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Resource Monitoring in Mangrove Ecosystem of Maharashtra Coast, India

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ABSTRACT

This study investigates the intricate coastal ecosystem of Maharashtra, focusing on the diverse array of mangrove species and their associated flora and fauna. Mangroves, vital plants in coastal regions, thrive due to their numerous adaptations, playing a crucial role in tropical and subtropical ecosystems worldwide. In Maharashtra, 20 true mangrove species flourish across five coastal districts, including Mumbai, Thane, Raigad, Ratnagiri, Sindhudurg, and the Mumbai Suburbs. Through extensive fieldwork, the researchers documented the presence of 20 true mangrove species, 54 halophytes and mangrove associates, 29 bird species, 19 fish species, 13 insect species, and various lower cryptogams. Our study aimed to elucidate the interconnectedness within this complex coastal ecosystem, exploring the relationships among different species groups. Mangroves serve as the cornerstone of this ecosystem, supporting a myriad of plant and animal life. Understanding these relationships is crucial for effective conservation and management strategies, especially in the face of increasing threats posed by

urbanization and industrialization along the coastlines.

Keywords: Coastal Ecosystem Dynamics, Mangroves, biodiversity, interconnectedness, Conservation etc.

INTRODUCTION

Mangroves are the most productive ecosystem among the world (Kathiresan & Rajendran, 2005; Palit et al., 2022); they are rich in bacteria, fungi, protists, algae, seagrasses, saltmarsh, zooplankton, sponges, ascidians, prawns, shrimp, crustaceans, crabs, insects, mollusks, fish, amphibians, reptiles, birds, & mammals (Kathiresan & Bingham, 2001; Wan Juliana et al., 2014). These species interact with complex interdependence and exhibit the pattern of predation, parasitism and commensalism (Pommerening & Grabarnik, 2019; Spalding, 2010).

The presence of greater faunal diversity might be attributed to the abundance of food resources and the diversity of plant (Rajpar & Zakaria, 2014), i.e. they provide ideal foraging and breeding sites and also provides shelter for these wide array of animals. Mangrove fauna are an important component of the food web and play a significant role in the mangrove ecosystem (Lee, 1998; Nagelkerken et al., 2008).Despite such a richness in animal communities, mangrove areas are still declining at an alarming rate day by day due to human interventions. The habitat loss has seriously caused threats to different mangrove dependent animals such as birds, mammals, reptiles and amphibians, i.e. extinct and critically endangered species (Mmom & Arokoyu, 2010; Thaman & Biogeography, 2002). The current information on the faunal components like reptiles, mammals, invertebrates and fishes in Asia's mangrove ecosystem is not sufficient. Determination of various aspects such as species richness, diversity, distribution and the association of fauna with water quality, food resources and habitats is a need of hour to explore the means and ways for the conservation of these species in and around mangrove areas. Therefore, the aim of this study is to document the floral and faunal composition, identify the interrelationship of these components and an attempt to reveal the food chain in the mangrove ecosystem.

METHODOLOGY

Study Area

The coastal Maharashtra is 720 km in length and covers five coastal districts viz. Mumbai, Thane, Raigad, Ratnagiri and Sindhudurg and the Mumbai Suburbs. The coast is indented with number of beaches, rivers, major estuaries, creeks and backwater regions.

Site selection and Data Collection

Survey was undertaken throughout the coats of Maharashtra especially on the coast of Mumbai, Mumbai suburbs and more emphasis was given to Raigad, Ratnagiri and Sindhudurg districts. The survey was conducted on seasonally during monsoon, winter and summer for three years successively from July 2020 to June 2023. Different sites were selected (Table 1) for the survey floral and faunal components were recorded and identified by using updated keys/ descriptions for each group.

Table 1

Comparative accounts of true mangroves in four major districts along the coast of Maharashtra

Sr. No.	Name of species	Raigad	Ratnagiri	Sindhudurg	Mumbai
1.	*Avicennia marina var acutissima*	+	+	+	
2.	*Avicennia marina var. resinifera*			+	
3.	*Avicennia officinalis*	+	+	+	
4.	*Avicennia alba*	+	+	+	
5.	*Avicennia marina (dwarf)*	+	+	+	+
6.	*Avicennia officinalis (dwarf)*		+	+	
7.	*Aegiceras comiculatum*	+	+	+	+
8.	*Acanthus ilicifolius*	+	+	+	+
9.	*Bruguiera cylindrica*	+	+	+	+

Table 1 continued

Sr. No.	Name of species	Raigad	Ratnagiri	Sindhudurg	Mumbai
10.	*Bruguiera gymnorrhiza*	+	+	+	
11.	*Ceriops tagal*	+	+	+	
12.	*Cynometra iripa*	+	+	+	
13.	*Excoecaria agallocha*	+	+	+	+
14.	*Kandelia candel*	+	+	+	+
15.	*Lumnitzera racemosa*	+	+	+	+
16.	*Rhizophora mucronata*	+	+	+	+
17.	*Rhizophora apiculata*	+	+	+	+
18.	*Sonneratia alba*	+	+	+	
19.	*Sonneratia apetala*	+	+	+	+
20.	*Xylocarpus granatum*	+	+	+	

Mangroves

Trees in mangroves were identified by using (Kulkarni & Bhosale, 2021; Tomlinson, 2016).

Halophyte and the associate species

Halophytes and the associate species were identified by using (Ghazanfar et al., 2014).

Lower plants (epiphytes)

Lower plants like epiphytes are also observed and identified by (Krömer & Gradstein, 2016; Mishra et al., 2016; Zotz, 2016).

Aves

Birds were observed from 0500-1600hr with the help of line transect method (Burnham et al., 1981; Järvinen & Väisänen, 1975), Birds were observed with a Vangard model- Vesta 10X42 Waterproof binoculars and photographed by Sony ILCA 68K/ BQ, Canon Sx520 HS digital camera and identified with the help of (Ali & Ripley, 1983; Grimmett et al., 2016).

Fishes

Fishes were collected from selected sites (Table 1) with the help of local fisherman using different types of gears viz. gill nets, cast net, drag net etc. and photographs of fishes were taken. Fish markets were also regularly visited and record the common species. No species harm or collect during the survey period. Identification of fishes were done by photographs and standard literatures(Fricke et al., 2018; Froese & Pauly, 2023; Manson et al., 2005).

Araneae

Spiders in the vicinity of mangroves were photographed and identified using following literature(Alvarez-Padilla & Hormiga, 2011; Catalog, 2014; Jose et al., 2003; Tikader, 1987; Tikader & Malhotra, 1980).

Insect

Hymenoptera were photographed for identification and identification done by using (Broad, 2011; Forshage & Nordlander, 2008; Sheth et al., 2020)also Lepidoptera, Odonata also photographed and identified by using (Nandy & Babu, 2012; Rao et al., 2013; Singh et al., 2022).

Crabs

Crabs were identified by using (Trivedi et al., 2018).

RESULTS AND DISCUSSION

Mangrove species are classified as true mangroves and mangrove associates. In the present investigation, twenty true mangroves in four major districts along the coast of Maharashtra (Table1). *A. vicennia marina var. resinifera* species of mangrove were uncommon and observed only at Sindhudurg mangrove area. Sindhudurg district shows geomorphic features like inlets of creeks, raised promontories, wave cut notches, pocket beaches with the coastlines and might be provides ideal geomorphology for the growth of the mangrove (Rafeeque et al., 2015).

The species recorded from the study site are reported in table 2. It is observed that, most of the halophyte and the associate species are common along the coast of Maharashtra. The common halophytes are *H. beccarii, Aaureum, A. lagopoides, I. pes-caprae*, Najas and *Sesuvium portulacastrum* etc. The association of X. granatum and *S. portulacastrum* is unique and observed only at Revdanda. Even as mangrove associates, they found near the main channel and are frequently

exposed to the tidal currents, otherwise on the other sites it was recorded on the landward side and on exposed habitats(Britton & Morton, 2014; Linneweber, 2013). Under abiotic stress (salt, drought, heavy metal) *Sesuvium* exhibit various adoptions through morphological and anatomical growth, water use efficiency, physiological and biochemical changes (Nikalje et al., 2018). *S. portulacastrum* exits under stress condition and adapt to salinity or drought. It is frequent pioneer in coastal beaches and categorized as member ecologically sensitive zone (C Nikalje et al., 2017; Li et al., 2020)

Table 2

Comparative accounts of Halophytes and mangrove associates of Maharashtra

Sr. No.	Name of species	Raigad	Ratnagiri	Sindhudurg
1.	*Abelmoschus angulosus*	+	+	+
2.	*Abelmoschus manihot*	+	+	+
3.	*Acasia auriculiformis*	+	+	+
4.	*Acampae premorsa*	+	+	+
5.	*Acrostichum aureum*	+	+	+
6.	*Aleuropus lagopoides*	+	+	+
7.	*Barringtonia racemosa*	+	+	+
8.	*Bauhinia racemosa*	+	+	+
9.	*Butea monosperma*	+	+	+
10.	*Caesalpinia nuga*	+	+	+
11.	*Caesalpinia sp*	+		
12.	*Calophyllum inophyllum*	+	+	
13.	*Carissa carandus*	+	+	+
14.	*Cerbera manghas*			+
15.	*Celosia argentea*	+	+	+
16.	*Clerodendrum inerme*	+	+	+
17.	*Cyperus javanicus*	+	+	+
18.	*Cyperus rotundus*	+	+	+

Table 2 continued

Sr. No.	Name of species	Raigad	Ratnagiri	Sindhudurg
19.	*Derris heterophylla,*	+	+	+
20.	*Dolicandron spathecae*	+	+	+
21.	*Eclipta alba*	+	+	+
22.	*Euphorbia* sp	+		
23.	*Fimbristylis ferrugenia*	+	+	+
24.	*Fimbristylis puberula*	+	+	
25.	*Flacourtia montane,*	+	+	+
26.	*Gloriosa superba*	+		
27.	*Halophilla. beccarii*	+	+	+
28.	*Holiogama antidysentrica*	+	+	+
29.	*Hygrophila auriculata*	+	+	+
30.	*Ipomoea blepharophylla*	+		
31.	*Ipomoea carnea*	+	+	+
32.	*Ipomea pes-caprae*	+	+	+
33.	*Lindemia antipoda,*	+	+	+
34.	*Mimosa pudica*	+	+	+
35.	*Mimusops elengi*	+	+	+
36.	*Nymphea nauchali*	+	+	+
37.	*Paspalum vaginatum*			+
38.	*Pongamia pinnata*	+	+	+
39.	*Porterasia coarctata*	+	+	+
40.	*Premna coriaceae*	+	+	+
41.	*Premna integrifolia*	+	+	+

Table 2 continued

Sr. No.	Name of species	Raigad	Ratnagiri	Sindhudurg
42.	*Premna serratifolia*	+	+	+
43.	*Ruppia maritima*			+
44.	*Salvadora persica,*	+	+	+
45.	*Scirpus littoralis*			+
46.	*Sesamum indicum*	+	+	
47.	*Sesbania grandiflora*	+	+	+
48.	*Sesuvium portulacastrum,*	+	+	+
49.	*Sporobolus virginicus*	+	+	+
50.	*Stenophyllus barbatu*	+	+	+
51.	*Tamarix gallica*	+	+	+
52.	*Thespesia populnea*	+	+	
53.	*Tribulus terrestris*	+	+	+
54.	*Vitex nigundo*	+	+	+
55.	*Vitis palida*	+	+	+

During the present work, the epiphytes (Table 3) i.e. *Vanda sp.* the lichens *Dirinaria* and the common fungi *Hexagonia* sp. collected form the species of *Bruguiera* and *Cynometra*. The epiphytes are generally distributed on braches, trunks and minor occurrence on the aerial roots. Many epiphytes like creepers, orchids and ferns which cannot tolerate salts can grows high in the mangroves canopy (Anna, 2018; Hogarth, 2015). The members of the family Orchidaceae and Bromelidaceae are common among the mangroves. Seven species of bromeliads epiphytes form Brazilian subtropical mangroves especially on *L. racemose* and *R. mangle* and 13 species of epiphytes in natural and artificial mangroves channel at Greenfield, Eastern Coast of Nicaragua [37, 39].

Table 3

Association of fungi, angiosperms, cryptogam and epiphytes lichen with the mangroves

Sr. No.	Group of plants	Species	Host
1.	Fungi	*Hexagonia* sp	*B. gymnorhiza*
2.	Angiosperms	*Ficus* sp	*B.gymnorhiza*
3.	Epiphytes	*Vanda* sp.	*B.gymnorhiza*
		Vanda tesellata	*Cynometrairipa*
4.	Lichens	*Dirinaria*	*Sonneratia alba*
		Dirinaria	Cynometrairipa

During the field survey, the researchers we have observed 29 species of birds (Table 4) and recorded the nesting pattern and feeding behavior of some of them. The feeding behavior is more or less similar. *E. garzetta* feeds on small fishes, crabs, insects and caterpillars, *A. grayii*, *A. purpurea* and *T. tetamus* feeds on fish, crabs, frogs and prawns whereas *H. indus* feed so dead fishes mostly locate dealing the side of fisherman activities. (Malwadkar, 2011; Pawar, 2011; Samant & Bhosale, 1985) reported 77, 56 and 121 birds from Raigad, Uran & Ratnagiri, respectively.

Nintey-five (95) species of birds were recorded by Chaudhari-Pachpande (2016) from Thane Creek, Maharashtra, India during the study and distinguished as per the pattern of their foraging. A healthy diversity of bird species observed indicates the high productivity of the creek.

The list of fishes belonging to 18 families and 19 genus found along the Maharashtra coast is depicted in table 5. Mangroves as a habitat for fish and prawns. Mangrove inlets and creeks in Selangor, Malaysia are the habitat for 119 species of fish and 9 species of prawns (Sasekumar et al., 1992). One hundred seventy-seven (177) species of fish are reported from Pichavaram mangroves (Kathiresan, 2000). The distribution and abundance of fish in estuarine, coastal environment is dependent on physical, chemical and biotic factors (Emmett, 1991; Peterson & Ross, 1991; Vega-Cendejas & de Santillana, 2004).

Table 4

List of various species of birds found along the coast

Sr. No.	Order	Family	Scientific Name	Common Name
1.	Passeriformes	Passeridae	*Passer domesticus*	House sparrow
		Sturnidae	*Acridotheres fuscus*	Jungle myna
		Pycnonotidae	*Pycnonotus cafer*	Red-vented bulbul
			Pycnonotu jocosus	Red-whiskered bulbul
		Aegithinidae	*Aegithina tiphia*	Common Iron
		Corvidae	*Corvus splendens*	House Crow
		Hirundinidae	*Hirundo smithii*	Wire-tailed Swallow
		Oriolidae	*Oriolus kundoo*	Indian Golden Oriole
		Laniidae	*Lanius schach*	Long-tailed Shrike
		Cisticolidae	*Prinia socialis*	Ashy Prinia
		Muscicapidae	*Copsychus saularis*	Oriental Magpie-robin
2.	Pelecaniformes	Ardeidae	*Ardeola grayii*	Indian pond heron
			Egretta garzetta	Little egret
			Ardea purpurea	Purple heron
			Ardea alba	Great egret
		Threskiornithidae	*Threskiornis melanocephalus*	Black headed ibis
3.	Charadriiformes	Recurvirostridae	*Himantopus himantopus*	Black winged stilt
		Scolopacidae	*Tringa tetanus*	Common redshank
		Charadriidae	*Vanellus indicus*	Red-wattledlapwing
4.	Coraciiformes	Alcedinidae	*Alcedo atthis*	Common kingfisher
		Meropidae	*Merops orientalis*	Common bee eater
		Alcedinidae	*Halcyon smyrnensis*	white throated kingfisher
5.	Suliformes	Phalacrocoracidae	*Phalacrocorax niger*	Little cormorant
			Phalacrocorax fuscicollis	Indian cormorant
6.	Columbiformes	Columbidae	*Spilopelia chinensis*	Spotted dove
			Columba livia	Rock dove, Rock pigeon

Table 4 continued

Sr. No.	Order	Family	Scientific Name	Common Name
7.	Gruiformes	Rallidae	*Amaurornis phoenicurus*	White-breasted water hen
8.	Psittaciformes	Psittaculidae	*Psittacula krameri*	Rose-ringed parakeet
9.	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy kite

Table 5

List of various species of fishes found along the coast

Sr. No	Order	Family	Scientific Name
1.	Perciformes	Leiognathidae	*Gazza minuta*
		Lutjanidae	*Lutjanus johni*
		Carangidae	*Parastromateus niger*
		Trichiuridae	*Trichiurus lepturus*
		Scatophagidae	*Pampus argenteus*
		Lutjanidae	*Lutjanus argentimaculatus*
		Priacanthidae	*Cookeolus japonicus*
2.	Carangiformes	Menidae	*Mene maculata*
		Carangidae	*Decapterus russelli*
3.	Cichliformes	Cichlidae	*Pterophyllum* Spp
			Etroplus suratensis
4.	Siluriformes	Clariidae	*Clarias gariepinus*
5.	Carcharhiniformes	Carcharhinidae	*Scoliodon laticaudus*
6.	Pleuronectiformes	Soleidae	*Synaptura commersonii*
7.	Clupeiformes	Engraulidae	*Stolephorus indicus*
8.	Scombriformes	Scombridae	*Rastrelliger kanagurta*
9.	Scatophagidae	Perciformes	*Scatophagus argus*
10.	Clupeiformes	Engraulidae	*Stolephorus indicus*
11.	Decapoda	Penaeidae	*Penaeus indicus*

This present investigation recorded five decapods from the different sites of mangroves (Table 6). The data on species diversity of decapods in mangrove ecosystem of Uran revealed the presence of 26 species representing 18 genera and 12 families of the recorded species, 50.00 % belonged to crabs, 42.31 % to Prawns and shrimps and 3.85 % each to lobsters and squilla (Pawar, 2012).

Table 6

Crabs species observed at the mangrove sites

Sr. No	Order	Family	Scientific Name
1.	Decapoda	Portunidae	*Portunus sanguinolentus*
			Portunus spelagicus
			Scylla serrata
		Ocypodidae	*Uca vocans*
		Penaeidae	*Portunus sanguinolentus*

Table 7 shows the species reported in this current study, which are *Tetraghatha manidibulata*, *Argiope aemula*, *Elaver lutescens*, *Cheiracanthium* sp., *Theridion* sp., *Apis* sps, *Tirumala limniace*, *Neptishylas*, *Rhodothemus rufa*, *Trithemis aurora*, *Libellula luctuosa* etc., belonging to 5 orders and 10 families. The report of attack by 102 insects herbivore on 21 mangroves have been reported form (Murphy, 1990) and 197 species of herbivore uses mangroves as alternate host in Andaman and Nikobar islands (Veenakumari et al., 1997).

Table 7

Species of insects observed on the study sites

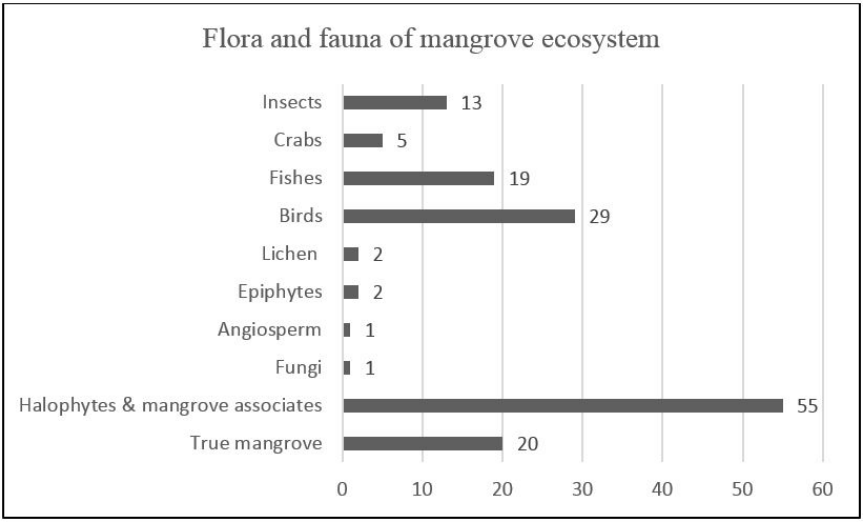
Sr. No.	Order	Family	Genus/species
1.	Araneae	Tetragnathidae	*Tetraghatha manidibulata*
		Araneidae	*Argiope aemula*
		Clubionidae	*Elaver lutescens*
		Theridiidae	*Theridion* sp.
		Eutichuridae	*Cheiracanthium* sp.

Table 7 continued

Sr. No.	Order	Family	Genus/species
2.	Hymenoptera	Apidae	*Apis mellifera*
			Apis florea
3.	Lepidoptera	Nymphalidae	*Tirumala limniace*
4.	Odonata	Libellulidae	*Rhodothemus rufa*
			Trithemis aurora
			Libellula luctuosa
5.	Lepidoptera	Nymphalidae	*Neptis hylas*
		Tortricidae	*Pandamis cerasana*

Figure 1

Flora and fauna of Mangrove ecosystem



CONCLUSION

The study underscores the critical ecological and economic importance of mangroves in coastal regions, particularly in Maharashtra, where they serve as a cornerstone of biodiversity and ecosystem stability. Through extensive fieldwork, this research documented a rich assemblage of mangrove species, associated flora and fauna, emphasizing the intricate interdependence within this ecosystem (Figure 1). The findings reveal the pivotal role of mangroves in sustaining local forestry and fishing industries, as well as their broader ecological significance in nutrient cycling, productivity, and biodiversity conservation. However, the study also highlights the alarming threats faced by mangroves due to unchecked urbanization and industrial expansion, leading to habitat destruction and loss of ecosystem services. Urgent conservation efforts are therefore warranted to safeguard these invaluable coastal ecosystems for present and future generations, underscoring the need for robust enforcement of environmental regulations and community-based conservation initiatives.

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