Sálim Ali Centre for Ornithology and Natural History

"Myristica Swamp" Ecosystem

Wetland Ecosystem

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Sálim Ali Centre for Ornithology and Natural History

Introduction

This Newsletter is devoted to "*Myristica Swamp Ecosystem*" which is an important component of freshwater wetland ecosystem. These freshwater swamp forest ecosystems are confined to low altitudes characterized by slow flowing streams of Western Ghats river systems. So far, the wetland classification systems prevalent in the country have not considered a formal inclusion in the classification system. There is an urgent meet to recognize the gap and take appropriate measures to provide conservation majors to this unique habitat.

Myristica swamps have been recorded from Goa, Karnataka and Kerala in India. Trees belonging to a primitive family of angiosperms; "Myristicaceae" are the dominant tree species of this unique wetland ecosystem. Some of these swamps are considered even as sacred groves and have thus eco-heritage value. These swamps having variety of microhabitats which provides favourable conditions for survival and procreation of many annelids, arthropods, molluscs, fishes, amphibians, reptiles, birds and mammals. Many of these animals found in the *Myristica* swamps are endemic and some are on the red-list of IUCN.

To make this effort worth while the editorial team of SARVAR SAURABH seeks active participation of its readers in terms of providing information, news, views, photographs and articles on issues of wetland conservation.

We welcome your feedback on the Newsletter and its contents.

Myristica Swamps-a forgotten wetland

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In the latter half of the 20th century, the world suddenly woke up to the fact that three centuries of active and aggressive destruction had led to the loss of almost 80% of wetlands. Laws were enacted and costly restoration projects were undertaken.

In India, too as in other developing countries – wetlands have often been classified as wastelands and "reclaimed" for human use. This in spite of the unique position of wetlands as a transition ecosystem between terrestrial and aquatic ecosystems. Studies, which reveal the biological role of these lands, were undertaken only in the recent past when much value in the terms of biodiversity and land space was already been lost. Recently the scientific community and the media seems to have sighted this lacuna in our environmental future and it is heartening to see a large amount of printed and electronic literature vociferously taking up sides of this neglected ecosystem.

But a quick browse through the available literature on wetlands may not tell anyone much about *Myristica* Swamps. Champion and Seth (1968) have classified them in the sub group – tropical fresh water forests (4c/FS1) and Rodgers and Panwar (1992) highlighted the vegetation as most critically needing conservation. Yet is it not surprising that only a few know about *Myristica* Swamps. Like the name this ecosystem is enigmatic, gravid with mystery and embedded with surprises-poised to become the cynosure of all ecologist's eyes.

Swamp forests are found in different parts of the world. *Myristica* swamps have been recorded from Goa, Uttara Kannara of Karnataka and Southern Kerala in India. Vasudeva et.al. (2003) reported *Myristica* swamps from Karnataka parts of Western Ghats. Some of these swamps are sacred groves with *Myristica malabarica* being one of the component species.

Krishnamoorthy (1960) was the first to describe *Myristica* swamps in Kulathupuzha region of Western Ghats. In Kerala fresh water swamp forests have been reported from the flat –bottomed, ill-drained, low altitude valleys of Kulathupuzha, Anchal and Shendureney forest ranges lying in 77°00'' and 77°55'' E and 08°00'' and 08°55'' N at altitudes ranging from 150-200 ASL. Almost all *Myristica* swamps are situated along the small first order streams or stream beginning areas, the trees being distributed on both sides of these streams.

Trees of *Myristicacea**e*** family are dominant hence these swamps are popularly known as *Myristica* swamps. These tree species have breathing roots (knee roots) for the breathing in the flooded condition of the swamps, and stilt root for anchoring the tree species in damp soil. Members of other families such as *Celestraceae*, *Diptereocarpaceae*, *Anacardiaceae*, *Xanthophyllaceae*, *Myrtaceae* etc. are a significant part of the swamp community in some of these swamps, but less frequently.

Ground vegetation consists mainly of *Pandanus, Calamus, Ochalandra* and members of *Araceae*, *Acanthaceae, and Zingiberaceae* family. Endemic and Endangered species such as *Myristica fatua var.magnifica*, *Syzygium trvancoricum*, *Litsea travancorica* are also found.

The variety of microhabitats present in the *Myristica* swamps, provide various annelids, arthropods, molluscs, fishes, amphibians, reptiles, birds and mammals favourable conditions for survival and procreation. Many of these animals are endemic and some are on the red –list. There is a possibility that the utilization of the many microhabitats in the *Myristica* swamps by herpetofaunal species may have reduced intra- specific and inter- specific competition in the *Myristica* swamps in spite of higher abundance when compared to the adjacent areas.

These fresh water swamps seem to be a potential haven for the endemic biota, especially amphibians of Western Ghats and may also play a critical role in water storing and maintaining ground water level. Despite many problems (Daniels, 1991) it would be fruitful to prioritise such high diversity areas from Western Ghats for conservation.The conservation of these swamps is imperative to safe guard the ecological fabric of the Western Ghats.

The Kerala Forest Research Institute has initiated a research program on the Myristca swamps in 2004 with funding from Ministry of Environment and Forest, Government of India (Principal Investigator: Dr. P. Vijayakumaran Nair, GIS/FIMS Division, KFRI). Myristica swamps were so far examined only from a floristic angle. The on going study reveals an unbelievable amount of animal biodiversity in the Myristica swamps.

Occurrence of the Forest Cane Turtle *Geoemyda silvatica* (Reptilia, Testudines, Bataguridae) from a *Myristica* swamp of Kulathupuzha Forest Range, Southern Kerala

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The Forest cane turtle is a terrestrial Testudine of the family Bataguridae. In 1911, two male specimens of *Geoemyda silvatica* were obtained from the Kadar tribals in the vicinity of Kavalai, in erstwhile Cochin State forests and was first described by Henderson in 1912[1]. In 1982, a single specimen, slightly larger than the type specimen, was found in Chalakudy[2] .

During the ongoing research project, "Mapping Biodiversity of *Myristica* Swamps in Southern Kerala", we obtained information from the Kani tribals and other locals of Kulathupuzha forest Range about the presence of four types of Testudines – 'Vella amai' (*Indotestudo forstenii*), 'Kara amai' (*Lissemys punctata* and *Melanochelys trijuga*) and 'Mootal amai' (*Geoemyda silvatica*) found here. The 'Mootal amai', according to the tribals, is elusive, rarely sighted, found in the vicinity of canes and reeds and well camouflaged by the growth of moss or algae on its carapace.The Kadar tribe refer to the 'Mootal amai' as 'Chooral amai'. Both the tribes consider the flesh of the animal as a delicacy. Due to the elusive nature of this rare turtle and as it had so far never been reported from below 400 MSL or from the southern part of Kerala.

On the third of May 2006 at about 11 AM, while taking a vegetation sample plot in the evergreen forest at the periphery of Channamala *Myristica* swamp at 08.882714°N and 77.882714°E, Amakulam, Kulathupuzha, Kollam District, Kerala, the first author noticed the turtle, immobile in a natural hollow of a rotting tree stump, about ten metres above the swamp. The Cane Turtle was captured by hand and was photographed using a JVC Handycam. After making measurements and taking photographs it was taken back and released at the very same spot where it was captured. Its movements were recorded.

Identification was done following Smith[3] and also by comparing our photographs with photographs published in the Internet[4]. The turtle sighted by us had a large head; the upper jaw was hooked. The skin on the hinder part of the head was divided into moderately large shields and was brown in colour. Enlarged pointed scales were visible on the limbs. The webbing between the digits of the forelimbs was observable while that of the digits of the hindlimb was rudimentary. Tail was short.

The carapace was dark bronze with a coating of dull green algae/moss on it (Figs. 2A & 2B).

Fig. 2A
Carapace covered with moss/algae

Fig. 2B
'Mottal Amai' in its natural habitat

The plastron was pale yellow with dark undefined faint blotches. The front part of the head just above the snout and the lower jaw were yellow (Fig 1B). The diagnostic red spot on the snout extending around the upper margin of the eye was very distinct. The region inside the eye around the irises had red of a lighter shade (Figs. 1A & 1B). The top of the head was brown with a faint reddish shade. Neck was brown. The limbs and tail were black. The shell measured 128 mm in length, 82 mm in breadth and 47 mm in depth.

After release the turtle remained immobile for about six minutes. It ventured its head slightly out of the shell and remained in this position for about two minutes. Then it put out its limbs and head and started moving around. When it was picked up it slightly withdrew its head but not completely. When put down it remained immobile for thirty seconds and then started moving around steadily.

It reached the buttress of a large *Lophopetalum wightianum* tree and investigated the area for about four minutes. Then it changed direction and moved down the slope towards the *Myristica* swamp. It reached a dense clump of *Calamus* sp. and disappeared into it.

It is significant that both in 1911 and 1982 the Forest cane turtle was reported from the upland forests of Chalakudy from altitudes of around 400 MSL.

Fig. 1A
The diagnostic red spot on the snout and around the eyes

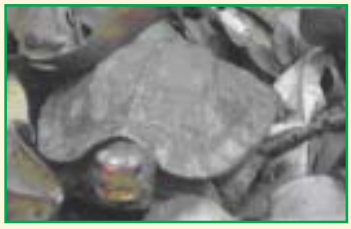

Fig. 1B
Yellow jaws and hooked upper jaw

This is the first time that this turtle is being reported from low altitude of 180 MSL. Though the species have been further recorded in 1990, 1995, 1996 and 1999, it has not been made clear by whom and when the two records from Southern Kerala are from Peppara and Aryankavu were recorded[5]. The Asian Turtle Trade Working Group 2000 has placed *Geoemyda silvatica* in the endangered category following IUCN Criteria B1+ 2c (1994 ver2.3). The main threats were loss of habitat and hunting for food[6].

It was suggested that sighting of six live specimens, in 1982, at a frequency of 0.16/man hour indicated low density and pressure due to habitat loss and human consumption. Habitat fragmentation, habitat disturbance and loss of habitat quality were also mentioned as possible threats faced by the species. They had called for studies to unravel the distribution and range of this unique animal for better conservation options[7]. In light of the recent sighting there is need for identifying the exact range of the species, its habit, habitat and threats to its existence with greater effort and vigour.

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Myristica swamps - An endangered ecosystem in Western Ghats

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Abstract

Myristica swamps are a unique fresh water ecosystem confined to low altitude, flat-bottomed valleys drained by sluggish streams of Western Ghats river systems. The present study reveals the geographic distribution of individual *Myristica* swamps in southern Kerala, its mapping and its plant diversity. A combination of survey methods using surveyors' compass, measuring tape and modern techniques such as GPS readings were used for delineating the swamps and fifteen swamps were accurately plotted in 1:50000 scale Survey of India topo-sheets and area of each swamp was calculated. About fifty three patches of *Myristica* swamps have so far located from the study area. All the patches were below four hectares. For vegetation study, plots of size 0.1 hectare were laid and tree species, GBH, were recorded herbs and shrubs were enumereted from subplots. A total of 65 tree species and 72 species of shrub –herb combination were recorded from the *Myristica* swamps. More than 60% of the trees belong to Myristicaceae family, the dominant species being *Myristica fatua var. magnifica* and *Gymnacranthera canarica*. Other species of *Myrsticaceae* and members of other families such as *Celestraceae*, *Diptereocarpaceae*, *Anacardiaceae*, *Xanthophyllaceae*, *Myrtaceae*, etc. were also present in the swamp, but less frequently. These swamps contain rare and endangered plant species such as *Syzygium travancoricum*, *Myristica fatua var. magnifica.* etc. *Myristica* swamp trees show adaptations such as knee roots and stilt roots. Ground vegetation is not dense. The dominant species beloing to *Araceae, Zingiberacea and Acanthaceae* members. Reeds, canes and *Pandanus* are also present.

Introduction

Swamps show a characteristic transitional condition between terrestrial land and deep water bodies. *Myristica* swamps are fresh water swamps. Fresh water swamps may differ accordingly the plant species present in them. They may be termed as *Myristica* swamps, *Terminalia* swamps, *Mesaleuca* swamps, *Casuarina* swamps, *Eucalyptus* swamps or sometimes reed or grass. Fresh water swamps get flooded in rainy season due to poor drainage and low slope. Swamps in general share certain features, rattans are often present and also *Pandanus* species. Swamp forests are found in different parts of the world. Vasudeva et.al., (2003) reported *Myristica* swamps from Karnataka parts of Western Ghats. Some of these swamps are sacred groves with *Myristica malabarica* being one of the component species. Krishnamoorthy(1960) was the

first to describe *Myristica* swamps in Kulathupuzha region of Western Ghats. Champion and Seth (1968) have classified them in the sub group – tropical fresh water forests (4c/FS1). Much of the *Myristica* swamps have been converted to paddy fields (Pascal, 1988). Rodgers and Panwar (1992) highlighted the vegetation as most critically needing conservation. Characteristics and distribution pattern *Myristica* swamps mainly contain tree species belonging to *Myristicaceae* family.

The peculiarity of the tree species is the breathing roots (knee roots) and stilt roots for surviving swampy condition, Knee roots for the breathing in flood condition in the swamp, stilt root for anchoring the tree species in damp soil. *Myristica* swamps are seen in low elevation, specifically below 180 m in flat bottomed valleys, containing sluggish streams. Almost all *Myristica* swamps are situated in the small streams or stream beginning areas, trees being distributed on both sides of these streams.

Myristicaceae : the dominant family of the swamps

Myristica swamps are dominated by members of *Myristicaceae,* a primitive family of angiosperms. It has 18 genera and 300 species. Kerala has three genera namely *Gymnacranthera***,** *Knema* and *Myristica* and altogether 6 species of which five are wild species *Myristica fatua var.magnifica*, *Myristica malabarica*, *Myristica dactyloids*, *Gymnacrnthera canarica*, *Knema attenuata*, and the widely cultivated *Myristica fragrans*. The characteristics of members of *Myristicaceae* -they are shade-tolerant, evergreen trees with pink or red resinous juice in the bark. The trees have central shaft like main stem producing horizontal branches like pine trees. The leaves are simple, dark green and alternate. The flowers are small, either male or female with only one whorl of perianth. The stamens in the male flower together form a central column. The ovary in the female has one chamber and one ovule. The wall of the fruit is fleshy and fibrous, and when mature splits into two halves exposing a single large seed covered with a bright orange yellow or red juicy cover called aril. The kernel of the seed is rich in starch and oil. Most of *Myristicaceae* family members are capable of producing aerial roots when faced with unfavorable conditions.

Study area

The study area is situated in Kollam and Trivandrum districts of Southern Kerala: in Kulathupuzha and Anchal forest ranges and Shendurny Wild life Sanctuary.

Methodology

Extensive survey was conducted in the study area. Mapping and vegetation study were done in different *Myristica* swamps of Kulathupuzha forest range.

Mapping and surveying

A combination of conventional survey using surveyors compass, measuring tape and modern techniques such as GPS readings were used for delineating the swamps. Individual swamps from Kulathupuzha Forest Range were accurately plotted in 1:50000 scale Survey of India topo-sheets. Area of each swamp was calculated from these maps.

Vegetation structure and composition

Vegetation study was done in ten swamps of Kulathupuzha Forest Range. Plots of size 0.1 hectare (100 X 10 m) were laid out in each of these swamps. GBH of tree species above 10cm were measured. Enumeration of tree species in each quadrate (10x10 m) was done. Regeneration was evaluated. Shrub and herb species were also enumerated.

Results

About 53 patches of *Myristica* swamps have been located from the study area. (Table -1) All the patches were below 4 hectares (Table -2) as these are the remnants after the conversion of *Myristica* swamps in to paddy field during the past. Fifteen individual swamps from Kulathupuzha Forest Range were accurately plotted in 1:50000 scale Survey of India toposheets. A total of 65 tree species (table-3) and 72 species of shrub –herb combine (table-4) were recorded from the *Myristica* swamps.

Anchal Forest Range	Kulathupuzha Forest Range	Shendumy Wild Life Sanctuary
Ambalathupacha	Ammayabalm	Onnam mile I
Chettadi	Chakidichal	Onnam mile II
Erail pachqa	Chennamala - II	Kurunthotti valavu
Kalyani	Chennamala -I	Viakumaram I
Kodukuthypacha	Choondipara	Mannukuthy
Konchukuzhi	Dalikarikam	Kattilapara I
Mukkode	Darpapana	Kattilapara II
Pandarikarikam	Embonge	Kattilapara III
Podiyanpacha	Karikurinjipacha -I	Kattilapara IV
Ambalathupacha	Karilurinjipacha - II	Choodal I
	Kinattinkarapacha	Choodal II
	Marapalam major	Choodal III
	Marapalam minor	Choodal IV
	Moonamchal	Irritar I
	Moonamnumber	Irritar II
	Moopathadychal	Onnakara thodu
	Mottalmood	Vilkumaraum II
	Pandarikunnu	
	Perumbadapy	
	Pillicode	
	Plavukidanachal	
	Poovanathummod II	
	Poovanathummod III	
	Poovanathummod IV	
	Poovanathumood I	
	Sasthanada	
	Utherenchira	

Table 1. *Myristica* swamps in Southern Kerala as on Oct 2005.

Above 60% of the trees belong to *Myristicaceae* family, the dominant being two species *Myristica fatua var. magnifica* and *Gymnacranthera canarica*. Other species of *Myrsticaceae* such as *Myristica malabarica*, *Myristica dactyloids*, *Knema attenuate* were also present in the swamp. Member of other families such as *Celestraceae, Diptereocarpaceae, Anacardiaceae*, *Xanthophyllaceae, Myrtaceae* etc. were also present in the swamp, but less frequently. In some swamps species of these families such as *Lophpopetalum wightianum*, *Vateria indica*, *Holigarna beddomei*, *Xanthophyllum arnottianum* were a significant part of the swamp community. (Table 5)

S no	Name of swamp	Area in hectares
1.	Karikurinjipacha	3.349
2.	Sasthanada	1.666
3.	Pillicode	0.930
4.	Moopathady	1.432
5.	Chakidichal	3.810
6.	Utherenchira	1.024
7.	Embonge	3.197
8.	Chennamala-1	2.144
9.	Chennamala-2	0.278
10.	Mottalmood	2.214
11.	Marapalam major	0.247
12.	Marapalam minor	1.306
13.	Poovanthumood-1	2.939
14.	Poovanthumood-3	0.802
15.	Poovanthumood-4	1.242

Table 2
Area of individual *Myristica* swamps in Kulathupuzha

Ground vegetation mainly *Pandanus, Calamus, Ochalandra* and members of *Araceae, Acanthaceae, Zingiberaceae species such as Lagenandra ovata, Barleria courtallica, Alpinia malaccensis*, *Zingiber zerumbet, Schumannianthus virgatus* etc. were also present. (Table -4)These swamps also contain many Endemic, Rare, Threatened and Endangered species such as *Myristica fatua var.magnifica*, *Syzygium trvancoricum*, *Litsea travancorica* etc. (table-3). Relative density, Relative frequency, Relative basal area, and Importance value index were calculated from the date collected. (Table-6)

Table-3 Tree species reported from *Myristica* swamps in Kulathupuzha

S.no	Species	Family	Status
1.	*Holigarna beddomei* *	*Anacardiaceae*	Vulnerable
2.	*Mangifera indica*	*Anacardiaceae*	
3.	*Semecarpus auriculata**	*Anacardiaceae*	Threatened
4.	*Polyalthea fragrance**	*Annonaceae*	
5.	*Xylopia parviflora*	*Annonaceae*	
6.	*Tabernaemontana heyneana**	*Apocyaanaceae*	Threatened
7.	*Alstonia scholaris*	*Apocynaceae*	
8.	*Elaeis guinensis*	*Arecaceae*	
9.	*Pinanga dicksonii* *	*Arecaceae*	
10.	*Bombax ceiba*	*Bombacaceae*	
11.	*Canarium strictum*	*Burseraceae*	
12.	*Kingiodendron pinnatum**	*Caesalpiniaceae*	Endangered
13.	*Lophopetalum wightianum*	*Celastraceae*	
14.	*Calophyllum inophyllum*	*Clusiaceae*	
15.	*Garcinia gummi-gutta*	*Clusiaceae*	
16.	*Mesua ferrea*	*Clusiaceae*	
17.	*Mastixia arboria**	*Cornaceae*	
18.	*Tetrameles nudiflora*	*Dasticaceae*	
19.	*Dipterocarpus bourdilloni* *	*Dipterocarpaceae*	Endangered
20.	*Hopea parviflora**	*Dipterocarpaceae*	
21.	*Vateria indica* *	*Dipterocarpaceae*	
22.	*Diospyros buxifolia*	*Ebenaceae*	
23.	*Diospyros panniculata**	*Ebenaceae*	
24.	*Elaeocarpus glandulosus*	*Elaeocarpacceae*	
25.	*Elaeocarpus tuberculatus*	*Elaeocarpacceae*	
26.	*Aporosa lindleyana*	*Euphorbiaceae*	
27.	*Baccaurea courtallensis* *	*Euphorbiaceae*	
28.	*Croton malabaricus**	*Euphorbiaceae*	
29.	*Glochidion zeylanicum*	*Euphorbiaceae*	
30.	*Macaranga peltata*	*Euphorbiaceae*	
31.	*Mallotus philippensis**	*Euphorbiaceae*	
32.	*Erythrina variegata*	*Fabaceae*	
33.	*Hydnocarpus pentandra**	*Flacourtiaceae*	
34.	*Actinodaphne hookeri* *	*Lauraceae*	Rare
38.	*Leea indica*	*Leeaceae*	
39.	*Lagerstroemia reginae*	*Lythraceae*	
40.	*Memeylon malabaricum**	*Melastomataceae*	
41.	*Dysoxylum malabaricum* *	*Meliaceae*	
42.	*Swietenia macrophylla*	*Meliaceae*	
43.	*Archidendron monadelphum**	*Mimosoidae*	
44.	*Artocarpus hirsutus**	*Moraceae*	
45.	*Ficus hispida*	*Moraceae*	
46.	*Gymnacranthera canarica*	*Myristicaceae*	
47.	*Knema attenuata* *	*Myristicaceae*	
48.	*Myristica dactyloides*	*Myristicaceae*	
49.	*Myristica fatua var.magnifica**	*Myristicaceae*	Endangered
50.	*Myristica malabarica* *	*Myristicaceae*	
51.	*Syzygium mundagam* *	*Myrtaceae*	
52.	*Syzygium trvancoricum**	*Myrtaceae*	Endangered
53.	*Syzygium gardneri*	*Myrtaceae*	
54.	*Strombosia ceylanica*	*Olacaceae*	
55.	*Olea dioica*	*Oleaceae*	
56.	*Carallia brachiata*	*Rhizophoraceae*	
57.	*Anthocephalus chinensis*	*Rubiaceae*	
58.	*Mitragyna parvifolia*	*Rubiaceae*	
59.	*Pistacia oleosa*	*Sapindaceae*	
60.	*Madhuca neriigifolia*	*Sapotaceae*	

*contd..*Table-3

61.	*Ailanthus excelsa*	*Simaroubaceae*	
62.	*Pterygota alata*	*Sterculaceae*	
63.	*Symplocos cochinchinensis*	*Symplocaceae*	
64.	*Vitex altissima*	*Verbenaceae*	
65.	*Xanthophyllum arnottianum* *	*Xanthophyllaceae*	

*** Endemic to: Western Ghats**

Table-4 Total shrub - herb species from *Myristica* swamps

S.No	Scentific name	Family	Threat Status
1.	*Barleria courtallica* *	Acanthaceae	
2.	*Abrus pulchellus*	Febaceae	
3.	*Acasia torta*	Mimosaceae	
4.	*Alpinia malaccensis*	Zingiberaceae	
5.	*Anaphyllum wightii* *	Araceae	Threatened
6.	*Artanema longifolia*	Scrophulariaceae	
7.	*Asparagus recemosus*	liliaceae	
8.	*Bauhinia phoenicea* *	Caesalpiniaceae	
9.	*Begonia malabarica*	Begoniaceae	
10.	*Calamus hookerianus* *	Arecaceae	
11.	*Calamus thwaitesii*	Arecaceae	
12.	*Calamus trvancoricus* *	Arecaceae	
13.	*Centrosema virginiana*	Febaceae	
14.	*Clausena heptaphylla* *	Rutaceae	
15.	*Clematis bourdillonii* *	Ranunculaceae	vulnerable
16.	*Clerodendrum viscosum*	Verbenaceae	
17.	*Commulina sp*	Commulinaceae	
18.	*Coscinium fenestratum*	Menispermaceae	
19.	*Costus speciosus*	Zingiberaceae	
20.	*Curculigo trichocarpa*	Hypoxidaceae	
21.	*Curcuma ecalcarata* *	Zingiberaceae	
22.	*Cyathula prostrata*	amaranthaceae	
23.	*Cyptolepis buchananii*	Periplocaceae	
24.	*Dalbergia horrida* *	Fabaceae	
25.	*Dichapetalum glenoids*	Dichapetalaceae	
26.	*Dracaena terniflora*	Dracaenaceae	
27.	*Ecbolium viride* *	Acanthaceae	
28.	*Entada rheedi*	Mimosaceae	
29.	*Eupatorium odoratum*	Asteraceae	
30.	*Globba ophioglossa* *	Zingiberaceae	
31.	*Glycosmis pentaphylla*	Rutaceae	

*contd..*Table-4

32.	*Gomphandra tetrandra*	Icacinaceae	
33.	*Helicteres isora*	Sterculiaceae	
34.	*Hibiscus furcatus*	Malvaceae	
35.	*Hoya sp*	Asclepidaceae	
36.	*Ixora leucantha* *	Rubiaceae	
37.	*Ixora nigricans*	Rubiaceae	
38.	*Jasminum azoricum*	Oleaceae	
39.	*Jasminum rottlerianum*	Oleaceae	
40.	*Lagenandra ovata*	Araceae	
41.	*Leptaspis urceolata*	Poaceae	
42.	*Lindernia ciliate*	Scrophulariaceae	
43.	*Macrosolen capitellatus*	Loranthaceae	
44.	*Memecylon umbellatum*	Melastomataceae	
45.	*Monstera deliciosa*	Araceae	
46.	*Myxospyrum smilacifolium*	Oleaceae	
47.	*Neurocalyx calycinus* *	Rubiaceae	
48.	*Ochalandra trvancorica* *	Poaceae	
49.	*Ophiorrhizha mungos*	Rubiaceae	
50.	*Osbeckia sp*	Melastomataceae	
51.	*Pandanus thwaitesii* *	Pandanaceae	
52.	*Pellionia heyneana*	Urticaceae	
53.	*Phyllanthus niruri*	Euphorbiaceae	
54.	*Piper longum*	Piperaceaae	
55.	*Piper trioicum*	Piperaceaae	
56.	*Pothos scandens*	Araceae	
57.	*Schumanianthus virgatus*	Marantaceae	
58.	*Scireria lithosperma*	Cyperaceae	
59.	*Smilax zeylanica*	Smilacaceae	
60.	*Sonerilla sp*	Melastomataceae	
61.	*Spilanthes calva*	Asteraceae	
62.	*Stachytarpheta jamaicensis*	Verbenaceae	
63.	*Tetracera acara*	Ranunculaceae	
64.	*Thottea siliquosa*	Aristolochiaceae	
65.	*Toxocarpus kleinii*	Asclepidaceae	
66.	*Turraea villosa*	Meliaceae	
67.	*Tylophora mollissima* *	Asclepidacea	
68.	*Vanilla aphylla* *	Orchidaceae	Rare
69.	*Ventilago bombaiensis* *	Rhamnaceae	
70.	*Zingiber zerumbet*	Zingiberaceae	
71.	*Zizyphus rugosa*	Rhamnaceae	
72.	*Zizyphus oenoplia*	Rhamnaceae	

*** Endemic to: Western Ghats**

Table-5 Dominant tree species with % frequency of occurrence in individual swamps.

Name of swamp	Dominant tree species in the swamps with frequency %					
	Species	%	Species	%	Species	%
Chakidichal	*M fatua var.magnifica*	43.82	*G canarica*	27.42	*H beddomei*	5.62
Embonge	*M fatua var.magnifica*	38.61	*L wightianum*	23.76	*G canarica*	5.94
Karikurinji	*G canarica*	36.36	*M fatua var.magnifica*	31.02	*L wightianum*	10.16
Marapalam	*G canarica*	47.41	*M fatua var.magnifica*	37.04	*H beddomei*	5.19
Moopathady	*G canarica*	46.98	*M fatua var.magnifica*	40.27	*L wightianum*	2.68
Mottalmood	*M fatua var.magnifica*	41.38	*G canarica*	23.28	*V indica*	19.83
Pillicode	*G canarica*	41.28	*V indica*	28.35	*L wightianum*	16.51
Poovanthumood	*G canarica*	53.58	*M fatua var.magnifica*	33.85	*L wightianum*	3.85
Sathanada	*G canarica*	45.27	*L wightianum*	18.24	*X arnottianum*	10.14
Utherenchira	*M fatua var.magnifica*	57.51	*G canarica*	37.81	*L wightianum*	1.49

Table-6 IVI of all the 10 plots with (Size of each plot 100x10m - 0.1Ha)

S No	Species	Avg. GBH	RF	RBA	RDen	IVI	RIVI
1	*Anthocephalus chinensis*	214.00	0.14	0.01	0.14	0.30	0.10
2	*Artocarpus hirsutus*	53.75	0.29	0.00	0.29	0.58	0.19
3	*Actinodaphne hookeri*	110.00	0.07	0.00	0.07	0.15	0.05
4	*Aporosa lindliyana*	22.78	0.65	0.00	0.65	1.31	0.44
5	*Alstonia scholaris*	20.00	0.07	0.00	0.07	0.14	0.05
6	*Baccaurea courtallensis*	20.18	0.80	0.00	0.80	1.60	0.53
7	*Cinnamomum malabaratum*	12.00	0.14	0.00	0.14	0.29	0.10
8	*Diospyros buxifolia*	16.50	0.14	0.00	0.14	0.29	0.10
9	*Diospyros paniculata*	53.00	0.14	0.00	0.14	0.29	0.10
10	*Elaeocarpus glandulosus*	29.00	0.07	0.00	0.07	0.14	0.05
11	*Elaeocarpus tuberculatus*	51.63	1.16	0.06	1.16	2.37	0.79
12	*Unknown sp-1*	15.00	0.07	0.00	0.07	0.14	0.05
13	*Ficus sp*	600.00	0.07	0.03	0.07	0.17	0.06
14	*Gymnacranthera canarica*	51.75	37.94	59.55	37.94	135.44	45.15
15	*Holigarna beddomei*	71.26	2.82	0.63	2.82	6.27	2.09
16	*Hopea parviflora*	20.75	0.29	0.00	0.29	0.58	0.19
17	*Hydnocarpus pentandra*	25.45	2.39	0.06	2.39	4.84	1.61
18	*Knema attenuate*	54.00	0.94	0.04	0.94	1.92	0.64
19	*Leea indica*	11.00	0.14	0.00	0.14	0.29	0.10
20	*Lagerstoemia reginae*	43.50	0.14	0.00	0.14	0.29	0.10
21	*Lophopetalum wightianum*	47.32	7.68	2.04	7.68	17.39	5.80
22	*Mastixia arborea*	36.20	0.72	0.01	0.72	1.46	0.49
23	*Myristica dactyloides*	75.00	0.07	0.00	0.07	0.15	0.05
24	*Myristica fatua var. magnifica*	46.06	33.53	36.82	33.53	103.88	34.63
25	*Mesua ferrea*	12.00	0.07	0.00	0.07	0.14	0.05
26	*Myristica malabaricum*	32.00	0.22	0.00	0.22	0.44	0.15
27	*Memecylon malabaricum*	18.00	0.07	0.00	0.07	0.14	0.05
28	*Macaranga peltata*	20.00	0.07	0.00	0.07	0.14	0.05
29	*Unknown sp-2*	12.00	0.07	0.00	0.07	0.14	0.05
30	*Pterygota alata*	40.00	0.07	0.00	0.07	0.14	0.05
31	*Pinanga dicksonii*	11.67	0.22	0.00	0.22	0.43	0.14
32	*Persea macrantha*	23.50	0.14	0.00	0.14	0.29	0.10
33	*Semecarpus auriculata*	21.67	0.43	0.00	0.43	0.87	0.29
34	*Stromboosia ceylanica*	12.60	0.36	0.00	0.36	0.72	0.24
35	*Syzygium gardneri*	82.00	0.07	0.00	0.07	0.15	0.05
36	*Swieteria macrophylla*	12.00	0.07	0.00	0.07	0.14	0.05
37	*Syzygium travancoricum*	198.64	0.80	0.39	0.80	1.98	0.66
38	*Syzygium mundagam*	185.00	0.07	0.00	0.07	0.15	0.05
39	*Tabernaemontana heyneana*	18.00	0.14	0.00	0.14	0.29	0.10
40	*Tetrameles nudiflora*	66.00	0.07	0.00	0.07	0.15	0.05
41	*Unknown sp -3*	23.90	0.72	0.00	0.72	1.45	0.48
42	*Vateria indica*	39.49	3.55	0.30	3.55	7.40	2.47
43	*Syzygium sp*	20.00	0.07	0.00	0.07	0.14	0.05
44	*Xanthophyllum arnottianum*	24.88	1.88	0.03	1.88	3.80	1.27
45	*Xylopia parviflora*	19.50	0.29	0.00	0.29	0.58	0.19

Economic value

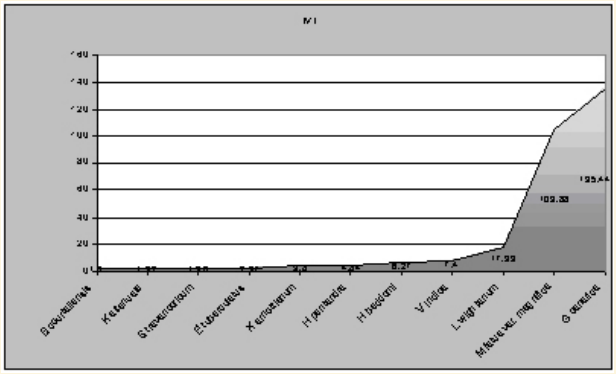
Economically the swamps are not very significant. Good quality timber yielding trees are very few. Wood of some species is used for plywood, pole of tree species are used for house construction, cloth hanger etc. The aril of the fruit of *Myristicaceae* family members is the main economic asset from these swamps. The aril of *Myristica fatua var. magnifca*, *Gymnacranthera canarica*, *Myristica malabarica* is used as raw material in paint industries. An oil extracted from the seeds of these species is used in varnishes, and also used for making vetinerary medicines.

Conclusion

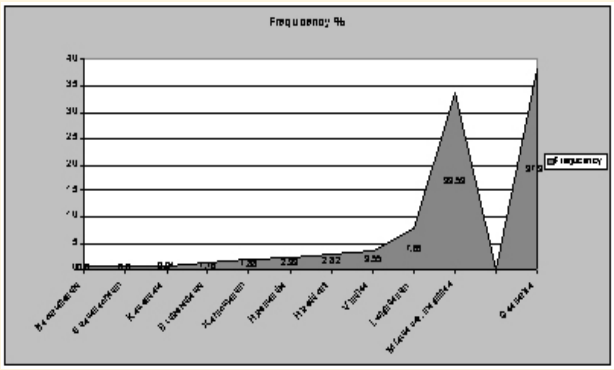
Myristica swamps are show high specificity in its distribution. The altitude, water bodies and slope of swamp play pivotal role in the formation of *Myristica* swamps and the survival of *Myristica* species. *Myristica* species is typically adapted to swampy condition; especially *Myritica fatua var,magnifica*, *Gymnacranthera canarica*. *Myristica fatua var. magnifica* are well adapted to water logging conditions because they produce more stilt roots than any other species of *Myristicaceae* family. Hence, *Myristica fatua var.magnifica* individuals are increasingly distributed in flooding swamps and are less frequent in swamps without flooding conditions. *Gymnacranthera canarica* has more or less equal survival capability both in swampy or less swampy condition because of a wide tolerance range.

Myristica swamps are critically endangered ecosystem in Western Ghats. Many of the swamps were converted into paddy fields in the past and many are in highly disturbed condition. These swamps are rich in biodiversity, contain many endemic and rare endangered threatened species, it is a breeding place of many faunal species and also play a critical role in water storing and maintaining ground water level. Hence, the conservation of these swamps is imperative to safe guard the ecological fabric of the Western Ghats.

Graph 1: IVI of dominant tree species of *Myristica* Swamps



Graph 2: Percentage Frequency of occurrence of dominant tree species of *Myristica* Swamps



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Biophysical characterization, conservation and management of a rare forest ecosystem, the Myristica swamps of Southern Kerala

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Approaches for setting conservation priorities are becoming a matter of concern, as the accelerating and potentially catastrophic loss of biotic diversity unlike other environmental threats is irreversible. Mittermier *et a1*(1998). The Western Ghats is considered as one of the 25 global biodiversity hotspots owing to its concentration of endemism. Myers(1990). Though the Western Ghats covers a very small area when compared to other hotspots, it boasts of a number of habitats - tropical evergreen, moist and dry deciduous, shola, riparian and fresh water swamp forests. Fresh water swamps may differ according to the plant species present in them; like *Myristica* swamps, *Terminalia* swamps, *Causarina* swamps, etc. Vasudeva *et. al.* (2003) reported *Myristica* swamps from Karnataka parts of Western Ghats. Some of these swamps are sacred groves with *Myristica malabarica* as component species. Krishnamoorty (1960) was the first to describe *Myristica* swamps in Kulathupuzha, Kerala.

Fig 1. *Myristica* swamps, location

Champion and Seth (1968) have classified them in them in the sub – group, tropical fresh water forests (4c/FS1). Much of the *Myristica* swamps have been converted to paddy fields Pascal(1988). Rodgers and Panwar (1992) highlighted the vegetation as most critically needing conservation.

Fig 2. Study Area

Myristica swamps in the Kulathupuzha region of Southern Kerala have been reported from the flat-bottomed ill-drained valleys of Anchal, Kulathupuzha and Shendureney Forest Ranges. These swamps are situated at the start of sluggish forest streams and are usually surrounded by low elevation evergreen forests.

In some areas, forest plantations or paddy fields, flank the *Myristica* swamps. These swamps lie between 77°0" and 77°55" E and 8 °0"and 8 °55"N at altitudes ranging from 180-200 MSL. The dominant vegetation is trees belonging to *Myristicaceae* family. These trees show adaptations such as breathing roots (knee rots) and stilt roots (for anchoring the tree in damp soil) to overcome the marshy conditions. *Pandanus*, canes and reeds dominate the undergrowth. A variety of lianas are also present.

The current sudy is part of an ongoing project sponsored by Ministry of Environment and Forests, Govt.of India. We conducted a survey of Myristica swamps in the study area to understand the ground realities. The following study methods were followed.

Fig 3. *Myristica* swamp habitat

Fig 4. *Myristica magnifica*

Mapping and Survey

Base line information was obtained from Survey of India topo sheets. Recent features such as roads; bridges, etc were recorded using GPS. Boundaries of the swamps were recorded using a combination of GPS and compass surveys. The information thus obtained was transferred to layers in GIS software MapInfo. Areas of these swamps were calculated.

Floristic studies

Sample plots of 100m x 10m were laid in selected swamps for the enumeration of trees. Identity and girth of the trees were recorded. Shrubs and herbs were also sampled in sub-plots of 4m x 4m and 1m x 1m respectively.

Faunistic studies

Visual Encounter Survey (VES), Heyer, *et. al*. (1994) and recording of opportunistic sightings were done to prepare the inventory of resident and visiting fauna. Sampling was done by moderate VES along stream and terrestrial transects to obtain quantitative data. The process was repeated in the forests adjoining the swamps for comparision. Twenty-three microhabitats for herpetofauna were classified inside the swamps. Percentage frequency of occurrence and niche breadth by Levin's formula (1968) has been calculated for selected herpetofauna.

Hydrology

Depth of water in streams at specific locations was being recorded every month. Soil samples are also being collected.

Results

Mapping and Survey

A total of fifty three *Myristica* swamps – 27 in Kulathupuzha, 10 in Anchal and 18 in Shendureney were located. Thirty six swamps have been surveyed exactly and these have been plotted in 1:50,000 scale Survey of India topo sheets. The size of the *Myristica* swamp patches range from below 1 hectare to 4 hectares, the smallest being 0.247 hectares and the largest being 3.810 hectares.

Floristic studies

A total of 65 tree species and 40 species of shrub and 32 species of herb combine were recorded from the *Myristica* swamps. Above 60% of the trees belong to Myristicaceae family. *Gymnacranthera canarica* and *Myristica fatua* var *magnifica* had the highest percent frequency of occurrence with 37.94% and 33.53 % respectively. Other dominant trees were *Lophopetalum wightianum* (7.685), *Vateria indica* (3.55%), *Holigarna beddomi* (2.82%), *Hydnocarpus pentadendra* (2.39%), *Xanthophyllum arnottianum* (1.88%), *Elaeocarpus tuberculatus* (1.16%), *Knema attenuata* (0.94%). The trees, *Semecarpus auriculata*, *Tabernomontana heyneana* found in the swamps have been listed threatened. *Holigarna beddomei* has been listed vulnerable. *Kingiodendron pinnatum, Dipterocarpus bourdilloni, Litsea travancorica, Myristica fatua* var *magnifica* and *Syzigium travancoricum* have been accorded endangered status. *Anaphyllum wightii, Clemantis bourdillonni* and *Vanilla aphylla* are listed under threatened, vulnerable and rare respectively. Ground vegetation consisted mainly of *Pandanus, Calamus, Ochalandra* and members of *Araceae*, *Acanthaceae, Zingiberaceae* species such as *Lagenandra ovata*, *Barleria courtallica*, *Alpinia malackensis*, *Zingiber zerumban, Schumanianthus verigatus* etc. were also present.

Faunistic studies

Fig 5. *Rana temporalis*

Fig 6. *Polypedates psuedocruciger*

Two species of earthworms, three species of crabs, ten species of fishes, thirty four species of amphibians, thirty three species of reptiles, fifty eight species of birds and twenty one species of mammals have been recorded as present in the swamps.In addition to this annelids and arthropods are also being recorded. Five species of herpetofauna- *Rana temporalis, Nyctibatrachus major, Nyctibatrachus aliciae, Polypedates psuedocruciger* and *Trimeresurus malabaricus* were selected for calculation of frequency of occurrence and niche breadth. A total of 2090 individuals were recorded in the swamps while 289 were recorded from the adjacent forests during the first year of the study, data of which is included in the present paper.

Rana temporalis was most abundant with 1391 and 141 sightings in the swamp and non swamp forests respectively. *Nyctibatrachus aliciae* was sighted 98 times inside the swamp and 25 times outside the swamps respectively.*Trimeresurus malabaricus* was sighted 74 times inside the swamp and 14 times outside the swamps. The most preferred microhabitats in the swamps were *Myristica magnifica* roots and *Gymnacranthera canarica* roots. Outside the swamps exposed roots were preferred. *Rana temporalis* showed the highest niche breadth both outside and inside the swamps with values of 18.01 and 11.21. *Nyctibatrachus major* had the lowest niche breadth of 8.64 inside the swamps while *Trimeresurus malabaricus* had the lowest niche breadth of 4.08 outside the swamps. The variety of microhabitats present in the *Myristica* swamps and their utilization trend by selected herpetofauna, which may have reduced competition in spite of higher abundance when compared to the adjacent forests, is highly significant. The Hydrology data is yet to be analysed and interpreted.

Wetlands support varied populations of plant and animal species.It is also notable that many endemic species are wetland dependent yet wetland ecosystems are under constant threat of destruction.Wetlands like *Myristica* swamps which show high specificity in its distribution, are even more prone to destruction as altitude, water avaliability and water velocity and slope of land play a pivotal role in their formation and the survival of its dominant species. *Myristica* swamps assume significance, as these swamps allow for a variety of microhabitats which supports biodiversity both in terms of numbers and variety. The unique environmental conditions of these swamps support the life cycles of many biota which have disappeared from the nearby ecosystems. Many of them are endemic and some are on the red-list.These swamps may also play a critical role in water storing and maintaining ground water level. Despite many problems(Daniels, 1991) it would be fruitful to prioritise such high diversity areas from the Western ghats for conservation. The conservation of these swamps is imperative to safeguard the ecological fabric of the Western Ghats as an entire community of endemics hangs on tentherhooks of extinction and conservation.

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