Sahyadri Conservation Series 46

FOREST STATUS AND MEDICINAL FLORA STUDIES IN JANKADKAL AND SHIRGUNJI MPCA AREA, UTTARA KANNADA

(Final Report)

Ramachandra T.V.	Subash Chandran M.D.	Joshi N V
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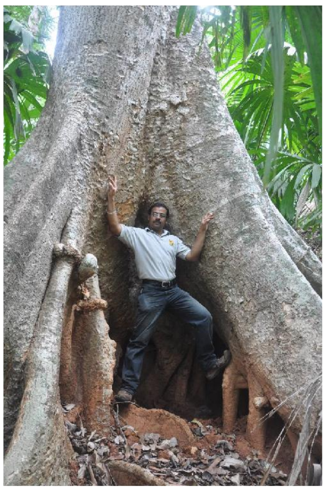

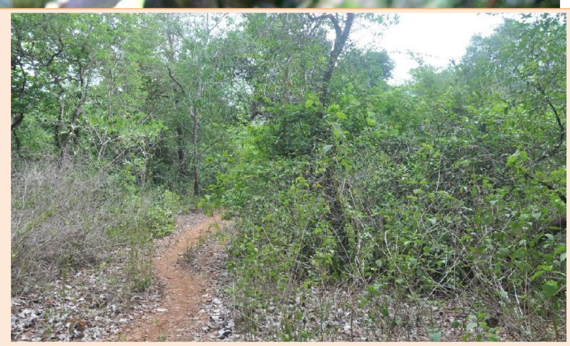

Karnataka Forest Department, Honavar Division, Uttara Kannada
The Ministry of Science and Technology, Government of India
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CHAPTER 1: INTRODUCTION AND METHODOLOGY

Plants form an important source of traditional medicines for a major portion of population living in the tropical countries, since time immemorial. Majority of the medicinal plants in India are higher flowering plants which play a significant role in the economy of the country, providing raw materials for a variety of industries. The complex forest types in Western Ghats serve as treasure troves of about 700 medicinal plant species of which many find their applications in the traditional and folk medicine practices by the local communities (Soni, 2009). The Western Ghats, running almost parallel to the west coast of India, along with Sri-Lanka is one among 34 biodiversity hotspots of the world. It also features among the 200 globally most important eco-regions in the world (Olson and Dinerstien, 1998). Covering an area of about 160,000 km^2, this rugged range of hills stretches for about 1600 km from the south Gujarat in the north to nearly the southern tip of the Indian Peninsula (8°N-20°N). 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.

The Central Western Ghats mainly encompassing Uttara Kannada and neighbouring districts of Karnataka State has a variety of climatic conditions, soil and topography leading to different ecological and environmental regimes which support their own characteristic set of plants and animals (Ramachandra et al., 2012), and of course, medicinal plants as well. The knowledge related to the medicinal properties of various plant resources goes back to the pre-historical days. The *Rigveda*, the earliest Indian scripture, contains the records of the preparation and use of medicines from plants. It was followed by *Atharvaveda* in which the uses of the plants described were more varied and these works were followed by monumental contributions like *Charaka Samhita*, *Sushruta Samhita* and *Ashhtanga Hridaya*. Many rural people throughout the tropics rely on medicinal plants because of their effectiveness, lack of modern medical alternatives, and cultural preferences (Balick, et al., 1996). The indigenous forest-dwelling people are known to possess an exceptional knowledge base on medicinal plants, which range from lichens and algae to various herbs, shrubs, climbers and trees. Many species are distributed from canopy to understory in the complex evergreen forest; whereas other occur in drier forests to scrub, grasslands, rocky areas, water bodies, sea beaches, even as weeds in household gardens or in the hedges. The individual species ecology and community ecology of medicinal plant species are often complex and their proper understanding, including their medicinal properties and uses requires taxonomic, ecological and ethno-botanical knowledge, as well as updated knowledge on such species from the fields of pharmacognosy and pharmacological applications. Depletion of biodiversity at an alarming rate due to anthropogenic activities has necessitated inventorying, monitoring, conservation and management of medicinal plants in their natural habitats. Hence, vegetation and floristic studies have gained increasing importance and relevance in recent years. The current study was carried out, with financial and logistic support from the Karnataka Forest Department, Honavar Forest Division, with the objective of assessing general floristic and medicinal plants status, their diversity and regeneration status in Shirgunji and Jankadkal, two of the Medicinal Plants Conservation Areas (MPCAs) of the Division in Uttara Kannada coast.

The tropical forests of Uttara Kannada district are bestowed with richness of medicinal plants which have formed an important component of the traditional knowledge of various tribes and local communities residing in the district. Several studies have focussed on the diverse applications/uses of the medicinal plants by these communities. Bhandari *et al* (1995) investigated upon the uses of medicinal plants by the Siddi tribe which is mainly located in the northern part of the district. The Siddis often cured stomach acidity with the infusion of stem bark of *Garcinia indica.* They believe that the consumption of the stem sap of *Calamus thwaitesii,* coinciding with menstrual cycle, prevented conception. Harsha *et al.* (2002) in their studies on the ethnobotanical knowledge on the medicinal plants of the Marathi/Konkani speaking Kunabi community in the district found that the acrid juice of endemic tree *Holigarna arnottiana* was applied as antiseptic for fresh cuts and wounds while the bark of *Mangifera indica* crushed along with bark of *Artocarpus heterophyllus*, given in water, was effective in treating dysentery. Harsha et al. (2003) documented the ethno-medical practices of local people residing mainly in and around the semi-evergreen to evergreen forested areas for treatment of skin diseases. They foun that plants such as *Ervatamia heyneana, Naravelia zeylanica* and *Aristolochia indica* were applied externally for the treatment of itches, boils, scabies and other skin allergies. The ethno-medico-botanical knowledge of Karivokkaliga community, living in interior forest hamlets of Uttara Kannada, was studied by Somashekhara et al. (2010). The Karivokkaligas used plants like *Holarrhena pubescens* for treatment of dysentery, fruit of *Garcinia indica* for treatment of cold, bark powder of *Artocarpus heterophyllus* for treatment of impotency and bark of *Ervatamia heyneana* for snake bite. Besides these the applications of other important medicinal plants found in the study region are found in many earlier works: oil from root, bark and leaves of *Cinnamomum malabathrum* for rheumatic affections as external applications; root powder of *Glycosmis pentaphylla* for fever; bark decoction of *Diospyros candolleana* for rheumatism and swellings; bark of *Mimusops elengi* as cooling agent, cardio-tonic, stomachic, anthelmintic, astringent and for curing biliousness, diseases of gums and teeth; fruits of *Embelia ribes* are used as appetizer, carminative, anthelmintic, laxative and helps in curing tumours, bronchitis, diseases of heart, jaundice and mental diseases (Kirthikar and Basu; 2003).

1.1 Study area and Methods: The study was carried out in two MPCA's of Jankadkal village of Honnavar taluk **(Figure 1.1**) and Shirgunji village of Kumta taluk (**Figure 1.2**), in Uttara Kannada district, Karnataka. Both the MPCAs are in central Western Ghats, at altitudes ranging from 50 to almost 500 m above msl. The vegetation in the study area mainly comprises of tropical wet evergreen to semi-evergreen forest as the rainfall exceeds 3500 mm. Moist deciduous forests mixed with savannas are found in areas disturbed by fire and deforestation. These landscape elements form a mosaic with *Acacia* and teak plantations, rice fields and arecanut gardens characteristic of the entire western slopes of the Western Ghats.

Studies on forest vegetation were carried out using transect cum quadrat method. Each transect with a length of 180m had alternating 5 tree quadrats at 20 m inter-distance between any two

(**Figure 1.3**). Each tree quadrat was 20 x 20 m, in which all trees (≥ 30 cm GBH) were studied. Members of the shrub layer, including shrubs, and tree saplings (GBH ≤30 cm and height more than 1 m) were enumerated in two sub-quadrats (5 x 5m) placed diagonally inside the tree quadrat. Inside each shrub quadrat two herb layer (all plants including tree saplings of height ≤ 1 m) quadrats were laid diagonally (1 x 1m). Total of 7 transects were laid in the Jankadkal MPCA. Each transect was linked to 5 tree quadrats, 10 shrub layer quadrats and 20 herb layer quadrats. Altogether with 35 tree quadrats, each of 400 sq.m, 70 shrub layer quadrats, each of 25 sq.m and 140 herb layer quadrats, each of 1 sq.m were laid to get a comprehensive picture of the flora, including of the medicinal plants. Such a picture would give the current status of vegetation, the status of medicinal plants and also the future trends in the population tendencies of various medicinal species. In the Shirgunji area 5 transects were laid with 25 tree quadrats, 50 shrub layer quadrats and 100 herb layer quadrats. Associated features such as presence of epiphytes, climbers, parasites, human disturbances etc. were noted.

Opportunistic survey was also carried out to list other species not encountered in the transect areas. The data from the transects were pooled into three classes, locality wise, with herb layer (<1m height), shrub layer (≥ 1m and < 30 cm GBH) and tree layer (≥ 30cm GBH) and analysed accordingly layer wise (mainly confined to tree and shrub layer as year-round survey could not be carried out especially for seasonal herbs due to short term nature of the forest, although tree seedlings were estimated and seasonal herbs recorded opportunistically). The different size classes gave the current status of vegetation and trends in regeneration of forests. From the overall plant diversity data collected medicinal plants were identified using standard literatures and local consultations and data analysed using standard vegetation analysis procedures.

1.2 Data analysis: Data analysis was carried out using various ecological parameters. To access species diversity, dominance and equitability, Shannon diversity, Simpson dominance, and Peilou'seveness index were used. To analyse the vegetation characteristics (dominant and co-dominant species), Importance Value Indices (IVI) were calculated for each species. IVI takes into consideration the number of individuals (density-rD) belonging to each species, their basal area (dominance-rB) and distribution (frequency- rF) in the plot (**Table 1.1** for the formulas).

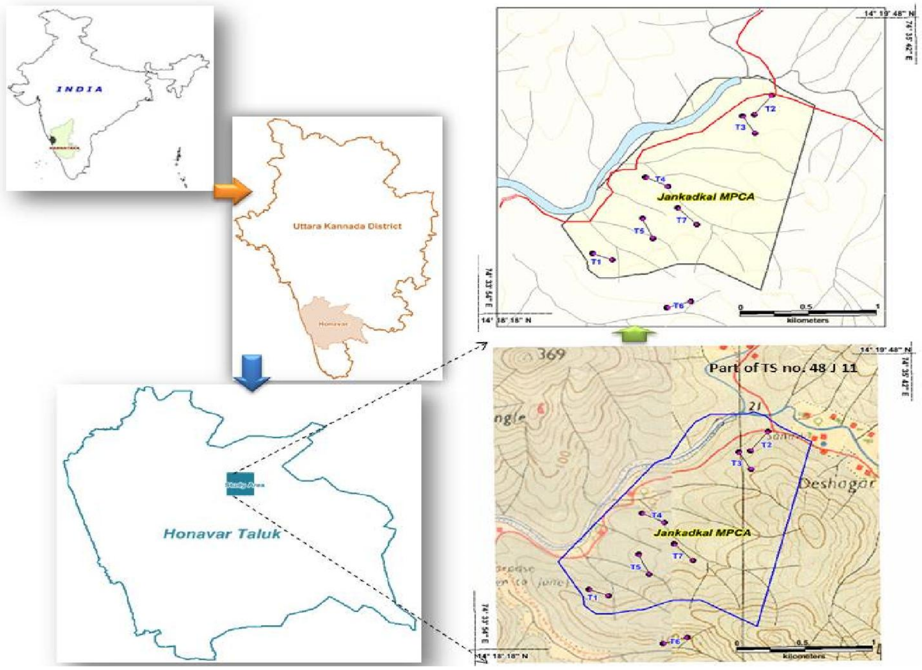


Figure 1.1. Location of Jankadkal MPCA with sampling locations (T1 toT7)

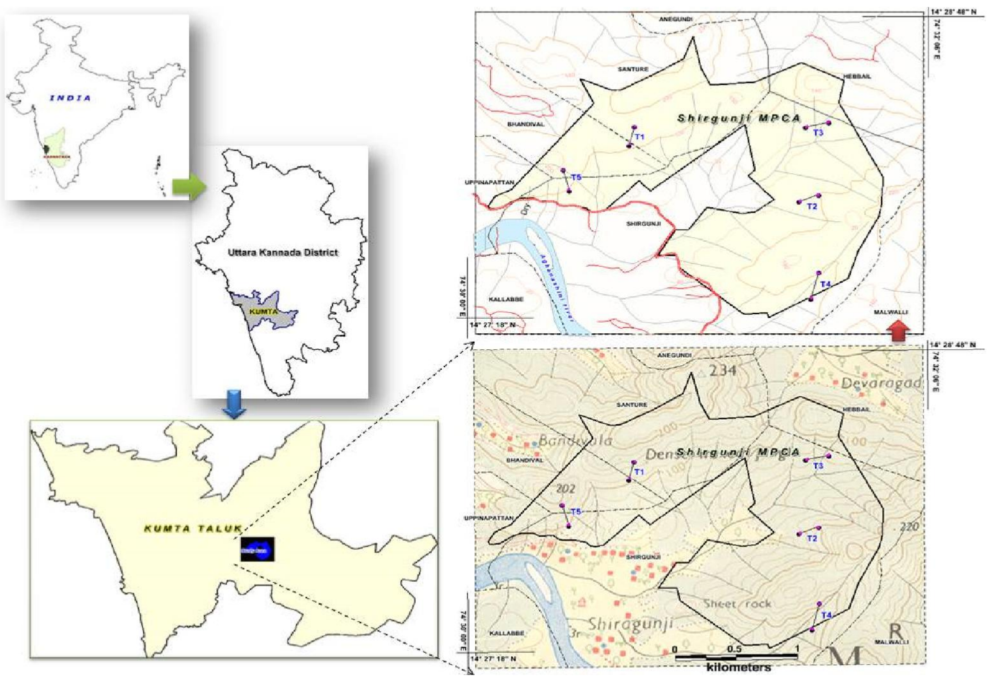


Figure 1.2. Location of Shirgunji MPCA with sampling locations (T1-T5)

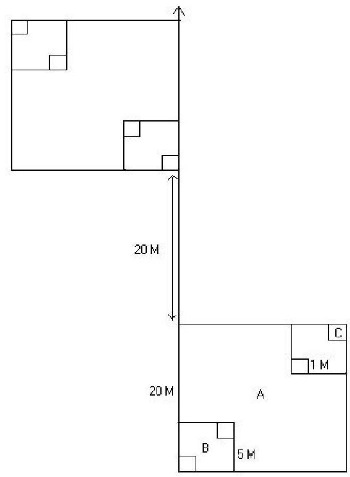


Figure 1.3. Transect cum quadrat method of forest vegetation study

Table 1.1: Details of indices and formulas used

Index	Equation	Notes
% Evergreenness (trees)	No. of evergreen trees X 100 / Total no. of trees	To estimate how evergreen a forest is.
% Endemism (trees)	No. of endemic trees X 100 / Total no. of trees	Percentage endemism of a forest patch
Basal area (m^2)	$(GBH)^2/4\pi$	
Important Value Index	R. density + R. frequency + R. basal area	To know dominant and co-dominant species
Density	No. Species A / Total no. of trees	Provides information on the compactness with which a species exists in an area.
Relative Density	Density of Species A X 100 / Total density of all species	
Frequency	No. points with Species A / Total No. points Sampled	Provides information on the repeated occurrence of a species
Relative Frequency	Frequency of Species A X 100 / Total Frequency of all Species	
Relative basal area	Basal area (m^2) of Species A X 100 / Total basal area of all species	
Shannon Weiner's diversity index	$H' = -\sum_{i=1}^{s} p_i ln p_i$	The value of Shannon's diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5.
Simpson's dominance index	$\text{SIDI} = 1 - \sum_{i=1}^{N} p_i \times p_i.$	
Pileou's evenness	Shannon value/Log(Total number of species)	

CHAPTER 2: JANKADKAL MPCA

General floristic composition: Transect cum quadrat data and opportunistic survey revealed a total of 219 species coming under 75 families and 125 genera. Habit-wise 113 species of trees, 33 of shrubs, 41 of herbs and 32 climbers were recorded. Families with highest number of species were Fabaceae (13), and Rubiaceae (13), followed by Euphorbiaceae (9), Anacardiaceae (8), Lauraceae (7), Meliaceae (7) and Myrtaceae (7). Other families were having less than 7 species (**Figure 2.1**). Details of most specious genera are given in **Figure 2.2.** Evergreen tree genera *Diospyros* (6 sp) was followed by *Syzygium* (5) and *Holigarna* (4) and others had lesser number.

Floristic diversity and forest structure: Except Jankadkal 2 and Jankadkal 3 patches which were semi-evergreen type all the five transects sampled were evergreen forests (**Table 2.1**). This shows their relatively lesser disturbance compared to more coastal facing areas which were very disturbed and some changed into moist deciduous types to barren hills due to land use pressures, especially in the past. Species area curve plotted for the seven transects showed flattened saturated curve (**Figure 2.3**) implying sufficiency of the sampling efforts. Jankadkal-Ammanabetta-T5 with 174 trees was the highest followed by Jankadkal-T4 with 167 individuals. Lowest was found in Jankadkal-T3 with 100 individuals (**Figure 2.4**). This particular transect passed through a dry, narrow streamlet, which on either side was covered with high entanglement of climbers with lesser trees showing probable earlier disturbances.

Jankadkal-T2 with 34 species and Jankadkal-Darbejaddi-T7 having 30 species were among transects with highest species number. Height of the forest constitutes one of the important parameter to characterize the forest stature. I general undisturbed old forests had bigger heights compared to crooked stunted trees in severely disturbed forest. Jankadkal-T1 (16.6m) had the highest average canopy height, followed by Jankadkal-T4 (16.5m). Jankadkal-T2 (13.4) had the least height which reflects its disturbed condition.

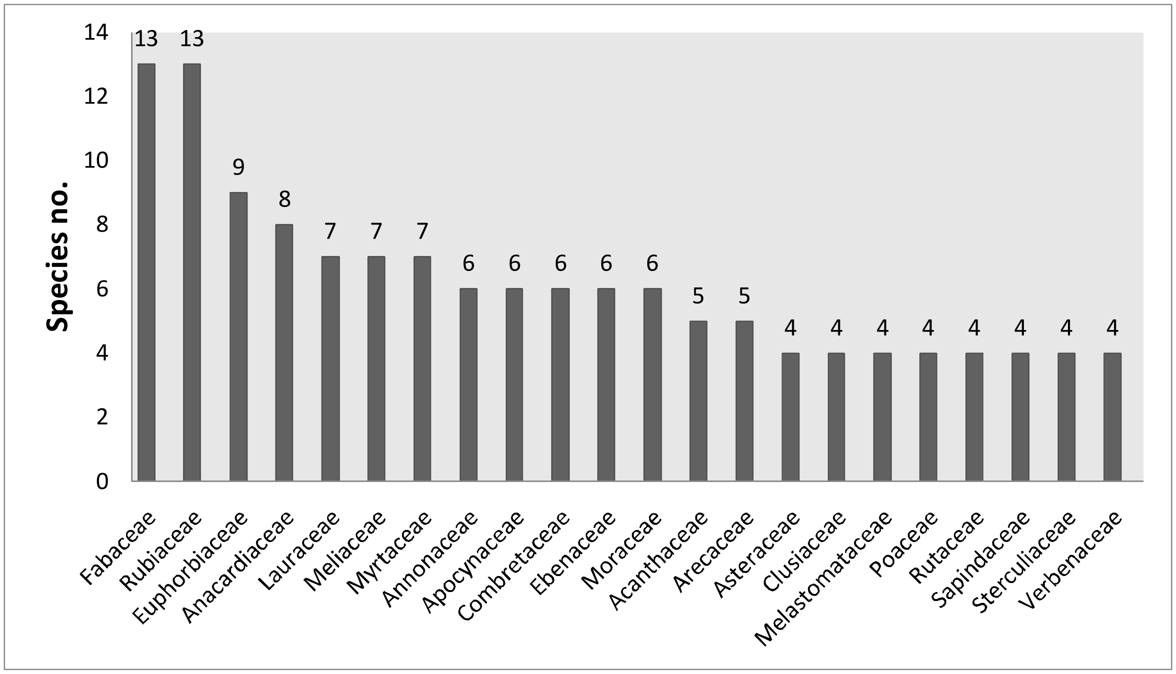


Fig. 2.1. Family-wise species richness in Jankadkal MPCA

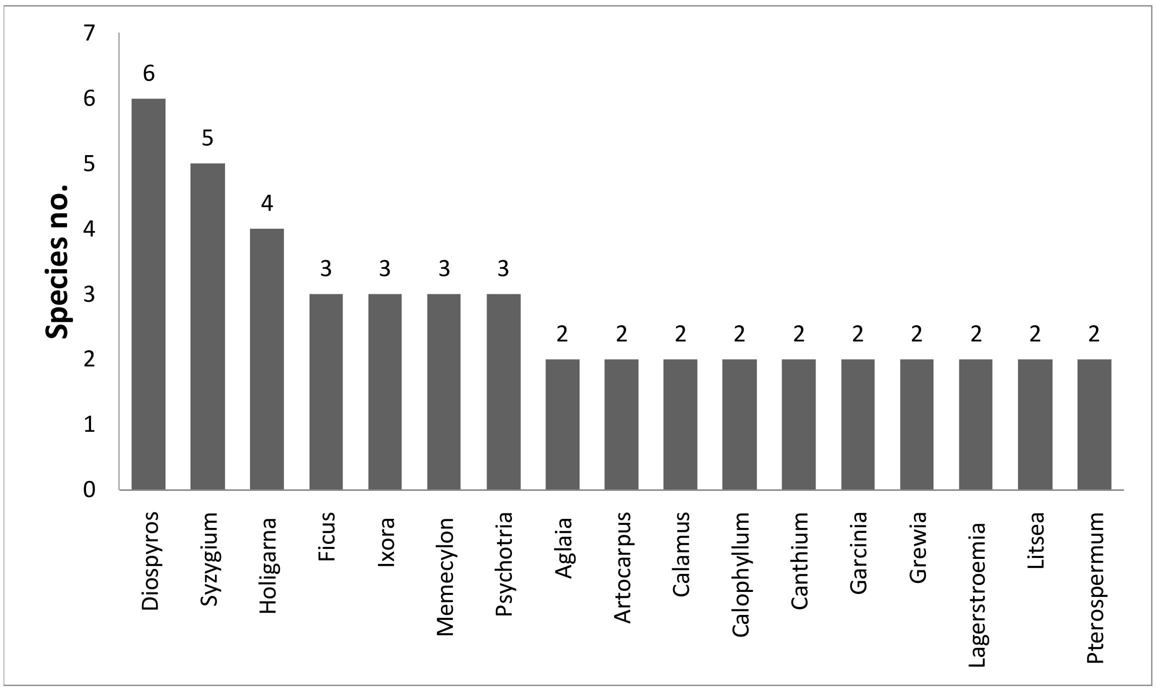


Fig. 2.2. Genera-wise species richness among trees in Jankadkal MPCA

Table 2.1. Jankadkal transects forest composition (trees) and basal area details.

Locality	Taluk	Forest type	Total individuals	Total species	Aver. height (m)	Tot.basal area (sq.m/ha)
Jankadkal-T1	Hona var	Evergreen	153	29	16.6	58.9
Jankadkal-T2	Hona var	Semi-evergreen	106	34	13.4	26.5
Jankadkal-T3	Hona var	Semi-evergreen	100	29	14.5	31.6
Jankadkal_T4	Hona var	Evergreen	167	29	16.5	58.2
Jankadkal-ammanabetta-T5	Hona var	Evergreen	174	25	16.4	58.2
Jankadkal-Darbejaddi-T6	Hona var	Evergreen	134	25	15.0	41.7
Jankadkal-Darbejaddi-T7	Hona var	Evergreen	152	30	15.2	76.5

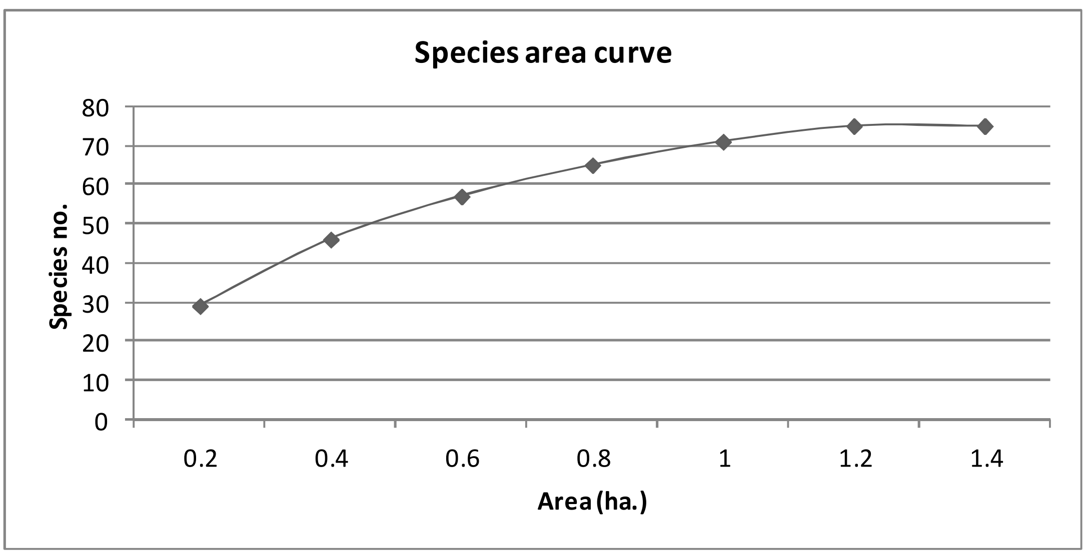


Fig. 2.3. Species area curve for trees in Jankadkal MPCA

Fig. 2.4. Jankadkal-Transect 3 -entanglement of climbers and lesser density of trees

Forest diversity: South East Asia has long been recognised as a centre of plant biodiversity. Being situated in the tropics, with areas of high rainfall and a year round hot humid climate, South East Asia boasts some of the largest numbers of vascular plants species in the world (Mittermeier et al. 1999). However Western Ghats, higher in latitude (8 degrees N to 20 degrees N), with its more seasonal climate and high anthropogenic pressure such high diversity as of more equatorial Amazonia or Malaysia cannot be expected. The anthropogenic causes disruption of forest structure and alters the species composition, leading towards reduction in tree species and density and finally drive the forest to extremely degraded stage (Baithalu et. al. 2013). Such is the case in most of the coastal area forest in Uttara Kannada. However Jankadkal forest which has escaped severe degradation has higher Shannon diversity in some semi-evergreen transects such as Jankadkal T2 (3.1) and Jankadkal-T3 (3.0). This increase in diversity in these two transects is due to addition of deciduous species (**Table 2.2**), indicators of past disturbances, mixing with the evergreens. Others have lower values with lowest in Jankadkal-Ammanabetta-T5 (2.5) due to mainly dominance of evergreens like *Strombosia ceylanica* and *Diospyros sylvaticus*. Lower diversity is also due to dominance of evergreens *D. sylvaticus,* along with *Knema attenuata, S. ceylanica* and *Hopea ponga*.

Basal area and population dynamics: Jankadkal-Darbejaddi-T7 (76.5 sq.m/ha) had the highest basal area contributed mainly by lofty trees of *Strombosia ceylanica and Diospyros sylvatica,* followed by *Knema attenuata* and *Holigarna ferruginea*. *Myristica malabarica* was also found in good number here. Huge trees with immense buttresses of *Tetrameles nudiflora* also contributed to the higher basal area of this transect (**Figure 2.5**). Lowest basal area was found in Jankadkal-T2 which had lesser number of trees and more of lower girths. This transect also had higher number of deciduous species such as *Lagerstroemia microcarpa* and secondary evergreen *Aporosa lindleyana* probably revealing past disturbance, especially shifting cultivation history.

Table 2.2. Species richness, Shannon diversity, Simpson dominance, Simpson diversity, and Pielou's evenness in Jankadkal MPCA.

Locality	Sps. richness	Shannon	Simp-dom.	Simp-div.	Pielou evenness
Jankadkal-T1	5.566	2.634	0.112	0.888	0.782
Jankadkal-T2	7.076	3.174	0.055	0.945	0.900
Jankadkal-T3	6.080	3.062	0.059	0.941	0.909
Jankadkal_T4	5.471	2.725	0.094	0.906	0.809
Jankadkal-ammanabetta-T5	4.652	2.524	0.114	0.886	0.784
Jankadkal-Darbejaddi-T6	4.900	2.607	0.106	0.894	0.810
Jankadkal-Darbejaddi-T7	5.772	2.583	0.115	0.885	0.759

Important value index: Most of the trees having higher IVI are evergreen species. *Strombosia ceylanica* and *Diospyros sylvatica*, followed by *Knema attenuata* and *Holigarna ferruginea* are leading trees in most of the transects (**Table 2.3 -2.5**). These, except *S. ceylanica*, are endemic to Western Ghats. Jankadkal MPCA is dominated by endemic tree species. Non-endemics are more towards western side foothills closer to human habitations. Deciduous trees of larger size, especially *Lagerstroemia microcarpa* had higher presence. It would have established in the past due to the use of fire for forest clearance during shifting cultivation history. Some smaller girth classes of this tree occurs indicating also recent disturbance. Hardy evergreens such as *Olea dioica* and *Aporosa lindleyana* were also seen in higher IVI values in many transects, indicating ongoing forest disturbances, or recovery process from such disturbances.

Fig. 2.5. *Tetrameles nudiflora,* a buttressed tree. In the background are talipot palm *Corypha umbraculifera*

Table 2.3. Transect-wise IVI of leading 10 trees in Jankadkal T1 to T3

Jankadkal-T1		Jankadkal-T2		Jankadkal-T3	
Species	**IVI**	**Species**	**IVI**	**Species**	**IVI**
Diospyros sylvatica	52.61	*Cinnamomum malabatrum*	30.76	*Holigarna ferruginea*	32.62
Hopea ponga	30.25	*Lagerstroemia microcarpa*	26.16	*Diospyros sylvatica*	26.65
Knema attenuata	28.25	*Holigarna ferruginea*	19.79	*Diospyros buxifolia*	23.51
Myristica malabarica	26.00	*Aporosa lindleyana*	19.61	*Ervatamia heyneana*	22.07
Polyalthia fragrans	19.03	*Lepisanthus tetraphylla*	17.32	*Aporosa lindleyana*	18.79
Diospyros buxifolia	17.76	*Hydnocarpus wightii*	16.21	*Cinnamomum malabatrum*	18.55
Holigarna ferruginea	17.34	*Diospyros sylvatica*	14.04	*Tetramelus nudiflora*	15.75
Syzygium gardenerii	17.15	*Hopea ponga*	13.65	*Knema attenuata*	14.98
Artocarpus hirsutus	16.86	*Pterospermum diversifolium*	12.85	*Syzygium cumini*	11.78
Strombosea ceylanica	7.07	*Knema attenuate*	10.90	*Macaranga pelatata*	11.06

Table 2.4. Transect-wise IVI of leading 10 trees in Jankadkal T4 and T5

Jankadkal_T4		Jankadkal-Ammanabetta-T5	
Species	**IVI**	**Species**	**IVI**
Diospyros sylvatica	46.26	*Strombosea ceylanica*	44.71
Hopea ponga	34.03	*Hopea ponga*	36.23
Strombosea ceylanica	23.87	*Diospyros sylvatica*	30.26
Holigarna ferruginea	21.22	*Knema attenuata*	25.25
Olea dioica	19.85	*Olea dioica*	22.35
Knema attenuata	18.84	*Artocarpus hirsutus*	22.14
Artocarpus hirsutus	18.25	*Syzygium gardenerii*	20.35
Myristica malabarica	16.32	*Aporosa lindleyana*	15.31
Cinnamomum malabatrum	13.82	*Diospyros buxifolia*	10.53
Diospyros candolleana	11.16	*Myristica malabarica*	9.92

Table 2.5. Transect-wise IVI of leading 10 trees in Jankadkal T6 and T7

Jankadkal-Darbejaddi-T6		Jankadkal-Darbejaddi-T7	
Species	**IVI**	**Species**	**IVI**
Diospyros sylvatica	42.45	*Strombosea ceylanica*	37.03
Strombosea ceylanica	41.94	*Diospyros sylvatica*	35.40
Knema attenuata	39.21	*Ficus sp.*	27.85
Hopea ponga	33.39	*Knema attenuata*	26.98
Cinnamomum malabatrum	12.80	*Holigarna ferruginea*	24.03
Macaranga pelatata	12.73	*Tetramelus nudiflora*	21.08
Lophopetalum wightianum	12.55	*Myristica malabarica*	20.28
Artocarpus hirsutus	12.00	*Aporosa lindleyana*	12.19
Holigarna ferruginea	11.94	*Olea dioica*	11.62
Polyalthia fragrans	9.96	*Lophopetalum wightianum*	10.83

Evergreenness and Endemism: Evergreenness (% of evergreen tree individuals in the total tree population) was high in most transects, Jankadkal-T2 and Jankadkal-T3 which were semi-evergreen, being exceptions. Nearly 43% of tree individuals were endemic to Western Ghats alone, and in combination (Western Ghats-Sri Lanka biodiversity hotspot) endemism is even more. Highest tree endemism was found in Jankadkal-T1 (60.8%) followed by Jankadkal -T4 (50.9%). Lesser endemism was found in Jankadkal-Ammanabetta-T5 (37.5%) and by Jankadkal-Darbejaddi-T7 (38.2%). As most of this MPCA has over 40% endemism it is important to have such a conservation centre for endemic medicinal species (**Figure 2.6**).

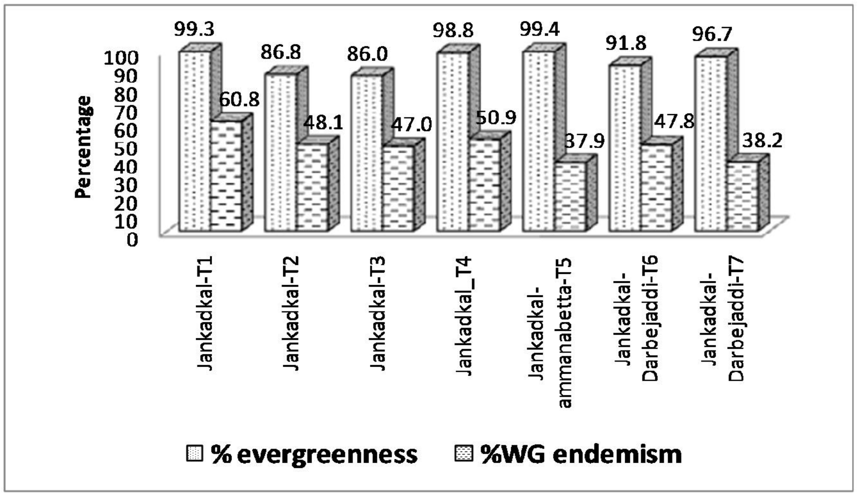


Fig. 2.6. Percentage of evergreenness and Western Ghat endemism in the tree community of Jankadkal MPCA

Medicinal plant diversity: A total of 178 medicinal plants were noted in Jankadkal forest study including also opportunistic surveys, outside the sample plots. Out of them 93 species were trees, 31 climbers, 23 shrubs, and 31 herb species. Habitat wise 74 medicinal plants came from evergreen to semi-evergreen forest, 28 from both evergreen and moist deciduous, 20 from moist deciduous and scrub-savanna, 8 occurred in evergreen-semi-evergreen, moist deciduous, and scrub savannah combination; 7 were exclusiv to moist deciduous, 7 exclusive to stream sides, and remaining 34 species were found in other habitats such as grassy areas, marsh, plantations etc. (**Annexure 1** for details). Within in any major habitat type microhabitat conditions, such as shade intensity, canopy opening, steepness, rockiness, soil, water and litter richness etc. influenced species distribution. From conservation angle more detailed studies need to be initiated on micro-habitat conditions and medicinal plant regeneration potential.

Transect wise medicinal plant composition: Transect wise Jankadkal-T1 had the highest number of medicinal trees in the transect (80) followed by Jankadkal-ammanabetta-T5 (76). Highest number of medicinal tree species per transect was found in Jankadkal-T2 (21 sp) followed by Jankadkal-Darbejaddi-T6 (19 sp) (**Table 2.4**). Jankadkal-Darbejaddi-T6 (76 %) had the highest percentage of medicinal plants, followed by Jankadkal-ammanabetta-T5 (68 %) (**Figure 2.7**).

Table 2.4: Total medicinal plant individuals and species among total individuals and species/transect in Jankadkal MPCA

Transects	Medicinal indv./transect	Medicinal sp/transect	Total indv./transect	Total sp/transect
Jankadkal-T1	80	18	153	29
Jankadkal-T2	67	21	106	34
Jankadkal-T3	59	17	100	29
Jankadkal_T4	68	15	167	29
Jankadkal-ammanabetta-T5	76	17	174	25
Jankadkal-Darbejaddi-T6	65	19	134	25
Jankadkal-Darbejaddi-T7	64	17	152	30

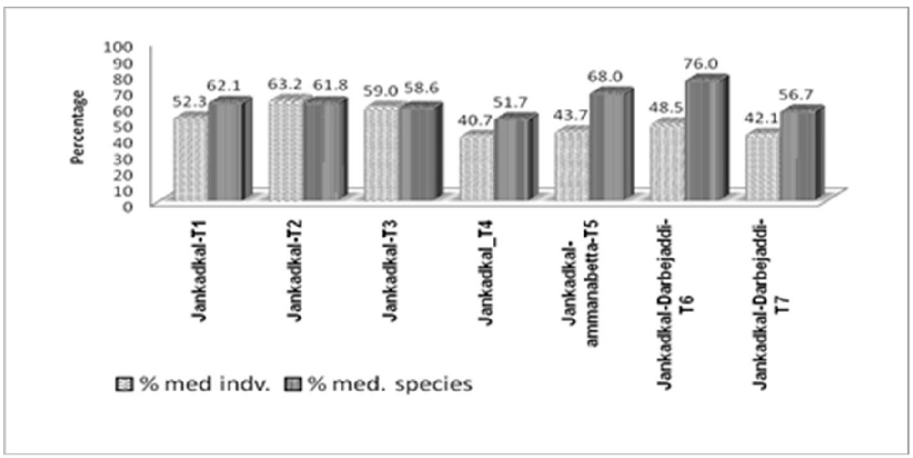


Fig. 2.7. Percentage of medicinal tree individuals in the total tree population and percentage of medicinal tree species per transect

Girth distribution in trees: Girth classes of individuals of important medicinal and some emergent tree species pooled together from Jankadkal shows an inverted "J" curve (**Figure 2.8**), indicating overall healthy recruitment in lower girth classes. Higher girth classes, though lesser, comparatively, are likely to increase under MPCA protection. A*rtocarpus hirsutus, Lophopetalum wightianum*, *Syzygium gardnerii* etc. were among the trees having highest girth classes. *Myristica malabarica, Olea dioica, Cinnamomum malabatrum, Syzygium hemispericum*, and *Polyalthia fragrans* were also having many trees with girth classes above 200 cm. However *Olea dioica* in more numbers in higher girth classes indicates past disturbances. Presence of *Lagerstroemia microcarpa* in lower girth classes in some transects indicates recent disturbances due to fire.

Medicinal tree *Knema attenuata* and another climax evergreen species *Strombosia ceylanica* had highest regenerating seedlings per hectare of more than 5000/ha (**Table 5**). This indicates that the forest is in the process of turning into high evergreen. Other medicinal trees species such as *Aporosa lindleyana, Ervatamia heyneana, Mallotus phillipensis, Nothopegia castaneaefolia, Olea dioica, Garcinia gummigutta, Pterospemum diversifolium* etc., had medium to high regeneration of more than 500 seedlings /ha. Medicinal tree species including *Myristica malabarica, Artocarpus hirsutus, Calophyllum apetalum, Dysoxylum* sp, *Garcinia morella, G. indica, Mangifera indica, Mimusops elengi, Neolitsea scrobiculata, Persea macrantha, Saraca asoca* etc., were not having regeneration in seedling stage in herb layer, which is a matter of some concern. Many medicinal deciduous trees such as *Terminalia's, Careya arborea* and *Stereospermum colais* had poor regeneration as the forest is turning into evergreen to semi-evergreen type giving little scope for regeneration of deciduous trees. Many medicinal plants from the forest is used mainly for local consumption. As per National Medicinal Plants Board (NMPB) and FRLHT assessment of Indian traded medicinal species the study area has nearly 44 plants in herb, shrub and tree species which are traded (not necessarily from the area under study) and some very highly traded requiring stringent protection (**Annexure 1, 2**).

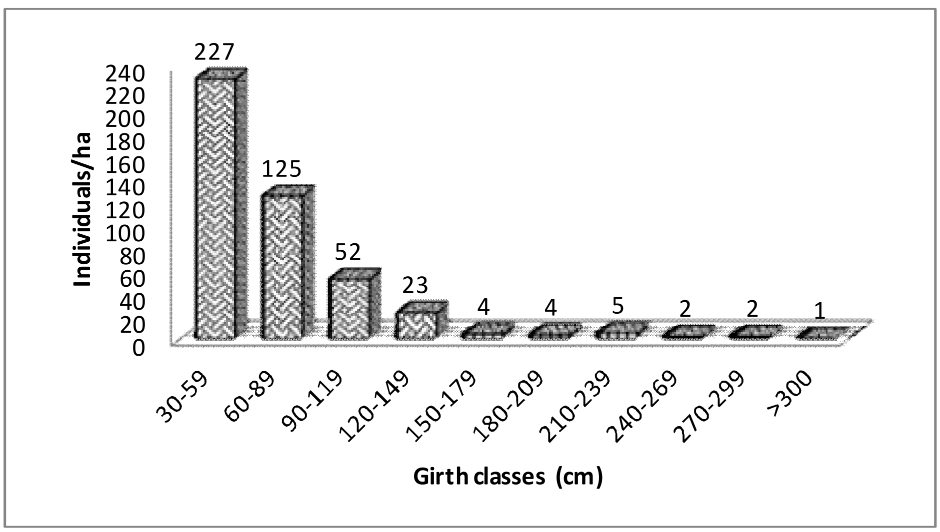


Fig. 2.8: Girth distribution of important trees in Jankadkal (all transects together)

Many shrubs and palms from the study site are also known for medicinal uses. Palms with some medicinal value, such as *Corypha umbraculifera* (Talemara) and *Arenga wightii* had the highest regeneration per hectare (**Figure 2.9**). Medicinally important shrubs *Psychotria flavida, Calamus thwaitsii, Ardisia solanaceae* etc. also had higher regeneration compared to other shrub species. Many shrubs such as *Apama siliqosa* (Chakrani) which need more special habitats were having less regenerating saplings compared to widely growing species such as *Psychotria*. Overall some dominant trees like *Knema* and *Strombosia* had higher regeneration compared to others. Many medicinal endemics such as *Myristica malabarica* (Rampatri), endemic climbers such *Salacia* sp. (Ekanayaka), and *Embelia ribes* (Vayuvilang) etc., also had lesser regeneration due to their sparser distribution requiring more specialised habitat needs. Hence more studies need to be conducted to understand the ecology medicinal such medicinal plants which are in high market demand.

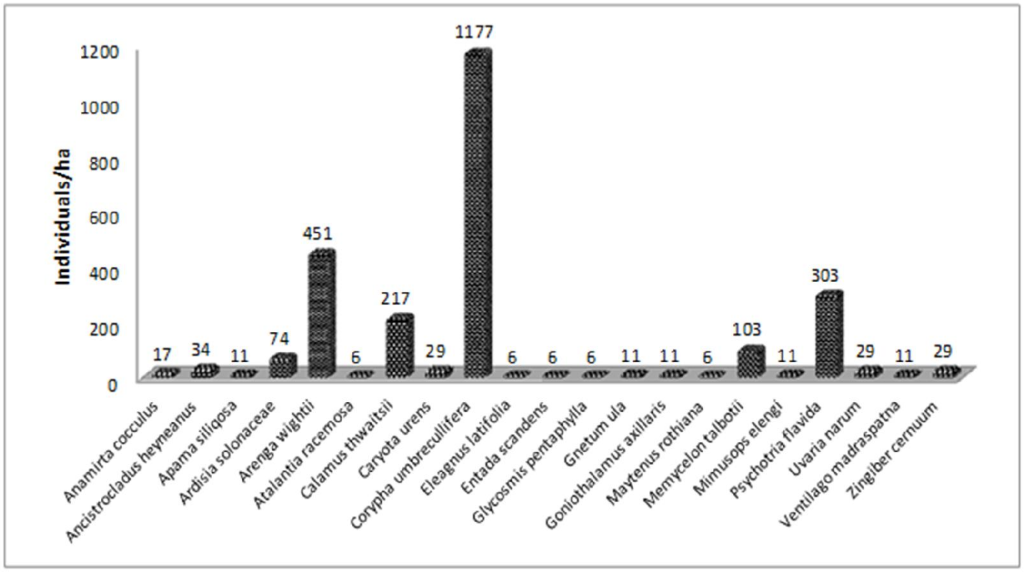


Fig. 2.9. Regeneration in medicinal shrubs and palms showing their population per hectare in shrub layer (<30 cm gbh and >1m)

Table 2.5: Estimated numbers of notable trees/ha girth classes & in seedling and sapling stages (regeneration profile)

Species	Seed lings/ ha.	Sapli ngs/ ha.	Girth classes (cm) 30-59	60-89	90-119	120-149	150-179	180-209	210-239	240-269	270-299	>300	Tot trees/ha.
Actinodaphne hookeri	357	69	2	1	0	0	0	0	0	0	0	0	3
Alangium salvifolium	0	17	1	0	0	0	0	0	0	0	0	0	1
Aporosa lindleyana	857	234	14	5	6	1	0	0	0	0	0	0	26
Artocarpus hirsutus	0	23	7	6	1	1	0	0	0	1	2	0	18
Artocarpus lacoocha	0	0	1	0	0	1	0	0	0	0	0	0	2
Calophyllum apetalum	0	11	0	0	0	0	0	0	0	0	0	0	0

Calophyllum polyanthum	0	0	1	0	0	0	0	0	0	0	0	0	1
Cinnamomum malabatrum	2000	269	6	9	4	3	0	0	0	1	0	0	23
Derris sp	571	6	0	0	0	0	0	0	0	0	0	0	0
Dillenia pentagyna	0	0	0	0	1	0	0	0	0	0	0	0	1
Diospyros candolleana	286	91	10	2	0	1	0	0	0	0	0	0	13
Diospyros paniculata	143	29	1	2	0	0	0	0	0	0	0	0	3
Elaeocarpus serratus	571	46	1	1	0	0	0	0	0	0	0	0	2
Ervatamia heyneana	714	97	11	2	0	0	0	0	0	0	0	0	13
Ficus drupacea	0	0	0	0	1	0	0	0	1	0	0	0	2
Flacourtia Montana	0	0	1	0	0	0	0	0	0	0	0	0	1
Garcinia gummi-gutta	357	34	0	1	0	0	0	0	0	0	0	0	1
Garcinia Morella	71	6	4	1	0	0	0	0	0	0	0	0	5
Grewia tiliifolia	0	0	0	0	0	0	0	0	0	0	0	0	0
Holigarna arnottiana	0	6	0	0	0	0	0	0	0	0	0	0	0
Holigarna grahamii	0	0	1	0	0	0	0	0	0	0	0	0	1
Hydnocarpus pentandra	143	74	5	4	1	0	0	0	0	0	0	0	10
Ixora brachiate	0	6	0	0	0	0	0	0	0	0	0	0	0
Knema attenuate	12143	1366	59	21	1	1	1	0	0	0	0	0	83
Lagerstroemia speciosa	71	11	0	0	1	0	0	0	0	0	0	0	1
Lagerstroemia microcarpa	0	0	0	2	2	1	1	0	0	0	0	0	6
Litsea laevigata	143	17	2	0	0	0	0	0	0	0	0	0	2
Lophopetalum wightianum	0	29	2	1	1	0	0	0	1	1	0	0	6
Macaranga peltata	0	109	4	4	1	0	0	0	0	0	0	0	9
Madhuca neriifolia	71	11	0	1	0	0	0	0	0	0	0	0	1
Mallotus philippensis	1214	0	4	0	0	0	0	0	0	0	0	0	4
Mangifera indica	0	131	1	0	1	0	0	0	0	0	0	0	2
Mimusops elengi	0	11	1	1	1	0	0	1	0	0	0	0	4
Myristica malabarica	0	86	19	9	2	1	0	1	0	0	0	0	32
Neolitsea scrobiculata	0	0	0	1	0	0	0	0	0	0	0	0	1
Nothopegia castaneaefolia	643	400	2	0	0	0	0	0	0	0	0	0	2
Olea dioica	786	114	6	6	7	2	0	1	1	0	0	0	23

Persea macrantha	0	17	0	0	0	1	0	0	0	0	0	0	1
Polyalthia fragrans	1786	217	6	6	1	2	0	0	1	0	0	0	16
Pterospermum diversifolium	1071	200	4	1	1	0	0	0	0	0	0	0	6
Sageraea laurifolia	71	17	1	0	0	1	0	0	0	0	0	0	2
Saraca asoca	0	11	0	1	0	0	0	0	0	0	0	0	1
Stereospermum colais	0	11	0	0	1	0	0	0	0	0	0	0	1
Strombosia ceylanica	5357	303	39	25	14	6	1	0	0	0	0	0	85
Syzygium cumini	0	0	1	4	1	0	0	0	0	0	0	0	6
Syzygium gardneri	0	343	9	2	1	1	1	1	1	0	0	1	17
Syzygium hemisphericum	0	11	1	1	0	0	0	0	1	0	0	0	3
Vitex altissima	214	11	0	2	1	1	0	0	0	0	0	0	4
Zanthoxylum rhetsa	0	0	0	0	1	0	0	0	0	0	0	0	1

CHAPTER 3: SHIRGUNJI MPCA

General floristic composition: Data analysis (including of opportunistic survey) revealed a total of 154 species coming under 68 families and 126 genera. Shirgunji had slightly more genera compared to Jankadkall because of lower dominance by any single species or group of species. Habit wise 21 were climbers, 24 herbs, 29 shrubs, and 80 tree species. Rubiaceae (11 sp) was the most represented family in terms of number of species followed by Lauraceae (7 sp) and Anacardiaceae (6 sp) (**Figure 3.1**). Others like Ebenaceae, Apocynaceae, Euphorbiaceae and Myrtaceae had 5 species each. Generic richness of Shirgunji is given in **Figure 3.2**.

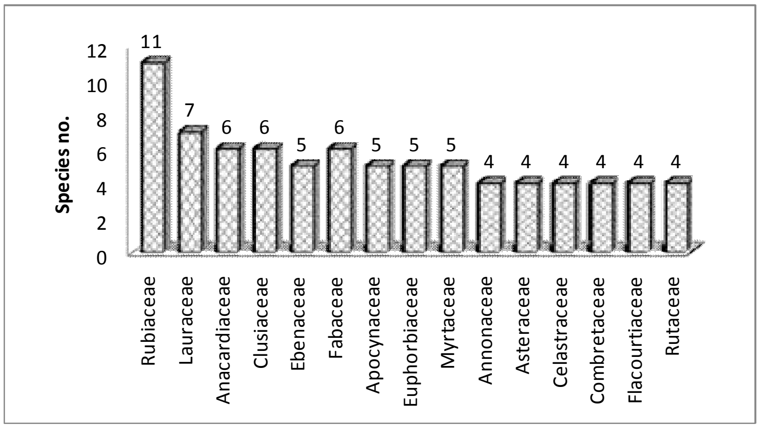


Figure 3.1: Family richness in Shirgunji MPCA

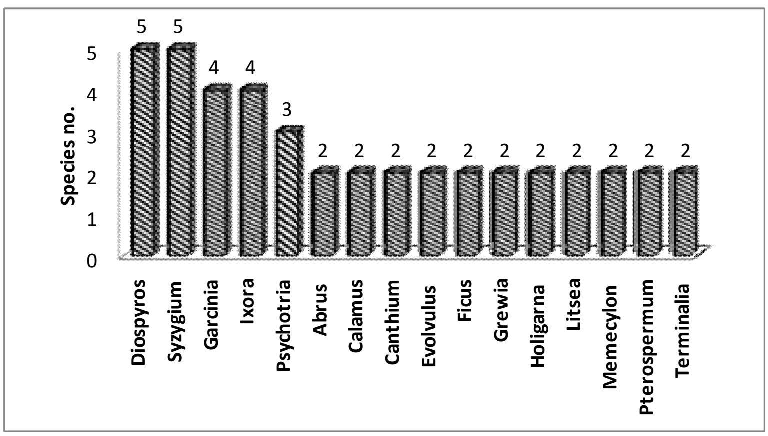


Figure 3.2: Generic richness in Shirgunji MPCA

Floristic diversity and Structure: Shirgunji MPCA forest though primarily composed of evergreen to semi-evergreen forest has been from earlier times been subjected to much exploitation as a minor forest (open to local privileges, especially closer to the village) resulting in higher degradation compared to Jankadkal MPCA. Shirgunji-31-T1 is a minor forest and in many places reduced to scrub. However due to control of fire forest is rich in evergreen species and highest number of species is seen in Shirgunji-mabgi-T2 (36 sp) followed by Shirgunji-T5 (33 sp). The number of species is also increased due to the inclusion of more deciduous species. Lowest number of species is seen in minor forest Shirgunji-31-T1 (22 sp) (**Table 3.1**)

Table 3.1: Shirgunji transects: Forest composition and basal area details (of trees).

Locality	Taluk	Forest type	Total individuals	Total species	Average Height (m)	Basal area (sq.m/ha)
Shirgunji-31-T1	Kumta	Semi-evergreen-minor forest	124	22	12.7	27.7
Shirgunji-mabgi-T2	Kumta	Semi-evergreen	145	36	13.2	48.5
Shirgunji-mastikallu-T3	Kumta	Semi-evergreen	143	26	13.5	53.1
Shirgunji-mastikallu-T4	Kumta	Semi-evergreen	139	31	13.4	43.6
Shirgunji-T5	Kumta	Evergreen	118	33	11.6	34.3

Average height is also lower due to earlier logging and disturbance. Also many emergent climax species are also rare with more of sub-canopy trees such as *Knema attenuata* and *Vitex altissima*. Species area curve shows rising curve in spite of 5 transects implying some more sampling may be needed (**Figure 3.3**). Overall the diversity was not so high, the S.W index being under 2.85. Shirgunji-Mabgi-T2 (2.83) followed by Shirgunji-Mastikallu-T3 (2.80), had the highest Shannon diversity and others slightly less. Shirgunji-31-T1 had the least Shannon diversity (evenness index 0.8.). Semi-evergreen part of the forest is shown in **Figure 3.4** and degraded portions illustration in **Figure 3.5.**

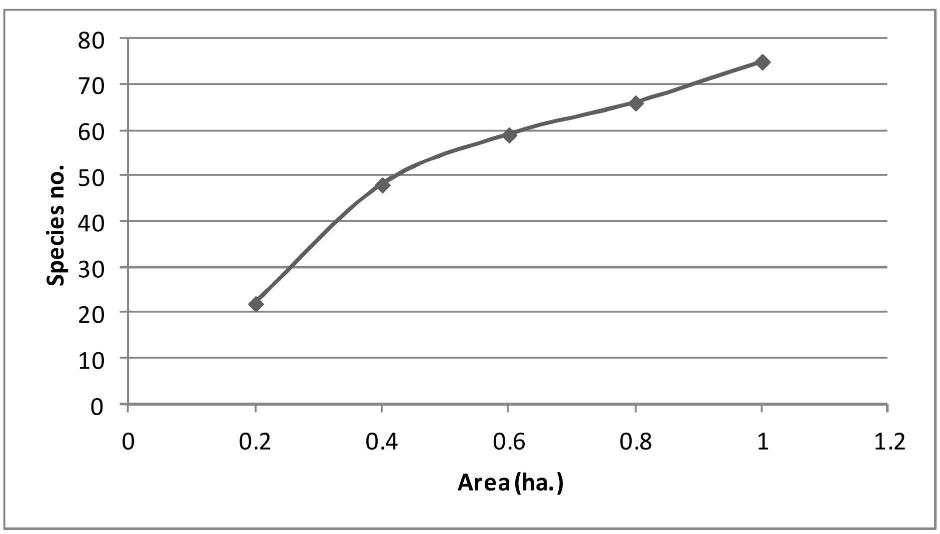


Fig. 3.3: Species area curve for Shirgunji MPCA

Fig. 3.4: Semi-evergreen patch adjacent to village in Shirgunji

Fig. 3.5. Degraded part of forest in Shirgunji MPCA

Important Value Index and Endemism: Most of the forests though having high number of evergreen species were having also fair mix of deciduous species, coming under higher IVI group (**Tables 3.3 & 3.4**). *Knema attenuata* was found as highest important tree in four transects followed by *Holigarna ferrugeniana* in one transect. *Lophopetalum wightianum* (Banate) a huge emergent tree having medicinal properties was also having second highest IVI in Shirgunji-Mabgi-T2 and Shirgunji-Mastikallu-T3 indicating existence of a richer forest in the past. However as earlier mentioned deciduous species were also high in most of these transects indicating past logging, fire, and other extraction pressures, at least till recent times, including ongoing. *Vitex altissima* (Bharanige), *Terminalia paniculata* ((Kindal), *Lagerstroemia microcarpa* (Nandi), *Stereospermum colais* (Patali) were seen in good numbers in most of transects. Although many of these are medicinally used plants their occurrence inside the evergreen to semi-evergreen along with *Aporosa lindleyana* and *Olea dioica* indicates logging, fire and other disturbances, at least in the past. As the forest gets converted from evergreen to secondary deciduous and further degradations (due to in Minor Forest category, where people were allowed to collect certain biomass) more of generalist and wide-spread medicinal plants tend to be more than the more sensitive ones and subject to high extraction pressures, such as *Saraca asoca* (Ashoka), *Salacia sp* (Ekanayaka), *Coscinium fenestratum, Embelia ribes* (Vayuvilanga) etc., which all require special microhabitats get scantier. As shortages happen for these important medicinal plants, exploitation of remaining plants in the wild is likely to intensify. Most of the forest, however, is semi-evergreen and one transect sample was in high evergreen (**Figure 3.6**). Western Ghat tree endemism was comparatively lower (34.3%) in the sample are Shirgunji-Mastikallu-T3, whereas the highest was in Shirgunji T5 (73.5%). This high endemism was mostly due to commoner endemics such as *Knema attenuata, Hopea ponga, Holigarna sp* etc., than rarer species of primary forests.

Table 3.2: Species richness, Shannon diversity, Simpson dominance, Simpson diversity, and Pielou's evenness in Shirgunji MPCA.

Locality	Species richness	Shannon Diversity	Simpson's dominance	Simpson's diversity	Pielou evenness
Shirgunji-31-T1	4.357	2.481	0.139	0.861	0.802
Shirgunji-mabgi-T2	7.033	2.833	0.125	0.875	0.790
Shirgunji-mastikallu-T3	5.037	2.806	0.081	0.919	0.861
Shirgunji-mastikallu-T4	6.080	2.609	0.147	0.853	0.760
Shirgunji-T5	6.708	2.771	0.116	0.884	0.793

Table 3.3. Important Value Index of first ten tree species in T1, T2 & T3

Shirgunji-31-T1		Shirgunji-mabgi-T2		Shirgunji-mastikallu-T3	
Sp	**IVI**	**Sp**	**IVI**	**Sp**	**IVI**
Knema attenuata	54.26	*Knema attenuata*	52.88	*Holigarna ferrugeniana*	30.93
Vitex altissima	42.77	*Lophopetalum wightianum*	29.19	*Lophopetalum wightianum*	29.20
Holigarna arnottiana	28.78	*Macaranga peltata*	17.49	*Madhuca neerifolia*	28.31
Mangifera indica	19.59	*Myristica malabarica*	17.17	*Vitex altissima*	23.85
Olea dioica	18.94	*Vitex altissima*	16.53	*Aporosa lindleyana*	22.19
Pterospermum reticulatum	18.08	*Diospyros microphylla*	16.01	*Olea dioica*	21.63
Holigarna ferrugeniana	16.57	*Holigarna ferrugeniana*	11.97	*Holigarna arnottiana*	15.89
Ixora brachiata	12.92	*Beilschmedia fagifolia*	11.28	*Terminalia paniculata*	13.04
Terminalia paniculata	12.33	*Holigarna arnottiana*	8.91	*Syzygium caryophyllatum*	12.70
Beilschmedia fagifolia	12.14	*Neolitsea scrobiculata*	8.81	*Hopea ponga*	11.63

Table 3.4. Important Value Index of first ten tree species in T4 & T5

Shirgunji-T4		Shirgunji-T5	
Sp	IVI	**Sp**	IVI
Knema attenuata	54.12	*Knema attenuata*	45.76
Olea dioica	34.67	*Olea dioica*	27.49
Terminalia paniculata	25.42	*Flacourtia montana*	25.80
Vitex altissima	20.64	*Ficus nervosa*	16.16
Terminalia paniculata	17.50	*Garcinia indica*	13.45
Diospyros candolleana	17.02	*Hopea ponga*	13.24
Pterospermum diversifolium	13.98	*Lagerstroemia microcarpa*	12.93
Aporosa lindleyana	9.38	*Holigarna ferrugeniana*	12.89
Lannea coramandelica	8.83	*Stereospermum colais*	11.20
Cinnamomum malabatrum	8.05	*Elaeocarpus serratus*	9.93

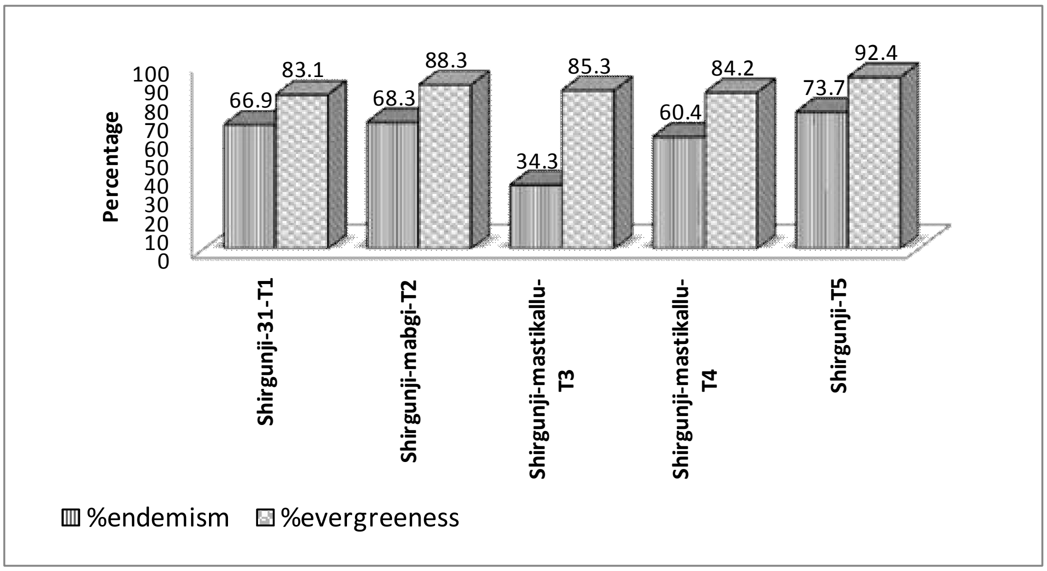


Fig. 3.6. Evegreenness and endemism% among trees in Shirgunji MPCA transects.

Medicinal plant diversity: A total of 122 medicinal plant species were recorded from the transect survey along with all out searches. However, the list cannot be exhaustive as we have missed seasonal herbs due to the limitation of the current study. Habit-wise 61 were medicinal trees, 21 shrubs, 20 climbers, and 20 herbs. Habitat wise evergreen to semi-evergreen forest patches accounted for 50 medicinal species; semi-evergreen–moist deciduous complex had 25 sp., while 16 species occurred in moist deciduous-scrub-savanna areas. Remaining occurred in other habitats such as grassy areas, streamside, seasonal marshes etc. (**Annexure 2**). Compared to Jankadkal, Shrgunji MPCA was found to experience higher disturbances due its proximity to villages. Whereas forest openings and other type of disturbance favour weeds and certain open area medicinal plants of commoner kinds many shade loving species were absent in heavily disturbed or open areas.

Transect wise medicinal plant composition: Altogether 92 medicinal species occurred in the transects-proper. Transect-wise details of total individuals of all flowering plants, total medicinal plant individuals, total species and total medicinal species are given in **Table 3.5.**

Table 3.5. Transect wise total medicinal plant individuals and species

Locality	Total individuals	Total medicinal plant individuals	Total species	Total medicinal plant species
Shirgunji-31-T1	124	98	22	15
Shirgunji-mabgi-T2	145	108	36	23
Shirgunji-mastikallu-T3	143	104	26	22
Shirgunji-mastikallu-T4	139	112	31	21
Shirgunji-T5	118	95	33	24

Most transects had higher number of species with known for at least some medicinal properties, whether already recorded or used in folk medicine. The others cannot be written off as non-medicinal, as pharmaceutical research rapidly happening in various laboratories of the country and abroad is bringing out the hidden properties of many species day by day. Rarer medicinal species occur in shaded forest patches and commoner ones in open areas.

Girth classes: Girth class structure of Shirgunji tree community, especially of climax species and medicinal trees, shows a regular inverted "J" curve with highest number of stems found in lower girth class (30-59 cm range) representing set of growing stock (**Figure 3.7**). The paucity of trees in higher girth classes is glaring with least numbers occurring in >200 cm class, a situation that reflects past disturbances. Scarcity of larger, mature medicinal trees, will affect the future normal regeneration of such species due to unavailability of seeds. Hence for effective conservation of medicinal plants, trees and shrubs of all age classes are important and have to be maintained in tact as a community. Details of the regeneration of individual medicinal trees in seedling and sapling stages and in their higher girth classes are given in **Table 3.6.** This Table gives a complete picture of each medicinal tree and its regeneration status in terms of seedling and sapling and tree stages. Regeneration of medicinal shrubs and climbers is given in **Figure 3.7**.

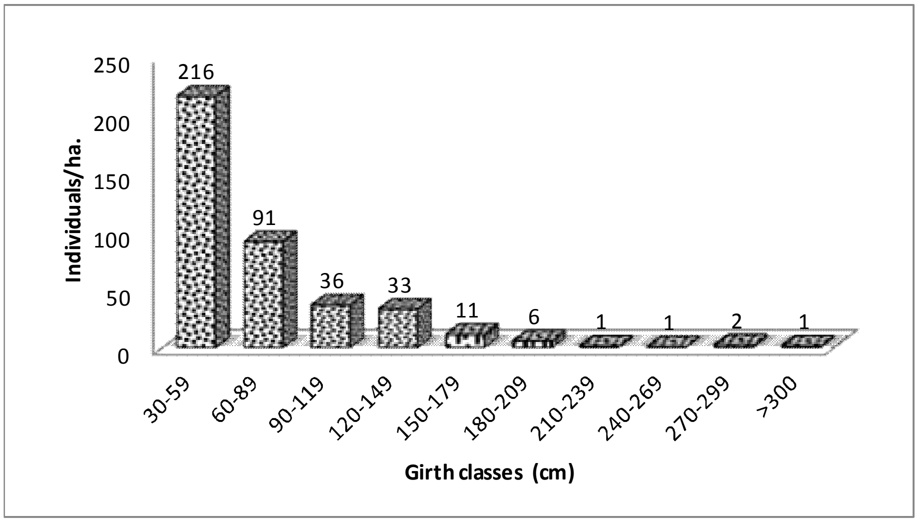


Fig. 3.7. Distribution of important medicinal and climax tree sp. tree individuals/ha., in Shirgunji MPCA (all transects pooled)

Table 3.6. Important medicinal and climax trees and no-trees (in seedling and sapling class) regeneration/ha.

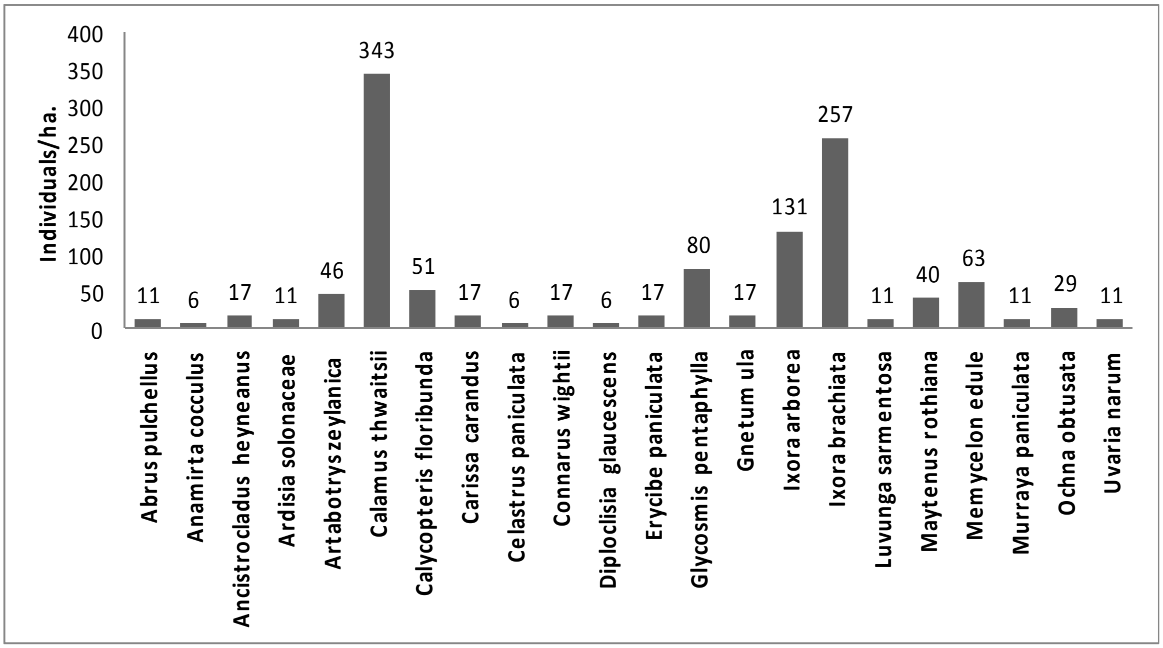
			Girth classes (in cm)										
Species	**Seed-lings /ha.**	**Sap-lings /ha.**	**30 - 59**	**60 - 89**	**90-119**	**120-149**	**150-179**	**180-209**	**210-239**	**240-269**	**270-299**	**>300**	**Tot. trees /ha.**
Actinodaphne hookeri	500	57	1	1	0	0	0	0	0	0	0	0	2
Ailanthus excelsa	0	0	0	1	0	0	0	0	0	0	0	0	1
Alangium salvifolium	0	6	0	0	0	0	0	0	0	0	0	0	0
Aporosa lindleyana	286	149	7	6	1	1	0	0	0	0	0	0	15
Artocarpus hirsutus	0	0	0	1	0	1	0	0	0	0	0	0	2
Calophyllum apetalum	286	40	0	0	0	0	0	0	1	0	0	0	1
Carallia brachiate	71	0	0	1	1	0	0	0	0	0	0	0	2
Careya arborea	0	0	0	0	0	0	1	0	0	0	0	0	1
Cinnamomum malabatrum	429	23	1	1	1	0	0	0	0	0	0	0	3
Dillenia pentagyna	71	0	1	0	1	1	0	0	0	0	0	0	3
Diospyros candolleana	357	303	11	3	0	0	0	0	0	0	0	0	14
Dysoxylum binectariferum	71	6	1	1	0	1	0	0	0	0	0	0	3

Elaeocarpus serratus	929	109	3	0	3	1	0	0	0	0	0	0	7
Ervatamia heyneana	143	17	1	0	0	0	0	0	0	0	0	0	1
Flacourtia Montana	1071	114	9	1	0	1	0	0	0	0	0	0	11
Garcinia cambogia	714	34	0	0	0	1	0	0	0	0	0	0	1
Garcinia indica	286	11	2	4	0	0	0	0	0	0	0	0	6
Garcinia Morella	0	17	0	0	0	0	0	0	0	0	0	0	0
Grewia tiliifolia	0	0	0	0	1	0	0	0	0	0	0	0	1
Holigarna arnottiana	1429	46	4	8	4	3	0	0	0	0	0	0	19
Holigarna grahamii	214	0	0	0	0	0	0	0	0	0	0	0	0
Homalium zeylanicum	0	0	0	1	0	0	0	0	0	0	0	0	1
Hydnocarpus pentandra	0	17	0	0	0	0	0	0	0	0	0	0	0
Ixora brachiata	929	257	11	1	0	0	0	0	0	0	0	0	12
Knema attenuata	6143	817	89	24	6	0	0	0	0	0	0	0	119
Lagerstroemia microcarpa	0	0	1	0	0	1	0	1	0	0	0	0	3
Litsea laevigata	0	11	1	1	0	0	0	0	0	0	0	0	2
Lophopetalum wightianum	0	11	0	0	1	1	0	0	0	0	1	1	4
Macaranga peltata	0	11	6	4	0	0	0	0	0	0	0	0	10
Madhuca neriifolia	286	6	10	7	0	1	0	0	0	0	0	0	18
Mallotus philippensis	0	97	2	0	0	0	0	0	0	0	0	0	2
Mangifera indica	0	17	3	1	1	3	0	0	0	0	0	0	8
Mimusops elengi	0	0	1	1	0	0	0	0	0	0	0	0	2
Myristica malabarica	214	91	4	3	2	1	0	0	0	0	0	0	10
Neolitsea scrobiculata	429	183	6	0	0	0	0	0	0	0	0	0	6
Nothopegia castaneaefolia	2500	74	6	0	0	0	0	0	0	0	0	0	6
Lannea coromandelica	0	0	0	0	1	1	1	0	0	0	0	0	3
Olea dioica	1357	389	26	6	6	2	1	0	1	0	0	0	42
Persea macrantha	71	0	0	1	1	0	1	0	0	0	0	0	3

Polyalthia fragrans	714	97	1	0	0	0	0	0	0	0	0	0	1
Pterospermum diversifolium	1000	11	1	1	0	1	0	0	0	0	0	0	3
Sageraea laurifolia	286	74	1	0	0	0	0	0	0	0	0	0	1
Schleichera oleosa	71	11	1	1	0	1	0	0	0	0	0	0	3
Stereospermum colais	0	11	0	0	0	0	1	1	0	0	1	0	3
Strombosia ceylanica	71	0	0	0	0	0	0	0	0	0	1	0	1
Syzygium caryophyllatum	71	0	1	3	0	1	0	0	0	0	0	0	5
Syzygium cumini	0	6	0	1	1	0	0	1	0	0	0	0	3
Syzygium gardneri	0	6	0	0	1	1	0	0	0	0	0	0	2
Syzygium hemisphericum	0	0	1	0	0	1	0	0	0	0	0	0	2
Terminalia bellirica	0	0	0	0	0	0	0	0	0	0	0	1	1
Terminalia paniculata	0	6	0	2	2	5	2	1	0	0	0	0	12
Toona hexandra	0	0	0	1	0	0	0	0	0	0	0	0	1
Vitex altissima	0	11	4	4	4	4	5	2	0	1	0	0	24

Commoner evergreens such as *Knema attenuata, Nothopegia sp*, etc., were more and sensitive climax species were rare. The ground layer was dominated hardy evergreens like *Ixora brachiata, Olea dioica, Aporosa lindleyana, Holigarna arnottiana* etc. indicating on-going disturbances. Through participatory management more care should be given to Uppage (*Garcinia camboga* syn *G. gummigutta*) and Kokum (*Garcinia indica*) fast emerging endemic medicinal plants, with rising global demands. Currently these trees are more represented in seedlings and saplings than in older stages. *Mallotus phillippensis* has a similar position and can be taken care more in semi-shaded areas. Developing more of *Persea macrantha, Cinnamomum malabathrum, Myristica malabarica, Terminalia bellirica* etc., all of which are medicinally very important and have potential habitats within the MPCA, requires greater attention. *Nothapodytes nimmoniana* and *Strychnox nux-vomica* may be grown experimentally, as it is natural zone for these species, despite their general absence currently. Important medicinal plants like such *Salacia, Saraca, Embelia, Coscinium fenestratum* etc., which could have been expected here were not noticed during the survey; probably due to over-exploitation, and therefore may be introduced in appropriate micro-habitats.

Fig. 3.7. Estimated climber and shrub population



CHAPTER 4: PROMISING MEDICINAL TREES FOR SPECIAL PROTECTION AND ENHANCEMENT

Potential anti-inflammatory, analgesic, antioxidant drug sources from MPCAs: Recent research has highlighted the anti-inflammatory properties of several plants found in MPCAs, such as *Alstonia scholaris* (Kan: Haalemara; San: Saptaparni), because of alkaloids, picrinine, vallesamine and scholaricine which have anti-inflammatory and analgesic properties (Shang et al., 2010). Three phenolic compounds viz., artocarpesin, norartocarpesin and oxyresveratrol, serving the same purpose, are identified in the leaves and roots of the jackfruit tree *Artocarpus heterophyllus* (Shailashree et al, 2012). *Embelia ribes* (Kan: Vayuvilang) has anti-inflammatory and cell death regulating properties, with potential in cancer treatment (Chitra et al., 1994). Garcinol from the fruit of *Garcinia indica* (Kokum) has strong antioxidant activity (Krishnamurthy et al., 1981). *Terminalia chebula* (San: Haritagi) fruit extract has anti-inflammatory property (Chattopadhyay and Bhattacharyya, 2007). Phenolic compounds are a class of antioxidant agents which act as free radical scavengers and are considered as a major group of compounds that contribute to the antioxidant activities of plant materials because of their neutralizing ability on free radicals due to their hydroxyl groups The climber *Naravelia zeylanica* and the shrubby plant, *Adhatoda zeylanica (*Kan: *Adusoge)* and *Vitex negundo* (Kan: Nukki) often grown in hedges, are high in phenolic compounds and are good antioxidants. These plants are rich in flavonoids, a group of polyphenolic antioxidant and antimicrobial compounds known for free radical scavenging, antibacterial and anti-inflammatory action (Sree et al., 2014).

In folk medicine leaf paste of *Ricinus communis* (castor), a common village shrub, is used as a pain reliever (Upadhya et al., 2012). The Paliyar tribes of Dindigul in Tamil Nadu apply the ground paste of rhizome and leaves of *Gloriosa superba* (also a rainy season herbaceous climber of MPCA areas) for rheumatism affected areas. Mango bark is boiled in water and inhaled for relieving toothache (Mayilsamy and Rajendran, 2013).

Anticancer properties: It is notable that some of the household garden medicinal herbs of the MPCA villages, like *Andrographis paniculata* (Kan: Kiriatha) has anticancer and immunostimulatory effect. Sweet potato (*Ipomoea batatas*) cultivated for the tubers, rich in caffeoylquinic acid, has potential cancer chemoprotective effect. 4-Ipomeanol isolated from *I. batatas* has been found to exhibit anticancer activity against non-small cell lung cancer lines. Leaves of *Martynia annua* (cat's claw), a common roadside weed and stem of *Rhaphidophora pertusa,* an aroid climber of evergreen forests, grown as ornamental like the 'money plant' have been used against and neck and abdominal cancers respectively. *Citrus limon* (lemon or nimbu), cultivated for the fruits in local gardens, is rich in flavonoid, tangeretin and nobiletin, which are potent inhibitors of tumor cell growth and can activate the detoxifying P450 enzyme system. Limonene (a terpenoid) of lemon also possesses anticancer activity. Nimbu fruit is used for inhibition of human breast cancer cell proliferation and delaying of mammary tumorigenesis. It is also used in metastasis and leukemia (Pandey and Madhuri, 2009). Leaf extract of *Garcinia morella* was highly cytotoxic and showed antiproliferative and anticancer property (Garg et al., 2007).

Herbal drugs for diabetes: Some extracts/drugs act as α-Glucisidase or α-Amylase Inhibitor. These types of drugs/extracts are able to reduce the blood glucose level by inhibiting the gastric enzymes which is obligatory for the breakdown of the polysaccharides into simple sugar. The seed extract of *Syzgium cumini* – (neerilu) and leaf extract of guava leaves (*Pisidium guajava*), common household fruit tree, show α-amylase inhibition. Some herbs like the tuber of locally cultivated sweet flag (Kan: Baje-gida) *Acorus calamus*, used in the therapy of diabetes in traditional folk medicine, when consumed sensitizes the insulin activity. Extracts from the leaves and bark of mango tree *Mangifera indica* have antihyperglycaemic activity which reduce blood glucose level directly. Similar activity is shown by the bark extract from banyan tree *Ficus bengalensis* (Kan: Aala). Extracts of the aerial parts of *Coccinea indica* (Kan: Tondekai), common vegetable creeper of the region, and fruits of *Ficus glomerata* (Kan: Atthi) have antiglycaemic activity (Pandeya et al., 2013).

A good list of antidiabetic plants/parts locally grown or found in the wild include leaves/bark/root of *Aegle marmelos* (Kan: Bilpatri), *Aloe vera* leaves (hypoglycaemic), leaves of *Amaranthus* spp. (Kan: Hargi-soppu), including 'Mullu-hargi' *Amaranthus spinosus* (α amylase inhibition), fruits of Sitaphal *annona squamosa,* fruit of ash gourd (Kan: Buthi-kumbla), *Benincasa cerifera* (antidiabetic and helps deranged lipid metabolism in diabetics), the household medicinal herb *Boerhaavia diffusa* (antidiabetic), mustard seeds from *Brassica juncea* (hypoglycemic), plant parts of *Kaare* tree, *Catunaregam tomentosa* (antioxidant and antihyperglycemic) of degraded forests, coriander seed from *Coraindrum sativum* (hypolipdemic and hypoglycaemic), cucumber fruits from *Cucumis melo* (antioxidant and hyperglycemic), pumpkin fruit from *Cucurbita maxima* (antioxidant and hyperglycemic), the common medicinal grass *Cynodon dactylon* (antidiabetic, antioxidant and improve diabetes associated neurological disorders), the yam (Kan: Suvarnagadde), *Elephantopus scaber* (antidiabetic and α glucosidase inhibition), leave and shoots of Vayu-vilang *Embelia ribes* (antihyperglycemic), bark of Aswata, *Ficus religiosa* (antihyperglycemic and antidiabetic), aerial parts of *Gymnema sylvestre* (reduces blood glucose level, increase plasma insulin level, hypolipidemic), fruit of Hirekai (Kan), *Luffa acutangula* (antihyperglycemic, antioxidant), Sensitive plant *Mimosa pudica* (antihyperglycemic), fruit of Hagalakai (Kan) *Momordica charantia* (antidiabetic), seed of *Mucuna pruriens* (hypoglycemic), leaves of Karibevu (Kan) *Murraya koenigi* (renal complications in diabetics), Tulsi, *Ocimum sanctum* (variously useful), Nelanelli (Kan) *Phyllanthus amarus* (antidiabetic), bark and leaves of Bet-honne (Kan) *Pterocarpus marsupium* (various benefits), fruit of Dalimbe *Punica granatum* (antidiabetic), leaves and root bark of Ekanayaka (Kan) *Salacia* spp. (α glucosidase inhibition, antidiabetic), fruit of brinjal *Solanum melongina* (hyperglycemic, antioxidant), fruit of Taare (Kan), *Terminalia bellirica* (various benefits), stem of Amruthaballi (Kan) *Tinospora cordifolia* (various benefits), fruit of snakegourd *Trichosanthes anguina* (antioxidant, hypoglycaemic), seeds of Kaadu-jeere *Vernonia anthelmintica* (various benefits) (Pandeya et al., 2013). The list continues emphasizing how a blend of traditional folk medicine, Ayurveda and modern medical treatment programmes derived from such traditional knowledge systems can take holistic health care of the people through awareness, biodiversity protection and appropriate utilisation.

US patent 6207714 granted in 2001 to Dallas L. Clouatre for use of hydroxycitric acid for treating or ameliorating diabetes or insulin resistance by lowering elevated blood sugar levels. Major source of hydroxycitric acid today in the world market is *Garcinia cambogia* and to lesser extent *G. indica.*

It is notable that the Paliyars of Dindigul in Tamil Nadu use the seeds of *Syzygium cumini* with shade dried leaves of *Andrographis paniculata* (Kan: Kiriyata), *Abrus precatorius* (Kan: Gulgunji) and *Gymnema sylvestre* are ground into powder and taken orally along with cow's milk for diabetes (Mayilsamy and Rajendra, 2013).

Speech, memory: *Acorus calamus* (Kan: Baje-gida) rhizome is used in small quantities, in traditional medicine, as a paste mixed with honey and given to the children for clarity of speech as well as for cold and diarrhea (Mayilsamy and Rajendran, 2013). Its cultivation needs to be promoted in household as the rhizome has good marketing potential as well. The leaves of the herb *Centella asiatica* found growing widespread in local gardens is consumed widely in Uttara Kannada and elsewhere for improving memory. It is a nutraceutical as well. Powder of *Bacopa monnieri* (Brahmi), a waterside herb, with *Saraca indica* (Ashoka) bark powder in equal amounts, administered 5g of everyday, is said to be effective for mental clarity, intelligence and memory One teaspoon of *Asparagus recemosus* (Satavari) root powder taken with milk everyday is stated as an effective memory enhancer. Powder of *Glycyrrhiza glabra* (Mulaithi) roots, *Asparagus recemosus* (Satavari) roots, *Centella asiatica* (Mandukparni) and *Evolvulus alsinoides* (Shankhpushpi), in equal amounts, one teaspoon with milk is considered useful for memory (Bhowmik et al., 2010).

Skin ailments: A good lot of medicinal plants found in MPCAs, or in nearby villages, are used for various skin ailments in traditional medicines, either locally or elsewhere in India. The Paliyars of Dindigul use *Aegle marmelos* (Kan: Bilpatri) leaf paste application for body itching. *Ardisia solanacea* seed paste, and *Gloriosa superba* leaf paste are used for skin diseases as topical application. They apply the root paste of 'Bringaraja' *Eclipta prostrata* for dandruff and 'Manjishta' (*Rubia cordifolia*) root paste for boils on the skin (Mayilsamy and Rajendran, 2013).

Bone setting: The Adivasis of the Eastern Ghats in Andhra Pradesh use 'Shivane' (*Gmelina arborea*) plant parts for bone setting in humans and cattle (Venkataratnam and Venkataraju, 2008). Stem-leaf decoction of Amruthaballi, *Tinospora cordifolia,* and stem decoction of *T. sinensis* are used for bone strengthening by forest/rural communities of Uttara Kannada and Belgaum districts. They apply Eppemara (Kan) *Madhuca longifolia* seed fat as a massage oil and leaf juice of Shivane, G. arborea, to set the broken bones. The common wild herb Kaadu-bende, *Urena lobata* decoction is used for bone hardening after bone setting and gingelli oil from *Seasamum indicum* (it grows also as escape from cultivation) is used for application as a pain reliever (Upadhya et al., 2012). Bone fractures are traditionally treated with many plants that have presence in and outside MPCAs. These include bark paste of Dodda-holegeru (Kan), *Holigarna grahamii* (Upadhya et al., 2009), corm paste of Suvarna-gadde (Kan) *Amorphophallus paeonifolius* (Das et al., 2008), leaf paste of Balagane (Kan) *Diospyros Montana,* root paste, leaf paste of Bolatali-naru (Kan), *Bridelia stipularis* (Ignacimuthu, 2006), seed/root paste of Gulagunji *Abrus precatorius* (Anam, 2001), Tagache (Kan), *Cassia senna* leaf paste (Upadhya et al., 2009), Aala (Kan) *Ficus bengalensis* , crushed seed paste of Jumminkai *Zanthoxylum rhetsa* etc. (Upadhya et al., 2012).

Cardio-vascular ailments: Ayurvedic knowledge needs to be coupled with modern medicine and more scientific research needs to be done to verify the effectiveness, and elucidate the safety profile of herbal remedies for their antihypertensive potential. *Rauwolfia serpentina* is considered the most promising hypotensive plant. The local promising plants which require more research are *Phyllanthus amarus* (Nela-nelli), leaf extracts of the stem semiparasite plant *Viscum album* etc. (Tabassum and Ahmad, 2011). *Vitex leucoxylon* (Hole-nukki) has property to lower serum cholesterol. *Terminalia bellirica* (Tare) reduced lipids in experimental studies (Dahanukar et al., 2000).

MEDICINAL RESOURCES OF FUTURE FROM MPCAs

Actinodaphne hookeri (Kan: Tud-genasu; Trade name: Pisa): The tree has promising growing stock in seedling and sapling stages and their localities of concentration need special protection. The seed fat or pisa has commercial value and also has export potential. According to the *Wealth of India* Vol.1 A, CSIR, Delhi, Reprint 2003, of the 340 tonnes of annual production of pisa from India, 132 are said to be from the forests of Sirsi. The fat (oil) from seed is used as an external application in sprain and joints. Pisa fat is a much better source of lauric acid than palm kernel or coconut oil. Lauric acid is used in the prepartation of compounds like sodium lauryl sulphate, methyl laurate and lauryl alcohol. The fat can be used for soap making, confectionary and agarbatties. A cold infusion of leaves used in treatment of urinary disorders and for treatment of diabetes.

Alangium salvifolium (Kan: Ankolimara, San: Ankola): This rambling tree or shrub has a spreading nature; therefore even few individuals make good resource. These need to be marked for special protection. Roots are used in Ayurvedic medicine. Root bark is prescribed for biliousness and colic. Roots are diaphoretic and used in fever as a decoction or powder. Root bark has antitubercular activity. Rootbark extract is effective against ascaroid parasites of poultry. The roots have several valuable alkaloids. Root extract has hypotensive properties. Alkaloid mixture from stem bark AL-60 is used in treating blood pressure. Leaves are applied as poultice in rheumatism. The edible berries have anti-phlegmatic, laxative, tonic and cooling properties, and are useful in emaciation and haemorrhages, strangury and consumption, and also useful for curing eye troubles. The fruit is rich in various alkaloids. The seeds, also rich in alkaloids, are reputed in indigenous medicine for their cooling and tonic properties and for treatment of haemorrhage and boils.

Aporosa lindleyana (Kan: Challe): Quite common in the degraded portions of both the MPCAs. The root is traditionally given for jaundice, fever, headache, insanity etc. (Chopra et al., 1966). Roots have strong antioxidant activity (Badami et al., 2005). Antimicrobial activity and analgesic activity of bark extracts of the plant is helpful in treating various kinds of diseases in future days. The antimicrobial and analgesic activities of this plant extracts in traditional preparations can be justified by modern studies (Srikrishna et al., 2008).

Artocarpus hirsutus (Kan: Hebbalasu; Eng. Wild jack)**:** The Kurichia tribe of northern Malabar hills use the ground bark of the species for application on piles (Prasad and Shyama, 2013). An infusion of the bark is applied to cure small pimples and cracks on the skin. The powdered bark is used to heal sores. Dried leaves are used to treat hydrocele (http://frlhtenvis.nic.in/KidsCentre/Artocarpus_hirsutus_1636.aspx). Leaves, fruits as well as bark are used to treat diarrhoea, skin diseases, intrinsic haemorrhoage and poisons . Fruit Leaves and Bark of Wild jack is used for diarrhoea, pimples and indigestion (www.toxicologycentre.com)

Artocarpus lakoocha (kan: Vate-huli; san: Lakooch)***:*** It is rare tree in the forest. But can be propagated in coast facing degraded areas. Bark when applied externally heals boils, cracked skin and pimples. Seeds are purgative, blood agglutinating and antibacterial. The heartwood containing large amount of oxyresveratrol, could be considered as a source of starting material for the development of a new natural product as anti-HSV and anti-HIV agent. It has therapeutic value on cutaneous *Herpes simplex* virus. The antioxidant constituents present in the fruits play important role in scavenging free radicals and reactive oxygen species which are responsible for number of human disorders. Another traditional use has been in the treatment of tapeworm infection (Gautam and Patel, 2014).

Cinnamomum malabatrum (Dalchini, Cinnamon)***:*** Getting well established in Jankadakal forest, especially in growing stock. The plant has been known for their multiple pharmacological effects such as analgesic and anti-inflammatory, hepatoprotective, antioxidant anticancer properties. The leaf extract has proven anti-hyperlipidemic activity (Natarajan et al., 2014). The fresh extract of the leaves has presence of phenolics and flavonoids in large amount, which are antioxidants (Aravind et al., 2012).

Diospyros candolleana (Karimara)***:*** The tree is rich in phytochemicals of which many are under investigation. It is used in folk medicine. Very common tree in Jankadkal.

Diospyros sylvatica: The tree has highest presence in Jankadkal. Three quinones from the root extract plumbagin, isodiospyrin and microphyllone have strong termiticidal properties against underground termite, *Odontotermes obesus* (Ganapathi et al., 2004). The extract from the plant has strong antimalarial properties requiring further studies (Kantamreddi and Wight, 2008).

Elaeocarpus serratus: Chemical investigation of the leaves of yielded myricitrin**,** a strong antioxidant against DPPH (Jayasinghe et al., 2012). Used in traditional medicine as diuretic and as a cardiovascular stimulant. The leaves are used in the treatment of rheumatism and as antidote to poison, while the fruits are locally prescribed for the treatment of diarrhoea and dysentery. Chemical investigation reveals the leaves as a good source of bioactive compounds such as fatty acid esters, alcohols, hydrocarbons, aldehydes, alkenes, fatty acids and amides that justify the use of this plant for its various ailments by traditional practitioners. These active bio compounds may yield nature friendly strong antioxidant, anti-microbial, anti-inflammatory agents and analgesic agents (Geetha et al., 2013). This evergreen tree is an ecotone indicator and ideal for peripheral forests between the human settlements and the forest.

Ervatamia heyneana (Kan: Maddarasa): A shrub or small tree with latex, this is a medicinal plant of repute in the traditional medicine. It is being used in traditional medicine to treat microbial infections, diabetes, skin and venereal diseases, hepatotoxicity, and renotoxicity (Sathishkumar and Baskar, 2014). The discovery of the anticancer alkaloid Campothecin, one of the most impressive anticancer molecules of the recent times in the stem of *E. heyneana* may be considered a great breakthrough discovery. The tree can be easily propagated in large canopy openings, in the clearances below power transmission lines, roadsides, scrub etc. Camptothecin, a quinoline alkaloid, is used as antitumor drug, in the treatment of cancers of colon, head, breast and bladder 3, 4. In addition to its antitumor property, camptothecin also possesses activity against retrovirus and human immunodeficiency virus 3. Campothecin is also present in good quantity in *Nothapodytes nimmoniana*. The stem has most content of Campothecin (Dighe et al., 2012). Heynein from the latex of *Ervatamia* has a potential protease for food and biotechnology applications (Patel and Jagannatham, 2003). Renoprotective compounds were discovered in the leaf extracts (Sathishkumar and Baskar, 2014). Raising these trees in large scale in scrub jungles, marginal lands of local farmers, may be a good option for the future, provided there is also market linkages and buy back guarantees.

Ficus nervosa (Kan: Neerathi): A large sized, soft wooded, evergreen tree occasionally present in both the MPCAs. It is used in Chinese traditional medicines for treating inflammation, cancer and pain, including diabetes mellitus. The leaf extract has has beneficial effects on blood glucose level as well as improving hyperlipidemia and other metabolic aberrations. It has the potential to impart therapeutic effects in diabetes (Raj et al., 2011; Devi et al., 2012). The bark extract, in experimental studies clearly acted as a stomach ulcer protective agent

Garcinia indica (Kan: Murugila; Eng: Kokum). The tree is found somewhat common in the partially open portions and lower slopes of Shrigunji MPCA. Kokum fruit juice is a healthy drink. It is digestive, relieves sunstroke and is good for digestive problems. Ayurveda recommends it for many ailments: Kokum seed fat for chaffed skin, as remedy for diarrhoes and dysentery, treatment of burns, scalds, allergies etc. Kokum syrup is appetizer and liver tonic (Kirtikar and Basu, 1991). The fruit extract has both antibacterial and antifungal properties (Varalakshmi et al., 2010). Garcinol from the fruit rind might be beneficial as a potent antioxidant and a glycation inhibitor under specified conditions (Yamaguchi et al., 2000). The fruit rind is used to prepare juice, pickles and as acidulant in curries. In the Ayurveda and in various folk systems of medicine, the fruit rinds and leaves are used to treat various inflammatory ailments, rheumatic pain and bowel complaints. The kokum butter prepared from the seed is of both commercial and medicinal use. Some of its phytochemicals possess antibacterial, antifungal, anti-ulcerogenic, cardioprotective, anticancer, chemopreventive, free radical scavenging, antioxidant and anti-obesity effects (Baliga et al., 2011). There is a continuous increase in demand in kokum products in the domestic and international market. Coastal Maharashtra and Goa have achieved greater success with increased cultivation of kokum and increase in employment in kokum products. Costal Karnataka is yet to realize such benefits, though the plant is endemic to this region.

Garcinia cambogea (Kan: Uppage): Fruit rind as souring agent for curries, like tamarind. Seed fat used for cooking. Medicinally important. It is used as a food preservative and condiment. It has positive effect on liver and cures bilious affections. It is also used in ethnomedicine for rheumatism and treatment of tumours. Modern research has found that such reduction in appetite is due to the richness of Hydroxycitric acid (HCA) in the rind. The Garcinia products have antiulcerogenic, antioxidative, antidiabetic, antimicrobial, antifungal, anti-inflammatory and anticancer effects. The fat from the seed (or seed oil) is used for preparation of special dishes in the Malnadu districts of Karnataka. Today there is raging global demand for G. cambogia fruit rind, mainly for extraction of HCA. Many international companies and Indian companies are actively in the market with G. cambogia products for obesity reduction.

Holigarna spp. (Kan: Holegeru, Kaduholegeru etc.): Several species of *Holigarna*, which occur in the Shirgunji-Jankadkal MPCAs are evergreen trees with proven medicinal properties. In traditional medical care they have been used for the management of arthritis, dysentery, hemorrhoids, skin diseases, cancer and also as antiseptic (Divakar et al., 2010; Shyama and Prasad, 2012). Retrospective researches evidenced that *H. arnottiana* has antioxidant, antifeedant, anticancer and allergic potentials. These activities might be due to the presence of diverse bioactives metabolites in this species. Some biochemicals were found very effective against various microorganisms and especially against shrimp pathogens (Manilal and Idayadhulla, 2014). ‘Hydroxy citric acid’’ from kokum has potential of anti- obesity agent which suppressed fatty acid synthesis.

Hydnocarpus wightiana (Kan: Thoratte; San: Chaulamoogra; Tuvaraka). Has moderate presence in Jankadkal MPCA. Known for antidiabetic properties in traditional medicine. The seeds have strong antioxidant, α-glucosidase inhibitory activity. Hydnocarpin and isohydnocarpin from the seeds are mainly responsible for free radical scavenging properties. Chaulmoogra oil obtained from the seeds has been traditionally used in treating leprosy. It was confirmed that the ethanolic extract of the seed hull of *Hydnocarpus Wightiana* has the antidiabetic activity (Reddy et al, 2005; Reddy et al., 2013). The tree needs to be propagated in peripheral forest areas, in shaded or partially shaded dry or perennial stream-sides, shaded gullies, ravines etc. as it is a promising medicinal plant for the future.

Knema attenuata: Trees are numerous in Jankadkal forest and also having good regeneration. The aril and kernel extracts have significant larvicidal action on mosquito larvae

(Vinayachandra et al, 2011). Forest tribes of Kerala use it as a repellent for leeches in the forest (Sudhakara- undated).

Lannea coromandelica (Kan: Gojjalu; San: Jinghani. It is a well-known tree of traditional medicine in India. It grows fairly well in the secondary deciduous forests and amidst the degraded portions of Shirgunji MPCA. The tree has been documented for its potential as anti-inflammatory, anti-microbial, hypotensive, wound healing, and aphrodisiac activities. The plant also illustrated its beneficial effect on ulcerative stomatitis, dyspepsia, general debility, gout, cholera, diarrhoea, dysentery, sore eyes, leprosy, sprains and bruises, elephantiasis, eruptions, snakebite, stomach ache, and vaginal trouble. Moreover, the plant gum is given in sprains, asthma and as to women during lactation. It has antibacterial activity against *S. pyogens, S. aureus* and antifungal property against *C. albicans* corroborating the Ayurvedic use (Kaur et. al., 2013).

Lepisanthes tetraphylla: Sapindaceae tree, with moderate presence in Jankadkal MPCA, is known in traditional medicine for the treatment of elephantiasis, skin disease, fever and for its anti-convulsant property. A recent study showed its highly significant anticonvulsant activity similar to the standard drug Phenytoin and Diazepam (Ranjini et al., 2013).

Mallotus phillippensis (Kan: Kumkumadamara; San: Kampillaka, Kamala): Good number of juveniles noticed in Jankadkal with few adults. The tree needs to be promoted with special care in view of its medicinal values. Red powder of the fruit (glandular hairs) makes the most medicinal product. It is used against intestinal parasites, especially roundworm and hookworm. It is given in combination with *Butea monosperma* and *Embelia ribes*. Follow up period for a month in children showed significant eosoniophil count. *Krimighatini vatika* is an Ayurvedic preparation based on the plant (http://herbalnet.healthrepository.org/). The root powder applied on the skin against fiery rashes. Kamala powder is effective against tapeworm. It may be given in water mucilage or syrup. The powder is effective against herpetic ringworm (http://www.botanical.com/botanical/mgmh/k/kamala01.html). The red powder is an excellent vegetable dye for textile and can have promising future as an important NTFP.

Mangifera indica (Mango): Sparingly seen in the wild though cultivated widely. During the decades of industrial extraction of timber mango suffered heavy casualties. Though lot of traditional medicinal uses are available in literature and in local practice modern research has also brought out many new things. According to Nunez-Selles (2005) extract of stem bark is attributed with antioxidant, anti-inflammatory, analgesic and immune-modulatory properties. It prevents the progress of AIDS, increase the patient's quality of life in gastric and dermatological disorders, in AIDS, cancer and asthma.

Mimusops elengi (Kan, San: Bakula): Grows to very large size. Infrequent in Jankadkal, but saplings are more frequent. It is very important in traditional medicine. The bark is used for cooling, a cardio tonic, stomachic, anthelmintic, tonic, astringent which cures biliousness, diseases of the gums and teeth. The flower is cooling, astringent to the bowels are used to cure the disease of blood, biliousness, liver complaints, diseases of the nose, headache, their smoke is good in asthma. The fruit is astringent to the bowel, good for the teeth. Seed strengthens the loose teeth. Root is used a gargle for receding gums. Recent research has shown that various phytochemicals from the tree possess analgesic, antibiotic, anti-hyperlipidemic, anti-inflammatory, antimicrobial, antioxidant, antipyretic properties and are useful in treating gum bleeding, gastric ulcer etc. (Kadam et al., 2012).

Myristica malabarica (Kan: Rampatri): The evergreen portions of the Jankadkal and Shirgunji forests ideal for the species. But threat exists from indiscriminate collection of seed arils by chopping of branches of the trees. Seed used in external application for unhealing ulcers; crude fat from seeds analgesic and used in rheumatism and gangrene (https://www.google.co.in).
It is used in traditional medicine for indigestion, ulcers, wounds, as rejuvenator, in treating inflammation, cough, diarrhoea, dropsy, liver disorders, paralysis and urinary calculi (Keshavamurthy, 1994), also used in bronchitis, fever, burning sensation, to relieve pain in muscles, sprains and sores (Purushothaman et al., 1977).

Persea macrantha (Kan: Gulmavu): Sparingly seen in Jankadkal, this well-known medicinal and NTFP tree requires much greater attention than it gets today. It is traditional medicinal plant, its bark being used in the treatment of asthma and rheumatism. Leaves are used externally in ulcer. Experimental animal study indicates anti-inflammatory and anti-arthritic properties of *Persea macrantha* and thus provide pharmacological support to the traditional use in the treatment and management of painful, arthritic inflammatory conditions (Kulkarni et.al., 2009). Bark is used in treatment of tuberculosis, bone fracture, in traditional medicine. In Uttara Kannada-Sagar region its bark is used in equal quantity with that of cinnamon bark to prepare a poultice for setting fractured bones of cattle (Harsha, et al., 2005). The Halakki-vokkaligas use the powdered bark with egg-white and applied locally to the affected part in form of poultice act as an anti-inflammatory and anti-rheumatic agent (Kumar and Surana, 2011). The forest dwelling communities like Kunbis, Gowlis, Siddis etc. use crushed bark of the plant is given with milk to treat weakness and debility (Harsha et al., 2002). It could be as effective as diclofenac sodium in controlling inflammation (Tatiya and Hattapaki, 2003). It is notable that the widespread use of diclofenac as cattle pain killer caused widespread extermination of vulture population in India.

Pterospermum diversifolium (Kesale)***:*** The tree has reasonably good presence in Jankadkal. Tannin rich leaves and bark, are used in traditional medicine e.g. as a poultice against itching and to treat wounds, and taken internally to treat dysentery. Leaves are given to cattle suffering from stomach disorder. The extract was found to have good antibacterial activity (Hidayatulla et al. 2011). The tree will not require any special propagation efforts as there is a tendency for it to colonise blanks in the evergreen forest.

Stereospermum colais (San: Pathiri)***:*** A deciduous tree occasionally present in both the MPCAs. All the parts of the tree are useful in treating many disorders. The leaves are used to treat earache, toothache and in relieving rheumatic pains. It is used for malarial fever and healing of wounds. Decoction of the leaves is used for fever and to treat chronic indigestion. The root is one of the important ingredients in Dasamula an Ayurvedic formulation. The roots are diuretic, useful for kidney stones, expectorant and cardio tonic, anti-inflammatory and anti-bacterial, used against vomiting and in treatment of asthma (Warrier et al., 2002). Stem bark extract has analgesic activity. It has significant antibacterial and antifungal properties. The root extract has anti-glycaemic and anti-radical activity (Prema et al., 2013). The tree needs to be propagated through nurseries, supplied to farmers and the products marketed.

Syzygium caryophyllata (Kan: Kuntneerilu). Leaf essential oils exhibited promising antibacterial activity suggesting further research towards bio-prospecting of active compounds. The oil had 55 compounds in winter and 129 compounds in summer (Natarajan and Pujari, 2014). Antioxidant, antimicrobial and anticancer studies using leaves showed that it has potential utilization in pharmaceutical industry (Gayathri et al., 2012).

Terminalia paniculata (Kan: Kindal)***:*** Bark used in Ayurvedic medicine for the treatment of inflammation of parotid glands and in menstrual disorders. Recent research shows it may be a potential preventive or therapeutic candidate for the treatment of chronic inflammation and arthritis (Talwar et al., 2011). It could be an effective and promising preventive agent against paracetamol induced hepatotoxicity (Eshha et al., 2011). It has a protective role in pathologies involving oxidative stress (Talwar et.al., 2013).

Tetrameles nudiflora: Giant sized soft-wooded trees. The bark is used traditionally to cure skin itching. These occur occasionally in the MPCAs. They are notable often for harbouring several large hives of *Apis dorsata.*

Vitex altissima (Bharanige)***:*** The tree is well represented in Jankadkal and Shirgunji MPCAs. Its parts are used in traditional medicine to treat stomatitis, cardiac diseases, anorexia, blindness, leprosy and worm infestation. Stem bark is taken to treat ephemeral fever, snake bite, rheumatic swellings and chest pains. Leaves are used for wounds and skin allergies. Recent study (Bose et al., 2014) shows that its leaf extract inhibited pain and oedema, brought down fever and was comparable to paracetamol, thereby justifying folklore use.

PATENTS ON GARCINIA

Garcinia indica (Kokum) and *G. cambogea* (Uppage) are tree species and well known medicinal and nutraceutical plants of Western Ghats. The recent years have witnessed both these species entering in a big way in the world market for their various medicinal and nutraceutical properties. It is necessary to create awareness on such species among the local people and work out a mechanism for regulating access to such valuable assets for large scale commercial production of drugs and nutraceuticals by multinational companies. According to the Biodiversity Act-2002 the benefits out such commercial production should be equitably shared. As of August 2012, a total of 66 patents that apply to *Garcinia cambogia* or Hydroxycitric acid (HCA) derived from Garcinia were filed with the US Patent and Details of some of the patents granted are given below:

U.S. Patent No. 5,783,603 granted to Majeed et al. for administration of potassium hydroxycitrate for the suppression of appetite and induction of weight loss. Hydroxycitric acid (HCA) was obtained from the rinds of Garcinia fruits

Patent WO 2003092730 A1: granted in 2003 to Unibar Corp for a method preparation of Hydroxycitric acid (HCA) from the fruit rinds of Garcinia indica and Garcinia cambogia using a method Invented by Sunil Bhaskaran and Sevanti Mehta. This form of HCA can be used in the preparation of a variety of foods (http://www.google.co.in/patents/WO2003092730A1)

US Patent 6160172 granted in 2000 to Vittal Mallya Scientific Research Foundation for a method preparation of HCA (Ref: ibid.)

US patent 6207714 granted in 2001 to Dallas L. Clouatre for use of hydroxycitric acid for treating or ameliorating diabetes or insulin resistance by lowering elevated blood sugar levels (Ref: ibid)

US patent application 20120252898 from Sevanti Mehta (Houston, Texas) published on 10/04/2012 provides a method of producing a stabilized naturally occurring hydroxycitric acid from Garcinia indica fruit (http://www.freepatentsonline.com/y2012/0252898.html)

Patent no. WO2005007088 A2 granted in 2005 to applicants Sunil Bhaskaran, Sevanti Mehta and Unibar Corp for method of extraction of stabilized anthocyanin pigment (hue of red) from Garcinia indica fruit rind. It can be used as a red colorant for a wide variety of foodstuffs, beverages, nutraceuticals, pharmaceuticals, toiletries and the like, and as a natural anti-oxidant in such products (http://www.google.im/patents/WO2005007088A2?cl=en)

US patents 7858128; 7335651 & 7937626: Super Citrimax: InterHealth's Super CitriMax® (Hydroxycitric acid) patented brand Garcinia cambogia is claimed for its weight management benefits. Research lead by Dr. Harry Preuss, Georgetown University, demonstrates 3x more effective than diet and exercise alone. Super CitriMax is a patented, natural, non-stimulant fruit extract used as an ingredient in dietary supplements, functional food and beverages for a healthy weight. It is marketed in India as 'Garcinia cambogia Gold' by GoIndiaOrganic.co.

US patent application no.20120252898: Sevanti Mehta has applied for a patent on a particular method of producing a stabilized naturally occuring Hydroxycitric acid (HCA) from Garcinia indica

US Patent 6147228 has been granted (2012-11-14) for "A convenient method for the large scale isolation of Garcinia acid" for inventors Ibrahim Ibnusaud et al. Owner name: DST, Govt. of India.

Patent EP 0866137 B1 granted to Lupin Laboratories Ltd. for 'Process for producing calcium salt of (-)-Erythrohydroxycitric acid' from Garcinia indica, G. cambogia and G. atroviridis on 15 January, 2003.
- Ref for details: http://www.faqs.org/patents/app/20120252898#ixzz3KrMTL3jm

GarCitirn: A widely patented bioavailable composition of natural and synthetic HCA. A standardized extract from the dried rind of Garcinia cambogia. It is used for weight reduction. Marketed by Sabinsa Corporation, an international company. The company's many trademarked products have Indian medicinal plants as their bases. For eg: Bacopin®, Boswellin®, Citrin®, Curcumin C3 Complex®, Curcumin C3 Reduct®, FenuFibers®, Fenusterols®, Gugulipid®, Gymnema Sylvestre GS4®, Momordicin®, Picroliv® etc. (http://garcitrin.com/about-sabinsa) D'AGE™ Slender U: Widely atented Garcinia cambogia. The hydroxycitric acid formulation is claimed as fastest fat burner and natural appetite suppressant. A product of KJI Pharma Co. Kula Lampur.

PATENTS ON TINOSPORA CORDIFOLIA

Patent US 7914824 B2 granted in 2011 to Piramal Life Sciences Ltd. for Extract of Tinospora cordifolia; immunoadjuvant; chronic recurrent urinary tract infections; nephrotic syndrome; Glomerulonephritis.

Patent US 20060045923 A1 granted in 2006 to Lal Higorani and Vijay Thawani in 2006 for a composition for use in a nutritional product and its extraction process.

Patent US 20080274212 A1 granted in 2008 to Nicholas Piramal India Ltd. for Extract of Tinospora cordifolia for use as immunoadjuvant; chronic recurrent urinary tract infections; nephrotic syndrome and Glomerulonephritis

PATENTS ON HYDNOCARPUS WIGHTIANA

Patent US 5514712 A granted in 1996 to Shiseido International France for use of oils of chaulmoogra (mainly from Hydnocarpus spp.) in the cosmetic and pharmaceutical domain, particularly in dermatology, for harmonizing pigmentation of the skin

CHAPTER 5: TOWARDS INTEGRATED HEALTH CARE AND STGRENGTHENING OF MEDICINAL PLANT RESOURCES THROUGH COMMUNITY INVOLVEMENT

The heritage of the Western Ghats: Today the world looks at Ayurveda, the codified system of Indian medicine, as a holistic healthcare system. It is emerging as one of the greatest tourist attractions of the country, and the growth of Ayurveda based healthcare centres of South India, especially Kerala, is contributing substantially towards its economic growth, apart from popularizing the magic of medical herbs. This is despite Ayurveda having roots in the Vedas, and bulk of the most popular and widely traded traditional medicinal plants belonging to the North, including the Himalayas. The South Indian system remained obscure until the late 17th century Governor of Dutch Malabar, Hendrik van Rheede compiled the enormous wealth of indigenous medical care system prevalent in the South Indian Western Ghats-west coast region, through a series of 12 volumes entitled *Hortus Malabaricus* published from Amsterdam through a period of 25 years1678-1703. That the publication of this well- illustrated botanical work on Malabar medicinal plants was completed three years before the birth of Carl Linnaeus, known as the 'Father of Modern Botany', revealed to the modern world the great treasure of medicinal plants of South-west India. It is also notable that before the proposal of binomial system of nomenclature for naming plants and animals by Linnaeus, the indigenous Malabar system had already applied two names to designate most plants. Thus different species of Piper were named in the *Hortus* as 'Molagu codi' (*Piper nigrum*), 'Betla codi' (*Piper betel*) 'Cattu tippali' (*Piper longum*), 'Am molagu' (*Piper argyrophyllum*) etc. Thus in Malayalam became *Uvaria narum*. The balsams were designated by several native binomials like: *Valli onapu (Impatiens latifolia), Tsjeria onapu (Impatiens tilo) Man onapu (Impatiens minor), Beluta onapu (Impatiens minor)* etc. Interestingly Linnneaus had used several Malabar names for plants in his binomial system: Eg. 'Wattakaka kodi' (*Wattakaka volubilis),* 'Chemmbakm' *(Michelia champaca), Basala (Basella alba*), 'Narum panel' (*Uvaria narum*) etc.

Conferring Global Biodiversity Hotspot status to the Western Ghats, the enactment of the Biodiversity Act-2002 (BDA-2002) by the Government of India, following the 1992 UN Convention on Biological Diversity, the formation of Village Forest Committees in forested areas in many parts, and the ongoing constitution of Biodiversity Management Committees at the level of local bodies, as is mandatory under the BDA-2002, there has been an awakening in the country towards documentation, protection and sustainable use of its great wealth of plant and animal diversity. Conferring Medicinal Plants Conservation Area (MPCA) status for promising forest patches is to be considered a move in the right direction to study in detail such areas and to come out with appropriate management regimes so as to enhance the medicinal plant wealth through habitat conservation, ex situ conservation and sustained, community based programmes for enrichment of local livelihoods through medicinal plants cultivation, scientific methods of extraction/processing and marketing assistance .

Coming to the prospects of harnessing medicinal plants wealth and associated traditional knowledge and outcomes of modern research, it needs to be stated that India's per capita annual consumption of drugs of Rs.125 is one of the lowest in the world mainly because medicinal plants constitute the principal health care resources for the majority of population. The World Health Organisation (WHO) estimated that 80% of the population of developing countries relies on traditional medicines, mostly plant drugs, for their primary health care needs. Modern pharmacopoeia still contains at least 25% drugs derived from plants and many other drugs are, are synthetic analogues, built on prototype compounds, isolated from plants. Transition from synthetic drugs and microbially produced antibiotics to plant based drugs for holistic health care is rapidly gaining acceptance. Global resurgence in use of plant based drugs is an opportunity for India to attain self-reliance and boost the export of herbal drugs (Task Force on Medicinal Plants, Govt. of India, Planning Commission, 2000). The demand on plant based therapeutics is increasing in both developing and developed counties due to the growing recognition that they are natural products, being non-narcotic, having no side-effects, easily available at affordable prices and sometimes the only source of health care available to the poor. Medicinal plants sector has traditionally occupied an important position in the socio-cultural, spiritual and medicinal arena of rural and tribal lives of India. The global thrust areas for drugs from medicinal plants include disease conditions, whose incidence is increasing and where the modern drugs are either unavailable or unsatisfactory (-ibid-).

At present, 90% collection of medicinal plants is from the wild, generating about 40 million man-days employment (part and full) and since 70% of plants collections involve destructive harvesting, many plants are endangered or vulnerable or threatened. Currently medicinal plants are collected without paying attention to the stage of maturity. They are stored haphazardly for long period of time under unsuitable conditions. This results in deterioration in quality. Such materials are not acceptable to importers and standard manufacturing drug units (-ibid-). Despite the wealth of resources (biological, human and financial) available, the sector has not developed in the absence of suitable standardisation, quality control and efficacy of drugs. It has yet to formalize and organise marketing and trade and integrate the development of medicinal plants from production to consumption to boost export of herbal formulations. The Task Force on Conservation and Sustainable use of Medicinal Plants, set up by the Planning Commission of India made several recommendations which include the following:

- Establishment of 200 Medicinal Plant Conservation Areas (MPCA), covering all ecosystems, forest types and subtypes
- Medicinal plant species which are rare or endangered or threatened should be identified and their ex-situ conservation may be attempted in the established gardens, plantations and other areas.
- Two hundred "Vanaspati Van" may be established in degraded forest areas (with an area of about 3500 - 5000 hectares each). Intensive production of medicinal plants from these "Vanaspati Vans" will produce quality herbal products and generate productive employment to 50 lakh people, specially women, who are skilled in herbal production, collection and utilization. "Vanaspati Van" should be managed under JFM for benefit sharing to alleviate poverty of tribals.
- Twenty five species having the maximum demand should be cultivated under captive and organic farming.

- To prevent patenting of our traditional knowledge by outsiders, all the available information should be properly formatted in a digital form by using international standards for wider use both at the national and international level. Efforts should be intensified to create an Indian Traditional Knowledge Base Digital Library.

The importance of Uttara Kannada MPCAs: Highlighting the importance of research and development to fully convert the potential of our medicinal plants into economic wealth, the Medicinal Plants Task Force stressed upon the essentiality of very active R&D programme to cover all aspects relating to the species from collection to utilisation. For convenience medicinal species may be classified into: (a) those which are of proven medicinal value as per scientific parameters, (b) those on which sufficient leads are available, and (c) those on which much work is required to be done. The MPCAs in the evergreen forest belt of Uttara Kannada certainly fit into this framework for the reasons that: Many of the Western Ghat plants have been used for medicinal purposes from pre-history. Several such plants are cited in this report on which recent researched carried out revealed their amazing potential for treating/preventing even deadly diseases like cancer and overall enhancement of health using plants rich in antioxidants. Much work needs to be done yet for scores of species in the MPCAs, especially from the genera like *Litsea*, *Diospyros*, *Syzygium*, *Polyalthia*, *Psychotria* and *Strobilathus*, on wild palms like *Caryota urens, Arenga wightii., Corypha umbraculifera* (umbrella palm or talipot palm), *Calamus* spp (canes)., *Piper* spp. (wild pepper), apart from orchids, ferns and lichens etc. Bulk of these species endemic to Western Ghats is rarely/insufficiently or never researched for their medicinal purposes. This justifies the importance of Uttara Kannada MPCAs which serve the primary purpose of *in situ* conservation of scores of plants awaiting modern research to unravel their therapeutic values.

The role of involving local communities: The village and forest dwelling communities are to be actively involved/employed in medicinal plants cultivation and conservation in the wild. This partnership will pave the way for implementation of the Biodiversity Act-2002 in its true spirit, to benefit these communities with economic rewards for their ethno-medical knowledge which are getting scientific validation through modern research at a rapid phase. The village communities are to be actively involved in bulk production of various medicinal plants suitable for cultivation in their household gardens in small or big scale or in the portions of forests under JFM programmes etc. Appropriate technology should be made available to local growers of medicinal plants to prepare value added products for marketing purposes.

The value of the current study and future needs: The current study, carried out in the MPCAs, despite its short term nature, has brought out many intrinsic features of valuable patches of forests, with their plant population estimates, especially for trees and to some extent of other life forms. We need to emphasize here that strengthening of such data bases on MPCAs through continued research, aimed at estimates of population and conservation of those less known species of potential medicinal values, is essential. Species mapping within the MPCAs is another challenging task to be achieved. The MPCAs could be ideally conservation centres for natural populations of medicinal plants as well as be sources for supply of authenticated plant specimens/samples for medical research. The ethno-botanical values of the MPCA species need to be investigated in greater detail through studies extended beyond the local areas, through inter-regional comparisons, to initiate validation processes through modern research. There is also need for technology transfers to local communities on production of marketable intermediate plant products so as to enhance their income levels and for their active involvement in MPCA protection. Large scale production of medicinal plants in high demand should be carried out in local villages utilizing assistance available from organizations like WHO, FAO etc. It is recommended here that, based on the MPCAs, educative literature may be produced in local languages on awareness creation and publicity on plant based medical products and their importance for integrated, holistic health management.

Cultivation and trade assistance for medicinal plants/products: According to the World Bank report 1998 world trade in medicinal plants and related products is expected to be of the order of US $ 5 trillion by A D 2050. In India, it is a known fact that most of the medicinal plant resources are from the wild- collected from mainly forests areas, rapidly depleting the stock. This situation has to change expeditiously. Establishment of linkages between farmers and pharmaceutical industries is an urgent necessity. The Forest Department, preferably through NGOs, may facilitate ‘contract farming’ of medicinal plants by local farmers to cater to the demand of local Ayurvedic pharmacies and for outside procurers, under a buy-back system to benefit local growers in a risk free manner and also to reduce dependence on forests for indiscriminate collections. Organic certification is essential for capturing good market prices for local growers and the departments of forests/horticulture have to facilitate necessary processes in this regard. Many larger pharmacies like Dabur, Zandu, Himalaya drugs, Arya Vaidya Sala- Kottakal, Shree Dhootpapeshwar etc., have started promoting contract farming of medicinal plants to meet their demand. The pharmaceutical industries like Cipla, Natural Remedies, Core Health Care, Cadila Health Care, Bio-Ved Pharma etc., who specialise in production of a few specialty drugs/chemicals from plant sources are also involved in such farming to supplement their requirements through buy-back arrangements with the growers. Established traders of crude drugs also feel that promotion of cultivation of medicinal plants is a step in right direction. Forest Department may fix minimum prices for the products sold from its jurisdictional areas to benefit the local producers. Threatened medicinal plants may be multiplied in forest Department nurseries and supplied to farmers. Growers should be given package of good agricultural practices, especially certified propagules, cultivation techniques, quality control of raw-material, species-specific post-harvest storage and preparation of value added products for marketing. It should be ensured that organic farming practices are strictly followed. Assistance of pharmacology experts may be sought for training growers in quality control of products.

Strengthening institutional mechanisms for management: The existing mechanisms of co-operatives, Joint Forest Management, Self Help Groups etc. need to be strengthened and made more competent in trading of medicinal plants and their productions. The services of local NGOs of repute may be enlisted in streamlining of activities related to awareness creation, establishing linkages with buyers, marketing processes etc. The Forest Department has to make a register of all traders in medicinal plants and their products and take care to see that collection from the wild is strictly adhering to existing regulations applicable to each species, whether the curative properties of such plants are already known or yet remain to be established.

Preparation of 'Health Heritage': There are scores of traditional vaidyas, who are herbal healers, in the Uttara Kannada villages. There is need to document comprehensively the expertise and knowledge base of these healers, separately for Shirgunji MPCA and Jankadkal MPCA zones (covering all adjoining panchayats). These records should be authentic documents for respective panchayats, mentioning the names of the knowledge holders and their specific area of knowledge related to ethnomedicinal practice. Such a database should be digitized and in retrievable form with the names of those knowledge-holders recorded. Such works should also incorporate the scientific advances of recent times pertaining to the studies carried out on the local medicinal plants, so that the benefits from ongoing/future commercial applications based on traditional knowledge should be shared with grass roots level people. A set of recommendations for follow up actions are given here for consideration:

1. Preparing a compilation of traditional uses of medicinal plants in MPCAs and status report on scientific investigations, current utilization levels, requirements and species-specific action plans for future.
2. Creating awareness among the public and local stakeholders about especially the less known medicinal plants and their uses, values and future prospects
3. Preparation of herbaria, posters and booklets on individual MPCAs incorporating the intrinsic value of these sites. Establishment of digital herbaria is advisable in view of the humid weather adverse to storage of herbarium specimens.
4. In view of the rising need for medicinal plants and their products, there has been widespread and unregulated exploitation and trade. Honavar Forest Division, with its rich forest resources, needs to have a unit meant for storing voucher specimens, samples of crude drugs and facilities for identification of samples referred to it. Tie up with other local institutions is advisable in case of difficulties in establishing/handling such units.
5. Documentation of traditional primary healthcare in the villages adjoining all the MPCAs will be also very helpful in preparation of People's Biodiversity Registers, mandatory under the Biodiversity Act-2002, so that there will be greater community participation in MPCA management and the communities stand to gain from benefit sharing mechanism under the BDA.
6. Awareness creation about the modern research on the plants inside the MPCAs and how such knowledge can be integrated into traditional health care systems is recommended.
7. In view of the decreasing availability of therapeutic herbs from the wild due to over-exploitation and forest degradation, cultivation has to be promoted.
8. Improved low cost technologies for medicine preparation at the village level healers should be made available to make the medicines more effective, stable, reproducible and saleable.
9. MPCAs should be frequently evaluated and enriched with appropriate site specific medicinal plants, ranging from herbs to trees, climbers and epiphytes.
10. Human intervention in habitat management in the MPCAs should be limited to peripheral areas than the core areas. As natural vegetational changes are already

happening through the process of succession, especially in secondary forests, efforts should not be made to retain the species which are getting phased out naturally; eg. deciduous tree species in a recovering evergreen forest belt after wholesale human induced changes like fire and deforestation in the past. Such interventions if needed are to be restricted to areas under constant disturbances only.

11. Developing sense of responsibility for maintenance of MPCAs is to be developed in the local community, especially among women and youth, through awareness and training in handling, nurturing, collection and processing of medicinal plants.
12. Ex-situ cultivation in household gardens of surrounding villages of MPCAs be carried out systematically, especially of those species which are rare and in high demand or routinely required for primary health care. This scheme has to be worked out and implemented through consultative meetings at village level, awareness programmes, assistance in processing and marketing etc., if necessary.
13. Sacred groves in the adjoining panchayats be documented, mapped and the status of their medicinal plants wealth to be documented for strengthening community based conservation of these ancient relics of forests in the rural areas.
14. Locality specific small scale medicinal plant *vanas* may be established in private holdings as well as in the peripheral forests through allowing especially women's self-help groups to undertake such ventures on JFM principle, to produce raw materials required for local markets and for sale outside. Some of the recommended species for the region are in the Table 5.1.

Table 5.1. A list of plants recommended for cultivation in household gardens/JFM/SHG controlled forest areas

Species	**Local/trade name**	**Habit**	**Parts used**	**Notable commercial products**
Saraca asoca	Ashoka	Tree (ever-green)	bark	Ashokarishta, Ashokaghrita; mainly for menstrual problems and as uterine tonic
Embelia ribes	Vayuvilang, Vidanga	Scandent shrub	fruits	Vidangadi churna, Vidanga lauha, Vidanga taila
Aegle marmelos	Bael, Bilpatri	Tree	All parts	Bilwapanchaka Kwath, Bilwandi Churna, Dashmoolarishta, Dashmools Kwath.
Bacopa monnieri	Brahmi	Herb	Plant	As nervine tonic/memory enhancer; Brahmighrit, Sarasvatarisht, Brahmivati.
Coscinium fenestratum	Tree turmeric	Climber	Plant	Stem antimicrobial, antidiabetic, anti-inflammatory and anti-oxidant. Roots for dressing wounds and ulcers. Plant for local formulation for herpes treatment in Karnataka coast. Various uses alone and in combination (Rai et al., 2013).

Andrographis paniculata	Kiriyata, Kalmegh	Herb	All parts	Ayurvedic formulations for debility, malaria, jaundice, anemia and loss of appetite. Homeopathic medicines.
Garcinia cambogia	Uppage	Tree	Ripe fruit, seed fat	Fruit in high global demand for extraction of Hydroxy-citric acid (HCA) considered the most popular anti-obesity principle. Seed fat for cooking, medicinal
Garcinia indica	Kokum	Tree	Ripe fruit, seed fat	Syrup for beverages, medicine, dried rind, seed fat in demand for pharmaceutical, cosmetic products, export demand. Fruit rich in HCA
Piper longum	Long pepper, Hippli	Herbace-ous climber	Dry spike	In high demand for various medicines. Gudapippali, Pippalikhanda, Pipalyasva
Gymnema sylvestre	Madhu-nashini	Climber	Leaves and roots	For various ailments, specially diabetes. Sarivadyasava, Sarivadyavaleha, Sarivadi Kwath, Sarivadi vati.
Asparagus racemosus	Shatavari	Climber	Tuberous roots	Various gastric ailments and nutritional values; milk production in lactating women; gastric ulcers Shatavari ghrita, Naraina taila, Vishnu Tails, Shatmulyadi lauha, Shatavari panaka.
Adhatoda vasica	Vasaca, Adusoke	Shrub	Leaves	Vasicin as antispasmodic and cough supperessant
Gloriosa superba		Climber	Tuber	Colchicine for gout, arthritis, kidney stones; anticancer agent through prevention of spindle formation in cell division.
Tinospora cordifoila	Amruthaballi	Climber	Various parts	Jaundice, diabetes, fever, skin problems etc; has anti-cancer, anti-tumour, anti-diabetic, anti-inflammatory, hypolipidaemic and immunity enhancing properties (Sinha, *et al*., 2004).
Curcuma zeodaria	Karpur kachori	Tuberous herb	Rhi-zome	Rhizome apart from having food values is anti-inflammatory and antiarthritic (Kaushik and Jalalpure, 2011). Has cancer cells inhibiting property. Stomach ailments, leucoderma etc. Used in Dasamularishtam, Valiya Rasnadi Kashayam etc. (Lakshmi et al., 2011)
Mallotus phillippensis	Kumkuma-mara, Kamala	Tree	Fruits	hypoglycaemic, anticancer,

				antispasmodic, antilithotropic, antiinflammatory, wound healing etc.
Rauwolfia serpentina	Sarpagandha	Herb	Roots	Cardio-vascular diseases
Terminalia bellirica	Thari	Tree	Fruits	Hypoglycaemic, hypolipidemic, anti-obese property (Makihara et al., 2012)
Terminalia chebula	Haritagi, Myrobalan	Tree	Fruits, seeds, leaves	Antioxidant, antidiabetic, anti-bacterial, antiviral, antifungal, anticancerous, antiulcer, wound healing (Prakash et al., 2012) Activities
Hemidesmus indicus	Sarasaparilla, Sugandhiberu	Climber	Roots	Suitable for degraded forests and lateritic soils
Soalanum xanthocarpum	Kaadu-baddine, Kantakari	Roots, fruits, seeds		Root in Dasamoola, seeds diuretic, berries diuretic, decoction for fertility, cough, asthma, bronchitis (Singh & Singh, 2010)
Vernonia anthelmintica	Kaadu-jeera	Herbs	Fruits	Suitable for lateritic soils. For asthma, kidney troubles, arthritis, leucoderma, worm infestation, oedema, convulsion, anticancer (Manvar & Desai, 2012)
Woodfordia fruticosa	Dhataki	Scandant shrub	Flowers	In high demand. Suitable for clay-mixed lateritic soils. Antifertility, menstrual problems Dhatakyadi churna (skin diseases, menorrhagia, diarrhea, fever); Dhatakyadi taila (Skin diseases), - Laghu gangadhara churna (gastric ulcers, diarrhoea.

15. Some of the medicinal plants which require special attention in Janakadkal MPCA are:

- *Salacia oblonga* (Ekanayaka): A medicinal climber which can be well propagated in lightly shaded areas in forest openings.
- *Embelia ribes* (Vidanga, Vayuvilanga): Another important medicinal climber well represented in more evergreen to semi-evergreen forest requires special efforts for *in-situ* conservation.
- *Garcinia* spp: Evergreen trees whose products are in high demand. *G. Morella and G. cambogia* (Uppage) are ideal trees for propagating in these more dense forests.

- *Calophyllum apetalum (*Bobbi): These riparian trees are valuable resources for special protection
- *Saraca asoca* (Ashoka): Requires special care in stream habitats .
- *Hydnocarpus pentandra* (Thoratte): Trees with high medicinal value can be also ideal candidates in more riparian areas.
- Oroxylum indicum: Trees with high medicinal value for open riparian areas.
- Other important medicinal plants in high demand which can be well brought into in-situ conservation in these areas include trees such as *Dysoxylum malabaricum* (Bili-devadari, White cedar) *Persea macrantha* (Gulmav), *Artocarpus hirsutus* (Hebbalasu), *A. lakoocha* (Vate-huli), *Nothopodytes nimmoniana*, *Symplocos racemosa*, *Alstonia scholaris* (Halemara), and shrubs and climbers such as *Acacia concinna* (Shikekai), *Tinospora cordifolia* (Amruthaballi), *Coscinium fenestratum* (Marada-arashina) etc. Some of the important medicinal deciduous trees such as *Cassia fistula, Stereospermum coleus*, *Strycnos-nux vomica*, *Terminalia bellarica*, *T. chebula, Bombax insigne*, *Phyllanthus emblica* etc. can be used in in-situ conservation in more degraded or barren areas, avoiding even small grassy patches needed for wildlife

16. Some of the medicinal plants which require special attention in Shirgunji MPCA are:

- *Garcinia indica* (Kokum; Murgila): In high demand for medicinal, culinary uses and as beverage. The distribution of this medicinal plant is good and occurs in most forest edges and other open areas. However with increasing anthropogenic pressure this tree is under threat and needs more *in situ* conservation measures. Restoration measures such as planting in forest open areas and edges will naturally increase the species survival.
- *Garcinia cambogia:* In high global demand for extraction of HCA.
- *Abrus precatorius* (Gulgunji): Mostly found in semi-evergreen areas. It also occurs in minor forests with high disturbance. Hence this species can be suitable candidate for in situ conservation in open forests.
- *Asparagus racemosus* (Shatavari): This important medicinal plant is found distributed in semi-evergreen forest and can be very important addition during planting with other medicinal plants in more shaded fragmented areas.
- *Celastrus paniculatus* (Jotishmati): Highly traded medicinal plant found in small number in these areas can be more intensively planted in open forest areas and edges.
- *Rauvolfia serpetina* (Sarpagandha): A valuable and highly traded and over-exploited medicinal plant found in the open degraded forest areas needs more intensive *in-situ* conservation. Scrubby forest areas are ideal.
- *Alstonia scholaris* (Halemara, Saptaparni): Found distributed more in semi-evergreen forest. This tree is suitable for forest openings and semi-evergreen degraded forest areas.
- Other less seen medicinal plants, mainly evergreens, in high demand for consideration are: *Cinnamomum sulphuratum. C.malabatrum* (Dalchini)*, Gmelina arborea*

(Shivuni), *Myristica malabarica* (Rampatri), *Artocarpus hirsitus* (Hebbalasu), *Calophyllum apetalum* (Bobbi). Shrubs and climbers such as *Salacia chinensis* (Ekanayaka), *Nothopodytes nimmoniana*, *Rubia cordifolia* (Majishta), *Smilax ovalifolia* (Kaadu-hambu), *Tinospora cordifolia* (Amruthaballi), *Piper* spp (Kaadu-menasu; wild pepper)., *Coscinium fenestratum* (Tree turmeric), *Acacia concinna* (shikekai), *Gloriosa superba* etc. can be more planted in disturbed forest areas.

- Deciduous species: Many important deciduous tree medicinal plants well distributed here includes *Buchnania lanzan* (Nurkalu), *Careya arborea* (Kaval-mara), *Terminalia bellirica* (Tari), *Phyllanthus emblica* (Nellikai), *Bombax insigne* etc. These also can be used in in-situ conservation for planting in highly degraded scrub areas.
- Cultivable species: Many medicinal plants have very high demand whhich cannot be catered to from wild sources only. Hence these can be brought into cultivation with the local farmers and medicinal gardens. Important medicinal plants such as *Adhadhoda zeylanica* (Vasaka; Adusoke), *Andrographis paniculata* (Kiriyata), *Baliospermum montanum*, *Bacopa monnerie* (Brahmi), *Gloriosa superba*, Piper longum (Hippali; Long pepper), *Tinospora cordifolia* (Amruthaballi), *Curcuma zerumbet* (Kasthuri) , Cyclea peltata, etc. (see also Table 5.1), are cultivable, have high demand and their shorter life cycle enables early harvest.

Farmers view regarding medicinal plants cultivation in Shirgunji (also holds good for Jankadkal)

Interview and group discussion with local farmers regarding cultivation of medicinal plants highlighted following points:

- Many farmers were interested in cultivation of medicinal plants.
- Farmers needed assurance from the Government or other agencies such as “buy back” scheme for the medicinal plants cultivated.
- They needed protocol for the cultivation methods of specific medicinal plants.
- They mostly opted for biennial or annual medicinal plants or which yield early as most farmers were from medium to low income group.
- Some farmers also insisted some initial monetary help from Government or other agencies for cultivating long term medicinal plants such as *Cassia fistula*, *Myristica malabarica*, *Phyllanthus emblica, Terminalia* spp., etc.

More awareness and knowledge regarding medicinal plant cultivation is required.

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Annexure 1: Checklist of Jankadkal MPCA plants with habit, habitat, distribution, medicinal use

(Note for Habitat: Evg-Evergreen to Semi-evergreen; MD-Moist deciduous; SS-Scrub, Savanna; RS-Roadside, Waste lands, Walls; STM streamside; MSW-Marsh, Wet areas; Pl-Plantations; GR-Grasslands)

Sl no	Family	Species	Habit	Distribution	Medicinal use (M)	Habitats
1	Fabaceae	*Abrus precatorius*	Climber		M	EVG
2	Fabaceae	*Abrus pulchellus*	Climber		M	EVG, MD, SS
3	Fabaceae	*Acacia concinna*	Climber		M	EVG, MD
4	Amaranthaceae	*Achyranthus aspera*	Shrub		M	RS
5	Lauraceae	*Actinodaphne hookeri*	Tree	Endemic	M	EVG
6	Acanthaceae	*Adhatoda zeylanica*	Herb		M	MD, SS
7	Orobanchaceae	*Aeginetia indica*	Herb		M	SS
8	Orchidaceae	*Aerides maculosa*	Herb	Endemic		EVG, MD, SS
9	Meliaceae	*Aglaia anamalayana*	Tree		M	EVG
10	Meliaceae	*Aglaia roxbhurgii*	Tree	Endemic		EVG
11	Alangiaceae	*Alangium salviifolium*	Tree		M	EVG, MD
12	Sapindaceae	*Allophylus cobbe*	Shrub		M	EVG, MD
13	Araceae	*Amorphophallus bulbifer*	Herb		M	EVG, RS, MD
14	Vitaceae	*Ampelocissus indica*	Climber	Endemic	M	EVG
15	Menispermaceae	*Anamirta cocculus*	Climber		M	EVG
16	Ancistrocladaceae	*Ancistrocladus heyneanus*	Climber	Endemic	M	EVG
17	Aristolochiaceae	*Apama siliquosa*	Shrub	Western Ghats, Sri Lanka	M	EVG, STM
18	Euphorbiaceae	*Aporosa cardiosperma*	Tree		M	EVG, MD
19	Myrsinaceae	*Ardisia solanacea*	Shrub		M	EVG, STM
20	Arecaceae	*Arenga wightii*	Tree	Endemic	M	EVG
21	Aristolochiaceae	*Aristolochia indica*	Climber		M	MD,
22	Annonaceae	*Artabotrys zeylanica*	Shrub	Western Ghats, Sri Lanka	M	EVG, MD
23	Moraceae	*Artocarpus gomezianus*	Tree	Endemic	M	EVG
24	Moraceae	*Artocarpus hirsutus*	Tree	Endemic	M	EVG
25	Liliaceae	*Asparagus racemosus*	Climber		M	EVG
26	Rutaceae	*Atalantia racemosa*	Shrub		M	EVG, MD
27	Lauraceae	*Beilschmiedia wightii*	Tree	Endemic	M	EVG
28	Oxalidaceae	*Biophytum sensitivum*	Herb		M	RS
29	Bombacaceae	*Bombax insigne*	Tree		M	EVG
30	Acanthaceae	*Bremekampia neilgherryensis*	Herb	Endemic		MD, SS
31	Arecaceae	*Calamus pseudotenuis*	Shrub	Endemic	M	EVG
32	Arecaceae	*Calamus thwaitesii*	Slender-climbing cane			EVG
33	Verbenaceae	*Callicarpa tomentosa*	Tree		M	EVG, MD
34	Clusiaceae	*Calophyllum apetalum*	Tree		M	EVG

35	Clusiaceae	*Calophyllum polyanthum*	Tree	Endemic	M	EVG, STM
36	Combretaceae	*Calycopteris floribunda*	Climber		M	EVG, MD, SS
37	Rubiaceae	*Canthium dicoccum*	Shrub	Endemic		EVG, MD
38	Rubiaceae	*Canthium parviflorum*	Tree		M	EVG
39	Capparaceae	*Capparis rheedii*	Shrub	Endemic	M	EVG, SS
40	Apocynaceae	*Carissa carandas*	Shrub		M	SS
41	Arecaceae	*Caryota urens*	Tree		M	EVG
42	Fabaceae	*Cassia tora*	Herb		M	RS
43	Vitaceae	*Cayratia mollissima*	Shrub	Endemic		EVG
44	Celastraceae	*Celastrus paniculatus*	Climber		M	EVG
45	Apiaceae	*Centella asiatica*	Herb		M	Pl, MSW
46	Oleaceae	*Chionanthus mala-elengi*	Tree	Endemic	M	EVG
47	Apocynaceae	*Chonemorpha fragrans*	Climber			EVG, MD
48	Lauraceae	*Cinnamomum malabatrum*	Tree	Endemic	M	EVG
49	Verbenaceae	*Clerodendrum viscosum*	Shrub		M	MD
50	Combretaceae	*Combretum latifolium*	Climber		M	EVG, MD
51	Arecaceae	*Corypha umbraculifera*	Tree	Western Ghats, Sri Lanka	M	EVG
52	Orchidaceae	*Cottonia peduncularis*	Herb			MD, SS
53	Hypoxidaceae	*Curculigo orchioides*	Herb		M	MD, SS
54	Poaceae	*Cynodon dactylon*	Herb		M	SS, Pl, MSW, GR
55	Cyperaceae	*Cyperus haspan*	Herb			MSW
56	Cyperaceae	*Cyperus iria*	Herb			MSW
57	Poaceae	*Cyrtococcum oxyphyllum*	Herb			EVG, MD
58	Fabaceae	*Dalbergia rubiginosa*	Shrub			EVG
59	Fabaceae	*Desmodium triquetrum*	Herb		M	SS
60	Annonaceae	*Desmos lawii*	Climber	Endemic	M	EVG, MD
61	Dichapetalaceae	*Dichapetalum gelonioides*	Shrub			EVG
62	Dilleniaceae	*Dillenia pentagyna*	Tree		M	EVG, MD, SS
63	Poaceae	*Dimeria ornithopoda*	Herb			GR, SS
64	Dioscoriaceae	*Dioscorea bulbifera*	Herb		M	EVG, MD, SS
65	Ebenaceae	*Diospyros buxifolia*	Tree	Endemic	M	EVG
66	Ebenaceae	*Diospyros candolleana*	Tree	Endemic	M	EVG
67	Ebenaceae	*Diospyros oocarpa*	Tree	Endemic	M	EVG
68	Ebenaceae	*Diospyros paniculata*	Tree	Endemic		EVG
69	Ebenaceae	*Diospyros saldanhae*	Tree	Endemic		EVG
70	Ebenaceae	*Diospyros sylvatica*	Tree			EVG
71	Menispermaceae	*Diploclisia glaucescens*	Climber		M	EVG
72	Agavaceae	*Dracaena terniflora*	Shrub		M	EVG, MD
73	Droseraceae	*Drosera burmannii*	Herb		M	MSW
74	Droseraceae	*Drosera indica*	Herb		M	MSW

75	Acanthaceae	*Ecbolium ligustrinum*	Shrub			EVG, MD
76	Asteraceae	*Eclipta prostrata*	Herb		M	RS
77	Elaeagnaceae	*Elaeagnus latifolia*	Shrub		M	EVG
78	Elaeocarpaceae	*Elaeocarpus serratus*	Tree		M	EVG
79	Asteraceae	*Elephantopus scaber*	Herb		M	EVG, MD, SS
80	Myrsinaceae	*Embelia ribes*	Climber		M	EVG
81	Asteraceae	*Emilia sonchifolia*	Herb		M	RS, MD, SS
82	Fabaceae	*Entada pursaetha*	Climber	Western Ghats, Sri Lanka	M	EVG
83	Acanthaceae	*Eranthemum roseum*	Herb	Endemic	M	EVG, MD
84	Apocynaceae	*Ervatamia heyneana*	Tree	Endemic	M	EVG
85	Convolvulaceae	*Erycibe paniculata*	Climber		M	EVG
86	Asteraceae	*Eupatorium odoratum*	Shrub		M	RS, MD, SS
87	Convolvulaceae	*Evolvulus nummularius*	Herb		M	SS, GR
88	Convolvulaceae	*Evolvulus alsinoides*	Herb		M	SS, GR
89	Moraceae	*Ficus callosa*	Tree		M	EVG
90	Moraceae	*Ficus drupacea*	Tree		M	EVG
91	Moraceae	*Ficus nervosa*	Tree			EVG
92	Flacourtiaceae	*Flacourtia montana*	Tree		M	EVG
93	Clusiaceae	*Garcinia gummi-gutta*	Tree		M	EVG
94	Clusiaceae	*Garcinia morella*	Tree	Endemic	M	EVG
95	Euphorbiaceae	*Glochidion javanicum*	Tree			EVG, MD
96	Rutaceae	*Glycosmis pentaphylla*	Shrub		M	EVG, MD
97	Gnetaceae	*Gnetum ula*	Climber		M	EVG, MD
98	Olacaceae	*Gomphandra axillaris*	Shrub		M	EVG
99	Annonaceae	*Goniothalamus cardiopetalus*	Climber	Endemic	M	EVG
100	Tiliaceae	*Grewia microcos*	Shrub		M	EVG, MD
101	Tiliaceae	*Grewia tiliifolia*	Tree		M	MD, SS
102	Asclepiadaceae	*Gymnema sylvestre*	Climber		M	MD, SS
103	Sterculiaceae	*Helicteres isora*	Shrub		M	MD, SS
104	Apocynaceae	*Holarrhena pubescens*	Shrub		M	MD, SS
105	Anacardiaceae	*Holigarna arnottiana*	Tree	Endemic	M	EVG
106	Anacardiaceae	*Holigarna ferruginea*	Tree	Endemic	M	EVG
107	Anacardiaceae	*Holigarna grahamii*	Tree	Endemic	M	EVG
108	Anacardiaceae	*Holigarna nigra*	Tree	Endemic		EVG
109	Dipterocarpaceae	*Hopea ponga*	Tree	Endemic		EVG
110	Flacourtiaceae	*Hydnocarpus pentandra*	Tree	Endemic	M	EVG
111	Apocynaceae	*Ichnocarpus frutescens*	Climber		M	MD, SS
112	Rubiaceae	*Ixora arborea*	Shrub	Western Ghats, Sri Lanka	M	EVG, MD, SS
113	Rubiaceae	*Ixora brachiate*	Shrub	Endemic	M	EVG, MD
114	Rubiaceae	*Ixora polyantha*	Tree	Endemic	M	EVG
115	Rubiaceae	*Ixora coccinea*	Tree	Endemic	M	EVG
116	Myristicaceae	*Knema attenuata*	Tree	Endemic	M	EVG

117	Cyperaceae	*Kyllinga melanosperma*	Herb		M	MSW
118	Lythraceae	*Lagerstroemia microcarpa*	Tree		M	MD, SS
119	Lythraceae	*Lagerstroemia speciosa*	Tree		M	STM
120	Anacardiaceae	*Lannea coromandelica*	Tree		M	MD, SS
121	Leeaceae	*Leea indica*	Tree		M	EVG, MD
122	Sapindaceae	*Lepisanthes tetraphylla*	Tree		M	EVG
123	Lauraceae	*Litsea floribunda*	Tree	Endemic		EVG
124	Lauraceae	*Litsea laevigata*	Tree	Endemic		EVG
125	Campanulaceae	*Lobelia alsinoides*	Herb		M	EVG, RS
126	Campanulaceae	*Lobelia nicotianaefolia*	Herb			GR, SS, MSW
127	Celastraceae	*Lophopetalum wightianum*	Tree		M	EVG
128	Euphorbiaceae	*Macaranga peltata*	Tree		M	EVG, MD
129	Sapotaceae	*Madhuca neriifolia*	Tree	Western Ghats, Sri Lanka		STM, EVG, MD
130	Myrsinaceae	*Maesa indica*	Climber		M	EVG
131	Euphorbiaceae	*Mallotus philippensis*	Tree		M	EVG
132	Anacardiaceae	*Mangifera indica*	Tree		M	EVG
133	Melastomataceae	*Melastoma malabathricum*	Herb			EVG
134	Melastomataceae	*Memecylon edule*	Tree	Endemic	M	EVG
135	Melastomataceae	*Memecylon talbotianum*	Tree	Endemic	M	EVG
136	Melastomataceae	*Memecylon terminale*	Tree	Endemic	M	MD, SS
137	Sapotaceae	*Mimusops elengi*	Tree	Endemic	M	EVG, MD
138	Fabaceae	*Moullava spicata*	Climber		M	EVG, MD
139	Fabaceae	*Mucuna monosperma*	Climber		M	EVG
140	Myristicaceae	*Myristica malabarica*	Tree	Endemic	M	EVG
141	Meliaceae	*Naregamia alata*	Herb		M	EVG, MD, MSW
142	Lauraceae	*Neolitsea scrobiculata*	Tree	Endemic	M	EVG
143	Icacinaceae	*Nothapodytes nimmoniana*	Tree		M	EVG, MD
144	Anacardiaceae	*Nothopegia castaneaefolia*	Tree		M	EVG
145	Poaceae	*Ochlandra scriptoria*	Shrub	Endemic		EVG
146	Rubiaceae	*Ochreinauclea missionis*	Tree	Endemic	M	STM
147	Oleaceae	*Olea dioica*	Tree		M	EVG, MD
148	Bignoniaceae	*Oroxylum indicum*	Tree		M	STM
149	Bignoniaceae	*Pajanelia longifolia*	Tree		M	EVG, STM
150	Lauraceae	*Persea macrantha*	Tree	Western Ghats, Sri Lanka	M	EVG
151	Orchidaceae	*Pholidota imbricata*	Herb			EVG, MD
152	Euphorbiaceae	*Phyllanthus emblica*	Herb		M	MD, SS, GR
153	Euphorbiaceae	*Phyllanthus urinaria*	Herb		M	SS, GR
154	Euphorbiaceae	*Phyllanthus simplex*	Tree		M	MD, SS
155	Piperaceae	*Piper nigrum*	Climber	Endemic	M	EVG
156	Pittosporaceae	*Pittosporum dasycaulon*	Tree	Endemic	M	EVG

157	Annonaceae	*Polyalthia fragrans*	Tree	Endemic		EVG
158	Fabaceae	*Pongamia pinnata*	Tree		M	STM
159	Araceae	*Pothos scandens*	Climber		M	EVG
160	Rubiaceae	*Psychotria truncata*	Shrub	Endemic	M	EVG, MD
161	Rubiaceae	*Psychotria dalzellii*	Shrub	Endemic		EVG
162	Rubiaceae	*Psychotria flavida*	Shrub	Endemic		EVG
163	Sterculiaceae	*Pterospermum diversifolium*	Tree		M	EVG
164	Sterculiaceae	*Pterospermum reticulatum*	Tree	Endemic		EVG
165	Sterculiaceae	*Pterygota alata*	Tree			EVG
166	Rubiaceae	*Randia dumetorum*	Tree		M	MD
167	Apocynaceae	*Rauvolfia serpentina*	Herb		M	MD, SS
168	Araliaceae	*Rhaphidophora laciniata*	Climber		M	EVG
169	Boraginaceae	*Rotula aquatica*	Herb		M	MSW
170	Connaraceae	*Rourea prainiana*	Climber		M	EVG
171	Rubiaceae	*Rubia cordifolia*	Herb		M	EVG, MD
172	Acanthaceae	*Rungia pectinata*	Herb		M	MD, SS, GR
173	Annonaceae	*Sageraea laurifolia*	Tree	Endemic	M	EVG
174	Sapindaceae	*Sapindus laurifolius*	Tree		M	Pl, RS
175	Euphorbiaceae	*Sapium insigne*	Tree		M	MD, SS
176	Fabaceae	*Saraca asoca*	Tree		M	STM
177	Araliaceae	*Schefflera venulosa*	Shrub		M	EVG, MD
178	Sapindaceae	*Schleichera oleosa*	Tree		M	MD, SS
179	Anacardiaceae	*Semecarpus anacardium*	Tree		M	MD
180	Malvaceae	*Sida acuta*	Herb		M	RS, SS
181	Malvaceae	*Sida rhombifolia*	Herb		M	SS, RS
182	Smilacaceae	*Smilax zeylanica*	Climber		M	EVG
183	Bignoniaceae	*Stereospermum colais*	Tree		M	MD
184	Moraceae	*Streblus asper*	Tree		M	MD, STM
185	Olacaceae	*Strombosia ceylanica*	Tree			EVG
186	Loganiaceae	*Strychnos nux-vomica*	Tree		M	MD, SS
187	Symplocaceae	*Symplocos racemosa*	Tree	Endemic	M	EVG
188	Myrtaceae	*Syzygium caryophyllatum*	Tree		M	EVG
189	Myrtaceae	*Syzygium cumini*	Tree	Endemic	M	EVG, STM
190	Myrtaceae	*Syzygium hemesphericum*	Tree	Western Ghats, Sri Lanka	M	EVG
191	Myrtaceae	*Syzygium macrocephala*	Tree		M	EVG, MD, SS
192	Myrtaceae	*Syzygium zeylanicum*	Tree	Endemic		EVG
193	Myrtaceae	*Syzygium gardneri*	Tree		M	STM, EVG
194	Myrtaceae	*Syzygium laetum*	Tree		M	STM, MD
195	Verbenaceae	*Tectona grandis*	Tree			MD
196	Combretaceae	*Terminalia bellirica*	Tree		M	MD, SS
197	Combretaceae	*Terminalia elliptica*	Tree		M	MD, SS
198	Combretaceae	*Terminalia paniculata*	Tree		M	MD, SS

199	Combretaceae	*Terminalia chebula*	Tree		M	MD, SS
200	Datiscaceae	*Tetrameles nudiflora*	Tree			EVG, MD
201	Vitaceae	*Tetrastigma gamblei*	Shrub	Endemic	M	EVG
202	Malvaceae	*Thespesia populnea*	Tree		M	RS
203	Meliaceae	*Toona hexandra*	Tree		M	EVG, MD
204	Ulmaceae	*Trema orientalis*	Tree		M	EVG, MD
205	Euphorbiaceae	*Trewia nudiflora*	Tree		M	EVG, MD
206	Rubiaceae	*Tricalysia sphaerocarpa*	Tree	Endemic		EVG
207	Meliaceae	*Trichilia connaroides*	Tree		M	EVG, MD
208	Meliaceae	*Turraea villosa*	Shrub			EVG
209	Asclepiadaceae	*Tylophora indica*	Climber		M	MD, SS
210	Annonaceae	*Uvaria narum*	Climber	Western Ghats, Sri Lanka	M	EVG
211	Dipterocarpaceae	*Vateria indica*	Tree	Endemic	M	EVG
212	Rhamnaceae	*Ventilago maderaspatana*	Climber		M	EVG
213	Rutaceae	*Vepris bilocularis*	Tree	Endemic	M	EVG
214	Verbenaceae	*Vitex altissima*	Tree			EVG, MD
215	Meliaceae	*Walsura trifoliata*	Tree		M	EVG
216	Fabaceae	*Xylia xylocarpa*	Tree		M	MD
217	Rutaceae	*Zanthoxylum rhetsa*	Tree		M	MD
218	Zingiberaceae	*Zingiber cernum*	Herb	Endemic	M	EVG
219	Fabaceae	*Zornia gibbosa*	Herb		M	GR, SS

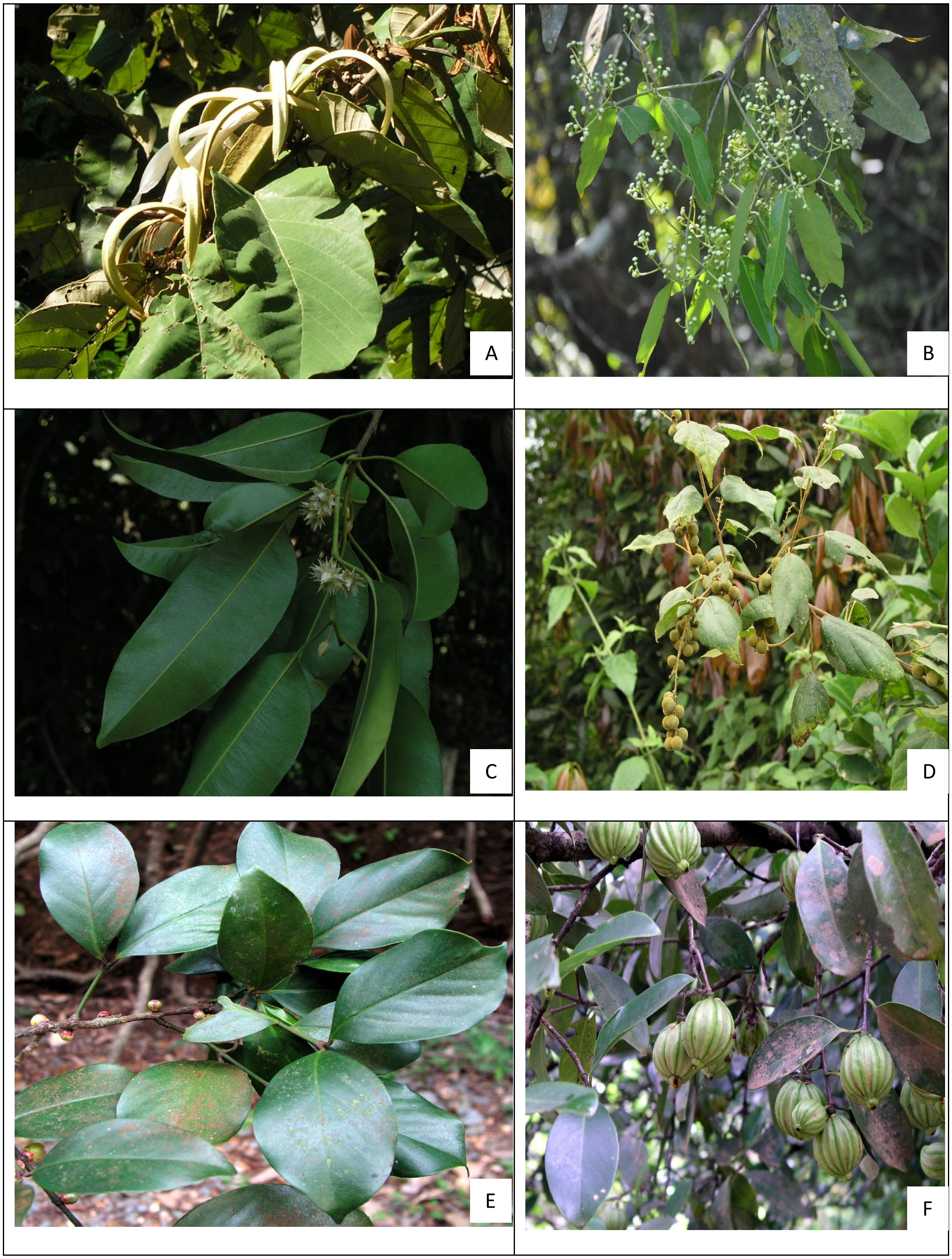

Figure 1: Medicinal trees in Jankadkal and Shirgunji area. A. *Pterospermum diversifolium* B. *Persea macrantha* C. *Mimusops elengi* D. *Mallotus phillipensis* E. *Garcinia morella* F. *Garcinia gummi-gutta*

Figure 2: Medicinal trees in Jankadkal and Shirgunji area. A. *Knema attenuata* B. *Lepianthus decipiens* C. *Fruits and seeds of Ervatamia heyneana* D. *Elaeocarpus serratus* E. *Cinnamomum malabathrum* F. *Aporosa lindleyana*

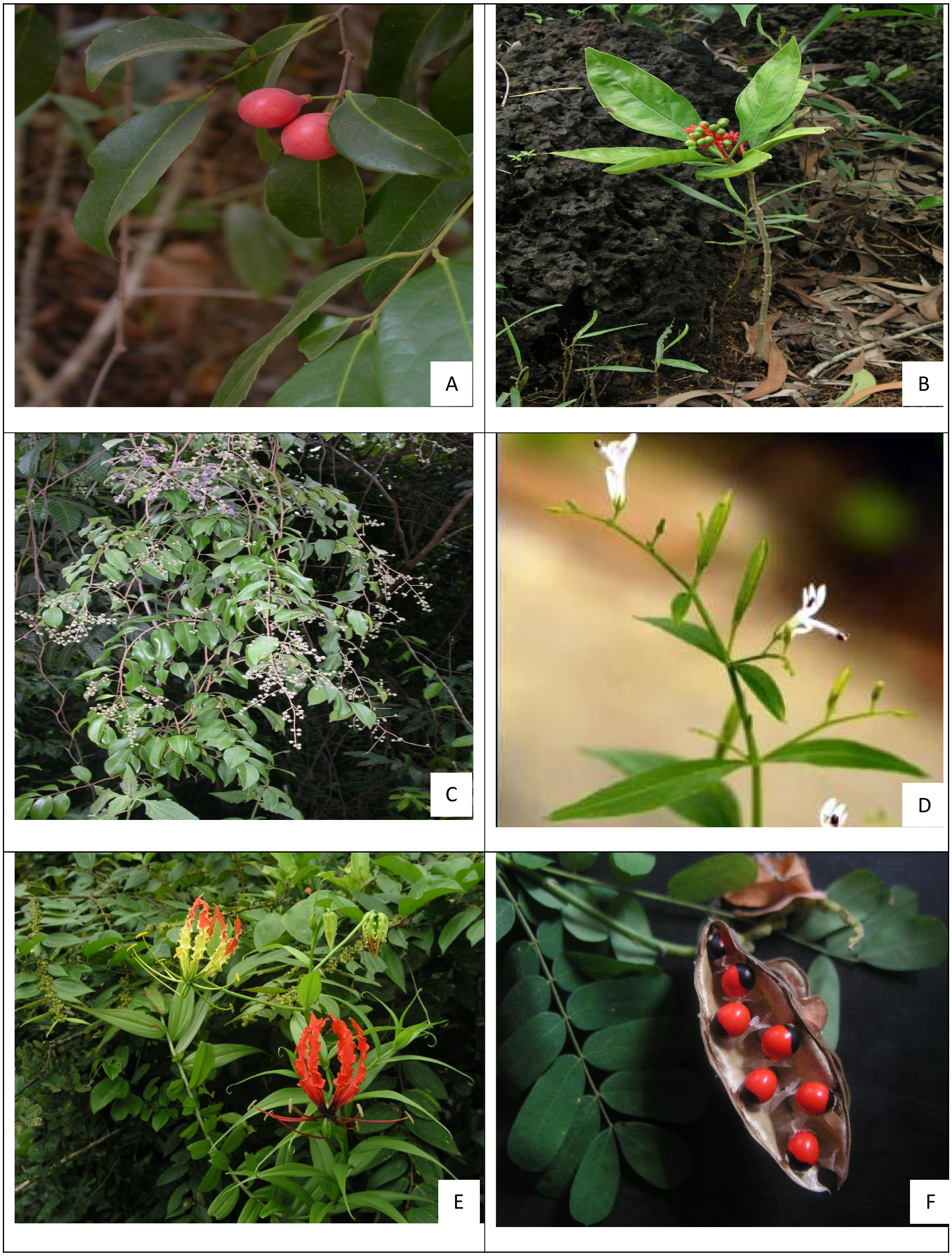

Figure 3: Medicinal shrubs, herbs and climbers in Jankadkal and Shirgunji area. A. *Salacia chinensis* B. *Ravolfia serpentina* C. *Embelia ribes* D. *Andrographis paniculata* E. *Gloriosa superba* F. *Abrus precatorius*

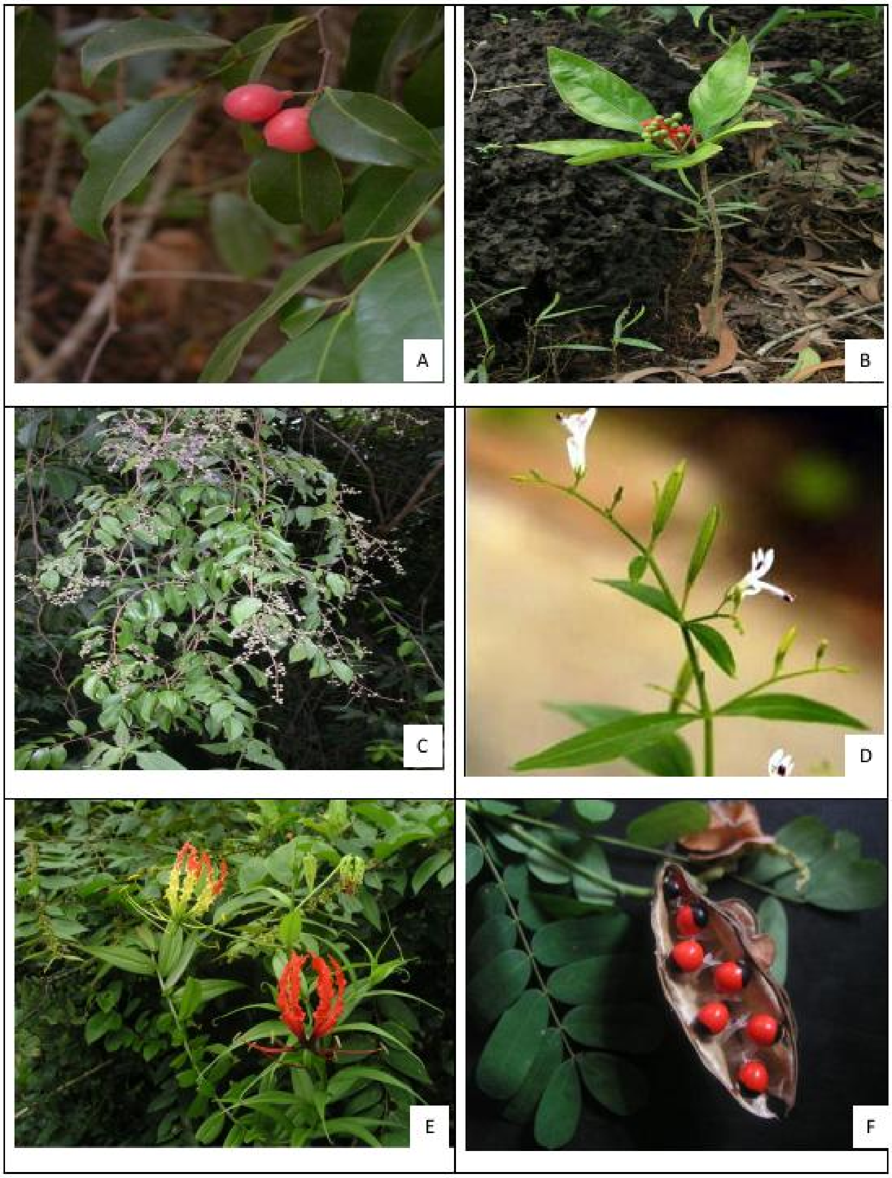

Figure 3: Medicinal shrubs, herbs and climbers in Jankadkal and Shirgunji area. A. *Salacia chinensis* B. *Ravolfia serpentina* C. *Embelia ribes* D. *Andrographis paniculata* E. *Gloriosa superba* F. *Abrus precatorius*

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