REPORTING AND PHYTOSOCIOLOGICAL ASSESSMENT OF *MYRISTICA* SWAMPS IN BEDTHI RIVER CATCHMENT OF UTTARA KANNADA DISTRICT: A THREATENED FRESH WATER SWAMP FORESTS OF WESTERN GHATS

Shrikant Gunaga[1], Narasimha Hegde[2], Balachandra Hegde[3], Srinivas Hegde[4] & Medha Hegde[5]

[1] College of Forestry, University of Agricultural Sciences, Sirsi campus-581 401, Karnataka, India

[2, 3, 4, 5] Life Trust and Senahkunja Sirsi- 581 401, Karnataka, India

[1]msgunaga@gmail.com (corresponding author), [2]lifetrusts@gmail.com, [3]blhegde@gmail.com, [4]ghsrinivas@gmail.com, [5]mksirsi@gmail.com

Western Ghats is regarded as one of the important biodiversity centers among 34 global biodiversity hotspots of the world as they harbor incredible diversity of biological creatures along with wide array of habitats running parallel to the West Coast of peninsular India over a total distance of about 1600 km (Nayar 1996; Myers et al. 2000). Various ecological and climatologically conditions of the Western Ghats region enables to the formation of diverse ecological habitats (Pascal et al. 2004). Fresh water swamps are one of the prime ecological habitats in the Western Ghats region where the forest species are inundated with freshwater, either permanently or seasonally (Anon 2005). Fresh water swamps are low lying, poorly drained depressions that often open into river/rivulet. Sometimes ground water levels in swamps lies very close to the ground surface. These swamps occur in areas with poor drainage and sufficient water supply to keep the ground waterlogged, and they have a high enough supply of minerals in the water to stimulate decay of organisms and prevent the accumulation of organic materials. Fresh water swamps perform numerous valuable environmental services such as recycling of nutrients, purifying

water, recharging ground water, augmenting and maintaining stream flow apart from providing habitat for a wide variety of flora and fauna. Fresh water ecosystems are also the sources, sinks and transformers of chemical, biological and genetic materials (Pascal 1998; Chandran & Mesta 2001; Roby et al. 2013).

Swamps in the Western Ghats are referred in different names based on the occurrence of dominant plant species such as *Myristica* swamps (Dominated by Myristicaceae members*)*, *Elaeocarpus* swamps (Dominated by Elaeocarpaceae members) (Ganesan 2002; Sheeba et al. 2013), Mangrove swamps (Dominated by different Mangrove species) etc. The ;occurrence of unique species with exceptional modification in their morphological as well as physiological characteristics to cope up with their special type of environment such as high inundation of water throughout its life time and also by predominant alluvial with iron rich soil which enables them to develop great modifications including stilt roots, pneumatophores etc. The *Myristica* swamps are the fresh water swamp forests as they dominated by unique floristic composition with exclusive swampy species from the family Myristicaceae such as *Myristica fatua* var. *magnifica*, *Gymnacranthera canarica* trees, the most ancient of the flowering plants on earth along with the association of many flood tolerant evergreen species such as *Calophyllum apetalum*, *Holigarna arnottiana*, *Dipterocarpus indicus* etc., in almost majority of the swamps (Talbot 1911).

The earliest description of a swamp was done by Gamble during 1921and mentioned about "swampy grounds in evergreen forests" while describing *Myristica fatua* and *Gymnacranthera canarica*. The swampy ecosystems were mentioned primarily without specifying exact locations by Davis et al. (1934) in the working plan of North Mangalore Forest Division of Madras presidency as “Swampy evergreens” including the unique *Myristica* species in the low lying poorly drained areas. Further, Krishnamoorthy (1960) reported first time the *Myristica* swamps in the Travancore region of Western Ghats as a

special type of habitat. Later in the Uttara Kannada district of Karnataka and Satari region of Goa states *Myristica* swamps were located and reported by Chandran et al. (1999) and Santhakumaran et al. (1995) respectively. Since its high endemism and threat status of the unique species in the *Myristica* swamps has stressed further to locate and map the threatened habitat in the Western Ghats (Chandran et al. 2008). The previous records of the *Myristica* swamps in the Uttara Kannada district of Central Western Ghats have reported only from the Sharavathi and Aghanahini river catchments and further all these swamps were reported only in the altitudinal range between 400 to 560 m above mean sea level. After the discovery of northern most low altitude *Myristica* swamps in the Satari region of Goa state has created enthusiasm in searching unique habitats in the gap between northern most Goa region and the Sharavathi and Aghanashini river catchment swamps of Central Western Ghats. With these efforts, our survey has resulted in the discovery of *Myristica* swamps in the Bedthi river catchment of Uttara Kannada district including low elevation swamps after a gap of 35 km from Sharavathi and Aghanashini catchment towards south and about 115 km from the northern swamp (Goa region) for the first time. However, earlier studies have not reported any swamps in the low elevation from the Uttara Kannada district of Karnataka state of Central Western Ghats. We consider the occurrence of low altitude *Myristica* swamps in the entirely different river catchment will be opened up for the studies of ecological continuity and its genetic relationship between different endemic living creatures of the *Myristica* swamps in the entire Western Ghats. However, this study mainly focuses on the mapping, distribution and floristic assessment of *Myristica* swamps in the Bedthi catchment area of the Uttara Kannada district of Central Western Ghats.

STUDY AREA

The focal study area is Bedthi river catchment of Uttara Kannada district in the Central Western Ghats of Karnataka state (Figure 1). The total area of swamp in Bedti catchment is about 12 hectares. Including Bedthi catchment, the total area of swamps in all other catchments in the Uttara Kannada district is about 86 hectares. Thus the area of swamps in Bedti catchment shares about 14% of the total swampy areas in the district. Average size of each swamp in the Bedthi catchment is about 0.75 hectares.

Figure 1. Map showing study area (Bedthi catchment)

The climate of the study area is distinctly seasonal with a hot and humid summer (32-35 °C during June - July) and cooler winters (18-25 °C - during December - January). Average annual rainfall is comparatively higher when whole district is considered and it is 3500 to 4000 cm with maximum precipitation occurring during July to August.

Bedthi is one of the five important West flowing rivers in the district. The river and its tributaries flows in three taluks include Yellapur, Sirsi and Ankola. The major tributary namely Shalmala and Bedthi both joins in the down ghat and finally become a single river in the name of Gangavali before it joins the Arabian Sea. During the course of flow, river forms three magnificent waterfalls including Magod, Shivaganga and Ganesh falls in the undulating hilly region. Several forest ecosystems includes evergreen, semi-evergreen, moist and dry deciduous forest and even very small fragments of Mangrove vegetation in the delta region also could be seen. The ideal condition of the catchment area along the river basin enables to sheltering amazing diversity of flora and fauna of a region. Because of its indomitable importance the riverine forest and its neighboring forest area has been declared as Bedthi Conservation Reserve in the year 2011 by Government of Karnataka under section (36) of Wild life act amended on 2006 (*Government order number, FEE 147 FWL 2011, Bangalore, Dated: 13-06-2011*). The conservation reserve comprises 5730 hectare

area are thus to facilitate protection, propagating and development of flora and fauna spreads in the forest land of 6 villages of Sirsi, Yellapur and Ankola subdivisions.

MATERIAL AND METHODS

In order to document *Myristica* swamps, reconnaissance survey was made in each and every streams of the river during March to May 2014. However, at the time of survey local people help also being taken for locating the new swamps. Geo-coordinates of each and every swamp were recorded with GPS (Global Positioning System) receiver. The GPS data for recorded swamps were digitized and a distribution map of the swamps in the catchment area is prepared (Figure 2, 3). Approximate areas of each and every recorded swamp were noted by measuring length and breadth. From the documented swamps two each swamp from low and high elevation were selected for vegetation sampling.

Sampling method

In order to sampling the vegetation, belt transect method was preferred. Since the swamps are in linear shape landscape, almost entire i.e., along the swamps from beginning to the end of the swamps were surveyed. Width of transect was 5 m with variable length depending upon length of the stream. Transect is flexible so that one doesn't leave the course of the stream or swamp. All the plants encountered in the sampling units were identified to the species level by referring regional and standard floras (Cook 1903; Talbot 1909) and keys (Pascal and Ramesh 1987) and their girth at breast height (GBH) was recorded. Approximate height was estimated in meters by visual observation.

To record the regenerating species, two plots (quadrates) of 5 x 5 m were laid one at 50^{th} and another at 100^{th} meter of the transect. Seedlings with less than 30 cm GBH were considered as the regenerating potential of the species. To determine the

girth class distribution of the species, the natural regenerates were grouped into following regeneration classes for further analysis (Puttaswamy et al. 2010):

0 – 40 cm height----------Class I

40 – 100 cm height---------- --Class II

>100 cm height and < 10 cm gbh-------Class III

>100 cm height and 10-30cm gbh-------Class IV

The numbers of regenerating individuals were counted according to their different height classes for every species. Shrub species also recorded in numbers in the respective the regenerating quadrate. Herbs of different species were counted their numbers by putting two 1 m^2 quadrates in the opposite corners of the regenerating quadrates. The vegetational data were quantitatively analyzed for abundance, density and frequency, according to the formula devised by Curtis and Mc Intosh (1950) and Mishra (1968). The average values were summed up to represent an Importance Value Index (IVI) as indicated by Curtis (1959).

REUSLTS AND DISCUSSION

Mapping

Totally 16 swamps were recorded from the Bedthi river catchment (Table 1.). Exact locations of *Myristica* swamps in Bedthi catchment were mapped using Garmin 60 Csx Global Positioning System (GPS) handheld receiver. The GPS data were plotted using Quantum GIS software and a distribution map was prepared (Fig. 2 and 3).

Table 1. Demographic details of *Myristica* swamps in Bedthi catchment

Of the newly identified swamps in the study area, seven swamps are recorded in the low elevation (≤ 125 meters above mean sea level) and rests of the nine swamps are from the high elevation (141 to 481 meter above mean sea level). However, this is the first time ever we identified the low altitude *Myristica* swamps in the district after

Sharavathi and Aghanashini catchment in the south of Uttara Kannada district in the Central Western Ghats of Karnataka state where its altitude is in the range of 400 to 560 m above mean sea level. Unlike the sluggish nature of low altitude *Myristica* swamps of Travancore region (Verghese & Kumar 1997), the nature of low elevated swamps of Bedthi catchment is of water-logged type. The studies of Chandran et al. (1999) mentioned 54 swamps in Sharavathi and Aghanashini river catchments.

Figure 2. Distribution of Myristica swamps in Bedthi catchment

Figure 3. Outline map showing the distribution of Myristica swamps

Floristic composition

Myristica swamps are characterized by the tree species of archaic family Myristicaceae (Chandran et al. 2010). The two species viz. *Gymnacranthera canarica* and *Myristica fatua* var *magnifica* are specially adapted to the swampy conditions of the ecosystem. The unique morphological characters of these species made them to adapt special abiotic conditions of the swamps (Roby et al. 2013). These species are considered among the relic trees of Uttara Kannada district (Chandran et al. 2010). Champion and Seth (1968) have put these Myristica swamps in "sub-group 4C Tropical Freshwater Swamp Forests" based on the nomenclature, description, distribution, locality factor and floristic etc., following Krishnamoorthy (1960).

Phytosociological details of *Myristica* swamps of Bedthi catchment is given in the Table 2. The floristic study resulted in 42 species belongs to 27 diverse families. Of which trees were the major life forms with 29 species followed by shrubs and lianas of 8 and 4 species each respectively. Chandran & Mesta (2001) recorded 88 species from the

Katlekan forests of Uttara Kannada district. Bhat et al (2000) reported 37-63 species ha^{-1} in the lowland evergreen forests of Uttara Kannada district. A total of 47.4 tree species ha^{-1} recorded in the present study corresponds with the low altitude species composition recorded for the Western Ghats. Elsewhere in other *Myristica* swamps of the Western Ghats, 2 species of Myristicaceae namely *Gymnacranthera canarica*, *Myristica fatua* var. *magnifica* (Chandran & Mesta 2001), *Mastixia arborea* (Cornaceae) and *Syzygium travancoricum* (Myrtaceae) are found to be exclusively swampy species and rest of the 23% (8 species) of the species were facultative swampy species. It is very interesting that, *Myristica fatua* var. *magnifica* was recorded only from the low altitude swamps of the present study area and moreover, this is the first time reporting of *Myristica fatua* var. *magnifica* in the entirely new catchment of the district. Earlier the occurrence of *Myristica fatua* var. *magnica* was reported from one locality of southern Uttara Kannada district (Chandran & Mesta 2005). Studies of Ramesh & Pascal (1997) show the occurrence and distribution of *Myristica fatua* var. *magnifica* from sea level to 700 m and 1000 m altitudes respectively. The presence of *Myristica fatua* var. *magnifica* in the newer catchment area shows the range extension of the species further to north of the district however, the northernmost limit of the species in the Western Ghats was reported from the Goa state (Prabhugaonkar et al. 2014). The other dominant species associated with the *Myristica* swamps are *Holigarna arnottiana*, *Lophopetalum wightianum*, *Arenga wightii* and *Chilocarpus atro-virens*.

Table 2. Phytosociological attributes of *Myristica* swamps

Western Ghats are unique with respect to its high endemism of species. Among the documented species in the present study, 65.7% are found to be the Western Ghats endemics and 31.4% of the species are belongs to threatened category. Chandran & Mesta (2001) have already reported the high endemism in the *Myristica* swamp than in

the adjoining non swampy areas. The obligatory swampy species such as *Gymnacranthera canarica, Myristica fatua* var. *mangnifica*, and *Syzygium travancoricum* are listed in the Red listed Data Book of Indian plants (Nayar & Sastary 1987, 1990; IUCN 2001). The species composition of the Bedthi catchment is similar composition with that of other *Myristica* swamp forests in the Western Ghats (Chandran & Mesta 2001; Bhat & Kaveriappa 2009) suggesting that the present *Myristica* swamps of new catchment area is not much difference in their species composition. The dominant species of the present study area includes *Gymnacranthera canarica* represented by 53 individuals followed by *Myrsitica fatua* var. *magnifica* (41 individuals), *Holigarna arnottiana* (18 individuals) and *Lophopetalum wightianum* (10 individuals).

The Shannon's diversity index in the present study area recorded was 2.96 which is almost similar to the species diversity of swamps of Kerala in the Western Ghats (Varghese & Kumar 1997) and it is slightly low when compared to the swamps of Katlekan of Uttara Kannada district (Chandran et al. 2010). However, Chandran and Mesta (2001) and Pascal (1998) have observed poor diversity in *Myristica* swamps. The presence of low diversity in the Bedthi catchment may be due to the factors like decrease in the flow of streams in the summer and also the diversion of water in the upland for cultivation and also habitat fragmentation which resulted in the loss of faunal assemblage between the species to facilitate the fruit dispersal (Devy, 2006).

Population structure

A total of 244 individuals including trees, shrubs, liana and herbs were recorded from 5270 m^2 sampled area with the total density of 349.1 individuals/ha with highest density recorded for *Gymnacranthera canarica* (100.5 individuals/ha) which accounts for 25% of the total basal area of all the species found in the swamps followed by

Myristica fatua var. *magnifica* (77.8 individuals/ha), *Holigarna arnottiana* (34.1 individuals/ha) and *Lophopetalum wightianum* (18.9 individuals/ha)

The average basal area of the tress recorded for the sampled area was 29.84 m^2/ha. Maximum basal area was contributed by *Gymnacranthera canarica* (13.2 m^2/ha) followed by, *Lophopetalum wightianum* (5.8 m^2/ha), *Myristica fatua* var. *magnifica* (4.8 m^2/ha) (Figure 4). It is comparatively lower to the Katlekan swamp forests (Chandran et al. 2010). Lower in basal area may be due to the smaller girth size (younger trees) of the other non-swampy species indicating most of the species composition in the swamps of Bedthi catchment is changing by the invasion of non-swampy evergreen species like *Dimocarpus longan, Artocarpus hirsutus, Diospyros buxifolia, Diospyros candolleana, Pterospermum diversifolium* etc., due to the disappearance of water logged condition of the swamp flour in the summer which created congenial condition for the non-swampy evergreen invaders. If the present trend continues the species composition of typical *Myristica* swamp forests particularly swampy species will continue to decline.

Figure 4. Density and basal area of prominent species of *Myristica* swamps (*GYMCAN-Gymnacranthera canarica, MYRFAT- Myristica fatua* var.*magnifica, LOPWIGH- Lophopetalum wightianum, MASARB- Mastixia arborea, SYZTRA-Syzygium travancoricum)*

Occurrence and their population structure and regeneration status of obligatory swampy species

This study highlighted on the population and regeneration status of above two obligatory swampy species in the Bedthi catchment. Totally 53 and 41 individuals of *Gymnacranthera canarica* and *Myristica fatua* var. *magnifica* have

been recorded from the Bedthi catchment respectively. *Gymnacranthera canarica* found in all the four sampled area where as *Myristica fatua* var. *magnifica* found only in the low altitude swamps. *G. canarica* recorded maximum IVI (Importance Value Index) value of 51.1 followed by *M. fatua* var. *magnifica* (31.6), *H. arnottiana* (17.3) and *L. wightianum* (15.8) (Figure 5). Bhat and Kaveriappa (2009) also recorded the similar species with maximum IVI value in the Katlekan swamp.

Figure 5. Importance value index of species of diameter class(n=29) and regenerating class (n=29)

While considering the importance value of regenerating species, other than the obligatory and facultative swampy species some invading species like *Dichapetalum gelanoides*, *Pajanelia longifolia*, *Calamus thawitessii* and *Diospyros buxifolia* took place among the top ten species suggesting the worry of concern of future of the swamps of study area. In the family level, Myristicaceae, Ebenaceae, Anacardiaceae, Clusiaceae and Arecacea were the predominant families among top ten families in the growing stock as well as in the regeneration potential of the species (Figure 6). However, these families are predominantly endemic families which are primarily seen in the *Myristica* swamps (Chandran & Mesta 2005).

Figure 6. Family importance value of growing stock species (n= 20) and regenerating species (n= 19)

Girth class distribution

In the girth class distribution of exclusive swampy species, both *Gymnacranthera canarica* and *Myristica fatua* var. *magnifica* are having abnormal type of girth class distribution with maximum number of individuals in the range of 91-120 and 121-150 cm. It is very much cleared from the Figure 7 that even though healthier pattern of seedlings and saplings of different classes in the regenerating individuals (Figure 8), it is failed to transform into next successional growth may be due to the drying up of swamps in the summer and also removal of larger size class saplings for the poles for fencing. It is suggested that the smaller girth class individuals are considered as the future of growing stock of the respective species (Chandran et al. 2010) however, in the present study the failure of transforming of saplings into adult stages of both obligatory swampy species is the matter of concern for its future.

Figure 7. Girth class distribution of obligatory swampy species

Figure 8. Size class distribution of regenerating individuals of obligatory swampy species

Summary

Myristica swamps are one of the unique and threatened habitats in the Western Ghats with varied range of ecological and biological importance. The occurrence of such fresh water swamps with the presence of unique flora which helps in feeding constant and continuous water supply to many rivers of the Western Ghats throughout the year. Due to ruthless developmental activities and also change in the land use pattern has led to the risk of disappearance of rare watershed network of the Western Ghats which sustain large amount of rare and sensitive endemic flora and fauna. The network of *Myristica* swamps in the Western Ghats would have occupied large areas in the past but they are now restricted to less than 200

hectares in the country (Ramesh & Pascal 1997) however, the discovery of swamps in the entirely new catchment is very crucial to appraise the pattern of linkages between the swamps and also evolutionary significance of its unique biological entity. Moreover, this swamp discovery in the Bedthi catchment will adds up more strength to the concept of notified conservation reserves and also gives more priorities to protect the precious ancient habitats of the Western Ghats.

References

Anonymous. **(2005).** Encyclopedia Britannica, ultimate reference suits CD.

Bhat, D.M., M.B. Naik, S.G. Patagar, G.T. Hegde, Y.K. Kanade, G.N. Hegde, C.M. Shastri, D.M. Shetty & R.M. Furtado, (2000). Forest dynamics in tropical rain forests of Uttara Kannada district in Western Ghats, India; Current Science 79 (7): 975-985.

Bhat, P.R. & K.M. Kaveriappa (2009). Ecological studies on *Myristica* swamp forests of Uttara Kannada, Karnataka, India. *Tropical Ecology* 50(2): 329–337.

Champion, H.G. & Seth, S.K. (1968). A Revised Survey of the Forest Types of India (New Delhi: Manager of Publications).

Chandran, M.D.S., Mesta, D.K. & Naik, M.B. (1999). Inventorying and Conservation of the Myristica Swamps of Uttara Kannada. Report (Forest Research and Training Institute, Bangalore.

Chandran, M.D.S, D.K. Mesta & M.B. Naik (1999). Myristica swamps of Uttara Kannada District. My Forest 35(3):217-222.

Chandran, M.D.S. & D.K. Mesta (2001). On the conservation of the Myristica swamps of the Western Ghats, pp. 1–19. In: Shankar, R.U., K.N. Ganeshaiah & K.S. Bawa (eds.). *Forest Genetic Resources: Status, Threats, and Conservation Strategies.* Oxford & IBH, New Delhi.

Chandran MDS, D.K. Mesta (2005). Myristica swamps. Sahyadri E-News, Issue 13, http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/ newsletter/issue13/index.htm accessed on 20 June 20014.

Chandran, M.D.S. & D. K. Mesta (2005). On the dying primeval swamps of the Western Ghats, *Proceedings of the state level UGC sponsored seminar on BIODIVERSITY AND ITS CONSERVATION* held at KLE Society's Gudleppa Hallikar Colleges, Haveri on 28th & 29th July 2005. 20-28pp.

Chandran, M.D.S., D.K. Mesta, G.R. Rao, S. Ali, K.V. Gururaja & T.V. Ramachandra (2008). Discovery of Two Critically Endangered Tree Species and Issues Related to Relic Forests of the Western Ghats. *The Open Conservation Biology Journal* 2: 1–8; http://dx.doi.org/ 10.2174/1874839200802010001

Cooke, T. (1903). *The flora of the Presidency of Bombay*. Taylor and Francis.

Curtis , J.T. (1959). The vegetation of Wisconsin. An Ordination of Plant Communities. University Wisconsin Press, Madison, Wisconsin, pp. 557.

Curtis, J.T., R.P. Mc Intosh, (1950). The interrelations of certain analytic and synthetic phytosociological characters, Ecology, 31,. 434-455 pp.

Davis, P.W., M.H. Krishnaswami & C.C. Wilson (1934). Working Plan for the North Mangalore Forest Divison, Madras (Madras: Supdt. Of Government Press).

Devy, S. (2006). Effects of fragmentation on a keystone tree species in the rainforest of Kalakad-Mundanthurai Tiger Reserve, India. Project report Submitted to Rufford, Ashoka Trust for Research in Ecology and the Environment, Bangalore 560024.

Gamble, J. S. & C.E.C. Fischer (1915-1936). The flora of the Presidency of Madras. 3 vols. Adlard & Son Ltd., London.

Ganesan, R. (2002). Evergreen forest Swamps and their Plant Species Diversity in Kalakad-Mundanthurai Tiger Reserve, South Western Ghats, India. Indian Forester, 128(12): 1351-1359pp.

IUCN (2001). IUCN Red List Categories & Criteria: Version 3.1. IUCN Species Survival Commission. World Conservation Union, Gland, Switzerland and Cambridge, United Kingdom, ii+30pp.

Krishnamoorthy, K. (1960). Myristica swamps in the evergreen forests of Travancore, In: Tropical Moist Evergreen Forest Symposium. Forest Research Institute, Dehradun, India.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. & A. B. Da Fonseca, & J. Kent, (2000). Biodiversity hotspots for conservation priorities. Nature 403: 853–858.

Mishra, R. (1968). Ecology workbook, *Oxford and IBH Publishing*, Calcutta.

Nayar, M. P. (1996). Hotspots of Endemic Plants of India, Nepal and Bhutan. Thiruvananthapuram: Tropical Botanical Garden and Research Institute.

Nayar, M.P. & A.R.K. Sastry (eds.) (1987). Red Data Book of Indian Plants. Vol. 1. Botanical Survey of India, Calcutta, 217–218pp.

Nayar, M.P. & A.R.K. Sastry (eds). (1990). Red Data Book of Indian Plants. Vol. 3. Botanical Survey of India, Calcutta, 243–244pp.

Pascal, J.P. (1988). Wet Evergreen Forests of the Western Ghats of India: Ecology, Structure, Floristic Composition and Succession. Pondicherry: Sri Aurobindo Ashram Press, 345pp.

Pascal, J. P. & B. R. Ramesh (1987). A field key to the trees and lianas of the evergreen forests of the Western Ghats (India). Trav. Sect. Sci. Techn. Inst. Franc. Pondichery, 23: 1–236.

Prabhugaonkar, A., Divakar K. Mesta & M.K. Janarthanam (2014). First report of three redlisted tree species from swampy relics of Goa State, India. Journal of Threatened Taxa 6(2): 5503–5506; http://dx.doi.org/10.11609/JoTT.o3376.5503-6.

Puttaswamy, H. C.G. Kushalappa, K.V. Ajayan & B.N. Sathish (2012). Distribution and Population Status of A Critically Endangered Tree Species *Dipterocarpus bourdillonii* Brandis in Central Western Ghats. *Proceedings of the 15th International Forestry and Environment Symposium, 26-27 November 2010. Published by Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Sri Lanka.* 150-154pp.

Ramesh, B.R. and Pascal, J.P. (1997). Atlas of endemics of the Western Ghats (India), Pondicherry: French Institute).

Ramesh, B.R. & J.P. Pascal (1997). *Atlas of Endemics of the Western Ghats (India): Distribution of Tree Species in the Evergreen and Semi - Evergreen Forests*. French Institute, Pondicherry, 403pp.

Santhakumaran, L.N., A. Singh & V.T. Thomas (1995). 186 Description of a sacred grove in Goa (India), with notes on the unusual aerial roots produced by its vegetation. Wood. Oct-Dec.: 24-28.

Sheeba, J., Irwin, D. Narasimhan & V. Madha Suresh (2013). Ecology, distribution and population status of *Elaeocarpus venustus* Bedd. (Oxalidales: Elaeocarpaceae), a

threatened tree species from Agasthiyamalai Biosphere Reserve, southern Western Ghats, India. Journal of Threatened Taxa, 5(9): 4378–4384.

Talbot, W.A. (1911). Forest Flora of the Bombay Presidency and Sind. Two Vols. (Poona: Government Photozicographic Press).

Roby, T.J., Joyce, Jose & P. Vijayakumaran Nair (2013). *Syzygium travancoricum* (Gamble)-a critically endangered and endemic tree from Kerala, India-Threats, Conservation and Prediction of potential areas; with Special emphasis on Myristica swamps as a prime habitat, International Journal of Science, Environment and Technology, Vol. 2, No 6, 1335–1352.

Varghese, A.V. & B.M. Kumar (1997). Ecological observations in the fresh water swamp forests of southern Kerala, India. J. of Tropical Forest Science 9(3), 299-314.

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Appendices: Checklist of plant species found in *Myristica* swamps of Bedthi catchment

TABLES

Table 1.

Sl. No.	Name of the Swamp	Area(Ha)	Longitude	Latitude	Altitude (Meters)
1	Adralli	0.3	14.73 N	74.59 E	112
2	Alavalli	0.5	14.74 N	74.60 E	66
3	Kodimoole Halla (Devanuru)	1.5	14.72 N	74.60 E	141
4	Dhoolalli	0.4	14.76 N	74.74 E	478
5	Maryana Kodlu(Dhollalli)	1	14.76 N	74.74 E	478
6	Doddakattu-A	0.5	14.72 N	74.58 E	82
7	Doddakattu-B	0.5	14.69 N	74.59 E	183
8	Doddakattu-C	0.4	14.69 N	74.59 E	191
9	Eitalimane	1	14.77 N	74.74 E	477
10	Hebbar Gudde	0.5	14.73 N	74.57 E	466
11	Jenmarankodlu	1	14.72 N	74.62 E	121
12	Kattepalu-Jambehalla	1.5	14.72 N	74.61 E	104
13	Kattepalu-kumanahalla	1	14.72 N	74.61 E	119
14	Kudre Jaddi	0.75	14.77 N	74.74 E	457
15	Kulikattu	1	14.41 N	74.75 E	80
16	Bhootan Kodlu	0.1	14.76 N	74.75 E	481
17	Madlamane	0.4	14.70 N	74.59 E	133

Table 2.

Sl. No.	Attributes	Details
1	Sampled swamps	04
2	Total sampled area	0.52 ha
3	Number of species	42
4	Number of genus	35
5	Number families	27
6	Number of individuals	244
7	Number of Trees	29
8	Number of Shrubs	08

9	Number of Liana	04
10	Number of herbs	01
11	Obligatory swampy species	04
12	Facultative swampy species	12
13	Western Ghats endemic species	34
14	Threatened species	11
15	Shannon's index (H')	2.96
16	Density/ha	349.1
17	Average basal area (m^2/ha)	29.84

FIGURES

Figure 1.

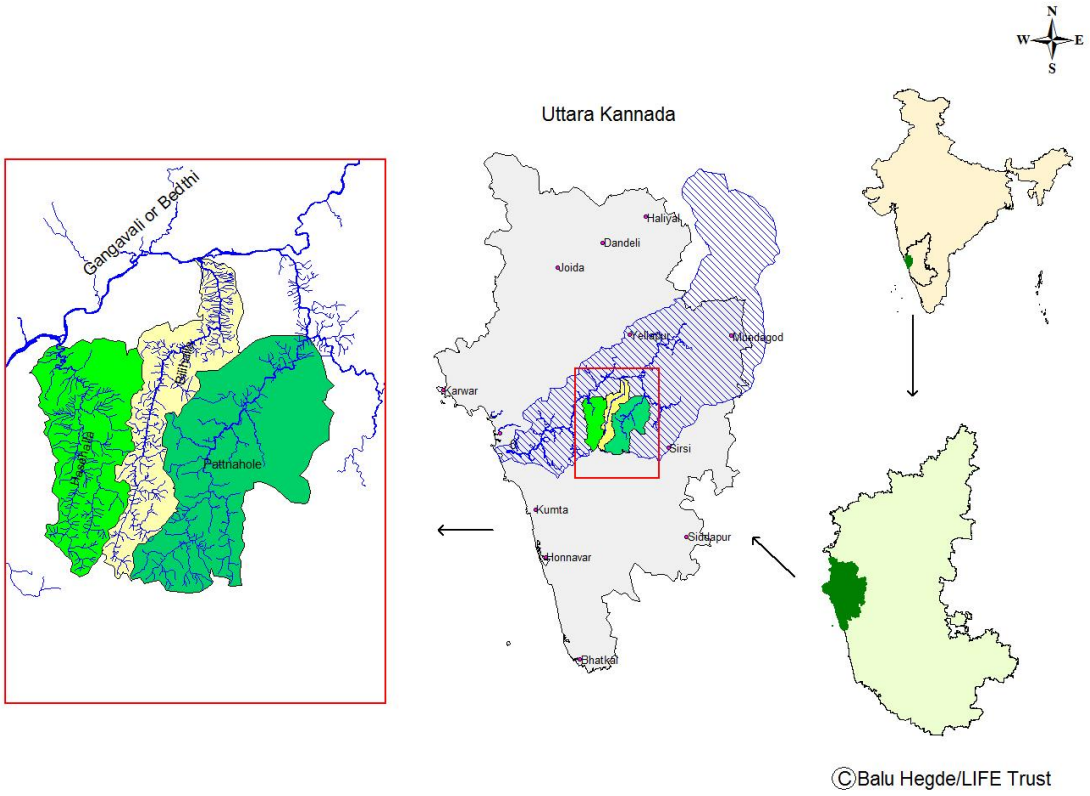


Figure 2.

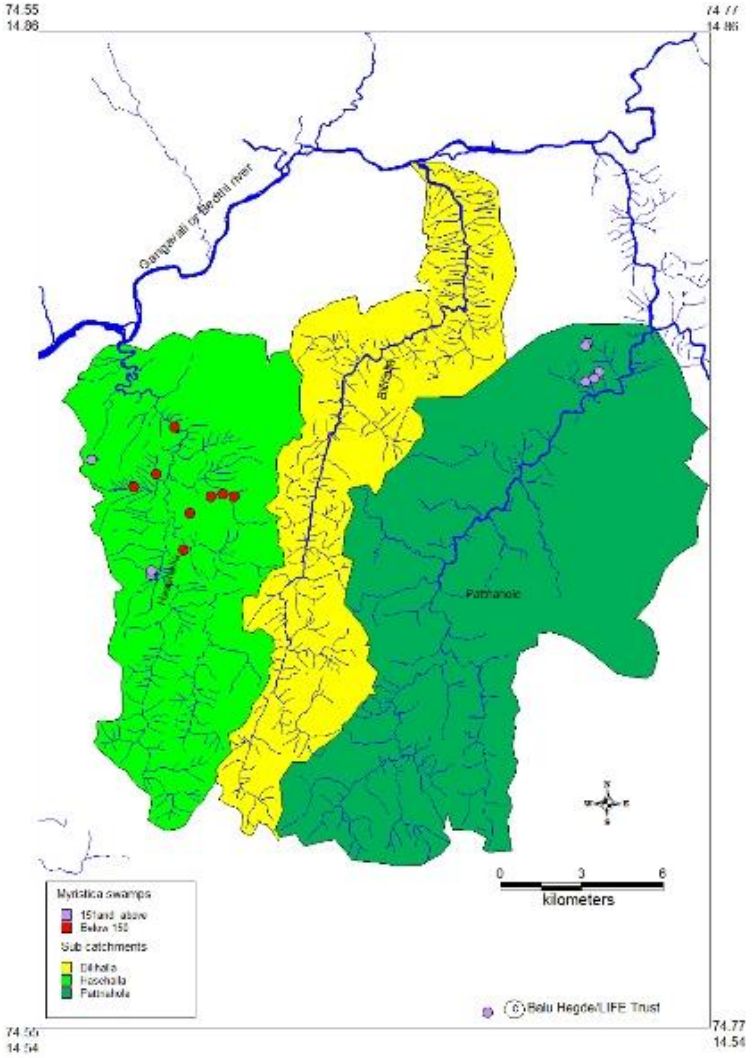


Figure 4.

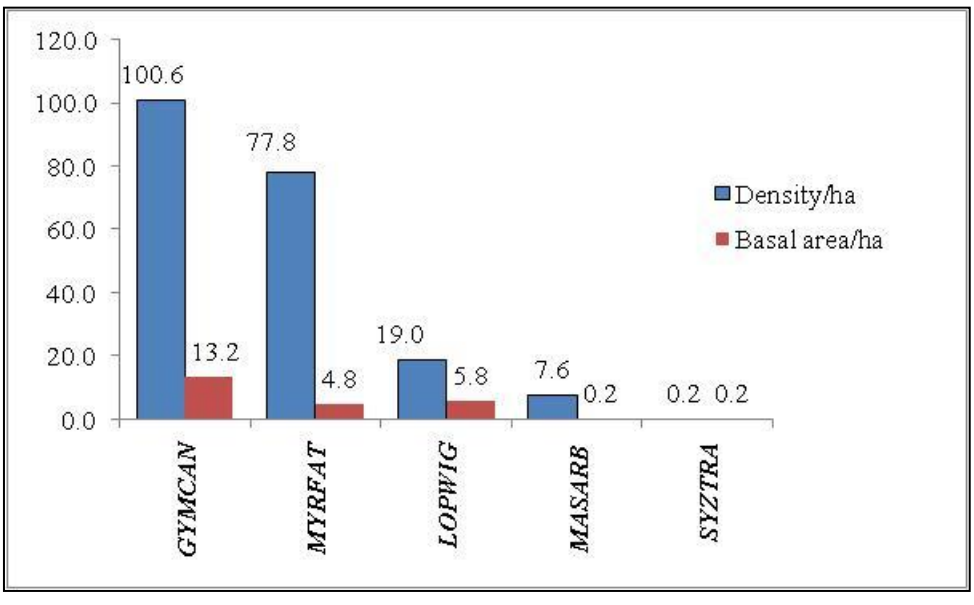


Figure 5.

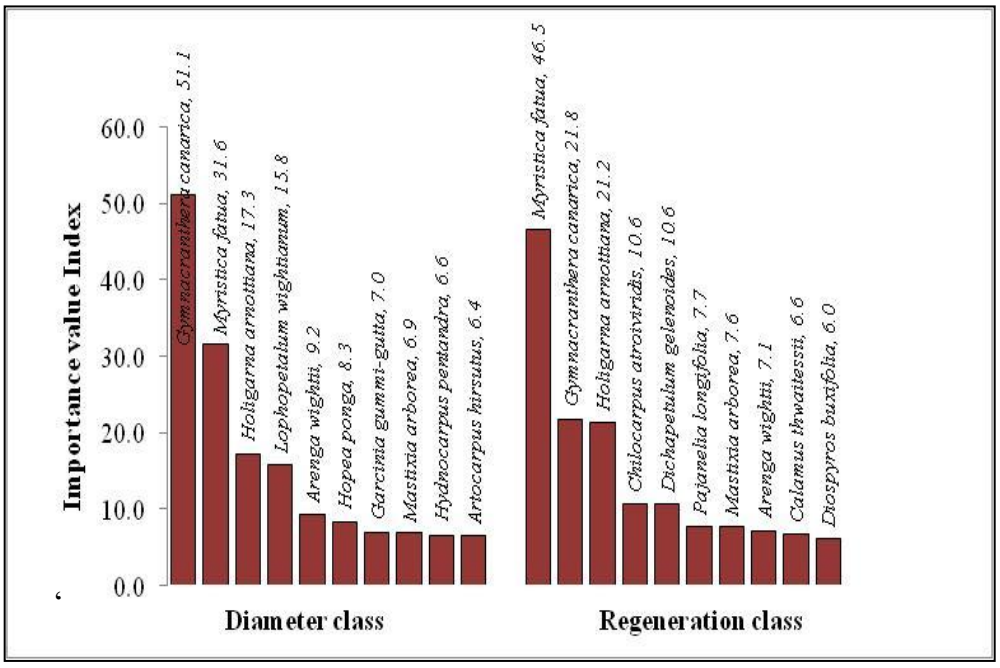


Figure 6.

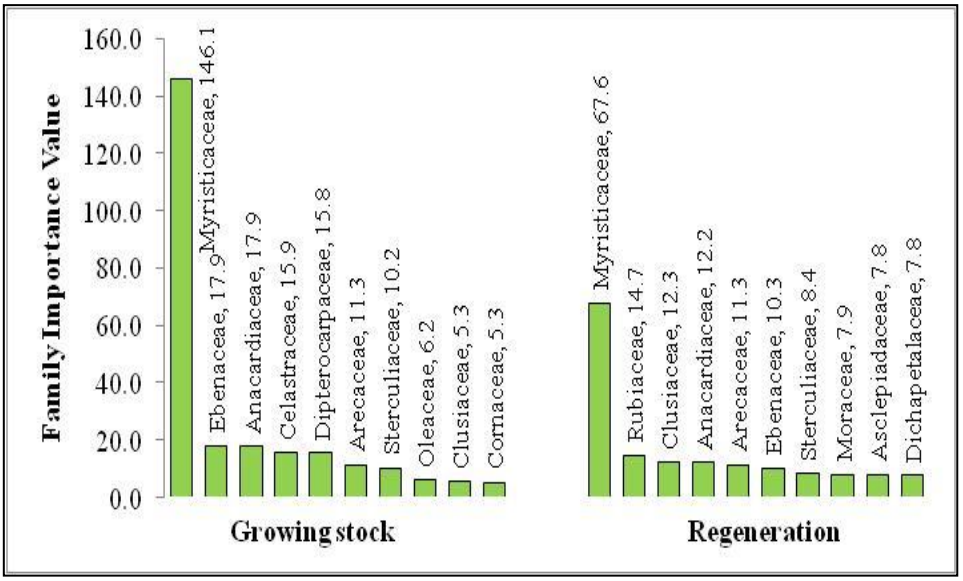


Figure 7.

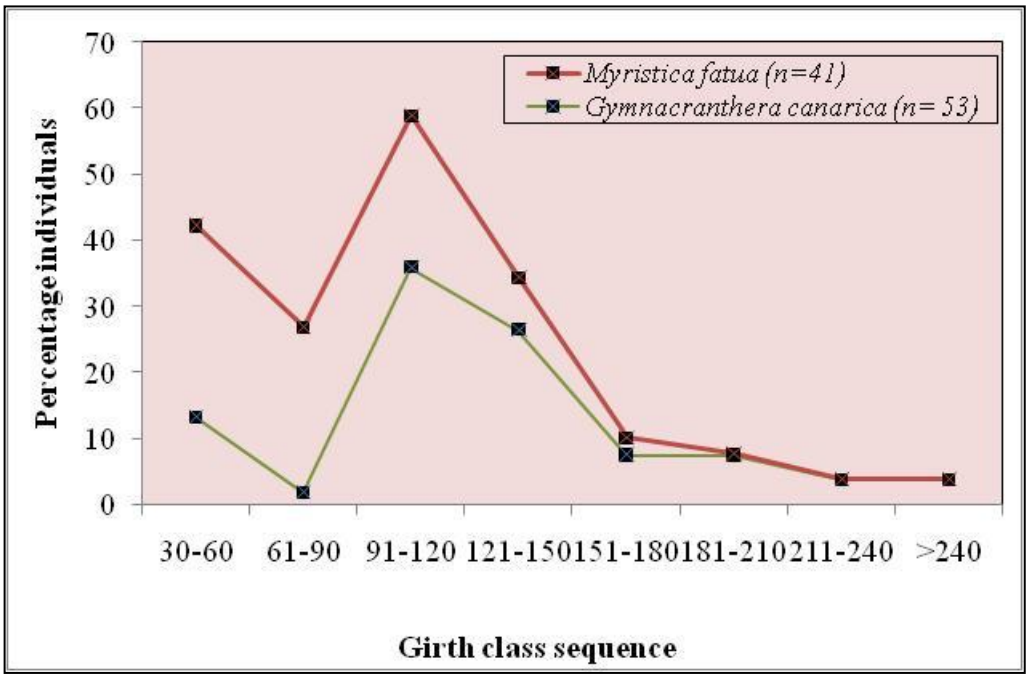
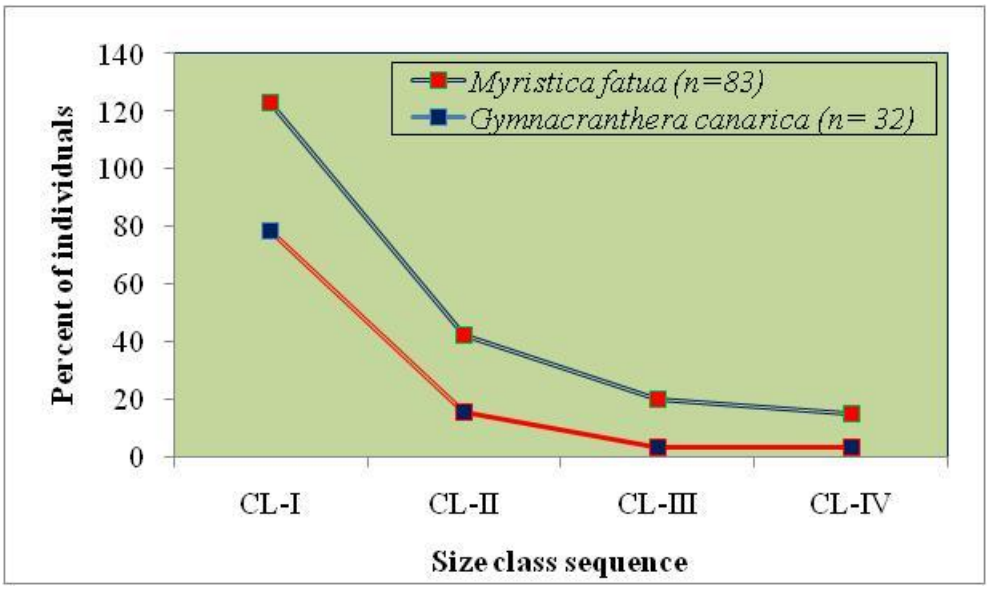


Figure 8.



APPENDICES

Sl. No.	Species	Family	Habit	Type	Distr.	Status
1	*Ardisia solanacea* Roxb.	Menispermaceae	S	Fc	NE	
2	*Arenga wightii* Griff.	Arecaceae	S	Fc	E	
3	*Artocarpus hirsutus* Lam.	Moraceae	T	Inv Eg	E	Vu-G
4	*Calamus thwaitesii* Becc.	Arecaceae	S	Inv Eg	E	
5	*Calophyllum apetalum* Willd.	Clusiaceae	T	Eg	E	
6	*Caryota urens L.*	Arecaceae	T	Fc	NE	
7	*Chilocarpus atrovirens* (G. Don.) Bl. Mus. Bot. Ludg.-Bay.	Asclepiadaceae	L	Fc	E	
8	*Clidion spiciflorum* (Burm. f.) Merr.	Euphorbiaceae	T	Inv Eg	E	
9	*Combretum latifolium* Bl.	Combretaceae	L	Inv Eg	NE	
10	*Dimocarpus longan* Lour.	Sapindaceae	T	Inv Eg	E	
11	*Cryptocareya bourdillonii* Gamble	Lauraceae	T	Inv Eg	E	
12	*Dichapetalum gelonioides* Engl.	Dichapetalaceae	S	Inv Eg	E	
13	*Diospyros candolleana* Wt.	Ebenaceae	T	Inv Eg	E	Vu-G
14	*Diospyros buxifolia* (Bl.) Hiern	Ebenaceae	T	Inv Eg	NE	
15	*Diospyros oocarpa* Thw.	Ebenaceae	T	Inv Eg	E	
16	*Diospyros paniculata* Dalz.	Ebenaceae	T	Inv Eg	E	Vu-G
17	*Entada pursaetha* DC.	Mimusoideae	L	Inv Eg	NE	
18	*Ficus nervosa* Roth	Moraceae	T	Fc	NE	
19	*Garcinia gummi-gutta* (L.) Robs.	Clusiaceae	T	Inv Eg	E	LrnT
20	*Gymnacranthera canarica* (King.) Warb.	Myristicaceae	T	Ob	E	Vu
21	*Gracinia talbotii* Raiz. & Sant.	Clusiaceae	T	Inv Eg	E	
22	*Hedychium coronarium*	Zingeberaceae	S	Ob	E	Vu
23	*Holigarna arnottiana* Hook.f.	Anacardiaceae	T	Fc	E	
24	*Hopea ponga* (Dennst.) Mabb..	Dipterocarpaceae	T	Fc	E	En
25	*Hydnocarpus pentandra* (Buch.-Ham.) Oken	Flacourtiaceae	T	Fc	E	
26	*Ixora nigricans* Wt. & Arn.	Rubiaceae	S	Fc	E	
27	*Knema attenuate* (J. Hk. & Thw.) Warb.	Myristicaceae	T	Inv Eg	E	Vu
28	*Leea indica* (Burm. f.) Merr.	Leeaceae	S	Inv		
29	*Lophopetalum wightianum* Arn.	Celastraceae	T	Fc	E	
30	*Mangifera indica* L.	Anacardiaceae	T	Fc	NE	

31	*Mastixia arborea* Cb. Clark	Cornaceae	T	Ob	E	
32	*Mimusops elengi* L.	Sapotaceae	T	Inv Eg		
33	*Myristica dactyloides* Gaertn.	Myristicaceae	T	Fc	E	Vu
34	*Myristica fatua* Houtt. var. *magnifica* (Bedd.) J. Sinclair	Myristicaceae	T	Ob	E	En
35	*Pajanela longifolia* (Willd.)	Bignoniaceae	T	Inv	NE	

Appendices contd…

Sl. No.	Species	Family	Habit	Type	Distr.	Status
36	*Psychotria annamalayana* Bedd.	Rubiaceae	S	Fc	E	
37	*Psychotria flavida* Talb.	Rubiaceae	S	Fc	E	
38	*Pteris confusa* T.G. Walker, Irudayaraj, V.	Pteridae	H	Fc	E	
39	*Pterospermum diversifolium* Bl.	Sterculiaceae	T	Inv Eg	NE	
40	*Pterygota alata* R. Br.	Sterculiaceae	T	Inv	NE	
41	*Syzigium travancoricum* Gamble	Myrtaceae	T	Ob	E	CR
42	*Ventilago madraspatana* Gaertn.	Rhamnaceae	L	Inv Eg	E	

Note: *Distr.- Distribution, Fc- Facultative, Inv Eg—Invaded Evergreen, Inv- Invaded, Ob- Obligatory, T- Tree, S- Shrub, L- Liana, H- Herb, Vu-G- Vulnerable Globally, En- Endangered, CR- Critically Endangered, Vu- Vulnerable, E- Endemic, NE- Non endemic*

Shrikanth Gunaga, Narasimha Hegde Balachandra Hegde 2014. Reporting and phytosociological assessment of Myristica swamps in Bedthi river catchment of Uttara Kannada district; a threatened fresh water swamp forests of Western Ghats (in press).