

Out of four species belonging to the genus *Bruguiera*, *B. cylindrica* has relatively wide distribution, however, it is not recorded from in Kottayam district. *B. gymnorrhiza* is a rare species which is not represented in Malapuram, Kozhikode, Kannur and Kasargode. *B. sexangula* is one of the endangered species, which is represented only in two districts namely Kollam and Ernakulam. *B. parviflora* has wide distribution in the northern parts of Kerala which is not present in Trivandrum, Kollam, Alappuzha and Kottayam. *Kandelia kandal* is also a rare species which is distributed in all districts except Trivandrum, so also *Sonneratia caseolaris* which is found in five districts namely Trivandrum, Kollam, Alappuzha, Kannur and Kasargode, whereas, *S. alba* is becoming endangered due to its small populations in the districts of Ernakulam, Kozhikode, Kannur and Kasargode. *Lumnitzera racemosa* is one of the rarest mangrove species in Kerala found in four districts namely, Trivandrum, Kollam, Alappuzha and Kannur, however, *Ceriops tagal*, the species which believed to be extinct from Kerala coast was rediscovered from the Ashtamudi estuary during the present survey. It is not reported from any other districts in Kerala so far. *Shirakiopsis indica* one of the endangered species is seen only in three districts namely Kollam, Alappuzha and Ernakulam. *Heritiera littoralis* is believed to be an extinct species but relocated during the present study from Kollam. *Nypa fruticans* is an endangered mangrove palm seen in Ernakulam and Thrissur. Of the two species of Phoenix, *P. sylvestris* is seen in Trivandrum, Thrissur and Kozhikode, whereas, *P. humilis* var. *pedunculata* is seen only at Kollam and Kannur (<http://indiabiodiversity.org>). The present study on the distribution of pure mangroves of Kerala revealed that *Lumnitzera racemosa*, *Nypa fruticans*, *P. sylvestris*, *P. humilis* var. *pedunculata* and *Ceriops tagal* are the most threatened species in the west coast. Similarly *Bruguiera sexangula* is also confined in few places wherein their population is facing further decline (Tresa Radhakrishnan and Anil Kumar, 2014).

Asramam is one of the most famous mangrove sites in Kollam district which had undergone severe destruction due to land reclamation/conversion and real estate activities. The most critically endangered species, *Syzygium travancoricum*, very few numbers is found here, similarly, *Lumnitzera racemosa*, one of the rare mangrove species in Kerala, has shown its restricted distribution in Asramam area. *Ceriops tagal*, believed to be extinct in Kerala coast was being rediscovered from Vincent Island of Kollam district (Vimal Raj *et al.*, 2014). Though degradation is vehemently noticed in certain areas of the district, it is observed few signs of regeneration of mangroves in certain other areas.

One of the endangered pure mangrove species, *Bruguiera sexangula* is also recorded first time in Kasaragod district during the present survey. A list of true mangroves of Kerala is displayed in Figs. 2 to 25. A total of 15 pure mangrove species and about 33 semi mangrove species were recorded in the study done by Vidyasagan and Madhusoodanan (2014). Investigation on floristic diversity of mangroves of Kannur indicated that the study area constituted 12 species under nine genera belonging to seven families. Rhizophoraceae represented maximum genera of four species (Vidyasagan *et al.*, 2011).

Status of mangroves represented at district level was examined in detail. Results indicated that Trivandrum district was endowed with luxuriant growth of mangroves had undergone severe degradation. The major threat was reclamation of most of the backwaters for housing, industrialization and other developmental activities. The remnants of past glory of mangroves in Veli backwater was remain confined in the areas under the custody of ISRO/VSSC, Thumba, Trivandrum. Kollam district encompasses with highest extent of mangroves among southern districts. However, degradation and conversion of mangroves is profoundly experienced in many parts of Kollam especially Kayamkulam, Ashtamudi and Paravoor areas. Asramam is one of the most famous mangrove sites in Kollam district had undergone severe destruction due to conversion and real estate activities. The most critically endangered species, *Syzygium travancoricum* is found in very few numbers here. Similarly, *Lumnitzera racemosa*, which is one of the rare mangrove species in Kerala, has shown its restricted distribution in Asramam area of this district. *Ceriops tagal*, believed to be extinct in Kerala coast was being rediscovered from Vincent island of Kollam district (Vimal Raj *et al.*, 2014). Though degradation is vehemently noticed in certain areas of the district, it is observed few signs of regeneration of mangroves in certain other areas.

Alapuzha was once famous for backwaters and swamps on which mangroves could be able to establish profusely. But now it is very difficult to locate good mangrove patches in Alapuzha district. Presently the available patches are confined in Kayamkulam and Pathiramanal Vembanad backwater areas. Due to blockade in saline water availability, many areas are invaded by semi mangroves like *Barringtonia racemosa*, *Annona glabra* and *Pandanus tectorius*. In Kottayam district, mangroves are mainly distributed in Kumarakom, which is represented as fragmented assemblage of few species. Tourism is causing severe damage to the existing mangroves in Kumaragum. Now good patches of mangroves confined in the protected areas under KTDC.

Ernakulam district occupy second highest extent of mangroves in the state after Kannur district. In the state, maximum extent of mangrove destruction was reported from this district. When Cochin became industrial capital of the state, there was flooding of developmental projects which took away prime areas of mangroves from Panangad, Gosree, Vallaradam, Vypin and Puthuvypin. The silver line in the conservation of mangroves in Ernakulam district is one with the declaration of Mangalavanam as bird sanctuary. Thrissur district consists of very less extent of mangrove in the state. Presently mangroves are confined in backwaters of Chettuwai, Azhikkodu, Kodungallur and few patches in Venkidung and Pavaraty Panchayats. Mangrove destruction is going on in Chettuwai by the name ecotourism whereas real estate activities took away good patches of mangroves in Pulloot of Kodungallur. Malappuram district occupy very less extent of mangroves in the state. Kadalundi, Kerala's first community reserve is endowed with relatively good patches of mangroves, however, Pulluni of Thirur, Murukummadu, Kootaikadavu are few places where relatively good patches of mangroves are found. However,

Pulluni mangroves face acute threat from developmental activities. Kozhikode district once occupied good extent of mangroves, but most of these luxuriant mangroves have been taken away by faulty land use and land reclamation. Part of Kadalundi community reserve is located in Kozhikode district also, however, Beypore, Kottooli, Akalapuzha are still supporting good patches of mangroves which is also under threat. Highest extent of mangroves in the state is occupied by Kannur district hence it is named as the capital of mangroves in Kerala.

More than 60 per cent of the total mangrove areas is under private ownership. Mangroves are luxuriant in certain areas due to the absence of so called developmental activities. Plant diversity of pure mangroves is also very high in Kannur when compared to other districts (12 out of 15 pure mangrove species). This is the only district which had undertaken extensive mangrove afforestation programmes with the auspices of Kerala Forest Department. The uncultivated Kaippad fields are being profusely invaded by mangroves. Places like Dalil, Kunhimangalam Kalliassery, Olavilam, Edat, Thekkumpadu, Cherukunnu are few places where mangroves are protected and devoid of any kind of human interference. Kasaragod faced less degradation of mangroves which in turn helped the protection of existing mangroves. Arekode mangroves are found along Kumbalapuzha has been considered as the largest patch of mangroves in Kasaragod district. One of the endangered pure mangrove species, *Bruguiera sexangula* is also recorded first time in Kasaragod district during the present survey.

Most of the mangroves in Kerala are in an irreversible process of degradation. Mangroves in Veli and Asramam are

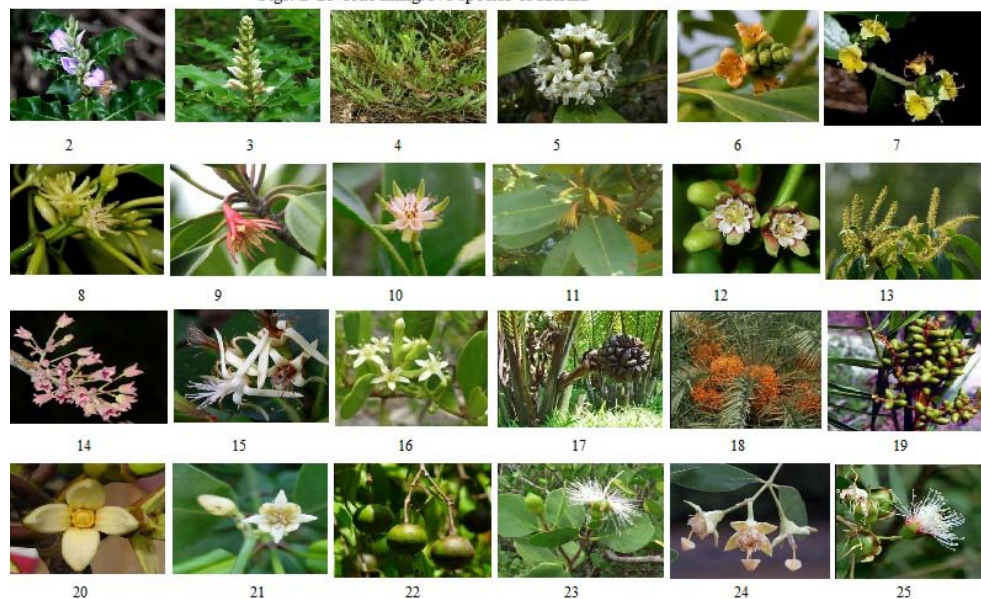
completely fragmented and destroyed and need immediate conservation. Similarly Kumarakom of Kottayam district is also facing major threat from ecotourism. Major portion of Puthuvypu mangroves have been disappeared due to the establishment of LNG terminal. Chettuwai mangroves are threatened mainly from tourism and encroachment. Pulluni of Thirur, Malappuram district is facing destruction as good patches of mangroves along with an endangered species, *Bruguiera sexangula*. Kallai of Kozhikode district lost its past glory of mangroves due to faulty land use and Kannur though have maximum extent of mangroves in Kerala, they are destroyed in few areas namely Irinavu, Pazhayangadi, Papiserry, Thalassery, Melur and Thazhaekavu.

The mangrove forests are considered to be as unique as human population. Under Sec.2(i) of Forest (Conservation Act 1980), no forest land can be diverted for non forestry purpose without prior approval of the Central Government. This description covers all statutorily recognized forests whether designated as 'reserve, protected forest' or otherwise for the purpose of Sec.2 (i) of FCA 1980. According to this clarification all mangrove areas qualify for the definition of forest irrespective of ownership. A complete ban on the conversion of mangrove areas, which are under the control of private agencies, should be encouraged. Preparation of a management plan by considering ecological amplitude, zonation, morphological and physiological adaptation of the species to their specific environment should immediately be initiated in order to conserve the remaining mangrove areas. A serious attempt has to be made in order to conserve existing luxuriant patches of mangroves in Vincent Island of Kollam, Arikadi of Kasaragod, Puthuvypu of Ernakulam, Pulluni of Malappuram and Chettuwai of Thrissur districts.

Table 1 District wise distribution of pure mangroves

Sl. No.	Name of Species	TVM	KLM	ALP	KTM	EKM	TCR	MLPM	KKD	KNR	KSD
1	<i>Acanthus ilicifolicus</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	<i>Acanthus ebracteatus</i> Vahl	✓	✓		✓	✓	✓	✓	✓	✓	✓
3	<i>Avicennia marina</i> (Forssk.) Vierh.	X	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	<i>Avicennia officinalis</i> L.	✓	✓	✓	✓	X	✓	✓	✓	X	✓
5	<i>Aegiceras corniculatum</i> (L.) Balsco	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	<i>Bruguiera cylindrica</i> (L.) Blume	✓	✓	✓	X	✓	✓	✓	✓	✓	✓
7	<i>Bruguiera gymnorhiza</i> (L.) Savi.	✓	✓	✓	✓	✓	✓	X	X	X	X
8	<i>Bruguiera parviflora</i> (Roxb.) Wight & Arn. ex Griff.	X	X	X	X	✓	✓	✓	✓	✓	✓
9	<i>Bruguiera sexangula</i> (Lour.) Poir.	X	✓	X	X	✓	X	X	X	X	X
10	<i>Ceriops tagal</i> (Perr.) C. B. Robins.	X	✓	X	X	X	X	X	X	X	X
11	<i>Kandelia candel</i> (L.) Druce	X	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	<i>Rhizophora apiculata</i> Blume	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
13	<i>Rhizophora mucronata</i> Poir.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	<i>Shirakiopsis indica</i> (Willd.) Esser	X	✓	✓	X	✓	X	X	X	X	X
15	<i>Excoecaria agallocha</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	<i>Heritiera littoralis</i> Dryand.	X	✓	X	X	X	X	X	X	X	X
17	<i>Lumnitzera racemosa</i> Willd.	✓	✓	✓	X	X	X	X	X	✓	X
18	<i>Sonneratia alba</i> J. E. Smith	X	X	X	X	✓	X	X	✓	✓	✓
19	<i>Sonneratia apetalae</i> L. f.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	<i>Sonneratia caseolaris</i> (L.) Engl.	✓	✓	✓	X	X	X	X	X	✓	✓
21	<i>Nypa fruticans</i> Wurmb	X	X	X	X	✓	✓	X	X	X	X
22	<i>Phoenix sylvestris</i> Roxb.	✓	X	X	X	X	✓	X	✓	X	X
23	<i>Phoenix humilis</i> var. <i>pedunculata</i> Becc.	X	✓	X	X	X	X	X	X	✓	X
24	<i>Acrostichum aureum</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Figs. 2-25 True mangrove species of Kerala



2. *Acanthus ilicifolius* L., 3. *Acanthus ebracteatus* Vah, 4. *Acrostichum aureum* L., 5. *Aegiceras corniculatum* (L.) Balso, 6. *Avicennia marina* (Forsk.) Vierh., 7. *Avicennia officinalis* L., 8. *Bruguiera cylindrica* (L.) Blume, 9. *Bruguiera gymnorhiza* (L.) Savi., 10. *Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff., 11. *Bruguiera sexangula* (Lour.) Poir., 12. *Ceriops tagal* (Perr.) C. B. Robins., 13. *Excoecaria agallocha* L., 14. *Hemitelia littoralis* Dryand., 15. *Kandelia candel* (L.) Druce, 16. *Lumnitzera racemosa* Willd., 17. *Nypa fruticans* Wurmb., 18. *Phoenix sylvestris* Roxb., 19. *Phoenix humilis* var. *pedunculata* Becc., 20. *Rhizophora apiculata* Blume, 21. *Rhizophora mucronata* Poir., 22. *Shirakiopsis indica* (Willd.) Esser, 23. *Sonneratia alba* J. E. Smith, 24. *Sonneratia apetala* L. f., 25. *Sonneratia caseolaris* (L.) Engl.

6. Conclusion

Present investigation on the distribution and plant diversity of mangroves revealed that out of the total extent of mangroves in Kerala (2502 ha.), 1313 ha. is under private ownership and 1189 ha. belongs to the State. Studies on floristic composition indicated that a total of 24 pure mangrove species were recorded from the mangrove areas and are belonged to 15 genera and 9 families. Similarly, there were 98 mangrove associates identified from various locations in different districts. Distribution of pure mangroves in Kerala revealed that *Lumnitzera racemosa*, *Nypa fruticans*, *P. sylvestris*, *P. humilis* var. *pedunculata* and *Ceriops tagal* are the most threatened species in the west coast of India. Mangroves of Kerala are considered as the relics of the past. Invasion by encroachers made extensive clearing and degradation of many areas. Hence there is an urgent need to protect the remaining mangrove areas and a massive afforestation campaign is to be initiated with the full hearted support and cooperation of the common people.

7. Acknowledgement

The first author acknowledges with thanks the financial support for this study from the INSPIRE, DST, India.

References

- [1] Kerala State Land use Board. Land Resources of Kerala, Government of Kerala, Trivandrum. 2013.
- [2] Khaleel K. M. Study of the quantitative structure of the true mangroves present in the mangal forests of Thellicherry, Pappinissery and Kunhimangalam of Kannur district. *Indian Forester*. 131, pp 81-89. 2005.
- [3] Krishnamurthy K, Kannan L, Jeyaseelan M. J. P., Palaniappan R, Ali M. A. S. A floristic study of the halophytes of the Pichavaram mangroves. *Bull. Bot. Sur. India*. 23 (344), pp 114-120. 1981.
- [4] Tresa Radhakrishnan and Anilkumar M. R. Kandal, Kerala's Vanishing Asset, Akshara Laser and Offset printers and Publishers, Trivandrum, Kerala, India. pp 302. 2014.
- [5] Vidyasagan K and Madhusoodanan V. K. Distribution and plant diversity of mangroves in the west coast of Kerala, India. *Journal of Biodiversity and Environmental Studies*, 4:5, pp 38-45. 2014.
- [6] Vidyasagan K, Ranjan M. V., Maneeshkumar M., Praseeda T. P. Phytosociological analysis of mangroves at Kannur District, Kerala. *International Journal of Environmental Sciences* 2: pp 671-677. 2011.
- [7] Vimal Raj R. V., Binushma Raju, W. Soumya, A. Shibu, S. Lekshmi, Y. Shibu Vardhanan, S. Sruthi and Tresa Radhakrishnan. Aquatic bioresources of Ashtamudi Lake, Ramsar Site, Kerala. *Journal of Aquatic Biology & Fisheries*, 2: pp 297-303 2014.
- [8] Tomlinson, P.B. The Botany of Mangroves. Cambridge University Press, Cambridge, London, New York. 1986.
- [9] Blasco, F. The Mangroves in India. Institute Francais de Pondicherry. Sect.Sci.Tech. India, 14, pp 180. 1975.
- [10] Singh, V.P., L.P. Mall, A. Garge and S.M. Pathak Human impact assessment of mangrove forest of Andamans Islands. *Indian Forester*, 116: pp 131-139 1990.
- [11] Duke, N.C. Mangrove Flora and Biogeography. In, Coastal and Estuarine Studies: Tropical Mangrove Ecosystems, (A. I. Robertson and D.M. Alongi (eds.),

American Geophysical Union, Washington DC., USA, pp 63-100. 1992.

[12] IUCN Global Status of Mangrove Ecosystems. In, Commission on Ecology Papers No. 3, (P. Saenger, E.J Hegerl and J. D. S. Davie, eds.), International Union for Conservation of Nature and Natural Resources, Gland, Switzerland, pp 88. 1983.

[13] Kathiresan, K. Mangrove Atlas and Status, Species in India. Report submitted to the Ministry of Environment and Forest, Govt of India, New Delhi, pp 235. 2000a.

Author Profile



Mini Mohandas received the B.Sc. in Biotechnology from Government College, Kariavattom, University of Kerala, Kerala, India in 2010 and M. Sc in Aquatic Biology and Fisheries from University of Kerala, Kariavattom, Kerala, India in 2013. She has secured the

first rank in the M.Sc programme conducted by the University of Kerala. She is now doing Ph.D programme under the Kerala University with the INSPIRE scholarship provided by DST, Delhi



Dr. Lekshmy.S Obtained the MSc. PG degree in Industrial Fisheries from School of Industrial Fisheries, CUSAT, Cochin, Ph.D. from Department of Aquatic Biology and fisheries, University of Kerala. At

present she is pursuing the Postdoctoral research in Department of Aquatic Biology and Fisheries, University of Kerala.



Dr. Tresa Radhakrishnan graduated with a PhD in Ecology/Aquatic Toxicology from the University of Hull, England in 1983, and MSc in Zoology from University of Kerala, Kerala, India. She is currently a

Professor at University of Kerala, Kerala, India. She has diverse interests in Ecology, Limnology, Estuarine Biology, Mangrove Ecology, Molecular Biology, Aquatic Toxicology & Aquatic Pollution.