the region who are completely dependent on fish resources for livelihood. The biomass composition of this region also reveals that other than catfishes, no other native species has succeeded to form a stable population. Thus the fishermen are dependent on an artificial system in the form of introduction and harvest. It is implicative that the original fauna has been changed and hardy fish species has taken advantage of the vacant niches. Thus translocation of fishes from other basins has led to changes in the species composition.

**Amphibians**

Amphibians are the best ecological indicators among vertebrates for the unique features like duplex life style, moist permeable skin and ectothermic nature. They are the indicators of habitat fragmentation, as they negatively respond to both qualitative and quantitative changes in the habitat, ecosystem stress, impact of anthropogenic activities like dam construction, and sedimentation in streams due to road construction.

Twenty-four species of amphibians with 178 individuals were recorded in SVWS accounting to 19% of the Western Ghats. Of the 24 species, 16 are endemic (71%) to the Western Ghats. Based on the IUCN criteria for conservation priority, 1 species endangered (*Nyctibatrachus aliciae*), 2 vulnerable, 2 threatened, 14 with least concern and 5 data deficient. These species belong to four families, namely bufonidae, microhylidae, ranidae and ichthyophiidae. Ranidae members predominate in the richness, abundance and endemism (20, 168, and 15). Based on the species abundance (Figure 2.4), the top six species include *Euphlyctis cyanophlyctis* (43) followed by *Philautus* cf. *leucorhinus* (24), *Nyctibatrachus aliciae* (21), *Indirana semipalmata* (16), *Micrixalus saxicola* (11) and *Rana temporalis* (10). Presence of endemics (16 amphibian species), endangered species *Nyctibatrachus aliciae* and vulnerable species *Micrixalus saxicola* and *Nyctibatrachus major* indicates the ecological importance of the region. Species list is provided in Table 13.5.

**Table 13.5: Amphibians of Sharavathi Valley Wildlife Sanctuary**

| Species | Endemism | IUCN status |
|---|---|---|
| Bufonidae | | |
| *Bufo melanostictus* | NE | LC |
| *Bufo scaber* | NE | LC |
| Microhylidae | | |
| *Microhyla ornata* | NE | LC |
| Ranidae | | |
| *Euphlyctis cyanophlyctis* | NE | LC |
| *Fejervarya keralensis* | E | LC |
| *Fejervarya limnocharis* | NE | LC |
| *Fejervarya rufescens* | E | LC |
| *Hoplobatrachus tigerinus* | NE | LC |
| *Indirana beddomii* | E | LC |
| *Indirana semipalmata* | E | LC |
| *Micrixalus saxicola* | E | VU |
| *Nyctibatrachus aliciae* | E | EN |
| *Nyctibatrachus major* | E | VU |
| *Philautus* cf. *leucorhinus* | E | DD |
| *Philautus* cf. *luteolus* | E | DD |
| *Philautus* cf. *ponmudi* | E | DD |
| *Philautus tuberohumerus* | E | DD |
| *Polypedates* cf. *leucomystax* | NE | LC |
| *Rana curtipes* | E | LC |
| *Rana malabarica* | NE | LC |
| *Rana temporalis* | E | NT |
| *Rana* sp. | E | DD |
| *Rhacophorus malabaricus* | E | LC |
| Ichthyophiidae | | |
| *Ichthyophis beddomei* | E | LC |

Note: E – Endemic to Western Ghats; NE – Non-endemic to Western Ghats; EN- Endangered; Vu – vulnerable; NT–Near threatened; LC – Least concerned; DD – data deficient.

**Nair and Gadgil (1975)** reported the elephants during 1960s in SVWS. Over the period the elephants have disappeared from the park. Similarly from the north of the sanctuary i.e. between Sharavathi and Aghanashini rivers also the elephants have disappeared in recent years (**Kumara and Singh 2005b**). The probable reasons could be developmental activities like dam, road and increased number of human enclaves, made them completely isolation from the main population, and probably resulted in biased sex ratios over a period and in turn on breeding efficiency. Further, gradual elimination of the individuals drove into local extinction.

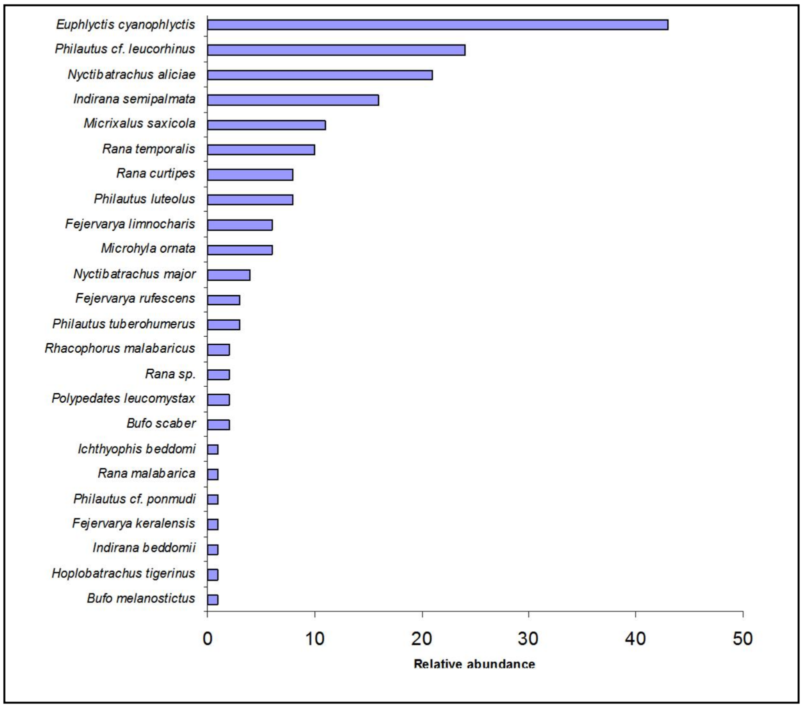



**Figure 2.4:** Amphibian species abundance in SVWS

An assessment of the Ecological status of Sharavathi Valley Wildlife Sanctuary (**Sameer Ali et.al 2007)** carried out through the estimation of species composition and their relative abundance with reference to space and time in a region. Faunal studies indicate the diverse groups of organisms found in the sanctuary. The data gathered both by sampling and opportunistic surveys are listed in Table 14.1.

Table 14.1: Faunal composition in Sharavathi Valley Wildlife Sanctuary

| **Fauna** | **Species** |
|---|---|
| Ants | 84 |
| Coleopterans | 166 |
| Butterflies | 173 |
| Molluscs | 21 |
| Amphibians | 24 |

| | |
|---|---|
| Fishes | 60 |
| Birds | 122 |
| Reptiles | 23 |
| Mammals (including Bats) | 43 |

**Kumara H.N. 2007** studied the mammals of Sharavathi wildlife Sanctuary. A total of 1,332 animals belongs to ten species were sighted in 550 encounters during the day walk (Table 14.2). The ten species includes four arboreal mammals and six terrestrial mammals, and the relative abundance of arboreal mammals (7.19 $\pm$0.471) was more than (z= 14.64, p< .000) the terrestrial mammals (0.24 $\pm$0.056). A total of 50 animals belonging to eight species including two unidentified small carnivores were sighted during the night walk (Table 14.3), which provides an overall relative abundance of 0.87 animals per kilometre. However the relative abundance of arboreal mammals (0.59) was higher than the small carnivores (0.22) and the other mammals include chevrotain and porcupine *Hystrix indica* (0.06), among arboreal mammals the slender loris (0.35) was more than the giant flying squirrel (0.23) and Travancore flying squirrel (0.01).

**Table 14.2: Relative abundance of mammals in the Sharavathi Valley Wildlife Sanctuary**

| Species | No. of sightings | Total no. of animals sighted during the day | No. animals seen/km (SE) |
|---|---|---|---|
| **Arboreal mammals** | | | |
| Hanuman langur | 243 | 835 | 4.52 ($\pm$0.380) |
| Bonnet macaque | 31 | 147 | 0.91 ($\pm$0.241) |
| Lion-tailed macaque | 7 | 23 | 0.12 ($\pm$0.057) |
| Indian giant squirrel | 238 | 287 | 1.54 ($\pm$0.117) |
| Total | 519 | 1292 | 7.19 ($\pm$0.471) |
| **Terrestrial mammals** | | | |
| Gaur | 1 | 1 | 0.004 ($\pm$0.004) |
| Sambar | 9 | 13 | 0.05 ($\pm$0.020) |
| Spotted deer | 4 | 6 | 0.05 ($\pm$0.026) |
| Indian muntjac | 15 | 17 | 0.11 ($\pm$0.030) |
| Wild pig | 1 | 2 | 0.01 ($\pm$0.012) |
| Indian grey mongoose | 1 | 1 | 0.005 ($\pm$0.005) |
| Total | | | |

**Table 14.3: Relative abundance of mammals in Sharavathi Valley Wildlife Sanctuary**

| Species | No. animals seen during the night | No. animals seen/km |
|---|---|---|
| **Small carnivores** | | |
| Leopard cat | 5 | 0.07 |
| Asian palm civet | 3 | 0.04 |
| Brown palm civet | 5 | 0.07 |
| Unidentified small carnivores | 2 | 0.03 |
| Total | 15 | 0.22 |
| **Arboreal mammals** | | |
| Slender loris | 24 | 0.35 |
| Giant flying squirrel | 16 | 0.23 |
| Travancore flying squirrel | 1 | 0.01 |
| Total | 41 | 0.59 |
| **Other mammals** | | |
| Indian spotted chevrotain | 3 | 0.04 |
| Indian crested porcupine | 1 | 0.01 |
| Total | 4 | 0.06 |
| Grand Total | 60 | 0.87 |

Among various anthropogenic impacts, impounding of waters for electricity generation seems to have significantly altered terrestrial as well as aquatic ecosystems and associated biota including fish fauna. In this regard, a study was conducted in Sharavathi River of central Western Ghats to understand fish species composition with respect to landscape dynamics. Of the 64 fish species recorded, 25 were exclusive to the tributary streams, 29 to the reservoir and 10 common to both. Among these, 18 species were endemic to the Western Ghats and 10 to peninsular India. The study, carried out using a combination of remote sensing data as well as field investigations, shows that the streams having their catchments covered with evergreen to semi-evergreen forests, having high levels of ever greenness and endemic tree species of Western Ghats, were also richer in fish diversity and endemism compared to those catchments with other kinds of vegetation. **It also highlights that endangered and endemic fish species are precariously clinging onto the stream habitats where patches of primeval forests, though degraded substantially, are still persisting. This illustrates the composition and a distribution of fish species have strong association with the kind of terrestrial landscape elements and highlights the importance of landscape approach to conservation and management of aquatic ecosystems**. Occurrence of endangered, endemic and discovery of **two new species of *Schistura* genus re-affirms 'hottest hotspot' status of the Western Ghats, a repository of biological wealth of rare kind, both in its aquatic and terrestrial ecosystems**. *Schistura nagodiensis* and *S. sharavathiensis* are the new fish species of *Schistura* described from

Sharavathi River, central Western Ghats. This also reported the range extension of *Schistura nilgiriensis* (earlier *Nemacheilus nilgiriensis,* Jayaram, 1999) from Sharavathi River. **(Annexure 1, 2 & 3)**

**Social Aspects:** The sanctuary is having 40 small villages comprising usually of 1 to 10 houses in each village. These villages are situated in valleys where perennial water source and deep soil is available (figure 3.1). None of the settlements are thickly populated. The people naturally move inside the sanctuary as they are depending upon the sanctuary for their fuel, fodder, small timber and other inevitable forest produces required for normal living.

**Park zonations:** The sanctuary has been divided in to three zones based on the utility. Spatial extent of each zone is provided in Table 15.

1. Core Area or Core Zone.
2. Buffer Area or Buffer Zone.
3. Tourism Area or Tourism Zone.

**Table 15: Zonations of Sharavathi Valley Wildlife Sanctuary**

| Zone | Forest | Compt | Extent in Ha. |
|---|---|---|---|
| Core zone | Karini SF | XX -1 to 7 (17) | 5102.53 |
| Buffer zone | Govardhanagiri SF | XX – 1 to 34 | 13473.68 |
| Buffer zone | Channagonda SF (P) | XIX – 13 (P) | 701.05 |
| Tourism zone | Attigodu SF (P) | XIX – 1 to 3 | 763.70 |
| Tourism zone | Muppani SF Bl. A | XIX – 4 to 7 | 961.77 |
| Tourism zone | Muppani SF Bl. B | XIX – 8 to 11 | 629.16 |
| Tourism zone | Sharavathi submerged area | | 12363.00 |
| Tourism zone | Islands within the submerged area | | 507.00 |
| | Others | | 8621.11 |
| | | **TOTAL:-** | **43123.00** |

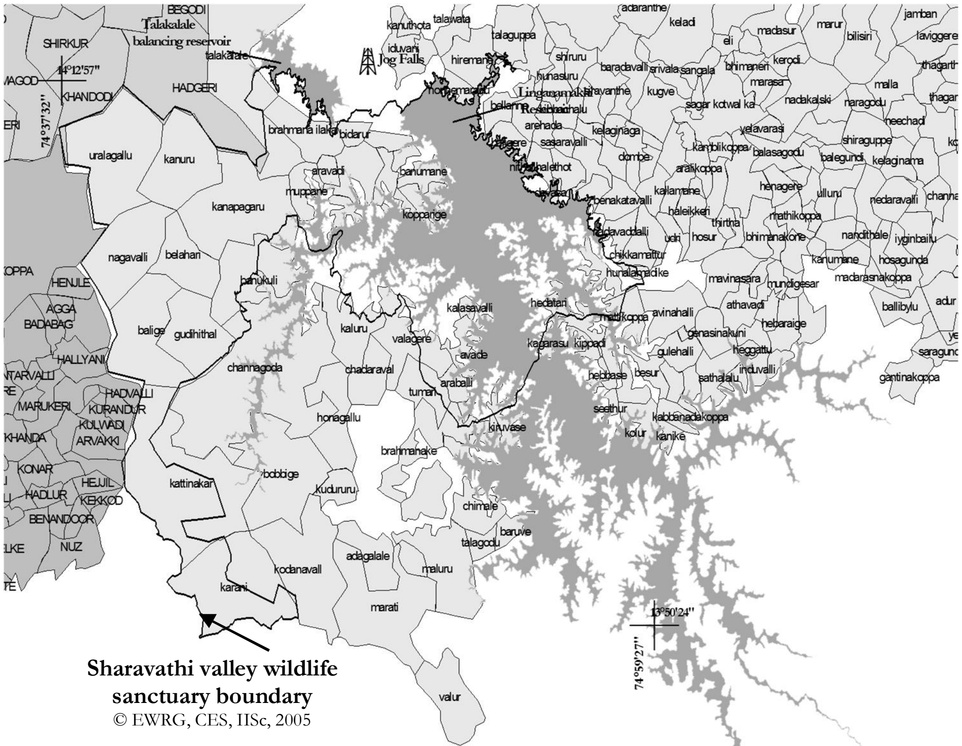



**Figure 3.1:** Villages in and around SVWS.

## Humans – Socio-Economic-Energy

Cooking and water heating are the two major end uses that require huge amount of firewood in the region. It is estimated that the average per capita firewood consumption is 1.17 tonnes/year, based on sample survey covering 25% of the villages and 20% of the households. The villagewise cooking and water heating energy consumption values are given in Table 16.1. Estimation of the total fuelwood requirement of the region amounts to 10435 tonnes for the year 1991 and it increased to 15328 during 2001.

***Forest biomass availability***

Spatial extent of SVWS is about 431 sq.km, with 110 sq.km under semi-evergreen to evergreen forests, 49 sq.km under deciduous forests, 66 sq.km under plantations and 90 sq.km under wastelands. Considering the average secondary productivities of each type of forest (3.6 t/h/y for evergreen, 12.5 t/h/y for deciduous, 5 t/h/y for plantations and 0.6 t/h/y for scrub and waste lands), the annual availability of forest biomass as a source of fuelwood is about $189.23 \times 10^3$ tonnes.

Population increase at 3.9% per year has resulted in increased fuel wood demand. Apart from gathering dried and fallen twigs and leaves, local people also cut young saplings, green twigs, and even whole tree. Several plant species preferred by wild animals are being cut for fuel wood as well as for mulching and fodder. Table 16.1, lists the villagewise fuelwood consumption.

**Table 16.1:** Villagewise per-capita fuelwood consumption (Kg/person/day)

| Village Name | Cooking | Water Heating | | |
|---|---|---|---|---|
| | | Monsoon | Winter | Summer |
| Ambargodlu | 1.5 | 1.5 | 1.2 | 1.2 |
| Chikkamathur | 1.7 | 1.5 | 1.3 | 1.3 |
| Mattikoppa | 1.5 | 1.4 | 1.2 | 1.2 |
| Hunalamadike | 1.8 | 2.8 | 1.7 | 1.7 |
| Valagere | 1.6 | 1.8 | 1.4 | 1.3 |
| Kalasavalli | 1.7 | 1.8 | 1.4 | 1.4 |
| Araballi | 1.4 | 1.8 | 1.4 | 1.4 |
| Honnemardu | 1.8 | 1.7 | 1.4 | 1.4 |
| Baliggere | 2.0 | 2.0 | 1.3 | 1.3 |
| Bannumane | 1.6 | 1.4 | 1.2 | 1.2 |
| Aravadi | 1.7 | 1.7 | 1.2 | 1.2 |
| Brahmana Ilakalale | 1.6 | 1.5 | 1.2 | 1.2 |

At present the domestic energy consumption is well within the total biomass availability from the region. However, with increasing population poses a serious threat to the sustainability of forest resources.

The average livestock holding is in the order of 3.33 buffaloes, 2.27 bullocks and 4.5 cattle per household. Most of the households opt for open grazing in forests that hampers natural regeneration. The estimated total number of livestock in the sanctuary area is 17655. Animal residue (dung) can be used for biogas production, which might minimise the fuelwood pressure on forests. Quantification shows an order of 7627 cu.m to 11122 cu.m per day of biogas generation potential in the region (assuming that a kilogram of fresh animal residue provides 0.03 – 0.042 $m^3$ of gas), which is sufficient to meet the cooking energy needs of 27572 – 21801 persons. However the energy transition from fuelwood to biogas requires policy initiatives as most collect firewood at zero cost due to proximity of forests.

Village forest farms in the selected village would reduce the pressure of cattle on natural forests. Promotion of stall-feeding and conversion of degraded common lands to community fodder farm would bring down the pressure on forests. Village self help groups to be involved in creation and maintenance of village fodder farms in selected villages

**Threats and Management**

Protected areas (PAs) are established for protecting a particular area with clear management objective. Factors such as encroachment of habitats, poaching and grazing are responsible for the depletion and extinction of wildlife resources. The cases of encroachment of habitats and activities like poaching and grazing are threatening a majority of the wildlife habitats around the world. With the passage of time, human influences on habitats had an alarming impact. SVWS harbours endemics and threatened species of flora and fauna, and hence requires immediate protection and conservation measures. Already large areas of pristine forests have been cleared for hydroelectric-projects, *Acacia auruculiformis* plantations, and for agricultural operations, etc. The failure in the conservation of reserve forests is visible in many places with the continued process of habitat destruction. The forests need to be protected from human interference that is detrimental to the growth and regeneration of the forest. This requires improved forest security, transparency in forest product utilization, and a stronger political will.

## Human and livestock inside the sanctuary

There are 121 villages inside the sanctuary, having higher human and cattle population (Table 16.2), and 59 of them are in protected area (enclosures). Increased human habitats with forest encroachments have seriously affected the wildlife population. The cultivation of *Vetiveria* sp. (lemon grass) extensively inside the sanctuary areas such as Meghane (located in Buffer zone of the sanctuary) poses serious threat to the wildlife population.

**Table 16.2:** Human and Cattle population inside the sanctuary area.

| Village name | Cattle population | Human population |
|---|---|---|
| Talakalale | 154 | 95 |
| B. Ilakalale | 59 | 487 |
| Karumane | 70 | 453 |
| Aralagodu | 66 | 338 |
| Bannumane | 58 | 355 |
| B.kopparige | 26 | 156 |
| Muppane | 38 | 413 |
| Arodi | 16 | 44 |
| Mandavalli | 80 | 555 |
| Ambargodlu | 41 | 192 |
| Kagarasu | 01 | 18 |
| Hedathri | 23 | 46 |
| Banukuli | 105 | 945 |

| | | |
|---|---|---|
| Kanur | 45 | 501 |
| Kanapagaru | 114 | 1524 |
| Gudihithlu | 37 | 367 |
| Nagavalli | 142 | 1242 |
| Balige | 47 | 498 |
| Nelahari | 28 | 284 |
| Uralagallu | 23 | 209 |
| Chennagonda | 181 | 616 |
| Karani | 69 | 617 |
| Kattinkaru | 128 | 1058 |
| **Total** | **1551** | **11013** |

Source: KFD, Wildlife Division, Kargal

People depend on forests for livestock grazing, which results in soil compaction and affects natural regeneration. Apart from domestic livestock, a large population of wild cattle is trapped inside the sanctuary (due to the submersion) contributing to grazing pressure throughout the year.

**Agriculture and Encroachment:** Agricultural practices in the region are traditional and dependent on forests. The forests provide leaf litter, green leaves and fencing material to the farmers. The dense forest patches are the sources of water to the crops. Present study found that the forest encroachments have resulted in increased agricultural lands. It has been found that the land submergence is one of the major reasons for increased land encroachment in the forests. Migrating and migrated population, marginal farmers and economically sensitive households were major contributors of land encroachments. The widespread occurrence of encroachment is observed in the Kanur, Hebbankeri, Meghane and Nagavalli area, where slash and burn practice is prevalent for growing cash crops especially cotton, pepper, lemon grass, ginger, paddy and areca.

NTFP collection: Resource use has been restricted to the buffer zones, where it has been regulated, while core areas are completely closed. An amendment in 1991 to the Wildlife Protection Act of 1972 specifies that, in wildlife sanctuaries, the chief wildlife warden must certify that any manipulation does not harm wildlife, and that the state government approves the manipulation. The major NTFP of the area is leaves of *Diospyros melanoxylon* and *Cinnamomum zeylanicum*. Apart from these, on a minor scale, *Emblica officinalis, Terminalia chebula,* and various medicinal plants, cane, *Bambusa* sp., and honey are also collected. Destructive methods of collection of NTFP by lopping the branches of trees like, *Myristica malabarica*, *Garcinia gummigutta, Cinnamomum zeylanicum* etc. will affect the endemic tree species.

The industrial extraction of timber from the primary evergreen forests in the past has led to the depletion of valuable endemic species and loss of many special habitats such as *Myristica* swamps.

NTFP collection is totally banned in the core zone of the sanctuary area since it may pose a threat to the endemic tree species and their regeneration. But, in some areas, the community-based approach can be carried out instead of collections done by tenders given to non-locals by the forest department. This approach will be more appealing since each villager will become more responsible for conserving the forests, as removal of a tree would curtail the financial gains through NTFP. Destructive methods of collection of NTFP by lopping the branches of trees have to be stopped.

**Timber smuggling:** Timber smuggling is reported to be a major problem in the sanctuary area. It is reportedly smuggled even out of the Linganmakki islands, indicating the involvement of some organized groups. The timber smugglers take advantage of the remoteness of the islands from the human settlements for their illegal activities. We have observed timber harvesting at many places like, Karani, Banukuli, Kanur etc., within the sanctuary, calling for greater and effective vigilance from the authorities and the village forest committees (VFCs).

**Monoculture Plantation:** Large areas of the sanctuary (15.27%) have been planted with monoculture plantations depriving the wildlife of their habitats. Preference of single species in forest plantations is another reason responsible for depletion of fodder for animals. This could become a major drawback to any kind of habitat restoration programmes as well as energy improvement technologies. The practice of planting of acacia and casuarina is still in progress in open areas of Muppane, Aralagodu, Karani, etc. These monoculture plantations have no other advantages to the wildlife, other than aiding as hiding places for some of the small mammals and agricultural pests. Changes in microclimate and huge litter cover in plantations adjacent to the evergreen and semi evergreen forests would inhibit the growth of younger tree species of natural forests.

Grasslands have been converted to monoculture plantations in the forest enclosures like, Madenur, Muppane, and Shashichowka denying the fodder to herbivores like gaur, sambar, spotted deer, etc. The monoculture of any exotic should be strictly discouraged in the areas of high animal population and movement. Any such reforestation activity should be in accordance with the local need and with indigenous species. Gradual shifting of natural plant species in the monoculture plantation areas is to be done. Habitat improvements with fodder plants species preferred by wild animals are to be planted instead of monocultures of acacia, pinus or casuarinas.

**Forest Fire:** Usually in this sanctuary forest fires are associated with highly fragmented areas. This plays an important role in the distribution of ungulates and bovines. The main reasons for the fire are the dryness of the forest and the deciduous vegetation. Humans on a yearly basis to enhance the growth of grasses burn much of the forest ground vegetation. While fire generally does not kill adult trees, it will effectively destroy the seedlings and young trees, thus preventing tree regeneration, creating senescent forests and eventually leading to the disappearance of forests (Kessler, 2001). Almost every year forest department burnt the grassy blanks in some places to improve the quality of fodder for wild animals; this phenomenon also affects the habitat of burrowing small mammals. The fire has become a major factor in the degradation of forests. In order to restore the vegetation, these forests must be protected from fire, by preventing it by undertaking measures such as creation of awareness on the implication of fire among the local communities and proper maintenance of fire line.

**Forest fragmentation**: The humid forests, repository of diverse flora and fauna have been subjected to severe habitat fragmentation. Increase in forest fragmentation also gives rise to edge effect with respect to micro climatic changes, species invasion from surrounding vegetation, aetc. Forest fragmentation is a major problem in this sanctuary. Several roads that pass through the sanctuary and Linganmakki reservoir have dissected and cleaved the habitats. Other than these, heavy biotic pressures in terms of encroachments for human settlements, agricultural fields, etc. have contributed significantly to the fragmentation of habitats.

Past land use practices such as shifting cultivation and selective felling have influenced the present-day forest quality and biodiversity patterns, which are evident from the presence of patch and perforated forest in primary forested areas. Wide scale selective felling of tree like *Poeciloneuron indicum*, *Callophylum tomentosum* and *Lopopetalum wightianum* and *Artocarpus hirsutus* had been carried out since 1921 to 1971 for railway sleepers, match wood and plywood in places like Karani, Govardhangiri and Kanur, which comes in the core and buffer zone of the sanctuary. The study shows that the regeneration of these species especially *Poeciloneuron indicum* and *Palaquium ellipticum* in Karani and Kanur is excellent. Selection felling of industrial timbers continued almost to the mid 1980's, causing considerable impoverishment of forests.

**Human-animal conflicts:** Due to fragmentation and reduction of natural habitats with the uncontrolled growth of agricultural practices in the sanctuary area over several years has resulted in repeated stress over the forest areas and acted negatively on the wildlife. Conflicts between wildlife and human have emerged as a problem in the arena of wildlife management. The conflicts, which result from the destruction of crops and damage to property, have raised both social as well as conservation issues, both in and outside the sancturary. Efforts to keep animals out of crop fields by wildlife officials have been futile and sometimes result in people perceiving the animals as being malevolent. Thus, human- animal conflict is a common scene over the entire area. Herbivore and omnivore animals like Indian gaur, Indian porcupine, sambar, wild boar, rodents, etc., inflict considerable damage to agricultural crops. Several incidences of sloth bear attack have been reported in the core and buffer zones of the wildlife sanctuary (villages like, Kattinkaru, Karani, Kanur and Kogar). To tackle this problem, fencing the crops is a common procedure, which is detrimental to both wildlife and forests. The fencing material is usually the locally available wooden log, brought from nearby forests. For supplementing the wooden logs, large number of regenerating forest trees were cut down thereby jeopardizing the forest growth itself. These fences act as enclosures for wildlife movement from one place to another.

Hunting is practised as a sport, for subsistence, for crop protection and as a part of religious tradition by many village communities. During night-times, people form groups and go for hunting. A number of communities (Nayaks, Edegaru and Namadari gowdru) in the sanctuary carry out poaching activity. They target on wild animals like mouse deer, rabbit, wild boar, etc., due to which, the wild animal population is decreasing at a rapid rate. People support hunting as it reduces the probable damage to crops. Even some of the birds like spotted dove, cattle egret, pond heron, jungle fowl, peacock etc., are being hunted for meat by the local tribes. Poaching for money is seldom indulged in and gaurs constitute the main victim. Outside people are believed to be coming to the area to carry out this kind of poaching. At least one or two episodes do occur every year. The remoteness of the area and sparsely distributed human settlements are again advantageous to these poachers. In aquatic environment high fishing activity of the local people, licensed fishermen and migratory fishermen has threatened the indigenous fish population along with the endangered tortoise population of the region.

**Proposed habitat corridors:** Wildlife present in the region are seasonal migrants from adjacent sanctuaries and hence, the corridors used by these animals should be given more attention. Three micro-habitat corridors have been proposed for linking fragmented habitats, so as to have continued link of populations to maintain sufficient viable reproductive groups to permit breeding. Corridors are to be developed with the native species of plants, which meet the food and fodder requirement of fauna during all seasons. Table 16.3 lists the present land-use in the proposed corridors; similarly Figure 3.2 illustrates the regions proposed for corridors.

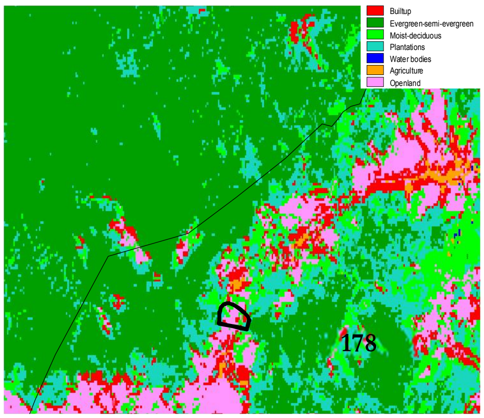
Channagonda and Kattinkar Corridor: These corridors are proposed in the western side of the sanctuary with evergreen and semi evergreen forests. This region comes under four state forests namely Muppane, Channagonda, Karani and part of Govardhanagiri.

**Table 16.3:** Details of land-use pattern in the proposed corridors.

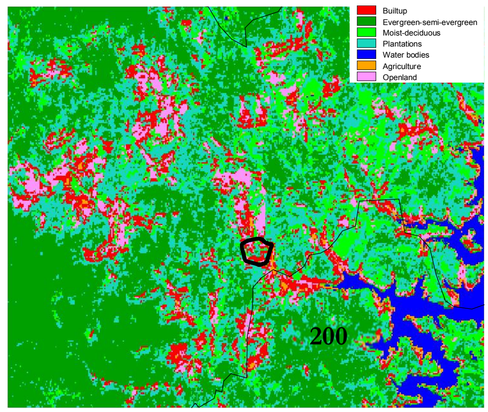
| Corridor | LC_No. | Village Name | Population | Area (ha) | Forest (ha) | Agriculture (ha) | CW (ha) | Un.Cultivated (ha) |
|---|---|---|---|---|---|---|---|---|
| 1 | 178 | Channagonda | 861 | 6391.49 | 2353.39 | 139.04 | 2158.74 | 1740.32 |
| 2 | 200 | Banukuli | 380 | 2250.59 | 340 | 80.68 | 1745.47 | 84.44 |
| 3 | 209 | Mandavalli | 425 | 875.23 | 0 | 61.12 | 760.20 | 53.91 |

Note: CW – cultivable waste

Corridor 1




Corridor 2




Corridor 3

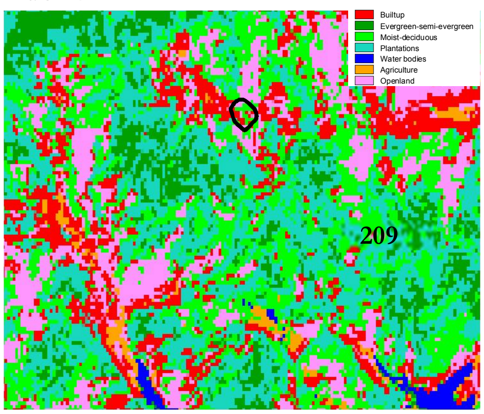



**Figure 3.2:** Proposed wildlife corridors in the SVWS.

Corridors 1 is proposed for free movement of sloth bear, sambar and gaur. It has grasslands and barren lands surrounded by a good semi evergreen and evergreen forest. It encompasses the areas like Channagonda, Kanapagaru, Muppane, Aralagodu and Bedrur. This corridor comes in Muppane state forest and Govardhanagiri state forest and has sparsely distributed semi evergreen and moist deciduous forest. This helps animals to migrate to adjoining forests of Talakalale balancing reservoir, Henni and Gerusoppa area.

Corridor 2 is proposed in Banukuli village and has grassland surrounded by semi evergreen and moist deciduous forests (Kanapagaru and Channagonda villages). Corridor 3 comes under Mandavalli village mainly for the movement of tiger, gaur and sambar. This corridor is nearer to Vatemadike village with grasslands interspersed with moist deciduous forest.

**Restoration of forest:** In order to restore the forest depending on the state of degradation the following list of plants has been recommended. The list of plants recommended for deciduous, semi-evergreen and evergreen degraded patches area given in Table 17.1, 17.2 and 17.3 respectively.

**Table 17.1: P**lant recommended for restoration of deciduous forests in the sanctuary.

| Plant species | Common name | Ecosystem and human value |
|---|---|---|
| *Olea dioica* | Madle | EV |
| *Mimusops elengi* | Ranjalu | EV, NTFP |
| *Aporosa lindleyana* | Salle | EV, FR |
| *Dillenia pentagyna* | Kanagalu | EV |
| *Garcinia indica* | Muruga | EV, FR, NTFP |
| *Terminalia paniculata* | Hunalu | EV |
| *Flacourtia montana* | Mullu sampige | EV, FR |
| *Mangifera indica* | Mavu | EV, FR, MD |
| *Syzygium caryophyllatum* | Kunnerlu | EV, FR |
| *Syzygium cumini* | Neralu | EV, FR |
| *Artocarpus heterophylla* | Halasu | EV, FR |
| *Artocarpus gomezianus* | Wote | EV, NTFP |

**Table 17.2:** Plants recommended for restoration of semi-evergreen forests in the sanctuary.

| Plant species | Common name | Ecosystem and human value |
|---|---|---|
| *Aglaia anamallayana* | Kempunola | EV |
| *Artocarpus heterophyllus* | Halasu | NTFP, F |
| *Artocarpus hirsutus* | Hebbalasu | EV, F |
| *Canarium strictum* | Kaidhupa | EV, NTFP |
| *Dimocarpus longan* | Kendal | EV |
| *Garcinia morella* | Harisina gurgi | EV, F |
| *Holigarna arnottiana* | Sannele holageru | EV |

| | | |
|---|---|---|
| *Holigarna beddomei* | Doddele holageru | EV |
| *Hopea ponga* | Haiga | EV |
| *Knema attenuata* | Hedaglu | EV |
| *Mimusops elengi* | Ranjalu | EV, NTFP |
| *Vepris bilocularis* | Mangappe | EV |
| *Polyalthia* sp. | | EV |
| *Mangifera indica* | Mavu | EV, F |
| *Symplocos racemosa* | Chunga | EV |

**Table 17.3:** Plants recommended for restoration of evergreen forests in the sanctuary.

| Plant species | Common name | Ecosystem and Human value |
|---|---|---|
| *Poeciloneuron indicum* | Balgi | EV |
| *Knema attenuata* | Hedaglu | EV, F |
| *Myristica malabarica* | Rampatre | EV, NTFP |
| *Myristica dactyloides* | Patre | EV, NTFP |
| *Persea macrantha* | Gulmavu | EV |
| *Calophyllum tomentosum* | Surhonne | EV |
| *Dipterocarpus indicus* | Dhuma | EV |
| *Palaquium ellipticum* | Hadasale | EV |
| *Ficus nervosa* | | EV |
| *Mastixia arborea* | Niratte | EV |
| *Vateria indica* | Saldhupa | EV, NTFP |
| *Elaeocarpus tuberculatus* | | EV |
| *Mangifera indica* | Mavu | EV, F |
| *Chrysophyllum roxburghii* | | EV |
| *Canarium strictum* | Kaidhupa | EV |
| *Calamus* sp. | Betha | NTFP |
| Syzygium gardneri | Nerlu | EV, FR |

Note: EV- Ecosystem value, FR- Fruit, LM- Leaf Manure, MD- Medicinal & NTFP- Non Timber Forest Produce.

**Policies:** In SVWS, forest enclosures play an important role in order to maintain viable wildlife population. Madenur, Muppane, Hallibyle and Shashichowka are the few forest enclosures with high density of gaur, sambar, and mouse deer. The intention of these enclosures is to provide protection to both flora and fauna of the region. These forest enclosures serve a better protection to some of the vulnerable species from the poachers. Most of these enclosures are planted with monoculture species like, Acacia, Casuarina, etc., which in turn not a suitable habitat for the above mentioned wildlife. In order to maintain the high density of these species, gradual conversion of monoculture into native species As the territories of wild animals extend beyond these enclosures, flocking of wild animals and futile attempts to cross these barriers have been noticed. This suggests the expansion of existing enclosures and creation of new enclosures, which has to be undertaken based on rigorous monitoring of wildlife movement.

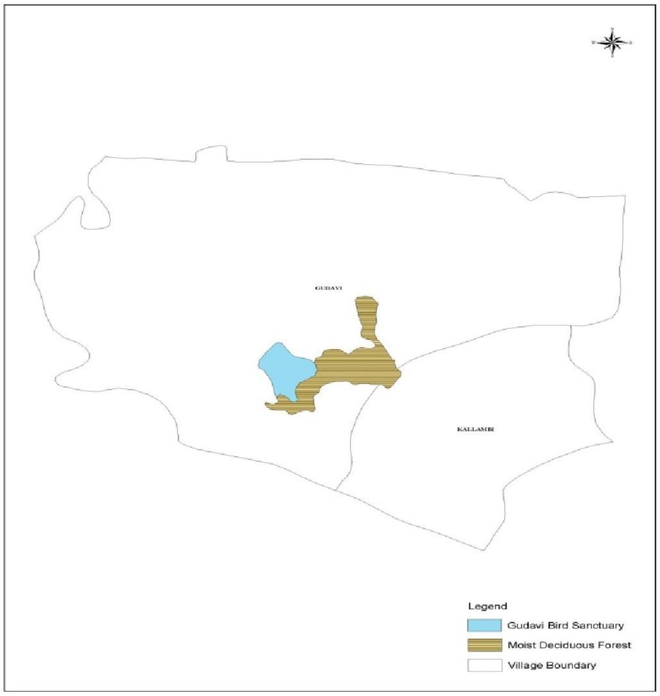
Effective vigilance has to be exercised by the forest department in order to stop the further encroachments and poaching of wild animals inside the sanctuary. To avoid water scarcity, large number of water holes/percolation ponds should be constructed inside the sanctuary. The existing awareness programmes such as wildlife weeks, wildlife census, etc., have to be expanded and strengthened in the sanctuary and surrounding areas in order to educate and create awareness among local people. Interaction of forest officials with local people helps to arrive at solutions based on clear understanding of situation in the sanctuary.

In the adjoining areas like, Gerusoppa, Uttarakoppa, Aruvakki etc., Kyasanur Forest Disease (KFD) is more prevalent due to high degree of forest degradation, that has led to the extensive growth of weeds, where in ticks, the main disease vector inhabit. Therefore restoration of full-canopied natural forest in the sanctuary area is of paramount importance. The Sharavathi valley wildlife sanctuary has to be extended further so as to link to the Mookambika wildlife sanctuary to facilitate the better movement of wild animals and also conservation of endangered and endemic fauna (like Lion-tailed Macaque) and pristine forest areas (like, Kodachadri, Gurta, Malemane and Kathalekan).

## 6.3 GUDAVI BIRD SANCTUARY

Gudavi bird sanctuary is located at 14° 25' 59" to 14° 26'41" N and 75° 6' 43" to 75° 1' 28" E in Soraba Taluk of Shimoga district (Figure 4). The Gudavi Bird Sanctuary was preliminary notified vide government notification No. AHFF-262-FWL-86 Dtd 10.07.1989 of Government of Karnataka and finally notified vide Government notification no. FEE-220-FWL-99 Dtd 4.09.2000 (**Karnataka Forest department, 2006**). The total area of Gudavi bird Sanctuary is 73.68 Hectares of which water spread area is 33 Ha and is surrounded by moist deciduous forest, interspersed with grassy patches (**Karnataka Forest department, 2006**). In this sanctuary there are two ponds called as Vaddakere and Gudavi ponds. The catchment area for this sanctuary is mainly agriculture land and other wooded areas. It is surrounded by paddy fields on North, West and Southern sides and dry and on North and Eastern sides. There are three villages namely Hullemaradi, Gudavi and Kallambi with a population of about 3000. Majority of the population are agriculturists. The area is plain and soil is deep and lateritic in origin. The average rainfall of the area is 1500 mm. The maximum and minimum temperature recorded in the sanctuary is 15°

C and 38º C respectively. The area surrounding the wetland is covered with dense moist deciduous forest.




The boundaries of the sanctuary are:
North: Tank bound and Hinduvaly S.No.199, 201, 211, 71 & 204 of Gudavi village.

East: Gudavi road and Hinduvaly S.No. 55 and 64 of Kallambi village.
South: S.No. 54 & 55 of Kallambi village.

West: Hulemardi road & Hiduvaly S.No. 182.

**Figure 4: Gudavi Bird Sanctuary**

**Composition of vegetation**
Mainly five tree species are utilized by birds for nesting – *Vitex leucoxylon*, *Kiranganelia reticulate*, *Phyllanthus polyphyllus*, *Ficus lacur* and *Terminalia* sp.

**Bird species composition:** There are about 191 species of birds, out of 63 species of birds are totally dependent on water. The number of species changes in different months. Highest number of species is observed during October and least number of species in July. (**Karnataka Forest department, 2006**)

**Dayananda G.Y. (2009)** studied the bird diversity of Gudavi Bird Sanctuary. The avifauna of Gudavi Bird Sanctuary belonged to 16 orders. Out of these members of Ciconiformes, Paliconiformes and Passeriformes contributed maximum to the avifauna of the ponds throughout the year. The members of order Anseriformes and Charadriformes are migratory species who utilize the ponds for foraging during winter months. However, the local migrants are widespread throughout the year and to adjacent wetlands, moving to and fro utilizing the best resources available to them. The total number of species recorded in this sanctuary was 218. Of the 218 species of birds sighted at the sanctuary, a large number of terrestrial birds (163 species) constituted 75.11% whereas 24.88% was constituted by a relatively small number of aquatic birds consisting of 54 species. In terms of species strength of families represented Muscicapidae was the largest with 35 species. (**Table 18)**

**Table18: Species composition of birds at Gudavi Bird Sanctuary**

| SN | Common name | Scientific Name | Residential Status | Abundance Status |
|---|---|---|---|---|
| | 1. Family: Podicipedidae | | | |
| 1 | Little Grebe | *Tachybaptus ruficollis* | R | V Com |
| 2.Family: Phalacrocoracedae | | | | |
| 2 | Great Cormorant | *Phalacrocorax carbo* | RM | Com |
| 3 | Indian Shag | *Phalacrocorax fuscicollis* | RM | Com |
| 4 | Little Cormorant | *Phalacrocorax niger* | RM | L Com |
| | 3. Family: Anhingidae | | | |
| 5 | Darter or Snake bird | *Anhinga melamogaster* | RM | L Com |
| | 4. Family: Ardeidae | | | |
| 6 | Grey Heron | *Ardea cinerea* | RM | L Com |
| 7 | Purple Heron | *Ardea purpurea* | RM | L Com |
| 8 | Little Green Heron | *Butorides striatus* | RM | Ra |
| 9 | Pond Heron | *Ardeola grayii* | R | L Com |
| 10 | Cattle Egret | *Bubulcus ibis* | RM | Com |
| 11 | Large Egret | *Casmerodius albus* | RM | Com |
| 12 | Smaller Egret | *Mesophoyx intermedia* | RM | L Com |
| 13 | Little Egret | *Egretta garzetta* | R | L Com |
| 14 | Night Heron | *Nycticorax nycticorax* | R | L Com |
| 15 | Chestnut Bittern | *Ixobrychus cinnamoneus* | RM | L Com |
| | 5. Ciconiidae | | | |
| 16 | Painted Stork | *Mycteria leucocephala* | RM | L Com |
| 17 | Openbill Stork | *Anastomus oscitans* | R | L Com |
| 6. Family: Threskiornithidae | | | | |
| 18 | Black-headed Ibis | *Threskiornis melanocephalus* | R | L Com |
| 19 | Black Ibis | *Pseudibis papillosa* | R | Un Com |

| | | | | |
|---|---|---|---|---|
| 20 | Glossy Ibis | *Plegadis falcinellus* | RM | Un Com |
| 21 | Spoonbill | *Platalea leucorodia* | RM | L Com |
| | 7. Family: Anatidae | | | |
| 22 | Lesser whistling Teal | *Dendrocygna javanica* | R | L Com |
| 23 | Pintail | *Anus acuta* | M | Com |
| 24 | Common Teal | *Anas crecca* | RM | V Com |
| 25 | Spot-billed Duck | *Anas poecilorhyncha* | RM | Com |
| 26 | Garganey | *Anas querquedula* | M | V Com |
| 27 | Shoveller | *Anas clypeata* | M | Com |
| 28 | Cotton Teal | *Nettapus coromandelianus* | R | L Com |
| 29 | Nakta or Comb Duck | *Sarkidiornis melanotos* | R | Un Com |
| | 8. Accipitridae | | | |
| 30 | Crested Honey-Buzzard | *Pernis ptilorhyncus* | R | L Com |
| 31 | Common P ariahkite | *Milvus migrans* | R | Com |
| 32 | Brahminy kite | *Haliastur indus* | R | L Com |
| 33 | Shikra | *Accipiter badius* | RM | Com |
| 34 | Sparrow Hawk | *Accipiter nisus* | R | L Com |
| 35 | Besra Sparrow Hawk | *Accipiter virgatus* | R | L Com |
| 36 | Tawny Eagle | *Aquila rapax* | RM | L Com |
| 37 | Greater spotted Eagle | *Aquila clanga* | RM | Ra |
| 38 | Ring tailed fishing Eagle | *Haliaeetus leucoryphus* | M | Ra |
| 39 | P ale Harrier | *Circus macrourus* | RM | L Com |
| 40 | P aid Harrier | *Circus melanoleucos* | M | Ra |
| 41 | Marsh Harrier | *Circus aeruginosus* | R | L Com |
| 42 | Common Kestrel | *Falco tinnunculus* | RM | L Com |
| | 9. Phasianidae | | | |
| 43 | Grey Partridge | *Francolinus pondicerianus* | R | Com |
| 44 | Jungle bush Quill | *Perdicula asiatica* | R | Com |
| 45 | Red Spurfowl | *Galloperdix spadicea* | R | L Com |
| 46 | Grey Jungle fowl | *Gallus sonneratii* | R | Com |
| 47 | Common Peafowl | *Pavo cristatus* | R | Com |
| | 10. Turnicidae | | | |
| 48 | Common Bustard Quail | *Turnix suscitator* | R | L Com |
| | 11. Rallidae | | | |
| 49 | IndianRail Blue-breasted Banded | *Rallus striatus* | RM | Un Com |

| | | | | |
|---|---|---|---|---|
| 50 | Slaty-legged Banded Crake | *Rallina eurizonoides* | R | Un Com |
| 51 | Brown Crake | *Amaurornis akool* | R | Com |
| 52 | White breasted Water hen | *Amaurornis phoenicurus* | R | Com |
| 53 | Water Cock | *Gallicrex cinerea* | RM | L Com |
| 54 | Indian Moorhen | *Gallinula chloropus* | R | Com |
| 55 | Purple Moorhen | *Porphyrio porphyrio* | RM | L Com |
| 56 | Coot | *Fulica atra* | R | V Com |
| | 12. Jacanidae | | | |
| 57 | P heasant tailed Jacana | *Hydrophasianus chirurgus* | R | Un Com |
| 58 | Bronze winged Jacana | *Metopidicus indicus* | R | L Com |
| | 13. Charadriidae | | | |
| 59 | Red-wattled Lapwing | *Vanellus indicus* | R | Com |
| 60 | Yellow-wattled Lapwing | *Vanellus malabaricus* | M | L Com |
| 61 | Grey P lover | *Pluvialis squatarola* | M | Un Com |
| 62 | Golden Plover | *Pluvialis dominica* | RM | Va |
| 63 | Little ringed Plover | *Charadrius dubius* | M | Com |
| 64 | Marsh Sandpiper | *Tringa stagnatilis* | M | L Com |
| 65 | Spotted Sandpiper | *Tringa glareola* | RM | L Com |
| | 14. Scolopacidae | | | |
| 66 | Common or Fantail Snipe | *Gallinago gallinago* | R | Com |
| 15. Recurvirostridae | | | | |
| 67 | Black-winged Stilt | *Himantopus himantopus* | R | Com |
| | 16. Laridae | | | |
| 68 | Indian River Tern | *Sterna aurantia* | RM | L Com |
| 69 | Common Tern | *Sterna hirundo* | R | L Com |
| | 17. Culumbidae | | | |
| 70 | Grey fronted Green Pigeon | *Treron pompadora* | R | L Com |
| 71 | Common Green Pigeon | *Treron phoenicoptera* | R | Com |
| 72 | Green Imperial Pigeon | *Ducula badia* | R | L Com |
| 73 | Blue Rock Pigeon | *Columba livia* | R | V Com |
| 74 | Spotted Dove | *Streptopelia chinensis* | R | V Com |
| | 18. Psittacidae | | | |
| 75 | Rose ringed P arakeet | *Psittacula krameri* | R | V Com |
| 76 | Blossom headed P arakeet | *Psittacula cyanocephala* | RM | L Com |
| 77 | Lorikeet | *Loriculus vernalis* | RM | L Com |

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|---|---|---|---|---|
| | 19. Cuculidae | | | |
| 78 | P ied crested Cuckoo | *Clamator jacobinus* | R | L Com |
| 79 | Common hawk Cuckoo | *Cuculus varius* | R | L Com |
| 80 | Indian Cuckoo | *Cuculus micropterus* | R | L Com |
| 81 | Koel | *Eudynamys scolopacea* | R | V Com |
| 82 | Large Greenbilled Malkoha | *Rhopodytes tristis* | R | L Com |
| 83 | Small Greenbilled Malkoha | *Rhopodytes viridirostris* | R | L Com |
| 84 | Coucal or Crow-Pheasant | *Centropus sinensis* | R | V Com |
| 85 | Lesser Coucal | *Centropus bengalensis* | R | V Com |
| | 20. Strigidae | | | |
| 86 | Barred Jungle Owlet | *Glaucidium radiatum* | R | L Com |
| 87 | Spotted Owlet | *Athene brama* | R | Com |
| 88 | Mottled wood Owl | *Strix ocellata* | R | L Com |
| 89 | Brown wood Owl | *Strix leptogrammica* | RM | L Com |
| | 21. Apodidae | | | |
| 90 | Indian edible nest Swiftlet | *Collocalia unicolor* | R | Com |
| 91 | House Swift | *Apus affinis* | RM | Com |
| | 22. Alcedinidae | | | |
| 92 | Pied Kingfisher | *Ceryle rudis* | R | Com |
| 93 | Small blue Kingfisher | *Alcedo atthis* | R | Com |
| 94 | Stork-billed Kingfisher | *Pelargopsis capensis* | R | L Com |
| 95 | White-breasted Kingfisher | *Halcyon smyrnensis* | R | Com |
| | 23. Meropidae | | | |
| 96 | Chestnut headed Bee-ater | *Merops leschenaultia* | RM | L Com |
| 97 | Small green Bee-eater | *Merops orientalis* | R | L Com |
| 98 | Blue bearded Bee-eater | *Nyctyornis athertoni* | R | L Com |
| | 24. Coraciidae | | | |
| 99 | Roller or Blue jay | *Coracias benghalensis* | R | Com |
| | 25. Upupidae | | | |
| 100 | Hoopoe | *Upupa epops* | R | V Com |
| | 26. Bucerotidae | | | |
| 101 | Common grey Hornbill | *Tockus birostris* | R | Com |
| 102 | Malabar Grey Hornbill | *Tockus griseus* | R | Com |
| 103 | Malabar pied Hornbill | *Anthracoceros coronatus* | R | Com |
| | 27. Megalaimidae | | | |
| 104 | Large green Barbet | *Megalaima zeylanica* | R | Com |

| | | | | |
|---|---|---|---|---|
| 105 | Lineated Barbet | *Megalaima lineate* | R | L Com |
| 106 | Small green Barbet | *Megalaima viridis* | R | Com |
| 107 | Crimson throated Barbet | *Megalaima rubricapilla* | R | Com |
| 108 | Crimson breasted Barbet | *Megalaima haemacephala* | R | Com |
| 28. Picidae | | | | |
| 109 | Rufous Woodpecker | *Micropternus brachyurus* | R | L Com |
| 110 | Lesser Woodpecker golden backed | *Dinopium benghalense* | R | L Com |
| 111 | Great black Woodpecker | *Dryocopus javensis* | R | L Com |
| 112 | Yellow Woodpecker fronted pied | *Picoides mahrattensis* | R | L Com |
| 113 | Pigmy Woodpecker | *Picoides nanus* | R | L Com |
| 29. Pittidae | | | | |
| 114 | Indian Pitta | *Pitta brachyura* | R | Com |
| 30. Alaudidae | | | | |
| 115 | Bush Lark | *Mirafra assamica* | R | Com |
| 116 | Red winged Bush-Lark | *Mirafra erythroptera* | R | L Com |
| 117 | Black bellied Finch-Lark | *Eremopterix grisea* | RM | L Com |
| 118 | Rufous tailed Finch-Lark | *Ammomanes phoenicurus* | R | L Com |
| 119 | Crested Lark | *Galerida cristata* | R | L Com |
| 120 | Sykes's Crested Lark | *Galerida deva* | RM | L Com |
| 31. Hirundinidae | | | | |
| 121 | Swallow | *Hirundo rustica* | RM | L Com |
| 122 | Wire tailed Swallow | *Hirundo smithii* | RM | L Com |
| 123 | Indian cliff Swallow | *Hirundo fluvicola* | R | L Com |
| 32. Laniidae | | | | |
| 124 | Rufous backed Shrike | *Lanius schach* | R | L Com |
| 33. Oriolidae | | | | |
| 125 | Golden Oriole | *Oriolus oriolus* | RM | Com |
| 126 | Black naped Oriole | *Oriolus chinensis* | R | Com |
| 127 | Black headed Oriole | *Oriolus xanthornus* | R | Com |
| 34. Dicruridae | | | | |
| 128 | King Crow or Black Drongo | *Dicrurus adsimilis* | R | Com |
| 129 | Grey or Ashy Drongo | *Dicrurus leucophaeus* | R | Com |

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|---|---|---|---|---|
| 130 | Racket tailed Drongo | *Dicrurus paradiseus* | R | Com |
| 35. Sturnidae | | | | |
| 131 | Brahminy Myna | *Sturnus pagodarum* | R | Com |
| 132 | Indian Myna | *Acridotheres tristis* | R | Com |
| 133 | Jungle Myna | *Acridotheres fuscus* | R | Com |
| 36. Corvidae | | | | |
| 134 | Tree pie | *Dendrocitta vagabunda* | R | Com |
| 135 | White bellied Treepie | *Dendrocitta leucogastra* | R | Com |
| 136 | House Crow | *Couvus splendens* | R | V Com |
| 137 | Jungle Crow | *Corvus macrorhynchos* | R | V Com |
| 37. Campephagidae | | | | |
| 138 | Pied Flycatcher-Shrike | *Hemipus picatus* | R | Com |
| 139 | Large Wood Shrike | *Tephrodornis gularis* | R | Com |
| 140 | Common Wood Shrike | *Tephrodornis pandicerianus* | R | V Com |
| 141 | Black headed cuckoo Shrike | *Coracina melanoptera* | R | Com |
| 142 | Scarlet Minivet | *Pericrocotus flammeus* | R | Un Com |
| 143 | Long tailed Minivet | *Pericrocotus ethologus* | R | Un Com |
| 144 | Small Minivet | *Pericrocotus cinnamomeus* | R | Com |
| 145 | White bellied Minivet | *Pericrocotus erythropygius* | R | Com |
| 38. Irenidae | | | | |
| 146 | Common Iora | *Aegithina tiphia* | R | V Com |
| 147 | Marshall's Iora | *Aegithina nigrolutea* | R | Com |
| 148 | Gold fronted Chloropsis | *Chloropsis aurifrons* | R | Com |
| 39. Pycnonotidae | | | | |
| 149 | Red whiskered Bulbul | *Pycnonotus jocosus* | R | V Com |
| 150 | White cheeked Bulbul | *Pycnonotus leucogenys* | R | Com |
| 151 | Red vented Bulbul | *Pycnonotus cafer* | R | V Com |
| 152 | Black Bulbul | *Hypsipetes madagascariensis* | R | Com |
| 40. Muscicapidae | | | | |
| Sub Family :Timalinae | | | | |
| 153 | Spotted Babbler | *Pellorneum ruficeps* | R | Com |
| 154 | Slaty headed scimitar Babbler | *Pomatorhinus horsfieldi* | R | Com |
| 155 | Common Babbler | *Turdoides caudatus* | R | V Com |

| | | | | |
|---|---|---|---|---|
| 156 | Large grey Babbler | *Turdoides malcolmi* | R | V Com |
| 157 | Jungle Babbler | *Turdoides striatus* | R | V Com |
| 158 | White headed Babbler | *Turdoides affinis* | R | Com |
| 159 | Wynaad laughing Thrush | *Garrulax delesserti* | R | Un Com |
| 160 | Jerdon's laughing Thrush | *Garrulax jerdoni* | R | Un Com |
| 161 | White headed shrike Babbler | *Gampsorhynchus rufulus* | R | Un Com |
| 162 | Black capped Sibia | *Heterophasia capistrata* | R | Com |
| Sub Family: Muscicapinae | | | | |
| 163 | Black and Orange Flycatcher | *Muscicapa nigrorufa* | RM | Un Com |
| 164 | Tickll's blue Flycatcher | *Muscicapa tickelliae* | R | Com |
| 165 | Verditer Flycatcher | *Muscicapa thalassina* | R | Com |
| 166 | Nilgiri verditer Flycatcher | *Muscicapa albicaudata* | R | Com |
| 167 | White spotted fantail Flycatcher | *Rhipidura albicollis* | R | Com |
| 168 | Paradise Flycatcher | *Terpsiphone paradise* | R | Com |
| 169 | Black naped blue Flycatcher | *Hypothymis azurea* | R | Com |
| Sub Family: Sylviinae | | | | |
| 170 | Rufous fronted Wren-Warbler | *Prinia buchanani* | RM | Com |
| 171 | Ashy Wren-Warbler | *Prinia socialis* | M | Ra |
| 172 | Jungle Wren-Warbler | *Prinia sylvatica* | M | Ra |
| 173 | Tailor bird | *Orthotomus sutorius* | RM | V Com |
| 174 | Striated marsh Warbler | *Megalurus palustris* | R | Un Com |
| 175 | Booted Warbler | *Hippolais caligata* | R | Un Com |
| 176 | Common Chiffchaff | *Phylloscopus collybita* | R | Un Com |
| 177 | Large billed leaf Warbler | *Phylloscopus occipitalis* | R | Un Com |
| Sub Family: Turdinae | | | | |
| 178 | Blue Chat | *Erithacus brunneus* | R | V Com |
| 179 | Magpie Robin | *Copsychus saularis* | RM | V Com |
| 180 | Shama | *Copsychus malabaricus* | R | Un Com |
| 181 | Brown rock Chat | *Cercomela fusca* | RM | Un Com |
| 182 | Pied bush Chat | *Saxicola caprata* | R | Com |
| 183 | Jerdon's bush Chat | *Saxicola jerdoni* | R | Com |
| 184 | Indian Robin | *Saxicoloides fulicata* | R | V Com |
| 185 | Blue Rock Thrush | *Monticola solitarius* | R | Com |
| 186 | Orange headed Thrush | *Zoothera citrine cyanotus* | R | Com |

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|---|---|---|---|---|
| 187 | Black Bird | *Turdus merula* | RM | Com |
| 41. Paridae | | | | |
| 188 | Grey Tit | *Parus major* | RM | Com |
| 189 | White winged Black Tit | *Parus nuchalis* | R | Com |
| 190 | Yellow cheeked Tit | *Parus xanthogenys* | R | Com |
| 42. Sittidae | | | | |
| 191 | Chestnut bellied Nuthatch | *Sitta castanea* | R | Com |
| 43. Motacillidae | | | | |
| 192 | Paddy field Pipit | *Anthus rufulus* | R | L Com |
| 193 | Forest Wagtail | *Motacilla indica* | R | L Com |
| 194 | Yellow Wagtail | *Motacilla flava* | R | Lcom |
| 195 | White Wagtail | *Motacilla alba* | R | Com |
| 196 | Large pied Wagtail | *Motacilla maderaspatensis* | R | Lcom |
| 44. Dicaeidae | | | | |
| 197 | Tickell's Flower pecker | *Dicaeum erythrorhynchos* | R | L Com |
| 198 | Plain coloured Flower pecker | *Dicaeun concolor* | R | L Com |
| 199 | Fire breasted Flower pecker | *Dicaeun ignipectus* | R | L Com |
| 45. Nectariniidae | | | | |
| 200 | Purple rumped Sunbird | *Nectarinia zeylonica* | R | Com |
| 201 | Small Sunbird | *Nectarinia minima* | R | Com |
| 202 | Maroon breasted Sunbird | *Nectarinia lotenia* | R | Com |
| 203 | Purple Sunbird | *Nectarinia asiatica* | R | Com |
| 204 | Little Spider hunter | *Arachnothera longirostra* | R | L Com |
| 46. Zosteropidae | | | | |
| 205 | White Eye | *Zosterops palpebrosus* | RM | L Com |
| 47. Ploceidae | | | | |
| Sub Family : Passerinae | | | | |
| 206 | House Sparrow | *Passer domesticus* | R | Com |
| Sub Family: Ploceinae | | | | |
| 207 | Baya weaver bird | *Ploceus philippinus* | R | Com |
| 208 | Balck breasted weaver bird | *Ploceus benghalensis* | R | Com |
| 209 | Streaked weaver bird | *Ploceus manyar* | R | L Com |
| Sub Family: Estrildinae | | | | |
| 210 | Red Munia | *Estrilda amandava* | R | Com |
| 211 | Green Munia | *Estrilda formosa* | R | Un Com |

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|---|---|---|---|---|
| 212 | White throated Munia | *Lonchura malabarica* | R | Com |
| 213 | White backed Munia | *Lonchura striata* | R | Com |
| 214 | Spotted Munia | *Lonchura punctulata* | R | Com |
| 215 | Black headed Munia | *Lonchura malacca* | R | Com |
| 48. Fringillidae | | | | |
| Sub Family: Carduelinae | | | | |
| 216 | Rose Finch | *Carpodacus erythrinus* | RM | Com |
| Sub Family: Emberizinae | | | | |
| 217 | House Striolated | *Emberiza striolata* | R | L Com |
| 218 | Crested Bunting | *Emberiza lathami* | R | L Com |
| Status of the birds: WM= Winter migrant, Com= Common, R/LM= Resident with local movements, L Com=Locally common, R= Resident, Un Com= Un common, M= Migratory, V Com= Very common, R/LM/SM=Resident with local as well as summer movements. | | | | |

**External threats**

About 8.0 Ha of the sanctuary area has been encroached. The tank is drained by the villagers during summer for agriculture and this disturbs the water bird habitation.

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## 7.0 *Kan* Sacred Forests

Sacred groves or Kans (Kaans) in India have pre-vedic origin and most of them are associated with indigenous or tribal communities who mostly believe in divinity of nature and natural resources, therefore distinctly different from icon oriented main stream religions. However, it is not always the religious or cultural issues but some underlying practical experiences may play major role in establishment of the tradition. In Western Ghats region, the culture of sacred grove was predominant in agro-pastural communities. The expansion of agriculture and human settlement destroyed vast tracts of forest land which resulted into gradual wash out of fertile top soil, depletion of water resources and loss of local biodiversity which affected their livelihood to great extent. These adverse consequences lead them to realize the importance of forest ecosystem in soil and water conservation as well as livelihood security which ultimately manifested in the form of protection of remaining forest patches under various socio-religious norms.

Protection of forest patches as sacred has been reported from many parts of India and trees are normally not cut in such forests as they were dedicated to gods. Such sacred groves still persist in many parts of Asia and Africa (Gadgil and Vartak, 1976). These sacred forests are known by various names in peninsular India: such as devarakadu, devarbana or kan in Karnataka, kavu in Kerala, kovilkadu in Tamil Nadu and devrai in Maharashtra. The forested districts of Uttara Kannada, Kodagu, Chikmagalur and Shimoga in the central Western Ghats of Karnataka are dotted with several groves with lofty lush-green forest cover known as ‘kaans’; literally meaning “thick evergreen forests” (Joshi and Gadgil 1991). These forest patches are also called ‘devarkaans’ (sacred forests), as the natives of these regions preserve kaan forests traditionally as the abodes of sylvan deities maintaining a lasting relationship with nature (Gokhale 2004). These Sacred forests served many functions like conservation of biodiversity and watershed, moderation of climate, and enhancement of landscape heterogeneity which promoted varied wildlife. Studies highlight that, groves support a good number of rare and endemic species, which are extra-sensitive compared to common species, and persist only in favourable niches, and the sacred groves are ideal places for them (Jamir and Pandey 2003; Sukumaran and Raj 2007). The village sacred forests ranged in size from few hectares to few hundred hectares. The Kans of SorabTaluk in Shimoga covered 13,000 ha or 10% of Sorab’s area. (Chandran, 1997).

Studies have reported their role in pollination and seed dispersal by harbouring honey bees and small mammals, species diversity maintenance, avifauna survival and many others (Deb *et al.* 1997; Bodin *et al.* 2006). Interestingly, in a good number of cases, these patches are culturally protected forest segments associated with local communities. Sacred groves which are present in humanised landscapes have limitations in their spatial extent. In a highly productive landscape grove is represented either by cluster of trees or small, isolated patches of few acres of land facing various levels of disturbances. Despite their size limitations, these fragments conserve local biodiversity and offer important ecological services although studies are scanty to substantiate the latter (Ray and Ramachandra, 2010). Except few ecological and floristic inventory studies, little is known about the ecological profile of these groves, adaptation of vegetation under adverse conditions and how do the diverse life forms survive in the system.

**Management of Kans – An Historical Perspective**

British government as soon as taking over the Old Mysore state surveyed the respective areas to explore the resources. In later years the government tried to make decisions relating to management of the forest area and certain years became the historical benchmarks in deciding the fate of the forests resources in the Western Ghats. Table 1 summarizes the chronological history of Kan management. Kan was defined to mean an evergreen jungle containing springs.

**Table 1:** Historical benchmarks for management of Kans in Shimoga district (Gokhale, 2004)

| Year | Event in Shimoga (old Mysore state) |
|---|---|
| 1801 | Mention of kans by Buchanan as forests of gods and pepper |
| 1848 | First record of Kan revenue from SorabTaluk |
| 1867 | British debated over existence of kans as separate land use pattern |
| 1868 | kans of Sorab reported by Brandis and Grant |
| 1878 | Prohibition of coffee cultivation inside kans |
| 1882 | Kans converted to coffee plantations in Chikmagalur (Kadur) district |
| 1885 | Kan rules were published |
| 1888 | Wingate, British forester remarks over destructive exploitation from kans |
| 1895 | Amendment in kan rule-1 |
| 1919 | M S N Rao, forester comments over the drying of streams due to felling in Shimogakans as 'disastrous' |
| 2001 | Left over kans as state forest or minor forest or reserve forest |

In the Old Mysore state, local landlords enjoyed the rights over the kans till 1970s. Thus the area under Old Mysore state had formulated elaborate rules and regulations regarding the management of kans. The rights of people over the produce were also identified as follows (Annon, 1901):

- May 1866 - Kans of Sorab Taluk were closed to public and classed as reserved forests.

- In May 1868 Dr. Brandis inspected Sorab Kans and divided them into 2 classes – Occupied and Unoccupied Kans. The holders of occupied Kans were to have all the produce of the Kans, such as coffee, pepper, toddy, honey, gum etc. In regard to timber trees the Government had full right; the Kan holder was allowed to cut unreserved timber, branches and leaves for his own use and not for sale. The occupied Kans was regarded as Government property.
- The concession granted in 1868 to holders of Kans to cut unreserved timbers for their own use was withdrawn in 1872. The Kan holder was declared to have a right to draw toddy to cultivate and collect pepper, coffee, fruits, gum, honey and all other produce and to cut and gather branches and leaves for manure.

The rights conceded to the Kan holder through the notification (October 1874) were-

i). The right of tapping toddy trees subject to the Abkari rules
ii). The right of cultivating pepper and of felling underwood to the extent absolutely necessary for securing the growth of the pepper vine
iii). The right of collecting honey, gum and all jungle produce
iv). The right of collecting leaves (Soppu)for manure

The right to cultivate coffee was withdrawn and the Kan holder did not have the right over timber trees. In April 1878 a new clause was added to the notification issued for Nagar taluk, indicating the need for prior permission to cultivate coffee.

On July 1878, the Chief Commissioner passed an order regarding coffee cultivation in kans in Thirthahalli Taluk: Kan holder need to apply in advance to cultivate coffee in kans land (belong to him). The decision would be taken by the deputy commissioner on the advice of forest officer considering objections if any for granting the land to such purposes.

In July 1878 the government of India requested the Nagar Commissioner to submit a statement showing particulars of *Kans* in which coffee had already been grown without *pattas*. The commissioner submitted statement in January 1879, indicating coffee cultivation in 902 acres of *Kan* land in Shimoga district held without *patta*. Subsequently, restriction was imposed on coffee cultivation in Kans.

The rights of *Kan* holders (such as collection of leaves for manure) were mentioned in the notification (dated 15-4-1879).. Lopping of reserved trees for leaves and cultivation of coffee were prohibited on Kans.

In 1885 the rules regarding the rights of occupants in *Kans* were revised as follows:

- ✓ Rule 1: The occupant of a Kan has the right to tap toddy trees, subject to the Abkari rules, and to cultivate pepper also to collect gum and honey and all jungle produce; he may further collect leaves (soppu) for manure for use in Kan itself and cut underwood and thin out top branches;

- ✓ Rule 2: The Kan holder has the right to lop unreserved trees growing in the Kan for soppu to be used in the Kan itself;
- ✓ Rule 3: If a Kan extends to within 50 yards of the Kan holder's house, he has the right to fell any unreserved trees or to lop for soppu any reserved trees which may be growing within 50 yards ofhis house on any side. Within those limits he was allowed fully liberty to plant any trees or carry on any cultivation. The soppu must be used within the Kan itself;
- ✓ Rule 4: (a)The Kan holder has as regards trees growing in the Kan no right either to fell or injure any timber whatever reserved or unreserved or (b) To lop for soppu or otherwise to injure or interfere with any reserved tree. In violation of this rule, the offender is liable to punishment for breach of the forest rules;
- ✓ Rule 5: The Kan holder has no right to plant coffee in the *Kan*;
- ✓ Rule 6: Trees in the Kans shall be considered as property of the State and no person shall have any right to cut or collect or remove any timber or lop or injure any trees therein. As regards Kan holder, the ***Kan* shall be deemed to be a district forest** and as regards strangers it shall be **deemed to be a state forest** within the meaning of state forest rules of 1878 and all breaches of this rules will be liable to be punished under the forest rules of 1878.

Accoring to the Survey Superintendent, during 1878 there are 109 cases of mixed survey numbers in Thirthahalli Taluk.

Kan and Soppinabettas – 87 numbers
Kan coffee and Soppinabetta – 2 numbers
Kan and coffee – 5 numbers
Kan and jungle – 15 numbers
Total 109

The area of Kans of Sorab in 1871 according to the survey report from the superintendent, Revenue survey Mysore is as follows:

Kans wholly occupied - 9,124 acres
Kans partly occupied, partly unoccupied – 21,098 acres
Kans wholly occupied - 2,372 acres
Total - 32594 acres

The two Kans of Kapgalali and Karchikoppa with 234 and 94 acres were reserved by forest department for experimental purposes.

The following Kans was taken out from reserved lists by the conservator of Forests from Kans of Sorab in March 1867. The reserved portions are the Kans in 8 maganies or hoblis of the taluk. These maganies are Chittoor, Sega, Midagi, Sorab, Tavanandy, Chandargutti, Hachy, Kusnoor.

Major Hunter in March 1866 in his letter to the commissioner wrote “The taluk of Sorab contains large Kan forests rich in timber of various kinds. They are preserved by few men paying Kan shist merely for the forest produce and the raiyat goes to the government forest for his timber, bamboos and firewood. The raiyat cannot take any timber or firewood from the said Kans. The Amildar allowed that raiyat has no privilege in Kan land of any kind. Only 10 men out of 100 obtained advantages from these Kans those are paying Kan shist.

According to joint report from Captain Grant, Superintendent Revenue Survey, Mysore and Dr. Brandis Inspector general of forest on Kans in Sorab Taluk, May 1868

i). A large portion of uncultivated area in Sorab Taluk is covered with two types of forests: Evergreen and dry forests. The evergreen forests cover most of the higher hills in the taluk and the catchment basins of hill streams which serve to irrigate arecanut gardens and sugarcane fields. Most of the evergreen forest in Sorab Taluk contained Sago palm and the pepper vine and in addition to these coffee is frequently cultivated under the shade of forest. Forests which yield certain kind of products such as pepper, coffee, toddy, leaves and branches for manure are called as Kans whether they are dry or evergreen.

The evergreen Kans which produces pepper, coffee and toddy are most important in Sorab are assessed and entered in Revenue accounts and portions of them are held in regular tenure generally by wurgdars or landholders in vicinity. Kans thus occupied and for which annual revenue is paid by the holder are called “Sagwulle” or cultivated. Of the remainder the produce as a rule annually sold to the highest bidder. They are less taken care and called “Banjar” or uncultivated.

The total number of Kans in different divisions of Sorab Tauk is 171 and the occupied portion is held by 648 wurgdars, two thirds of whom are said to belong to class of “Halpaiks” or toddy drawers. Each Kan had some recognized name of its own or the name of village where it was situated.

ii). The dry forests are considered as Government Forests - Korkain Kan East of Sorab cover an area of 6 miles by 3, one third was occupied by 71 holders. Hireh Shekuna Kan, close to Sorab bazaar covers about 300 acres and held by 100 wurgdars.

The Kans of Sorab was entered in the list of reserved forests in the annual administration report of Mysore of 1865-66. In June 1866 supplementary forest rules for the Nagur division was declared by order of commissioner. No 12 of this rule defines the rights of government and of the Kan holders as follows:

> ***"All timber trees in Kans particularly those in the Sorab Taluk were reserved by the forest department but the right of collecting two items of bagani or toddy and wild pepper to the Kan renters."***

In forest rules of July 1865 Kans are mentioned in 16th rule as follows

> ***"Private individuals, whether raiyats or others may cut reserved trees or bamboos on their own lands and Kans for their own use without restriction but such wood cannot be sold without a license being obtained as in the case of traders"***

The conservator was directed to cancel the steps which were taken to include Kans as reserved forests.

In Shimoga, as the state claimed the timber rich deciduous forests, the peoples were required to meet their biomass needs from the evergreen kans, which they had conserved through ages as safety forests. Not aware of the role of kans in the traditional land use system of Karnataka Western Ghats, Brandis and Grant wondered***: "why should a certain locality be covered with evergreen and another in its immediate vicinity with dry forest?" and Kans were released for coffee cultivation.***

## 7.1 Status of Kans in Shimoga district:

There were 116 kans in the Sorab Taluk but according to the forest department the present number of kans is 65. The total number of kans in SorabTaluk could be more than 65 as many earlier kans are now have the status of minor forest or district forest and are not necessarily reserved forests as considered by many forest officials.

Recognised regime by the forest department till 1960: The Shimoga circle of the Karnataka state forest department administered kans under a separate management regime till 1960, i e, until the last reorganization of the forests in the circle. There were official prescriptions followed for the maintenance of the kans since the time of the Old Mysore state under the management of British government. The management of kans and sharing of benefits was vested with local landlords like the gowdas of the village. There was a system of tax/lease ('shisht') to be paid by the local gowdas in whose name the kans were leased out. The state forest department continued the system till the local landlords lost their rights on kans mainly due to the land tenancy act.

In Shimoga district kans have been reported from taluks like **Tirthahalli, Hosanagar, Sagar, Sorab,** etc. Records available with Sagar forest division mention kans in taluks **such as Sagar (82), Sorab (172) and Hosanagar (60)**. The monograph on Malnadkans, Soppinabetta and Kumri lands (1901) also mentions the existence of kans in Chikmagalur (erstwhile Kadur) district of Old Mysore state (**Gokhale, 2004).**

The status of Kans of Sagar division in 2003 is given in tables **below (Table 2.1, 2.2, 2.3 and 2.4 8) (Working Plan, Sagar division 2003)**

### Table 2.1: Status of Kans in HosnagarTaluk

| Sl. No | Village name | | Survey. No. | Total area Handed over In ha | Area notified Under SF/MF/RF In ha | Area notified Under Sec4 in ha | Area to Be Notifiedundersec17 | Balance Area to be Notified in ha |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Basavapura | Kan | 75&76 | 7.82 | - | - | - | 7.82 |
| 2 | Jeni | " | 16 | 19.10 | - | - | - | 19.10 |
| 3 | Masagalli | " | 63,64,72,34 | 47.55 | - | - | - | 47.55 |
| 4 | Neelakanthantota | " | 59 | 14.72 | - | - | - | 14.72 |
| 5 | Haletota | " | 8,14,10,12,13 | 75.15 | - | - | - | 75.15 |
| 6 | Kalur | " | 75 | 13.00 | 13.00 | - | - | - |
| 7 | Punaje | " | 55 | 5.69 | 5.69 | - | - | - |
| 8 | Mumbaru | " | 72 | 8.20 | - | - | - | 8.20 |
| 9 | Matturu | " | 28 | 29.99 | - | 30.02 | 30.02 | - |
| 10 | M.Guddekoppa | " | 22 | 30.02 | 14.50 | - | - | 15.52 |
| 11 | Varamballi | " | - | - | - | - | - | - |
| 12 | Varkod | " | 26,30 | 40.62 | 40.62 | - | - | - |
| 13 | Ganganakoppa | " | 30,34,47 | 40.95 | - | - | - | 40.95 |
| 14 | Hiriyogi | " | 24 | 0.24 | - | - | - | 0.24 |
| 15 | Savantur | " | 6,11,66,51 | 342.92 | 24.29 | 250.91 | 250.91 | 67.72 |
| 16 | Kumbatti | " | 50,52,7,4 | 11.86 | - | - | - | 11.86 |
| 17 | Nivane | " | 11,26 | 17.58 | - | 7.28 | 7.28 | 10.30 |
| 18 | Borikoppa | " | 3 | 0.42 | - | | | 0.42 |
| 19 | Gawtur | " | 32,12,3,4,306,328,364 | 66.41 | - | | | 66.41 |
| 20 | Mugudthi | " | 21 | 34.54 | - | | | 34.54 |
| 21 | Hirejeni | " | 10 | 3.68 | - | | | 3.68 |
| 22 | Karakki | " | 22 | 1.27 | - | | | 1.27 |
| 23 | Kodur | " | 57,81 | 33.86 | 3.47 | | | 30.39 |
| 24 | K.Hunasvalli | " | 56,68 | 22.29 | 18.21 | | | 4.08 |
| 25 | Harathal | " | 73 | 20.74 | - | | | 20.74 |
| 26 | Hosakere | " | 18 | 15.12 | - | | | 15.12 |
| | | | ***TOTAL*** | **903.74** | **119.78** | **288.21** | | **495.78** |

### Table 2.2: Status of Kans in ShiralkoppaTaluk

| Sl No | Name of the village | | Survey. No. | Total area Handed over In ha | Area notified Under SF/MF/RF Inha | Area notified Under Sec4 in ha | Area to Be Notified undersec17 | Balance Area to be Notified in ha |
|---|---|---|---|---|---|---|---|---|
| 1 | Shigga | Kan | 146 | 622.05 | 523.21 | 98.84 | 98.84 | 0.00 |
| | | " | 178 | 336.26 | 290.26 | 46.00 | 46.00 | 0.00 |
| 2 | Induvalli | " | 1 | 354.16 | - | 354.16 | 354.16 | 0.00 |
| | | " | 62 | 50.00 | - | 48.20 | 48.20 | 1.80 |
| 3 | Syadalkoppa | " | 53 | 51.01 | - | 65.10 | 65.10 | -14.09 |
| 4 | Kanbutlu | " | 3 | 285.08 | 247.14 | 37.94 | 37.94 | 0.00 |
| 5 | Udri | Districtjungle | 91 | 253.06 | - | 253.06 | 253.06 | 0.00 |
| | | " | 164 | 668.15 | - | 668.15 | 668.15 | 0.00 |
| 6 | Negavadi | " | 324 | 228.03 | - | 203.10 | 203.10 | 24.93 |
| 7 | Udri | Forestjungle | 103 | 515.31 | - | 515.31 | 515.31 | 0.00 |
| 8 | Bedavatti | " | 91 | 423.20 | - | 423.20 | 423.20 | 0.00 |
| | | | | **3786.31** | **1060.61** | **2713.06** | **2713.06** | **12.64** |

## Table 2.3: Status of Kans in Sagar Taluk

| Sl No | Name of the village | | Survey. No. | Total area Handed over in ha | Area notified Under SF/MF/RF in ha | Area notified Under Sec4 in ha | Area to Be Notified under sec17 | Balance Area to be Notified in ha |
|---|---|---|---|---|---|---|---|---|
| 1 | Masur | Kan | 145,1,47,144,102,103,129 | 396.32 | 128.38 | | 9.6 | 258.34 |
| 2 | Belur | " | 43,93,122 | 90.77 | - | - | | 90.77 |
| 3 | Chikkanallur | " | 28,37,49,168,50,159,150 | 327.05 | 50.74 | 254.44 | | 21.87 |
| 4 | Shiravala | " | 95,99 | 53.96 | - | - | | 53.96 |
| 5 | Bilisiri | " | 10,37,75,81 | 179.65 | 120.45 | - | | 59.20 |
| 6 | Bhimneri | " | 17,18,30,36 | 25.75 | - | - | | 25.75 |
| 7 | Ullur | " | 29 | 22.68 | - | - | | 22.68 |
| 8 | Madsur | " | 79,47 | 45.82 | - | - | | 45.82 |
| 9 | Balasagodu | " | 46 | 42.03 | - | - | | 42.03 |
| 10 | Barur | " | 137 | 206.10 | - | 205.18 | | 0.92 |
| 11 | Mulkere | " | 17 | 13.91 | - | - | | 13.91 |
| 12 | Nadamanchale | " | 45 | 136.96 | 109.67 | - | | 27.29 |
| 13 | Kamblikoppa | " | 1,2,82,11 | 88.03 | - | - | | 88.03 |
| 14 | Bandakoppa | " | 57 | 3.38 | - | - | | 3.38 |
| 15 | Adaranthe | " | 62 | 4.87 | - | - | | 4.87 |
| 16 | Marur | " | 40,73 | 147.53 | 123.62 | - | | 23.91 |
| 17 | Marsa | " | 44,27,17,18 | 165.86 | - | 16.22 | | 149.64 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18 | Nadakalsi | " | 1,111 | 250.77 | - | | | 250.77 |
| 19 | Yelavarsi | " | 18 | 8.94 | - | | | 8.94 |
| 20 | Keladi | " | 96 | 277.06 | - | 114.98 | | 162.08 |
| 21 | Balegere | " | 13 | 49.04 | - | | | 49.04 |
| 22 | Varadahalli | " | 3 | 48.32 | 47.85 | | | 0.47 |
| 23 | Avinalli | " | 101,35 | 108.68 | 43.08 | | | 65.60 |
| 24 | Besur | " | 20,50,104,84 | 425.86 | - | 488.26 | | -62.40 |
| 25 | Marthur | " | 120,190 | 31.25 | - | 31.36 | | -0.11 |
| 26 | Kanle-Shirur | " | 10,6,94,81,51,68,461,465 | 182.85 | - | 21.11 | | 161.74 |
| 27 | Shiraguppe | " | 56 | 56.68 | - | | | 56.68 |
| 28 | Mathikoppa | " | 54,59,78 | 60.84 | - | | | 60.84 |
| 29 | Genasinakun | " | 121 | 31.00 | - | | | 31.00 |
| 30 | Gulehalli | " | 15,37 | 22.94 | - | | | 22.94 |
| 31 | Sathalalu | " | 41,42 | 127.35 | - | | | 127.35 |
| 32 | Kanike | " | 15 | 10.69 | - | | | 10.69 |
| 33 | Kabbinadakoppa | " | 23 | 26.60 | - | | | 26.60 |
| 34 | Mavinasara | " | 62,67 | 22.54 | - | | | 22.54 |
| 35 | Heggodu | " | 33 | 4.58 | - | | | 4.58 |
| 36 | Heggahu | " | 24 | 13.14 | - | | | 13.14 |
| 37 | Hitur | " | 11 | 16.19 | - | | | 16.19 |
| 38 | Balagodu | " | 15,43 | 37.70 | - | | | 37.70 |
| 39 | Hessega | " | 14,39 | 40.36 | - | | | 40.36 |
| 40 | Lavigere | " | 104 | 8.00 | - | | | 8.00 |
| 41 | Hunsur | " | 1 | 33.80 | - | | | 33.80 |
| 42 | Bellenne | " | 44,50 | 17.88 | - | | | 17.88 |
| 43 | Arehadha | " | 80 | 17.24 | - | | | 17.24 |
| 44 | Hosahalli | " | 35 | 12.41 | - | | | 12.41 |
| 45 | Sasarvalli | " | 80 | 2.97 | - | | | 2.97 |
| 46 | Hosakoppa | " | 53,68 | 40.14 | - | | | 40.14 |
| 47 | Bardavalli | " | 227285286 | 122.53 | - | | | 122.53 |
| 48 | Shuntikoppa | " | 133,234,22 | 228.32 | - | | | 228.32 |
| 49 | Kugve | " | 111 | 36.30 | - | | | 36.30 |
| 50 | Kandika | " | 140 | 12.71 | - | | | 12.71 |
| 51 | Hirenellur | " | 284,213,231,249 | 218.95 | - | 67.20 | | 151.75 |
| 52 | Malve | " | 1 | 197.87 | - | 43.77 | | 154.10 |
| 53 | Dombe | " | 38 | 13.27 | - | | | 13.27 |
| 54 | Hulegar | " | 161,84 | 24.16 | - | | | 24.16 |
| 55 | Tadagalale | " | 155,300 | 185.42 | - | | | 185.42 |
| 56 | Sydur | " | 221,272,388,344,352,358,3 | 272.00 | - | | | 272.00 |
| 57 | Honnemaradu | " | 61,91 | 6.95 | - | | | 6.95 |
| | | | **TOTAL** | **5254.97** | **623.79** | **1252.12** | | **3379.06** |

## Table 2.4: Status of Kans in Soraba Taluk

| Sl No | Name of the village | | Survey. No. | Totalarea Handedover Inha | Areanotified Under SF/MF/RF Inha | Area notified UnderSec4in ha | Areato Be Notifiedundersec 17 | Balance Areatobe Notifiedin ha |
|---|---|---|---|---|---|---|---|---|
| 1 | Pura | Kan | 59 | | 67.75 | 57.52 | | 10.23 |
| 2 | Br.Holekatte | " | 4 | | 18.11 | - | | 18.11 |
| 3 | N.Holekatte | " | 13 | | 1.63 | - | | 1.63 |
| | | " | 14 | | 0.94 | - | | 0.94 |
| 4 | Kuluvalli | " | 30 | | 75.52 | 52.55 | | 22.97 |
| | Kerekoppa | " | 41 | | 50.81 | 48.79 | | 2.02 |
| 5 | Eranapura(Kereko | " | 91 | | 25.17 | - | | 25.17 |
| | | " | 112 | | 15.28 | - | | 15.28 |
| 6 | Eranapura | " | 11 | | 42.56 | - | | 42.56 |
| 7 | Nandigudde | " | 7 | | 65.45 | 59.18 | | 6.27 |
| 8 | Magadi | " | 31 | | 99.53 | - | | 99.53 |
| 9 | Banadakoppa | " | 1 | | 21.62 | - | 14.16 | 7.46 |
| 10 | Br.Dodderi | " | 29 | | 21.88 | - | | 21.88 |
| 11 | Charantihosakoppa | " | 5 | | 6.08 | - | | 6.08 |
| 12 | Talakalakoppa | " | 47 | | 32.14 | - | 30.25 | 1.89 |
| 13 | Kanahalli | " | 28 | 112.61 | | - | | 112.61 |
| 14 | Kanaur | " | 26 | 166.78 | | - | | 166.78 |
| | | " | 40 | 116.36 | | - | 3.24 | 113.12 |
| 15 | Heggodu | Jadikan | 28 | | 21.36 | 20.23 | | 1.12 |
| 16 | Ulavi | " | 47 | | 23.27 | 20.23 | | 3.04 |
| | | " | 50 | | 23.25 | - | | 23.25 |
| | | " | 53 | | 55.71 | 47.35 | | 8.36 |
| 17 | Kaisodi | " | 26 | | 70.47 | 64.75 | | 5.72 |
| | | " | 90 | 165.00 | | 133.55 | | 31.45 |
| 18 | Baragi | " | 92 | 171.07 | | 165.12 | | 5.96 |
| 19 | Halagalale | " | 28 | 258.31 | | 190.72 | 50.59 | 17.00 |
| 20 | Nisarani | " | 66 | | 14.09 | - | | 14.09 |
| 21 | Kolisalu | " | 49 | | 70.56 | 55.42 | | 15.14 |
| 22 | Ammagondanakop | " | 16 | | 87.61 | 61.11 | | 26.50 |
| 23 | Kondagalale | " | 5 | 115.90 | | 68.86 | | 47.05 |
| 24 | Chilanoor | Kan | 1 | | 83.39 | 67.58 | | 15.80 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 25 | Chikkalagodu | " | 18 | | 3.96 | - | | 3.96 |
| 26 | Bennur | " | 17 | | 36.60 | 34.80 | | 1.80 |
| 27 | Harishi | " | 116 | | 15.77 | - | | 15.77 |
| | | " | 197 | | 29.72 | 21.51 | | 8.22 |
| 28 | Mangalore | " | 175 | | 97.42 | - | | 97.42 |
| 29 | Marur | " | 158 | | 0.65 | - | | 0.65 |
| | | " | 198 | | 21.64 | - | | 21.64 |
| 30 | Adur(Edur) | " | 30 | | 6.61 | - | | 6.61 |
| | | " | 34 | | 43.28 | 43.28 | | 0.00 |
| | | " | 35 | 150.07 | | - | | 150.07 |
| 31 | Mannattu | " | 35 | | 55.63 | - | | 55.63 |
| 32 | Kakkarsi | " | 13 | | 76.09 | - | | 76.09 |
| | | " | 14 | | 12.56 | - | 18.00 | -5.44 |
| 33 | Absi | " | 223 | | 15.67 | - | | 15.67 |
| 34 | Andavalli | " | 339 | | 33.51 | - | | 33.51 |
| | | " | 340 | | 16.50 | - | | 16.50 |
| 35 | Uyaguddekoppa | " | 2/2 | | 19.16 | - | | 19.16 |
| 36 | Salekoppa | " | 2/1 | | 73.33 | - | | |
| | | " | 2/2 | | 73.33 | - | 226.22 | |
| | | " | 2/3 | | 73.32 | - | | |
| | | " | 2/4 | | 71.33 | - | | 65.08 |
| | | " | 167/1 | | 25.19 | - | | 25.19 |
| | | " | 167/2 | | 25.19 | - | | 25.19 |
| | | " | 167/3 | | 25.19 | - | | 25.19 |
| 37 | Kuluga | " | 1/1 | 135.59 | | - | | 135.59 |
| | | " | 1/2 | 135.57 | | - | | 135.57 |
| | | " | 38/1 | | 11.30 | 11.30 | | 0.00 |
| | | " | 38/2 | | 11.30 | 10.15 | | |
| 38 | Totlagondanakop p | " | 76 | | 45.81 | 18.44 | 44.52 | -17.15 |
| 39 | Kuppagadde | " | 306 | 479.72 | | 269.77 | | 209.96 |
| 40 | Bilavagodu | " | 42 | | 80.11 | | | 80.11 |
| 41 | Tavanandi | " | 195 | 515.02 | | 381.75 | 101.17 | 32.10 |
| 42 | Dodderikoppa | " | 19 | | 82.92 | 62.04 | 20.23 | |
| 43 | Bendekoppa | " | 6 | 105.25 | | 75.11 | 29.95 | |
| 44 | Sampagodu | " | 86 | | 5.16 | - | | |
| 45 | Korakodu | " | 9 | 314.40 | | 220.46 | 91.06 | |
| 46 | Kodakani | " | 4 | 578.60 | | - | 321.73 | 256.87 |
| 47 | Kuppalli | " | 57 | | 95.41 | - | 76.89 | 18.51 |
| 48 | Yalasi | " | 77 | | 19.09 | - | | 19.09 |
| | | " | 102 | | 4.14 | - | | |
| | | " | 141 | | 62.59 | - | | 62.59 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 49 | Tandige | " | 58 | 146.42 | | - | 136.79 | |
| 50 | Chikkachauti | District jungle | 143 | | 65.70 | 55.58 | | 10.12 |
| 51 | Thudaneer | " | 32 | 110.18 | | - | | 110.18 |
| | | " | 38 | | 67.52 | - | 21.04 | 46.48 |
| 52 | Shiddihalli | " | 11 | | 88.17 | - | 84.99 | |
| 53 | Kerehalli | " | 85 | | 54.23 | - | 52.61 | |
| 54 | Talaguppa | " | 20 | | 83.67 | - | 76.89 | |
| 55 | Harishi | " | 179 | | 94.73 | 76.47 | | 18.26 |
| 56 | Kunaji | Forest jungle | 16 | 169.53 | | - | | 169.53 |
| 57 | Andige | " | 113 | | 22.72 | - | | 22.72 |
| | | " | 135 | | 41.34 | - | | 41.34 |
| 58 | Kolagunasi | " | 106 | | 95.16 | - | 54.63 | 40.53 |
| 59 | Kuppagalale | " | 16 | 124.88 | | 88.25 | 30.35 | |
| 60 | Bhadrapura | " | 16 | | 56.24 | 45.06 | | 11.18 |
| 61 | Anavatti | " | 133 | 101.06 | | - | | 101.06 |
| 62 | Kuntagalale | " | 70 | 153.09 | | 127.48 | 18.21 | |
| | | " | 117 | 138.87 | | 60.70 | 26.31 | 51.86 |
| 63 | Suranige | " | 69 | 195.55 | | - | 176.04 | 19.51 |
| 64 | Anavatti | " | 10 | | 65.50 | - | | 65.50 |
| 65 | Bommenhalli khan | " | 33 | | 94.96 | - | | 94.96 |

**Actions taken by Forest department to protect the encroachment of Kan Lands in Sagar forest division:**

The Kans of Sagar divisions are under the threats of encroachment. Farmers encroach the Kans attached to their fields and convert it into agriculture land. In Sagar division these Kans are identified and cattle proof trenches were done. In the beds of these trenches native tree species are planted. During 2011-12 around 2000 hectares of Kans were protected from encroachment. (**Sagar division, 2012-13**).

The important steps taken by Sagar division for protection of Kans are as follows:

- Solving the conflict regarding the ownership of Kans
- Digitization of Kans from Uttara Kannada to Chikmanglur using Satellite images and declaring these areas as “Protected Kan Areas”
- Declaring protected Kans as “Special Conserved Area”
- Preparing list of least harmed Kans and identifying the borders of these Kans
- Stopping Encroachment in the Kans

- Identifying the borders of Kans and if Encroachment is there construction of CPT lines
- Creating Village Forest Committee in Kan villages and giving the authority of Kans to them
- People awareness programmes regarding protection of Kans
- Preparing brochures regarding importance of Kans to distribute to forest officials and common people
- Studying complete biodiversity of Kans
- Distribution of gobber gas and astra ole to village peoples to avoid pressure on Kans for firewoods

Plant species found in these Kans of Sagar Forest division are listed in Table 3.

**Table 3: Plant species in Kans of Sagar Forest division**

| Species | Local name | Distribution | Status |
|---|---|---|---|
| *Diospyros crumenata* | Tumri | Endemic | |
| *Diospyros paniculata* | Karimara | Endemic | Endangered |
| *Saraca asoca* | Ashoka | Endemic | Endangered |
| *Syzygium gardneri* | Henneralu | Endemic | |
| *Flacourtia montana* | Hannu Sampige | Endemic | |
| *Canarium strictum* | karidoopa | Endemic | Endangered |
| *Vateria indica* | Saludoopa | Endemic | Endangered |
| *Antiaris toxicaria* | Ajanapatti | | |
| *Mimusops elengi* | Renjalu | | |
| *Holigarna arnottiana* | Holageru | Endemic | |
| *Mangifera indica* | Mavu | Endemic | |
| *Holigarna graham* | Dodda Holageru | Endemic | Endangered |
| *Garcinia gummigutta* | Uppage | Endemic | |
| *Garcinia morella* | Arisina mandi | Endemic | |
| *Ailanthus triphyssa* | Maddi Dhoopa | Endemic | |
| *Artocarpus hirsutus* | Hebbalasu | Endemic | |
| *Artocarpus integrifolius* | Halasu | Endemic | |
| *Knema attenuate* | Hedamangala | Endemic | Endangered |
| *Myristica malabarica* | Ramapatre | Endemic | Endangered |
| *Myristica dactyloides* | Gidda Ramapatre | Endemic | Endangered |
| *Dipterocarpus indicus* | Dhooma | Endemic | Endangered |
| *Chrysophyllum lanceolatum* | Hale | Endemic | |
| *Entada persuetha* | Ganape balli | | |
| *Gnetum ula* | Koogale balli | | |
| *Ficus nervosa* | Neeratti | Endemic | |
| *Margaretia indica* | Kempanala | Endemic | |
| *Dysoxylum malabaricum* | Bilidevadaru | Endemic | Endangered |
| *Sterculia guttata* | Basavanate | | |

| | | | |
|---|---|---|---|
| *Alangium salvifolium* | Ankole | | |
| *Garcinia indica* | Murugalu | Endemic | Endangered |
| *Symplocos racemosa* | Lodha | Endemic | Endangered |
| *Diospyros candolleana* | Karivala | Endemic | |
| *Hopea ponga* | Haiga | Endemic | Endangered |
| *Hydnocarpus pentandra* | Shulti | Endemic | Endangered |
| *Aphananthe cuspidate* | Naru Bhutala | Endemic | |
| *Casearia rubescens* | Simbala Mara | Endemic | |
| *Salacia chinensis* | Ekanayaka | | Endangered |
| *Cansjera rheedii* | KaradiSoppu | | |
| *Chonemorpha fragrans* | Chandu Huvina Balli | | Endangered |
| *Strombosea ceylanica* | Kari Kadama | Endemic | |
| *Bischofia javanica* | Neela | Endemic | |
| *Orophea zeylanica* | Sanna Gouri | Endemic | |
| *Persea macrantha* | Gulimavu | Endemic | Endangered |
| *Beilschmeidia wightii* | Kamatti | Endemic | |
| *Diospyros assimilis* | Kari Tumari | Endemic | |
| *Nothapodytes nimmoniana* | Durvasane | Endemic | Endangered |
| *Actinodaphne hookeri* | Tudagenasu | Endemic | |
| *Harpulia arborea* | Bidasale | Endemic | |
| *Pterospermum reticulatum* | Kesala | Endemic | Endangered |
| *Syzygium laetum* | Kanu Jambe | Endemic | |
| *Syzygium cumini* | Nerale | | |
| *Aglaia elaegnoidea* | Nyavala | Endemic | |
| *Moulluva spicata* | Huliuguru Balli | Endemic | |
| *Piper nigrum* | Menasu | Endemic | |
| *Caryota urens* | Baine | Endemic | |

Tree diversity and disturbance of Kan Forests of Sagar have been studied by **Gunaga et.al (2013).**. A comparative description of tree diversity of community-protected kaan forests and state-managed reserve forests influenced by the level of disturbance and rainfall was assessed in Sagar taluk, Shimoga district. Kaan forests possessed higher species richness, with 85 tree species, than the reserve forests (57). Basal area and tree density were also higher in the kaan forests, although the difference was only marginal in some instances. Richness of endemic, rare, endangered and threatened species, as well as species of medicinal or economic importance, was higher in the kaan forests than in the reserve forests. With increased disturbance, the number of rare, endangered and threatened species also decreased, as did the number of endemics.

As part of the biodiversity assessment of Ammanghatta Kan of Hosanagar Taluk **(Vinayaka et.al** 2011)., Table 4.1 and 4.2 lists hers, shrubs and trees. Ammanghatta contains Evergreen, semi evergreen and Scrub forests.

**Table 4.1: Herbs and Shrubs found in Ammanghatta**

| **Scientific name** | **Local Name** |
|---|---|
| *Achyranthes aspera* | Uttarani |
| *Alternanthera sessilis* | Honegone soppu |
| *Asclepias curassavica* | Kakatundi |
| *Ageratum conyzoides* | Uralagida |
| *Blepharis repens* | Hadaratta |
| *Boerhavia diffusa* | Adakaputtina gida |
| *Biophytum sensitivum* | Doddahoramani |
| *Crassocephalum crepidiodes* | Ajjanagadda |
| *Cassia tora* | Gundarchi gida |
| *Cassia sophera* | Alluri gida |
| *Cyperus iria* | Dodda Jambuhullu |
| *Curculigo orchioides* | Nelatati gedde |
| *Canscora decussata* | Shankha huli |
| *Evolvulus alsinoides* | Vishnukranti soppu |
| *Elephantopus scaber* | Anekalu gida |
| *Emilia sonchifolia* | Elikivi gida |
| *Euphorbia hirta* | Achhe soppu |
| *Hoya ovalifolia* | Neerele |
| *Justicia simplex* | Eluva sandhigida |
| *Kalanchoe pinnata* | Kadubasale |
| *Leucas aspera* | Tunchigida |
| *Memecylon malabaricum* | Olle gida |
| *Melastoma malabathricum* | Kinkarike |
| *Mimosa pudica* | Nachike gida |
| *Ophiorrhiza mungos* | Patala garuda |
| *Oxalis corniculata* | Hulisoppu |
| *Polygonum chinense* | Bilicheeni kanagalu |
| *Rauvolfia serpentina* | Sarpagandhi |
| *Remusatia vivipara* | Kadugedde |
| *Spilanthes calva* | Hommagali |
| *Sida acuta* | Beemana kaddi |
| *Hydrocotyle javanica* | |
| *Urena lobata* | Doddabende |
| *Scoparia dulcis* | Mrugandhi gida |
| *Phyllanthus amarus* | Bhoonelli |
| *Themeda triandra* | Bheema handihullu |
| *Abutilon indicum* | Pettige gida |

| | |
|---|---|
| *Cyanotis cristata* | Bettada kannesoppu |
| *Drosera indica* | |
| *Tridax procumbens* | Adikesoppu |
| *Solanum nigrum* | Kakihannina gida |
| *Stachytarpheta indica* | Uttarani |
| *Cynodon dactylon* | Garike hullu |
| *Lantana camara* | Lantana |
| *Caesalpinia mimosoides* | Mullukendige |
| *Carissa carandas* | Kabaligida |
| *Clerodendrum serratum* | Karitekke |
| *Clerodendrum viscosum* | basavanapada |
| *Desmodium gangeticum* | Ondale honne |
| *Helicteres isora* | Edemuri kai |
| *Ixora coccinea* | Kiskara |
| *Leea indica* | Andilu |
| *Lobelia nicotianifolia* | Kadu hogesoppu |
| *Callicarpa tomentosa* | Arati soppu |
| *Ziziphus oenoplia* | Kanevi gida |
| *Maesa indica* | Mandase |
| *Canthium parviflorum* | Karemullu |
| *Nilgirianthus barbatus* | korige |
| *Bambusa arundinacea* | Bidire |
| *memecylon angustifolium* | Kavu gida |
| *Ixora nigricans* | Kisugare |
| *Calycopteris floribunda* | Kuksada balli |
| *Crotalaria pallida* | Gejje gida |
| *Alangium salvifolium* | Ankole |

**Table 4.2: Trees of Ammanghatta**

| **Scientific name** | **Common name** |
|---|---|
| *Lantana camara* | Lantana |
| *Caesalpinia mimosoides* | Mullukendige |
| *Carissa carandas* | Kabaligida |
| *Clerodendrum serratum* | Karitekke |
| *Clerodendrum viscosum* | basavanapada |
| *Desmodium gangeticum* | Ondale honne |
| *Helicteres isora* | Edemuri kai |
| *Ixora coccinea* | Kiskara |

| | |
|---|---|
| *Leea indica* | Andilu |
| *Lobelia nicotianifolia* | Kadu hogesoppu |
| *Callicarpa tomentosa* | Arati soppu |
| *Ziziphus oenoplia* | Kanevi gida |
| *Maesa indica* | Mandase |
| *Canthium parviflorum* | Karemullu |
| *Nilgirianthus barbatus* | korige |
| *Bambusa arundinacea* | Bidire |
| *Memecylon angustifolium* | Kavu gida |
| *Ixora nigricans* | Kisugare |
| *Calycopteris floribunda* | Kuksada balli |
| *Crotalaria pallida* | Gejje gida |
| *Alangium salvifolium* | Ankole |

### 7.2 Threats to Kans - Sacred Kan on the wane:

The Kan forests of Central Western Ghats were important natural sacred sites and cultural centers of the pre-British village communities. At one time, they rose majestically in the horizons, covering large areas in the high places of the malnadu village landscapes, surrounded by cultivations, timber rich secondary forests, and savannized grazing areas. Perennial streams gushing out of these sacred forests were often embanked to make irrigation tanks. Unfortunately, the Kans did not merit consideration as sacred places of village communities under the British rule and so after independence. In Shimoga district, particularly, many kans were brought under the jurisdiction of the revenue department, which allotted Kan lands for meeting various non-forestry purposes such as for growing coffee, expansion of cultivation, for grazing purposes and numerous others, neglecting the rare species they conserved and also of their crucial hydrological importance. The Government also conceded large portions of Kans on long leases to the Mysore Paper Mills for growing industrial woods like *Eucalyptus* and *Acacia* sp. after clearing the natural vegetation.

Expansion of the agricultural activities and subsequent encroachments is the major threat for the survival of kans in central Western Ghats. Comparative assessment of two time remote sensing data (data acquired through space borne sensors) for 2006 and 2010 illustrate substantial reduction (4 to 12%) in vegetation cover in Kuppe Kan, Sagar taluk (Figures 1.1 and 1.2), Chikkanallur Kan, Sagar Taluk (Figures 2.1 and 2.2), Sorab Pura Kan, Sagar taluk (Figures 3.1 and 3.2) and Hunuvalli Kan, Hosnagar Taluk (Figures 4.1 and 4.2)

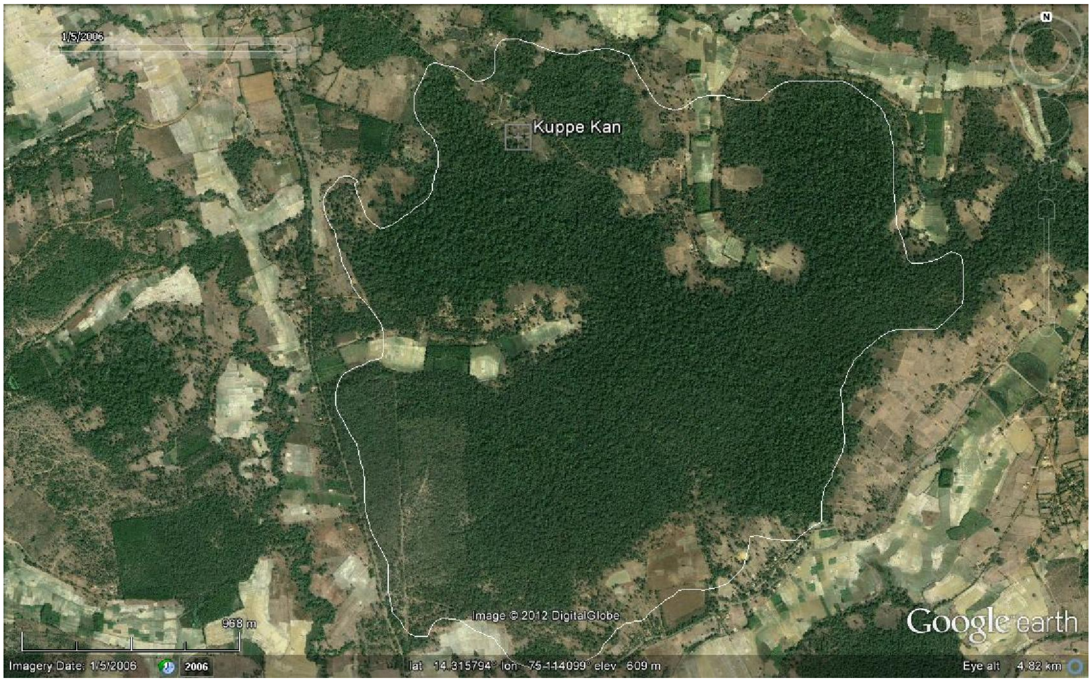


Figure 1.1: Kuppe Kan, Sagar taluk (2006)


Figure 1.2: Kuppe Kan, Sagar Taluk (2010)

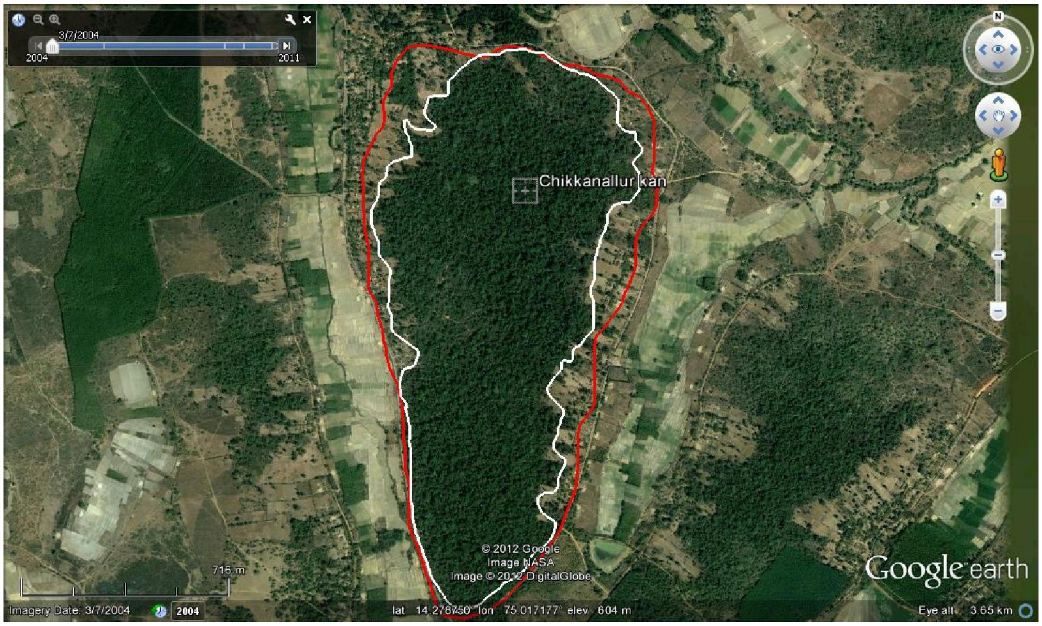


Figure 2.1: Chikkanallur Kan, Sagar Taluk (2006)

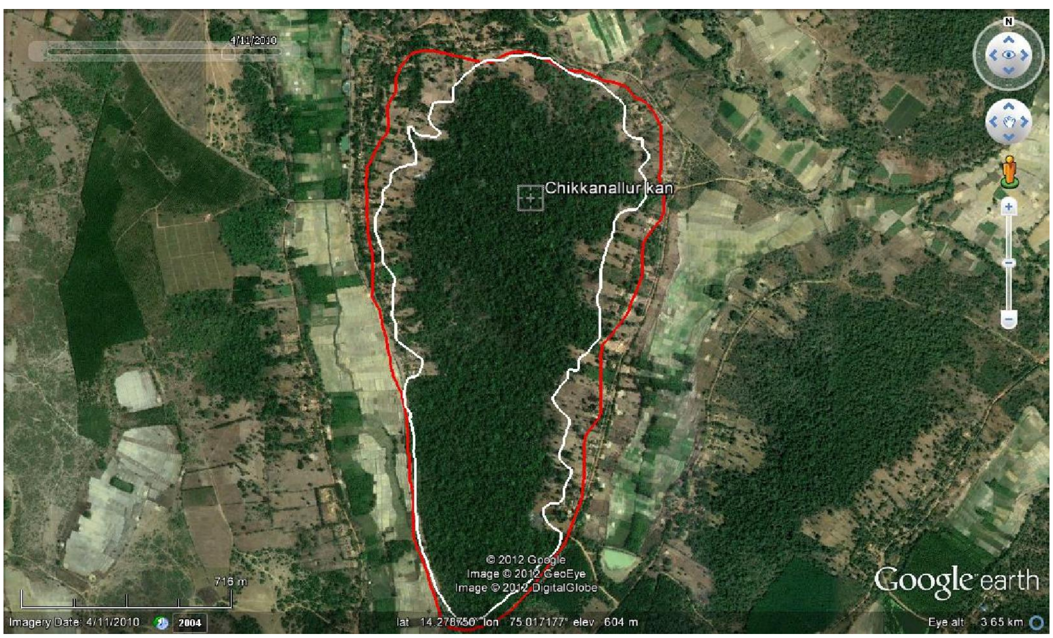


Figure 2.2: Chikkanallur Kan, Sagar Taluk (2010)


Figure 3.1: Sorab Pura Kan, Sagar taluk (2006)


Figure 3.2: Sorab Pura Kan, Sagar taluk (2010)


Figure 4.1: Hunuvalli Kan, Hosangar taluk, 2006


Figure 4.2: Hunuvalli Kan, Hosnagar taluk, 2010

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# TRAGEDY OF THE *KAN* SACRED FORESTS OF SHIMOGA DISTRICT: NEED FOR URGENT POLICY INTERVENTIONS FOR CONSERVATION

## (CASE STUDIES OF KURNIMAKKI-HALMAHISHI AND KULLUNDI *KANS* OF THIRTHAHALLI)

*Study carried out for Vriksha Laksha' Andolan, Sagar Taluk, Shimoga*
*Western Ghats Task Force, Government of Karnataka*


| | | |
|---|---|---|
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## EXECUTIVE SUMMARY


The *kan* forests of Central Western Ghats of Karnataka, were most often climax evergreen forests, preserved through generations by the village communities of Malnadu regions, as sacred forests, or sacred groves, dedicated to deities and used for worship and cultural assemblage of the local communities. Various taboos and regulations on usage of the *kans* were self-imposed by the local communities. In the normal course trees were never to be cut, but the adjoining villagers enjoyed the privileges of taking care and gathering of wild pepper, that was abundant in the *kans*, and many other non-wood produce, demarcating portions of the *kans* informally between the different families for collection purposes.

The *kans* functioned as important sources of perennial streams and springs used for irrigation of crops and for domestic needs. They moderated the local microclimate favouring the spice gardens in their vicinity, and were also fire-proof being evergreen in nature.

The landscape of pre-colonial times had *kans* forming mosaic with secondary, timber rich forests, grassland and cultivation areas, promoting also rich wildlife.

*Kans* were characteristic in the traditional land use of Shimoga, Uttara Kannada and Chikmagalur districts specially, and were equivalent to the *devarakadus* of Kodagu region.

With the domination of Central Western Ghats region of Karnataka by the British, the State asserted its control over the *kan* lands, which were in thousands, each *kan* measuring originally from few hectares to several hundred hectares in area. The curtailment of community rights in the *kans*, including heavier taxation for collection of forest produce resulted in the abandonment of many of them, causing various hardships to the villagers.

Whereas most *kans* of Uttara Kannada got merged with the rest of the forests ensuring the conservation of rare and endemic species of Western Ghats, in Shimoga district the *kans* were not properly documented except in Sorab taluk and to some extent in Sagar and Thirthahalli taluks. Moreover the Shimoga *kans* were brought under either the forest or revenue departments. As communities lost their traditional biomass collection privileges in secondary deciduous forests, in many places they resorted to *kans* for fuelwood, timber and leaf manure, causing their decline.

As the *kans* were not of much timber value due to the growth of easily perishable softwoods in them, the British thought it suitable to keep many such under the control of the revenue department. The revenue authorities started allotting these precious watershed areas and reserves of biodiversity for expansion of cultivation, especially of coffee and garden crops, creating widespread fragmentation of the *kans*. The practice of allotments ranging in area per applicant, individual or organization varied from one or two acres to hundreds of acres each. As the *kans* under revenue department was given more importance as land resources than as forests, the forests were cleared partially or entirely for alternative land uses.

The rampant use of fire for clearing the evergreen vegetation for cultivation areas or creating grassy areas caused change of climax evergreen vegetation to savannas, scrub and secondary deciduous forests with diminished water flow in the streams and rivers, which can be detrimental to the livelihoods of people in malnadu and beyond even in the drier Deccan plains.

Large chunks of *kan* lands were allotted to the Mysore Paper Mills for raising of pulpwood plantations, especially in Shimoga district.

Soil erosion, consequent on the clearance of *kans*, has adversely affected forest regeneration and is also detrimental to cultivation as well as causing siltation of water bodies, resulting in the abandonment of many irrigation tanks adjoining the *kan* lands.

Expressing deep concern on such dismal state of affairs, at a time when forest conservation is of paramount need, the Vriksha-Laksha Andolan, Sagar and the Western Ghat Task Force of the Government of Karnataka assigned us with the task of making a rapid study of two of the *kan* forests, the Kurnimakki-Halmahishikan and Kullundikan in the Thirthahalli taluk of Shimoga district, which are facing severe threats from rampant allotments of large areas to private parties for non-forestry purposes and from conflicting claims of ownership, with the forest department not enjoying adequate power to save these *kans* from *liquidation* of their natural vegetation.

The study in the Kurnimakki-Halmahishi *kan* of about 1000 ha reveals the vegetation of the kan, though heavily fragmented, due to ever increasing human impacts, nevertheless, is a mosaic of various kinds of forests. The most significant is the discovery of swampy areas within this kan which have few individuals of large sized threatened tree species *Syzygium travancoricum,* classified in the IUCN Red List as "Critically Endangered". The tree is on the verge of extinction, and for the Shimoga district, the only occurrence of this tree is the Kurnimakki-Halmahishi *kan*.

The Kullundikan of about 453 ha has a narrow belt of original tropical rainforest dominated by the tree *Dipterocarpus indicus,* considered 'Endangered' by the IUCN. The revenue department in control of this *kan*, being totally ignorant of its vegetation richness has made several grants within the *kan* for cultivation of coffee and arecanut. The grantees have also done encroachments within this climax forest area of high watershed value. The cutting of the climax forest for raising coffee or any other crop is totally unjustified.

We therefore recommend that the Government of Karnataka take immediate action to arrest the degradation of *kan* forests on priority basis by:

- Proper survey and mapping of boundaries of all *kans*;
- Assign the *kan* forests to the Forest Department for conservation and sustainable management;
- Constituting Village Forest Committees for facilitating joint forest management of the *kan* forests;
- Taking speedy action on eviction of encroachers from the *kans*;
- Giving proper importance to the watershed value and biodiversity of the *kans*;
- Taking special care of threatened species and threatened micro-habitats within the *kans*;

- **Heritage sites status to '*kans*' under section 37(1) of Biological Diversity Act 2002, Government of India** as the study affirms that *kans* are the repository of biological wealth of rare kind, and the need for adoption of holistic eco-system management for conservation of particularly the rare and endemic flora of the Western Ghats. The premium should be on conservation of the remaining evergreen and semi-evergreen forests, which are vital for the water security (perenniality of streams) and food security (sustenance of biodiversity). There still exists a chance to restore the lost natural evergreen to semi-evergreen forests through appropriate conservation and management practices.

# TRAGEDY OF THE *KAN* SACRED FORESTS OF SHIMOGA DISTRICT: NEED FOR URGENT POLICY INTERVENTIONS FOR CONSERVATION

**(CASE STUDIES OF KURNIMAKKI-HALMAHISHI AND KULLUNDI *KANS* OF THIRTHAHALLI TALUK)**

## I. INTRODUCTION

Most human societies, in the course of millennia of social and cultural evolution, had evolved a variety of regulatory measures to ensure sustainable utilization of natural resources. These measures included family-wise restricted quota of forest biomass, removal of only dead and fallen plants, sharing of natural resources, prohibition on sale of forest biomass to outsiders (all of which are to this day followed in the Halkar village in the outskirts of Kumta town in Uttara Kannada district). The fishing families in the estuarine villages in the Kumta taluk of Aghanashini River had shared among them traditional fishing privileges in the individual 'kodis' or estuarine channels. Traditional hunting was a taboo until Deepavali festival in the forested villages of Uttara Kannada. To quote, Madhav Gadgil (1992):

> *For local people, degradation of natural resources is a genuine hardship, and of all the people and groups who compose the Indian society they are the most likely to be motivated to take good care of the landscape and ecosystems on which they depend. The many traditions of nature conservation that are still practiced could form a basis for a viable strategy of biodiversity conservation.*

Protection of forest patches as sacred has been reported from many parts of India and many other countries in the recent decades. Trees were normally not to be cut in such forests as they were dedicated to gods. Such sacred groves still persist in many parts of Asia and Africa (Gadgil and Vartak, 1976; Frazer, 1935; Gadgil, 1987).

Most of Himalayas, the rain forest clad North East India, the Central Indian hills, parts of Rajaputana region, many parts of Deccan and the Western Ghat-west coast regions of India had witnessed through ages the strong tradition of conservation of patches of forests as sacred, especially by village and forest dwelling communities. During the period of British colonialism the government asserted its ownership over common lands, including sacred forests, which the local communities had safeguarded and managed through generations. Sweeping cultural changes concomitant with industrial and agricultural advancements also changed traditional belief systems in which nature had a central role. Worship of gods associated with natural sacred sites and 'panchabhutas' or the five elements, has in a major scale given way to installing deities in man-made structures, causing neglect and even exploitation of the precious heritage of natural sacred sites. Nevertheless, Malhotra et al. (2001) have made an excellent compilation from the states like Andhra Pradesh, Arunachal Pradesh, Assam, Chattisgarh, Himachal Pradesh, Jarkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, western Rajasthan, Tamil Nadu, Tripura, Uttaranchal etc., which have more forest wealth than other states, strong evidences of nature conservation tradition, in the form of sacred groves. These sacred forests are known by various names in peninsular India: such as *devarakadu, devarubana* or *kan* in Karnataka, *kavu* in Kerala, *kovilkadu* in Tamil Nadu and *devrai* in Maharashtra.

D. Brandis (1897), the first Inspector General of Forests in India, was one of the first persons to make commendation on the system of sacred groves in the country:

> *Very little has been published regarding sacred groves in India, but they are, or rather were, very numerous. I have found them nearly in all provinces. As instances I may mention the Garo and Khasi hills which I visited in 1879, the Devarakadus or sacred groves of Coorg....and the hill ranges of the Salem district in the Madras Presidency....These are situated in the moister parts of the country. In the dry region sacred groves are particularly numerous in Rajputana. In Mewar, they usually consist of Anogeissus latifolia, a moderate sized tree with small leaves, which fall early in the dry season....Before falling the foliage of these trees turns a beautiful yellowish red, and at that season these woods resemble our beech forests in the autumn. In the southernmost States of Rajaputana, in Partabgarh and Banswara, in a somewhat moister climate, the sacred groves, here called Malwan, consists of a variety of trees....These sacred forests, as a rule, are never touched by the axe, except when wood is wanted for the repair of religious buildings*

Brandis also referred to a “ remarkable little forest of Sal (*Shorea robusta*)” near Gorakhpur being maintained by a Muslim saint, Mian Sahib. The forest was in good condition and well protected. Nothing was allowed to be cut except wood to feed the sacred fire and “this required the cutting annually of a small number of trees which were carefully selected among those that showed signs of age and decay.”

## II. *KANS* AS SACRED GROVES

***Francis Buchanan (1870):*** Alluding obviously to the system of sacredness of forests in the Western Ghats-west coast of Uttara Kannada, Dr. Francis Buchanan, officer of the British East India Company, who travelled through Uttara Kannada in 1801, soon after capturing Canara region by the British stated:

> ***The forests are the property of the gods of the village in which they are situated, and the trees ought not to be cut without having leave from the Gauda (headman of the village).... who here also is pujari (priest) to the temple of the village god. The idol receives nothing for granting this permission; but the neglect of the ceremony of asking his leave brings his vengeance on the guilty person.***

Buchanan (1870 continued further: "Each village has a different god, some male, some female, but by the Brahmins they are called *Saktis*, as requiring bloody sacrifices to their appease their wrath"

From these statements may be inferred that the forests were virtually under the control of the village communities with well defined territories and many had sacred values attributed to them. Buchanan's references to the then practice of slashing and burning of forests in the hills for shifting cultivation, indicates the fact that all forests were not sacred, and the sacred forests also bore the name ***kan*** or ***kanu***.

***W.A. Talbot (1909)***: In his monumental floristic work *Forest Flora of the Bombay Presidency and Sind* Talbot referred to the sacredness of *kans*, a rare such remark from a British officer:

> ***In North Kanara and even as far east as the Hangal subdivision of the Dharwar district along the Western Ghats under an annual rainfall of not less than 70", isolated irregularly distributed patches of rain-forest, locally called Kans and Rais are found surrounded by cultivation or monsoon-forest. These are often the mere remnant of larger areas and have in many instances been respected by the natives as the abode of a sylvan deity.***

Talbot's statement makes it clear that even towards the drier east of Uttara Kannada district bordering the Hangal taluk, with rainfall much lower, compared to the mountainous malnadu part of Western Ghats, there existed evergreen forests equivalent to rain forests, the *kans*, which were home to village deities. These *kans* were already on the decline as they were mere "remnant of larger areas."

The special protection given to the *kans* by the village communities of Sorab in Shimoga district had won full praise from Peter Ashton (1988), renown tropical forest ecologist, who considered *kans* as:

> ***Prototypes of a technique currently being promoted as a new approach to forestry: agroforestry. In a region dominated by deciduous forests (Sorab is bordering on the drier Deccan Plateau) that were annually burned, the kans stood out as belts, often miles long, of evergreen forest along the moist scrap of the Western Ghat hills. Assiduously***

> ***protected by the villagers, these once natural forests had been enriched by the inhabitants through interplanting of jackfruits, sago and sugar palms, pepper vine, and even coffee, an exotic.***

Ashton (1988) justifies such kind of conservation in India seeking an explanation in its culture:

> ***The Indian sub-continent is without doubt the world centre of human cultural diversity… The Hindus have inherited perceptions of a people who have lived since ancient times in a humid climate particularly favourable for forest life. Settled people, they see themselves as one with the natural world, as both custodians and dependents…. Forests of the mountains and watersheds have been traditionally been sacred; springs and the natural landscape in their vicinity have attracted special veneration. The Hindus learned from their predecessors millennia ago, a mythology, sociology and technology of irrigation that has enabled the most intensive yet sustainable agriculture humanity has so far devised.***

In the above remarks, Ashton was referring to culture based conservation in India, and how the veneration of watershed forests in the highlands facilitated "most intensive yet sustainable agriculture humanity has so far devised."

### *Area under the kans*

It is difficult to get a consolidated account of the area under the *kans*, at the time of the establishment of British authority over the forest resources of the malnadu regions of Karnataka. It appears that survey and demarcation of the *kans* was an incomplete work. Several *kans* of Uttara Kannada district got merged with rest of the state reserved forests and lost their special identities. They are to be recognized today by their names, such as Kathalekan, Karikan, Hulidevarukan etc. and also by the relics of primeval vegetation that still might be persisting in them to some degrees. According to the earliest ever survey on the *kans* conducted by Brandis and Grant (1868), Sorab taluk of Shimoga district had 171 *kans* covering a total of 32,594 acres (about 13,000 ha). Halesorabkan, the largest of them covered an area of about 400 ha. The *kans* were different from the secondary forests of deciduous kinds. Such systematic documentation of *kans* was not conducted elsewhere. Cowlidurg (present Thirthahalli taluk) was leading in the number of *kans* (436); Kadur district (present Chikmagalur) had 128 *kans* (Brandis and Grant, 1868).

*The Gazetteer of Mysore: Shimoga District* (1920) merely refers to the *kans* as evergreen forests of not much value, at a time when the hardwood timber yielding deciduous forests were paid much more attention. *The Gazetteer* states on the *kans* of Sagar taluk:

> ***Excepting the great Hinni forest, which lies to the south of the Gersoppa Falls, the remainder are chiefly kans, or tracts of virgin evergreen forest, in most of which pepper***

> ***grows abundantly self-sown and uncared for, but little of the produce being collected owing to the depredations of the monkeys.***

The Gazetteer considers the *kans* towards the summits of ghats as not of much use owing to inaccessibility. It admits to the decline of *kans*; yet had much in praise for the *kans* of Sorab:

> ***The taluk of Sorab abounds with kans, many of which are cultivated with pepper vines and sometimes coffee. The sago palm(Caryota urens) is also much grown for the sake of its toddy. These kans are apparently the remains of the old forests, which appear once to have stretched as far east as Anavatti. At the present day at Anavatti itself there is no wood, and the surrounding country is clothed with either scrub jungle or small deciduous forest....Kans are found also in Sagar, Nagar and other Malnad taluks, but those in Sorab are, from their number, situation and accessibility the most valuable.***

## III. ROLE OF KAN FORESTS IN PRE-COLONIAL LAND USE SYSTEM

a. **Kans as sacred groves:** While they acted as decentralized, community-based system of biodiversity conservation, these specially preserved forest patches played major roles as important centres of local religion and culture. They, with or without any man-built structures, functioned as abodes of village deities. Today most *kans* are under state ownership; nevertheless their roles continue as centres of worship, as far as the local communities are concerned. When we surveyed the *kans* of 10 villages of Sirsi taluk, which were included in a forest working plan for firewood supply to Sirsi town (Thippeswami, 1963), all of them were associated with sacred spots with deities, where people gathered and worshipped, despite state ownership over the forests. Such is the case with most other *kans* elsewhere too, in which matter, they are comparable to the *devarakadus* of Coorg. Whereas the latter got recognition from the State as sacred forests, and community rights were honoured, the same did not happen in Uttara Kannada and Shimoga districts. Whereas ownership on the former were claimed by the forest department of the Government of Bombay, the *kans* of Shimoga, in the erstwhile kingdom of Mysore district, came under the jurisdiction of either the forest or revenue departments, under the overlordship of the British, after the defeat of Tippu Sultan in 1799.

   Timber felling was a taboo in the *kans* ensuring their preservation through ages as in the *devarakadus* of Coorg, *devrais* of Maharashtra and *kavus* of Kerala. The deities of most *kans* belong to the folk tradition of India and not to the Vedic tradition. To name a few from Karnataka malnadu are Choudamma, Rachamma, Jataka, Birappa, Bhutappa, Hulidevaru (tiger deity) etc. Occasionally are smaller groves called *naagarabanas* dedicated to the serpents.

b. ***Kans* as safety forests:** The *kan* forests, well preserved in pre-colonial landuse system, in many ways ensured safety and integrity of the rural landscapes of Western Ghats. From a landscape ecological point of view these intact forest patches formed a mosaic with other elements such as secondary forests, scrub, shifting cultivation fallows, grasslands, farms and water bodies to enhance landscape heterogeneity holding highest amount of species diversity. As safety forests they performed the following functions as well:

   i. ***Watershed protection:*** The *kans* are often found to be associated with water sources like springs or ponds. The Government of Bombay (1923) highlighted the watershed value of the *kans* of Uttara Kannada:

      > ***Throughout the area, both in Sirsi and Siddapur, there are few tanks and few deep wells and the people depend much on springs .... If a heavy evergreen forest is felled in the dry season the flow of water from any spring it feeds increases rapidly though no rainwater may have fallen for some months.***

   ii. ***Keeping favourable microclimate***: Wingate (1888), the forest settlement officer for Uttara Kannada noted that the *kans* were of great economic and climatic importance as they favoured the existence of springs, and perennial streams, and generally indicated the proximity of valuable spice gardens, which derived from them both shade and moisture- a scenario, that holds good to this day if the *kan* is good state.

   *iii.* ***Kans for fire protection***: Brandis and Grant (1868), in their report on the *kans* of Sorab observed that during dry months jungle fires swept through every part of the dry forest which was composed of deciduous trees and bamboo. But, “No fires enter the evergreen forest, leaves, branches and fallen trees accumulate and gradually decay, forming ultimately a rich surface layer of vegetable mould.” Not aware of the village communities’ stakes in preservation of these *kan* safety forests, Brandis and Grant wondered: “why a certain locality should be covered with evergreen, and another in its immediate vicinity with dry forest.” The degradation of evergreen *kans* in Shimoga district has increased from the rising threats from forest fires in the recent years.

   iv. ***Protection from soil erosion***: Rain forests are considered fragile places, their collapse in highlands and slopes often associated with soil erosion, compaction and rockiness. The *kans* -understood as heavy evergreen forests, the ground covered with “a rich surface layer of vegetable mould” (Brandis and Grant, 1868) with very sharply defined limits, alternating with bare grounds covered with laterite was a common spectacle of malnadu area. “The real cause of this alternation of bare ground and densely wooded patches is to be found in the laterite formation. Wherever the hard bed of laterite is near the surface, wood refuses to grow” (*Gazetteer of Mysore-*

*Shimoga*, 1920). Further “In the kans the soil is rich and deep, but in most of the taluks (of Shimoga) the soil is hard and shallow, with much laterite” (-ibid-).

v. ***Kans for subsistence***: Despite grain crops and gardens, the malnadu people lived at subsistence level, with much dependence on forests. Dependence on *kans* was mainly for wild pepper, cinnamon (both were traded commodities), edible fruits and seeds, medicinal plants, toddy and palm sugar from *Caryota* palm (bainy) etc. Combined with a regulated form of hunting the common people, by and large, lived in harmony with the rain forests. The landscape heterogeneity of grasslands and forests (including the well preserved *kans*) would have favoured rich wildlife and many people hunted for subsistence. The *kans* would act as buffers especially during times of drought and famines by providing not only water but also various kinds of food from the wild.

vi. ***Biodiversity conservation***: *Kans* ranging in size from part of an hectare to few hundred hectares each and protected from time immemorial, may be considered as the best samples of climax forests of the region. These sacred groves often served as good refuges for arboreal birds and mammals, especially primates, and many other denizens of deep forests. Thus Kathalekan in Siddapur taluk of Uttara Kannada is home to the rare rain forest habitat called *Myristica* swamps with their threatened flora that include *Myristica magnifica, Gymnacranthera canarica, Dipterocarpus indicus, Semecarpus kathalekanensis, Syzygium travancoricum* etc. Karikan in the Honavar taluk of Uttara Kannada has a rare and magnificent stand of the climax forest tree *D. indicus. S. travancoricum* survives today in Mathigar *kan* and in Aralihonda of Siddapur, which are sacred groves, small fragments of around one hectare each, in the midst of otherwise an agricultural landscape. When a 2.5 sq. km area of Kathalekan was surveyed about 35 species of frogs and their relatives were discovered there, a number that is equal to almost the entire amphibian population of Maharashtra State. Katalkean and its immediate vicinity harbor the northernmost population of the Endangered primate Lion-tailed macaque.

vii. **Care of pepper vines in the *kans:*** Black pepper (*Piper nigrum*) was an important item of trade through the west coast port for over 2000 years (Saletore, 1973). Pepper grows wild in the wet evergreen forests of Western Ghats and is also cultivated in the gardens. A 16th century queen of Gersoppa was popularly known as ‘Pepper Queen” to the Portuguese (Campbell, 1883). From Buchanan’s writings it becomes clear that in at least in some of the *kans* of coastal Uttara Kannada the villagers used to take care of the wild pepper. Buchanan understood these as ‘myanasu canu’ meaning ‘menasu kanu’ or *kans* with black pepper. Wild pepper required human attention for better yield. Such *kans* with lofty evergreen trees were seen in the otherwise much denuded coastal hills. The practice of tending to wild pepper in the *kans* may be older to pepper cultivation in the arecanut gardens (Chandran and Gadgil, 1993). The amount of pepper produced from *kans*, at one time was said to be "very great".

c. **Land tenure:** The village communities of Karnataka malndu enjoyed various kinds of forest privileges in the pre-colonial times. They had as such no rights to claim forest lands as their own. The *kans* were entered in the revenue records as assessed lands held in regular tenure by *wargdars* or landholders in the vicinity. These *wargdars* paid certain taxes or *warg* to the state for use of the *kans* (for mainly collection of non-wood produce). Some of the *kans* of Sorab were 'unoccupied' and yielded no revenue at the time of the survey by Brandis and Grant (1868). They were deserted because of higher taxation by the state, thereby implying that the ownership of *kans* was vested with the state despite the people enjoying traditional privileges. Usually the *kans* had distinct boundaries marked by old trenches or footpaths. Each holder or *wargdar* had a portion demarcated by some lines or footpaths or other identification marks. Captain Someren (1871) found several unoccupied *kans* in the Belandur area of Shimoga.

## IV. DECLINE OF THE KANS

State domination over the forests, beginning in the British period in early 19$^{th}$ century, resulted in the villagers losing their hold over forests, including the *kans*. Following the Indian Forest Act of 1878 the *kans* of Uttara Kannada were mostly brought under the state reserved forests. People's rights in the *kans* of Uttara Kannada were curtailed to certain minor concessions like collection of dry fuelwood as in eastern parts of Sirsi and Siddapur (Government of Bombay, 1923). The *kans* of Shimoga district in the Mysore kingdom came under the jurisdiction of the forest department or revenue department.

a. ***Introduction of contract system*:** Contract system was introduced in the *kans* of Uttara Kannada for collection of non-timber forest produce. The contractors used to extract products like pepper and cinnamon in a destructive fashion, cutting down the pepper vines to collect their produce and hacking down the cinnamon trees for the bark, as for example in Kallabbe *kan* of Kumta (Wingate, 1888).

b. ***Kans for meeting timber and fuel needs:*** Tree cutting in the *kans*, as in any other sacred forests, was considered a taboo. In Uttara Kannada, following forest reservation, communities lost their traditional hold over forests. Though degraded forests around densely populated villages and towns were set aside as 'minor forests' for extraction of especially fuel and leaf manure, as the earlier community centred management system had collapsed, there was rising pressure on these minor forests, leading to their rapid degradation. Yielding to such demand from local people for forest biomass, in eastern Sirsi and Siddapur, villagers were allowed to gather firewood from the *kans*, which hitherto, the local communities had preserved as sacred places. Collins (1922) reported that in eastern Sirsi and Siddapur the *kans* were getting infested with the shrubby weed *Lantana* because of forest degradation. Similar was the situation regarding the *kans* of Shimoga. Resource shortage faced by the common people after reservations, especially of the timber rich forests, prompted people to fell trees in the *kans* of Shimoga. According to M.S.N. Rao, a forest officer (1919) fellings in the *kans* of Shimoga had disastrous effects, including the disappearance of the water supply. Today we can see scores of canopy gaps in these *kans*, periodical fires burning annually drier patches of woods, inviting once again more deciduous vegetation and bamboo which have become potential fire hazards in otherwise evergreen forests. As the *kans* were getting exposed to more intense sunlight through wider canopy gaps many have turned too dry for pepper-vines, which was once a major product from the *kans*, and a priced commodity for international trade from the dawn of history.

c. ***Logging in the kans:*** During 1940's *Dipterocarpus indicus* from Kathalekan in Uttara Kannada was supplied to the railways and a plywood company. A forest working plan of 1966 for Sirsi and Siddapur taluks included 4,000 ha of *kans* for felling of industrial timbers (Shanmukhappa, 1966). Another working plan for Sirsi included 670 ha of *kans* for selection of firewood species for Sirsi town supply (Thippeswami, 1963). Menasikan of Siddapur was clear-felled and converted into forest monoculture plantation (Chandran and Gadgil, 1993).

d. ***Pressure from developmental processes:*** Towns and villages are expanding into even the kan areas. For eg. In the neighborhood of Sorab a major road is passing through Gundsettykoppakan. The Sorab town itself has expanded into Hiresekunikan of 20 ha.

e. ***Kans turn into coffee estates:*** Coffee introduced into the *kans* of Chikmagalur district apparently made at least some of the local *Wargadars* into estate owners. Because of the Revenue Department ownership of many of the *kans* in Shimoga district, lands within these *kans* were indiscriminately allotted for coffee cultivation, ignoring their ecological significance, sacredness, and village community based management systems. The Forest Department of Shimoga is making fervent efforts to salvage 90 acres of *kan* granted to five persons from Survey no. 27 and 52 acres of *kan* land from Survey no. 29 (both from Kullunde kan of Tirthahalli taluk) granted to three persons for coffee cultivation. Such things have taken place throughout the *kans* of Shimoga district.

f. ***Encroachment of kans:*** *Kan* encroachment in large-scale, especially for cultivation, is widespread throughout Shimoga district. In Uttara Kannada district even *Myristica* swamps associated with some of the *kans* were not spared by encroachers.

**g.** ***Contract system in the kans:*** The state takeover of *kans* was followed by the introduction of contract system for collection of non-wood produce. The impact in Uttara Kannada, on account of this may be described in the words of Wingate (1888), the forest settlement officer:

> *I am still of the opinion that the system of annually selling by auction the produce of the kans is a pernicious one. The contractor sends forth his subordinates and coolies, who hack about the kans just as they please,the pepper vines are cut down from the root, dragged from the trees and the fruits then gathered, while the cinnamon trees are all but destroyed.... I was greatly struck with the general destruction among the Kumta evergreens, they were in far finer state of preservation 15 years ago.*

**h.** ***Kan allotment for leaf manure and conversion into minor forests:*** Collins (1922) pointed out that as a variation from its policy of strict protection of *kans* the Government of Bombay allotted them in any villages of Sirsi and Siddapur taluks to arecanut farmers as betta or leaf manure forests. In eastern Sirsi 769 hectares of *kans* were added to the minor forests open for exploitation. In Shimoga district several privileges were conceded to the local peoples inside the *kans*, also leading to their degradation. In Sorab and rest of Shimoga as the timber rich deciduous forests were taken over by the Government as state reserved forests the people were given certain concessions, including fuelwood harvests from *kans*, which they had conserved through ages as sacred forests. In Uttara Kannada *kans* (after British domination of the district from 1799, over a period of next 50 years or so, the British consolidated their hold over the forests) contract system was introduced for collection of non-timber forest produce from the *kans*. This system obviously replaced the system of people's management that prevailed earlier. The contractor, being interested more in making short term profits, often resorted to destructive harvest of non-timber forest produce from the *kans*.

## 8.1 CASE STUDIES ON TWO KAN FORESTS OF THIRTHAHALLI TALUK

## I. INTRODUCTION

Thirthahalli taluk (area:1254 sq.km) is situated towards the south-west of Shimoga district between lat. 13°27’22” to 13°55’27” and long. 75°01’57” to 75°30’42”. It is predominantly a hilly taluk right in the middle of central Western Ghats at a mean altitude of 603 m above the msl. Whereas most high rising hills are within 750 m, Heggargudda hill range, covered mostly by Kurnimakki-Halmahishikan, has its summit at 850 m. The taluk is rich in water courses and is drained mainly by the Tunga River and its smaller tributaries and streams. Most of the forest clad hills are associated with such water courses which along their passages through narrow valleys irrigate rice fields and arecanut gardens. The hill ranges of Thirthahalli, which also include the Agumbe Ghat, famed as one of the highest rainfall areas of India, much of it was clad in extremely rich rain forests of central Western Ghats is, is at the heart of the watershed for good part of Karnataka because of the Tunga-Bhadra River. The taluk, as per 2001 Census, had a population of 143,207 persons. Majority of them (128,399 persons) residing in rural areas. The livestock population (1993 census) was quite high at 144,299.

1) **Abundance of tanks and streams:** Thirthahalli taluk is rich in water resources, especially in streams, compared to the drier eastern portions of Shimoga district. Numerous streams which originate in the hills of the taluk rush through rugged terrain before entering narrow valleys cultivated with gardens and rice fields. The Tunga River that winds its way through in between hills receives most of these streams. In addition there are 741 tanks, most of them built along the stream courses generations back. Gross area irrigated by the tanks in the taluk amounts to 7328 ha, and net irrigated area is 6911 ha. Net area irrigated in the taluk, from all sources, is 11537 ha which highlights the richness of water resources.

2) **Rainfall:** Thirthahalli, is one of the rainiest taluks in Shimoga district. Agumbe towards the south-west of Thirthahalli is one of the rainiest places in India. The taluk has a normal average rainfall of 3042 mm/yr. It received 2938 mm of rainfall during 2010-11, as shown in the Table 1.

3) **Cultivation:** Total cropped area in the taluk, in the year 2010-2011 was 25,879 ha, approximately about 20% of the total area of the taluk. Most details on area under various notable crops are given in the Table 2. Paddy occupies most of the cultivable land. Arecanut, coconut, banana, sapota, pepper, cardamom and cashew are the notable horticultural crops. Details regarding the output of various important crops are given in the Table 3.

Table 1: Actual and normal rainfall in Thirthahalli taluk for 2010-11

| Months | Actual monthly rainfall –mm | Normal monthly rainfall-mm |
|---|---|---|
| January | 1 | 6 |
| February | 2 | 0 |
| March | 5 | 7 |
| April | 35 | 37 |
| May | 100 | 62 |
| June | 562 | 521 |
| July | 1119 | 890 |
| August | 728 | 866 |
| September | 196 | 338 |
| October | 140 | 169 |
| November | 41 | 146 |
| December | 9 | 0 |
| **Total** | **2938** | **3042** |

Table 2: Area under various crops in 2010-11

| **Crops** | **Area (ha)** |
|---|---|
| Foodgrains (mainly paddy and just 3 ha of maize) | 13820 |
| Sugarcane | 54 |
| Fruit crops | 1209 |
| Pulses | 53 |
| Oil seeds | 129 |
| Horticultural crops | 1209 ha (4.67%) |

Table 3: Production details of horticultural crops (in tons) in Thirthahalli taluk

| **Crops** | **Production in tons** |
|---|---|
| Banana | 16,310 |
| Mango | 210 |
| Sapota | 510 |
| Coconut | 69 lakh no. |
| Arecanut | 9338 |

| | |
|---|---|
| Pepper | 65 |
| Cardamom | 8 |
| Cashew | 648 |

## II. FOREST VEGETATION

With the high rainfall in the taluk one can expect tropical evergreen forests everywhere. But actually we find mosaic of various kinds of forests. It is apparent that the original primary forests have given way to secondary forests in most places because of human impact. Pascal et al (1982) considers the main forest type of the taluk as ***Low elevation (disturbed) evergreen and semievergreen*** and their various ***secondary and degraded stages.*** More towards the east of the district, because of relatively less rugged terrain and larger cultivable areas associated with more populated villages and declining rainfall the forests are more susceptible to desiccation. ***Secondary moist deciduous forests*** form a mosaic with cultivation areas, savannas and scrub. Savanna type formations which are grassy lands with isolated trees are created by humans through fire and felling, and used for cattle grazing and meeting local biomass needs.  Annual summer fires, often set on by humans, especially for burning bushes and dry litter arrests regeneration of evergreen trees in the secondary moist deciduous forests. The degraded stages of all the above types of forests in the form of scrub, isolated shrubby areas etc. are found closer to human habitations.

**Case stdy-1: KURNIMAKKI-HALMAHISHIKAN**

Kurnimakki-Halmahishikan (*kans* are known locally usually by the name of the villages adjoining them, unless there is any other recognized name) in the taluk of Thirthahalli in Shimoga district was studied in the month of April, 2012, mainly from the vegetation angle and for cognizance of threats facing it. The *kan* is said to be about 1000 hectares and situated between lat. 13.68°-13.73°N and 75.29°-75.35°E. It is not in a single piece but distributed in several survey nos. There is considerable confusion on the demarcation of the boundaries of the *kan* due to encroachments, conflicting claims of ownership and other practical problems. Looking at all the ancient maps available the *kan* boundaries need to be more precisely demarcated. Shimoga and Chikmagalur districts were part of erstwhile Mysore State. *Kan* lands were recognised by the State Forest Department till almost 1970. But after that those survey numbers were merged in Reserved Forests and other kinds of forests including Minor Forests, State forests and District forests (Gokhale et.al, undated). A  Google Earth image of the *kan* and associated landscape elements/villages is given in the Figure 1. The study localities in Halmahishi, Bekshikenjigudda and Kesagaru villages are shown in them. Evergreen to semi-evergreen forests and secondary moist deciduous forests were the main forest types encountered. The geographical coordinates of study sites are shown in the Table 4.

***Fragmentation of vegetation***: The *kan* forests were praised in the past for their unique evergreen vegetation of lofty trees, rich, moldy soils, fire security, as source of perennial streams and production of various products in demand for human subsistence, especially as centres of pepper production, a commodity that commanded high prices worldwide. Today, a close look at the Kurnimakki-Halmahishi kan on the ground or using aerial imageries, reveal a shocking spectacle of high degree of forest fragmentation. The composition of the landscape elements of the kan does not conform to the past descriptions of such sacred forests from central Western Ghats, being today an assemblage of relics of the evergreens forming an non-cohesive mix with various degraded stages including scrub and periodically fire affected areas. It appears that many a stream originating in the *kan* get dried up in the summer months resulting in abandonment of the minor tanks constructed along their courses, thus obviously, with adverse consequences on farming downstream and water-flow into the Thunga River diminished. Such severe human induced changes in the evergreen forests of Western Ghats are bound to have cascading consequences on human welfare in the Deccan plains mainly because of reduced water flow in the east-flowing rivers. The condition of the forested terrain, the portion mostly falling in the erstwhile spread of the *kan* area, as depicted in the Forest Map of South India (Pascal et al., 1982) is shown in the Figure 2. (The legend for the map covers more kind of vegetational types than shown in the selected block)

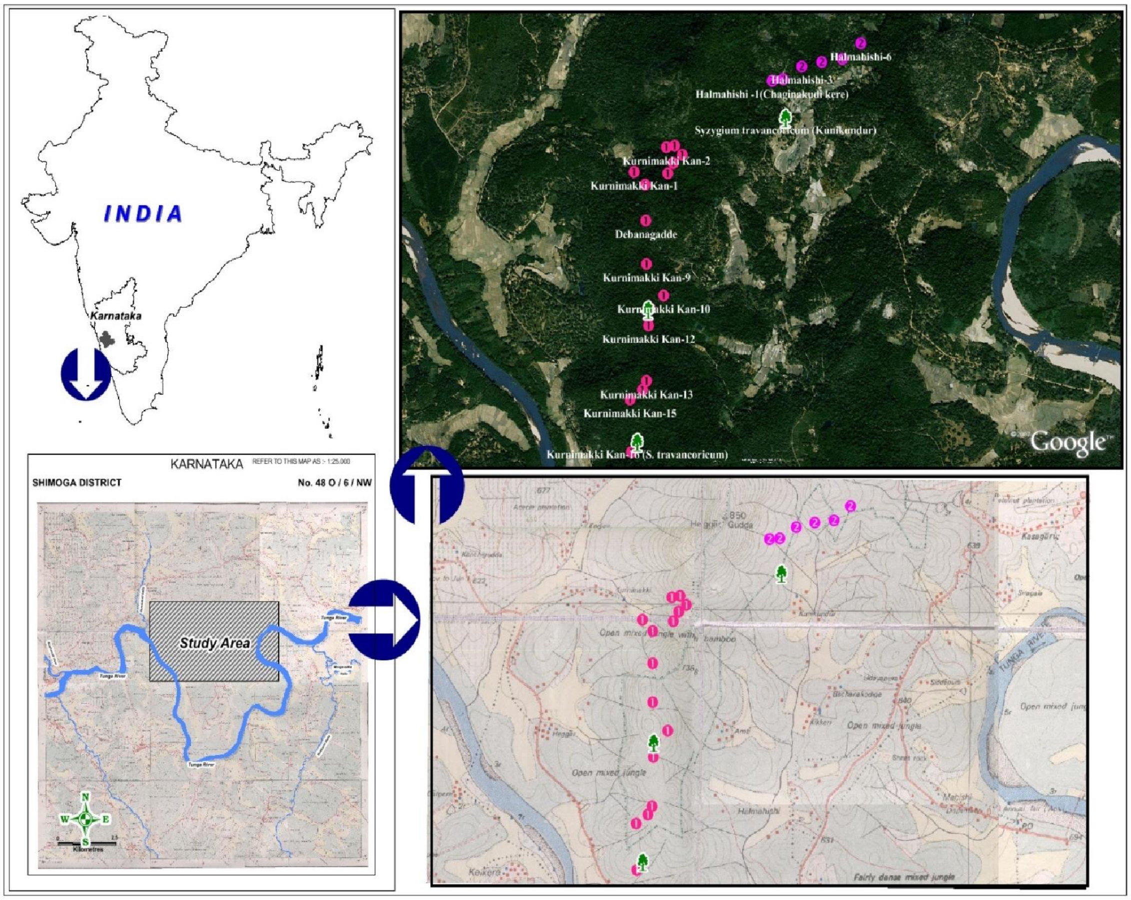
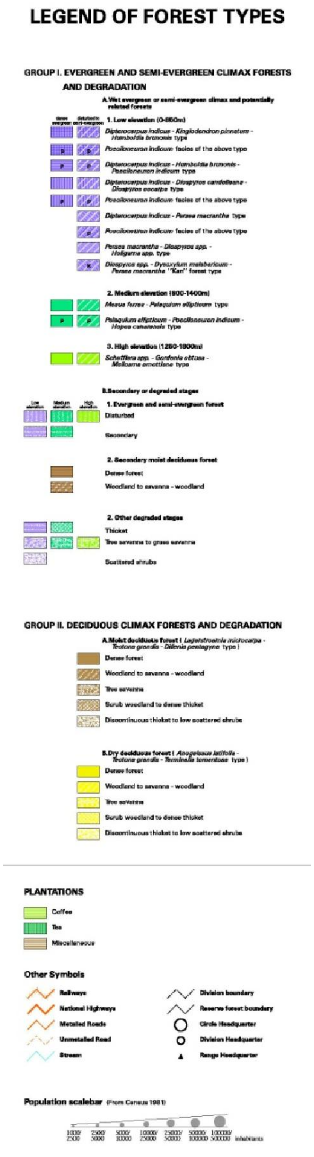



**Figure 1:** Location, topographic, and vegetational features and forest sampling sites. The presence of *Syzygium travancoricum,* Critically Endangered tree in Kunikundur, Kurnimakki-10 and Kurnimakki-16. The passage of Tunga River encircling three sides of the *kan* is notable



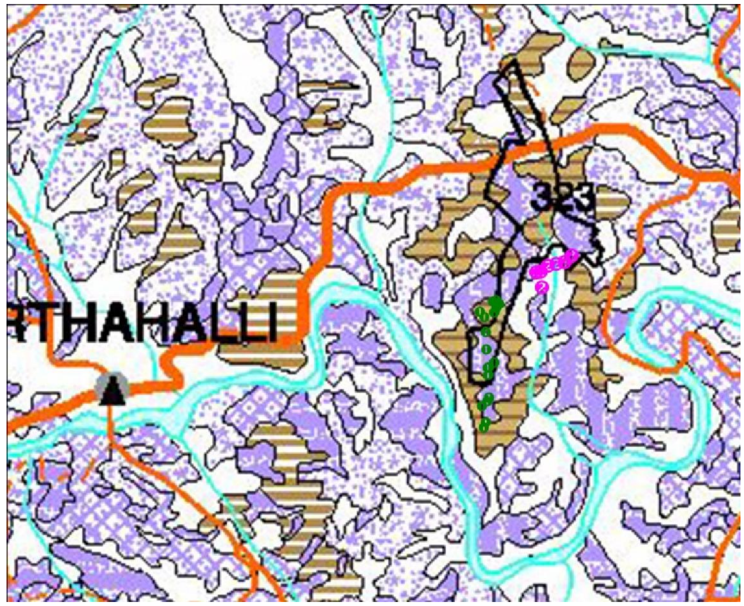




Figure 2: Vegetation types of Kurnimakki-Halmahishi kan based on Pascal. Degradations of evergreen forests have created an assortment of patches

## i. Land use Land cover analysis of Select Kan forests in Shimoga

Land use land cover (LULC) information of a region depicts the status of a landscape for environmental progression and sustainable development. Land cover configuration is stated as a unified reflection of the existing natural resources, dynamic natural processes whereas land use refers to the human induced changes in the land cover. The main effects of human activities on the environment are land use and resulting land cover changes. Such changes impact the capacity of ecosystems to provide goods and services to the human society. Human induced land cover change such as for agricultural expansions have caused large scale deforestation leading to soil erosion, watershed degradation, reduced biodiversity, and agrochemical pollution. In forest dominated landscapes fragmentation issues of prominence seem to relate typically to deforestation and loss of forest cover over a period of time. Monitoring these changes is essential for sustainable management of the natural resources. It has become an essential to integrate the patterns of land cover change with the processes of land use change by identifying various drivers for the change process.

Tropical deforestation, rangeland modification, agricultural area shrink and urbanization are the major land-use and land-cover changes around the globe (Geist and Lambin, 2001). The driving force of land-use/cover change vary and their dynamic interactions result in diverse change and trajectories of change, depending upon the specific environmental, social, political and historical context from which they arise (Meyer and Tuner II, 1992). The resulting changes from these drivers exist as a complex between subtle modification and total conversion as seen in a change in forest density and forest to agricultural land or urban area (Geist and Lambin, 2001; Veldkamp and Lambin, 2001). The complexity of land use land-cover changes is illustrated by functional differences within types of land cover, structural variance between types of land-cover change, with regards to spatial arrangement and temporal pattern of change (Giest and Lambin, 2001).

Availability of multi-resolution temporal remote sensing (RS) data has aided in monitoring larger areas at various spatial and spectral resolutions. Remote sensing data along with GIS (Geographical Information Systems), GPS (Global positioning system) and other collateral data (spatial as well as statistical) help in effective land cover analysis (Ramachandra & Kumar, 2004; Ramachandra et al., 2009). Mapping, quantifying, and monitoring the physical characteristics of land cover has been widely recognized as a key element in the study of regional and global changes (Nemani & Running, 1996). The objectives of this work is

a) Classification of multi-temporal RS data to obtain LU LC map.
b) Multi-temporal analysis for characterise the type and extent of fragmentation or loss of vegetation cover, Visualising the consequences of changes in the region.

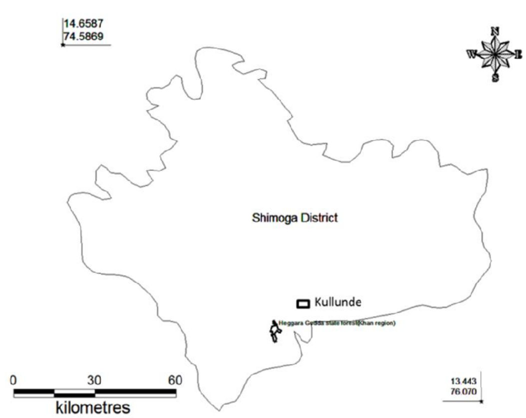


Figure 3: Shimoga district with kans


Figure 4: Halmahishi kan -Study area

Area lies between long $74.2944^0$ Nto $75.3338^0$ E and lat $13.7474^0$ E to $13.7133^0$ N in the district of Shimoga, Karnataka (state), India. This region is very near to the Tunga River and having the vegetation cover ranges from Evergreen to semi evergreen with a smaller amount of moist deciduous. The region is very rich in its biodiversity and a hot spot for high endemism. The agriculture and coffee estates are the main drivers for the deforestation in the region. The region covers Kudamalgi, Chicksangudi, Muttur, Dabbangadde, Halmahishi viilages of Thirthahalli taluk. Remote sensing (RS) data used in the study include Landsat TM (1989), IRS (2001, 2010), and Google Earth (http://earth.google.com). The Landsat data is cost effective, with high spatial resolution and freely downloadable from public domains like Glcf (http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp) and USGS (http://glovis.usgs.gov/). The summery characteristics of datasets used in the current study are summarized in Table 4. Besides remote sensing data, many other data sources were used in the study. Topographic maps provided ground control points to rectify remotely sensed images and scanned paper maps.

Table 4: Data used in the study

| Data | Sensor | Year | Resolution (M) |
|---|---|---|---|
| Landsat | TM | 1989 | 28.5 |
| IRS | Lis3 | 2001 | 23 |
| IRS | Lis4 | 2010 | 5 |

Figure 5 explains the method adopted for land cover and land use analysis. The RS data of different sensors of Landsat and IRS satellites were acquired. The remote sensing data requires the preprocessing stages like atmospheric correction and geo correction in order to enable correct area measurements. Geometric correction is done by using ground control points collected from field study and Landsat data is resampled to 30 meters. The resampling is required because of the dissimilar spatial resolutions of Landsat sensors. The field investigation is carried out for intensive ground-truth studies during pre-monsoon and post-monsoon seasons. The geographic coordinates of a land cover classes are determined by using GARMIN Global Position Systems (GPS), which provides an advantageous (Zhao et al., 2003). To obtain historical land-cover data, interviewees and group discussions are conducted with farmers and forest officials at different locations in the study region.

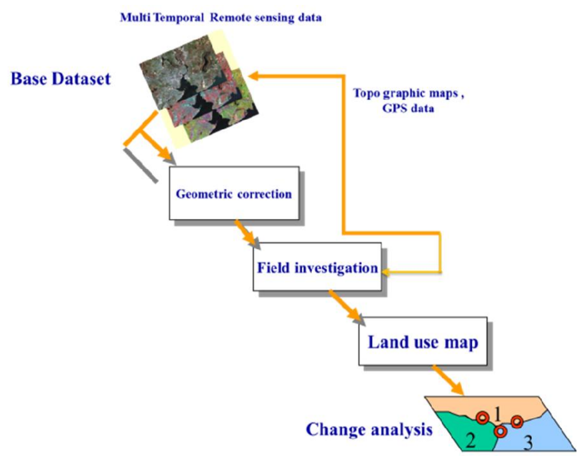



Figure 5: Land cover and land use analysis - method

Land cover analysis was done using NDVI (Normalized Difference Vegetation Index). Calculation of NDVI for Multi-temporal data is advantageous in areas where vegetation changes rapidly. Among all techniques of land cover mapping NDVI is most widely accepted and applied (Weismiller et al., 1977, Roy et al., 2002; Ramachandra et al., 2009). NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1).

NDVI was calculated using Eq. (1)

$$\mathbf{NDVI = (NIR\text{-}R) / (NIR+R)} \qquad \ldots (1)$$

Land use analysis was done using supervised classification scheme with selected training sites. Maximum Likelihood algorithm is a common, appropriate and efficient method in supervised classification techniques by using availability of multi-temporal "ground truth" information to obtain a suitable training set for classifier learning. GRASS GIS

(Geographical Analysis Support System) software is used for the analysis, which is a free and open source software having the robust support for processing both vector and raster files accessible at http://wgbis.ces.iisc.ernet.in/grass/index.php. An accuracy assessment is done to assess the quality of the information derived from remotely sensed data by a set of reference pixels. These test samples are then used to generate the error matrix (also referred as confusion matrix) kappa ($\kappa$) statistics and producer's (PA) and user's accuracies (UA) to assess the classification accuracies. Accuracy assessment and kappa statistics are included in table 7.

**Results:** Land cover analysis was done by computing Normalized Difference Vegetation Index (NDVI) NDVI is based on the principle of spectral difference based on strong vegetation absorbance in the red and strong reflectance in the near-infrared part of the spectrum. Vegetation index differencing technique was used to analyze the amount of change in vegetation (green) versus non-vegetation (non-green) with the two temporal data by considering 1989 as a base. Figure 6 illustrates the land cover dynamics. The vegetation cover has decreased from 79.94 % to 69.91 % due to land encroachments for agricultural activities. Table 5 explains the land cover change with respect to each year considered in the study.

| Year | Vegetation (%) | Non Vegetation (%) |
|---|---|---|
| 1989 | 79.94 | 20.06 |
| 2001 | 76.75 | 23.23 |
| 2010 | 69.91 | 30.01 |

Table 5: Land cover changes during 1989 to 2010

Temporal land use changes are shown in the figure 7 at landscape level from 1989 to 2010 carried out by using remote sensing data. Table 6 lists the land use changes with respect to time. The area of forest is decreased from 79.59% (1989) to 68.41% (2010), whereas agricultural land is increased from 20.41% to 29.62%. This illustrates the conversion of land for agricultural activities. The accuracy of the classification ranges from 87.38 % to 92.47% (Table 8).

| Year | 1989 | | 2001 | | 2010 | |
|---|---|---|---|---|---|---|
| Category | Ha | % | Ha | % | Ha | % |
| Built-up | 0.00 | 0 | 20.58 | 2.09 | 20.5781 | 1.96 |
| Vegetation | 782.29 | 79.59 | 718.28 | 73.08 | 716.4776 | 68.41 |
| Water | 0.00 | 0 | 1.19 | 0.12 | 0 | 0 |
| Cropland &open fields | 200.52 | 20.41 | 242.75 | 24.71 | 245.7443 | 29.62 |

Table 6: Land use

| Category | 1989 | | 2001 | | 2010 | | Overall Accuracy | Kappa |
|---|---|---|---|---|---|---|---|---|
| | **PA** | **UA** | **PA** | **UA** | **PA** | **UA** | | |
| **Built-up** | 62.69 | 40.83 | 78.23 | 93.02 | 89.18 | 100.00 | 87.38 | 0.81 |
| **Water** | 99.99 | 99.86 | 98.98 | 79.49 | 91.42 | 92.44 | 91.25 | 0.86 |
| **Cropland** | 79.60 | 97.29 | 99.47 | 93.84 | 97.58 | 98.46 | 92.47 | 0.88 |
| **Evergreen forest** | 94.78 | 100.00 | 99.84 | 100.00 | 97.86 | 81.39 | 87.38 | 0.81 |

Table 7: Accuracy assessment

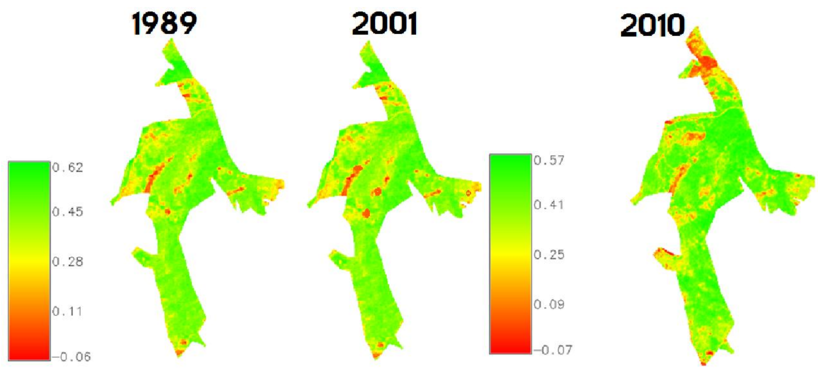



Figure 6: Land cover dynamics

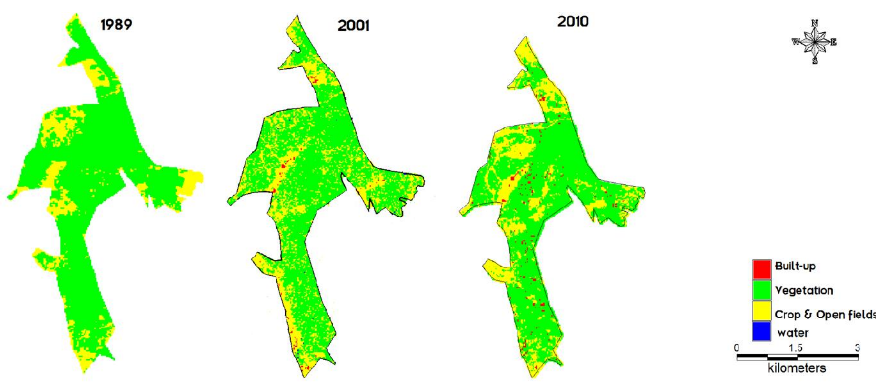



Figure 7: Land use dynamics during 1989-2010

### ii. Vegetation studies

Vegetation was studied in 26 sampling localities within the *kan* using Point-centred quarter method. The geographical coordinates of the localities sampled are shown in the Table 8.

Table 8: The localities within the *kan* chosen for quantitative sampling of forest

| Sl | Localities visited | LONGITUDE | LATITUDE |
|---|---|---|---|
| 1 | Kurnimakki Kan-1 | 75.3079 | 13.7075 |
| 2 | Kurnimakki Kan-2 | 75.3102 | 13.7091 |
| 3 | Kurnimakki Kan-3 | 75.3108 | 13.7092 |
| 4 | Kurnimakki Kan-4 | 75.3113 | 13.7086 |
| 5 | Kurnimakki kan-5 | 75.3107 | 13.7081 |
| 6 | Kurnimakki kan-6 | 75.3103 | 13.7074 |
| 7 | Kurnimakki kan-7 | 75.3087 | 13.7067 |
| 8 | Kurnimakki kan-8 | 75.3107 | 13.7081 |
| 9 | Kurnimakki Kan-9 | 75.3088 | 13.7017 |
| 10 | Kurnimakki Kan-10 | 75.31 | 13.6997 |
| 11 | Kurnimakki Kan-11 | 75.309 | 13.6989 |
| 12 | Kurnimakki Kan-12 | 75.3089 | 13.6978 |
| 13 | Kurnimakki Kan-13 | 75.3088 | 13.6943 |
| 14 | Kurnimakki Kan-14 | 75.3085 | 13.6937 |
| 15 | Kurnimakki Kan-15 | 75.3076 | 13.6931 |
| 16 | Kurnimakki Kan-16 (S. travancoricum) | 75.3081 | 13.6905 |
| 17 | Kurnimakki Kan-17 | 75.3077 | 13.6898 |
| 18 | S. travancoricum (Wadape) | 75.3089 | 13.6989 |
| 19 | Debanagadde | 75.3088 | 13.7044 |
| 20 | Syzygium travancoricum (Kunikundur) | 75.3186 | 13.711 |
| 21 | Halmahishi -1(Chaginakudi kere) | 75.3177 | 13.7133 |
| 22 | Halmahishi-2 | 75.3185 | 13.7134 |
| 23 | Halmahishi-3 | 75.3198 | 13.7142 |
| 24 | Halmahishi-4 | 75.3212 | 13.7145 |
| 25 | Halmahishi-5 | 75.3227 | 13.7147 |
| 26 | Halmahishi-6 | 75.324 | 13.7157 |

### iii. Tree species in evergreen-semievergreen forest type

Lofty evergreen trees of 25 to 30 m height were quite many in the forest and belonged to species such as *Aphanantha cuspidata, Canarium strictum* (Kan: Karidhupa), *Mangifera indica, Syzygium hemisphericum, S. travancoricum* etc. Evergreen trees of the second level of general heights from 15-25 m include *Actinodaphne hookeri, Aglaia roxburghiana, Anthocephalus kadamba, Beilsmeida fagifolia, Dimocarpus longan, Ficus callosa, Holigarna ferruginea, Hopea ponga, Olea dioica, Syzygium cumini* etc. Evergreen trees of still smaller stature include *Aporosa lindleyana, Ixora brachiata, Knema attenuata, Litsea wightiana, Vepris bilocularis* etc. We could list 46 tree species from this type of forest. Some deciduous species are also found in this type *viz. Careya arboa, Lagerstroemia microcarpa, Stereospermum personatum, Terminalia paniculata*, *T. bellirica, Vitex altissima, Xylia xylocarpa; Zanthoxylum rhetsa,* etc. The secondary deciduous forests within the *kan* and their peripheral areas are obviously due to forest fragmentation through cutting and burning. They have, in addition to the leaf shedding trees mentioned above also have *Madhuca latifolia, Bombax ceiba, Terminalia paniculata, Firminia colorata* etc. Altogether only 25 tree species were found in the deciduous forests, which include a small number of tolerant evergreens such as *Olea dioica, Aporosa lindleyana, Syzygium cumini, Alstonia scholaris* etc. Two patches of forests, one of evergreen remains and the second of moist deciduous kind (secondary) are shown in the Figure 8. The Shannon diversity index for trees was found to be higher (3.45) for the evergreen dominated patches than for the deciduous (2.79) (Figure 9 Shannon diversity). Details of tree species inventorised from the sample points of evergreen and deciduous areas are given in Figure 10, along with estimated basal areas/ha in both.


Figure 8: Relic evergreen forest patch and a farmland below. Water input from the *kan* is vital for cultivation; R. Vegetation survey in a secondary moist deciduous forest within the *kan*

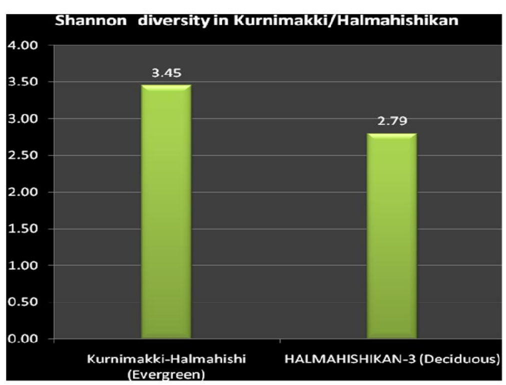



Figure 9: Shannon diversity index for evergreen dominated and deciduous dominated areas

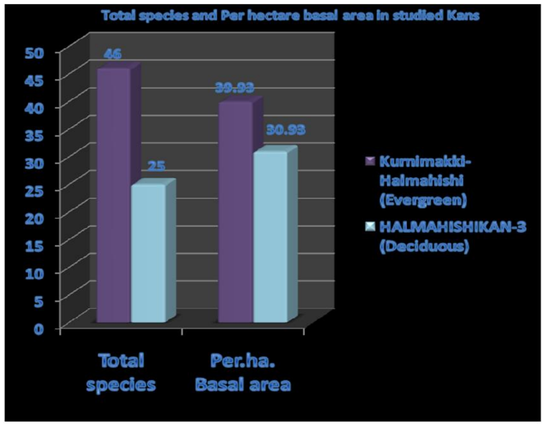



Figure 10: Tree species inventorised for evergreen sample points and deciduous areas and basal area estimated/ha for both.

a. ***Tree density/ha***: The evergreen-semi-evergreen forests had more tree numbers/ha in the *kan* at 234/ha compared to the moist deciduous patches at 181/ha. The estimated number was lower for both types of forests than any good low elevation Western Ghat forests where the number could be >300 to 500/ha. The *kan* forest particularly, belonging to the traditional category of sacred forest, is expected to have more number of trees. Ever increasing human impact and conflicting claims on ownership, diluting the authority of the Forest Department, may be a pertinent factor for less than expected number of trees.

b. ***Basal area of trees:*** Basal areas of trees/ha was calculated based on the girth measurements taken for the sampled trees. The basal area was found to be 39.93 $m^2$/ha for evergreen/semi-evergreen areas and 30.93 $m^2$/ha for deciduous forest areas. This lowered basal area of a sacred forest, which reflects particularly a thinning of the forest in the catchment of the Tunga River, does not augur well for hydrology of the region as a whole. The fate of the other *kans* in Thirthahalli taluk does not appear to be better, as the category of *kan* forest itself is fading away from the face of the taluk, which had once 436 *kans* on the record.

c. **Evergreenness and endemism of trees**

The Western Ghats, along with Sri Lanka, constitute one of the 34 Global Biodiversity, on account of high species diversity, high degree of species endemism as well as heavy human impact on the ecosystems. Endemism in any group of plant or animal is typically linked to levels of tree endemism in the forests. If there is high percentage of endemic trees in an area, endemism among lower plant groups and in the animal community is also expected to rise. The rise in percentage of Western Ghat endemism in relation to increase in percentage evergreen trees in the community is evident from the Figure 11.

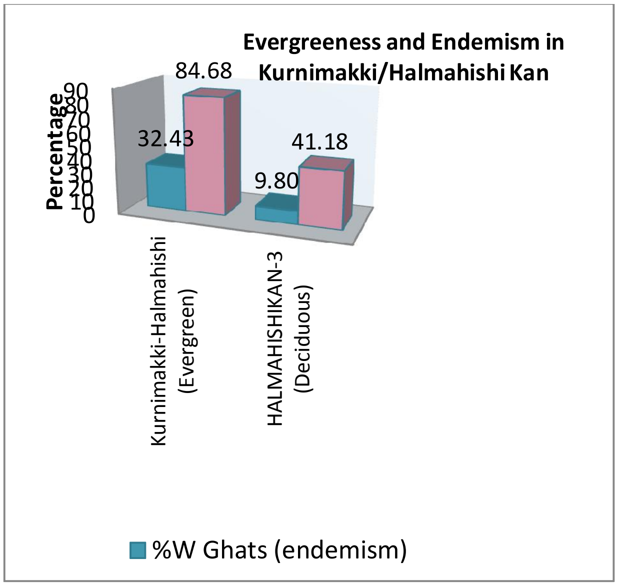



Figure 11: Tree endemism in evergreen-semi-evergreen forests versus deciduous forests

Figure 12 depicts that the evergreen-semi-evergreen forest patches considered collectively for percentage of evergreen trees, showing a higher result (almost 85% individuals belonging to evergreen type) account for higher Western Ghat tree endemism (32%), compared to the predominantly deciduous patches collectively accounting for only 41% evergreenness having barely 10% endemics. Some endemics survive there because these deciduous forest patches occur in an evergreen zone of higher rainfall, and some of the desiccation and large gap tolerant trees like *Lagerstroemia microcarpa* (deciduous) and *Taberna-montana coronaria*, an understorey plant are considered endemics. One of the first casualties of gross human interference with humid forest ecosystem of the Western Ghats would be disappearance of the most sensitive endemic species. The *kan* forests, in the pre-colonial days would have been important local centres of plant and animal endemism, as they were considered sacred and there was strong taboo on tree cutting in such forests. Notable among the endemic trees were *Calophyllum apetalum, Cinnamomum malabathrum, Holigarna arnottiana, H. ferruginea, Hopea ponga, Mastixia arborea, Polyalthia fragrans* etc.

d. ***Swamps with Syzigium travancoricum: Tree back to life from fear of extinction:*** To our great surprise in some of the swampy water bodies associated with the *kan* we could see small populations of *Syzygium travancoricum,* an evergreen, endemic tree of the Western Ghats, which has been Red Listed as **Critically Endangered** by the IUCN. Our discovery of this majestic tree in the Kurnimakki-Halmahishikan, while an altogether new report of such a species from Shimoga district itself, underscores the importance of preservation of *kans* as 'Heritage Sites' from cultural, biological angles. The tree was considered extinct from its original known home range from

Travancore Western Ghats, after its first discovery by Bourdillon in 1894, as it was not observed later, probably due to its rarity. Subsequently it was rediscovered from southern Western Ghats in the early 1990's. Its rare occurrence associated with swampy places in some of the evergreen *kan* forests of Ankola and Siddapur, 700 km north of Travancore came as a surprise, while this finding highlights the role of *kans* as centres of biodiversity conservation in otherwise human impacted landscapes (Chandran et al., 2008). As our primary objectives for the study also included bringing to light rare elements of biodiversity conserved through generations in the system of *kans*, we went out of way, beyond the domains of random sampling, so as to draw attention to this Critically Endangered species in its imperilled swampy habitat. Fire damages and the recent cuttings of this threatened species is a matter of grave concern (Figures 12 and 13)

Figure 12: Syzygium travancoricum close to water bodies

Figure 13: Cutting of Syzygium travancoricum in a relic primary evergreen forest patch inside the *kan*

*e.* **Importance value index (IVI):** The IVI of evergreen and deciduous species, listed in Table 9, show the contrast in the vegetation. Evergreens are, understandably, dominating the evergreen forest areas. *Syzygium travancoricum* dominated swamps were specially studied with greater efforts, because of the rarity of the species (Critically Endangered as per IUCN Red List), as already explained above. A lofty and buttressed evergreen tree species, *Aphananthe cuspidata* (Figure 14) has the highest IVI in the forest. The high occurrence of evergreen forest disturbance indicator and more light loving tree *Aporosa lindleyana*, although itself an evergreen, shows the *kan* forest is under stressed conditions. There are, however, several individuals of *Canarium strictum* (Figure 14), in the evergreen forest which is one of the good indicators of the evergreen high forest for the region.

Table 9: IVI of evergreen and deciduous species

| | **Evergreen tree dominated forest patches** | | **Deciduous trees dominated forest patches** | |
|---|---|---|---|---|
| **Sl** | **Species** | **IVI** | **Species** | **IVI** |
| **1** | *Aphana nthe cuspidata* | 47.70 | *Xylia xylocarpa* | 67.99 |
| **2** | ***Syzgium travancoricum*** | 33.57 | ***Olea dioica*** | 35.89 |
| **5** | ***Aporosa lindleyana*** | 14.62 | ***Syzygium cumini*** | 30.69 |
| **3** | ***Mangifera indica*** | 14.39 | ***Term inalia bellirica*** | 21.40 |
| **6** | ***Dimocarpus longan*** | 12.94 | ***Alstonia scholaris*** | 13.20 |
| **4** | ***Canarium strictum*** | 12.06 | ***Terminalia paniculata*** | 11.27 |
| **8** | ***Term paniculata*** | 10.19 | ***Vitex altissima*** | 10.84 |
| **7** | ***Hopea ponga*** | 9.96 | ***Dimocarpus longana*** | 10.54 |
| **9** | ***Terminalia bellirica*** | 9.52 | ***Spondias acuminata*** | 10.35 |
| **10** | ***Canthium dicoccum*** | 8.20 | ***Ervatamia heyneana*** | 8.89 |

**Figure 14:** *Aphananthe cuspidata* and *Canarium strictum*, dominant evergreen species

*f.* ***Species-richness: family-wise:*** The details of species numbers, family-wise, are given in the Figure 15. Rubiaceae and Rutaceae were the most specious families, followed by others. The details of species observed during the short term survey, including their geographic distribution, are given in the Annexure 1.

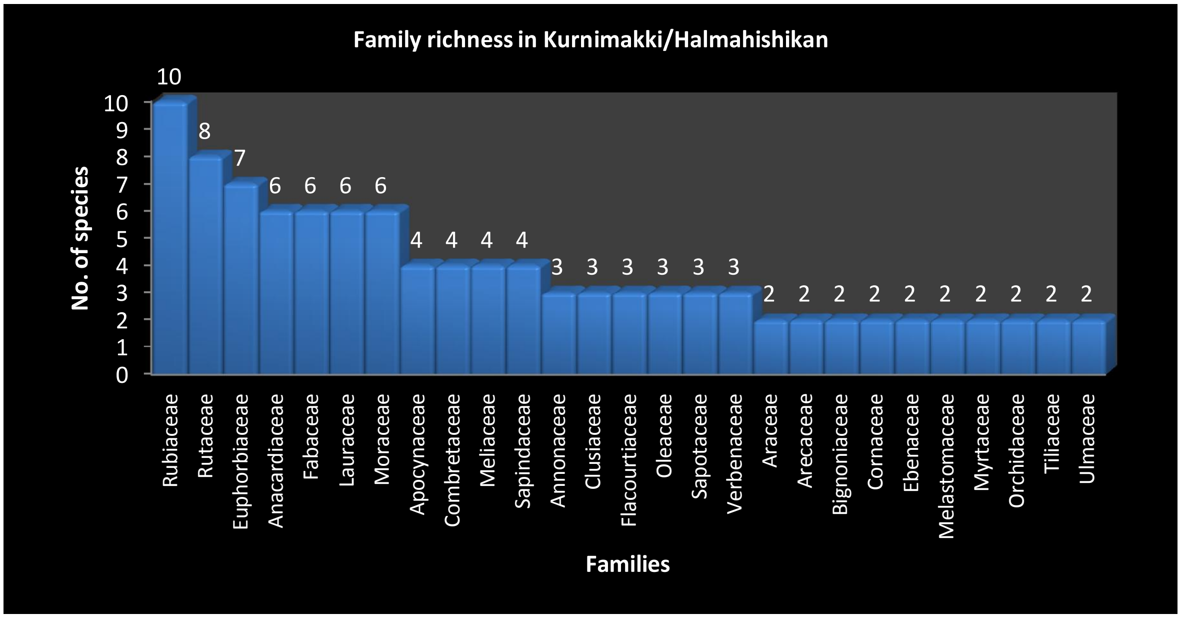



**Figure 15: Vegetation richness in Kurnimakki/Halmahishi Kan**

**iv. Decline in hydrological value**

The concept of *kans* as important watershed areas diminished in due course with major changes in the vegetation, especially, with the decline of evergreens and the entry of fire to clear portions of the *kans* where subsequently only deciduous woods regenerated causing exposure of rocks underneath and compacted and eroded soils. Subsequently many tanks, especially smaller ones, got silted up and their utility from irrigation point stopped. The Figures (figure 16) of a small, silted tank (which is still a refuge for several *Syzygium travancoricum* trees), adjoining a fire burned forest, and subsequently abandoned water canal are given here.

Figure 16: A silted water tank with dead and fallen *Syzygium travancoricum* (on account of fire) and an abandoned water canal within the *kan*

**v. A sacred *kan* on the wane**

The *kan* forests of central Western Ghats, were important natural sacred sites and cultural centres of the pre-British village communities. They were like similar natural sacred sites elsewhere in the Western Ghats, *viz*. the *devrais* of Maharashtra, *devarakadus* of Coorg or *kavus* of Kerala. At one time, they rose majestically in the horizons, covering large areas in the high places of the malnadu village landscapes, surrounded by cultivations, timber rich secondary forests, and savannized grazing areas. Perennial streams gushing out of these sacred forests were often embanked to make irrigation tanks. The run of numerous such streams ended with their merger with the rivers, which owed for their perennial nature to such streams which flowed even during the hot and rainless months. Unfortunately, the *kans* did not merit consideration as sacred places of village communities under the British rule and also after Independence. There were only stray references to the sacredness of the *kans* by some officers of the British regime. And as such the *kans* were simply viewed as dense evergreen forests important for pepper, toddy and sugar from the palm *Caryota urens* and for few other items of commercial or subsistence values. In Shimoga district, particularly, many *kans* were brought under the jurisdiction of the Revenue Department, which conveniently allotted *kan* lands for meeting various non-forestry purposes such as for growing coffee, expansion of cultivation, for grazing purposes and numerous others, inconsiderate and negligent of the rare species they conserved and also of their crucial hydrological importance. The Government also conceded large portions of *kans* on long leases to the Mysore Paper Mills for growing industrial woods like *Eucalyptus* and *Acacia* spp. after clearing the natural vegetation (Annexure 2).

**Continuation of sacred sites**

As far as sacredness of the Kurnimakki-Halmahishi *kan* is concerned we need to state that there are still several sites within the *kan* which are abodes of village deities; for instance, Chowdi, Siddaradevaru, Betedevaru and Nagaradevaru are names of some such deities of Kunikundur village. The abode of a deity within the *kan* (represented by crude stones only) is shown in the figure 17. Other villages also have their deities still associated with the *kan.*

Figure 17: A sacred spot within the kan, where the deity is worshipped

**Case study II. KULLUNDE KAN**

Kullundekan in the taluk of Thirthahalli in Shimoga district was studied in the month of April, 2012, mainly from the vegetational angle and for cognizance of threats facing it. The *kan*, situated between lat. 13.76° & 13.81° N and $75.4319^0$ Nto $75.4288^0$ E , is spread over in the Survey nos. 25, 27, and 29 covering an area of altogether 453.86 ha. Lack of consolidation of forest areas and conflicting claims of ownerships, allotments for non-forestry purposes by the Revenue Department come in the way of precise boundary identification for Kullundikan. Most other *kans* of Shimoga district are also plagued with similar problems. Shimoga and Chikmagalur districts were part of erstwhile Mysore State. *Kan* lands were recognised by the State Forest Department till almost 1970. But after that those survey numbers were merged in Reserved Forests and other kinds of forests including Minor Forests, State Forests and District forests (Gokhale et.al, undated). A Google Earth image of the *kan* and associated landscape elements is given in the Figure 18. The study localities mainly covered Kullundi, Singanabidare, and Garaga villages. The vegetation ranges from evergreen to semi-evergreen and secondary moist deciduous forests, in addition to their degradation stages ultimately resulting in small bare areas and scrub. The geographical coordinates of 16 study localities, where vegetation was sampled, are given in the Table 10.

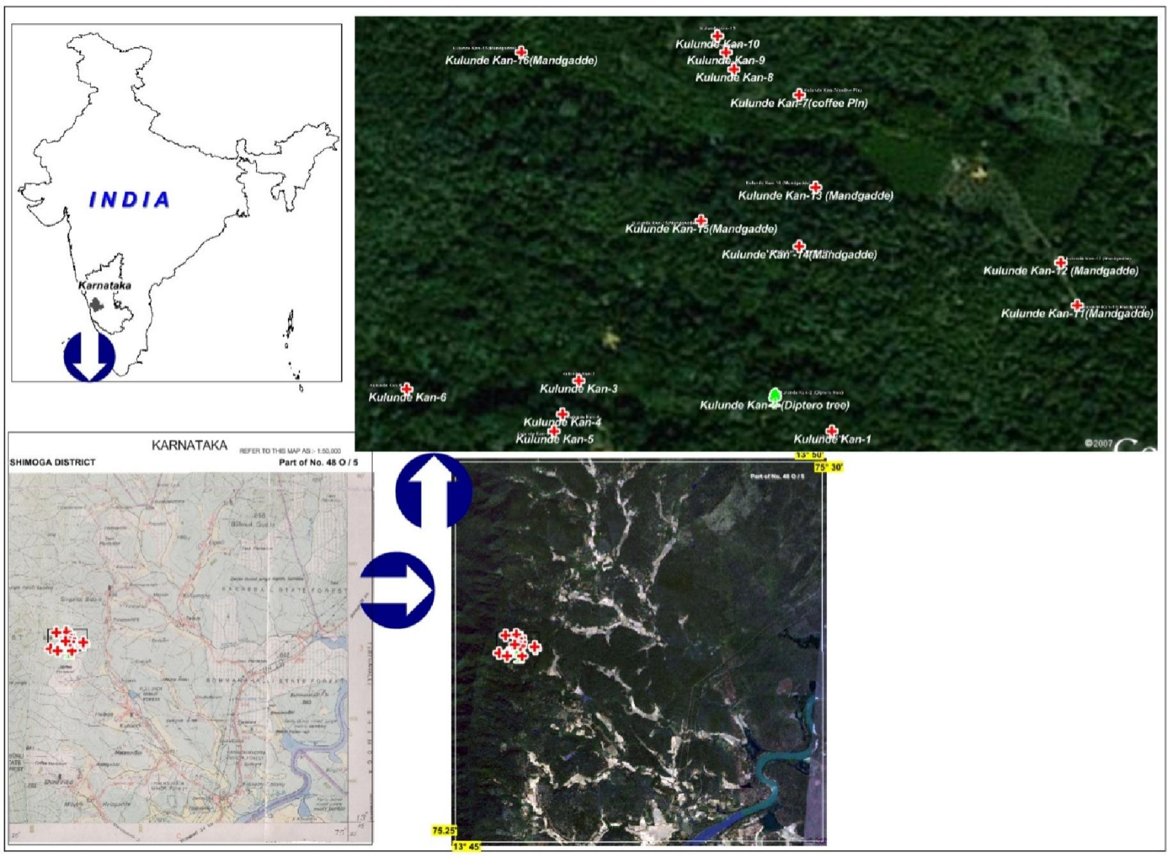



**Figure 18:** Location, topographic, and vegetational features and forest sampling sites.

i. ***Fragmentation of vegetation***: The *kan* forests were praised in the past for their unique evergreen vegetation of lofty trees, rich, moldy soils, fire security, as source of perennial streams and production of various products in demand for human subsistence, especially as centres of pepper production, a commodity that commanded high prices worldwide. The composition of the landscape elements of the kan does not conform to the past descriptions of such sacred forests from central Western Ghats, being today an assemblage of relics of the evergreens forming an non-cohesive mix with various degraded stages including scrub and periodically fire affected areas. Severe human induced changes in the evergreen forests of Western Ghats are bound to have cascading consequences on human welfare in the Deccan plains mainly because of reduced water flow in the east-flowing rivers. The condition of the forested terrain, the portion mostly falling in the erstwhile spread of the *kan* area, as depicted in the Forest Map of South India (Pascal et al., 1982) is shown in the Figure 19. (The legend for the map covers more kind of vegetational types than shown in the selected block). Bulk of the forest is evergreen and a portion was once dominated by *Dipterocarpus indicus* of the climax evergreen type formation of the lower altitudes. However, many mighty trees of the species were cut down for planting coffee and for forest based industries in the past. Many changes appear to have taken place after the preparation of the vegetation map by Pascal, due to land allotments for non-forestry purposes and due to other human interventions.

**ii. Quantitative studies**

Vegetation was studied in 16 sampling localities within the *kan* using Point-centred quarter method. The geographical coordinates of the localities sampled are shown in the Table 10.

Table 10: Study localities of forest sampling

| Sl | NAME | LONGITUDE | LATITUDE |
|---|---|---|---|
| 1 | Kulundikan-1 | 75.4319 | 13.7911 |
| 2 | Kulundikan-2 | 75.4312 | 13.7915 |
| 3 | Kulundikan-3 | 75.4288 | 13.7917 |
| 4 | Kulundikan-4 | 75.4286 | 13.7913 |
| 5 | Kulundikan-5 | 75.4285 | 13.7911 |
| 6 | Kulundikan-6 | 75.4267 | 13.7916 |
| 7 | Kulundikan-7 | 75.4315 | 13.7951 |
| 8 | Kulundikan-8 | 75.4307 | 13.7954 |
| 9 | Kulundikan-9 | 75.4306 | 13.7956 |
| 10 | Kulundikan-10 | 75.4305 | 13.7958 |
| 11 | Kulundikan-11 | 75.4349 | 13.7926 |
| 12 | Kulundikan-12 | 75.4347 | 13.7931 |
| 13 | Kulundikan-13 | 75.4317 | 13.7940 |
| 14 | Kulundikan-14 | 75.4315 | 13.7933 |
| 15 | Kulundikan-15 | 75.4303 | 13.7936 |
| 16 | Kulundikan-16 | 75.4281 | 13.7956 |

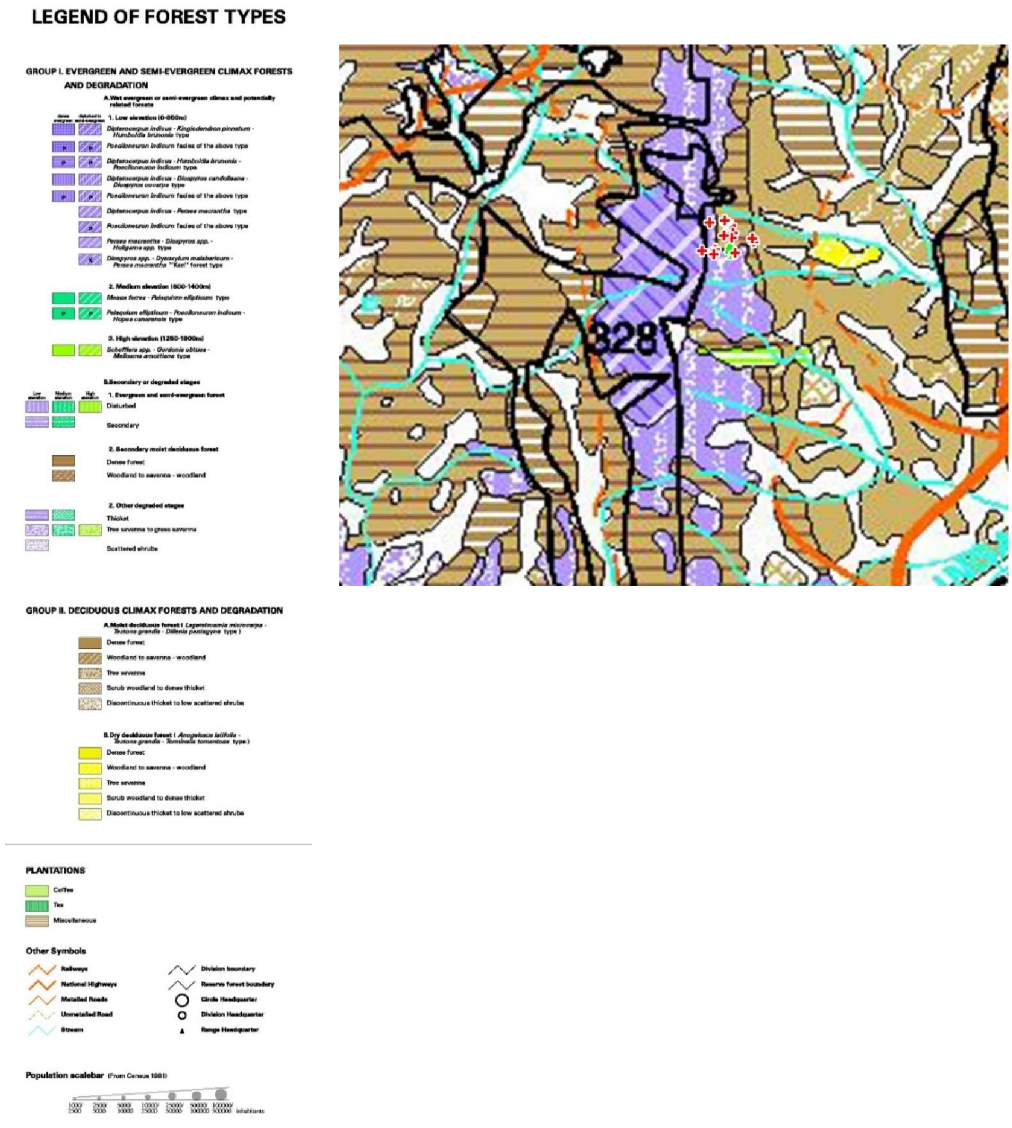



Figure 19: Forest Map of South India (Pascal et al., 1982)

**iii. Tree species in evergreen-semievergreen forest type**

The *kan* originally had *Dipterocarpus indicus* and *Calophyllum tomentosum* dominated climax forests. Clearances have taken place in many places in lands allotted for planting coffee and arecanut, as well as encroachments have happened. The forests would have suffered heavily due to the selection felling of industrial woods during especially 1950's to early 1980's, as there were several large canopy gaps. Yet there were many majestic evergreen trees exceeding 30 m in height and of girths exceeding 4-5 m (Figure 20). Of the trees of the emergent type still present in portions of the *kan* are in addition to *D. indicus* and *C. tomentosum, Ficus nervosa, Ficus callosa, Artocarpus hirsuta, Cyclostemon confertiflorus, Canarium strictum, Bischofia javanica etc, Mangifera indica, Tetrameles* *nudiflora, Alstonia scholaris* etc. The next in order in the height, and belonging to the 20-30 m group were *Mimusops elengi, Aphananthe cuspidata, Homalium zeylanicum, Chrysophyllum roxburghii, Strombosia zeylanica, Aglaia roxburgiana, Alseodaphne semecarpifoli* etc. Of the still smaller trees of 10-20 m, the notable ones were the palm *Caryota urens, Olea dioica, Dimocarpus longan, Pterospermum* sp., *Sapindus laurifolius* etc. Here and there, because of fire and felling deciduous forests of secondary nature have appeared, where the notable species were *Lagerstroemia microcarpa, Grewia tilifolia, Spondias acuminate, Terminalia bellirica, T. paniculata, Xylia xylocarpa, Macaranga peltata* etc.

Figures 20: *Calophyllum tomentosum* and *Dipterocapus indicus*

Some patches allotted for coffee cultivation (Figure 21) has been planted with coffee after fully or partially clearing the trees, whereas one patch of eight acres, allotted to Sri Chidambara Gowda was seen as such without forest clearance or planting of coffee (Figure 22)

Figure 21: Coffee cultivation in a *kan* area allotted to private farmer

Figure 22: Area allotted (8 acres) for coffee plantation maintained as forest

The secondary deciduous forests within the *kan* and their peripheral areas are obviously due to forest fragmentation through cutting and burning. These have come through succession in the place of evergreen high forest of the Western Ghats. Among the notable tree species observed were *Grewia Lagerstroemia microcarpa, Terminalia bellirica, T. paniculata, Xylia xylocarpa,*

Diversity index (Shannon diversity) for tree species for the evergreen forest was highest at 3.11, for the forest patch allotted to private person and protected as such (figure 23). When a climax evergreen forest of *Dipterocarpus indicus* and *Calophyllum tomentosum* domination was partially cleared and planted with coffee, despite the isolated towering trees remaining, the diversity index was lower at 2.75. Yet another portion with coffee had reasonably good number of species, although they were of secondary nature and smaller in stature with diversity index at 2.87. The lowest diversity of 1.85 was for the secondary moist deciduous forest.

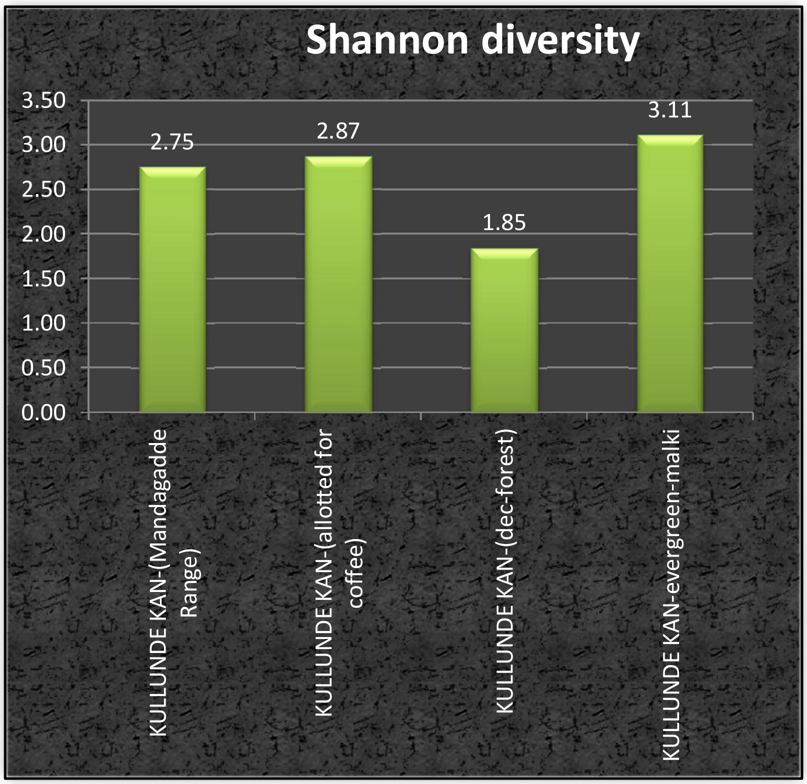



**Figure 23:** Shannon diversity index for tree species in four categories of forests, with the intact preserved forest in malki land showing marginally higher diversity.

g. ***Number of tree species:*** Part of Kullundekan, partially cleared an panted with coffee, with very large trees still remaining had only 21 species of trees, compared to the intact forest which had 27 species. Another coffee planted area had only 19 species, whereas the deciduous forest had least number as expected (7). Moreover the deciduous patch sampled was too small and degraded and therefore no higher diversity is expected. But opportunistic surveys elsewhere yielded more number of trees in the deciduous forest, the details of which are given in the plant diversity of Kullundikan given as Annexure-3

h. ***Basal area of trees:*** Estimated basal areas/ha based on sample surveys of the four patches referred to was highest at $47.2^2$/ha for the intact forest, followed by 40.34 $m^2$/ha for the coffee area with large proportioned relic trees (Figure 24). Considering the fact that this basal area was for the remnant patch of estimated 69 trees/ha, one could visualize the fact if such a forest were not to be felled for coffee, with 300 plus trees/ha, the basal area/ha could have exceeded 100 m², perhaps the highest for Western Ghat vegetation. Next in importance was the normal coffee planted area without such huge trees and the least was for the deciduous forest.

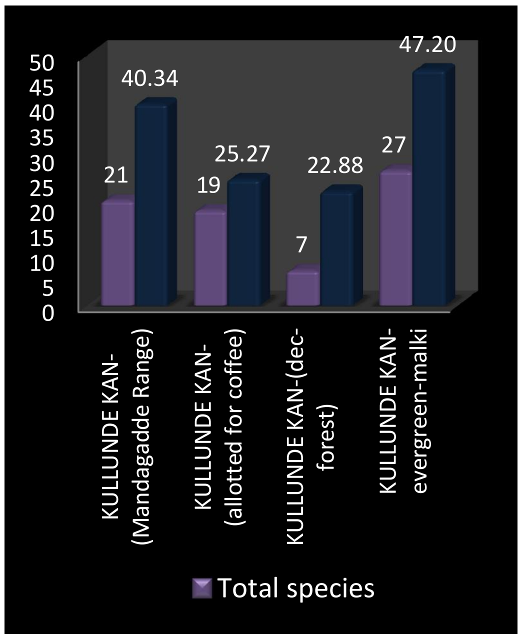



Figure 24: Tree species numbers and basal area/ha for the forest samples

i. ***Evergreenness and endemism among trees:*** Interesting trend is seen in the evergreenness of the forest versus percentage of Western Ghat specific tree endemism (Figure 25). In general, more evergreen a forest is higher is the tree endemism, with the deciduous forest showing zero endemism. This reaffirms the fact clearances of well preserved evergreen forests with high endemism can wipe out endemics altogether on clear-felling and burning, with practically little scope for endemic species recovery in such areas.

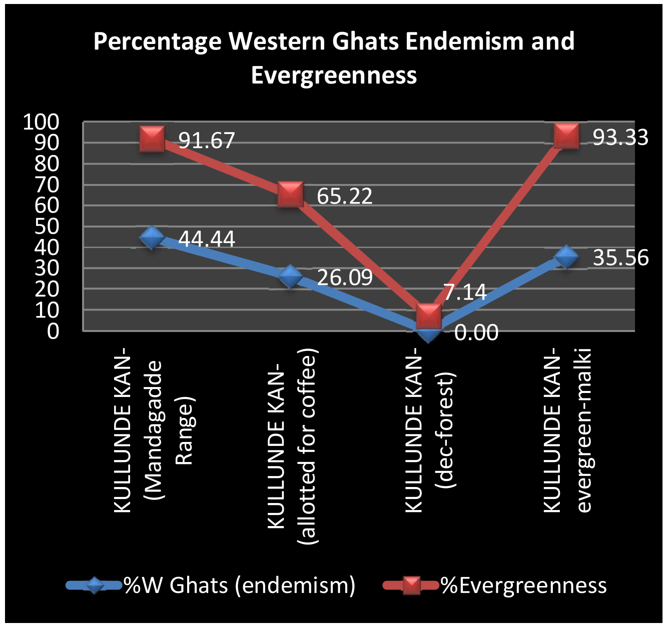



Figure 25: Decline in evergreen trees in a forest causes decline of endemic tree species

**IV. Importance Value Index**

The IVI details of the five most dominant forest tree species from the four localities sampled are given in Tables 11 and 14

Table 11: IVI of a climax relic forest vegetation partially cleared for coffee cultivation

| | KULLUNDI KAN -1 | |
|---|---|---|
| **Sl** | **Species** | **IVI** |
| 1 | *Calophyllum tomentosum* | 59.29 |
| 2 | *Dipterocarpus indicus* | 54.15 |
| 3 | *Ficus nervosa* | 20.29 |
| 4 | *Homalium zeylanicum* | 19.75 |
| 5 | *Artocarpus hirsuta* | 19.15 |

Table 12: IVI of secondary type forest cleared for coffee

| | KULLUNDIKAN-2 | |
|---|---|---|
| **Sl** | **Species** | **IVI** |
| 1 | *Alstonia scholaris* | 38.07 |
| 2 | *Cyclostemon confertiflorus* | 30.38 |
| 3 | *Tetrameles nudiflora* | 23.30 |

| | | |
|---|---|---|
| 4 | *Sapindus laurifolius* | 20.33 |
| 5 | *Syzygium cumini* | 19.30 |

Table 13: IVI of Secondary moist deciduous forest

| | KULLUNDE KAN-3 (Deciduous forest) | |
|---|---|---|
| **Sl** | **Species** | **IVI** |
| 1 | *Terminalia paniculata* | 61.49 |
| 2 | *Xylia xylocarpa* | 56.42 |
| 3 | *Terminalia bellirica* | 55.62 |
| 4 | *Grewia tilifolia* | 53.21 |
| 5 | *Spondias acuminata* | 34.81 |

Table 14: IVI of a forest allotted for coffee planting but preserved by the allotted person

| | KULLUNDE KAN-4- evergreen | |
|---|---|---|
| **Sl** | **Species** | **IVI** |
| 1 | *Ficus microcarpa* | 33.37 |
| 2 | *Calophyllum tomentosum* | 26.32 |
| 3 | *Artocarpus hirsuta* | 22.04 |
| 4 | *Aglaia anamallayana* | 20.86 |
| 5 | *Olea diocia* | 18.70 |

The IVI tables clearly reveal that the relic forest has still some unique vegetation with *Dipterocarpus indicus* and *Calophyllum tometosum.* The former is an Endangered tree species according to IUCN. Destruction of the climax forest is bound to wipe out such species, as the same is not seen in other forms of land use, including the forest preserved in tact by the person who was granted the same for coffee cultivation. That forest appears to be old growth forest on land cleared in the pre-colonial times, probably for shifting cultivation.

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**Annexures**

| **ANNEXURE-1:** CHECKLIST OF THE HIGHER PLANTS OF KURNIMAKKI-HALMAHISHIKAN IN THIRTHAHALLI & THEIR DISTRIBUTION | | | | | |
|---|---|---|---|---|---|
| HALMAHISHI KAN | | NATURE OF PLANT | Western Ghats | General distribution | Habitats |
| | | | | | |
| Buchanania lanzan | Anacardiaceae | Medium tree | | India, Myanmar | Deciduous forests |
| Holigarna arnottiana | Anacardiaceae | Medium tree | Western Ghats | | Semievergreen forests |
| Holigarna ferruginea | Anacardiaceae | Large tree | Western Ghats | | Evergreen forests |
| Mangifera indica | Anacardiaceae | Tree | | Indo-Malesia | Evergreen-S.evergreen forests |
| Nothopegia colebrookeana | Anacardiaceae | Small tree | | S. India-S. Lanka | Evergreen-S.evergreen forests |
| Spondias pinnata | Anacardiaceae | Large tree | | Indo-Malesia | Moist deciduous forests |
| Artabotrys zeylanicus | Annonaceae | Woody climber | | Penin. India-Sri Lanka | Kurnimakki |
| Polyalthia fragrans | Annonaceae | Large tree | Western Ghats | | Evergreen-s.evergreen |
| Uvaria narum | Annonaceae | Climber | | S. India-S. Lanka | Semievergreen forests |
| Alstonia scholaris | Apocynacae | Large tree | | Asia-Australia | S.evergreen- moist deciduous |
| Chonemopha macrophylla | Apocynaceae | Liana | | India, S. Lanka | Evergreen-s.evergreen |
| Holarrhena pubescens | Apocynacae | Small tree | | Indo-Malesia | Deciduous forests |
| Tabernamontana heyneana | Apocynacae | Shrub/small tree | Western Ghats | | Forest gaps, scrub |
| Lagenandra toxicaria | Araceae | Herb | Western Ghats | | Marshes in forests |
| Pothos scandens | Araceae | Climber | | Indo-Malesia, Madagascar | Evergreen-s.evergreen |
| Schefflera venulosa | Araliaceae | Scandent shrub | | South and S.E. Asia | Evergreen-s.evergreen |
| Calamus thwaitesii | Arecaceae | Climbing palm | | India, S. Lanka | Evergreen-s.evergreen |
| Caryota urens | Arecaceae | Tree | | Indo-Malesia | Evergreen-s.evergreen |
| Chromolaena odorata | Asteraceae | Shrub | | Pantropical weed | Widespread |
| Pajanelia longfola | Bignoniaceae | Tree | | India, Myanmar | Kurnimakki-Vittage border |

| | | | | | |
|---|---|---|---|---|---|
| Stereospermum personatum | Bignoniaceae | Tree | | Indo, China, Malesia | S.evergreen- moist deciduous |
| Bombax ceiba | Bombacaceae | Large tree | | Asia, New Guinea | Deciduous forests |
| Canarium strictum | Burseraceae | Large tree | | India-Myanmar | Evergreen forests |
| Lophopetalum wightianum | Celastraceae | Large tree | | Indo-Malesia | Evergreen-s.evergreen |
| Calophyllum apetalum | Clusiaceae | Large tree | Western Ghats | | Evergreen forests |
| Garcinia morella | Clusiaceae | Medium tree | | Indo-Malesia | Evergreen forests |
| Garcinia xanthochymus | Clusiaceae | Medium tree | | Indo-Malesia | Evergreen-s.evergreen |
| Calyopteris floribunda | Combretaceae | Liana | | Indo-Malesia | Deciduous forests |
| Terminalia bellirica | Combretaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Terminalia paniculata | Combretaceae | Large tree | | Penin. India-S. Lanka | S.evergreen- moist deciduous |
| Terminalia tomentosa | Combretaceae | Large tree | | India, S. Lanka | Deciduous forests |
| Connarus wightii | Connaracea | Scandent shrub | Western Ghats | | Evergreen-s.evergreen |
| Erycibe paniculata | Convolvulaceae | Liana | | India | Semievergreen forests |
| Alangium salvifolium | Cornaceae | Small tree | | Asia-Africa | S.evergreen-moist deciduous |
| Mastixia arborea | Cornaceae | Small tree | Western Ghats | | Evergreen; near swamps |
| Dillenia pentagyna | Dilleniaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Hopea ponga | Dipterocarpaceae | Medium tree | Western Ghats | | Evergreen-s.evergreen |
| Diospyros malabarica | Ebenaceae | Small tree | | Indo-Malesia | Severgreen forests |
| Diospyros montana | Ebenaceae | Small tree | | Indo-Malesia, Australia | Deciduous forests |
| Elaegnus conferta | Elaeagnacae | Scandent shrub | | Indo-Malesia | Evergreen-s.evergreen |
| Elaeocarpus serratus | Elaeocarpaceae | Small tree | | Penin. India | Evergreen-s.evergreen |
| Aporosa lindleyana | Euphorbiaceae | Tree | | Penin. India-S. Lanka | Evergreen-s. evergeen forests |
| Bridelia scandens | Euphorbiaceae | Scandent shrub | | Penin. India | Degraded moist forests |
| Croton roxburghii | Euphorbiaceae | Tree | | India, Myanmar, S.lanka | Kurnimakki |
| Macaranga peltata | Euphorbiaceae | Tree | | Penin. India-S. Lanka | S.evergreen-moist deciduous |
| Mallotus phillippensis | Euphorbiaceae | Tree | | Peninsular India | Semievergreen forests |

| | | | | | |
|---|---|---|---|---|---|
| Margaritaria indica | Euphorbiaceae | Medium tree | | Indo- Malesia to Australia | Semievergreen forests |
| Phyllanthus emblica | Euphorbiaceae | Small tree | | Tropics | Deciduous forests |
| Albizzia procera | Fabaceae | Large tree | | Indo-Mlesia, China | Deciduous forests |
| Cassia fistula | Fabaceae | Small tree | | Indo-Malesia | Deciduous forests |
| Dalbergia horrida | Fabaceae | Liana | Western Ghats | | S.evergreen-moist deciduous |
| Dalbergia latifolia | Fabaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Pterocarpus marsupium | Fabaceae | Large tree | | India, S.Lanka | Deciduous forests |
| Xylia xylocarpa | Fabaceae | Large tree | | Indo-Malesia | Moist deciduous forests |
| Casearia ovata | Flacourtiaceae | Shrub/small tree | | India, S.Lanka | Evegreen-s.evergreen |
| Flacourtia montana | Flacourtiaceae | Smll tree | | Penin. India | Semievergreen forests |
| Hydnocarpus pentandra | Flacourtiaceae | Small tree | Western Ghats | | S.evergreen-moist deciduous |
| Gnetum edule | Gnetaceae | Liana | | Penin. India | Evegreen-s.evergreen |
| Nothapodytes nimmoniana | Icacinaceae | Small tree | | Indo-Malesia, China | Moist deciduous-s.evergreen |
| Actinodaphne hookeri | Lauraceae | Medium tree | Western Ghats | | Evergreen-s.evergreen |
| Alseodaphne semecarpifolia | Lauraceae | Large tree | | Penin.India, S.Lanka | Semievergreen forests |
| Beilschmiedia bourdillonii | Lauraceae | Medium tree | | Penin.India | Evergreen-s.evergreen |
| Cinnamomum malabatrum | Lauraceae | Tree | Western Ghats | | Evergreen-s.evergeen forest |
| Litsea wightiana | Lauraceae | Small tree | Western Ghats | | Evergreen forests, Kurnimakki |
| Persea macrantha | Lauraceae | Large tree | | Penin.India-S.Lanka | Evergreen-s.evergreen |
| Careya arborea | Lecythidaceae | Small tree | | Tropical Asia | Deciduous forests |
| Asparagus racemosus | Liliaceae | Climber | | Paleotropics | Widespread |
| Lobelia nicotianifolia | Lobeliaceae | Herb | | Indo-Malesia | Evergreen forest edges |
| Strychnos colubrina | Loganiaceae | Woody climber | | Penin India-Sri Lanka | Kurnimakki |
| Lagerstroemia microcarpa | Lythraceae | Large tree | Western Ghats | | Moist deciduous forests |
| Kydia calycina | Malvaceae | Small tree | | India-China | Pioneer in gaps, decidous forests |
| Memecylon talbotianum | Melastomaceae | Shrub or small | Western | | Evergreen forests |

| | | | | | |
|---|---|---|---|---|---|
| | | tree | Ghats | | |
| Memecylon umbellatum | Melastomaceae | Tree | | Penin India-Sri Lanka | Widespread |
| Aglaia anamallayana | Meliaceae | Small tree | Western Ghats | | Evergreen forests |
| Aglaia roxburghiana | Meliaceae | Tree | | Indo-Malesia-Pacific islands | Evergreen-S.evergreen |
| Chukrasia tabularis | Meliaceae | Tree | | Indo-Burma | Kurnimakki |
| Toona ciliata | Meliaceae | Large tree | | Asia, Africa, Hawai | S. evergreen- moist deciduous |
| Anamirta cocculus | Menispermaceae | Liana | | Indo-Malesia | Moist deciduous to evergreen |
| Artocarpus gomezianus | Moraceae | Medium tree | W Ghats-S. Lanka | | S. evergreen- moist deciduous |
| Artocarpus heterophyllus | Moraceae | Tree | | South India | Cultivated and wild |
| Artocarpus hirsuta | Moraceae | Large tree | Western Ghats | | Evergreen-s.evergreen |
| Ficus amplissima | Moraceae | Large tree | | Penin India, S, Maldives | S.evergreen, moist deciduous |
| Ficus callosa | Moraceae | Large tree | | Indo-Malesia | S. evergreen- moist deciduous |
| Ficus drupacea | Moraceae | Large tree | | India, S.E.Asia | Moist deciduous forests |
| Knema attenuata | Myristicaceae | Tree | Western Ghats | | Evergreen-S.evergreen |
| Syzygium cumini | Myrtaceae | Tree | | Indo-Malesia | S. evergreen- moist deciduous |
| Syzygium hemisphericum | Myratceae | Large tree | | S. India-S. Lanka | Evergreen-s.evergreen |
| Syzygium travancoricum | Myratceae | Large tree | Western Ghats | | Evergreen forests |
| Ardisia solanacea | Myrsinaceae | Shrub | | Indo-Malesia, W. China | |
| Jasminum sp | Oleaceae | Climber | | Penin India | Widespread |
| Linociera malabarica | Oleaceae | Small tree | | Penin India | Closer to water bodies |
| Olea dioica | Oleaceae | Tree | | | Evergreen-s.evergreen |
| Cottonia peduncularis | Orchidaceae | Epiphtic herb | | Penin India-Sri Lanka | Evergreen-s.evergreen |
| Dendrobium sp. | Orchidaceae | Epiphtic herb | | | Evergreen-s.evergreen |
| Pandanus canaranus | Pandanaceae | Shrub | | Penin India | Stream bank |
| Adenia hondala | Passifloraceae | Climber | W Ghats-S. | | Kurnimakki forests |

| | | | | | |
|---|---|---|---|---|---|
| | | | Lanka | | |
| Piper nigrum | Piperaceae | Climber | | Penin India-Sri Lanka | Evergreen-s.evergreen |
| Pittosporum dasycaulon | Pittospraceae | Small tree | Western Ghats | | Evergreen-s.evergreen |
| Bambusa bambos | Poaceae | Tree | | India-S.Lanka | Deciduous forests |
| Naravelia zeylanica | Ranunculaceae | Climber | | South East Asia | S.evergreen-moist deciduous |
| Carallia brachiata | Rhizophoraceae | Large tree | | Indo-Malesia, Australia | Evergreen-s.evergreen |
| Anthoceplus kadamba | Rubiaceae | Large tree | | Asia, Pacific, Australia | River/stream banks |
| Canthium dicoccum | Rubiaceae | Small tree | | Indo-Malesia, China | Evergreen-s.evergreen |
| Catunaregam spinosa | Rubiaceae | Small tree | | Asia, Africa | Savanna, scrub |
| Chassalia curviflora | Rubiaceae | Herb | | Indo-Malesia | Forest undergrowth |
| Geophla repens | Rubiaceae | Prostrate herb | | Pantropical | S.evergreen-moist deciduous |
| Haldina cordifolia | Rubiaceae | Large tree | | Asia | Moist deciduous forests |
| Hymenodictyon obovatum | Rubiaceae | Small tree | Western Ghats | | Moist deciduous forests |
| Ixora nigricans | Rubiaceae | Small tree | | Indo-Malesia | S.evergreen-moist deciduous |
| Meyna laxiflora | Rubiaceae | Shrub | | Indo-Malesia | Evergreen forest |
| Tarenna asiatica | Rubiaceae | Shrub | | Indo-Malesia | S.evergreen-moist deciduous |
| Atalantia racemosa | Rutaceae | Small tree | | Penin.India-S.Lanka | S.evergreen forests, Kurnimakki |
| Clausena Indica | Rutaceae | Small tree | | Penin.India-S.Lanka | Evergreen-s.evergreen |
| Lavunga sarmentosa | Rutaceae | | | | |
| Murraya paniculata | Rutaceae | Shrub/small tree | | Indo-Malesia to Australia | Evergreen-S.evergreen |
| Murraya koenigi | Rutaceae | Shrub/small tree | | Indo-Malesia, China | Moist deciduous forests |
| Vepris bilocularis | Rutaceae | Evergreen tree | Western Ghats | | Evergreen-S.evergreen |
| Toddalia asiatica | Rutaceae | Climber | | Indo-Malesia, Africa | S.evergreen-moist deciduous |
| Zanthoxylum ovalifolium | Rutaceae | Shrub/small tree | | Indo-Malesia | S.evergreen-moist deciduous |
| Salix tetrasperma | Salicaceae | Small tree | | Indo-Malesia, S. China | Near forest swamp |

| | | | | | |
|---|---|---|---|---|---|
| Santalum album | Santalaceae | Small tree | | Penin India, Malesia | Deciduous forests |
| Allophyllus cobbe | Sapindaceae | Shrub | | South & S.E. Asia | S.evergreen-moist deciduous |
| Dimocarpus longan | Sapindaceae | Tree | | Indo-Malesia | Evergreen-S.evergreen |
| Lepisanthes tetraphylla | Sapindaceae | Medium tree | | Indo-Malesia, Africa | Evergreen-S.evergreen |
| Schleichera oleosa | Sapindaceae | Medium tree | | Indo-Malesia | Deciduous forests |
| Madhuca indica | Sapotaceae | Large tree | | India, Myanmar | Deciduous forests |
| Madhuca insignis | Sapotaceae | Small tree | | | Evergreen forests |
| Mimusops elengi | Sapotaceae | Large tree | | Indo-Malesia | Evergreen-S.evergreen |
| Smilax zeylanica | Smilacaceae | Climber | | Indo-Malesia | Evergreen-S.evergreen |
| Firmiana colorta | Sterculiaceae | Small tree | | Indo-Malesia, China | Deciduous forests |
| Gnidia glauca | Thymeliaceae | Shrub | | India, S. Lanka, Africa | Hill savanna |
| Grewia heterotricha | Tiliaceae | Climbing shrub | Western Ghats | | Semi-evergreen forests |
| Grewia tilifolia | Tiliaceae | Medium tree | | Asia, Africa | Deciduous forests |
| Aphananthe cuspidata | Ulmaceae | Large tree | | South & S.E. Asia | Evergreen-S.evergreen |
| Celtis timorensis | Ulmaceae | Small tree | | Indo-Malesia | S.evergreen forests |
| Callicarpa tomentosa | Verbenaceae | Shrub/small tree | | Penin India, S. Lanka | S.evergreen-moist deciduous |
| Gmelina arborea | Verbenaceae | Medium tree | | Indo-Malesia | Deciduous forests |
| Vitex altissima | Verbenaceae | Large tree | | South & S.E. Asia | S.evergreen-moist deciduous |

**ANNEXUR 2: KULLUNDIKAN CHECKLIST OF HIGHER PLANTS**

| NAME | FAMILY | NATURE OF PLANT | Western Ghats | General distribution | Habitats |
|---|---|---|---|---|---|
| Carvia callosa | Acanthaceae | Shrub | | | S.evergreen- moist deciduous |
| Buchanania lanzan | Anacardiaceae | Medium tree | | India, Myanmar | Deciduous forests |
| Holigarna arnottiana | Anacardiaceae | Medium tree | Western Ghats | | Semievergreen forests |
| Holigarna grahami | Anacardiaceae | Large tree | Western Ghats | | Evergreen forests |
| Mangifera indica | Anacardiaceae | Tree | | Indo-Malesia | Evergreen-S.evergreen forests |
| Nothopegia colebrookeana | Anacardiaceae | Small tree | | S. India-S. Lanka | Evergreen-S.evergreen forests |

| | | | | | |
|---|---|---|---|---|---|
| Spondias pinnata | Anacardiaceae | Large tree | | Indo-Malesia | Moist deciduous forests |
| Ancistrocladus heyneanus | Ancistrocladaceae | Climber | | | Evergreen-s.evergreen |
| Artabotrys zeylanicus | Annonaceae | Woody climber | | Penin. India-Sri Lanka | Kurnimakki |
| Polyalthia fragrans | Annonaceae | Large tree | Western Ghats | | Evergreen-s.evergreen |
| Alstonia scholaris | Apocynacae | Large tree | | Asia-Australia | S.evergreen- moist deciduous |
| Holarrhena pubescens | Apocynacae | Small tree | | Indo-Malesia | Deciduous forests |
| Tabernamontana heyneana | Apocynacae | Shrub/small tree | Western Ghats | | Forest gaps, scrub |
| Pothos scandens | Araceae | Climber | | Indo-Malesia, Madagascar | Evergreen-s.evergreen |
| Arenga wightii | Arecaceae | Small palm | | | |
| Calamus thwaitesii | Arecaceae | Climbing palm | | India, S. Lanka | Evergreen-s.evergreen |
| Caryota urens | Arecaceae | Tree | | Indo-Malesia | Evergreen-s.evergreen |
| Chromolaena odorata | Asteraceae | Shrub | | Pantropical weed | Widespread |
| Bombax ceiba | Bombacaceae | Large tree | | Asia, New Guinea | Deciduous forests |
| Canarium strictum | Burseraceae | Large tree | | India-Myanmar | Evergreen forests |
| Lophopetalum wightianum | Celastraceae | Large tree | | Indo-Malesia | Evergreen-s.evergreen |
| Calophyllum apetalum | Clusiaceae | Large tree | Western Ghats | | Evergreen forests |
| Calophyllum polyanthum | Clusiaceae | very large tree | | | Evergreen forests |
| Garcinia cambogea | Clusiaceae | Medium tree | | | Evergreen forests |
| Garcinia morella | Clusiaceae | Medium tree | | Indo-Malesia | Evergreen forests |
| Garcinia xanthochymus | Clusiaceae | Medium tree | | Indo-Malesia | Evergreen-s.evergreen |
| Calyopteris floribunda | Combretaceae | Liana | | Indo-Malesia | Deciduous forests |
| Terminalia bellirica | Combretaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Terminalia paniculata | Combretaceae | Large tree | | Penin. India-S. Lanka | S.evergreen- moist deciduous |
| Terminalia tomentosa | Combretaceae | Large tree | | India, S. Lanka | Deciduous forests |
| Alangium salvifolium | Cornaceae | Small tree | | Asia-Africa | S.evergreen-moist deciduous |
| Tetrameles nudiflora | Datisticaceae | very large tree | | | Semievergreen forests |
| Dichapetalum gelonioides | Dichapetalaceae | Shrub | | | Semievergreen forests |
| Dillenia pentagyna | Dilleniaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Dipterocarpus indicus | Dipterocarpaceae | Very large tree | Western Ghats | | Evergreen forests |
| Hopea ponga | Dipterocarpaceae | Medium tree | Western Ghats | | Evergreen-s.evergreen |
| Dracena ternatea | Dracenaceae | Small shrub | | | Evergreen forests |
| Diospyros assimilis | Ebenaceae | Large tree | | | Evergreen forests |

| | | | | | |
|---|---|---|---|---|---|
| Diospyros montana | Ebenaceae | Small tree | | Indo-Malesia, Australia | Deciduous forests |
| Elaegnus conferta | Elaeagnacae | Scandent shrub | | Indo-Malesia | Evergreen-s.evergreen |
| Aporosa lindleyana | Euphorbiaceae | Tree | | Penin. India-S. Lanka | Evergreen-s. evergeen |
| Bischofia javanica | Euphorbiaceae | Large tree | | | Evergreen-s.evergreen |
| Bridelia scandens | Euphorbiaceae | Scandent shrub | | Penin. India | Degraded moist forests |
| Cyclostemon confertiflorus | Euphorbiaceae | Medium tree | | | Semievergreen forests |
| Drypetes oblongus | Euphorbiaceae | Medium tree | | | |
| Macaranga peltata | Euphorbiaceae | Tree | | Penin. India-S. Lanka | S.evergreen-moist deciduous |
| Mallotus phillippensis | Euphorbiaceae | Tree | | Peninsular India | Semievergreen forests |
| Phyllanthus emblica | Euphorbiaceae | Small tree | | Tropics | Deciduous forests |
| Dalbergia latifolia | Fabaceae | Large tree | | Indo-Malesia | Deciduous forests |
| Derris sp | Fabaceae | Liana | | | S.evergreen-moist deciduous |
| Pterocarpus marsupium | Fabaceae | Large tree | | India, S.Lanka | Deciduous forests |
| Xylia xylocarpa | Fabaceae | Large tree | | Indo-Malesia | Moist deciduous forests |
| Flacourtia montana | Flacourtiaceae | Smll tree | | Penin. India | Semievergreen forests |
| Hydnocarpus pentandra | Flacourtiaceae | Small tree | Western Ghats | | S.evergreen-moist deciduous |
| Gnetum edule | Gnetaceae | Liana | | Penin. India | Evegreen-s.evergreen |
| Nothapodytes nimmoniana | Icacinaceae | Small tree | | Indo-Malesia, China | Moist deciduous-s.evergreen |
| Alseodaphne semecarpifolia | Lauraceae | Large tree | | Penin.India, S.Lanka | Semievergreen forests |
| Cinnamomum malabatrum | Lauraceae | Tree | Western Ghats | | Evergreen-s.evergeen forest |
| Litsea wightiana | Lauraceae | Small tree | Western Ghats | | Evergreen forests, Kurnimakki |
| Persea macrantha | Lauraceae | Large tree | | Penin.India-S.Lanka | Evergreen-s.evergreen |
| Careya arborea | Lecythidaceae | Small tree | | Tropical Asia | Deciduous forests |
| Asparagus racemosus | Liliaceae | Climber | | Paleotropics | Widespread |
| Lobelia nicotianifolia | Lobeliaceae | Herb | | Indo-Malesia | Evergreen forest edges |
| Lagerstroemia microcarpa | Lythraceae | Large tree | Western Ghats | | Moist deciduous forests |
| Memecylon talbotianum | Melastomaceae | Shrub or small tree | Western Ghats | | Evergreen forests |
| Memecylon umbellatum | Melastomaceae | Tree | | Penin India-Sri Lanka | Widespread |
| Aglaia anamallayana | Meliaceae | Small tree | Western Ghats | | Evergreen forests |
| Aglaia roxburghiana | Meliaceae | Tree | | Indo-Malesia-Pacific islands | Evergreen-S.evergreen |
| Anamirta cocculus | Menispermaceae | Liana | | Indo-Malesia | Moist deciduous to evergreen |
| Artocarpus gomezianus | Moraceae | Medium tree | | W Ghats-S. Lanka | S. evergreen- moist deciduous |

| | | | | | |
|---|---|---|---|---|---|
| Artocarpus heterophyllus | Moraceae | Tree | | South India | Cultivated and wild |
| Artocarpus hirsuta | Moraceae | Large tree | Western Ghats | | Evergreen-s.evergreen |
| Ficus callosa | Moraceae | Large tree | | Indo-Malesia | S. evergreen- moist deciduous |
| Ficus drupacea | Moraceae | Large tree | | India, S.E.Asia | Moist deciduous forests |
| Ficus microcarpa | Moraceae | Small tree | | | Moist deciduous forests |
| Ficus nervosa | Moraceae | Very large tree | | | Evergreen-S.evergreen |
| Knema attenuata | Myristicaceae | Tree | Western Ghats | | Evergreen-S.evergreen |
| Myristica dactyloides | Myristicaceae | Tree | | | Evergreen forests |
| Syzygium cumini | Myrtaceae | Tree | | Indo-Malesia | S. evergreen- moist deciduous |
| Syzygium gardneri | Myrtaceae | Very large tree | | | Evergreen forests |
| Jasminum sp | Oleaceae | Climber | | Penin India | Widespread |
| Linociera malabarica | Oleaceae | Small tree | | Penin India | Closer to water bodies |
| Olea dioica | Oleaceae | Tree | | | Evergreen-s.evergreen |
| Dendrobium sp. | Orchidaceae | Epiphtic herb | | | Evergreen-s.evergreen |
| Vanda testacea | Orchidaceae | Epiphtic herb | | | |
| Adenia hondala | Passifloraceae | Climber | | W Ghats-S. Lanka | Kurnimakki forests |
| Heckeria piperita | Piperaceae | Herb | | | Evergreen forests |
| Piper nigrum | Piperaceae | Climber | | Penin India-Sri Lanka | Evergreen-s.evergreen |
| Bambusa bambos | Poaceae | Tree | | India-S.Lanka | Deciduous forests |
| Grevillia robusta | Proteaceae | Tree | | Australia | Shade tree, coffee plantation |
| Carallia brachiata | Rhizophoraceae | Large tree | | Indo-Malesia, Australia | Evergreen-s.evergreen |
| Canthium dicoccum | Rubiaceae | Small tree | | Indo-Malesia, China | Evergreen-s.evergreen |
| Catunaregam spinosa | Rubiaceae | Small tree | | Asia, Africa | Savanna, scrub |
| Chassalia curviflora | Rubiaceae | Herb | | Indo-Malesia | Forest undergrowth |
| Coffea arabica | Rubiaceae | Shrub | | | |
| Geophla repens | Rubiaceae | Prostrate herb | | Pantropical | S.evergreen-moist deciduous |
| Ixora nigricans | Rubiaceae | Small tree | | Indo-Malesia | S.evergreen-moist deciduous |
| Meyna laxiflora | Rubiaceae | Shrub | | Indo-Malesia | Evergreen forest |
| Ophiorrhiza harrisiana | Rubiaceae | Herb | | | Evergreen-S.evergreen |
| Acronychia pedunculata | Rutaceae | Small tree | | | Evergreen-S.evergreen |
| Atalantia racemosa | Rutaceae | Small tree | | Penin.India-S.Lanka | S.evergreen forests, Kurnimakki |
| Clausena Indica | Rutaceae | Small tree | | Penin.India-S.Lanka | Evergreen-s.evergreen |

| | | | | | |
|---|---|---|---|---|---|
| Glycosmis pentaphylla | Rutaceae | Shrub | | | Forest edges, open places |
| Murraya paniculata | Rutaceae | Shrub/small tree | | Indo-Malesia to Australia | Evergreen-S.evergreen |
| Murraya koenigi | Rutaceae | Shrub/small tree | | Indo-Malesia, China | Moist deciduous forests |
| Vepris bilocularis | Rutaceae | Evergreen tree | Western Ghats | | Evergreen-S.evergreen |
| Toddalia asiatica | Rutaceae | Climber | | Indo-Malesia, Africa | S.evergreen-moist deciduous |
| Santalum album | Santalaceae | Small tree | | Penin India, Malesia | Deciduous forests |
| Allophyllus cobbe | Sapindaceae | Shrub | | South & S.E. Asia | S.evergreen-moist deciduous |
| Dimocarpus longan | Sapindaceae | Tree | | Indo-Malesia | Evergreen-S.evergreen |
| Sapindus laurifolius | Sapindaceae | Small tree | | | Semi-evergreen forests |
| Schleichera oleosa | Sapindaceae | Medium tree | | Indo-Malesia | Deciduous forests |
| Chrysophyllum roxburghi | Sapotaceae | Medium tree | | | Evergreen forests |
| Madhuca indica | Sapotaceae | Large tree | | India, Myanmar | Deciduous forests |
| Mimusops elengi | Sapotaceae | Large tree | | Indo-Malesia | Evergreen-S.evergreen |
| Smilax zeylanica | Smilacaceae | Climber | | Indo-Malesia | Evergreen-S.evergreen |
| Pterospermum acerifolium | Sterculiaceae | Medium tree | | | Evergreen forests |
| Pterospermum diversifolium | Sterculiaceae | Medium tree | | | Semi-evergreen forests |
| Gnidia glauca | Thymeliaceae | Shrub | | India, S. Lanka, Africa | Hill savanna |
| Grewia tilifolia | Tiliaceae | Medium tree | | Asia, Africa | Deciduous forests |
| Aphananthe cuspidata | Ulmaceae | Large tree | | South & S.E. Asia | Evergreen-S.evergreen |
| Celtis timorensis | Ulmaceae | Small tree | | Indo-Malesia | S.evergreen forests |
| Callicarpa tomentosa | Verbenaceae | Shrub/small tree | | Penin India, S. Lanka | S.evergreen-moist deciduous |
| Gmelina arborea | Verbenaceae | Medium tree | | Indo-Malesia | Deciduous forests |
| Vitex altissima | Verbenaceae | Large tree | | South & S.E. Asia | S.evergreen-moist deciduous |
| Strombosia | | | | | Evergreen forests |
| Homalium zeylanicum | | | | | Evergreen forests |
| Ventilago sp | | Climber | | | Semievergreen forests |

**ANNEXURE-3: ALLOTMENTS MADE IN KURNIMAKKI-HALMAHISHIKAN AND KULLUNDIKAN TIRTHAHALLI FOR NON-RORESTRY PURPOSES**

| **Study area** | **Hobli** | **village** | **Sy.No** | **Area in Acre-** | **Allotted Area** | **Govt order** | Type of Govt.order | Land use |
|---|---|---|---|---|---|---|---|---|

| | | | | Gunta-Ana | | | | |
|---|---|---|---|---|---|---|---|---|
| **Kurnimakki-Halumahishi Kan** | Mandagadde | Bekshikenjigudde village | 64 | 175-09-00 | 02-09-00 | MR 20/2011-12 dt. 20-09-2011 | Akrama-Sakrama | Arecanut |
| | Mandagadde | Bekshikenjigudde village | 64 | | 02-00-00 | MR 24/2011-12 dt. 20-09-2011 | Akrama-Sakrama | Arecanut |
| | Mandagadde | Bekshikenjigudde village | 64 | | 00-08-00 | MR 26/2011-12 dt. 20-09-2011 | Akrama-Sakrama | Arecanut |
| | Mandagadde | Bekshikenjigudde village | 98 | 17-00-00 | 04-08-00 | MR 7/2003-04 dt. 03-03-2004 | Dividing | |
| | Mandagadde | Bekshikenjigudde village | 12 | 95-35-00 | 14-27-00 | MR 4/78-89 | Birama shetu Mune Vranda matha, Bimankatte | |
| | Mandagadde | Bekshikenjigudde village | 13 | 446-37-00 | 445-37-00 | MR 6/79-80 | Birama shetu Mune Vranda matha, Bimankatte | |
| | Mandagadde | Bekshikenjigudde village | 13 | | 10-00-00 | MR 22 99-00 | Paddy land-Division | K.D.Satyanarayana |
| | Mandagadde | Bekshikenjigudde village | 13 | | 10-10-00 | MR 22 99-00 | Paddy land-Division | K.Ratnakar |
| | Mandagadde | Bekshikenjigudde village | 13 | | 20-00-00 | MR 4/93-94L RF 99-00 | Paddy land-Division | N.H.Annayya |
| | Mandagadde | Bekshikenjigudde village | 95 | 45-29-00 | | MR 4/78-79 | Birama shetu Mune Vranda matha, Bimankatte | |
| | Mandagadde | Bekshikenjigudde village | 96 | .12-30-00 | | MR 4/78-79 | Birama shetu Mune Vranda matha, Bimankatte | |
| | | | | | | | | |
| | Mandagadde | Kadumallige | 86 | 283-06-00 | 150-00-00 | MR 76/97-98 | 40 year lease tp MPM | |
| | Mandagadde | Kadumallige | 97 | 73-24-00 | 53-00-00 | GO. No. 6680 F/26-12.30 | Dividing | |
| | | | | | | | | |
| | Muttur | Mahishi | 24 | 808-16-00 | 00-10-00 | MR 2/2007-08 dt. 07-08-2007 | Akrama Sakrama | |
| | Muttur | Mahishi | 24 | | 154-25-00 | Lease for Quarry | | |
| | Muttur | Mahishi | 24 | | 03-20-00 | MR 15/200-01 | Crematorium | |
| | Muttur | Mahishi | 25 | 28-20-00 | 01-20-00 | MR 16/2006-07 dt. 29-06-2007 | Akranma sakrama of Kan | |
| | | | | | | | | |
| | Muttur | Dabbangadde | 13 | 229-16-00 | 01-00-00 | 200 MFMRNO 1/90-91 | D.R.Giddaya gouda | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Muttur | Dabbangadde | 13 | | 28-36-00 | 200 MFMRNO 1/90-91 | Grazing | |
| | Muttur | Dabbangadde | 13 | | 81-20-00 | MR 23/97-98 | MPM Forest | |
| | Muttur | Dabbangadde | 17 | 130-29-00 | 01-03-00 | MR 9/2002-03 | Kan Division (Arecanut) | Shemegouda |
| | Muttur | Dabbangadde | 17 | | 0-25-00 | MR 9/2002-03 | Kan Division (Arecanut) | Chandrashekar |
| | Muttur | Dabbangadde | 17 | | 0-19-00 | MR 9/2002-03 | Kan Division (Arecanut) | Nagraj |
| | Muttur | Dabbangadde | 49 | 129-04-00 | | MR no 8/78-79 | Birama shetu Mune Vranda matha, Bimankatte | |
| | Muttur | Dabbangadde | 102 | 50-00-00 | | MR no 8/78-79 | Birama shetu Mune Vranda matha, Bimankatte | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Kulunde Kan** | Mandagadde | Kulunde | 29 | 136-05-00 | Pending Govt. Survey | MR 23/2004-05 dt.31-05-2005 | Dividing | |
| | Mandagadde | Kulunde | 101 | 20-12-00 | | Relese 01/11/2001 | | |
| | Mandagadde | Kulunde | 27 | 80-30-00 | 10-00-00 | MR 23/98-99 | Coffee | H.C.Mangaladevi |
| | Mandagadde | Kulunde | 27 | | 25-00-00 | MR 7/85-86 | Coffee | B.V. Shekar |
| | Mandagadde | Kulunde | 27 | | 25-00-00 | MR 8/81-82 | Coffee | Manchayya |
| | Mandagadde | Kulunde | 27 | | 20-30-00 (Govt.) | MR 23/2004-05 dt.31-05-2005 | Coffee | Govt. |
| | Mandagadde | Kulunde | 58 | 81-08-00 | 03-08-00 | MR No. 9/ 98-99 | Grazing | |
| | Mandagadde | Kulunde | 69 | 132-28-00 | 10-00-00 (Sy 69/1) | MR 4/95-96 | Dividing Sy. No 69 | Shidda Naik |
| | Mandagadde | Kulunde | 99 | 10-35-00 | Court found Sy No to be false and hence, cancelled it | MR 17/2004-05 dt. 16-04-05 | Coffee | K.T. Ramaswami |
| | Mandagadde | Kulunde | 100 | 20-00-00 | Court found Sy No to be false and hence, cancelled it | MR 17/2004-05 dt. 16-04-05 | Coffee | T.R.Arunachal |
| | Mandagadde | Kulunde | 101 | 20-12-00 | Help aid grant | Adhar 01/11/2011 | Coffee | Padmavathi M |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mandagadde | Kulunde | 103 | .12-12-00 | Sale to second party | MR 25/2007-08, dt.20-03-2008 | Coffee & Arecanut | Chandreka H.N. |
| | Mandagadde | Kulunde | 25 | 60-39-00 | 30-00-00 | MR 4.84-85 ( Survey map correction) | Coffee | K.V.Timmayya |
| | Mandagadde | Kulunde | 25 | | 15-00-00 | MR 4.84-85 ( Survey map correction) | Coffee | K.D. Devakar |
| | Mandagadde | Kulunde | 25 | | 15-00-00 | MR 8.96-97 ( Survey map correction) | Coffee | K.D. Devakar |

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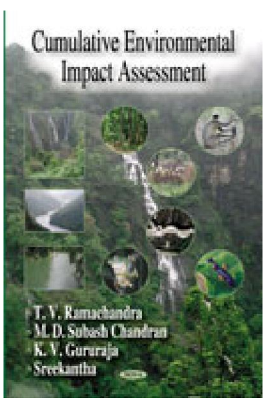
**Cumulative Environmental Impact Assessment**

**Abstract:** An ecosystem is a complex of interconnected living organisms inhabiting a particular area or unit of space, together with their environment and all their interrelationships and relationships with the environment having a well-maintained ecological processes and interactions. It is characterized by the abundance of individual species populations; interspecies relationships; activity of organisms; physical and chemical characteristics of environment; flows of matter, energy, and information; and description of changes of these parameters with time. Hence, its surroundings can be categorised into physical and biological environment, which are self-defined, self-maintained and self-sustained dynamic natural systems. The physical environment comprises of lithosphere, hydrosphere and atmosphere, while the living beings in the biosphere constitute biological environment. The biosphere contains many delicate biological processes that have taken billions of years to evolve and there is a natural equilibrium for life sustaining processes dependent on relatively slow rates of recycling. These natural processes as well as resources are being over driven by human activities to meet the growing demands of the population. These developmental activities by humans ignoring the ecosystems and functional aspects are instrumental in bringing about irreversible changes in the ecosystem and their environment. The concern now is on the rise for the changes due to human induced activities that are proving detrimental, as it has exceeded the recycling rates of natural processes, which are altering the very nature of the environment. These changes are drastic, both to the environment and its inhabitants alike. Under such circumstances, it is necessary to do a retrospective analysis of the present situation to identify the degree of seriousness of different kinds of anthropogenic activities on the environment, plausible measures to curb further damaging to environment and better ways to live in harmony with the environment.

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# BIOENERGY STATUS OF SHARAVATHI RIVER BASIN, WESTERN GHATS, INDIA

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**ABSTRACT**
Most of the developing countries including India depend heavily on bioenergy and it accounts for about 15% of the global energy usage. Its role in meeting a region's requirement has increased the interest of assessing the status of biomass availability in a region. The present work deals with the bioenergy status in the Linganamakki reservoir catchment of the Sharavathi river basin, Western Ghats, India, by assessing the energy supply and sector wise energy consumption. The study reveals that majority of the households (92.17%) depend on fuelwood for their domestic energy needs with the per capita fuelwood consumption of 1.2 tonnes/year, which is higher than the national average (0.7 tonnes/year). This higher dependence on fuelwood has contributed to the degradation of forests, resulting in scarcity of bioresources necessitating exploration of viable energy alternatives to meet the growing energy demand.

**Keywords:** Bioenergy, Biostatus, Energy alternatives, Biogas, Sustainable Energy.

## 1.INTRODUCTION

Energy is considered as the prime mover of a region's development. In India, more than 70% of the total population inhabits rural areas and 85–90% of energy requirement is being met by bioresources. In the context of energy crisis due to dwindling of fossil fuel based energy resources, the importance of biomass as a renewable energy resource has increased in recent years. Although biomass energy is

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predominantly used in rural areas, it also provides an important fuel source for the urban poor, and many rural, small and medium scale industries. Field investigations reveal that most of the rural population still depends on the traditional devices (which are energy inefficient) for cooking and water heating, etc. leading to excess consumption of local resources. Lack of information about the resources and technologies may be cited as the reason for this situation.

Bioresources are diverse solid carbonaceous material ranging from fuelwood collected from farmlands and natural woodland, to plantation crops grown specifically for energy purposes, agricultural and forestry residues, food and timber processing residues, animal residues and aquatic flora. The energy released from the reaction of these materials with oxygen is known as bioenergy and it is being used in various ways to meet daily energy needs of the society. Bioenergy is the most developed renewable energy, providing 38% of the primary energy needs of developing countries. In the developing world as a whole, about 2 billion people rely solely on fuelwood as their energy source for water heating and cooking. In order to achieve sustainable, self-reliant and equitable development of a region, it is imperative to focus on efficient production and use of bioenergy to meet both traditional and modern fuel requirements.

The rural energy scenario in India is dominated by the domestic sector, which accounts for 75% of the total energy consumed. The fuel consumption pattern of the domestic sector in rural areas is characterized by higher dependence on bioresource-based fuels such as fuelwood, agricultural residues, etc. Cooking and water heating (for bathing and washing) are the prime end-uses in domestic sector accounting for over 90% of the energy. Rural population still depends on the traditional devices for cooking and water heating, etc., which are energy inefficient leading to excess consumption of local resources. This is mainly due to the lack of knowledge of energy efficient devices and renewable energy technologies. According to the recent National Sample Survey (NSS) data, about 36.5% of fuel needs in urban and 17.2% fuel needs in rural area is met by sources like kerosene and electricity. All other cooking is done either with fuelwood or dung cakes. This reveals the higher dependence on bioresource to meet the energy requirement that is mainly due to availability of bio-fuels at zero private cost and also non-availability of other sources of energy (high costs and unreliable supply network).

The estimate done at regional level for Karnataka (a federal State in India) shows that 8.5 million tonnes of fuelwood is required annually for cooking purpose in Karnataka. Inclusion of additional domestic demands such as water heating, space heating, etc., pushes it to 11.2 million tonnes annually. The demand for fuelwood is continuously rising along with increase in population. The State has only 16.9% of the area under forests (38,724 $km^2$ of the total area of 191,791 $km^2$).

The burgeoning population coupled with unplanned developmental activities based on ad-hoc decisions has led to bioresource scarcity in many parts of Karnataka. Present fossil fuel potential is unable to meet the growing demands of the society. There is a need to look for viable alternatives to meet the scarcity. Thus, there is a requirement for interventions particularly in rural development and in general, the energy system to boost the energy potential at disaggregated levels to balance demand

and availability. This necessitates the understanding of the present energy consumption pattern and exploring locally available alternative energy sources in order to ensure resource sustainability.

Alternatives like biogas technology has made inroads in rural economy in some districts like Uttara Kannada,Udupi, Shimoga, etc. in Karnataka State (with higher literacy among women) during the last two decades due to economic viability, ecological soundness, technical feasibility and social acceptance. Biogas from biomass and animal wastes is an excellent technology that provides an alternate source of fuel in rural areas with an output of both energy and manure by using locally available resources like animal dung and other organic material.India is a pioneer in the field of developing technology for biogas production from animal dung (Srinivaran, 1979). Animal dung is a potentially large biomass resource and dried dung has the same energy content as wood. When burned for heat, the efficiency is only about 10%. About 150 million tonnes of cow dung (dry) is used for fuel each year across the globe, 40% of which is in India (UNEP, 1980). Biogas is produced by biological decomposition of organic material in the absence of air. The efficiency of conversion of animal residues could be raised to 60% by digesting anaerobically (to produce biogas). Biogas production will also resolve the conflict between energy recovery and nutrient utilisation as the effluent from the digester could be returned to the fields.

For 2002–03, a target of setting up of 0.12 million family type biogas plants had been allocated to States and agencies. About 70,440 plants have been completed during the period April to December 2002, which is almost 117% over the target of 60,000 plants planned for the corresponding period (MNES, 2003).

Current study was carried out in the Linganamakki reservoir catchment of Sharavathi river basin, Western Ghats, India to assess the impacts due to developmental work (in the form of hydroelectric power stations with reservoir) on local energy resources and demand. This region is considered to be one of the biodiversity hotspots as it harbours rich flora and fauna. The people residing in this area are largely dependent on these forests for daily energy needs (fuelwood) and sustenance. It is observed that the boundary of the energy flow extends beyond the sub-basin limit of the Sharavathi River. Hence a river basin-hydrological unit is considered for this investigation as energy movement is related to geographical features and shows similar trends in relatively homogenous features.

Karnataka State mainly depends on hydroelectricity (67%) of which Sharavathi river basin's share is about 48%. It is one of the west flowing rivers of India, which traverses over a length of 132 km through undulating terrain in the Western Ghats with rich biodiversity and joins the Arabian Sea. The study area is situated at latitude 74°67'11" to 75°30'63" east and longitude 14°7'27" to 13°77'08" north with an area of 1992 sq. km. This river is extensively utilized for hydroelectric power generation (1450 MW). The Karnataka Power Transmission Corporation Limited (KPTCL) has constructed a dam at Linganamakki towards meeting the electricity requirement of the State.

The Linganamakki reservoir is about 105 km west of the district headquarter, Shimoga. Figure 1 provides the location of the study area while; Figure 2 is the remote sensing composite image that was used to assess the bioresource availability in various

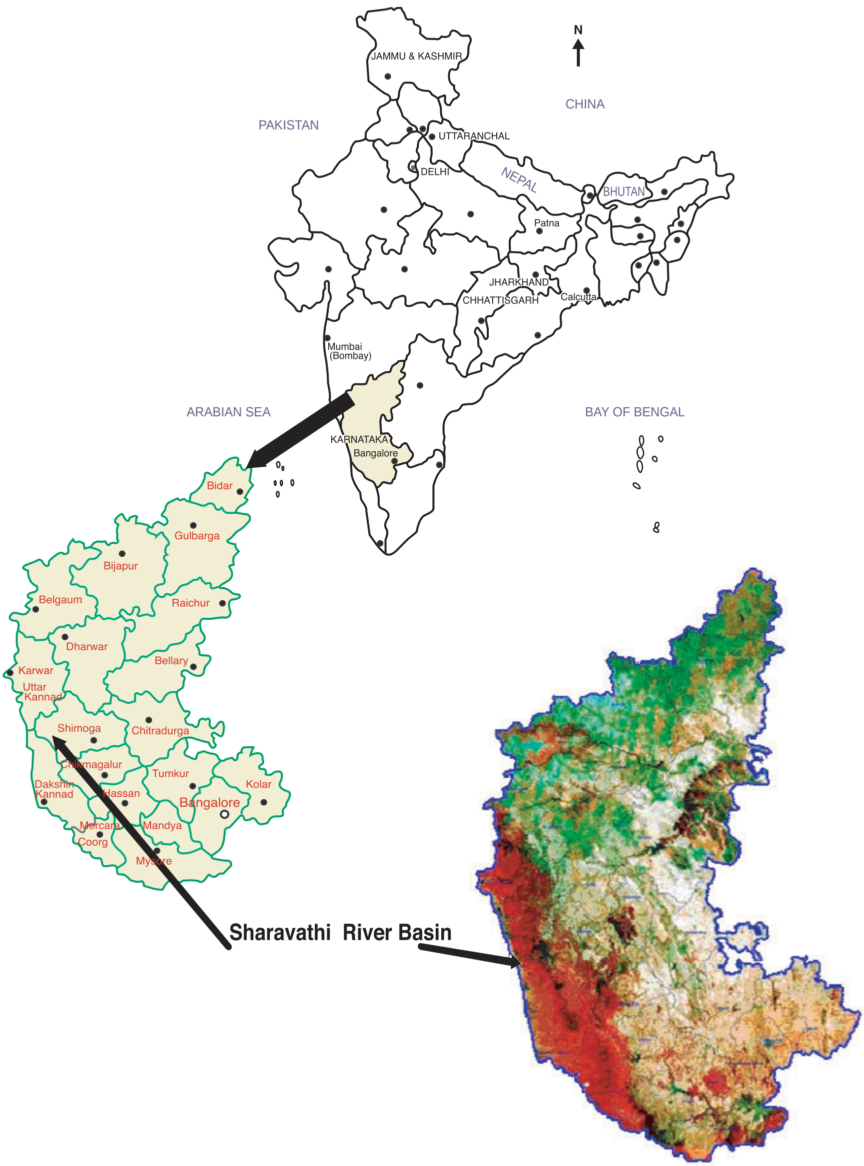



Figure1: Location of the study area.

land use categories. The mountainous terrain of Western Ghats binds the western part of the study area, which has rich vegetation cover of evergreen to semi-evergreen type. The vegetation richness gradually recedes towards east. The hills slope towards east and transition between Maidan and Malnad can be seen on eastern part of the study area. It is further divided in to sub-basins based on major tributaries and associated streams as given in Figure 3.

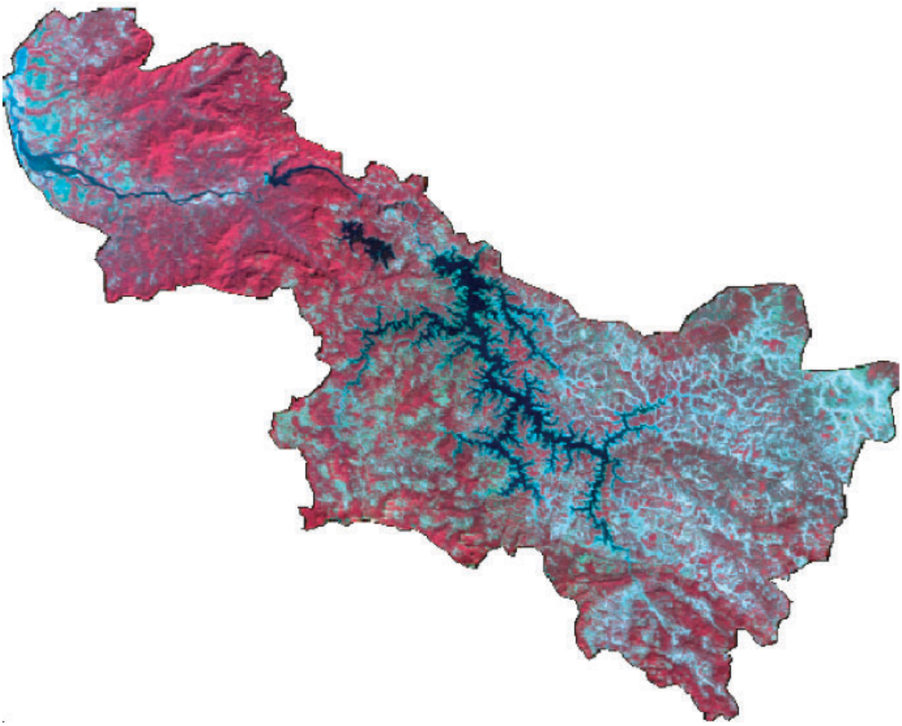
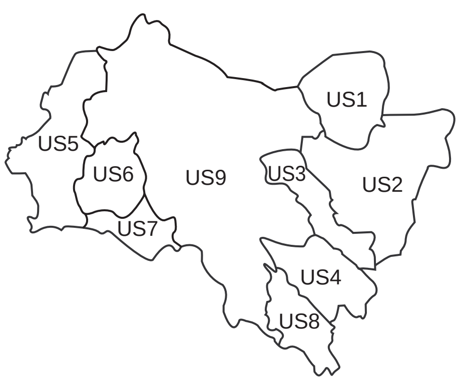


Figure 2: Remote sensing composite image of the study area.




| | | | | | |
|---|---|---|---|---|---|
| US1 | Nandiholé | US2 | Haridravathiholé | US3 | Mavinaholé |
| US4 | Sharavathi | US5 | Yenneholé | US6 | Hurliholé |
| US7 | Nagodiholé | US8 | Hilkunjiholé | US9 | Linganmakki (Central Zone) |

Figure 3: Sub-basins in the study area.

Assessment of the energy consumption pattern and bioresources availability was done in order to quantify the energy demand and to understand the present status of energy supply and prospects for alternate policies and technologies along with management strategies to ensure the sustainability of the ecosystem. The Ministry of Environment and Forests, Government of India through the forest departments in each State has implemented the JFPM (Joint Forest Participatory Management) programme through a participatory approach involving village communities and voluntary agencies in the conservation and regeneration of forests. The performance of this programme in the river basin has been explored to assess the efficacy in resource management. Presently under JFPM, about 23 Village Forest Committees (VFCs) are active.

The National Commission on Agriculture (NAC) in 1976 projected the fuelwood demand up to the year 2000 (Kumar, 1999). The net per capita fuelwood consumption was estimated at about 194 kg/year. The demand projections estimated on that basis for fuelwood was 157.5 million tonnes in 2000. The Commission did not project an appreciable shift away from non-commercial fuels.

Comparative analysis of village level domestic energy consumption patterns across coastal, interior, hilly and plain zones considering regional and seasonal variations was done for Uttara Kannada District in 1999. Average consumption (kg/capita/day) of fuel wood for cooking ranges from 2.01 ± 1.49 (coastal) to 2.32 ± 2.09 (hilly). Season wise cooking fuel wood requirement for coast and hilly zones, ranges from 1.98 and 2.22 (summer) to 2.11 and 2.51 (monsoon) respectively, while for water heating (for bathing and washing), it ranges from 1.17 ± 0.02 (coast) to 1.63 ± 0.05 (hilly). Examination of present role of biomass in the energy supply of Uttara Kannada district, Karnataka and the potential for future biomass provision and scope for conversion to both modern and traditional fuels reveals that fuel wood was mainly used for cooking, and horticultural residues from coconut and areca nut trees were used for water heating purposes. Most of the households in this region still use traditional stoves whose efficiency is less than 10%. Energy from various crop residues was calculated: paddy husk-170.12 million kWh, bagasse-136.3 million kWh, groundnut-11.64 million kWh and maize-1.66 million kWh. The total residues available for the district were calculated to be 42020.37 tonnes. The total energy available from horticultural residues is: areca-540.58 million kWh, coconut-247.04 million kWh and cashew–38.365 million kWh. The total biogas available was calculated to be 46.29 million $m^3$, which could meet 30% of the population's energy demand. The fodder requirement was estimated to be 1.09 million tonnes of which 0.21million tonnes could be met by agro-residues. The improved cook stoves (ASTRA stoves-designed at ASTRA, Indian Institute of Science) were distributed under an eco-development programme, which was done through local people's active participation and after consultations with the villagers and local NGOs (Non-Governmental Organizations). These stoves are characterized by complete fuel combustion with as little excess air as practicable to generate the highest temperature of flue gases. The efficiencies of these stoves are in the range of 32–41%.The study also reveals that grazing in forests as well as removal of fuelwood (for domestic and small scale industries) has affected the sustainability of the forests, as there is large-scale degradation in many localities (Ramachandra et al, 2000).

Centre for Sustainable Technologies (formerly known as ASTRA), Indian Institute of Science conducted a detailed survey in six villages in a dry arid zone that revealed: (a) fuelwood is a dominant energy source (81.6%) used mainly for household activities, (b) cooking is a major activity consuming human and fuelwood energy and efficiency of improved stoves are in the range of 5.08%, (c) human energy in h/day/household (especially women and children) was inefficiently used in fuelwood gathering (2.6), cooking (3.68), carrying food to farms (1.82), fetching water (1.53), taking cattle for grazing (5.54) etc., (d) kerosene consumption for lighting is about 4.3l% non-electrified house (78% of the houses being non-electrified) and (e) industrial consumption is very small. Essential factors determining biomass availability for energy are: (i) The future demand for food, determined by the population growth and the future diet; (ii) The type of food production systems that can be adopted world-wide over the next 50 years; (iii) Productivity of forest and energy crops; (iv) The (increased) use of bio-materials; (v) Availability of degraded land; (vi) Competing land use types, e.g. surplus agricultural land used for reforestation. The focus has been put on the factors that influence the potential biomass availability for energy purposes.

Six biomass resource categories for energy are (i) energy crops on surplus cropland, (ii) energy crops on degraded land, (iii) agricultural residues, (iv) forest residues, (v) animal manure and (vi) organic wastes. The amount of re-circulating biomass is the key variable for controlling nutrient availability within an ecosystem. In this regard, recycling of biomass, rotation of crops, and biomass-producing strips inter-cultured with crop areas maintain the nutrition balance in agricultural lands. Part of the biomass is locally consumed in providing fodder to the draught animals. It can be used as a layer to suppress evaporation and as organic input for crop production, satisfying part of the nutrient requirements enhancing soil fertility and improving its moisture holding and permeability characteristics (Datye, 1997).

Even though forests cater most of the daily energy needs in rural areas, there is a need to focus on viable energy alternatives to cater to the growing demand of the burgeoning population. In this context, biogas generators lessen the dependence on forest and increases green areas leading to improved environment. More than 2 million biogas plants have been built in India so far. With a potential market for 30 plants attached to households with 3 cattle or more, the social and environmental advantages of biogas are just beginning to be explored. In rural areas, where there is generally no electricity supply, the introduction of biogas has given women a sense of self-worth and time to engage in more activities outside the home (Rene and Gunnar, 1997). Important sociological issues that have prevented widespread adoption of Biogas generators in India (during the evolution of biogas) are scarcity of animal residues, asphyxiation, fire explosion, kitchen fire, digester bursting or cracking and hazardous developments with respect to human safety (Goswami and Sutar, 1993).

Stall-feeding instead of field grazing is one of the best ways to circumvent the scarcity of animal residues and it facilitates increased production of biogas. Also, it would aid the regeneration of forests as the damages to saplings are minimised. However, stall-feeding is a labour-intensive activity demanding high labour inputs during the growing season. Cutting and carrying grass and carrying water to the cattle absorb 60–75% of the total labour. Slurry of biogas plant serves as manure and supply humus to soils, thereby helps in soil conditioning (John, 1986).

However, certain barriers hinder the overall potential of community biogas plants for cooking. Compared to biogas, fuel wood is available at zero cash cost and the cost of a stove is still high and acts as a deterrent, especially for the poor. Scarcity of large funds hinders the installation process of biogas plants. NGOs are suffering with improper incentive facilities for construction and maintenance, and also with unavailability of technology packages and adequate demonstration units. No organization at village level is willing to take leadership and accept responsibility of biogas plants. Inadequate funding and scarcity of skilled personnel for construction and maintenance affect the full potential use of biogas plants. Maintenance of biogas plants in some areas is affected by scarcity of water. Women and children play a dominant role in most of the household activities (like gathering of fuelwood, cooking etc.), but lack of representation of women in decision-making has also contributed to the problem.

The barriers for improved cooking technologies could be grouped as financial, technical and institutional from both supply and demand perspective. The improved stove cost varies with the design and is expensive compared to the traditional stoves. The government provides subsidy for improved stoves, which the households claim after the installation. Some households still consider the cost as high due to lack of knowledge of certain direct and indirect benefits, and also availability of fuel wood, dung cakes and crop residues with no cash expenditure. Inaccessibility of the improved stove accessories along with the scarcity of the trained builders and service facilities in rural areas hinder the diffusion of devices. The distance from the nearest urban centre and availability of transportation facilities also plays a dominant role in adopting the alternate energy technologies (Ravindranath and Hall, 1995).

The entire study area falls under two taluks namely, Sagar and Hosanagara of Shimoga District. Talukwise bioenergy available in the study area from agricultural residues, forests, horticultural residues, plantation and livestock is tabulated in Table 1.This shows that despite good resource potential in the region, growing demand for fuelwood would threaten the sustainability of the resources. In order to understand the impacts at local scale, the entire upper river basin is divided into eight sub-basins based on the major tributaries and their respective watershed areas. The central part does not fall under any of the major tributaries and was considered separately (central zone). The western part of the river basin has three sub-basins, southern part has two sub-basins and the eastern part has three sub-basins.

Bioresource availability and energy demand assessments were done through primary and secondary data collections. The primary data collection mainly aimed at quantifying the energy needs, identifying the technological options, selection of the best options and integrating the optimal mix of technologies. Secondary data collected from government departments at district and taluk head quarters included villagewise demography and occupational and infrastructural facilities data, land holding particulars of the individual households (agriculture, horticulture, landless, etc.), household list of each village, village level data on livestock population, landuse data, cropping pattern, productivity and the daily rainfall data for the last 50 years.

**Table 1: Talukwise bioenergy availability in the study area**

| Taluk | Total area (ha) | Total Population | Total bioenergy availability (million kcal) | | | | | Total Availability (million kcal) | Demand (million kcal) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Agricultural Residues | Horticultural Residues | Forests | Plantation | Livestock | | | |
| Sagar | 194009 | 200211 | 36367.10 | 2404076 | 1807114.0 | 41607.49 | 45072.44 | 4334237.03 | 816860.9 | 5.30 |
| Hosanagara | 142279 | 115019 | 29818.66 | 1387760 | 956524.2 | 15185.86 | 59453.78 | 2448742.50 | 469277.5 | 5.22 |

**Table 2: Category wise adult equivalents (AE) for computation of PCFC**

| Category | AE |
|---|---|
| Men (between 18–59 years) | 1.00 |
| Women (between 18–59 years) | 0.80 |
| Men (>59 years) | 0.80 |
| Women (>59 years) | 0.80 |
| Boys (between 6–18 years) | 0.50 |
| Girls (between 6–18 years) | 0.50 |
| Kids (between 1–5 years) | 0.35 |
| Child (1 year) | 0.25 |

In this regard, questionnaire based stratified random sampling of households was done in a cluster of selected villages to collect the data of energy consumption pattern, resources available, and social, economical and cultural aspects. Forty-two villages were selected which are distributed over the entire study area and based on factors such as per capita forest area, per capita agricultural area, etc., which have a role in the energy consumption pattern in a village.

Land holding by a family is considered as the primary criterion for selection of households for energy survey. Households were selected covering all communities from all land holding (small/medium/large) and land less categories. Totally 447 households in 42 villages were covered, which comprises households of 90 landless labourers. Affordability to advanced technologies is determined by the household income and agriculture is the main income source in the rural area. The social and cultural aspects of the households lead to their own fuel preferences. Thus, community-wise variation in the fuel type and quantity in use can be expected.

Representation of energy consumption data in terms of per capita consumption and standard adult equivalents are useful to visualize the consumption pattern and for easier comparison. Hence the analysis was done through the computation of per capita fuel consumption (PCFC) and is given by ‘eqn (1)’.

$$PCFC = FC/P \tag{1}$$

Where, FC ( fuel consumed in kg/day, P = number of adult equivalents.

The adult equivalents for computation of PCFC are listed in Table 2, depending on the age and sex. The total demand for a sub-basin was computed based on the total population and the annual per capita fuelwood requirement.

Quantification of the source-wise bioresources potential (sub-basin wise) was done through land cover and land use analysis using remote sensing data-IRS 1C MSS (Multi Spectral Sensor) data of 1999 and 2003. The land cover analysis shows that 70% of river basin is under vegetation indicating the predominance of bioresources. The bioresource availability under each category was obtained by multiplying the spatial extent of each land use type with the annual productivity. The annual

**Table 3: Demographic features of the study area**

| Sub-basin | Total area (sq. km) | Population density (persons/sq. km) |
|---|---|---|
| Yenneholé | 189.00 | 35.87 |
| Nagodiholé | 65.17 | 48.41 |
| Hilkunjiholé | 85.08 | 72.87 |
| \Hurliholé | 97.88 | 76.63 |
| Sharavathi | 119.40 | 94.19 |
| Central zone | 540.55 | 100.48 |
| Nandiholé | 143.60 | 101.27 |
| Mavinaholé | 95.08 | 106.84 |
| Haridravathiholé | 278.90 | 112.49 |

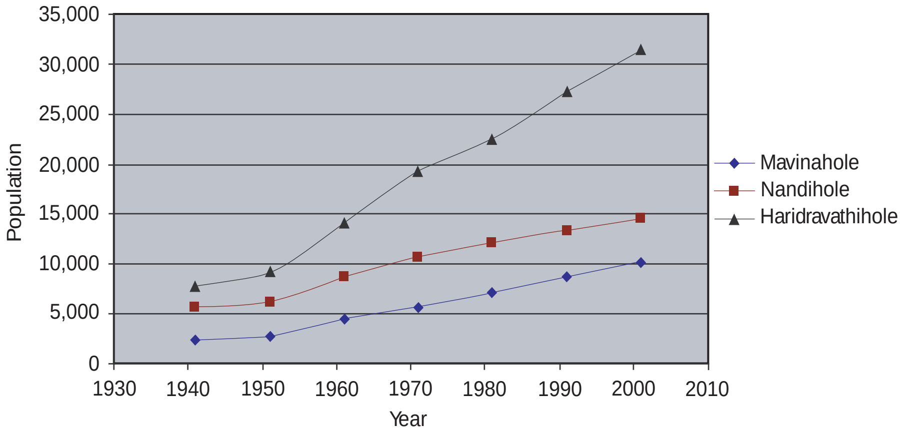



Figure 4: Population trend for the eastern clusters.

availability is based on aggregation of biomass productivity for each type of forest patches. In the present case, the productivity of evergreen to semi-evergreen forests was considered as 3.6–6.5 tonnes/ha/year. The deciduous forests have biomass productivity of 3.9–13.5 tonnes/ha/year. The homogenous plantations were considered as 3.6–6.5 tonnes/ha/year in terms of annual biomass productivity.

## 2. RESULTS AND DISCUSSIONS

### 2.1. Demography

The population density computed for each sub-basin is listed in Table 3. Yenneholé sub-basin, which is a part of Sharavathi Wildlife Sanctuary, has low population density. Among all sub-basins, Haridravathiholé sub-basin on the eastern part has high population density (112.49 persons/sq. km). Trends in population change over six decades were analysed for eastern, central and western sub-basins and is depicted in Figures 4, 5 and 6 respectively. In the eastern part of the study area, apart from

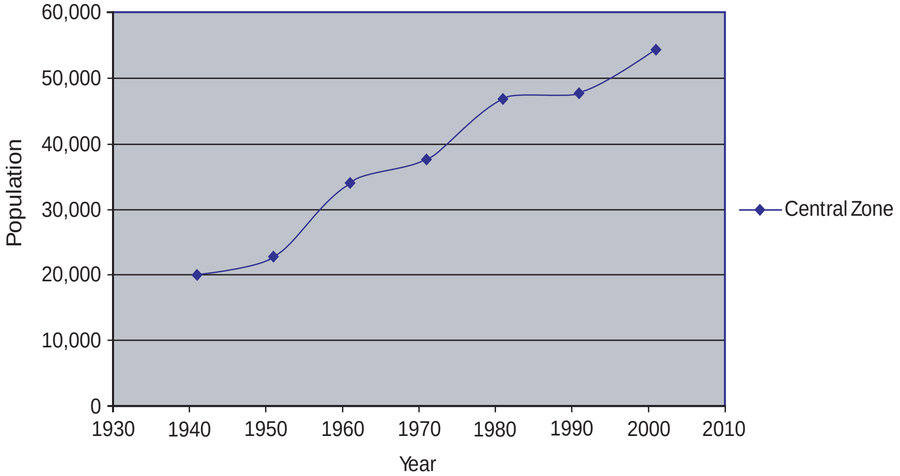



Figure 5: Population trend for the Central zone.

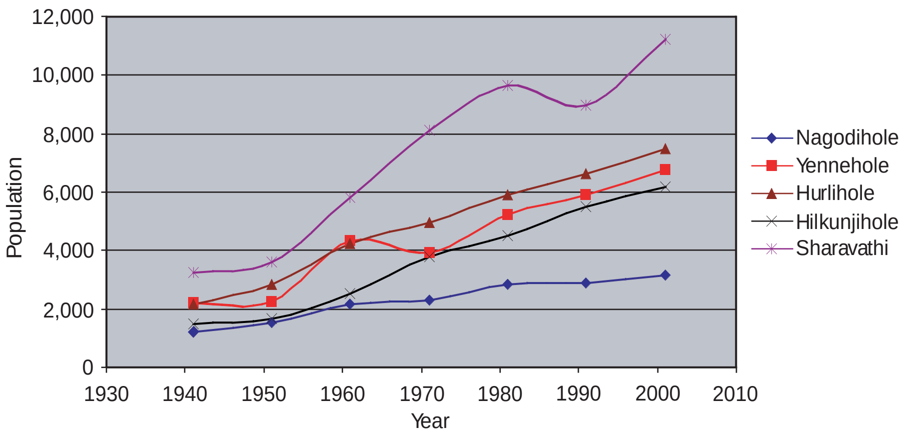



Figure 6: Population trends for the western and southern clusters.

Haridravathiholé sub-basin, Nandiholé and Mavinaholé sub-basins have low rates of population increase. The Sharavathi sub-basin and central zone recorded rapid increase compared to the neighbouring Hilkunjiholé sub-basin. Similarly, population increase is comparatively higher in Hurliholé and Yenneholé (western part) than the Nagodiholé sub-basin.

**2.2. Energy Scenario**

From Table 4, it is evident that the majority of the households (92.17%) still depend on fuelwood for their cooking energy needs followed by biogas plants (10.06%) and LPG (3.80%). This higher dependence on fuelwood is due to the availability of the

**Table 4: Individual share of energy sources in cooking**

| Energy Source | Number of Households | % Households |
|---|---|---|
| Fuelwood | 412 | 92.17 |
| Biogas | 45 | 10.06 |
| LPG | 17 | 3.80 |

forest resources in the immediate vicinity at zero cost. Two types of fuelwood collection are observed in the region namely, daily collection and seasonal collection. The daily fuelwood collection is the task performed by women who normally spend about 1–5 hours to collect dry and fallen trees from forest areas during non-rainy seasons. The seasonal fuelwood collection is usually performed by men (from nearby households in a group) during summer for usage in monsoon. It involves mainly lopping of trees and some times it is more harmful to the forests as full tree is removed. It was seen that the fuelwood extraction is not uniform over the entire forest patch. The forest areas nearer to human settlements tend to be more deteriorated. Also, normally people cut tree branches or trees, as collecting dead and fallen tree parts are a tedious and time-consuming task. Less dependence on LPG may be due to the lack in availability of resources, infrastructure and higher costs.

The study shows that there is enormous potential for the biogas technology over the study area to replace the usage of fuelwood in domestic energy for cooking. Biogas has a higher heating value than producer gas and coal gas, which implies increased services. As a cooking fuel, it is cheap and extremely convenient. Based on the effective heat produced, a 2m$^3$ biogas plants could replace, in a month, fuel equivalent of 26 kg of LPGor 37 litres of kerosene or 88 kg of charcoal or 210 kg of fuelwood or 740 kg of animal dung cake. It is a clean fuel without any health hazards or offensive odour and burns with soot less, clean bluish flame thereby making cleaning of cooking utensils easier. Biogas technology has enhanced energy supply decentralization, thus enabling rural areas to meet their energy requirements especially when the commercial fuels are inaccessible. In terms of cost, biogas is cheaper than conventional biomass fuels (dung cakes, fuelwood, crop wastes, etc.) as well as LPG, and is only fractionally more expensive than kerosene. Biogas systems have attracted considerable attention for the potential of waste recycling, pollution control and improvement of sanitary conditions, in addition to providing fuel and manure free of pathogens.

All surveyed houses use twigs and horticultural residues (coconut wastes, etc.) for water heating. In Sagar taluk alone, out of 230 sampled houses, 141 areca land owners use green manure for the plantations. Green leaves required for this purpose, are obtained from the forestland. Each areca plantation owner is permitted by the government to use forests (in the ratio 1:9) for collection of leaves. Farmers lop trees in one-third of the allocated forest area and use green leaves for mulching, while twigs and branches are used for energy production. This method of collection results in canopy opening and degradation of forest patches. This necessitates the exploration of viable energy alternatives to conserve forests while meeting the growing energy demand.

Cooking and water heating are the major domestic end-uses of wood energy. Space heating during winter is met either along with water heating or in paddy fields while

**Table 5: Fuelwood consumption among landholding category for cooking and water heating**

| Type of activity | Season | kg/person/day |
|---|---|---|
| Cooking | All | 1.82 |
| Water heating | Summer | 1.41 |
| | Winter | 1.43 |
| | Monsoon | 1.56 |

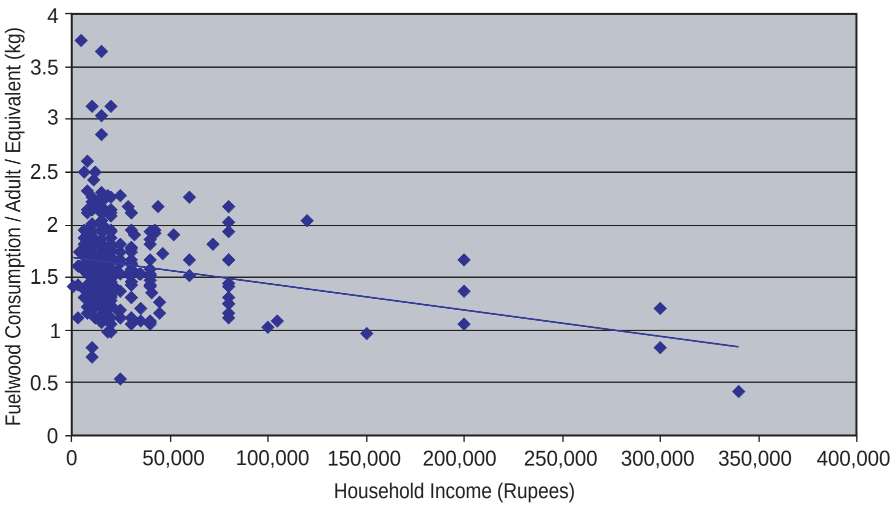



Figure 7: Variation in Fuelwood Consumption for cooking with respect to Household Income.

guarding the crops from wild animals. Quantification of fuelwood requirement specifically for this activity is difficult. The per capita fuelwood consumption for cooking and water heating among landholding category is given in Table 5. Seasonal variation can be clearly seen for water heating as the region experiences extremes in temperature throughout the year. There is no significant variation in cooking fuelwood consumption. Average annual fuelwood consumption by an individual including all activities amounts to 1.2 tonnes. This value is double the national average of 0.7 tonnes/capita/year (Ramchandra et al., 2000a; Sinha et al, 1997). A similar trend of fuelwood consumption was observed in the neighbouring Uttara Kannada district, which showed a yearly per capita fuelwood consumption of 1.44 tonnes (Ramachandra et al, 2000b).

Analyses of fuelwood requirement with respect to income show a linear declining trend as shown in Figure 7. The low-income groups depend on fuelwood as a source of cooking energy. Increase in income promotes the people to afford alternative energy sources like biogas, etc. This transition in the energy ladder has considerably reduced the dependence on fuelwood. The household survey shows that out of 43 biogas

**Table 6: Fuelwood consumption among landless category for cooking and water heating**

| Season | Cooking (kg/person/day) | Water heating (kg/person/day) |
|---|---|---|
| Summer | 1.62 | 1.29 |
| Winter | 1.88 | 1.33 |
| Monsoon | 1.90 | 1.52 |
| Average | 1.80 | 1.38 |

**Table 7: Details of the small-scale industries of the region**

| Industry type | Number of Industries | %Share of wood | Average employment |
|---|---|---|---|
| Agriculture based | 21 | 18.75 | 5.00 |
| Brick making | 5 | 4.46 | — |
| Food processing | 11 | 9.82 | 6.14 |
| Wood based | 72 | 64.29 | 2.78 |
| Miscellaneous | 3 | 2.68 | — |

owners in the sampled households, 33 households have an annual income of Rs. 30,000. Further, out of the 17 LPG owning households, 16 households have an annual income above Rs. 30,000. However, most of the households in this region belong to low-income category and cannot afford LPG, etc.; there is a scope for energy interventions in the form of improved energy-efficient fuelwood cook stoves or biogas with appropriate financial incentives, service back up, etc.

Due to the changes in socio-cultural practices, livelihood aspects and accessibility to resources, the energy consumption pattern in landless category shown in Table 6, seems to vary from that of landholding category. This category is solely dependent on fuelwood for cooking and water heating activities. Based on this, the annual consumption of fuelwood works out to be 1.16 tonnes/capita. Seasonal variation is seen in fuelwood consumption for cooking as well as water heating. During field survey, it was observed that all households depend on traditional devices for cooking, which are energy inefficient. Use of biogas, LPG and kerosene is absent for cooking.

To assess energy in industry sector, sample survey was conducted for 32 industries out of 112 industries, which depend on biomass. Totally about 112 natural resource based industries were surveyed for analysing the composition and employment abilities of the small-scale industries of the region and results are given in Table 7. These industries being situated in the sub-urban areas of the region, serve as the source of employment to many local people. Wood based industries such as carpentry, manufacture of cane products, etc., constitute 64.29% of the total due to the cheap and easily available wood in the region. This is followed by agriculture-based industries like rice and flourmills with 18.75%.

Sub-basin wise bioenergy status was computed to evolve specific management strategies based on the local conditions, which is given in Table 8. This shows that the

**Table 8: Sub-basin wise annual fuelwood availability and demand**

| Sub-basin | Availability (tonne/year) | Demand (tonne/year) | % Utilization |
|---|---|---|---|
| Central zone | 213484.86 | 65175.6 | 30.53 |
| Yenneholé | 112386.10 | 8136.0 | 7.24 |
| Hurliholé | 50281.10 | 9001.2 | 17.90 |
| Nagodiholé | 36978.70 | 3786.0 | 10.24 |
| Hilkunjiholé | 13788.70 | 7440.0 | 53.96 |
| Sharavathi | 33564.50 | 13496.0 | 40.21 |
| Mavinaholé | 34886.90 | 12189.6 | 34.94 |
| Haridravathiholé | 77481.70 | 37645.2 | 48.59 |
| Nandiholé | 48416.00 | 17923.2 | 37.02 |

**Table 9: Biomass availability from areca residues**

| Sub-basin | Areca (ha) | Production (tonnes) | Leaves (tonnes) | Inflorescence (tonnes) | Nuts and Husk (tonnes) | Leaf sheath (tonnes) |
|---|---|---|---|---|---|---|
| Mavinaholé | 146.48 | 183.10 | 1799.47 | 1384.21 | 545.77 | 593.23 |
| Haridravathiholé | 282.98 | 353.72 | 3476.38 | 2674.13 | 1054.37 | 1146.06 |
| Hilkunjiholé | 64.23 | 80.28 | 789.02 | 606.94 | 239.31 | 260.11 |
| Hurliholé | 260.24 | 325.30 | 3197.05 | 2459.27 | 969.65 | 1053.97 |
| Nagodiholé | 142.66 | 178.32 | 1752.55 | 1348.11 | 531.54 | 577.76 |
| Nandiholé | 341.81 | 427.26 | 4199.13 | 3230.10 | 1273.58 | 1384.32 |
| Sharavathi | 220.97 | 276.21 | 2714.66 | 2088.20 | 823.34 | 894.94 |
| Yenneholé | 180.39 | 225.49 | 2216.08 | 1704.68 | 672.13 | 730.58 |
| Central zone | 1160.50 | 1450.61 | 14256.59 | 10966.61 | 4323.98 | 4699.97 |
| Total | 2800.20 | 3500.30 | 34400.92 | 26462.25 | 10433.69 | 11340.96 |

eastern and southern sub-basins have percentage utilisation greater than 30. The sub-basin wise area and bioresidues available for areca (*Areca catechu*) and coconut (*Cocos nucifera*) are given in Tables 9 and 10 respectively. These residues (and bagasse during seasons) are most commonly used as a source of fuel for water heating. Bagasse is the fibrous residue left after extracting the juice from sugarcane (*Saccharum officinarum*). The quantity of bagasse depends on the fibrous content of the sugarcane and is in the range of 30–32%, which is a rich energy source. The area under sugarcane in the river basin is 281.82 ha with a production of 17,094 tonnes. The bagasse available is about 5470.08 tonnes, which has an energy equivalent of 19145.28 million kcal/year. One tonne of bagasse can generate 2.5 tonne of steam in steam generators. Bagasse is used as a fuel in improved jaggery making stoves in Baniga village of Hosanagara Taluk. With this, the plant has attained self-sufficiency in terms of fuel requirement. This technology has not reached all places in the river basin, which is evident from the survey that most households still use, huge wooden logs in traditional stoves (with efficiency of 5–8%).

**Table 10: Biomass availability from coconut residues**

| Sub-basin | Coconut (ha) | Nuts (tonnes) | Leaves (tonnes) | Inflorescence (tonnes) | Husk (tonnes) | Nut/shells (tonnes) | Leaf sheath (tonnes) |
|---|---|---|---|---|---|---|---|
| Nagodiholé | 9.05 | 10858 | 53.26 | 9.86 | 16.29 | 42.80 | 5.61 |
| Haridravathiholé | 127.87 | 153439 | 752.62 | 139.37 | 230.16 | 604.80 | 79.28 |
| Hilkunjiholé | 13.51 | 16210 | 79.51 | 14.72 | 24.31 | 63.89 | 8.37 |
| Central zone | 211.20 | 253447 | 1243.10 | 230.21 | 380.17 | 999.00 | 130.94 |
| Mavinaholé | 21.43 | 25713 | 126.12 | 23.36 | 38.57 | 101.35 | 13.28 |
| Nandiholé | 62.43 | 74920 | 367.48 | 68.05 | 112.38 | 295.31 | 38.71 |
| Sharavathi | 64.19 | 77028 | 377.82 | 69.97 | 115.54 | 303.61 | 39.80 |
| Yenneholé | 11.33 | 13597 | 66.69 | 12.35 | 20.39 | 53.59 | 7.03 |
| Total | 521.01 | 625213 | 3066.67 | 567.90 | 937.81 | 2464.38 | 323.03 |

**Table 11: Sub-basin wise livestock population and dung yield**

| | | Dungyield | | | Dung yield | |
|---|---|---|---|---|---|---|
| Sub-basin | Buffalo population | High (kg/day) | Low (kg/day | Cattle population | High (kg/day) | Low (kg/day) |
| Nagodiholé | 1008 | 15120.0 | 12096 | 3106 | 23295.0 | 9318 |
| Central zone | 12510 | 187650.0 | 150120 | 29218 | 219135.0 | 87654 |
| Nandiholé | 818 | 12270.0 | 9816 | 1761 | 13207.5 | 5283 |
| Haridravathiholé | 6011 | 90165.0 | 72132 | 20471 | 153532.5 | 61413 |
| Yenneholé | 1850 | 27750.0 | 22200 | 7913 | 59347.5 | 23739 |
| Hurliholé | 2285 | 34275.0 | 27420 | 3350 | 25125.0 | 10050 |
| Sharavathi | 2168 | 32520.0 | 26016 | 6303 | 47272.5 | 18909 |
| Hilkunjiholé | 2416 | 36240.0 | 28992 | 3708 | 27810.0 | 11124 |
| Mavinaholé | 67533 | 640702.5 | 363645 | 6490 | 48675.0 | 19470 |

Agricultural households own 5–6 animals (considerably high number) for manure, tilling and transportation purposes. Free fodder availability due to vast grazing areas in the region has contributed to higher number of livestock per household. Table 11 show sub-basin wise livestock population and dung yield, while Table 12 gives the biogas availability with potential for cooking energy. The dung yield by livestock depends on various factors and differs from place to place. Usually the effective dung available from stall-fed animals is more than that of grazing animals. Similarly, dung available during monsoon and winter is more due to the availability of sufficient green fodder compared to summer. It is estimated from the survey that, the average dung yield by various livestock is 7.82 kg/cattle/day, 12.64 kg/buffalo/day, 10.3 kg/bullock/day, 1.95 kg/sheep/day and 1.95 kg/goat/day. Table 13 shows the extent of stall-feeding and open grazing by different livestock. Grazing in forests reduces the effective dung available and also harms forest regeneration.

**Table 12: Sub-basin wise biogas availability with potential for cooking energy**

| Sub-basin | Human population | With maximum efficiency Biogas ($m^3$/day) | Usage | % Potential | With minimum efficiency Biogas ($m^3$/day) | Usage | % Potential |
|---|---|---|---|---|---|---|---|
| Nagodiholé | 3155 | 1613.43 | 548.56 | 17.38 | 770.90 | 262.11 | 8.30 |
| Central zone | 54313 | 17084.97 | 5808.88 | 10.69 | 8559.86 | 2910.35 | 5.35 |
| Nandiholé | 14542 | 3758.89 | 1278.02 | 8.78 | 1835.67 | 624.13 | 4.29 |
| Haridravathiholé | 31371 | 10235.29 | 3480.00 | 11.09 | 4807.62 | 1634.59 | 5.21 |
| Yenneholé | 6780 | 3658.09 | 1243.75 | 18.34 | 1653.80 | 562.29 | 8.29 |
| Hurliholé | 7501 | 2494.80 | 848.23 | 11.30 | 1348.92 | 458.63 | 6.11 |
| Sharavathi | 11247 | 3351.28 | 1139.43 | 10.13 | 1617.30 | 549.88 | 4.88 |
| Hilkunjiholé | 6200 | 2690.10 | 914.63 | 14.75 | 1444.17 | 491.01 | 7.91 |
| Mavinaholé | 10158 | 3409.87 | 1159.35 | 11.41 | 1675.83 | 569.78 | 5.61 |
| Total | 145267 | 48296.74 | 16420.89 | 11.30 | 23714.09 | 8062.79 | 5.55 |

**Table 13: Extent of stall feeding and open grazing by different livestock**

| Type of livestock | % Householdswith livestock | % Households with open grazing livestock | % Households with stall feeding livestock |
|---|---|---|---|
| Buffalo | 74.94 | 66.9 | 33.13 |
| Bullock | 34.90 | 9.0 | 91.00 |
| Cattle | 73.10 | 95.1 | 4.89 |

Table 14 illustrates the role of family income in energy transition as biogas plants are found more in high-income households. However, there are several non-operational biogas plants due to technical snags. This necessitates proper training and awareness among the villagers as well as local service units with trained technicians to handle energy efficient devices. Among the 91 surveyed landless, low-income category households, none of them had biogas plants mainly due to high installation cost, space limitation and lack of service support in post installation period.

Table 15 shows the relative share of various fuel types in the river basin. In all the sub-basins, nearly 90% of energy potential is of forest resources. This also accounts for energy used in the commercial sectors such as hotels, and fuelwood used during festivals, etc., which is about 30% of the total energy consumption. To understand the sub-basin wise bioenergy status, percentage share of energy demand to the availability is computed and is listed in Table 16. This reveals that Hilkunjiholé (61.8%) and Haridravathiholé (57.2%) sub-basins need immediate intervention to prevent further degradation of natural resources. Central zone, Nandiholé, Sharavathi and Mavinaholé sub-basins are having moderate availability of resources.

**Table 14: Income-wise biogas distribution in the river basin**

| Income range (Rupees/year) | Number of households having biogas plants among sampled households | Category-wise percentage of biogas plant holders |
|---|---|---|
| 00000–15000 | 1 | 0.58 |
| 15000–25000 | 7 | 5.22 |
| 25000–50000 | 10 | 13.33 |
| 50000–100000 | 6 | 28.57 |
| >100000 | 19 | 76.00 |

**Table 15: Percentage share of energy from various sources**

| Sub-basin | % Share of Forest resource | % Share of Biogas | % Share of Coconut | % Share of Areca |
|---|---|---|---|---|
| Nagodiholé | 93.73 | 1.31 | 0.19 | 4.76 |
| Central zone | 90.41 | 2.35 | 0.77 | 6.47 |
| Nandiholé | 89.99 | 0.65 | 0.99 | 8.37 |
| Haridravathiholé | 90.56 | 3.81 | 1.28 | 4.36 |
| Yenneholé | 96.88 | 0.99 | 0.08 | 2.05 |
| Hurliholé | 92.19 | 1.53 | 0.00 | 6.28 |
| Sharavathi | 88.10 | 2.82 | 1.40 | 7.64 |
| Hilkunjiholé | 88.13 | 5.72 | 0.74 | 5.41 |
| Mavinaholé | 91.57 | 2.89 | 0.48 | 5.06 |
| Total | 91.72 | 2.18 | 0.66 | 5.44 |

### 2.3. Role of JFPM in Energy Development

The participatory approach in forest management with 23VFCs was initiated in the study area in 1996. The data of 10VFCs illustrates that about 286 ha of land was brought under plantations, within which, 215 ha was of Non-Timber Forest Produce (NTFP) type and remaining 71 ha was of Acacia plantation to cater the fuelwood requirement.

The data collected on the plantation activities in sampledVFCs show that the scheme formulated from ecological and energy point of view has lost its significance due to the improper selection of species and plantation area. The vital objective of the JFPM scheme to fulfil the daily fuel, fodder and food requirement of the local population is deprived due to monoculture plantations. Apart from this, VFCs failure in protecting the degraded land and forest patches is leading to considerable decrease in regeneration.

Land use analysis (Table 17) shows that Haridravathiholé has about 34.7% barren area. Similarly, in all the sub-basins, the percentage barren lands available ranges between 10 and 35%. Thus, there is greater scope for initiating energy plantations in

**Table 16: Sub-basin wise energy demand and availability**

| | Energy availability (million kcal) | | | | | Energy demand | |
|---|---|---|---|---|---|---|---|
| Sub-basin | Forest | Biogas | Coconut | Areca | Total | (million kcal) | % Usage |
| Nagodiholé | 166404.15 | 2323.65 | 348.28 | 8453.05 | 177529.13 | 22148.10 | 12.47 |
| Central zone | 960681.87 | 24992.17 | 8129.38 | 68763.75 | 1062567.17 | 381277.26 | 35.88 |
| Nandiholé | 217872.00 | 1572.55 | 2403.09 | 20253.66 | 242101.30 | 104850.70 | 43.31 |
| Haridravathiholé | 348667.65 | 14660.07 | 4921.61 | 16767.59 | 385016.92 | 220224.42 | 57.20 |
| Yenneholé | 505737.45 | 5176.71 | 436.13 | 10688.80 | 522039.09 | 47595.60 | 9.12 |
| Hurliholé | 226264.95 | 3745.89 | ——— | 15420.31 | 245431.15 | 52657.02 | 21.45 |
| Sharavathi | 151040.25 | 4842.13 | 2470.70 | 13093.58 | 171446.66 | 78951.60 | 46.05 |
| Hilkunjiholé | 62049.15 | 4029.05 | 519.93 | 3805.68 | 70403.81 | 43524.00 | 61.82 |
| Mavinaholé | 156991.05 | 4956.28 | 824.76 | 8679.39 | 171451.48 | 71309.16 | 41.59 |
| Total | 2795708.52 | 66298.50 | 20053.88 | 165925.81 | 3047986.71 | 1022537.90 | 33.55 |

**Table 17: Details of barren area in the river basin**

| Sub-basin | Total area (sq. km) | Barren area (sq. km) | % Barren area |
|---|---|---|---|
| Haridravathiholé | 278.9 | 96.78 | 34.70 |
| Hilkunjiholé | 85.1 | 10.10 | 11.86 |
| Hurliholé | 97.8 | 19.80 | 20.22 |
| Mavinaholé | 95.1 | 21.27 | 22.37 |
| Nagodiholé | 65.1 | 8.31 | 12.74 |
| Nandiholé | 143.6 | 42.34 | 29.48 |
| Sharavathi | 119.4 | 20.61 | 17.26 |
| Yenneholé | 189.0 | 37.47 | 19.82 |
| Central zone | 540.5 | 131.95 | 24.41 |

the eastern clusters where there is urgent requirement for energy planning. The selection of the species considering the local needs in terms of fuel, food and fodder, through active public participation will ensure the success of the programme.

### 2.4. Integrated Energy Planning

Analysis at the sub-basin level illustrated that the energy situation varies within various sub-basins and correspondingly the management strategies need to be designed. Decentralized approach can be considered for planning the energy interventions. By introducing the improved fuelwood cook stoves, fuelwood consumption can be reduced considerably. Because, the most commonly used traditional cook stoves have very less efficiency of 10%. Fuel efficiency studies (Ramchandra et al, 2000) conducted in 82 households showed that for cooking, there is a fuel saving of 42% in improved stoves compared to traditional stoves, whereas, for water heating, the fuel saving is 19–24% with improved stoves. Use of improved stoves for cooking activity and water heating can save annually about 38,600 tonnes and 16,507 tonnes of fuel wood respectively.

Along with this, restriction on open grazing in the forestlands and promotion of stall-feeding allows regeneration and increases the effective dung availability. Thus, appropriate livestock rearing with the introduction of improved varieties along with natives would enhance the dung yield for biogas as well as manure. According to the data, about 88% of the total households have the potential to install biogas plants. At least 60% utilization of this resource can lead to fuelwood saving of 8839.8 tonnes annually. The estimation shows that about 119 villages have the potential to supplement the cooking energy for more than 60% of the total population.

Monsoon paddy cultivation is practiced in the study area. After the crop is harvested, the fields are kept unused until the next season. In this regard, farmers need to be properly guided to suitably select the cropping system depending on water availability such as cultivating horse gram in areas where moisture content is less. Fodder cultivation can supplement fodder requirement for the livestock, which can be stall-fed considerably, there by increasing the dung yield.

The Gram Panchayath (at village level), Revenue and Forest Departments should take active participation in energy planning and development. With proper training to the village people as well as departmental staffs, it is possible to manage their own ecosystem with effective scientific guidance. JFPMoffers an opportunity to increase the forest wealth of the region. If sufficient protection is provided, the forests in the study area, though under extensive population pressure, can retain self-regenerating capacity due to highly favourable environmental conditions. If this protection is extended to other degraded areas of the river basin with complete protection from destructive wood collection, grazing by animals, etc., there is tremendous scope for re-establishing the healthy forests in most of the study area.

## 3. CONCLUSIONS

Based on the survey, it was found that the per capita fuelwood consumption for cooking and water heating, which are the major end-uses of the energy consumption, is 1.2 tonnes/year. As per the data, some of the eastern and southern sub-basins are facing scarcity of resources and there is a large scope for energy plantations in the degraded forestlands. Viable alternatives like biogas will help in meeting the energy demand efficiently for the river basin. The analysis shows that about 88% of the total households have the potential to install biogas plants. At least 60% utilization of this resource can lead to fuelwood saving of 8840 tonnes annually. The estimation shows that in 119 villages, biogas has the potential to supplement the cooking energy of more than 60% of the total population.

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# A New Frog Species from the Central Western Ghats of India, and Its Phylogenetic Position

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**Tropical evergreen forests of Indian subcontinent, especially of the Western Ghats, are known hot spots of amphibian diversity, where many new anuran species await to be identified. Here we describe from the Sharavathi River basin of central Western Ghats a new shrub-frog taxon related to the anuran family Rhacophoridae. The new frog possesses the characteristic features of rhacophorids (dilated digit tips with differentiated pads circumscribed by a complete groove, intercalary cartilages on digits, T-shaped terminal phalanges and granular belly, the adaptive characters for arboreal life forms), but also a suite of unique features that distinguish it from all known congeners in the region. Morphogenetic analysis based on morphological characteristics and diversity in the mitochondrial 12S and 16S rRNA genes revealed it to be a new *Philautus* species that we named *Philautus neelanethrus* sp. nov. The phylogenetic analysis suggests the new frog to represent a relatively early *Philautus* species lineage recorded from the region. The distribution pattern of the species suggests its importance as a bioindicator of habitat health. In general, this relatively widespread species was found distributed only in non-overlapping small stretches, which indirectly indicates the fragmentation of the evergreen to moist deciduous forests that characterize the Western Ghats. Thus the discovery of the new rhacophorid species described here not only further reinforces the significance of the Western Ghats as a major hotspot of amphibian biodiversity, but also brings into focus the deterioration of forest habitats in the region and the need for prioritization of their conservation.**

**Key words:** amphibian biodiversity, conservation, shrub frog, Western Ghats, habitat, rDNA diversity

## INTRODUCTION

The Western Ghats, a chain of hills of varied width and height running parallel to the western coast of India, is a hotspot of biological diversity (Myers *et al.,* 2000). This region harbors a high proportion of endemic species, especially in lower-vertebrate group such as amphibians, reptiles and fishes (Daniels, 2001; Dahanukar *et al.,* 2004); this endemism has been attributed to the prevailing geographical, climatic and phenological conditions providing the necessary humid environment and habitat (Roelants *et al.,* 2004). Amphibians form an important faunal group of this region, but are incompletely documented (Bossuyt, 2002); some represent disjunct populations that necessitate the integrated morphological and molecular analyses to resolve their phylogeography (Karanth, 2003).

It is quite evident that the Western Ghats, as a part of the Old World region, represent a Cenozoic refugium for old lineages and a unique reservoir of ancient endemic anurans (Duellman, 1999; Roelants *et al.,* 2004). In recent years, there has been increasing interest worldwide in understanding the biogeography and evolutionary lineages of amphibians of the Western Ghats, especially in relation to their links with Madagascar's fauna and to patterns of amphibian dispersal in the Indian Ocean region (Vences *et al*., 2003). With the discovery of a new primitive frog, it was established that India had an ancient biogeographical link with the Seychelles, and that amphibian endemism in the region dates back to 150–195 Mya (Biju and Bossuyt, 2003; Dutta *et al.,* 2004). Several lineages may have originated on the Indian subcontinent during the trans-Tethys drift (Bossuyt and Milinkovitch, 2001).

Approximately 500 species of ranids have been recorded in the Oriental realm. To date about 135 species have been recorded from the Western Ghats (Gururaja,

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2004), of which over 100 (nearly 75%) are endemic to the region. The order Anura is represented by 109 species, including members of the Rhacophoridae. Species of the genus *Philautus* in the family Rhacophoridae form a unique group because they undergo direct development, wherein the tadpole stage is avoided (Marmayou *et al.,* 2000). Since the recent revision of the genus *Philautus* (Bossuyt and Dubois, 2001), several new *Philautus* species have been described from the Western Ghats (Kuramoto and Joshy, 2003; Bossuyt, 2002; Biju and Bossuyt, 2005a, b), which strongly reinforces that this region is a center of amphibian diversity, where many more new species await description (Aravind *et al.,* 2004; Gower *et al.,* 2004). However, this pristine biogeographic reservoir of evolutionary history in the Western Ghats is now threatened by heavy human demographic pressure and interference (Aggarwal, 2004; Dutta *et al.,* 2004), warranting urgent protective measures and a preemptive conservation strategy. We here describe a new species of *Philautus* and analyze its phylogenetic relationships. Our results further highlight the significance of the Western Ghats as hotspot of amphibian diversity and the need for prioritization of its conservation.

## MATERIALS AND METHODS

### Study area

The Sharavathi River basin is situated in the central part of the Western Ghats (Fig. 1). The Sharavathi River originates at Ambuthirtha and flows towards west for about 132 km before joining the Arabian Sea at Honnavar. The type specimens of the new frog species described in this study were collected during stratified systematic sampling (Heyer *et al.,* 1994) with time-constrained and search-all methods (Vasudevan *et al.,* 2001). The type locality is Arodi, Sagar Taluk, Shimoga District, Karnataka state (14°08'25"N, 74°47'44"E), 534 m asl (meters above sea level), a moist deciduous forest patch. The region has an undulating terrain, with forests of evergreen and moist-deciduous types. Relatively flat areas within this terrain form a freshwater habitat known as *Myristica* swamps, dominated by members of plant family Myristicaceae. Localities across the study area where the new species was found are listed in Table 1.

### Sampling

The new frog species was recorded in the study area (Fig. 1) over a period of 4 years since 2001. Although more than 150 specimens were enumerated during multiple field explorations, only nine individuals of the new species (including holotype and paratypes)

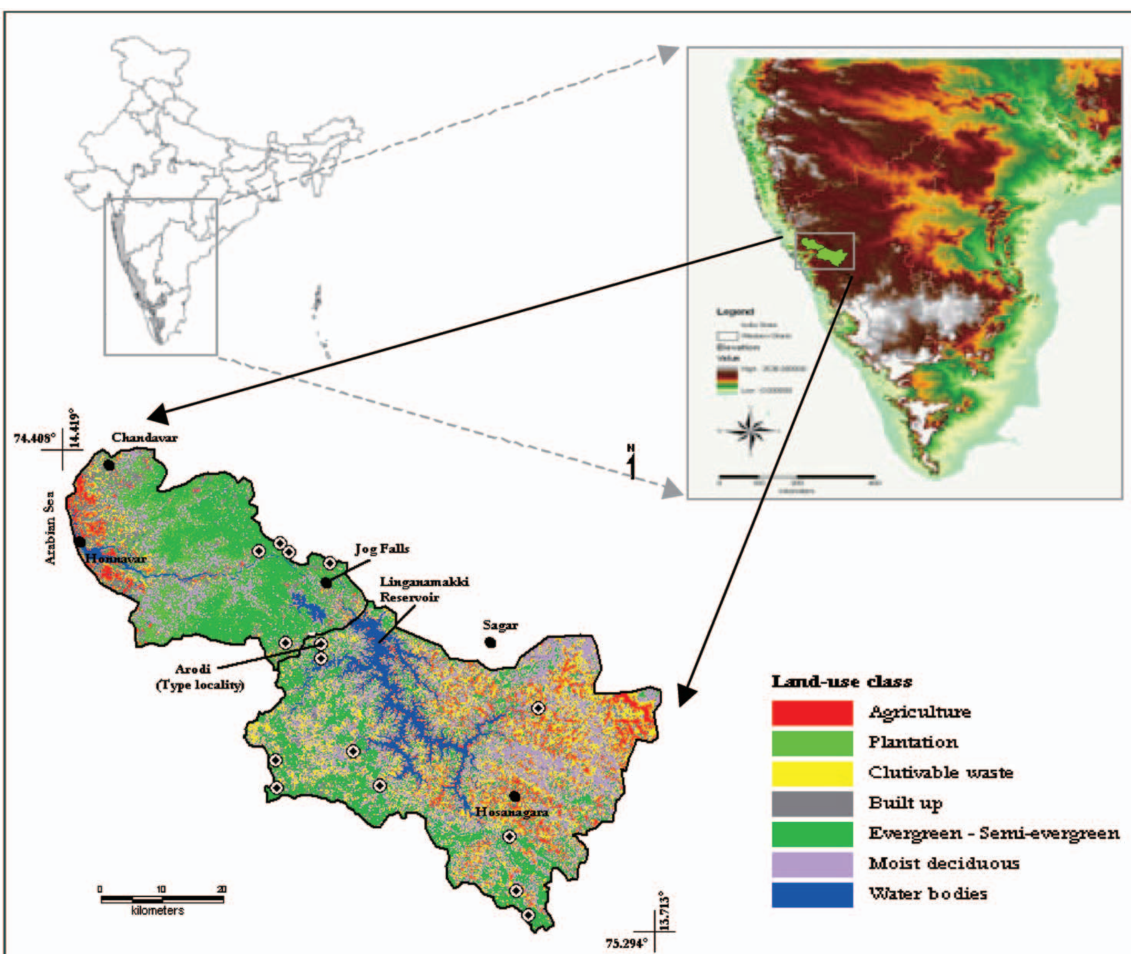


**Fig. 1.** Sharavathi River basin and the type localities of the new *Philautus* species.

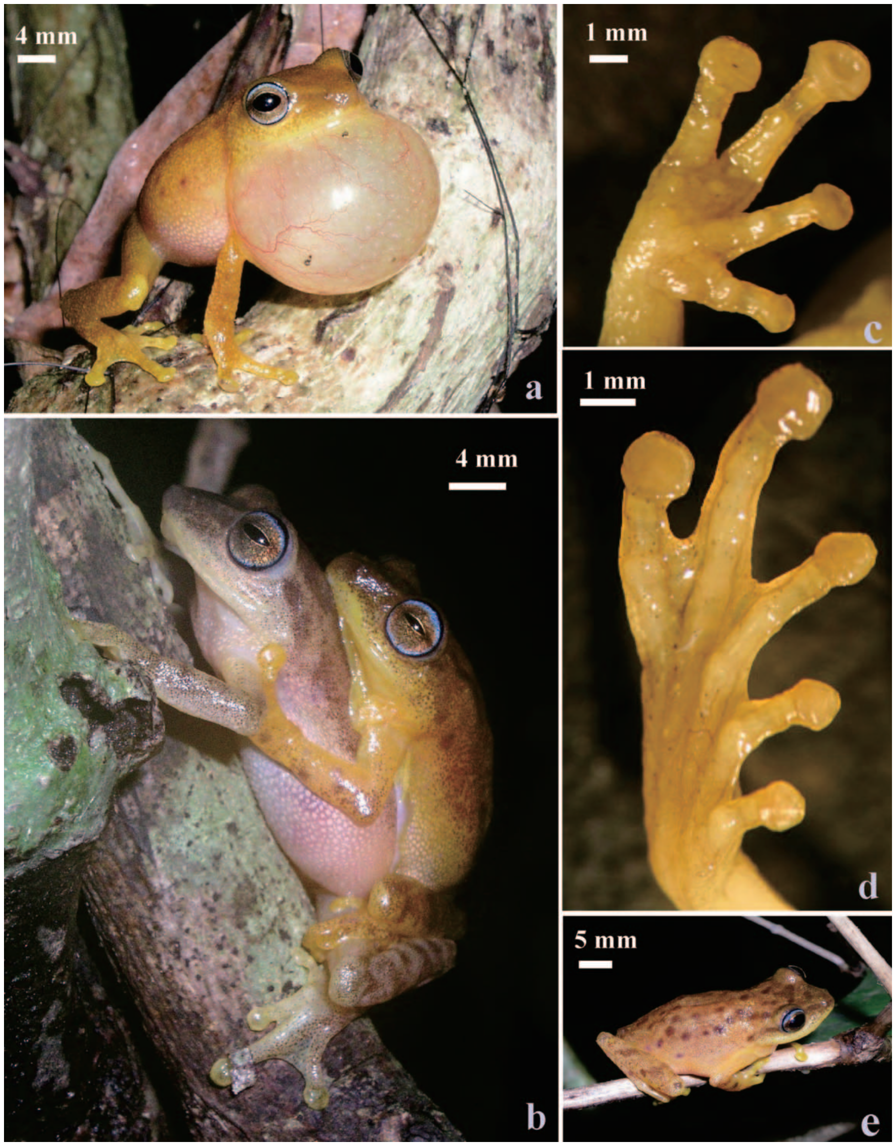


**Fig. 2.** Characteristic features of *P. neelanethrus* sp.nov. **(a)** Male while calling (SVL 29.8 mm, collected from the Nandiholé locality); **(b)** amplected pair (specimens not collected); **(c)** ventral view of forelimb; **(d)** ventral view of hindlimb; **(e)** dorsolateral view of an adult male.

**Table 1.** Localities across the central Western Ghats, India, where *Philautus neelanethrus* sp. nov. was recorded.

| Area | Altitude (m asl) | Habitat |
|---|---|---|
| Kathalekan | 619 | *Myristica* swamp |
| Niluvase | 692 | Evergreen |
| Malemane1 | 603 | Evergreen |
| Malemane2 | 615 | Evergreen |
| Hilkunjiholé | 599 | Evergreen |
| Karni | 598 | Evergreen |
| Mavingundi | 583 | Evergreen |
| Nagodiholé | 580 | Evergreen |
| Dabbefall | 566 | Evergreen |
| Yenneholé | 563 | Evergreen |
| Hurliholé | 598 | Moist deciduous |
| Sharavathi | 586 | Moist deciduous |
| Muppane | 571 | Moist deciduous |
| Nandiholé | 557 | Moist deciduous |
| Arodi | 534 | Moist deciduous |

were collected, on different dates by KVG, NAA and SA. The specimens were used for detailed morphometric description, as well as for molecular analysis to resolve its taxonomic status. Adult specimens of the new frog species were deposited in the Bombay Natural History Museum (BNHS), Mumbai (Holotype, BNHS-4510; Paratype, BNHS-4511) and in the museum of the Zoological Survey of India (ZSI), Kolkata, India (Paratype ZSI-A9866). Specimens were collected from the type locality, photographed, euthanized, and preserved in salt saturated 20% DMSO (dimethyl sulfoxide) solution and/or 80% ethanol. The preserved specimens were used for morphometric studies, and soft tissues taken from the same specimens were used to extract genomic DNA for molecular analysis.

### Type specimens

Holotype (BNHS-4510): adult male, SVL 29.9 mm, collected at Arodi in the Sharavathi River basin on 7 July 2005 by KVG. Paratypes, two adult males: SVL 23.4 mm (ZSI-A9866) collected at Niluvase (13°44’18”N, 75°06’30”E; 692 m asl) on 6 November 2003 by KVG; SVL 28.7 mm (BNHS-4511) collected at Arodi (14°08’25”N,

**Table 2.** Morphometric measurements of *Philautus neelanethrus* sp. nov. (values are in millimeters, n=9, all males).

| Parameter* | Mean±SD (n=9) | Range | Holotype (BNHS–4510) | Paratype (BNHS–4511) |
|---|---|---|---|---|
| SVL** | 25.41±3.403 | 21.4–29.9 | 29.9 | 28.7 |
| EL** | 3.90±0.301 | 3.5– 4.4 | 4.1 | 4.1 |
| EN** | 2.66±0.205 | 2.5– 3.1 | 2.8 | 2.5 |
| HL** | 8.00±0.948 | 6.8– 9.1 | 9.0 | 9.1 |
| HW** | 9.54±1.334 | 7.8–10.8 | 10.8 | 10.7 |
| IBE | 8.81±1.108 | 7.6–10.2 | 10.0 | 10.2 |
| IFE | 4.94±0.777 | 4.0– 6.1 | 6.1 | 6.0 |
| IN** | 2.29±0.393 | 1.6– 2.7 | 2.4 | 2.7 |
| IUE** | 3.43±0.285 | 2.9– 3.8 | 3.8 | 3.6 |
| MBE | 1.78±0.285 | 1.3– 2.2 | 2.1 | 1.7 |
| MFE | 4.78±0.591 | 4.2– 5.7 | 5.7 | 5.5 |
| MN | 6.88±1.003 | 5.0– 8.2 | 8.2 | 8.0 |
| NS** | 1.30±0.247 | 1.0– 1.7 | 1.4 | 1.5 |
| SL | 3.66±0.403 | 3.1– 4.2 | 4.1 | 3.7 |
| TYD** | No value | – | Absent | Absent |
| TYE | No value | – | Absent | Absent |
| UEW** | 1.83±0.389 | 1.2– 2.8 | 2.2 | 2.4 |
| $fd_3$ | 1.78±0.140 | 1.6– 1.9 | 1.8 | 1.9 |
| FLL | 6.35±0.833 | 4.8– 7.2 | 7.1 | 6.8 |
| $fw_3$ | 0.77±0.163 | 0.7– 1.0 | 0.7 | 1.0 |
| HAL** | 7.91±0.442 | 7.4– 8.2 | 8.2 | 8.2 |
| TFL** | 5.65±0.980 | 4.6– 7.4 | 4.7 | 4.9 |
| FFTF | 4.97±0.203 | 4.8– 5.2 | 5.2 | 4.8 |
| FL** | 12.93±1.509 | 11.0–15.1 | 15.1 | 14.4 |
| FOL** | 9.80±1.581 | 7.7–12.0 | 12.0 | 11.4 |
| FTL** | 7.45±0.627 | 6.6– 8.1 | 7.0 | 6.7 |
| IMT** | 1.01±0.089 | 0.9– 1.1 | 0.9 | 1.1 |
| ITL** | 2.34±0.364 | 2.0– 3.1 | 2.0 | 2.3 |
| MTFF | 6.46±0.476 | 5.9– 6.7 | 6.7 | 6.7 |
| MTTF | 6.03±0.421 | 5.6– 6.4 | 6.4 | 6.1 |
| $td_4$ | 1.61±0.110 | 1.5– 1.7 | 1.7 | 1.6 |
| TFOL** | 16.74±2.420 | 13.5–19.8 | 19.8 | 19.6 |
| TFTF | 5.14±0.104 | 5.1– 5.3 | 5.3 | 5.1 |
| TL** | 12.87±1.491 | 10.6–15.3 | 14.3 | 13.5 |
| TW | 2.24±0.566 | 1.4– 3.1 | 3.1 | 3.1 |
| $tw_4$ | 0.92±0.185 | 0.7– 1.0 | 1.0 | 1.0 |

* See Supplemental Table 1 for explanation of abbreviations for various parameters.

** Parameters used for morphometric comparisons with congeners; for morphometric and meristic data on congeners, see Supplemental Tables 2 and 4.

74°47'44"E; 534 m asl) on 7 July 2005 by KVG.

**Morphometric analysis**

Nine individuals of new species were used for morphometric measurements. Thirty-five morphometric measurements were taken to the nearest 0.1 mm with digital slide calipers (Mitutoyo Corporation, Japan, CD-6BS) for each of the specimens (Table 2). Terminology (Supplemental Table 1) used in the description is based on Bossuyt and Dubois (2001).

A cluster analysis based on unweighted pair-group averages (UPGA) was used to understand the relationship of the new species to other, known congeners (Supplemental Tables 2, 3), and included data on 19 morphometric and three meristic characters (Table 2, Supplemental Table 4). The analysis was carried out using the software package STATISTICA (StatSoft Inc.).

**Advertisement call analysis**

Advertisement calls of the new species were recorded with a digital voice recorder (W-10, Olympus, Japan). A total of 16 calls from seven individuals were recorded at five different localities in the study area. Spectral features of the advertisement calls were analyzed using Sigview (version 1.91) acoustical software (SignalLab, Goran Obradovic).

Call-pattern characteristics of *P. neelanethrus* sp. nov. (n=16) were also compared with those of one of its closest congeners, *P. luteolus*, using Bartlett's test for homogeneity and significance of variances (Snedecor and Cochran, 1989). The data for *P. luteolus*, comprising six acoustic parameters based on 51 call samples, were taken from Kuramoto and Joshy (2001), where *P. luteolus* was referred to as *P.* cf. *travancoricus*. Parameters considered were total call duration, call duration in the fast and slow phases, number of pulses in the fast and slow phases, and frequency range.

**DNA extraction and rDNA sequencing**

Ribosomal typing was carried out to establish the species status of the new frog taxon. Total genomic DNA was extracted from muscle tissues, taken from preserved specimens collected from different localities, by the proteinase K, phenol-chloroform-isoamyl alcohol method (Shanker *et al.,* 2004). The DNA samples were used to determine molecular diversity across the 12S and 16S mitochondrial rRNA genes, in order to ascertain the species uniqueness and phylogenetic position of the new taxon. Parts of the 16S (~575 bp) and 12S rDNA (~435 bp) genes were amplified and sequenced as described by Dutta *et al.* (2004). Each sample was sequenced three times for both strands to confirm the sequence data. Sequences have been deposited in GenBank under accession numbers AY763797 (12S rDNA, 415 bp) and AY753560 (16S rDNA, 546 bp).

**Phylogenetic analysis**

The 12S and 16S rDNA sequences of the new frog taxon were used in similarity-based BLAST searches of the NCBI-GenBank database (National Center for Biotechnology Information, USA; http://www.ncbi.nlm.nih.gov) to identify related reference anuran species. Initially, corresponding sequences of >100 different reference anuran species were retrieved from the database. The final phylogenetic analysis included reference sequences for only 35 taxa, mainly of different *Philautus* species (Table 3), to ascertain the phylogenetic position of the new species, and also for possible molecular dating.

All sequences were aligned using the CLUSTAL-X program and then checked for large gaps. The aligned sequences were terminated flush at the ends to avoid missing data for any of the compared reference entries. Three aligned sequence sets, one each for 12S and 16S rDNA and one for combined 12S+16S, were used separately to derive corrected Kimura two-parameter distance estimates (Kimura, 1980) and to infer the phylogenetic position of the new taxon. Neighbor-joining trees were constructed with analytical routines available in the software packages PHYLIP 3.6 (http://evolution.genetics.washington.edu/phylip.html) and MEGA 2.1 (http://www.megasoftware.net). Character state-based maximum likelihood (ML) and maximum parsimony (MP) phylogenetic trees were also constructed using PhyloWin (http://pbil.univ-lyon1.fr/software/phylowin.html). In order to test for earliest branching patterns, all substitutions were considered, and separate analyses were conducted for assumed transition/transversion rate ratios (k) of 2 and 4. Support for nodes on the shortest tree and estimates of divergence time were derived using 1,000 bootstrap pseudoreplicates. The relative-rate test was performed to test the molecular clock hypothesis with MEGA 2 using Tajima's algorithm for clock hypotheses. In the final analysis, the phylogenetic trees were rooted using a representative species from each of the families, Dicroglossidae, Nyctibatrachidae, and Ranidae (Table 3).

**Table 3.** Details of the 12S and 16S rDNA sequences of the reference anuran taxa used in the final phylogenetic analysis (all sequences were retrieved from the NCBI-GenBank database).

| Family | Sub-family | Genus | Species | 16S rDNA | 12S rDNA | Distribution |
|---|---|---|---|---|---|---|
| ***New frog species sequenced in the present study*** | | | | | | |
| Rhacophoridae | Rhacophorinae | *Philautus* | *neelanethrus* sp. nov. | AY753560 | AY763797 | India |
| ***Ingroup Reference sequences*** | | | | | | |
| Rhacophoridae | Rhacophorinae | *Philautus* | *luteolus* | AB167932 | AB167904 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *wynaadensis* | AF249059 | AF141796 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *microtympanum* | AF249046 | AF249030 | Sri Lanka |
| Rhacophoridae | Rhacophorinae | *Philautus* | *femoralis* | AY141833 | AY141787 | Sri Lanka |
| Rhacophoridae | Rhacophorinae | *Philautus* | *signatus* | AY141841 | AY141795 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *charius* | AF249062 | AY141794 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *aurifasciatus* | AY141851 | AY141805 | Java |
| Rhacophoridae | Rhacophorinae | *Philautus* | *petersi* | AF026366 | AF026349 | Malaya |
| Rhacophoridae | Rhacophorinae | *Philautus* | Sp. TBGRI*A* | AY880510 | AY880596 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | Sp. TBGRI*B* | AY880506 | AY880592 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *griet* | AF536203 | AY706108 | India |
| Rhacophoridae | Rhacophorinae | *Philautus* | *schmarda* | AY880530 | AY880617 | Sri Lanka |
| Rhacophoridae | Rhacophorinae | *Philautus* | Sp. WHT3420 | AY880515 | AY880601 | Sri Lanka |
| Rhacophoridae | Rhacophorinae | *Philautus* | *ingeri* | AY880496 | AY880581 | Malaya |
| Rhacophoridae | Rhacophorinae | *Philautus* | Sp. Java | AY880509 | AY880595 | Java |
| Rhacophoridae | Rhacophorinae | *Philautus* | *mjobergi* | AF026365 | AF026348 | Malaya |
| Rhacophoridae | Rhacophorinae | *Philautus* | *acutirostris* | AY326059 | AY326059 | Philippines |
| Rhacophoridae | Rhacophorinae | *Rhacophorus* | *pardalis* | AF215363 | AF215189 | Malaya |
| Rhacophoridae | Rhacophorinae | *Rhacophorus* | *malabaricus* | AF249050 | AF249029 | India |
| Rhacophoridae | Rhacophorinae | *Rhacophorus* | *arboreus* | AF458142 | AF118476 | Japan |
| Rhacophoridae | Rhacophorinae | *Polypedates* | *maculatus* | AF215358 | AF215184 | India |
| Rhacophoridae | Rhacophorinae | *Polypedates* | *cruciger* | AF215357 | AY141799 | Sri Lanka. |
| Rhacophoridae | Rhacophorinae | *Polypedates* | *leucomystax* | AF215343 | AF161037 | India |
| Rhacophoridae | Rhacophorinae | *Aglyptodactylus* | *madagascariensis* | AF458119 | AF026341 | Madagascar |
| Rhacophoridae | Rhacophorinae | *Boophis* | *erythrodactylus* | AF215339 | AF026343 | Madagascar |
| Rhacophoridae | Rhacophorinae | *Chirixalus* | *eiffingeri* | AF026363 | AF026346 | China |
| Rhacophoridae | Rhacophorinae | *Chirixalus* | *idiootocus* | AY141852 | AY141806 | China |
| Rhacophoridae | Rhacophorinae | *Chirixalus* | *palpebralis* | AF458130 | AF458130 | China |
| Rhacophoridae | Rhacophorinae | *Chirixalus* | *vittatus* | AF458131 | AF161042 | Myanmar |
| Rhacophoridae | Rhacophorinae | *Theloderma* | *corticale* | AF268256 | AF268254 | Vietnam |
| Rhacophoridae | Rhacophorinae | *Mantella* | *betsileo* | AF215282 | AF215174 | Madagascar |
| Rhacophoridae | Rhacophorinae | *Mantidactylus* | *boulengeri* | AF215318 | AF215152 | Madagascar |
| ***Reference sequences used as outgroup in the final analysis*** | | | | | | |
| Ranidae | | *Rana* | *temporalis* | AF249054 | AF249022 | India |
| Dicroglossidae | | *Euphlyctis* | *cyanophlyctis* | AY014366 | AF249015 | India |
| Nyctibatrachidae | | *Nyctibatrachus* | *major* | AF249052 | AF249017 | India |

## RESULTS

### Taxonomy

*Philautus neelanethrus* sp. nov.

**Diagnosis.** A small sized frog, described as *Philautus* (Male: 23.2–29.9 mm SVL) based on small size, all digits with well-differentiated disks, predominantly inhabiting in shrubs, and presumably having direct development, is distinguished from all known congeners in the Western Ghats by the combination of absence of tympanum and supratympanic fold, both dorsal and ventral surfaces granular, unpigmented vocal sac (Fig. 2a, e), yellow to cream body coloration with minute brown dots and larger brown patches on the back, and a complete blue ring on the outer margins of the golden pupil.

**Etymology.** The species name *neelanethrus* is derived from Sanskrit meaning 'blue eye', and is a nominative singular noun standing in apposition to the generic name.

**Description of the holotype (Male, BNHS-4510).** A small-sized bush frog (SVL=29.9 mm), width of head broader than head length (HW=10.8 mm; HL=9.0 mm), flat dorsally, snout pointed in total profile, protruded slightly beyond mouth. Snout length is equal or subequal to diameter of eye (SL=4.1 mm; EL=4.1 mm). Canthus rostralis angular, loreal region slightly concave. Inter orbital distance (IUE=3.8 mm) flat and broader than upper eyelid (UEW=2.2 mm), wider than internarial distance (IN=2.4 mm). Internal distance between posterior margins of the eyes 1.64 times that of anterior margins (IFE=6.1 mm, IBE=10.0 mm). Nostrils oval, nearer tip of snout (NS=1.4 mm) than eye (EN=2.8 mm). Pineal ocellus absent. Vomerine ridge absent. Eyes protruding, prominent, pupil rounded, horizontal, with blue ring on the outer margin. Tympanum indistinct. Tongue bifid, without papilla, Supratympanic fold obscure/absent (intense brown dots indicate the fold), unpigmented single vocal sac present. In alcohol-preserved specimens, the blue ring on the eye turns dark blue in color.

Forearm (FLL=7.1 mm) less than hand (HAL=8.2 mm). Relative length of fingers I<II<IV<III. Finger tips with well-developed disks ($fd_1$=1.0 mm; $fd_2$=1.3 mm; $fd_3$=1.8 mm; $fd_4$=1.7 mm; $fw_1$=0.7 mm; $fw_2$=0.7 mm; $fw_3$=0.7 mm; $fw_4$=0.8 mm), with distinct circum-marginal grooves, fingers with dermal fringes on both edges. Webbing in hand absent, subarticular tubercles prominent, rounded and single, pre-pollex tubercle oval, distinct (Fig. 2c).

Hindlimbs long, heels do not overlap when folded at right angles to the body, tibia 4.6 times longer than wide (TL=14.3 mm, TW=3.1 mm). Tibia shorter than femur (FL=15.2 mm). Tibia longer than foot (FOL=12.0 mm). Heel to tip of fourth toe (TFOL=19.8 mm) 2.8 times length of fourth toe ($LT_4$=7.0 mm). Relative toe lengths I<II<III<V<IV. Toe disk width and toe width are: $td_1$=1.0 mm, $td_2$=1.0 mm, $td_3$=1.1 mm, $td_4$=1.7 mm, $td_5$=1.5 mm, $tw_1$=0.7 mm, $tw_2$=0.7 mm, $tw_3$=0.9 mm, $tw_4$=1.0 mm, $tw_5$=1.0 mm. Webbing distinct and medium (MTTF=6.4 mm, MTFF=6.7 mm, TFTF=5.3 mm, FFTF=5.2 mm). Tibiotarsal articulation reaches anterior border of eye. Inner metatarsal tubercle present (IMT=0.9 mm), nearly 2.6 times length of first toe (ITL=2.0 mm) (Fig. 2d).

Overall coloration of the male of *P. neelanethrus* sp. nov. (live specimen) yellowish (during breeding season) to creamish white (non-breeding season). Abdominal region turned pink during and after advertisement-call bouts. Dorsum with varied intensity of brown granulation. Skin on dorsal as well as on ventral surface granular. Granulation on ventral surface round and white, on dorsum brownish. Feeble cross bars present on forelimbs and hindlimbs. Circular brown patches (region with more brown granules) on head (4–5 in a line) and nearer to vent (1–2). In alcohol-preserved specimens, the overall yellow coloration turned to cream and the blue-colored ring around the eye turned to dark blue/black, but there were no changes in the brown pigmentation. The morphological measurements were based on nine specimens, with ranges, means, and standard deviations detailed in Table 2.

During one of the field surveys, an amplected pair was spotted wherein the female was larger than the male (Fig. 2b). The female was cream colored with brownish black granulation on the body. We observed this pair for more than 9 hours (from 21:30 to 6:30 h), during which time the amplected pair descended from a shrub and entered a leaf-litter heap, making their way into a cavity inside the wet foliar litter.

**Advertisement calls.** The mating call of *P. neelanethrus* sp. nov. starts with a shrill 'treeek' note followed by repeated 'tink' notes (treeek – tink-tink-tink-tink-……………….-tink). Variation was observed in the duration and pattern of calling, even though call notes and peak frequencies remained same. Calls were in the region of 2.35–2.41 kHz, and peak frequency was 2.35 kHz. The spectrogram of a call lasting for 6.6 sec, generated from a single call of a 29 mm *P. neelanethrus* sp. nov. male at 20:30 h on 18 June 2004, at 26.8°C (97% relative humidity), within 50 cm from the species and approximately 2 m above the ground, is shown in Fig. 3. Calling patterns analyzed using 16 calls (total duration of each call [mean±SD] 3.86±0.312 sec, range 1.93–

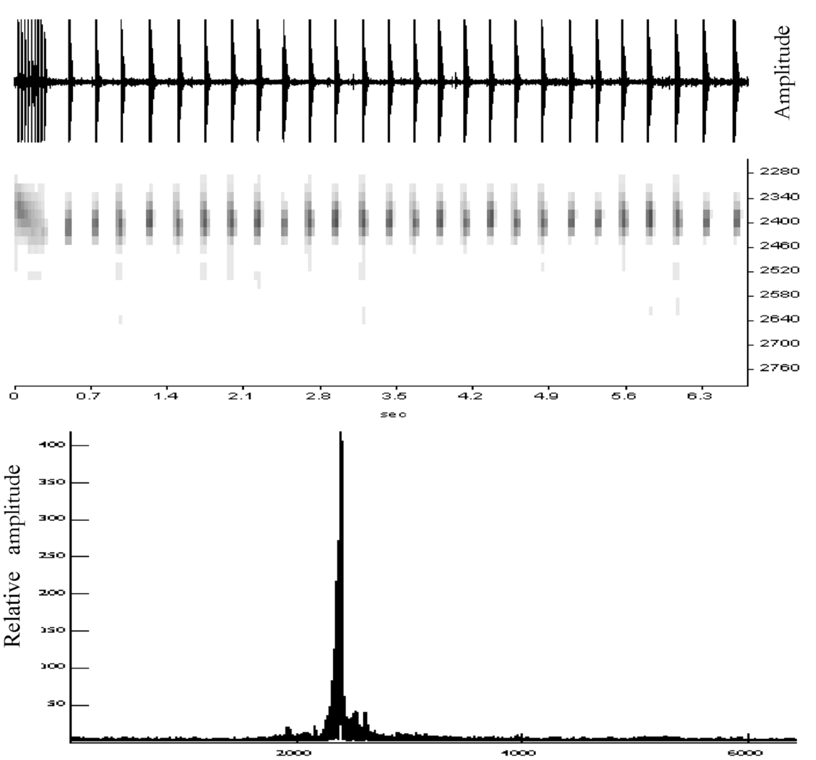


**Fig. 3.** Advertisement call spectrogram of *P. neelanethrus* sp.nov.

14.35 sec) revealed two types of calls, one with repeated short-duration calls (call duration 0.33±0.04 sec, range 0.27–0.42; number of pulses 10.88±1.654, range 9–15) and another with long-duration calls (call duration 3.34±3.029 sec, range 1.42–13.84; number of pulses 13.6±13.3, range 6–60). Two exceptionally long-duration calls examined (not included in the analysis) were 39.77 sec and 71.92 sec in duration, with 101–191 tinking notes.

The Bartlett test of homogeneity of variances revealed significant differences in many call characteristics of *P. neelanethrus* sp. nov. from *P. luteolus*, as evident from the $\chi^2$ values for peak frequency, total duration, slow-phase duration, and number of pulses.

**Comparison with congeners.** As many as 118 valid species names are recognized in *Philautus* (Manamendra-Arachchi and Pethiyagoda, 2005), and we examined the nomenclature of all of them. For morphometric comparisons, data from 14 congeners (Supplemental Table 2) among the 20 available names (Supplemental Table 3) endemic to the Western Ghats, and *P. longicrus* (a species described from Borneo and Philippines, but included in the Indian frog fauna by some workers; Rao, 1937), were included in an unweighted pair-group average cluster analysis. The data on 19 morphometric and three meristic characters for the 15 reference taxa used for the cluster analysis are shown in Supplemental Table 4. As systematic morphometric information was not available for six congeneric species (Supplemental Table 3), these were not included in the cluster analysis; nonetheless, their known morphological features such as pointed snout, supratympanic fold, tympanum, granulation on dorsum and belly, and dorsum coloration, were used for comparisons to distinguish *Philautus neelanethrus* sp. nov. from each of them. *Philautus* taxa from Sri Lanka were not used for comparisons, as advocated by Manamendra-Arachchi and Pethiyagoda (2005).

With relatively small size (21.4–29.9 mm), yellow to cream coloration on the body, lack of tympanum, indistinct supratympanic fold, granular dorsum and ventral region, blue-colored outer margins of the eye, and distinct calling pattern, the new species clearly differs from all congeners. *Philautus neelanethrus* sp. nov is distinct from *P. beddomi, P. bombayensis, P. chalazodes, P. femoralis,* and *P. travancoricus* in having a pointed snout. It is distinct from *P. temporalis* in the absence of a tympanum and a distinct supratympanic fold. Apart from these, the dorsal coloration in *P. beddomi*, *P. chalazodes, P. femorali*s, and *P. temporalis* varies from green to brown, whereas in *P. neelanethrus* sp. nov. it is yellowish. Moreover, while the dorsum is smooth in *P. beddomi, P. chalazodes, P. femoralis, P. travancoricus*, and *P. temporalis*, whereas it is distinctly granular in *P. neelanethrus* sp. nov.

The UPGMA cluster analysis, based on 19 morphometric and three meristic characters for the other 15 congeners and reference species, revealed *P. neelanethrus* sp. nov. as a distinct species and closest to *P. luteolus* (Fig. 4). The distinction of *P. neelanethrus* sp. nov. from *P. luteolus* was even clearer when the clustering was done using only morphometric characters and excluding meristic characters, which are constrained by being subjective in their comparative weighting (data not shown). The relationship observed between *P. neelanethrus* sp. nov. and *P. luteolus* is also apparent in morphological features, many of which distinguish between them, though many others are similar between them. Distinctive features of *P. neelanethrus* sp. nov. include lack (indistinct) of tympanum and supratympanic fold, snout length equal/subequal to eye diameter, and a distinct blue ring on the outer margin of the eye. In contrast, *P. luteolus* has a distinct supratympanic fold seen as

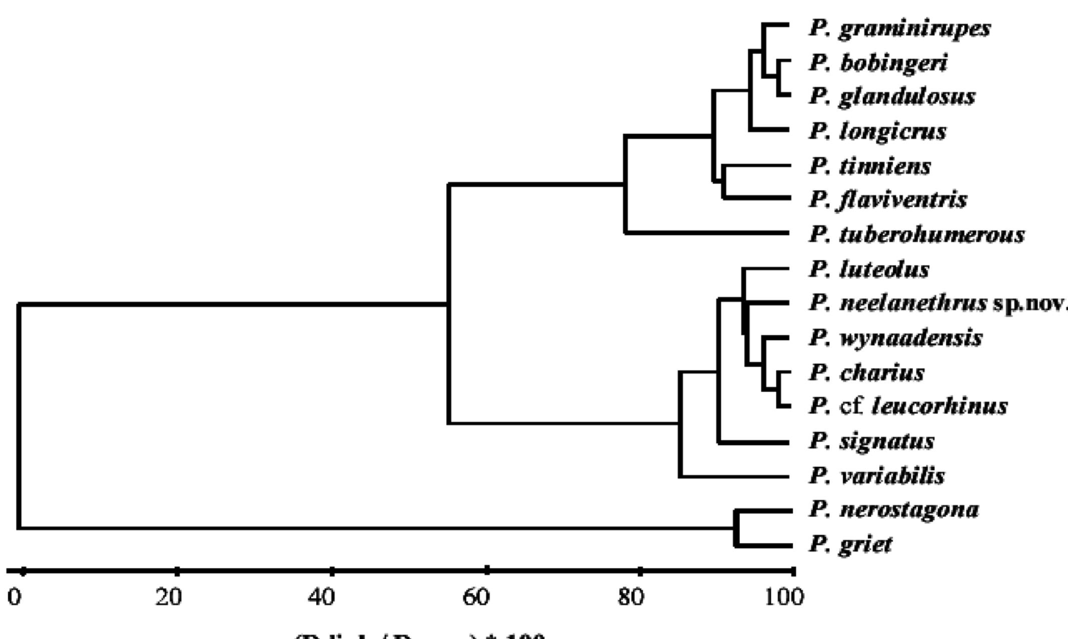


**Fig. 4.** UPGA cluster analysis of 16 *Philautus* species based on 19 morphometric and three meristic characters (see Table 2, and for reference data, Supplemental Table 4).

a strong, arch-shaped skin fold extending from behind eyes to the shoulder, and a longer snout compared to eye diameter (Kuramoto and Joshy, 2003). In their description of *P. luteolus*, Kuramoto and Joshy (2003) did not mention a distinct blue ring around the iris, which is also not visible in the preserved type specimen. The two species also differ in advertisement call pattern, and emerged as distinct in the phylogentic analysis. Advertisement call characteristics differed significantly, with a peak frequency of 2.39 kHz (range 2.35–2.41 kHz) in *P. neelanethrus* sp. nov. compared to 2.70 kHz (range 2.45–2.87 kHz) in *P. luteolus*. There were significant differences in peak frequency, total call duration, slow-phase duration, and number of pulses.

## rDNA phylogenetic analysis

The sequenced rDNA fragments were identical for individuals of the new taxon collected from different localities. Phylogenetic analysis of the 12S and 16S sequences with a large number (>100) of reference amphibian taxa representing families Nyctibatrachidae, Dicroglossidae, and Ranidae revealed the new taxon to be a member of the family Rhacophoridae of Rhacophoroidea, and closest to the *Philautus* species (data not shown). A subsequent analysis done to resolve the exact taxonomic status of the new taxon, using a reduced number of reference taxa belonging mainly to the Rhacophoridae and including three taxa from the related families Ranidae and Nyctibatrachidae (Table 2) as outgroup species, revealed *P. neelanethrus* to be a new, distinct *Philautus* species most closely related to *P. luteolus* (Fig. 5). Moreover, *P. neelanethrus* sp. nov. was revealed to be a distinct and relatively early member of the sub-clade/ lineage including other *Philautus* species described from the Western Ghats, and overall as a member of a broader clade distributed in the Western Ghats and Sri Lanka.

## Distribution

*Philautus neelanethrus* sp. nov. was widespread across the study area (Fig. 1, Table 1), though its abundance varied. There were 6–8 individuals/mhs (man-hours of search) in the *Myristica* swamps, where densities were relatively

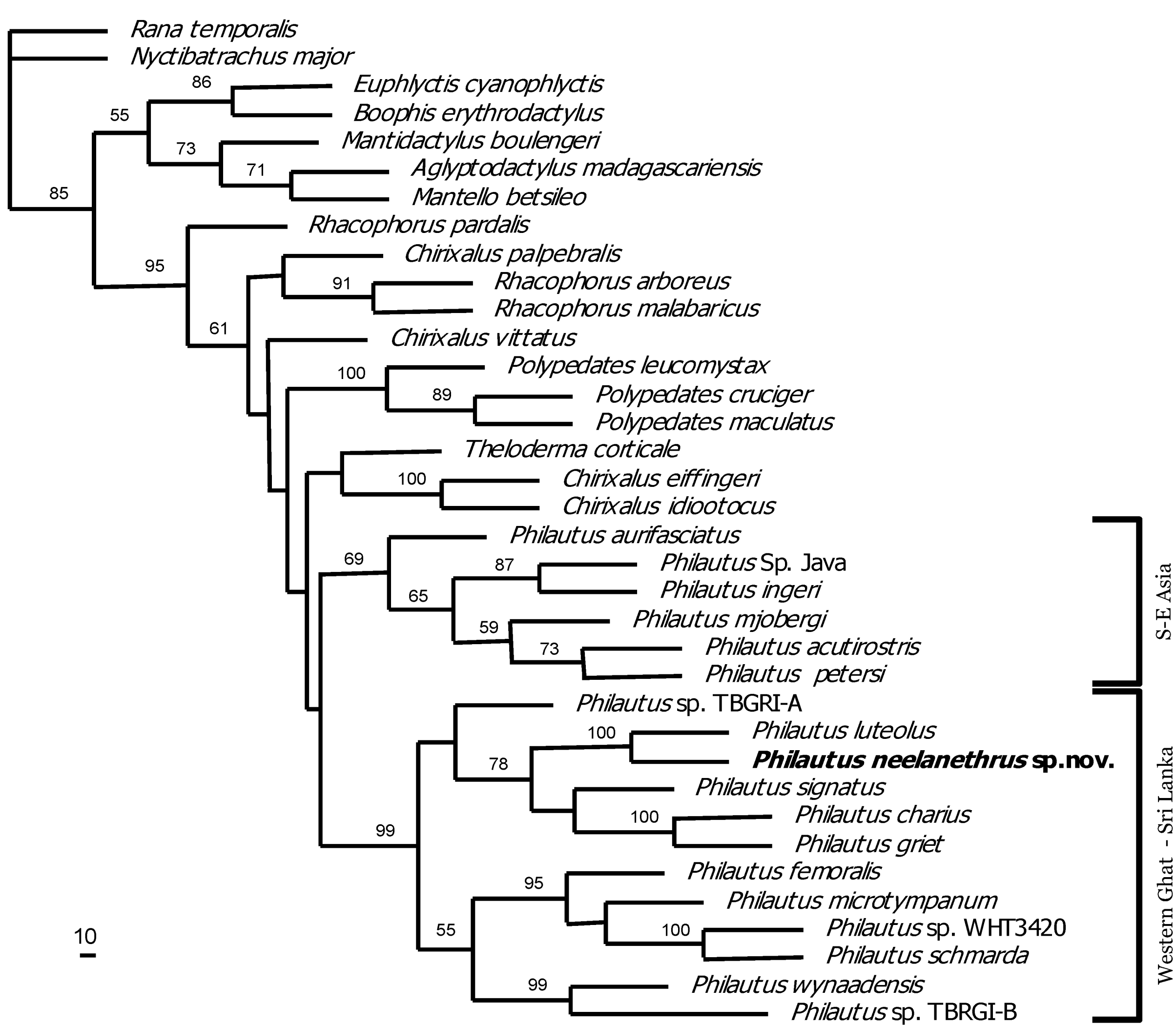


**Fig. 5.** NJ phylogram (gamma-corrected Kimura two-parameter consensus tree with Tr/Tv=4) based on the combined 12S+16S rDNA data set (alignment 788 bp long, of which 575 sites were complete (without any gaps) and 256 were phylogenetically informative) showing the phylogenetic position of the new frog taxon, *P. neelanethrus* sp. nov. Values at the nodes are bootstrap values.

high compared to the densities of 2–4 individuals/mhs observed in other locations in the Western Ghats (Table 1). Moreover, different localities where the frog was spotted were far from each other, with long stretches of the Ghats without any sign of the frog. Importantly, these stretches were characterized by various ecological (*e.g*., rock outcrops, forest fires) and/or anthropogenic disturbances (*e.g*., open/barren lands, agricultural fields, plantations, and built-up areas).

## DISCUSSION

In recent years a number of reports on new descriptions and ancient lineages have suggested that the Western Ghats represent a major hotspot of amphibian diversity and probably a relict habitat (Dutta *et al.,* 2004). In the last five years, 13 new species of amphibians have been discovered from the Western Ghats. Of these, nine are anurans (Dubois *et al.,* 2001; Krishnamurthy *et al.,* 2001; Bossuyt, 2002; Biju and Bossuyt, 2003; Kuramoto and Joshy, 2003; Biju and Bossuyt, 2005a, b; Das and Kunte, 2005) and four are caecilians (Ravichandran *et al.,* 2003; Giri *et al.,* 2003; Bhatta and Prashath, 2004; Bhatta and Srinivas, 2004). Our description of a new species based on morphogenetic analysis from the same biodiversity hotspot adds to the growing list of amphibians from the region, clearly indicates the hotspot status of the region, and reinforces the current notion that there are several new species yet to be discovered (Aravind *et al.,* 2004) requiring proper methods for describing new species.

We described the new species based on morphometry, molecular analysis, and acoustics, which complemented the taxonomic description of the species. Also, the observation that the amplected pair of *P. neelanethrus* sp. nov. descended to the ground without any water body nearby was probably indicative of ground nesting and direct development to a froglet, which are characteristic of the genus (Marmayou *et al.,* 2000).

The study also revealed that although traditional approaches based on morphometric comparisons and acoustics provided an initial indication that *P. neelanethrus* was a new species, its identity and overall taxonomic relationships could most reliably be inferred based on molecular analysis. Furthermore, it is important to note that the specimens of the putative new species from different localities carried identical rDNA sequences, which strongly suggests that the isolated, disjunct small populations spread over a considerable part of the central Western Ghats were indeed *P. neelanethrus* sp. nov., which is expected to be a very poor disperser.

*Philautus neelanethrus* sp. nov. was found mainly in the mid-altitudinal range (500–700 m asl) characterized by evergreen/semi-evergreen/moist deciduous forest patches in the central Western Ghats, and most importantly in *Myristica* swamps, which are considered to be living fossils among the vegetation types prevailing in the region (Chandran and Divakar, 2001). The phylogenetic and molecular-dating analysis suggests that *P. neelanethrus* sp nov. is a relatively old taxon among other species of *Philautus* endemic to the Western Ghats. Systematic sampling carried out in the Sharavathi River basin shows that forest patches (as mentioned above) are a prerequisite for this species to survive; these patches are not found in many parts of the study area due to multiple anthropogenic disturbances. These unique features, the relatively older origin of the taxon but presence of its extant population in restricted, non-overlapping and non-contiguous patches, suggests that there had been significant habitat fragmentation in the Western Ghats leading to the present day disjunct populations. The species thus appears to be a useful, indirect bioindicator of the ecological health of the Western Ghats, where the remaining evergreen/semi-evergreen/moist deciduous forests are becoming patchy and insularized.

A number of recent studies have documented habitat fragmentation in the Western Ghats due to various anthropogenic activities, *viz*, construction of dams for hydropower, extension of agricultural fields into forested areas, and urbanization (Vasudevan *et al.,* 2001; Gururaja *et al.,* 2003; Aggarwal, 2004). We emphasize here that such fragmentation of natural forest habitats has led to the formation of ecological barriers. These barriers have curtailed poor dispersers like *P. neelanethrus* sp. nov. from dispersing into adjoining similar habitats, leading to the formation of metapopulations. Such metapopulations are always at high risk of extinction due to progressively decreasing native habitats, inbreeding stress, invasion by introduced species, etc. Thus the new species is clearly an indicator of forest fragmentation, at the same time warning of the consequences of fragmentation of the remaining biodiversity in the region and calling for immediate conservation measures to be initiated.

The supplementary data for this article can be found online at http://dx.doi.org/10.2108/zsj.24.525.

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# *Micrixalus fuscus* (Anura: Ranidae) in Sharavathi River basin, Karnataka.

**Key words : Western Ghats, Sharavathi River Basin, amphibians, Micrixalus fuscus, range extension.**

***Micrixalus fuscus*** (Boulenger, 1882) is endemic to the Western Ghats (Chanda, 2002). Inger et al., (1984) recorded this species from Ponmudi hill range in Kerala, (9°55'N and 77°05'E), whereas Vasudevan et al., (2001) observed them in Kalakkad-Mundanthurai Tiger Reserve, Tamil Nadu (8°25' – 8°53'N and 77°10' – 77°35'E).

Eight individuals of *M. fuscus* are recorded from Niluvase (13°44'18"N; 75°06'30"E;, and 692 m above msl) during ecological status assessment studies at Sharavathi River Basin on 6 November 2003. This species is found in the small rocky crevices amidst the flowing perennial streamlet covered with leaf litter in evergreen forest (Water depth: 78.33±10.41 mm; water temperature: 22°C; air temperature: 23°C). It was observed to jump quickly from one rocky surface to other on disturbance, and hid in the crevices. The vegetation includes *Mastixia arborea, Ventilago madraspatana, Aglaia sp. and Agrostistachys indica*. Specimen has been deposited at National Zoological Collections of Zoological Survey of India, Kolkata (Reg. No. A9865)

***Micrixalus fuscus*** (Figure 1) is a small, brown torrent frog (Snout vent length: 19.34±2.3 mm). Finger and toe tips are dilated into small discs. Webbing in foot is more than ¾. Distinct features of this species are tibio-tarsal articulation reaching between eye and snout, indistinct tympanum and strongly overlapping hindlimbs (when folded at right angles to body).

The specimens are dark reddish brown on entire dorsum. Blackish inverted 'V' on the mid-dorsum and also between eyes is observed in two specimens. Dorsolateral fold is with dark brown or with white dots. Lateral band is black and extends up to groin. Limbs are cross-barred. Brown reticulation is notices on the ventral side up to the abdomen and a light white strip from anus to knee joint.

Other species found in the region during the field survey are *Nyctibatrachus major, Indirana semipalmatus, Euphlyctis cyanophlyctis, Sphaerotheca rufescens* as well as species of unidentified

*Philautus* and *Sylvirana.*
The record of *M. fuscus* from Sharavathi River Basin is the first record from Karnataka with an extended range of 13-14° N in the Western Ghats, as there was no record from Karnataka.

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# Developmental mode in white-nosed shrub frog *Philautus* cf. *leucorhinus*

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**Direct development in amphibians bypassing intermediary tadpole stage has behavioural evolutionary and ecological significance. This paper presents direct development in *Philautus* cf. *leucorhinus*, while comparing with other congeners of the Western Ghats.**

**Keywords:** Amphibians, direct development, *Philautus* cf. *leucorhinus*, shrub frogs, Western Ghats.

AMPHIBIANS exhibit remarkable variations in development from egg to adult. One such extreme modification is direct development, wherein free-swimming tadpole stage is completely eliminated and eggs hatch into baby frogs, resembling the adults except for their size. Species adapted completely to terrestrial living generally exhibit direct development. The advantage of being adapted to such development includes avoidance of predation, which is prevalent in aquatic media, parental care and more importantly, dependency on water body for development and complex metamorphic processes[1].

Direct development bypassing an aquatic, free-swimming tadpole stage in amphibians seems to be the fastest reproductive mechanism adapted in vertebrates and specifically among anamniotes[2,3]. Based on site of egg development, as many as 29 breeding types have been recorded in amphibians[2]. Nevertheless, direct development has an evolutionary significance in adapting to non-aquatic habitats, resembling oviparous development of birds and reptiles.

The Western Ghats, a hill range on the west coast of India, with rich biodiversity harbours as many as 137 amphibian species. Among these, *Philautus* genus (Anura: Ranidae: Rhacophorinae), commonly known as Oriental shrub frog has direct development from egg to adult.

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About 90 *Philautus* species have been recorded throughout the world and over 30 species have been described from India, among which 23 are from the Western Ghats[4–8]. Rao[9] has reported tadpole stages in '*Philautus leucorhincus*' or '*Philautus leucorhyncus*', *P. hypomelas*, *P. nassutus*, *P. pulcher* and *P. variabilis*. Later, Patil and Kanamadi[3] provided a detailed description of direct development in *P. variabilis*. Similarly, Bossuyt and Dubois[4] rejected the tadpole descriptions in *P. hypomelas* by Rao[9], which is supposed to be of the genus *Nyctibatrachus*. Subsequently, direct development was reported in *P. glandulosus*[10,11] and later in *P. bobingeri*, *P bombayensis*, *P. graminirupes*, *P. nerostagona*, and *P. tinniens*[4,6,7,12,13]. The present communication reports direct development in white-nosed shrub frog, *Philautus* cf. *leucorhinus* Lichtenstein and Martens, 1856, is contrary to earlier reports of tadpole stage in its development[9,8] and only the third species from the Western Ghats to be described completely.

*Philautus* cf. *leucorhinus* is a small-sized arboreal shrub frog, coloured pale to dark brown on the dorsum with varied black patches, and resembles the earlier description of the species[8,14–16], (S. K. Dutta, pers. commun.). It has a hexagonal white spot on the snout tip and a dark band between eyes passes through a distinct tympanum till the shoulder. Prominent supratympanic fold. Throat speckled with brown in male. Toes half-webbed. Calling male of *P.* cf. *leucorhinus* (SVL: 28.9 mm; Figure 1 *a*) was observed from a tree trunk at a height of 2 m facing down, whereas the female (SVL: 33.7 mm; Figure 1 *b*) was observed less than a metre away at 0.3 m from the ground on a *Myristica malabarica* tree stilt root. This was observed at 2015 h IST on 14 June 2004 with incessant rain (air temperature: 28.8°C and relative humidity: 97%) from Yenneholé, Sagar taluk, Shimoga (563 m amsl; 13°57′54″N, 74°43′37″E). Pairs got amplected axially at 2315 h (Figure 1 *c*) and female carried the male to ground level. All eggs were laid on a leaf of *Hopea ponga* less than 10 cm from the ground, between two rocky boulders by morning (0600 h). Male and female got separated after the spawning process. Later eggs were collected ($N = 51$) and developmental stages were observed in the laboratory (Figure 1 *d*) at an interval of 24 h.

Diameter of eggs was $3.5 \pm 0.16$ mm, with a thin gelly coat. Eggs were unpigmented with uniform cream colouration. Pole differentiations followed by the process of cleavage, gastrulation and neurulation were observed within 24 h. Neural folds were seen at 24 h (Figure 2 *a*). Neural fold and neural plate elongated and formed into neural tube and at 72 h, head and tail buds were formed at the anterior and posterior ends of the neural tube respectively (Figure 2 *b*). Hind limb and forelimb buds were seen as embedded beads on the surface of the egg near the neural tube attachment region. Head, tail and limb buds elongated and were more pronounced at 96 h and eyespots as a bulged region on the lateral positions on the head were observed (Figure 2 *c*). Tail was curved to the left in all the eggs. Pigmentation was observed on the mid-dorsal line at 120 h and it spread initially along the neural tube, then on upper and lower portions of the abdomen during the entire developmental process (Figure 2 *d*). At 144 h, head and tails further elongated and pigmentation intensity also increased. Tail was translucent, flat and membranous. During the same period, pigmentation of iris and heart beats were also observed. Tail and head region differentiated further during 168 h. Hindlimb bud elongated, with recognizable differentiation of femur, tibia and foot. At 240 h, mouth-

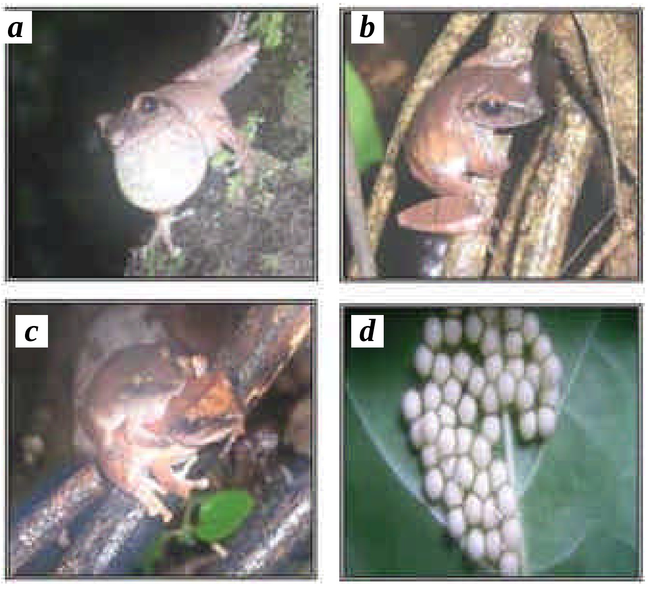


**Figure 1.** Amplexus and egg deposition of *Philautus* cf. *leucorhinus*. ***a***, Male (SVL: 28.9 mm); ***b***, Female (SVL: 33.7 mm); ***c***, Amplected pair and ***d***, Egg clutch ($3.5 \pm 0.16$ mm, $N = 51$).

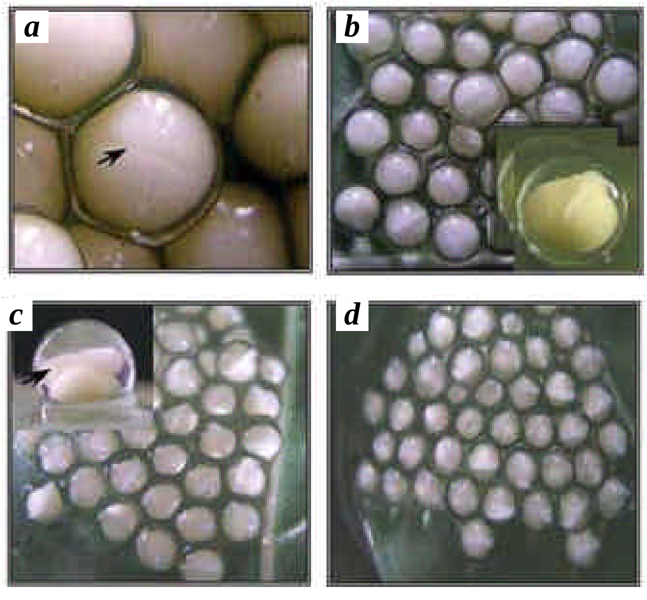


**Figure 2.** Developmental stages of *P.* cf. *leucorhinus* till day 5. ***a***, Neural fold at 24 h; ***b***, Head, limbbud and tail differentiation at 72 h; ***c***, Curved tail bud, bead-like limb buds at 96 h and ***d***, at 120 h.

**Table 1.** Various features of direct developmental pattern in *Philautus* of the Western Ghats

| Species | SVL (mm) | Eggs | Days to hatch | Mode* | Habitat | Parental care | Egg diameter (mm ± SD) (*N*) | Locality | Geographic coordinates | Observation | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Philautus cf. leucorhinus* | ♀: 33.7<br>♂: 28.9 | 51 | 19 | 20 | Above ground, (10 cm) on wet leaves, between rocks | Pair separates after spawning | 3.5 ± 0.16 (51) | Yenneholé, Sharavathi River, Karnataka | 13°57′54″N, 74°43′37″E, 563 m asl | 14 June 2004 | Present study |
| *P. glandulosus* | ♀: 25; 24.5–26[#]<br>♂: 21; 20.4–22.9[#] | 12–18; 48[#] | 22; 28[#] | 20 | Above ground (1.5–3 m) on wet leaves | Pair separates after spawning | 4.9 ± 0.9 (14); 4.4 ± 0.2 (48)[#] | Kudremukh, Karnataka; Kalpatta, Waynaad, Kerala[#] | 13°10′–13°26′N, 75°05′–75°10′E, ~ 600 m asl; 11°38′N, 76°08′E, 1000 m asl[#] | 12 August 2000<br>28 June 1997[#] | 10, 11[#] |
| *P. variabilis* | ♀ and ♂: 30.0 ± 4.5 | 54–62 | 12 | 20 | Above ground | Eggs beneath abdomen of female, chasing intruding males | 4.1 ± 0.2 (30) | Dharwad, Karnataka | 15°17′N, 75°03′E, ~ 780 m asl | June–August 1994–96 | 3 |
| *P. nerostagona* | ♀: No report<br>♂: 30.1–34 | 41 | 20 | 20 | In ~10 cm deep tree hole, 10 m above ground | – | 4.5 ± 0.3 (41) | Kalpatta, Waynaad, Kerala | 11°38′N, 76°08′E, ~ 1000 m asl | 20 July 2000 | 6 |
| *P. tinniens* | ♀: 25<br>♂: No report | – | – | 17 | On ground | – | – | Nilgiri hills, Tamil Nadu | 11°24′N, 76°42′E, ~ 1800+ m asl | – | 4, 18 |
| *P. bombayensis* | ♀: No report<br>♂: No report | 26–27 | – | 20 | Above ground, wet leaves | – | – | Sakleshpur, Karnataka | 12°59′N, 75°43′E, ~ 850 m asl | 29 July 1996 | 12 |
| *P. bobingeri* | ♀: 23.5–26<br>♂: 21.3–24.8 | 24 | 18 | 20 | Acacia tree, 4 m from ground | – | 3.9 ± 0.4 (24) | Ponmudi hills, Kerala | 8°45′N, 77°08′E, 1000 m asl | July 1999 | 7 |
| *P. graminirupes* | ♀: 27.3–29.4<br>♂: 21.4–22.6 | 30–38 | 24 | 17 | On ground, grass clump, rocky crevice | – | 4.9 ± 0.5 (38) | Ponmudi hills, Kerala | 8°45′N, 77°08′E, 1000 m asl | 7 July 2000 | 8 |

*Based on Duellman and Trueb[2].

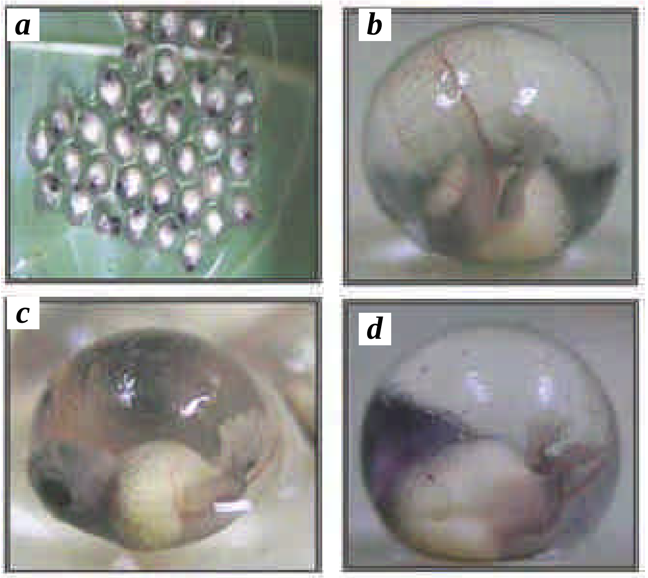


**Figure 3.** Developmental stages of *P.* cf. *leucorhinus* till day 13. ***a***, Mouth differentiation at 264 h; ***b***, Toe demarcation, translucent tail at 264 h; ***c***, Toe digit differentiation at 288 h and ***d***, Elongation of toe at 312 h.

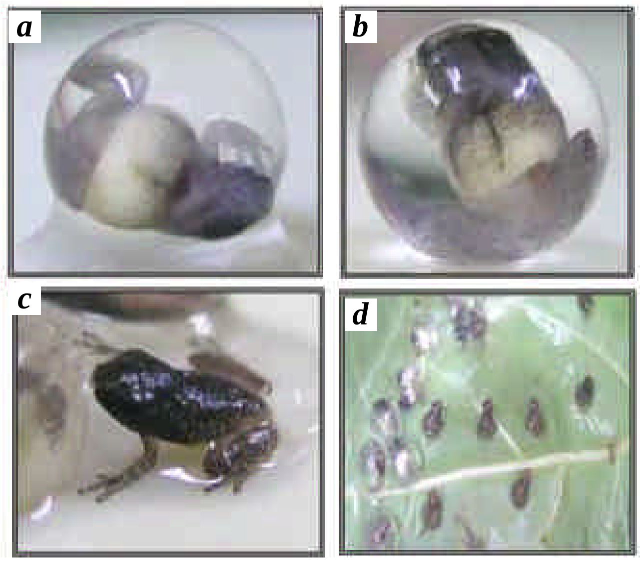


**Figure 4.** Developmental stages of *P.* cf. *leucorhinus* till day 19. ***a***, Finger differentiation, limb bends at 384 h; ***b***, Tiny froglet, with reduced tail at 408 h; ***c***, Hatched froglet at 432 h and ***d***, Froglets at 432 h.

parts were observed, but prominently into upper and lower lips during 336–384 h. Forelimb buds elongated during this period. Intermediate developmental stages are illustrated in Figures 3 and 4. Considerable reduction in yolk and proportional enlargement of head and elongation of hindlimb was observed. Toes emerged at 312 h, and differentiated by 336 h. By 384 h, fingers clearly differentiated and movements inside the jelly were observed. Tail and yolk got remarkably reduced during 432 h and tiny froglets measuring 4.54 ± 0.07 mm emerged out after 19 days (Figure 4 *c* and *d*).

Analysis of the intra group developmental stages of *P.* cf. *leucorhinus* with *P. glandulosus* and *P. variabilis* from the Western Ghats, shows that within 144 h, major developmental stages like demarcation of head, mouth, eye, fore limbs and hind limbs take place and the remaining period (that varies from species to species) is utilized for differentiation of fingers, toes, mouth parts, eyes and overall morphology of the body with utilization of yolk and regression of tail, which supposedly has a respiratory function[17]. Except for the variation in hatching periods, developmental pattern remains the same. However, the significant differences observed between these three species in female sizes, number of eggs and hatching periods might be attributed to the influence of environmental factors associated with their microhabitats. Table 1 compares the pattern of direct development in various *Philautus* species available in the Western Ghats. It was observed that the number of eggs in a clutch depends on the size of the female ($r = 0.85$, $P < 0.05$). Size of female, egg diameter and period of hatching are negatively influenced by each other; however, they are not statistically significant. All these observations were made during June to August (the period of the southwest monsoon in this region) highlighting the breeding period of the species.

There is an urgent need to look into the molecular, developmental and evolutionary aspects in detail to understand the phylogeography of the species from the Western Ghats, considering frequent reporting of new species in *Philautus* genus (since 2001, six species out of eight anurans were discovered from the Western Ghats).


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# Discovery of Two Critically Endangered Tree Species and Issues Related to Relic Forests of the Western Ghats

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**Abstract:** *Madhuca bourdillonii* (Gamble) Lam. and *Syzygium travancoricum* Gamble, considered almost extinct but later found to be occurring in small numbers in their home range in Western Ghats, south of Palghat Gap, have been now discovered in some of the relic primeval evergreen forests of Uttara Kannada, over 700 km north. These relic forests also shelter scores of other rare endemic elements of flora and fauna. These findings highlight the need for making intensive efforts for locating more of such relic forests and documenting their biota. Also, biologists need to restrain from the tendencies of considering any novel occurrences of species away from their home ranges as new species, before ruling out the possibilities that these could be the relics of ancient populations or their morphological variants. Presence of relic forests does reveal the legacy of erstwhile contiguous forests, which is now fragmented due to rapid land use changes. Conservationists handling biodiversity hotspots should be able to distinguish between relics of primeval forests and advanced stages of secondary successions. Lack of such understanding will result in imperceptible extinctions of many endemic species.

**Keywords:** *Madhuca bourdillonii, Syzygium travancoricum,* critically endangered, relic forests, *Myristica* swamps, local extinction, Uttara Kannada, Western Ghats.

## INTRODUCTION

The Western Ghats is one among the 34 global hotspots of biodiversity and it lies in the western part of peninsular India in a series of hills stretching over a distance of 1,600 km from north to south and covering an area of about 1,60,000 sq.km. In the course of our ecological studies in the Uttara Kannada (formerly North Kanara) district of central Western Ghats, we came across two critically endangered tree species, far away from their home range much in the south. These trees *viz*., *Madhuca bourdillonii* (Gamble) Lam. and *Syzygium travancoricum* Gamble, were even considered almost extinct. Their rare presence in some of the relic evergreen forests of Uttara Kannada, over 700 km towards the north of their original home range, in southern Western Ghats, that too beyond the geographical barrier of the Palghat Gap, which halts the continuity of several sensitive endemics, throws up before us fresh questions regarding conventional approach to conservation, which has not given due merit to the ecological history of the region. These tree species occur in the vicinity of some of the *Myristica* swamps of the district, which are obviously part of the relic patches of primeval low altitude evergreen forests that survived human impacts to some degree. Historically, the overall forest disturbance in the Western Ghats increased in spatial extent as well as in intensity, during the post World war era, with the emphasis on industrialization and economic development. Forest based industries coupled with large scale hydroelectric projects and conversions of forest land for agriculture have contributed significantly in the decline of primeval forests. The *Myristica* swamps did not get enough attention until Chandran and Mesta [1] reported them as highly threatened relics of primeval forests of the Western Ghats. These swamps have high watershed value and are associated with perennial water courses. They also act as a treasure trove of endemic plants and animals of ancient lineage. These swamps are dominated by species of Myristicaceae (nutmeg family), one of the most ancient families of flowering plants. *Myristica fatua* var. *magnifica* (Bedd) Sinclair and *Gymnacranthera canarica* (King) Warburg, are tree species exclusive to the swamps. Recent discovery of *Semecarpus kathalekanensis*, an altogether new tree species of the mango family Anacardiaceae [2], in these swamps has created ripples in the conservation circles.

The micro-heterogeneity of these relic evergreen forests has several more endemic and interesting plant species, which include the trees *Dipterocarpus indicus, Mastixia arborea, Agrostystachys longifolia* and *Myristica malabarica* (Fig. **1**); an undergrowth palm *Pinanga dicksonii,* a species of pepper *Piper hookerii,* a tree fern *Cyathea nilgirica,* etc. Lion-tailed macaque, an endemic endangered primate of the Western Ghats, has its northern-most range in the relic evergreen forests of southern Uttara Kannada, which also often harbour *Myristica* swamps. In addition are several other rare endemic animal species, which include amphibian genera like *Nyctibatrachus* and *Micrixalus*. The *Myristica* swamps of southern Uttara Kannada are found to harbour 29 species of amphibians of which 19 are Western Ghat endemics. Birds like Wyanad laughing thrush and Malabar pied hornbill associated with these swamp forests are also endemics. *Phylloneura westersmanii,* a damselfly of endemic monospecific genus *Phylloneura* was recently found in *Myristica* swamps of Siddapur (14.5° N), the northern range of which was earlier considered to be Coorg (12° N) district [3].

The *Myristica* swamps, which are sure indicators of relics of primeval forests of the Western Ghats, today occur in iso-

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lated patches; the southern-most swamps are found in Travancore region and the northern-most occur in Goa. Due to ever increasing human impacts, over the last few centuries, most of the primeval forests have given way to secondary forests, savannas, monoculture tree plantations, cash crops such as tea, coffee and rubber, rice fields, arecanut gardens, etc [4,5]. In addition, developmental projects such as hydel, and nuclear power plants, mining, etc., have mushroomed especially during the post-independence period. Nevertheless, the remains of numerous ancient sacred groves, specially preserved pepper forests of the past and many forest patches with difficult approach are serving as repositories of the endemic biodiversity of Western Ghats. Recent study of Western Ghats using WiFs (wide field sensor with spatial resolution of 70 m) remote sensing data mapped certain unique evergreen forest patches, which coincided with *Myristica* swamps, *Ochlandra* reed ecosystems and *Nagea wallichiana* facies [6], which are obviously relics of primary evergreen forests.

*Myristica* swamps are considered as priceless possessions for evolutionary biology. The swamp, with its entanglement of aerial roots, and canopy of dark green large leaves, and high degree of endemism, is doubtlessly, the relic of one of the most primeval ecosystems of the Western Ghats. As much remained undone regarding the diversity and ecology of these swamps, they are considered "virtually live museum of ancient life of great interest to biologists"[1,4]. With the presumption that the *Myristica* swamps and their immediate surroundings, studded with *Dipterocarpus* trees (Fig. **1**), could shed some light on the nature of the primeval low altitude evergreen forests of Uttara Kannada district, we began surveying these forest relics more systematically. Our search resulted in the discovery of two critically endangered tree species *viz.*, *Madhuca bourdillonii* (Gamble) Lam. and *Syzygium travancoricum* (Gamble). We consider the occurrence of these species in Uttara Kannada as very significant due to the following reasons:

- These species were originally reported only from Travancore region [7].
- They were feared to be extinct according to the *Red Data Book of Indian Plants* [8,9].
- Subsequent investigations revealed their rare presence in southern Western Ghats, but only towards the south of the Palghat Gap [10,11].
- The *Myristica* swamps near which we found these species had the status of *kan* forests. The *kans* were safety forests cum sacred groves during the pre-colonial times [12].

### *Madhuca bourdillonii* (Gamble) Lam.

Bourdillon [7], the discoverer of this species in Travancore during 1894-95 described it as a "rare tree of medium size occurring in the Ariankavu and Shenduruny valleys, but not seen elsewhere". Gamble [13], quoting Bourdillon, also described it in the *Flora of the Presidency of Madras* (vol.2). The *Red Data Book of Indian Plants* considered its status as "possibly extinct", since the species was not collected after Bourdillon's observation. The book states [9], "Indiscriminate and steady destruction of its natural habitats, compounded by selective felling of *Madhuca* trees in the past for their purported all round value, accounts for the present day state of scarcity in the Western Ghats region". Sasidharan and Sivarajan [10] found this species in the forests of Thrissur district (10.66° N, 76.25° E), to the north of the type localities. Later, it was also found in its type localities namely Arainkavu and Shenduruny valley and was reported [11] as "rare".

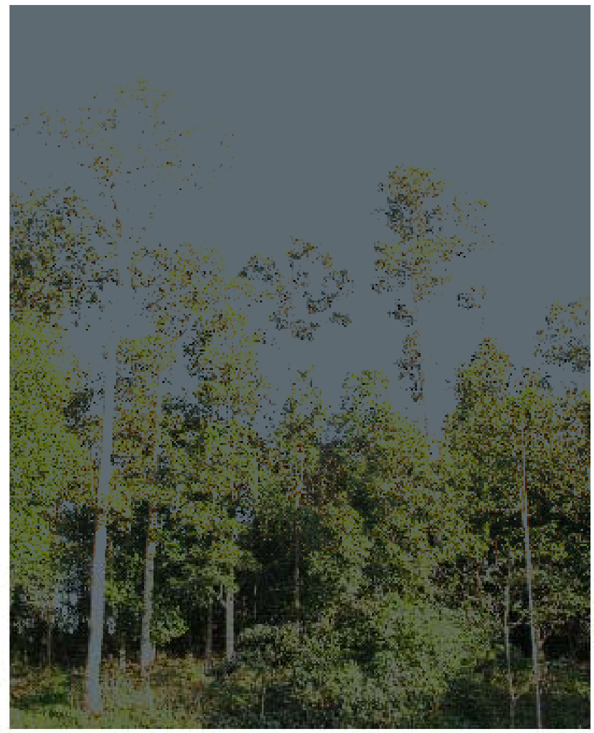

**Fig. (1).** A relic forest with *Dipterocarpus indicus.*

## OCCURRENCE OF *M. BOURDILLONII* IN UTTARA KANNADA

Notably all the findings of the species hitherto were towards the south of Palghat Gap, until we came across a rare population in Ankola taluk (14.7° N), of Uttara Kannada district, in the central Western Ghats. Our find extends the northern limit of the species by about 500 km; but more significantly, this is the first report of the species from north of the Palghat Gap. Fig. (**2**) depicts these locations along with the earlier sightings. There were only 13 trees of this critically endangered species dispersed within a stretch of evergreen forests. Three of them exceeded 30 m in height and were about 2 m in girth while others were much smaller. These trees occurred in a relic forest characterised by a *Myristica* swamp and endemic trees such as *Aglaia anamallayana, Dipterocarpus indicus, Garcinia talbotii, Holigarna* spp., *Gymnacranthera canarica, Knema attenuata, Myristica malabarica,* etc. Incidentally, this site is also a northward extension for *D. indicus* by about 30 km, from the previous report [14].

## DESCRIPTION OF *M. BOURDILLONII*

*Madhuca bourdillonii* is a medium to large tree exceeding 30 m height at maturity (Fig. **3a**). Though described as an evergreen [9], it has a brief period of leaf-fall, which is not strictly season bound. Flowering is simultaneous with leaf-fall and new flush that follows is mingled with late

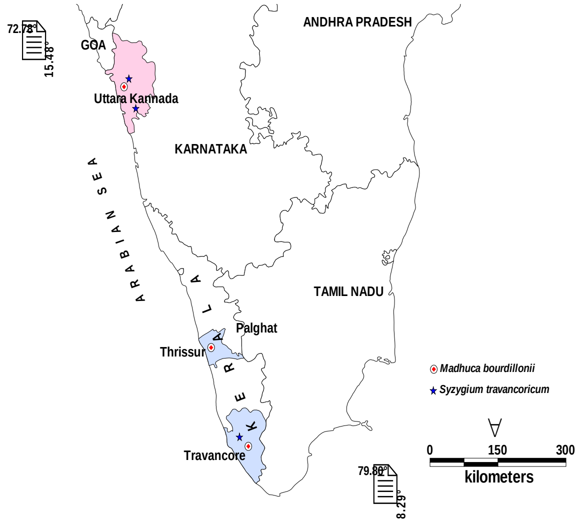


**Fig. (2).** Distribution map of *Madhuca bourdillonii* and *Syzygium travancoricum* in the South-west India.

blooming flowers and early fruits. The trees have grayish brown, longitudinally fissured and flaky bark with a pinkish interior (Fig. **3b**). The plant parts have milky latex like other species of *Madhuca*. Young shoots, including young leaves, are densely covered with brownish-orange, wooly hairs. In the mature leaves the undersurface of veins retains the hairs. In other related species like *M. longifolia* var. *longifolia* and *M. longifolia* var. *latifolia* and *M. neriifolia* mature leaves are not hairy. The leaves are simple (Fig. **3a**) reaching dimensions of 20-32 x 6-10 cm and crowded towards the tips of branchlets. They have conical base and bluntly acute to narrowing tips. In having 20-25 pairs of lateral nerves *M. bourdillonii* stands apart from its close associates *M. longifolia* var. *longifolia* (10-12 pairs) and *M. longifolia* var. *latifolia* (10-14 pairs). Flowers appear in dense clusters (Fig. **3c**) from the axils of fallen leaves or of older leaves that are about to fall. When the tree is in full bloom, clusters of young leaves appear from the tips of branchlets. The stalks of flowers, 1.5-2 cm long, are also covered with dense hairs. Sepals are 4, ovate and hairy outside. Corolla consists of 12 united petals. Stamens are often twice the number of petals, in two whorls. The anther is tipped with a narrow outgrowth.

Genus *Madhuca* produces berries (Fig. **3d**) with one to few seeds. Globose fruit is a key distinguishing character of *M. bourdillonii*. *Madhuca longifolia* var. *latifolia* has globose fruit, with oblique apex [15] and *M. longifolia* var. *longifolia* has ovoid fruit. Both these varieties have 1 or 2 seeds whereas *M. bourdillonii* has 2-3 seeds (Fig. **3e**). Table **1** compares the various *Madhuca* spp. of South India.

### *Syzygium travancoricum* Gamble

The tree was first discovered in the swampy lowlands (altitude <65 m) of Travancore by Bourdillon in 1894. Gamble [17] described it in 1918 in the *Kew Bulletin* and in the *Flora of the Presidency of Madras* in 1919. The *Red Data Book of Indian Plants* [8], quoting Nair and Mohanan [18], states: “Apparently no tree is surviving in the type locality. Recently only four trees have been spotted in a sacred grove of Aikad in Quilon district”. However, Sasidharan [11] rediscovered it in the type locality - Shenduruny Wildlife Sanctuary. According to him this species, endemic to southern Western Ghats of Kerala, is associated with the *Myristica* swamp forests.

## OCCURRENCE OF *S. TRAVANCORICUMIN* UTTARA KANNADA

We came across about 35 trees of this species in association with some of the *Myristica* swamps of Siddapur taluk (14.4° N). The tree occurred along with several other Western Ghat endemics such as *Aglaia anamallayana*, *Calophyllum apetalum*, *Diospyros paniculata*, *D. pruriens*, *Dipterocarpus indicus*, *Gymnocranthera canarica*, *Holigarna grahamii*, *Hydnocarpus pentandra*, *Hopea ponga*, *Mastixia arborea*, *Myristica fatua* var. *magnifica*, *Pinanga dicksonii*, etc. In Ankola taluk, a single tree was observed in a *Myristica* swamp (Fig. **4a**). Some bushy forms, obviously coppice shoots (Fig. **4b**), occurred close to it. The occurrence of the species in Ankola is a range extension for it by about 700 km from Travancore (Fig. **2**), where it was considered to be restricted.

## DESCRIPTION OF *S. TRAVANCORICUM*

Gamble [17] described the species as medium sized or large tree, while, Sasidharan [11] found only small trees. The largest trees that we observed were about 30 m in height. Two of the trees had girths of 253 and 254 cm respectively. The older trees have buttresses at the base. The young branchlets are 4-angled; in the saplings the angles are winged. Stream side trees have floating water roots, an adaptation to swampy habitat (Fig. **4c**). Leaves are simple, opposite, ovate and bluntly acute towards the tip. The leaf base is shortly decurrent (continued) on the 2 cm long petiole. Leaf measures 9-18 cm in length and 6-9 cm in breadth. It has 12-15 pairs of lateral nerves. Flowers occur in the axils of leaves in corymbose cymes of 5-8 cm long (Fig. **4d**). They are very small, only 3 mm across. The white petals form a calyptra (cap) in the bud enclosing the stamens. Fruits 0.7-1 cm across, purplish to maroon-red (Fig. **4e**). Fruits ripen in May-June. None of the floras provide the description of the fruit although it is sketched in the flora of Shenduruny Wildlife Sanctuary [11].

## THE VALUE OF FOREST PATCHES

The impact of forest fragmentation is severe in the tropics, where biodiversity is rich, and human populations are rapidly growing. Studies show decline of forest birds [19], large wide ranging species [20] and more specifically specialised species [21] that require unique habitat for survival. It also influences distribution and availability of spatial resources, forest connectivity and edge characteristics, which are important for species persistence [22-24]. Also, trees in the fragmented habitats have higher annual tree mortality rates due to vagaries of wind [25]. Fragmentation effects cascade through the community, modifying inter-specific interactions, providing predator or competitive release, altering social relationships and movement of individuals, exacerbating edge effects, modifying nutrient flows, and potentially even affecting the composition of local population [26]. In many tropical regions, rain forest is restricted to small (<100 ha), isolated fragments. The conservation of such smaller fragments had not merited much attention till recent years. In regions like Western Ghats, there is not much hope for creation of more and more large-sized protected area systems due to social, economic and political


**Fig. (3). a**) *Madhuca bourdillonii* in flush; **b**) An old tree of *M. bourdillonii* – showing fissured and flaky bark; **c**) flower; **d**) fruit and **e**) seeds.

**Table 1. Comparative Morphology of Different Species of *Madhuca***

| Characters | *M. bourdillonii* | *M. longifolia var. longifolia* | *M. longifolia var. latifolia* | *M. neeriifolia* | *M. insignis* |
|---|---|---|---|---|---|
| Tree height | Large (>25 m) | Large (>25 m) | Large (>25 m) | Small (8-10 m) | Moderate |
| Bark | Grayish brown, fissured and flaky | Dark brown, scaly | Dark, fissured and scaly | Dark, scaly | |
| Leaf size (cm) | 20-32 x 6-10 | 5.5-12 x 1.5-4 | 7-22 x 5-14 | 7-24 x 3-6 | 9-13 x 4-6 |
| Leaf hairiness (mature leaf) | Petioles and underside of veins with brownish-orange, wooly hairs | Glabrous | Glabrous | Glabrous | Glabrous |
| No. of lateral nerves (pairs) | 20-25 | 10-12 | 10-14 | 14-25 | 11-13 |
| Ovary | Glabrous | Hairy | Hairy | Glabrous | |
| Fruit shape | Globose | Oblong | Globose with oblique apex | Fusiform, beaked | Fusiform-ovoid |
| Surface of mature fruit | Glabrous | Hairy | Hairy | Glabrous | Glabrous |
| No. of seeds | 2-3 | 1-4 | 1-4 | 1 | 1 |

Table based on observations by authors and floras of Bourdillon [7], Gamble [13], Saldanha [15], Sasidharan and Sivarajan [10], Sasidharan [11], Bhat [16].

constraints [27, 28]. Also, the presence of roads, power lines and substantial nearby human population has prevented the recovery [29]. ‘Forest patches’ include a diversity of habitats which are in close proximity forming a mosaic, or even in isolation like a sacred forest in the middle of a village or small town. Investigations into the ecological history of the Western Ghats reveal that the forests here, especially of altitudes below 1000 m, constitute a mosaic of patches of varied nature and ages.

In the Uttara Kannada district of central Western Ghats, where we conducted our present study, this landscape mosaic, according to traditional pre and early colonial land use, typically consisted of sacred forests (*kans* or *devarabana*), ordinary forests (*kadu* or *adavi*), shifting cultivation areas (*kumri* or *hakkalu*), leaf manure forests (*betta*), grazing lands (*bena*), etc., in addition to lands under permanent agriculture and horticulture. Such traditional mosaic within it might contain streams, ponds, waterfalls and rivers, gorges and steeps and rocky pinnacles, each with its own characteristic species composition [12, 27-28, 30]. Sacred forest fragments are shelters of biodiversity, meeting the needs of non-timber forest produce requirement and are best protected by local communities [31]. The lower altitudes of pre-historical Western Ghats, before the beginning of shifting cultivation, around 3,000 years ago, would have been covered with pristine ecosystems, more or less untrammeled by man, except by hunter-gatherers, who seldom if at all, indulged in forest alterations. Especially due to the heavy rainfall, western facing portions of the mountains would have been covered with tropical evergreen forests, laced with water courses and swamps [24,27]. Earlier studies in the Western Ghats also showed that remnants foster successional processes in natural restoration of rainforests [32]. Shifting cultivation was a major activity of forest dwelling tribals, throughout the Western Ghats, sparing only the higher altitudes. Carried out through centuries this might have altered substantially the primary evergreen forests. In sparsely populated interior places of South Indian Western Ghats, the forests would regrow and through time get back most of the original elements of the flora barring a few, as the fallow period was long (sometimes the tribes never returned to the original areas). As fire was an important factor in shifting cultivation, it may be that hygrophilous endemic tree species such as *Dipterocarpus indicus* and *Vateria indica*, failed to regenerate on slash and burn areas, but survived in protected areas like the sacred forests. The same could be true of *Madhuca bourdillonii* and *Syzygium travancoricum* (Fig. **5**).

## DISCUSSION

Forest history of Uttara Kannada reveals that shifting cultivation was a decisive force that altered the primary forests substantially, creating vast stretches of secondary forests. The early agricultural communities, however, left behind a great legacy of sacred forests (*kans*) in Uttara Kannada and other adjoining districts. Many of these *kans* to this day are relics of the primary forests of the Western Ghats and are centers of endemism for both plants and animals. *Myristica* swamps are associated with some of these sacred forests [1,12,27,28]. These relics lost their special identity as sacred forests and got merged with the state reserve forests during the British administration [27]. Subsequently, they were subjected to commercial timber harvests, tree monocultures, etc. In many places, the *kans* were cut down for expansion of cultivation or converted into leaf manure forests or subjected to other kinds of human impacts [28, 29].

Our finding of *Dipterocarpus* in Ankola (14.7° N) goes to substantiate Caratini *et al*. [33], who have reported the presence of its pollen in marine core samples close to Kali River estuary (14.8° N). This is incidentally range extension of present distribution of *Dipterocarpus* towards north by 30

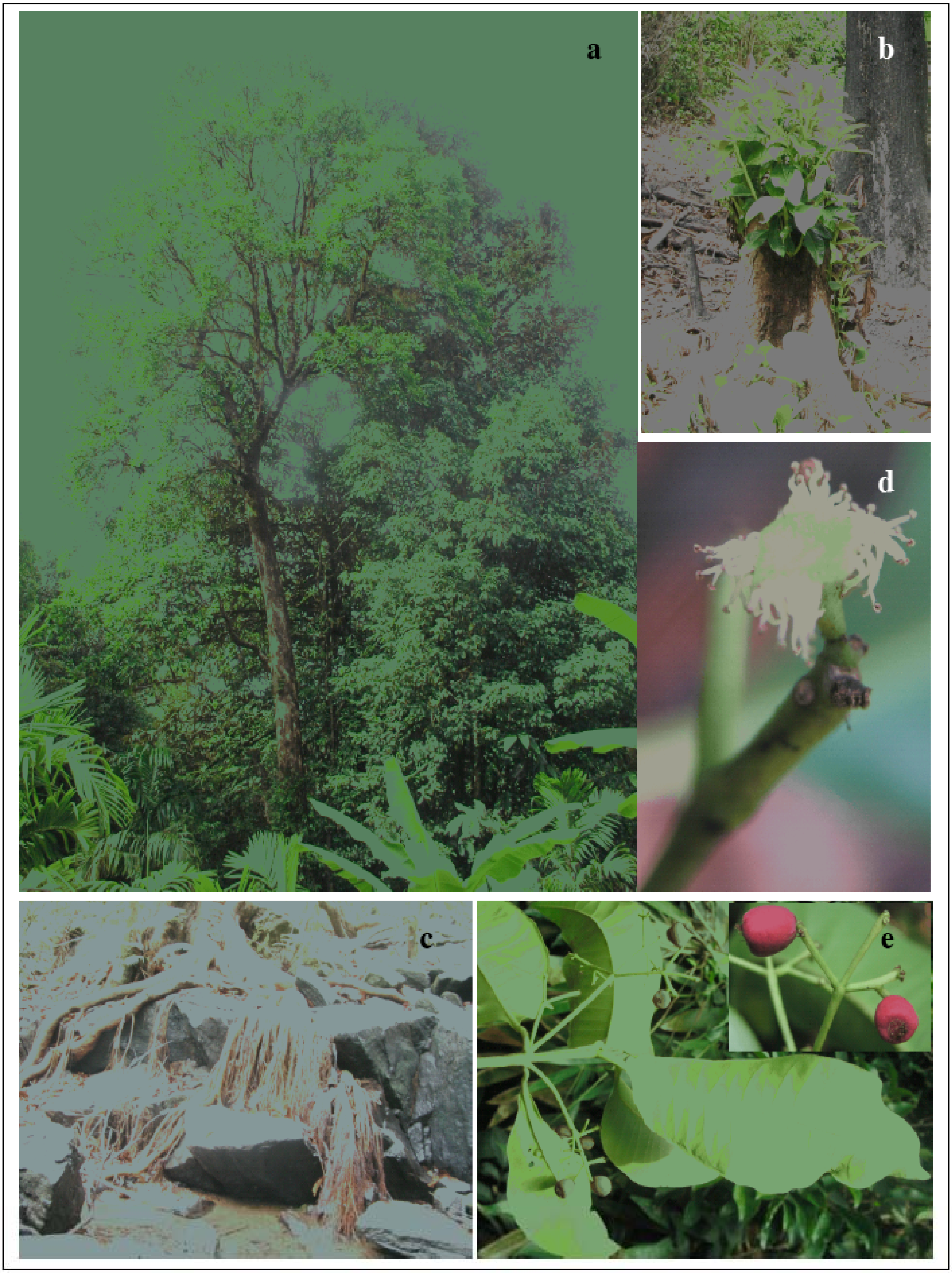


**Fig. (4). a**) *Syzygium travancoricum* – habit; **b**) coppicing stump; **c**) floating water roots; **d**) a single flower and **e**) twig with fruits.

**Fig. (5).** The habitat of *Syzygium travancoricum* – under threat from encroachment.

km. The *Dipterocarpus* patch in Ankola was obviously part of a sacred *kan* forest. A small *Myristica* swamp is also associated with it. Same could be stated about *Syzygium travancoricum*, a stately tree, thought to be extinct once, but rediscovered later, only in southern Western Ghats. Our findings of this critically endangered tree in Siddapur of Uttara Kannada and a single individual in Ankola, in forest patches of ancient antiquity, is very significant. The Siddapur relic forests are also home to recently discovered new tree species *Semecarpus kathalekanensis* [2]. However, biologists should restrain themselves from the general tendency of naming any apparent novel occurrences of plants or animals that they might come across in relic forests as new species; these could as well be the relics of ancient populations or their morphological variants.

The occurrence of *Madhuca bourdillonii* and *Syzygium travancoricum* in Uttara Kannada forests of central Western Ghats, along with *Myristica* swamps and *Dipterocarpus*, clearly goes to prove that low altitude climax evergreen forests with the entire gamut of endemic species of flora and fauna, had more northern ranges for their distribution. Their present day disjunct distribution is largely on account of human impacts on the primeval forests, which have been largely wiped out. Several authors also consider that the current discontinuity of some faunal species in India, might represent relics of a former continuous distribution [34-37]. Karanth [38] considers climatic change and deforestation might be the major causes for present day disjunct distribution and aggregation of the endemic and endangered primate lion-tailed macaque (*Macaca silenus*) in the relics of wet evergreen forest patches of the South Indian Western Ghats.

The view is strengthening among the conservationists about the importance of protecting also smaller patches of forests in the tropics that lie outside large reserves as a substantial number of forest species can persist for decades in fragmented forest [6,38-40]. Inevitably, small fragments will become the last refuges of many rainforest species that are on the brink of extinction, despite the proneness of such populations suffering from depressed reproductive outputs [41]. It is in some such fragmented forests that we have observed the critically endangered species *Madhuca bourdillonii* and *Syzygium travancoricum*.

What is of grave concern for conservationists is the casual attitude with which the Western Ghat forests are managed, nearly oblivious of their ecological history. Bulk of the primeval forest fragments, in whose conservation the pre-colonial farmers appear to have played key role have perished during the period of modern forestry, whose foundations were laid by the British. Foresters and ecologists should be able to distinguish between relics of primeval forests and advanced stages of secondary successions. Lack of this perception would result in the silent extinctions of scores of endemic species. *Madhuca bourdillonii* in Uttara Kannada is on the verge of extinction on account of unsatisfactory reproduction as well as human and predatory pressures. We are hopeful that more such relic patches with their valuable biota might be in existence in between Travancore and Uttara Kannada.

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# Small sacred groves in local landscape: are they really worthy for conservation?

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*Sacred groves are communally-protected forest fragments with significant religious connotations. These community lands attain significance due to biodiversity conservation and provide ecological services in local landscapes. However, it has often been found that interests related to sacred groves are often concentrated towards the groves with conspicuous presence, i.e. in terms of expanse, economic importance or presence of charismatic species, etc. This undermines the role played by the small groves (mostly < 1 ha) and also lead to degradation over time. This commentary analyses the role and need for conservation of small groves in local landscape scenario.*

Sacred groves are 'natural areas of special spiritual significance to peoples and communities. They include natural areas recognized as sacred by indigenous and traditional peoples, as well as natural areas recognized by institutionalized religions or faiths as places for worship and remembrance'[1]. They are characterized as relics of past vegetation and remnants of large ancient forest lands[2]. Studies substantiate the presence of rich endemism and biodiversity in grove areas apart from highlighting their ecological services and their role in livelihood development[3–8]. Present day groves are the epicentres of ecological research, conservation policy and management planning at state and national level[9,10]. However, in recent times sacred groves are threatened due to unplanned developmental activities apart from various biological (invasive species, soil erosion, land-use change, etc.) and social (loss of belief, violation of social taboos, change in religious and cultural life, population increment, etc.) threats.

Sacred groves vary in size from < 1 to > 100 ha, depending on their location and management profile. Larger groves, which are usually part of reserve/protected forest or under strong community management, are usually in conservation and management agenda for their expanse, rich biodiversity, heritage and cultural values. Nevertheless, changing social and cultural perspectives have altered the grove management system, thus influencing their existence. The fate is severe for the smaller groves or cluster of trees (especially < 1 ha) at sacred places, due to either disturbances (biological/social/developmental) or indifference because of their negligible spatial extent. Often, these are considered as vegetation patches without any biological and ecological significance, and provide meagre monetary benefits. In this context, question arises whether these small degrading groves or sometimes clusters of a few trees are really insignificant? Do they have any role to play in the local landscape? Whether or not conservation is necessary to protect them from further degradation?

Seeking an answer to these questions would be easier if we consider/conceptualize grove as a small fragment of forest or remnants of a past forest landscape. Forest fragmentation is the process whereby a large, continuous area of forest is both reduced in area and divided into two or more fragments. The decline in size of the forest and the increasing isolation between two remnant patches of the forest have been cited as one of the major causes of declining biodiversity[11]. Once a vast forest tract is fragmented, organisms have to face many adverse situations. These include opening up of habitat to the outer world, exposure to harsher climatic conditions, resource crunch, immigration of new members/competitors, etc., which ultimately lead to migration or extinction of a good number of species from the area. Therefore, ideally fragmentation is not desirable at any level. However, practically fragmentation is an obvious fact and is gaining momentum day by day all over the world. Therefore, how the species survive in a fragmented landscape, what are the adaptations taking place to the community due to fragmentation and conservation importance of fragmented landscape, are some of the burning issues in fragmentation research.

Fragmented patches serve as an integral part of the local landscape matrix[12]. Amidst the agriculture field and monoculture plantations, forest patches maintain the local biodiversity by increasing the likelihood of the survival of the indigenous members. For a sacred grove which is nothing but a fragmented forest patch nowadays, this biodiversity value is more significant as they contain many primary forest species due to their antiquity in origin[5]. Although secondary forest species as well as introduced species are also available due to higher order effect, primary members are noticed because of their longer life span. However small a grove could be, it influences the local biodiversity by providing shelter to a large number of small organisms such as arthropods, insects, microbes, amphibians along with the charismatic larger ones. It is evident that a couple of trees or even a single tree can support other life forms efficiently[13].

Scientific literature and reports from India suggest that groves support a variety of plant and animal species among the heterogeneous landscape matrix. However, documentation pertaining to small groves (< 1 ha) or a cluster of trees is either scanty or rare. Studies on selected groves in West Bengal show that groves within a size range of 0.04–1 ha harbour 114 species of flowering plants distributed in 52 different families whose ethnobotanical usage is noteworthy[14]. Similarly, 30 species of medicinal plants have been reported from three small groves (0.6–0.8 ha) in Midnapur district of West Bengal[15]. Sukumaran *et al.*[8,16] highlighted the floristic richness of 201 (13.1 ha area) and 11 (2.6 ha) miniature sacred groves of Kanyakumari district in Tamil Nadu. Collectively, these groves represent a good number of endemic, rare, endangered and economically important plants of the region. In Kerala, Sujana and Sivaperuman[17] have reported the presence of rare threatened flora in small sacred groves (0.08–0.33 ha) with an emphasis on their conservation importance.

The strategic locations of small fragments and their connectivity in landscape have paramount importance for maintaining ecological activities as well as local biodiversity. Ecological services like pollination and seed dispersal are mostly dependent on available faunal diversity whose survival is controlled by availability of favourable habitat. Bodin *et al.*[18] studied the importance of small patches (which are mostly preserved by local taboos) and the consequences of their sequential removal on pollination and seed dispersal in agricultural fields of southern Madagascar. Simulation models have shown the consequences of the removal of small patches ($\leq$ 3 ha) thus, affecting overall pollination activity in the study region. Similarly, seed dispersal by ring tail lemur was also affected by the removal of small patches as it affected their habitat/resting places or transport corridor. Moreover, result also shows that it is the position rather than size of the patch which plays an important role in pollination and seed dispersal services. Tambat *et al.*[19] studied the effect of grove area on seedling mortality of two species *Artocarpus hirsutus* (Moraceae) and *Canarium strictum* (Burseraceae). It has been found that, seedling fitness decreases as the grove area reduced which could be due to inbreeding among the fewer individuals and accumulation of lethal characters. The distance between the groves (average of 6.5 km) imposes constraint on pollination activities and also leads to inbreeding depression, reducing the survival capacity of individuals in the long run. This emphasizes the need to protect groves against fragmentation to ensure the conservation of threatened flora and fauna.

For faunal populations it has been found that, despite the absence of large predators, small mammals and other groups adapt to sustain the impact of fragmentation[20–22]. Gascon and Lovejoy[23] reviewed effects of fragmentation in Amazon. The study showed that edge effect is species specific – the diversity of birds and ants was found to decrease after fragmentation whereas frogs, small mammals and butterflies showed increase in diversity. Studies also indicate that survival of species in a fragment is more dependent on fragment quality rather than size. Fragment quality includes better management of fragment vegetation and its surroundings[24]. Considering avifauna, groves are already established as refugia for them[25,26]. In an agriculture-dominated landscape they provide the necessary microenvironment required for the local avifauna.

There is a need to explore and understand the role of these small patches in ecosystem services like carbon sequestration, temperature control and water conservation. Few studies in this direction however endorse the role and potential of groves. Being a part of relic forests, groves are repositories of ancient trees and undisturbed soils which play a pivotal role in sequestering considerable amount of carbon, which is evident from a study in Nagoni sacred grove, Garhwal Himalaya[27]. It is seen that carbon stock in vegetation and in soil is significantly higher in grove area compared to other forest ecosystems. Isolated small fragments may not have greater impact on temperature control in large scale but their role in local level cannot be ignored. Studies on scattered trees in African savanna have shown that due to interception of radiation and precipitation, they offer cooler microclimate in their surroundings[28], which act as shelter for many small organisms. Similarly in Australian woodland, it has been pointed out that, through stem flow and water uptake by root system and infiltration, water concentration is higher near the given tree as compared to the surrounding dry environment[29]. Considering the extreme small populations in degraded groves (as seen in many places of central and eastern India), these studies on temperature and water control could be useful to find out the local ecological importance of these scattered vegetations in an area.

It is important to remember that present day grove is a part of the local landscape matrix. Its unique biological diversity and ecological services are dependent on the complex interaction of organisms and environmental factors for which entire landscape matrix is involved. Fencing the grove for protection against grazing or cultivation of rare species for saving biodiversity may fulfil the short-term objectives but for long-term achievements landscape level management planning is necessary. It is an obvious fact that most of the surrounding landscapes in grove are economically productive areas (agriculture, plantation, construction, etc.). Therefore, any decision or planning towards landscape level conservation is extremely controversial and difficult to materialize[30]. However, concepts such as retention harvesting, agroforestry and green tree retention can be considered for this purpose as these are dealing with sustainable utilization of resources and integrated management of different land use forms. It is a common perception that large groves are worthy of conservation because of their species richness, probable ecological significance and their magnitude. On the contrary, smaller groves or cluster of trees at sacred places are often neglected due to their smallness and lack of knowledge about their potential. Although few studies have already pointed out their role in biodiversity and ecosystem maintenance, more detailed study is yet to be done at national and local levels. It should be kept in mind that these small patches can serve at a local level in a more efficient way in terms of management, cost and acceptance. For conservation purposes, these small patches usually require good monitoring to prevent further degradation and a certain minimum resource input for maintenance. In recent years, peoples' participation in conservation activity and planning is increasing positively. In fact the most important inherent law of successful conservation planning is how much it is acceptable to the local inhabitants. For a sacred grove, this issue is pivotal one as the concept is intermingled with peoples' cultural and religious life. Although sacred grove conservation is a known issue now, there is a possibility that the maximum positive effects could not come out due to some misconceptions. It is a popular idea that unless there is some minimum threshold size, the vegetation patch has no special significance in terms of biodiversity and ecology which eventually leads the farmer or villager to remove the patch[20]. For a single event or at a very small scale it may not have much impact but repeated occurrence of the same incidence gradually leads to altered landscape and ecosystem functioning. Alternatively, if the local people are informed about the biological/ecological significance of these small patches and are encouraged to protect them, conservation activity would be more accepted and widespread than the current extent.

Biodiversity encompasses a wide spectrum of life forms, from microbial to large vertebrates and giant trees, all contribute significantly to make our planet a hospitable place. However, it is our better understanding of some members and their magnificent presence (e.g. tiger, elephant, etc.), conservation activities are often inclined towards them at the cost of comparatively silent less charismatic members. An ideal conservation approach should treat every organism with same importance which we may find difficult to follow in reality but the goal must be set in that direction. The increment of fragmented forest lands in recent times compels ecologists and conservationists to reorient their thinking towards maximum utilization of minimum lands available for biodiversity and ecosystem conservation in a heterogeneous landscape. The importance of small groves or a cluster of trees in protecting various life forms outside the forest has already been established. The need of the hour is to generate awareness among people and proper planning to conserve these small patches at a local level. Ideas such as 'community reserve' as mentioned in the Wild Life (Protection) Amendment Act, 2002 can be utilized for favourable policy development to provide legal framework for these small patches apart from usual social protection from community. The timely acknowledgement of their invaluable services may help us to preserve biodiversity at humanized landscape.

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# TWO NEW FISH SPECIES OF THE GENUS *SCHISTURA* MCCLELLAND (CYPRINIFORMES: BALITORIDAE) FROM WESTERN GHATS, INDIA

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***web supplement***

**ABSTRACT**

Schistura nagodiensis *and* S. sharavathiensis *are the new fish species described from Sharavathi river, central Western Ghats. These species are distinct from their closest congeners in* Schistura*, which are evident from variations in the combination of characters such as processus dentiformis, barbels, bars on body, extent of lateral line with pores, marks on lower lip, ray counts, shape of caudal fin, caudal bar, adipose crest, etc. Distinct clusters of Principal Components based on morphometric variables (PCA) further substantiate that these are significantly different from their closest congeners.*

**KEYWORDS**

*Nemacheiline fishes, new descriptions, Principal Component Analysis (PCA),* Schistura nagodiensis*,* S. sharavathiensis *Sharavathi river, Western Ghats*

**ABBREVIATIONS**

CES - Centre for Ecological Sciences; IISc - Indian Institute of Science; ZSI - Zoological Survey of India; SRS - Southern Regional Station; WGBIS - Western Ghats Biodiversity Information System; SL - Standard length.

The freshwater fish family, Balitoridae has been divided into two sub-families; Balitorinae and Nemacheilinae. Balitorinae consists of genera *Bhavania*, *Homaloptera*, *Travancoria* and *Balitora*, whereas *Aborichthys*, *Triplophysa*, *Acanthocobitis*, *Yunnanilis*, *Neonemacheilus*, *Nemacheilichthys*, *Oreonectes*, *Longischistura*, *Physoschistura*, *Schistura*, *Mesonemacheilus* and *Nemacheilus* belong to the Nemacheilinae. Of these, *Schistura* McClelland, 1838 has the largest assemblage of Nemacheiline species (Jayaram, 1999), which inhabits mainly hill streams, waterfalls and also penetrates into sub-terranean region (Vidthayanon, 2003), having wide distribution throughout South, Southwest and Southeast Asia. Western Ghats of India with a distinct biogeographical regime, has six taxa, namely *S. semiarmatus, S. denisoni denisoni, S. nilgiriensis, S. kodaguensis, S. denisoni mukambbikaensis* and *S. denisoni pambaensis* (Jayaram, 1999). Recent discoveries of fish species in Western Ghats conforms Dahanukar *et al*. (2005) highlight that there are many more unexplored species in the region, which requires detailed field investigations.

Ichthyodiversity and species distribution studies carried out in Sharavathi river basin, Western Ghats (Fig. 1) covering all seasons and microhabitats over a period of 36 months has led to the discovery of two new species of *Schistura* in ecologically sensitive habitats as well as provided insight into habitat preference of many endemic and rare species.

## MATERIALS AND METHODS

Specimens were collected using a 1m × 2m net, dragging at the bottom of the streams and preserved in 6% formaldehyde, and were deposited at the Southern Regional Station, ZSI and CES, IISc. These specimens were classified as per Jayaram (1999) and compared using Menon (1987); Kottelat (1990); Talwar and Jhingran (1991); Kottelat (2004); Vishwanath and Shanta (2004); Vishwanath and Nebeshwar (2004); Vishwanath and Sharma (2005). Menon (1987); Kottelat (1990); and Jayaram (2002) were referred for terminologies and Kottelat (1990) for counts and measurements. Morphological measurements were done with a slide caliper (0.1mm precision). Thirty-one (26 nophometric and 5 meristic) characters of new species and congeners were analysed using Principal Component Analysis (STATISTICA, 1999).

## *Schistura nagodiensis* sp. nov.

### Material examined

Holotype: 26.xii.2003, Sharavathi river (13°54'40"N-74°53'49"E), Algod, Shimoga, Karnataka, coll. Sreekantha and Vishnu D, F-7595 ZSI/SRS, 28.0mm SL.

Paratypes: 12 exs., Sharavathi river (13°54'40"N-74°53'49"E), Algod, Shimoga, Karnataka, coll. Sreekantha and Vishnu D, 28.0mm SL and 25.0mm SL, F-7596 ZSI/SRS, 26.xii.2003; 25.0mm SL, 25.0mm SL, 26.0mm SL, 25.0mm SL, 26.0mm SL, 26.0mm SL, 25.0mm SL, 26.0mm SL, 25.0mm SL and 23.0mm SL IISc/CES/ WGBIS: 3-5-3-5-007.

### Etymology

Named after its type locality, Nagodi tributary of Sharavathi river, central Western Ghats.

### Diagnosis

A species of *Schistura* depicted in Image 1[w], distinguishable from other members by the following combination of characters; processus dentiformis present; 6-9 broad dark brown bars on body, the anterior bars not reaching ventral side; males without a suborbital flap; posterior extremity of anterior nostril prolonged in a filament; incomplete lateral line extending to half length of pectoral with 8-10 pores; lower lip with a black mark on each side of median interruption (Image 2[w]); 8 ½ dorsal rays, 7-9 pectoral, 6 pelvic and 9+9 caudal rays; deeply emarginate or slightly forked caudal fin; black basal caudal bar, sometimes interrupted; caudal fin with two rows of spots; no axillary pelvic lobe; anus much nearer to anal fin; weakly

[w] See Images in the websupplement at www.zoosprint.org



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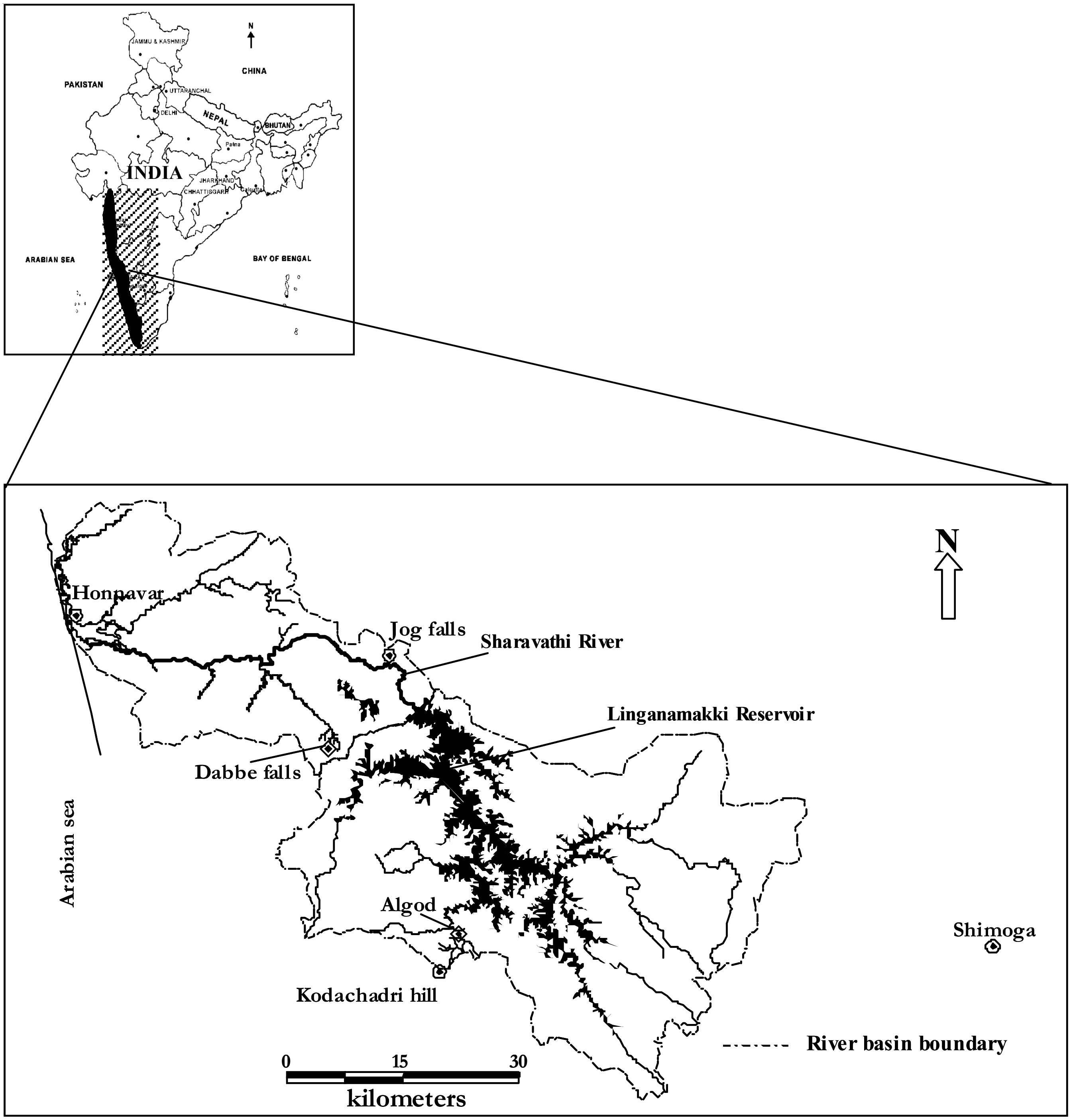


***Figure 1. Sharavathi river basin with type localities of Schistura nagodiensis (◈) and Schistura sharavathiensis (◈).***

developed adipose crest on peduncle.

**Description**

Morphological data and their proportionate values are listed in Tables 1 and 2 respectively. A relatively small species (largest 28mm in SL) compared to other species of *Schistura* with moderately elongated body, rounded anteriorly to origin of dorsal fin, slightly compressed thereafter; head depressed; snout obtuse; mouth semi-circular; lips thin, upper lip with a small incision in the middle, lower lip with a black mark on either side of median interruption; anterior nostril pierced in the front, posterior extremity prolonged in a filament; eyes large, diameter equals inter orbital width; barbels-inner maxillary shorter than outer, outer maxillary shorter than nasal, not extending to margin of eye; processus dentiformis present; incomplete lateral line with 8–10 pores, extending to half length of pectoral fin; cephalic lateral line system with 6 supraorbital, 4+10 infraorbital, 9 preoperculomandibular and 3 supratemporal pores; fin ray counts, dorsal 2/8½, pectoral 7–9, pelvic 1/6, anal 2/5 and caudal 9+9; dorsal fin equidistant from tip of snout to caudal fin base; distal margin of dorsal fin slightly convex; pelvic fin inserted slightly behind the origin of dorsal fin; anal fin at three quarters of SL, not reaching base of caudal fin; pectoral fin reaches half the distance to pelvic origin, pelvic fin extends beyond anus; caudal fin without axillary lobes, varies from deeply emarginate to slightly forked; weakly developed adipose crest on caudal peduncle.

**Colour**

Live specimens (in natural condition) light yellowish-brown with 6–9 dark brown cross bars, broader than interspaces; preserved specimens creamy white with black cross bars; bars broader along the lateral line, without reaching ventral surface and restricted to upper two-third of body except near caudal peduncle; near caudal peduncle extend to ventral surface; head and snout mottled with dark black spots; a shade of wine red on entire body surface, intense on dorsal fin in live specimens; two rows of spots at one quarter and three quarters of the height of dorsal fin; band on caudal fin base varies from dot to dissociate to complete; a prominent dark black spot on each side of median interruption.

**Habitat**

Specimen was collected from the Nagodi tributary, a perennial tributary of river Sharavathi with annual rainfall of over 5500mm. The catchment of this tributary is endowed with numerous torrential hill streams and vegetation cover (nearly 88%) (Figure 5a). Vegetation cover comprises of evergreen to semi-evergreen (36.54%), moist deciduous forests (20.04%), plantations (26.28%) and agricultural area (1.03%). The species is aptly named after the tributary to signify its occurrence as well as habitat preference.

**Distribution**

Sharavathi river basin, Central Western Ghats, Karnataka, India

**Discussion**

Characters such as elongated body with almost uniform depth, blunt snout, inferior mouth, dorsal fin inserted opposite to pelvic fin, with eight branched rays, emarginate caudal fin, pelvic fins not extending up to anal fin, body with scales, a dark band on the base of caudal fin, presence of characteristic colour pattern on the body in terms of cross bands and a band at the base of caudal fin indicates that this species is a member of *Schistura* genus.

Diagnostic features highlight that the new taxon has unique combination of characters compared to any other species of *Schistura* reported so far in Menon (1987), Kottelat (1990), Talwar and Jhingran (1991), Kottelat (2004), Vishwanath and Shanta (2004), Vishwanath and Nebeshwar (2004), and Vishwanath and Sharma (2005). Comparison with the species of Western Ghats is provided in Table 3. *Schistura nagodiensis* is comparable only to *S. kodaguensis* Menon. However, it differs from *S. kodaguensis*, which has 11–14 bands, tapering below, caudal fin slightly emarginate, dorsal with a light margin bounded below by an arched black band and a dark base. It resembles to *S. robertsi* in the presence of black mark on the median part of lower lip, prolonged nasal filament, and banding pattern on the body, while differing in caudal fin (emarginate and with one row of dark pigments on the proximal area in *S. robertsi*), dorsal branched rays (7½), caudal rays (8–9+8 in *S. robertsi*). Plot of principal components (of PCA) gives distinct clusters indicating variations between *S. nagodiensis* and *S. kodaguensis* (Fig. 2). Eigen value of PC 1 is 264.2 (accounts for 98.85% variability) and PC 2 is 2.63. Appendix-I provides identification keys to new species.

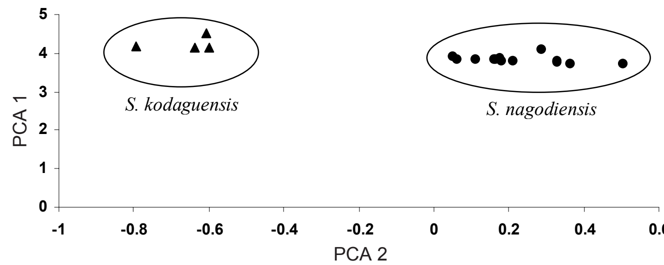


***Figure 2. Plot of principal components of 31 morphological parameters*** **– Schistura nagodiensis *and* S. kodaguensis**

**Comparative Material**

*Schistura kodaguensis*: 06.x.2004, Kootu Holé (12⁰26'59"N-75⁰42'46"E), about 8km northwest of Mercara, Coorg, Karnataka, 2 exs. 23.0mm SL and 29.0mm SL, coll. Sreekantha, Vishnu D. and Gururaja K.V., IISc/CES/WGBIS: 3-5-3-5-005.

*Schistura nilgiriensis*: 06.xi.2003, Sharavathi river, Niluvase (13⁰44'18"N-75⁰06'30"E), Shimoga, Karnataka, 2 exs. 39.0mm SL. and 43.0mm SL, coll. Sameer Ali, Gururaja KV and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-004.

*Schistura denisoni denisoni*: 21.xi.2003, Sharavathi river (13⁰52'44"N-75⁰03'64"E), Jayanagar, Shimoga, Karnataka, 2 exs. 31.0mm SL and 39.0mm SL, coll. Sreekantha and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-001.

*Schistura semiarmatus*: 23.xi.2003, Sharavathi river (75⁰03'52"N-13⁰52'45"E) Suttha, Shimoga, Karnataka, 2 exs. 32.0mm SL and 34.0mm SL. Coll. Sreekantha and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-006.

## *Schistura sharavathiensis* sp. nov.

**Material examined**

Holotype: 26.iii.2004, Sharavathi river (14⁰8'15"N-74⁰44'30"E), Kalkatte tributary, 1km upper to Dabbe falls, Shimoga, Karnataka, 29.0mm SL, coll. Sreekantha and Vishnu D. F–7597 ZSI/SRS.

Paratypes: 26.iii.2004, 3 exs., 26.0mm SL and 24.0mm SL, ZSI/SRS F–7598, 28.vii.2004; 26.0mm SL, IISc/CES/WGBIS: 3-5-3-5-008, locality and collectors as in Holotype.

**Etymology**

Named after its type locality, Sharavathi river, Central Western

Ghats.

**Diagnosis**
A species of *Schistura* depicted in Image 3$^{w}$, distinguishable from other members by the following combination of characters: processus dentiformis well developed; 16–18 almost regular brown bars on body, narrower than interspaces; males without suborbital flap; nasal tube with a prolonged barbel, long with unculi; lateral line with 5–6 pores, reaching one third of pectoral fin; lower lip with a median interruption, each side with 4–5 deep furrows; 8½ dorsal, 9 pectoral, 7 pelvic and 7–8+8 caudal rays, slightly emarginate caudal fin; black basal caudal bar with a darker central spot; caudal fin plain; no axillary pelvic lobe; pelvic origin below dorsal or slightly behind; anus much nearer to anal fin; a long and high adipose crest from just behind dorsal fin, a shorter ventral crest.

**Description**
Morphological and proportionate values of *Schistura sharavathiensis* are listed in Tables 1 and 2 respectively. Body moderately elongate, depth increasing to dorsal fin and thereafter tapering posteriorly; mouth semi-circular; both lips fleshy, median incision in upper lip and lower lip interrupted in the middle with 4–5 deep furrows on each side (Image 4$^{w}$); processus dentiformis well-developed; nasal tube with a prolonged barbel; head length slightly greater than depth; barbels well-developed, long with unculi; nasal barbel prolonged as in members of the genus *Oreonectes* of the same family; lateral line incomplete, ending at mid level of mid region of pectoral fin, with 5–6 pores, cephalic lateral line system with 6 supraorbital, 4+8 infraorbital, 9 preoperculomandibular and 3 supratemporal pores; fin ray counts include, dorsal $8^{1}/_{2}$ , pectoral 9, pelvic 1/7, anal 2/5 and caudal 7–8+8; dorsal fin equidistant from tip of snout to caudal fin base; dorsal fin with convex distal margin; pelvic fin does not reach vent and separated by a wide distance; no axillary pelvic lobe; anal fin not reaching caudal fin base; pectoral fin reaches half the distance to pelvic origin; pelvic fin reaches half the distance to anal fin without reaching anus; caudal fin slightly emarginate with rounded lobes and upper lobe longer than lower; long ventral and dorsal adipose crest present.

**Colour**
Body light yellowish-brown with 16–18 almost regular thin cross bars, narrower than interspaces, dark brown in live specimens and dull white in preserved specimens, the bars reach ventral surface behind dorsal fin; dorsal fin with a row of spots at three quarters height; caudal fin plain with dissociated band at base with a central spot; other fins without any prominent colour pattern.

**Distribution**
Sharavathi river basin, Central Western Ghats, Karnataka, India.

**Discussion**
*Schistura sharavathiensis* resembles the species of the genus *Longischistura* Banarescu and Nalbant, only in the presence of a long adipose crest extending from a short distance behind

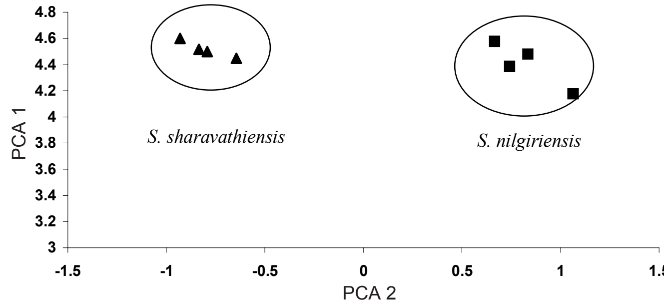


***Figure 3. Plot of principal components of 31 morphological parameters – Schistura sharavathiensis and S. nilgiriensis***

dorsal fin to caudal base; but differs with respect to 10 dorsal rays, deeply forked caudal fin, complete to almost complete lateral line in *Longischistura* genus. It also resembles genus *Indoreonectes* in long nasal barbel (*Oreonectes* genus, Kottelat, 1990) and adipose crest on the caudal peduncle. However, it differs from *I. keralensis* and *I. evezardi* in the presence of rounded and banded caudal fin, broad and incomplete, irregular vertical bands or mottled all over the body. The identity of the species is confirmed based on the available literatures of *Schistura* in South-Asian region (Menon, 1987; Kottelat, 1990; Talwar and Jhingran, 1991; Jayaram, 1999; Kottelat, 2004; Vishwanath and Nebeshwar, 2004; Vishwanath and Shanta, 2004; Vishwanath and Sharma, 2005). Table 3 shows the comparison between the six recorded taxa of Western Ghats, which reveals that *S. sharavathiensis* differs significantly from the congeners, except for *S. nilgiriensis*. It differs in the presence of 5–14 vertical bands and a black spot at anterior base of dorsal fin in *S. nilgiriensis*. Appendix-I gives the identification keys for species. Plot of principal components (of PCA) shows different clusters indicating variations between *S. sharavathiensis* and *S. nilgiriensis* (Fig. 3) with eigen values of 159.29 for PC 1 (accounts for 96.48% variability) and 5.42 for PC 2.

**Comparative Material**
*Schistura kodaguensis*: 06.x.2004, Kootu Holé (12$^{0}$26'59"N-75$^{0}$42$^{0}$46"E), about 8 km northwest of Mercara, Coorg, Karnataka, 2 exs. 23.0mm SL and 29.0mm SL, coll. Sreekantha, Vishnu D. and Gururaja K.V., IISc/CES/WGBIS: 3-5-3-5-005.

*Schistura nilgiriensis*: 06.xi.2003, Sharavathi river, Niluvase (13$^{0}$44'18"N-75$^{0}$06'30"E), Shimoga, Karnataka, 2 exs. 39.0mm SL. and 43.0mm SL, coll. Sameer Ali, Gururaja KV and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-004.

*Schistura denisoni denisoni*: 21.xi.2003, Sharavathi river (13$^{0}$52'44"N-75$^{0}$03'64"E), Jayanagar, Shimoga, Karnataka, 2 exs. 31.0mm SL and 39.0mm SL, coll. Sreekantha and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-001.

*Schistura semiarmatus*: 23.xi.2003, Sharavathi river (75$^{0}$03'52"N-13$^{0}$52'45"E) Suttha, Shimoga, Karnataka, 2 exs. 32.0mm SL and 34.0mm SL. Coll. Sreekantha and Vishnu D, IISc/CES/WGBIS: 3-5-3-5-006.

***Table 1. Nophometric characteristics of*** **Schistura nagodiensis** ***sp. nov. and*** **Schistura sharavathiensis** ***sp. nov. (dimensions in mm)***

| Parameters | *Schistura nagodiensis* | | | | *Schistura sharavathiensis* | | | |
|---|---|---|---|---|---|---|---|---|
| | Holotype | Range (n=13) | Mean | SD | Holotype | Range (n=4) | Mean | SD |
| Total length | 34.0 | 28.0–34.0 | 30.9 | 1.2 | 35.0 | 31.0–35.0 | 32.5 | 1.7 |
| Standard length | 28.0 | 23.0–28.0 | 25.6 | 1.1 | 29.0 | 24.0–29.0 | 26.2 | 1.7 |
| Body depth | 3.7 | 3.0–5.0 | 3.9 | 0.6 | 4.4 | 3.7–4.4 | 4.0 | 2.1 |
| Head length | 6.0 | 5.0–6.0 | 5.4 | 0.5 | 5.4 | 5.3–5.9 | 5.6 | 0.3 |
| Head width | 3.8 | 2.7–3.8 | 3.2 | 0.3 | 3.5 | 3.2–4.3 | 3.7 | 0.3 |
| Eye diameter | 1.3 | 0.9–1.5 | 1.3 | 0.2 | 1.5 | 1.2–1.5 | 1.4 | 0.5 |
| Inter orbital width | 1.5 | 0.9–1.7 | 1.3 | 0.2 | 1.6 | 1.2–1.8 | 1.5 | 0.2 |
| Width of mouth | 1.8 | 1.4–1.9 | 1.6 | 0.2 | 1.9 | 1.9–2.4 | 2.1 | 0.2 |
| Snout length | 2.0 | 1.5–2.5 | 1.9 | 0.3 | 2.6 | 2.1–2.6 | 2.3 | 0.2 |
| Height of head at occiput | 2.8 | 1.9–3.1 | 2.6 | 0.3 | 3.3 | 3.0–3.4 | 3.2 | 0.2 |
| Pre-dorsal length | 14 | 11.7–14 | 12.7 | 0.6 | 14.0 | 12.0–14.0 | 13.2 | 0.2 |
| Post dorsal length | 13.5 | 12.0–13.5 | 12.6 | 0.5 | 13.7 | 12.0–13.7 | 12.9 | 0.9 |
| Inter-nostril distance | 1.4 | 0.6–1.5 | 1.2 | 0.3 | 1.1 | 0.9–1.5 | 1.2 | 0.7 |
| Pre-pelvic distance | 14.5 | 11.3–14.5 | 12.5 | 1.1 | 13.8 | 10.8–13.8 | 12.1 | 0.3 |
| Height of dorsal fin | 3.8 | 3.2–4.4 | 3.9 | 0.3 | 5.8 | 5.1–5.8 | 5.4 | 1.3 |
| Length of base of dorsal fin | 4.7 | 3.1–4.7 | 3.9 | 0.5 | 4.2 | 4.2–5.0 | 4.4 | 0.3 |
| LCPD | 4.3 | 3.3–4.5 | 3.7 | 0.4 | 3.6 | 3.6–4.3 | 4.0 | 0.4 |
| HCPD | 3.5 | 2.8–3.9 | 3.2 | 0.3 | 4.2 | 3.1–4.7 | 3.8 | 0.3 |
| Length of base of anal fin | 2.2 | 1.9–3.5 | 2.4 | 0.4 | 2.7 | 1.6–2.7 | 2.1 | 0.7 |
| Length of pectoral fin | 4.2 | 3.8–4.7 | 4.3 | 0.2 | 5.1 | 3.4–5.2 | 4.6 | 0.6 |
| Length of pelvic fin | 4.1 | 3.3–4.3 | 3.9 | 0.3 | 4.7 | 3.7–4.7 | 4.2 | 0.8 |
| Pre-anal length | 19.0 | 15.0–19.0 | 17.1 | 1.0 | 21.0 | 18.2–21.0 | 19.1 | 0.4 |
| Pre-anus length | 20.0 | 17.0–21.0 | 18.7 | 1.2 | 18.0 | 14.3–18.0 | 16.6 | 1.3 |

HCPD - Height of caudal peduncle; LCPD - Length of caudal peduncle

***Table 2. Proportional values of morphometry of*** **Schistura nagodiensis** ***sp. nov. and*** **Schistura sharavathiensis** ***sp. nov.***

| Parameters | *S. nagodiensis* (N = 13) | | *S. sharavathiensis*(N = 4) | |
|---|---|---|---|---|
| | Range | Mean ± S.D. | Range | Mean ± S.D. |
| Standard length (mm) | 23.0–28.0 | 28.0 (max) | 24.0–29.0 | 29.0 (max) |
| Total length (mm) | 28.0–34.0 | 34.0 (max) | 31.0–35.0 | 35.0 (max) |
| **%Standard length** | | | | |
| Body depth | 12.0–20.0 | 15.2 ± 2.3 | 14.2–16.2 | 15.3 ± 0.9 |
| Head length | 19.2–26.1 | 21.3 ± 2.0 | 18.6–22.7 | 21.3 ± 1.8 |
| Snout length | 6.4–10.0 | 7.5 ± 1.1 | 8.1–9.6 | 8.8 ± 0.6 |
| Pre-dorsal length | 47.6–52.0 | 49.8 ± 1.4 | 48.3–53.1 | 50.3 ± 1.9 |
| Pre-pelvic length | 45.2–56.0 | 48.9 ± 3.0 | 43.5–47.7 | 45.9 ± 2.0 |
| Height of dorsal fin | 12.8–18.7 | 15.3 ± 1.6 | 19.6–22.9 | 20.8 ± 1.5 |
| Base of dorsal fin | 11.9–17.2 | 15.4 ± 1.7 | 14.5–19.2 | 16.9 ± 2.1 |
| Pectoral fin length | 15.0–20.4 | 16.8 ± 1.5 | 13.1–20.0 | 17.7 ± 3.3 |
| Pelvic fin length | 13.2–16.5 | 15.1 ± 0.9 | 14.2–18.3 | 16.0 ± 1.7 |
| Base of anal fin | 7.6–12.6 | 9.3 ± 1.4 | 6.5–9.6 | 8.0 ± 1.6 |
| Length of caudal fin | 16.2–24.0 | 20.9 ± 2.2 | 20.7–29.1 | 24.0 ± 3.6 |
| Length of caudal peduncle | 13.2–17.3 | 14.7 ± 1.2 | 12.4–17.1 | 15.4 ± 2.1 |
| Pectoral fin to pelvic fin distance | 22.8–36.0 | 27.6 ± 3.6 | 21.5–28.9 | 24.6 ± 3.2 |
| Pre-anal length | 68.0–80.0 | 73.2 ± 3.4 | 70.0–75.8 | 72.8 ± 2.4 |
| **Other proportions (%)** | | | | |
| VA in PA | 14.3–40.0 | 26.7 ± 8.9 | 15.5–52.7 | 33.9 ± 16.5 |
| HCPD in LCPD | 62.2–97.1 | 86.1 ± 9.3 | 75.6–116.7 | 96.1 ± 19.9 |
| Eye diameter in Snout length | 52.4–88.2 | 67.7 ± 11.3 | 52.2–71.4 | 62.4 ± 8.9 |
| Snout length in Head length | 28.3–50.0 | 35.4 ± 6.5 | 36.8–48.1 | 41.4 ± 5.4 |
| IOW in Eye diameter | 80.0–115.4 | 98.1 ± 9.5 | 100.0–120.0 | 106.6 ± 9.4 |
| Eye diameter in Head length | 15.0–30.0 | 23.7 ± 4.2 | 22.6–27.8 | 25.5 ± 2.2 |

VA in PA - Vent to anal fin origin in pelvic fin to anal fin; HCPD in LCPD - Height of caudal peduncle in length of caudal peduncle; IOW - Interorbital width

***Table 3. Comparison of morphological characters of* Schistura *of Western Ghats.***

| Species | SL (mm) | Pectoral fin rays | Black spot on Dorsal fin | Rows of spots on caudal fin | Lateral line | Caudal fin shape | Bars on body |
|---|---|---|---|---|---|---|---|
| ***Schistura nagodiensis* sp. nov.** | 28 | 7–9 | Absent | Feeble | Incomplete | Deeply emarginated | 7–9 |
| ***Schistura sharavathiensis* sp. nov.** | 29 | 9 | 1/4$^{th}$ the height | Absent | Incomplete | Slightly emarginated | 16–18 thin bands |
| ***Schistura denisoni denisoni*** | 51.1 | 11 | At the base | Present | Incomplete | Deeply emarginated | Variable |
| ***Schistura denisoni pambaensis*** | 40 | 11 | At the base | Present | Incomplete | Deeply emarginated | 10–14 |
| ***Schistura denisoni mukambbikaensis*** | 36 | 10 | At the base | Present | Incomplete | Deeply emarginated | 5–6 |
| ***Schistura kodaguensis*** | 36 | 10 | Absent | Present | Incomplete | Slightly emarginated | 11–14 |
| ***Schistura semiarmatus*** | 56.5 | 11 | At the base | Present | Complete | Slightly forked | 9–10 |
| ***Schistura nilgiriensis*** | 51 | 10 | At the base | Absent | Incomplete | Emarginated | 11–13 |

### *Key to the* Schistura *species of the Western Ghats (modified after Jayaram, 1999).*

1. Lateral line complete; body with bands and conspicuous black spots. ................................................................ *S. semiarmatus*
- Lateral line incomplete; body with only bands. .......................................................................................................... 2

2. Black spot at anterior base or slightly above on dorsal fin ...................................................................................... 4
- No black spot at anterior base or slightly above on dorsal fin ................................................................................ 3

3. 11–14 black bars on body, black markings on lower lip absent, feeble if present, caudal fin emarginate .................. *S. kodaguensis*
- 6–9 black bars on body, two black markings on lower lip, caudal fin deeply emarginate or slightly forked .... ***S. nagodiensis* sp.nov**

4. Caudal fin slightly emarginate, without rows of spots .............................................................................................. 5
- Caudal fin deeply emarginate or slightly forked, with 3 or 4 rows of spots .............................................................. 6

5. 11–12 brown bars, broader than interspaces; black spot at base of dorsal fin; moderately long nasal barbels .............. *S. nilgiriensis*
- 16–18 brown bars, narrower than interspaces; black spot at 1/4$^{th}$ height of dorsal fin; very elongated nasal barbel .......................... ........................................................................................................................ ***S. sharavathiensis* sp.nov**.

6. Body slender, about 6.5 times in SL; pelvic fin separated from anal opening by a considerable distance ...... *S. denisoni pambaensis*
- Body deeper, about 5 to 5.5 times in SL; pelvic fin reaching or almost reaching anal opening .................................................... 7

7. Pelvic fin reach anal opening; caudal fin deeply emarginate with several rows of spots; dorsal with rows of spots ......................... ........................................................................................................................................... *S. denisoni denisoni*
- Pelvic fin falling short of anal opening; caudal fin slightly emarginate without conspicuous spots; dorsal with a dark base and a dark band at distal end ....................................................................................................... *S. denisoni mukambbikaensis*

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# Nestedness pattern in freshwater fishes of the Western Ghats: an indication of stream islands along riverscapes

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**Fragmented habitats exhibit distinctive patterns of species richness and species composition. They often exhibit patterns of pronounced nestedness, wherein the species present in comparatively depauperate locations represent statistically proper subsets of those present in locations that are richer in species. The current study has been conducted on the freshwater fishes of Sharavathi River, considering 41 stream and reservoir sites with 261 sampling events to understand the nestedness pattern in fish communities. Of the 64 fish species collected, 39 are from the reservoir and 33 from the stream islands. For the species of the stream islands, including the reservoir fishes in the stream, the nestedness index, *T* was 8.27°C, while species exclusive to stream islands had *T* = 10.5°C. In contrast, in species that are common to both stream islands and the reservoir, *T* was 0.37°C. Relatively higher *T* in the exclusive stream species composition implies that they are highly depauperated due to fragmentation in the streams and its negative influence on the stream fish communities.**

**Keywords:** Community structure, freshwater fish, habitat fragmentation, island biogeography, nestedness pattern, riverscape, stream island, Western Ghats.

HUMAN activities have changed about one-third to one-half of the earth's land surface and are leading to substantial and growing modification of the earth's biological resources. Worldwide, 34 areas have been identified as biodiversity hotspots that have exceptional concentrations of endemic species and are experiencing exceptional loss of habitat[1,2]. It is estimated that in 1995 more than 1.1 billion people, nearly 20% of the world's population, were living within these hotspots that cover about 12% of the earth's terrestrial surface, with a population growth rate of 1.8% $yr^{-1}$, which is substantially higher than that of the world as a whole (1.3% $yr^{-1}$) as well as above that of the developing countries (1.6% $yr^{-1}$)[3]. Humans derive many utilitarian benefits from ecosystem services and goods, and the resulting impact on the global biosphere now controls many major facets of ecosystem functions[4,5], especially in the tropical regions. The most important impact is the massive degradation of habitat and extinction of species, taking place on a catastrophically short time-scale[6], resulting in the modification of both the identities and numbers of species in ecosystems[7]. The decline of many biological populations worldwide is attributed to habitat fragmentation of the terrestrial and aquatic ecosystems[8].

In aquatic systems, fragmentation can have deleterious effects on ecosystem integrity. A continuous (non-fragmented) riverine ecosystem is dominated by flow seasonality imposed by monsoonal rains[9], with floods and droughts as important features of these rivers. The aquatic environments are known for their dynamic nature, especially stream landscapes, which are highly variable in space and time. Dynesius and Nilsson[10] determined that 77% of the total discharge of the 139 largest river systems in the northern third of the world is affected by river fragmentation caused by dams, reservoirs, inter-catchment diversions, and irrigation. Thus construction of dams has resulted in the disruption of natural dispersal pathways and subsequent changes in the structure and function of aquatic and wetland communities[11], and is regarded as the biggest conservation threat to aquatic communities in many river basins throughout the world[12] due to the biased extinctions of rare species[7]. Thus understanding how populations persist in fragmented environments is a central problem in basic and applied ecology.

Among fishes inhabiting running waters, three modes of adaptation (life history, behavioural and morphological) exist for surviving floods and droughts[13]. Many species have clear adaptation to life in rapidly flowing streams, few other typical of upstream regions, large and predators are exclusive to the deep pools. Overall life-history stages of the stream fishes must be adapted to changes that occur at different spatial and temporal scales. Morphological, physiological and behavioural characteristics accompanied by climatic factors result in migration of fish species that is reflected by local extinction during unfavourable conditions and recolonization during favourable conditions[14].

Fragmented habitats, both terrestrial and aquatic, tend to exhibit distinctive patterns of species richness and species composition. As fragmentation of natural, continuous habitats continues, the areas of the fragments become

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smaller, and distances between them increase. The taxa occurring in fragments become isolated, as the surrounding habitat is often unsuitable, hampering successful immigration[15]. In such conditions, species distribution patterns within these fragmented habitats have often exhibited patterns of pronounced nestedness[16], which are common among many communities[17].

A nested biota is one in which the species present in comparatively depauperate locations represent statistically proper subsets of those present in locations that are richer in species. An area of suitable habitats, initially inhabited by a common ancestral biota, is fragmented into an archipelago of islands. On each island of the archipelago, there will be one species which is nearest its minimum sustainable population size, and thus at greatest risk of local extinction. As the area continues to shrink, populations of the archipelago's constituent species will tend to become extinct in the order of their specific extinction risks[18]. This orderly extinction pattern is the key factor in the nestedness pattern. The nestedness phenomenon has been recognized for quite some time, but only recently have statistical tests been developed for the analysis of orderliness in species assemblages[19]. Patterns of community structure in many naturally and anthropogenically fragmented environments can be analysed[20]. The best way to quantify nestedness is to use the Atmar and Patterson method, which utilizes a combination of a thermodynamic measure of order and a Monte-Carlo simulation[21]. The nestedness pattern has been revealed for several archipelagos and communities associated with them, e.g. plants, mussels, butterflies, caddisflies, orthopterans, fish parasites, fish, amphibians, reptiles, birds and mammals[15,17,19–21].

Fish assemblages in tropical rivers are characterized by high taxonomic diversity[22]. Recent compilation of freshwater and secondary freshwater fishes of the Western Ghats shows that there are 318 species, of which 27 are critically endangered and 55 endangered, while 128 are data-deficient species. Of the 27 critically endangered species, 24 are endemic to the region. Similarly, of the 55 endangered species, 37 are endemic. Yet, 49 endemic species are data-deficient[23]. Analysis of fish species composition, distribution and ecological status with reference to the terrestrial ecosystem in the catchment, revealed the preference of the endemic fish fauna to perennial streams with their catchments having evergreen to semi-evergreen forests, which also have higher levels of plant endemism[24]. Many of the species in the Western Ghats are characterized by their localized distribution (to a river basin or part of a river basin) and specific adaptation to lotic environments. Although damming the rivers at small scales is being practised widely in the region for centuries, with large-scale planning, massive projects have been initiated and implemented over the past century. The necessity to understand the implications of aquatic habitat fragmentation and its influence on the fish species composition and structure resulting due to such massive transformation has led the present study. This is the first attempt to provide the nestedness pattern in the fish community in the Western Ghats, something that is unique for fish survey. As most of the rivers of the Western Ghats are now altered, understanding the implications is vital for the effective management and restoration of running water ecosystems of the region.

## Materials and methods

### *Study area*

Sharavathi river (catchment area of 2784 km$^2$), one of the west-flowing rivers of Central Western Ghats, traverses over a distance of 132 km before joining the Arabian Sea (Figure 1). The region spans between 74°50′54″–75°30′63″E and 13°77′08″–14°7′27″N. It receives high annual rainfall (1715–5598 mm) that occurs mainly during June to October. The river has been exploited to generate hydroelectric power, which resulted in the construction of two major dams across it. The Linganamakki dam (74°50′54″E, 14°14′24″N, 512 m amsl), constructed in 1964 has a water-spread area of 326.34 km$^2$.

Eight major tributaries with numerous stream networks of this river are considered as sub-basins. These sub-basins with undulating terrains have tropical evergreen, semi-evergreen and moist deciduous forests in their catchments[24]. Formation of lacustrine ecosystem in the form of the Linganamakki reservoir has isolated these eight sub-basins into discrete flowing reaches, disrupted the flow connectivity and converted them into stream islands. We used the terms 'stream island' and 'sub-basin' interchangeably, according to the context.

### *Sampling*

Fish sampling was carried out in 41 selected stream and reservoir sites with 261 samplings from January 2002 to August 2004. Collections were made using gill nets, cast nets, dragnets and hooks and lines of varying sizes[24]. Within each site all microhabitats like riffle zone, pools, cascade, falls, embayment, run and plunge were considered for sampling. Based on the standard literature available, the collected specimen were identified[24]. Species richness of a stream island is the sum total of the individual sampling species richness that falls within the catchment of a sub-basin. Similarly, species richness from the sampling sites of the reservoir was pooled and used as a reference list.

### *Data analysis*

Presence–absence (1 = present, 0 = absent) matrices were assembled representing stream islands as rows in order of decreasing species richness and species as columns in

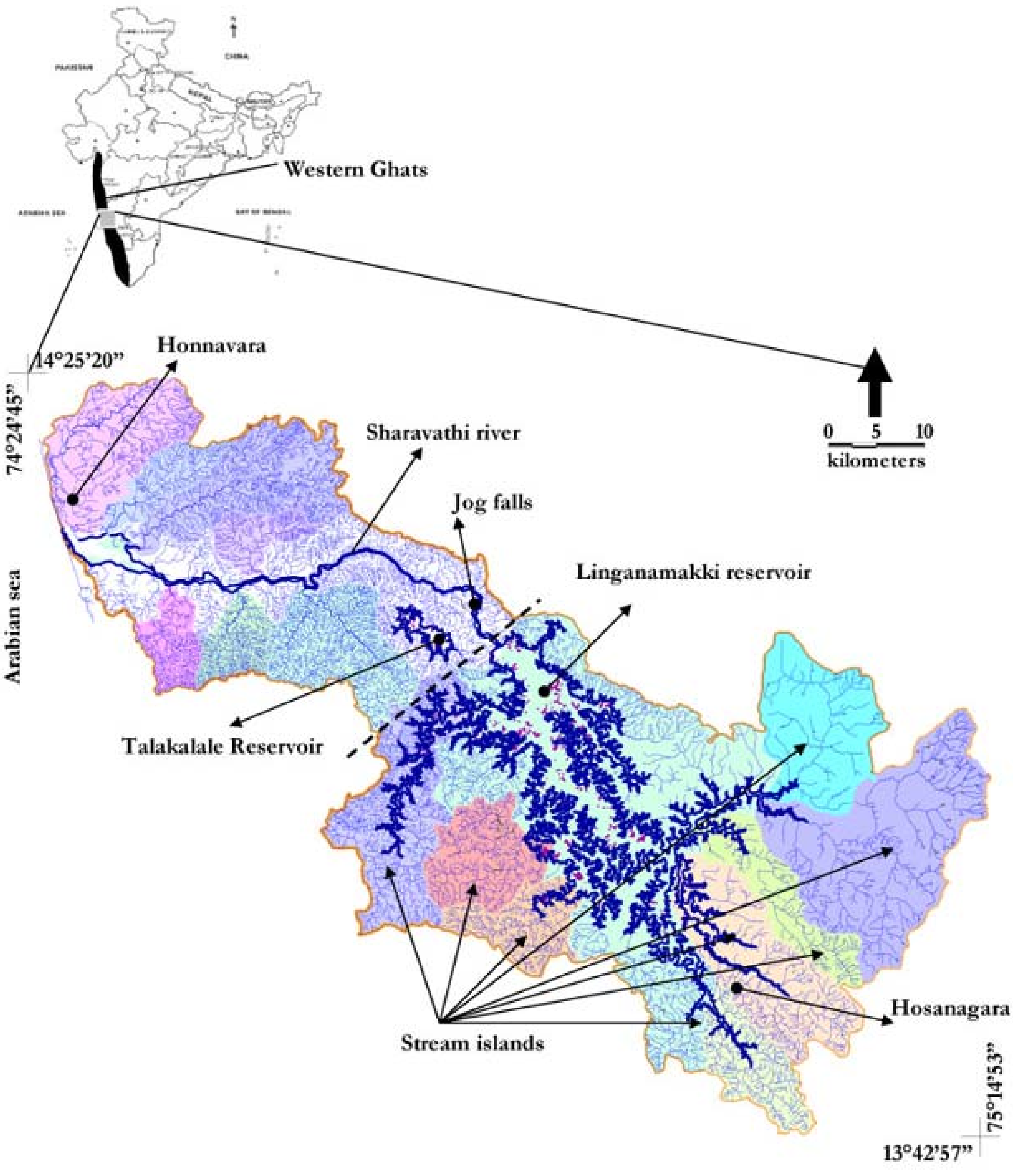


**Figure 1.** Sharavathi river basin drainage network. South of dashed line constitutes study area.

order of decreasing ubiquity. Nestedness analyses for different groups of species were carried out in stream islands, viz. (i) all species from the stream islands, (ii) species common to stream islands and reservoirs (derived from reference list) and (iii) species that are exclusive to stream islands.

The basis for this classification was purely on the species occurrence during sampling. Nestedness of species assemblages was determined using nested temperature calculator[25]. Nested patterns can be related to thermodynamics[26] with an index *T* on scale of 0–100°C, with 0°C representing complete nestedness and 100°C representing complete randomness[25]. Indication of unmarked heterogeneity in the original dataset is given by the mixed presence and absence of species or sites along the boundary line. The stability of individual populations was determined by calculating the state occupancy of the individual species[18]. Monte-Carlo randomizations of the data matrix

**Table 1.** Stream island-wise data on fish attributes and corresponding land-use values

| Data type | Parameter | Eastern stream islands | | | Southern stream islands | | Western stream islands | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Nandi Holé | Haridravathi | Mavina Holé | Sharavathi | Hilkunji | Huruli Holé | Nagodi | Yenne Holé |
| Fish | Species richness | 22 | 25 | 22 | 28 | 25 | 32 | 41 | 49 |
| | Western Ghats endemics (%) | 8.3 | 14.3 | 9.1 | 22.2 | 20.0 | 40 | 23.5 | 35.5 |
| | Endangered (%) | 0.0 | 7.1 | 9.1 | 5.5 | 13.3 | 12.0 | 11.8 | 9.7 |
| | Vulnerable (%) | 16.7 | 21.4 | 9.1 | 16.7 | 6.7 | 24.0 | 17.6 | 0.0 |
| | Lower risk (%) | 58.3 | 57.1 | 63.6 | 61.1 | 66.7 | 44.0 | 52.9 | 38.7 |
| | Data deficient (%) | 16.7 | 14.3 | 18.2 | 11.1 | 13.3 | 12.0 | 17.7 | 22.6 |
| Land-use | Semi-evergreen (%) | 3.31 | 2.3 | 4.4 | 19.2 | 43.3 | 32.8 | 52.1 | 37.9 |
| | Moist-deciduous (%) | 38.1 | 28.2 | 41.6 | 22.9 | 22.5 | 27.9 | 16.6 | 19.8 |
| | Plantation (%) | 5.5 | 5.6 | 7.9 | 14.7 | 11.6 | 10.7 | 13.7 | 15.9 |
| | Water (%) | 0.01 | 0.1 | 0.03 | 0.0 | 0.0 | 0.9 | 0.0 | 0.1 |
| | Agricultural (%) | 11.3 | 18.2 | 9.8 | 10.3 | 4.2 | 1.9 | 1.1 | 1.4 |
| | Non-vegetated (%) | 11.1 | 13.9 | 11.6 | 12.5 | 5.6 | 7.6 | 7.5 | 10.1 |
| | Open field (%) | 30.6 | 31.9 | 24.7 | 20.4 | 12.9 | 18.2 | 9.1 | 14.9 |

Note: Non-vegetated: Habitation, roads, rocky area; Open field: uncultivated agricultural land, barren land, dry river bed.

(500 runs) were used to compare with the observed matrix. If the obtained value was lower than that of the randomly generated assemblage, the assemblage can be declared as nested[27].

## Results and discussions

The present investigation reports 64 fish species from the study area. Among these, 39 species are found in reservoir sampling sites (lacustrine region) and 33 in the stream islands. Stream island-wise data on species richness, endemism, IUCN (World Conservation Union) status, existing land-use pattern and fragmentation details are given in Table 1. Species richness, endemism and extent of threatened species are relatively high in the western stream islands than the southern and eastern stream islands. Similar pattern follows in case of forest cover, wherein extent of semi-evergreen to evergreen forests is relatively more in the western stream islands than the southern and eastern stream islands.

### *Nestedness pattern*

The species assemblages in eight stream islands were nested significantly as indicated by the *T* value (Tables 2–5). Nestedness index considering all the species from the stream islands was 8.27°C, the probability of which is similar to a randomly generated nesting pattern is almost zero ($P < 6.15 \times 10^{-10}$). The species such as *Schistura denisonii denisonii*, *Oreichthys cosuatis* and *Schistura semiarmatus* with both unexpected presence and unexpected absence along with stream island Nandi Holé are responsible for idiosyncrasy. Presence of *Amblypharyngodon melettina* in the Hilkunji stream island and *Barilius gatensis* in the Haridravathi stream island represents unexpected presence (Table 2). These are the species with high risk of local extinction from those stream islands. Similarly, the ideal candidates for reintroduction are *O. cosuatis* to Huruli, Sharavathi and Haridravathi stream islands, *S. semiarmatus* to Huruli stream island and *Schistura* sp. to Yenne Holé stream island, where their probability of survival is high.

*Aplocheilus lineatus*, *Barilius bendelisis*, *Brachydanio rerio*, *Chanda nama*, *Cirhina fulungee*, *Danio aequipinnatus*, *Garra gotyla stenorhynchus*, *Lepidocephalus thermalis*, *Mystus cavacius*, *Mystus malabaricus*, *Parambassis ranga*, *Puntius sophore*, *P. ticto*, *Rasbora daniconius*, *Glossogobius giuris*, *Ompok bimaculatus*, *P. chola*, *Gonoproktopterus kolus*, *Acanthocobitis botia*, and *P. filamentosus* are the most ubiquitous species. Whereas species like *A. mellettina*, *Barilius canarensis*, *Clarias dussumieri dussumieri*, *Glyptothorax lonah*, *Pseudophromenus cupanus*, *Puntius arulius*, *Schistura sharavathiensis*, and *Schistura* sp.1 are the most marginal species.

*T* for species that are common to stream islands and reservoirs was 0.37°C. This is almost completely nested without many idiosyncratic species (Table 3). Reservoirs and streams provide hospitable habitats, resulting in structured immigration and emigration of these fish species.

For species that are exclusive to stream islands, *T* was 10.5°C, with more number of idiosyncrasy in species as well as in stream islands (Table 4). Species such as *O. cosuatis*, *B. gatensis*, *A. melettina*, *S. denisoni denisoni*, *Nemacheilus anguilla*, *Salmostoma boopis*, etc. are responsible for idiosyncrasy in the system.

Table 5 provides *T* and Monte Carlo run results for various species groups. Most of the hospitable species have wider distribution in general and are less susceptible to fragmentation, while marginal species with narrower distribution are more susceptible to fragmentation. The processes for such nestedness are selective immigration,

**Table 2.** Nestedness pattern of all the species found in the stream islands

| Species | YNH | NGH | HRH | SVH | HDH | HKH | MVH | NDH |
|---|---|---|---|---|---|---|---|---|
| *Aplocheilus lineatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Barilius bendelisis* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Brachydanio rerio* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Chanda nama* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Cirhina fulungee* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Danio aequipinnatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Garra gotyla stenorhynchus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Lepidocephalus thermalis* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mystus cavacius* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mystus malabaricus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Parambassis ranga* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius sophore* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius ticto* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Rasbora daniconius* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Glossogobius giuris* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Ompok bimaculatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius chola* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gonoproktopterus kolus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Acanthocobitis botia* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius filamentosus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mastacembelus armatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Puntius sahyadriensis* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Salmostoma boopis* | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| *Schistura denisonii denisonii* | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| *Nemacheilus anguilla* | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Osteocheilichthys nashii* | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Oreichthys cosuatis* | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| *Barilius bakeri* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Channa marulius* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Ompok pabo* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Schistura semiarmatus* | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Puntius fasciatus* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Schistura nagodiensis* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Tor khudree* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Batasio sharavatiensis* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clarias batrachus* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Labeo kontius* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pseudeutropius atherinoides* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tor mussullah* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Channa orientalis* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Wallago attu* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Barilius gatensis* | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Amblypharyngodon mellettina* | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Barilius canarensis* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clarias dussumieri dussumieri* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Glyptothorax lonah* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pseudophromenus cupanus* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Puntius arulius* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Schistura sharavathiensis* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Schistura* sp.1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

YNH, Yenne Holé; NGH, Nagodi Holé; HRH, Huruli Holé; SVH, Sharavathi Holé; HDH, Haridravathi Holé; HKH, Hilkunji Holé; MVH, Mavina Holé, and NDH, Nandi Holé.

selective extinction, selective levels of stress tolerance, nested habitats and passive sampling[28]. Superior dispersers generally exhibit a greater degree of nestedness than poor dispersers, and the weakest nested patterns may be expected among species with naturally poor dispersal abilities[15]. This is evident in the present analyses, wherein the species common to both reservoir and stream island show greater degree of nestedness compared to those of

**Table 3.** Nestedness pattern of the species common to both stream islands and reservoirs

| Species | YNH | NGH | HRH | SVH | HKH | HDH | MVH | NDH |
|---|---|---|---|---|---|---|---|---|
| *Barilius bendelisis* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Brachydanio rerio* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Chanda nama* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Cirrhinus fulungee* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Garra gotyla stenorhynchus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mystus cavesius* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mystus malabaricus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Parambassis ranga* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Glossogobius giuris* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Ompok bimaculatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius chola* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Gonoproktopterus kolus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Mastacembelus armatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Puntius filamentosus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Salmostoma boopis* | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| *Osteocheilichthys nashii* | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Channa marulius* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Ompok pabo?* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Tor khudree* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Batasio sharavatiensis* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clarias batrachus* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Labeo kontius* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pseudeutropius atherinoides* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tor mussullah* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Wallago attu* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clarias dussumieri dussumieri* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Glyptothorax lonah* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Puntius arulius* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 4.** Nestedness pattern of exclusively stream-dwelling species in the stream islands

| Species | YNH | NGH | SVH | HDH | HRH | HKH | MVH | NDH |
|---|---|---|---|---|---|---|---|---|
| *Aplocheilus lineatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Brachydanio rerio* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Chanda nama* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Danio aequipinnatus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Garra gotyla stenorhynchus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Lepidocephalus thermalis* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Parambassis ranga* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius sophore* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius ticto* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Rasbora daniconius* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Glossogobius giuris* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Acanthocobitis botia* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Puntius chola* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Puntius filamentosus* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| *Salmostoma boopis* | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| *Puntius sahyadriensis* | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| *Schistura denisonii denisonii* | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| *Nemacheilus anguilla* | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| *Osteocheilichthys nashii* | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| *Barilius bakeri* | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Puntius fasciatus* | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Schistura nagodiensis* | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Schistura semiarmatus* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Channa orientalis* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oreichthys cosuatis* | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| *Amblypharyngodon mellettina* | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Barilius canarensis* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pseudophromenus cupanus* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Puntius arulius* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Schistura sharavathiensis* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Schistura* sp.1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Barilius gatensis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

**Table 5.** Nestedness parameters for three species groups

| Case | Matrix results | | System temperature (°C) | |
|---|---|---|---|---|
| | $T$ (°C) | Fill (%) | Average ± SD | Statistical significance ($P$) |
| All species in stream islands | 8.27 | 36.6 | 50.3 ± 6.91 | $6.15 \times 10^{-10}$ |
| Species common to stream islands and reservoirs | 0.37 | 41.1 | 46.6 ± 8.35 | $1.1 \times 10^{-8}$ |
| Species exclusive to streams | 10.5 | 44.0 | 48.8 ± 7.39 | $1.39 \times 10^{-7}$ |

stream islands alone (Table 5). The fish species common to both reservoirs and stream islands showed almost packed matrix with very low $T$. This leads to the inference that the anthropogenic activities in the catchment area of Sharavathi river over the last century in the form of construction of dams have resulted in homogenization of pool-loving fish fauna. Large reservoir area provided them an ideal habitat to flourish and to migrate from one stream island to another in accordance with the changing habitat conditions favoured by changes in climate. Whereas the species restricted to stream islands are responsible for the overall increase in $T$, for the very reason that more randomness, many idiosyncratic species and sites with unexpected absence and presence occur here. This indicates that the construction of the dam might have led to the randomization of fish fauna in the lotic systems (stream-island fishes) due to submergence of lotic habitats, in addition to complete isolation of stream islands.

Analysis of the land-use data revealed that the study area is experiencing rapid changes over the last 50 years[29]. Submersion of about 326.34 km$^2$ area by the dam and the corresponding impacts in the form of human migrations and immigrations resulted in unequal distribution of human population over the study area. Human habitations in the stream islands of the western and southern part are less compared to the eastern stream islands due to remoteness and isolation. Consequently, large forests areas were cleared and converted to agriculture and monoculture plantations in the eastern stream islands, resulting in higher sedimentation and conversion of perennial streams into ephimeral and seasonal ones, which had further implications on the microhabitat characteristics of the streams[29]. Specific levels of stress tolerance among the species resulted in selective extinction, while species capable of migrating over a long distance and withstand lacustrine ecosystem migrated to other regions. It is apparent from the present study that selective extinction, selective migrations and selective levels of stress tolerance of the fish species determine the nestedness in a fragmented riverscape.

## Conclusions

Major streams and tributaries of a riverscape become isolated stream islands due to a reservoir that choked the stream network and continuity due to habitat fragmentation as a consequence of anthropogenic activities. Fish assemblages in these isolated streams often exhibit strong nestedness pattern driven by selective extinction, levels of stress tolerance and immigration in species. The present study indicates the randomization of fish fauna in the lotic systems (stream-island fishes) and at the same time homogenization of species in the lacustrine habitats due to construction of dams.


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# MEETINGS/SYMPOSIA/SEMINARS

**International Congress of Global Warming on Biodiversity of Insects: Management and Conservation (GWBIMC, 2009)**

Date: 9–12 February 2009
Place: Coimbatore, India

Themes: Impact of global warming on insect migration and behaviour; Impact of global warming on biodiversity/management of agricultural insects; Impact of global warming on conservation/management of forestry insects; Impact of global warming on management of medical and veterinary insects; Impact of global warming on mosquito and its transmitted diseases; Global warming on biotechnological advancement in insects; Global information system (GIS) and remote sensing (RS) on insects.

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**3rd National Conference on Recent Trends in Instrumentation Applications (RETINA '09)**

Date: 19–20 March 2009
Place: Kovilpatti

Topics include: Process measurement and instrumentation; Biomedical engineering; Industrial automation; Instrumentation RAG–BAG.

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# *SCHISTURA NILGIRIENSIS* (MENON) IN SHARAVATHI RIVER BASIN, WESTERN GHATS, KARNATAKA

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***web supplement***

The Western Ghats is one of the hottest hotspots of biodiversity (Myers *et al*., 2000) endowed with rare, endemic and threatened species of flora and fauna. Freshwater fishes form a major endemic vertebrate group in the Western Ghats after amphibians and reptiles (Gururaja, 2002). India reports 930 species of fresh water fish (Rema Devi, 2003) and 288 are from the Western Ghats. Of these 118 species are endemic to the Western Ghats and Sri Lankan region (Dahanukar *et al*., 2004). This write up reports the range extension of *Schistura nilgiriensis* (earlier *Nemacheilus nilgiriensis*, Jayaram, 1999) from one of the west flowing rivers in the Western Ghats (Sharavathi river 13-15$^0$N & 74-76$^0$E).

## DIAGNOSIS

*Schistura nilgiriensis,* a small-sized, Endangered (Molur & Walker, 1998) and endemic fresh water fish of Western Ghats belongs to family Balitoridae (Image 1[w]). Five specimens were collected from a first order perennial stream of river Sharavathi at Niluvase (13$^0$44'18"N & 75$^0$06'30"E, 692m), Thirthahalli taluk, Shimoga district, Karnataka (Fig. 1) on 6 November 2003 at 18:30hr.

Since water was very shallow (Mean: 6.69cm, Range: 1.1-10.5cm) fishes were collected by dragging a 30x30cm cloth. The stream had rocky bottom, with meager flow. Width of the stream with flow ranged from 0.6-4.5m and water temperature was 23$^0$C. One of the preserved specimen was deposited at Zoological Survey of India (Southern Regional Station, Chennai) on 9 December 2003 (Reg. No. F-7594 SRS/ZSI), and the remaining four are deposited at the Centre for Ecological Sciences field station, at Kumta, Karnataka.

## CHARACTERS

Total length is 48.18±3.5mm (range: 42.3-51.1), with uniform depth (Table 1). Barbules are well developed, thread like, six in number, four on the anterior and two on margins of the mouth. Body has 11-13 light brown bands with thin cream coloured interspaces. Lateral line is incomplete, extended till the tip of pectoral fin. Bright red colouration on the anal and dorsal fins was noticed. This colouration gets paler towards the margin. Menon (1999) describes of pelvic fins not reaching the anal opening, however collected specimen have pelvic fins reaching the anal opening.

## SPECIAL NOTES

Menon (1999) reported *S. nilgiriensis* from Pykara dam, Nilgiri district, Tamil Nadu. Easa and Shaji (1997) recorded this species from Nilgiri Biosphere Reserve (10$^0$45'-12$^0$05'N & 76$^0$10'-77$^0$10'E). An earlier study (Shaji *et al*., 1995) reported *S. nilgiriensis* from Kurukkathodu (11$^0$49'-11$^0$50'N & 75$^0$49'-75$^0$57'E), a stream of west flowing river Uruttipuzha in Aralam Wildlife Sanctuary, Kerala. All these earlier reports were restricted to the southern Western Ghats within 10-12$^0$N & 74-77$^0$E. The aerial distance calculated (using MapInfo Version 6.0 GIS software) between the new reports from Niluvase to Kurukkathodu is approximately 225km north-west and over 300km north-west of Pykara dam.

*Schistura nilgiriensis* was collected from the south-western part of the Sharavathi river basin which is rich with evergreen to semi-evergreen forests (tree species include *Mastixia arborea, Ventilago maderaspatana, Aglaia sp.* and *Agrostistachys indica*). Stream flow monitoring of 28 months show perennial water in the streams in this part (western side least disturbed) compared to the eastern part of the river basin.

This highlights the ecological sensitivity and richness of the region. Presence of *S. nilgiriensis* in the Sharavathi river basin (Karnataka) is a range extension in west flowing river, central Western Ghats

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[w] See Image 1 in the web supplement at www.zoosprint.org

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***Table 1. Body measurements (in mm) of*** **Schitura nilgiriensis** ***(N = 5). Values in parenthesis denote the range.***

| Parameter | Mean±Sd |
|---|---|
| Total length | 48.18±3.5 (42.3 – 51.1) |
| Head length | 8.34±0.4 (7.8 – 8.7) |
| Body depth | 5.78±0.8 (4.7 – 6.5) |
| Diameter of eye | 1.58±0.2 (1.4 – 1.8) |
| Inter-orbital distance | 2.7±0.4 (2.0 – 3.0) |
| Snout length | 3.7±0.3 (3.5 – 4.0) |

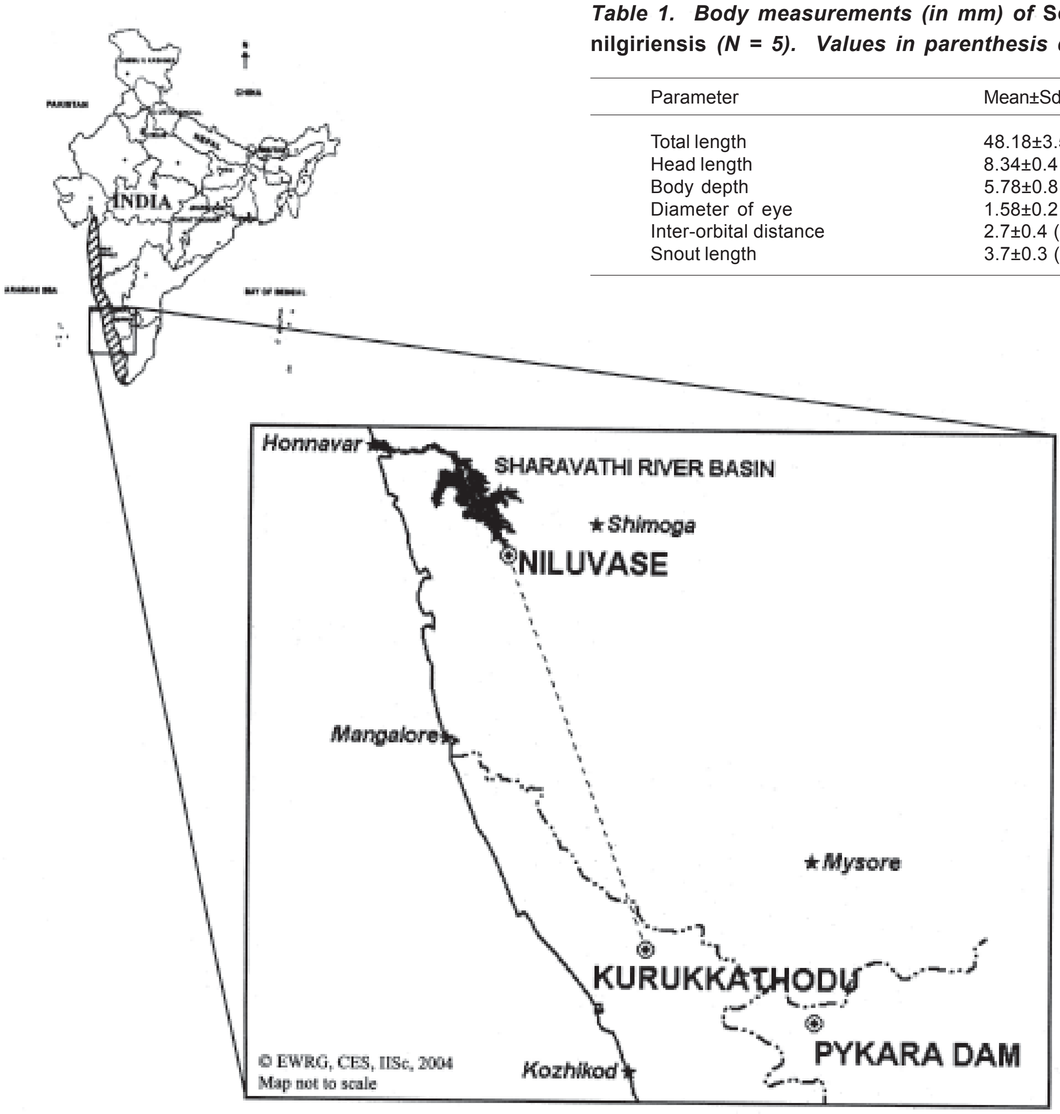


***Figure 1. Map of Western Ghats showing new location (Niluvase) and earlier reports***

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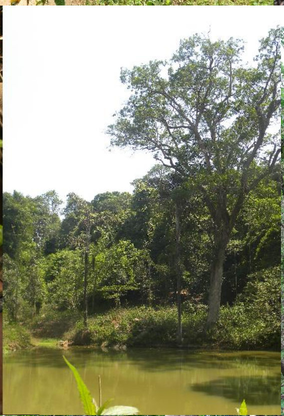






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