

Studies on Northernmost *Myristica* Swamp Ecosystem in Western Ghats at Bambarde-Hewale, Maharashtra, India

Jagdish Dalavi¹, Rohit Mane¹, Nikhil Gaikwad¹, Savaliram Ghane¹, Yogesh Phonde² and Shrirang Yadav^{1*}

¹Department of Botany, Shivaji University, Kolhapur–416 004, Maharashtra, India

²Chief Conservator of Forest (T) Office, Forest Department Kolhapur Circle, Govt. of Maharashtra, Maharashtra, India

ABSTRACT

Myristica swamps are unique ecosystems where trees of early divergent angiosperms belonging to family Myristicaceae are the dominant elements. These primeval forest types have been reported only from the Western Ghats of India. Most of the swamps are restricted to the southern parts, in states Karnataka and Kerala, but swamps have been reported in the northern states of Goa and Maharashtra. The present communication is focused on the recently discovered *Myristica* swamp in Maharashtra state. Being a floristic assessment with respect to vegetation, a checklist of angiosperms growing in the swamp is presented and the possible role of *Myristica* swamps, anthropogenic threats and conservation measures are discussed. The present study will provide baseline data for further studies.

Key words: *Myristica* swamp, Maharashtra, Myristicaceae, relic, Northern Western Ghats

*Author for correspondence: S.R. Yadav; e-mail: sryadavdu@gmail.com;
ORCID: <https://orcid.org/0000-0002-3528-9604>

Introduction

Wetlands are among the most productive ecosystems worldwide and provide critical habitats for the survival of a diverse groups of organisms, ecological services and economic benefits (Bobbink et al., 2006). Wetlands are divided into some important habitats such as stagnant water bodies, riparian habitat, marshy-muddy lands, swamps, oceanic vegetation and estuarine ecosystems. Even though fresh water wetlands cover only 6% of total geographical surface of world, they contain about 12% carbon pool and play crucial role in global carbon cycle according to Intergovernmental Panel on Climate Change. Western Ghats of India is home to patches of fresh water swamp forests which support some unique endemic species of Myristicaceae R.Br. and therefore are commonly known as *Myristica* swamps (Talbot, 1911). *Myristica* swamps are freshwater ecosystems occupied by members of the family Myristicaceae (Chandran & Mesta, 2008; Bhat et al. 2009). Chandran et al. (1999a, b) suggested that Indian *Myristica* swamps are the remnant of primeval forests of the Western Ghats and evolved about 140 million years ago. Moorthy (1960) first described the floristic composition of *Myristica* swamps from Travancore region in Kerala state. Subsequently, more such swamps were described from Southern Kerala and Karnataka (Champion & Seth, 1968; Saldanha, 1984; Gadgil & Chandran

1989). These swamps received much attention when Rodgers and Panwar (1988) described them as the most endangered forest ecosystems in India. Similar swamps were reported from elsewhere in the Western Ghats of Karnataka, with reports of high endemism associated with the swamps (Ramesh & Pascal, 1997). Detailed floristic composition and ecological studies of *Myristica* swamps of South-Western Ghats of Kerala in relation to species diversity, forest composition and edaphic factors were done (Varghese, 1992; Varghese & Menon, 1999). More recently, Nair et al. (2007), Bhat & Kaveriappa (2009), Roby et al. (2014a) contributed comprehensive checklists of floristic components of *Myristica* swamps from southern Western Ghats. Phytosociological and species abundance studies and reports of many little-known amphibians, reptiles and swamp specific fauna of *Myristica* swamps of southern Western Ghats were made (Jose et al., 2007 a,b,c,d,e, 2014; Roby et al., 2014b). As per the literature available, these swamps were found restricted mostly to moist evergreen forests in Western Ghats of Goa, Karnataka and Kerala. Recently, Sreedharan & Indulkar (2018) reported a swamp, locally known as ‘Kanhachi Rai’ in the northern Western Ghats of Maharashtra. In the present report, the floristic composition of the *Myristica* swamp of Kanhachi Rai is documented. In addition, efforts were taken to prepare a checklist of

angiosperms and observations made on anthropogenic activities and threats during these studies. We have also suggested conservation measures to allow these interesting communities to survive.

Material and Methods

Study Area

The study area Kanhalachi Rai is in Hewale village (near Bambarde), Dodamarg taluka, Sindhudurg district, Maharashtra state, India (Fig. 1). It is located at 15.8069 N, 74.1138 E at an elevation of 73 MSL, where the *Myristica* swamp forms a small patch of about 11,000 sq.m (2.70 acres).

Floristic Studies

For detailed floristic studies, we visited the swamp during the post monsoon, summer and pre-monsoon seasons in 2020 and 2021. All the species associated with *Myristica* swamp were documented through survey. The numbers of the most abundant trees (*Gymnacranthera* (DC.) Warb. and *Myristica* Gronov, Myristicaceae) were recorded by random counting. Important angiosperm elements were processed for herbarium and deposited at Shivaji University Herbarium (SUK).

Results

Characteristic Features of *Myristica* swamp at Bambarde-Hewale

The swamp showed an abundance of trees belonging to the family Myristicaceae, with two species predominant, namely, *Myristica magnifica* Bedd. and *Gymnacranthera canarica* (Bedd. ex King) Warb. It is revered (conserved due to deep religious feelings) by local people who have named it Kanhalachi Rai. The swamp is surrounded by rubber plantations on its northern & north-eastern sides, rice and areca plantation on the eastern side and small evergreen forest patch on the southern side. Water in the swamp flows mainly from the north towards the south. The stream from the swamp is partly diverted to paddy fields by local people, and used for irrigation and domestic (Fig. 1).

The dominance of spiny *Calamus pseudotenuis* Becc., *Pandanus furcatus* Roxb. and *Mezoneuron cucullatum* (Roxb.) Wight & Arn. offered protection to the swamp. The undergrowth mainly consisted of *Saraca asoca* (Roxb.) de Wilde, a vulnerable medicinal plant species. *Myristica magnifica* was predominant, accounting for most maximum population of total plant species.

Composition of Vegetation

The *Myristica* swamp at Bambarde-Hewale contains two dominant species of Myristicaceae namely, *Myristica magnifica* represented by about 6000 individuals with about 350 mature trees of which about 45 are female plants and *Gymnacranthera canarica* with about 20 mature trees. The diversity of flowering plants consists of a total of 42 species of which 14 (33%) species are endemic to India, and some of them are threatened (Table 1). These species are *Calophyllum apetalum* Willd. (vulnerable), *Gymnacranthera canarica* (vulnerable), *Hydnocarpus pentandrus* (Buch.-Ham.) Oken (vulnerable), *Myristica magnifica* (endangered), *Nothopogia castaneifolia* (Roth) Ding Hou (critically endangered), *Saraca asoca* (vulnerable) and *Strobilanthes ciliata* Nees (vulnerable). The dominant species *Gymnacranthera canarica* and *Myristica magnifica* are dioecious in nature. Female plants are of crucial importance in seed setting and regeneration of the species. Field observations showed that there were only few mature female individuals of both the species in the swamp. Thus, strategic protection of mature female plants of both the species is of priority in conservation of the swamp.

General Observations on the Community

Bambarde-Hewale *Myristica* swamp is located in the vicinity of the hills of northern Western Ghats but all hills surrounding it are deforested and used for plantation of rubber, areca-nut, coconut, cashew nut and rice. Thus, the whole area surrounding swamp has become open and poor in moisture content causing desiccation of evergreen forest and also adversely affecting underground water table. It was also observed that some noxious weeds viz. *Chromolaena odorata* (L.) King & Rob., *Mikania micrantha* Kunth, *Ageratum conyzoides* L. and *Scoparia dulcis* L. etc. have already entered along the margins of swamp. Increased human activity, construction works near Bambarde-Hewale and adjoining areas exert pressure on local flora and fauna of the region.

Some common plant species associated with *Myristica* swamp at Bambarde-Hewale include *Calamus pseudotenuis*, *Pandanus furcatus*, *Lagenandra toxicaria* Dalz., *Lophopetalum wightianum* Arn., *Holigarna arnottiana* Hook.f., *H. grahamii* (Wight) Kurz, *Nothopogia castaneifolia*, *Anamirta cocculus* (L.) Wight & Arn., *Dalbergia horrida* (Dennstedt) Mabb., *Diploclisia glaucescens* (Blume) Diels, *Gnetum edule*

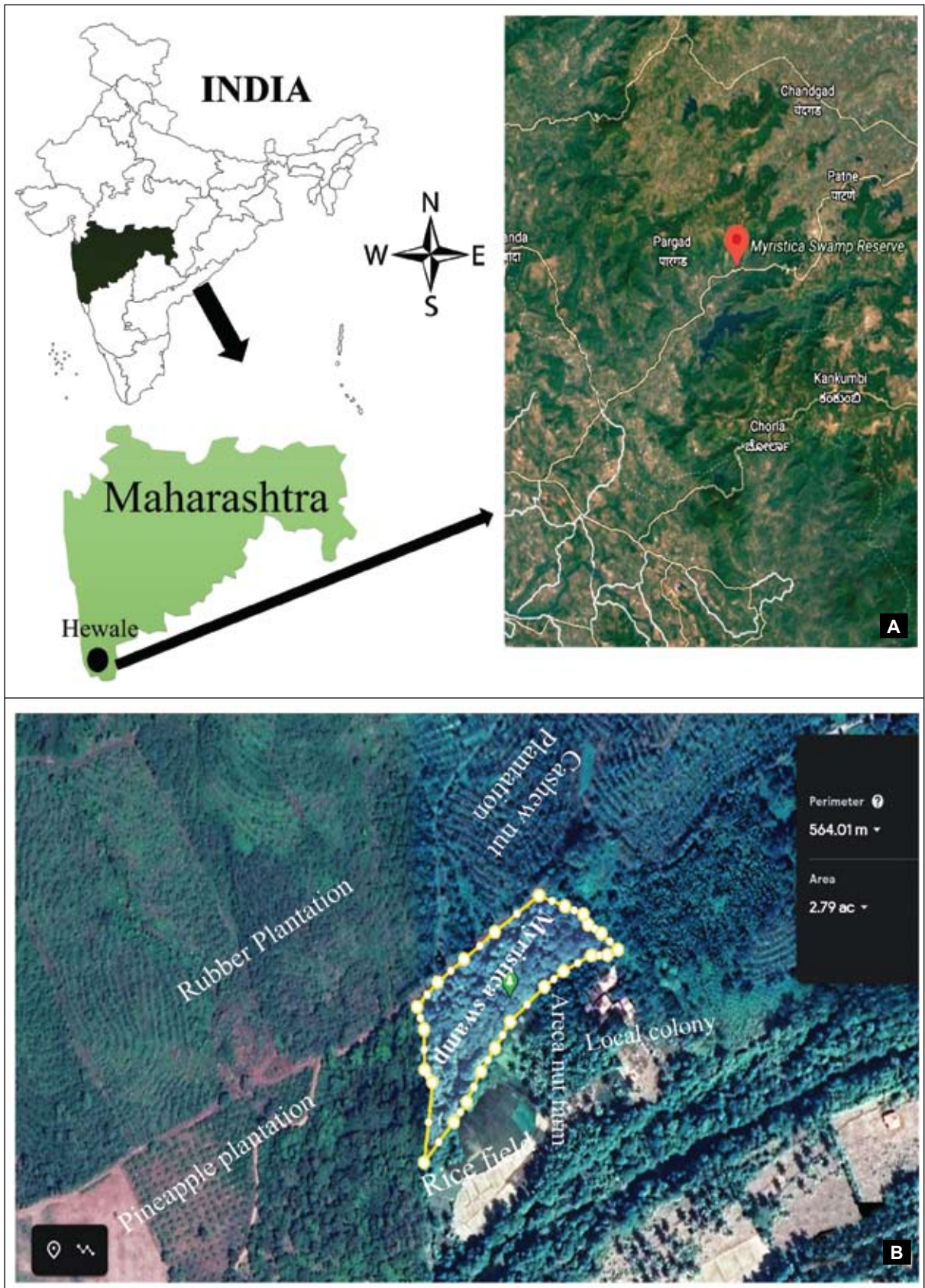


Figure 1. (A) Geographical location of Bambarde-Hewale *Myristica* swamp; (B) Satellite map of Bambarde-Hewale *Myristica* swamp designed through Google Earth Pro (2020) and edited by Jagdish Dalavi.

Table 1. Checklist of seed plants from Bambarde-Hewale *Myristica* swamps.

S.No.	Species name	Family	Habit	IUCN status	Exsiccata
1	<i>Anamirta cocculus</i> (L.) Wight & Arn.	Menispermaceae	Liana	Data Deficient	–
2	<i>Calamus pseudotenuis</i> Becc.	Areaceae	Shrub	Data Deficient	RNM-215
3	<i>Calophyllum apetalum</i> Willd.	Calophyllaceae	Tree	Vulnerable/ Endemic	RNM-216
4	<i>Camonea vitifolia</i> (Burm.f.) A.R.Simões & Staples	Convolvulaceae	Climbing herb	Data Deficient	JVD-1703
5	<i>Caryota urens</i> L.	Areaceae	Tree	Least Concern	RNM-217
6	<i>Chionanthus mala-elengi</i> (Dennst.) P.S.Green	Oleaceae	Tree	Data Deficient/ Endemic	JVD-1701
7	<i>Combretum ovalifolium</i> Roxb. ex G.Don	Combretaceae	Liana	Data Deficient	JVD-1702
8	<i>Dalbergia horrida</i> (Dennst.) Mabb.	Fabaceae	Climbing shrub	Data Deficient/ Endemic	JVD-1704
9	<i>Diploclisia glaucescens</i> (Blume) Diels	Menispermaceae	Liana	Data Deficient	JVD-1705
10	<i>Dracaena terniflora</i> Roxb.	Asparagaceae	Herbs	Data Deficient	JVD-1706
11	<i>Ficus hispida</i> L.f.	Moraceae	Shrubs	Least Concern	JVD-1708
12	<i>Flacourtia montana</i> J.Graham	Salicaceae	Tree	Not accessed/ Endemic	–
13	<i>Garcinia indica</i> (Thouars) Choisy	Clusiaceae	Tree	Vulnerable/ Endemic	JVD-1709
14	<i>Gnetum edule</i> (Willd.) Blume	Gnetaceae	Liana	Least Concern	RNM-218
15	<i>Gomphandra tetrandra</i> (Wall.) Sleumer	Icacinaceae	Scandent shrubs	Least Concern	JVD-1710
16	<i>Gymnacranthera canarica</i> (Bedd. ex King) Warb.	Myristicaceae	Tree	Vulnerable/ Endemic	JVD-1711
17	<i>Hibiscus hispidissimus</i> Griff.	Malvaceae	Scandent shrubs	Not accessed	JVD-1712
18	<i>Holigarna arnottiana</i> Hook.f.	Anacardiaceae	Tree	Not accessed/ Endemic	RNM-219
19	<i>H. grahamii</i> (Wight) Kurz	Anacardiaceae	Tree	Least Concern	RNM-220
20	<i>Hydnocarpus pentandrus</i> (Buch.-Ham.) Oken	Achariaceae	Tree	Vulnerable/ Endemic	JVD-1713
21	<i>Lagenandra toxicaria</i> Dalzell	Araceae	Herb	Least Concern	NGCPR-2213
22	<i>Lagerstroemia microcarpa</i> Wight	Lythraceae	Tree	Not accessed	JVD-1714
23	<i>Leea indica</i> (Burm.f.) Merr.	Leeaceae	Scandent shrubs	Least Concern	JVD-1715
24	<i>Litsea tomentosa</i> Blume	Lauraceae	Tree	Least Concern	JVD-1716
25	<i>Lophopetalum wightianum</i> Arn.	Celastraceae	Tree	Least Concern	JVD-1718
26	<i>Macaranga peltata</i> (Roxb.) Müll.Arg.	Euphorbiaceae	Tree	Not accessed	JVD-1719
27	<i>Mangifera indica</i> L.	Anacardiaceae	Tree	Data Deficient	–
28	<i>Melastoma malabathricum</i> L.	Melastomataceae	Shrubs	Not accessed	JVD-1720
29	<i>Mezoneuron cucullatum</i> (Roxb.) Wight & Arn.	Fabaceae	Scandent shrubs	Not accessed	JVD-1721
30	<i>Myristica magnifica</i> Bedd.	Myristicaceae	Tree	Endangered/ Endemic	JVD-1722
31	<i>Nothopogia castaneifolia</i> (Roth) Ding Hou	Anacardiaceae	Tree	Critically endangered / Endemic	JVD-1723
32	<i>Pandanus furcatus</i> Roxb.	Pandanaceae	Shrubs	Not accessed	JVD-1724
33	<i>Paramignya monophylla</i> Wight	Rutaceae	Scandent shrubs	Not accessed	JVD-1725

S.No.	Species name	Family	Habit	IUCN status	Exsiccata
34	<i>Phyllanthus assamicus</i> Müll. Arg.	Phyllanthaceae	Tree	Not accessed	–
35	<i>Pothos scandens</i> L.	Araceae	Climber	Not accessed	JVD-1726
36	<i>Pterospermum acerifolium</i> (L.) Willd.	Malvaceae	Tree	Least Concern	JVD-1727
37	<i>Saraca asoca</i> (Roxb.) J.J.de Wilde	Fabaceae	Tree	Vulnerable	JVD-1728
38	<i>Stereospermum chelonoides</i> (L.f.) DC.	Bignoniaceae	Tree	Not accessed	JVD-1729
39	<i>Strobilanthes barbatus</i> Nees	Acanthaceae	Shrubs	Not accessed/ Endemic	–
40	<i>S. ciliatus</i> Nees	Acanthaceae	Shrubs	Vulnerable/ Endemic	–
41	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Tree	Least Concern	JVD-1730
42	<i>S. hemisphericum</i> (Wight) Alston	Myrtaceae	Tree	Not accessed	JVD-1731
43	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Combretaceae	Tree	Not accessed	JVD-1732
44	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Shrubs	Not accessed	JVD-1733

(Willd.) Blume, *Mezoneuron cucullatum*, *Saraca asoca*, *Caryota urens* L. etc (Figs. 2, 3). These species and characteristic features are summarized, with proposed roles in sustaining this ecosystem (Table 2).

Discussion

The present investigation describes the floristics of the northern-most patch of *Myristica* swamps in the Western Ghats, located at Hewale, Sindhudurg district,

Table 2. Associated species in *Myristica* swamp and their role in swamp maintenance.

S.No.	Associated species	Family	Plant features; postulated role in <i>Myristica</i> swamp
1	<i>Calamus pseudotenius</i> Becc.	Arecaceae	Spinescent species forming dense network in the swamp; protect the swamp from anthropogenic pressure and animal activities
2	<i>Mezoneuron cucullatum</i> (Roxb.) Wight & Arn.	Fabaceae	
3	<i>Pandanus furcatus</i> Roxb.	Pandanaceae	
4	<i>Anamirta cocculus</i> (L.) Wight & Arn.	Menispermaceae	Woody liana reach to the top of canopy and provide shade to young plants; help to maintain microclimate required by typical species of <i>Myristica</i> swamps.
5	<i>Dalbergia horrida</i> (Dennst.) Mabb.	Fabaceae	
6	<i>Diploclisia glaucescens</i> (Blume) Diels	Menispermaceae	
7	<i>Gnetum edule</i> (Willd.) Blume	Gnetaceae	
8	<i>Pothos scandens</i> L.	Araceae	Acts as ground cover in muddy areas maintain moist conditions; prevent the growth of invasive species.
9	<i>Dracaena tenuiflora</i> Roxb.	Asparagaceae	
10	<i>Saraca asoca</i> (Roxb.) J.J.de Wilde	Fabaceae	Common species found as an undergrowth second storey species
11	<i>Lagenandra toxicaria</i> Dalzell	Araceae	Aquatic plant with rhizomatous root system; protect muddy soil erosion due to continuous water flow and also regulate the water flow which is of crucial importance for <i>Myristica</i> swamp.
12	<i>Lophopetalum wightianum</i> Arn.	Celastraceae	Evergreen plant species form thick canopy; act as thermo-regulator and provide conducive conditions for the seedling growth of tree species
13	<i>Gymnacranthera canarica</i> (Bedd. ex King) Warb.	Myristicaceae	
14	<i>Holigrna arnottiana</i> Hook.f.	Anacardiaceae	
15	<i>Holigarna grahamii</i> (Wight) Kurz	Anacardiaceae	
16	<i>Nothopegia castaneifolia</i> (Roth) Ding Hou.	Anacardiaceae	
17	<i>Syzygium hemisphericum</i> (Wight) Alston	Myrtaceae	



Figure 2. (A) Prop roots of *Myristica magnifica*; (B) Knee roots of *Gymnacranthera canarica*; (C) Thick root network of *Myristica swamp*. Photos by Jagdish Dalavi.

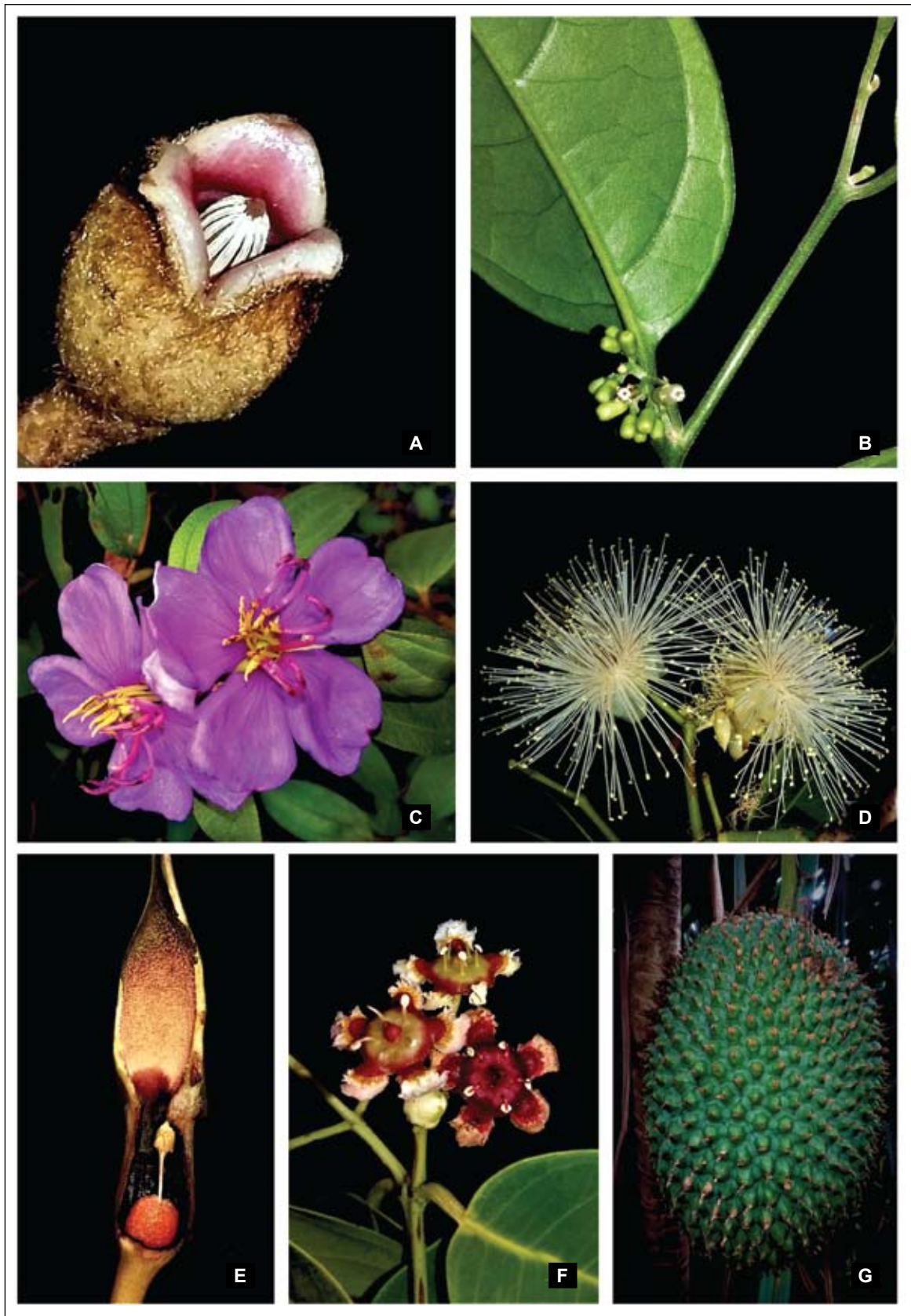


Figure 3. (A) *Myristica magnifica*; (B) *Gomphandra tetrandra*; (C) *Melastoma malabathricum*; (D) *Syzygium hemisphericum*; (E) *Lagenandra toxicaria*; (F) *Lophopetalum wightianum*; (G) *Pandanus furcatus*. Photos by Jagdish Dalavi.

Maharashtra. Southern swamps are said to show more species diversity than northern swamps (Moorthy, 1960; Nair, 2007; Sujitha et al., 2019). In the present case, this swamp shows lower species diversity, with uniform and dense patches of *Myristica magnifica*, than in central and southern *Myristica* swamps.

Prabhugaonkar et al. (2014) reported *Gymnacranthera canarica*, *Semecarpus kathalekanensis* Dasappa & Swam., *Syzygium travancoricum* Gamble and *Myristica magnifica* from *Myristica* swamp at Brahma Karmali (15033.874°N & 74010.378°E; 45 m) of Valpoi taluka in Goa. They also reported dominant species viz. *Careya arborea*, *Terminalia elliptica*, *Lagerstroemia microcarpa*, *Dillenia pentagyna* and *Bridelia* spp. surrounding the swamp. Another *Myristica* swamp named 'Nirankaranchi Rai' has been reported from Nanoda village, Sattari taluka, Goa (Chhapiwala, 2017). Detailed studies on these swamps are needed. *Semecarpus kathalekanensis* and *Syzygium travancoricum* commonly found in *Myristica* swamps are not recorded from swamp at Hewale. These *Myristica* swamps are referred as evolutionary relics and are treasure houses of biological carbon and minerals, they play important role in regulation of water flow of perennial streams and rivers (Jain, 2019). Nair (2007) & Sujitha (2019) concluded that *Myristica* swamps are dwelling houses of 600 animals and more than 206 species of butterflies of which more than 60 % species are endemic. *Myristica* swamps are the breeding places of many aquatic animals and amphibians. They gained immense importance in ecological balance by acting as pollution controller and temperature regulator (Nair, 2007).

Sensitization, education and creating awareness among local people especially youth about importance, functions and most importantly as our natural heritage will help in protection and conservation of the only *Myristica* swamp in Maharashtra state. In addition, the following actions may be taken to achieve the goal of conservation of the unique ecosystem.

All *Myristica* swamps must be declared as biodiversity heritage sites/biosphere reserve. Any harmful activity such as cutting and exploitation of any biotic and abiotic material should be strictly prohibited. *Myristica* swamps are very delicate, fragile and sensitive ecosystems. Any type of tourism and camping in and around such areas should be completely banned. Canopy walk, walk through swamp, photo-shooting, camping, night stay, food plaza, resorts, information center etc. should be strictly avoided. *Myristica* swamps need

detailed scientific research; however, such research should be conducted under the vigilance of forest department. For all research activities, prior permission should be taken from the respective authority. Collection of any biological material from swamp should be avoided unless and until it is essential for study. Any agricultural activity in and around swamp must be minimized or completely banned. Diversion of water from *Myristica* swamps for agriculture or any other use must be stopped and entry of weeds in *Myristica* swamp must be checked

Awareness programmes for locals especially youth to educate them on scientific basis about the ancient heritage that they possess, importance of *Myristica* swamps, and need for their conservation must be conducted. *Myristica* swamps near Bambarde-Hewale are conserved by local people as sacred forests. Local people use the tallest *Myristica* tree trunk during Holi festival as 'Ovhaliche zad' (Plant growing in natural streams). Each year one mature tree is cut for the festival. This practice needs to be discouraged through awareness programmes and by providing alternative common tree species in the region.

The *Myristica* swamp of Bambarde-Hewale is rich in biodiversity and is an ecological heritage that is worthy of conservation.

Acknowledgements

The authors are thankful to the Head, Department of Botany, Shivaji University Kolhapur for laboratory facilities and support. SRY is thankful to Indian National Science Academy (INSA) for financial assistance. JVD is thankful to the Ministry of Environment Forest and Climate Change, Govt. of India, New Delhi for financial assistance, RNM is thankful to the Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra (RGSTC) for financial assistance. DST-FIST and UGC-DRS-SAP programmes are also duly acknowledged.

References

- Bhat, P.R. & Kaveriappa, K.M. 2009. Ecological Studies on *Myristica* Swamp Forests of Uttara Kannada, Karnataka, India. *Tropical Ecology* 50, 329-337.
- Bobbink, R., Beltman, B., Verhoeven, B. & Wigham, D.F. 2006. Wetlands: Functioning, Biodiversity Conservation, and Restoration. Springer. 80 pp.
- Champion, H.G. & Seth, S.K. 1968. A Revised Survey of Forest Types of India, Govt. of India Press, New Delhi. 404 pp.
- Chandran, M.D.S., Mesta, D.K. & Naik, M.B. 1999a. Inventorying and conservation of the *Myristica* swamps of Uttara Kannada.

- Report of Research and Training Institute, Bangalore 20 pp.
- Chandran, M.D.S, Mesta, D. K & Naik, M.B. 1999b. *Myristica* swamps of Uttara Karnataka District. *My Forest*, 35: 217-222.
- Chandran, M.D.S. & Mesta, D.K. 2008. *Myristica* Swamps: Remnants of Primeval Tropical Forests of Western Ghats, Forest Research and Training Institute, Bangalore, India. 10 pp.
- Chhapiwala, Z. 2017. Nirankaranchi Rai – The Mysterious *Myristica* Swamp. Vrasat-E-Hind Foundation. Preserving, Propagating and Protecting India's Heritage. Issue 21 March 2017, 1-14.
- Gadgil, M. & Chandran, M.D.S. 1989. Environmental Impact of Forest Based Industries on the Evergreen Forests of Uttara Kannada District, A Case Study (Final Report). Department of Ecology and Environment, Bangalore. 20 pp.
- Jain, N. 2019. Why the ancient *Myristica* swamps need more protection. Mongabay Series: India's Iconic Series. <https://india.mongabay.com/2019/11/> (Accessed on 1st January, 2021)
- Jose, J., Ramachandran, K.K. & Nair, P.V. 2007a. Animal diversity of the *Myristica* swamp forests of Southern Kerala with special reference to herpetofauna. In: The Proceedings of the 19th Kerala Science Congress, 29th -31st January 2007. 724-726.
- Jose, J., Ramachandran, K.K. & Nair, P.V. 2007b. Occurrence of the Forest Cane Turtle *Geoemyda sylvatica* (Reptilia, Testidunes, Bataguridae) from a *Myristica* swamp of Kulathupuzha Forest Range, Southern Kerala. *Envis Newsletter SACON*, 3: 3-4.
- Jose, J., Ramachandran, K.K. & Nair, P.V. 2007c. A preliminary overview and checklist of the spider fauna of *Myristica* swamp forests of Southern Kerala, India. *Newsletter of British Arachnology Society*, 109: 12: 3-4.
- Jose, J, Ramachandran K.K., & Nair, P.V. 2007d. A rare and little-known lizard, *Otocryptis beddomii* from the *Myristica* swamps of Southern Kerala, India. *The Herpetological Bulletin*, 101: 27-31.
- Jose, J., Roby T.J., Ramachandran, K.K., Thomas, T.P. & Nair, P.V. 2007e. *Myristica* swamps – a forgotten wetland. *Envis Newsletter SACON*, 3: 2.
- Jose, J., Roby, T.J., Ramachandran, KK & Nair, PV. 2014. Species abundance distribution of selected communities in the *Myristica* swamp forest of southern Kerala. *Current Science*, 107. 447-453.
- Moorthy, K. 1960. *Myristica* swamps in the evergreen forests of Travancore. *Indian Forester*, 86: 314-315.
- Nair, P.V., Ramachandran, K.K., Swarupanandan, K. & Thomas, T.P. 2007. *Mapping Biodiversity of Myristica Swamps in Southern Kerala, Final Report*. Kerala Forest Research Institute. Peechi. 255 pp.
- Prabhugaonkar, A., Mesta, D.K. & Janarthanam, M.K. 2014. First report of three redlisted tree species from swampy relics of Goa State, India. *Journal of Threatened Taxa* 6: 5503-5506.
- Ramesh, B.R. & Pascal, J.P. 1997. Atlas of Endemics of the Western Ghats (India): Distribution of Tree Species in the Ever-green and Semi-Evergreen Forests. French Institute, Pondicherry. 403 pp.
- Roby, T.J., Jose, J. & Nair, P.V. 2014a. Checklist of flora of *Myristica* swamps—a critically endangered freshwater ecosystem of southern Western Ghats of Kerala, India. *Indian Forester*, 140: 608-616.
- Roby, J., Nair, P.V. & Jose, J. 2014b. GIS techniques for mapping highly fragmented ecosystems: a case study on the *Myristica* swamp forests of southern Kerala, India. *Research Journal of Recent Science*, 3 (ISC-2013): 110-119.
- Rodgers, W.A. & Panwar, H.S. 1988. Planning Wildlife Protected Area Network in India. *Wildlife Institute of India*. 1-20 pp.
- Saldanha, C.J. 1984. *Flora of Karnataka – Volume 1*. Oxford and IBH Publishing Co, New Delhi. 535 pp.
- Sreedharan, G. & Indulkar, M. 2018. New distributional record of the northernmost *Myristica* swamp from the Western Ghats of Maharashtra. *Current Science*, 115: 1434-1436.
- Sujitha, P.C., Prasad, G. & Sadasivan, K. 2019. Butterflies of the *Myristica* swamp forests of Shendurney Wildlife Sanctuary in the southern Western Ghats, Kerala, India. *Journal of Threatened Taxa*, 11: 13320-13333.
- Talbot, W.A. 1911. *Forest Flora of the Bombay Presidency and Sind – Volume II*, Government Photozincographic Press, Poona. 574 pp.
- Varghese, V. 1992. Vegetation structure, floristic diversity and edaphic attributes of the freshwater swamps forests in southern Kerala. Dissertation (B. Sc.) submitted to College of Forestry, Kerala Agricultural University, Mannuthy, Kerala. 50 pp.
- Varghese, A.O. & Menon, A.R.R. 1999. Floristic composition, dynamics and diversity of *Myristica* swamp forests of southern Western Ghats, Kerala. *Indian Forester*, 125: 775-783.