



Diversity Status of Mangrove Species in Estuarine Regions of Goa, Central West Coast, India

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ABSTRACT

The present study is based on standardized field work extending over a five-year period using well established diagnostic identification keys. The paper documents the diversity of true mangroves in seven major and three minor estuaries of Goa, which house 15 species belonging to ten genera under seven families. Mangrove associates were also studied along with quantitative analysis, hydrological parameters and sediment analysis of estuaries in relation to mangrove flora. The present study reports that mangrove cover in Goa has increased to 2617 hectares from 2000 hectares.

INTRODUCTION

A mangrove has been defined as a tree, shrub, palm or ground fern, generally exceeding more than half a meter in height and which normally grows above mean sea level in the intertidal zones of marine coastal environments or estuarine margins (Duke 1992). The forests are typically distributed from mean sea level to highest spring tide level (Alongi 2009). They are largely restricted to latitudes between 30°N and 30°S. Northern extensions of this limit occur in Bermuda (32°20' N) and southern extensions are in Australia (38°45' S) (Kathiresan & Bingham 2001). They interact and supports a diverse marine, freshwater and terrestrial flora and fauna (Macintosh & Ashton 2002). Tomlinson (1986) used a more clear criteria to distinguish true mangroves and mangrove associates which were largely accepted (Duke 2006). The most recent estimates suggest that mangroves presently occupy about 14,653,000 ha of tropical and subtropical coastline (Wilkie & Fortuna 2003, FAO 2004). India has a coastline of more than 7500 km including island, deltaic and lagoon. According to the report of Forest Survey of India (1999), the total area of mangrove cover is estimated to be 4,87,100 ha of which, 96,000 ha is present along the Andaman and Nicobar islands. The remaining 2,75,800 ha and 1,14,700 ha are found along the east coast and the west coast respectively. Kathiresan & Bingham (2001) recognised 65 mangrove species globally belonging to 22 genera and 16 families. Mandal & Naskar (2008) estimated 82 species belonging to 52 genera and 36 families from 12 different habitats of India.

STUDY AREA

Goa, the smallest State in India, with an area of 3702 km² is located at latitude 14°54'33" N and longitude 74°4'27"E (southern border) and latitude 15°43'30" N and longitude 73°40'43" E (northern border) on west coast of India. It has a coastline, which extends up to 105 km. On the eastern, southern and northern sides, it is surrounded by Western Ghats, Karnataka State and Maharashtra State respectively. On western side it is surrounded by the Arabian Sea. Due to the tidal influence, estuaries in Goa often experience feature like erosion in monsoon followed by accretion at river mouth. There are 7 major estuaries and 3 minor estuaries, having their origin in Western Ghats, and all of them flow into Arabian Sea and Cumbarjua canal connecting Zuari and Mandovi estuaries with mangrove area covering around 2,619 hectares. The general features of the estuaries are given in Table 1.

MATERIALS AND METHODS

Specimens of mangrove species with the reproductive parts were collected from different study stations by cutting from November 2005 to December 2011, and identified by using keys mentioned in Ecology and Biodiversity of Indian Mangroves. Quantitative studies were done by quadrat method and relative mangrove diversity by Naskar & Mandal (2008). Hydrological parameters and sediment analysis were done using standard methods.

Table 1: Data of Goa estuaries.

Station No	Name of estuary	Abbreviation for rivers (R)	Estuary length (km)	Water area (ha)	MGR area (ha)	MGR %	S.S.C. Composition%		
							Sand	Silt	Clay
1	Terekhol (MJ)	Tk	26 km	349	45	1.71	62	26	12
2	Chapora (Mj)	Cp	30 km	771	145	5.53	65	16	7
3	Baga (Mn)	Bg	11 km	12	7	.26	70	23	7
4	Mandovi (Mj)	Md	77 km	3567	934	35.66	51.5	28	20.5
5	Cumbarjua canal (Cn)	Cj	15	375	248	9.46	54	30	16
6	Zuari (Mj)	Zr	134	5790	1177	44.94	73	14	13
7	Sal (Mj)	Sl	35	325	16	0.61	53	28	19
8	Saleri (Mn)	Se	10	8	6	0.22	75	13	12
9	Palolem (Mn)	Pl	7	5	4	0.15	54	38	8
10	Tolpona (Mj)	Tp	19	50	14	0.53	60	25	15
11	Galgibaga (Mj)	Gb	16.5	28	23	0.87	50	40	10

Mj-Major river, Mn-Minor river, Cn-Canal, MGR-mangrove, S.S.C-(sand-silt-clay)

Table 2: Diversity of true mangroves in the different estuaries of Goa.

S.No.	Family	Scientific names	RT	RC	RB	RM	RCj	RZ	RSI	RSe	RPI	RTp	RGb
1	Rhizophoraceae	<i>Rhizophora mucronata</i> (Lamk.)	***	***	**	***	**	***	***	**	**	***	***
2		<i>Rhizophora apiculata</i> (Blume.)	***	**	***	***	***	***	**	**	**	**	**
3		<i>Bruguiera gymnorrhiza</i> (Linn) Savigny	**	*	*	*	*	*	*	*	*	*	**
4		<i>Bruguiera cylindrica</i> (Linn.)Bl.	*	*	-	**	*	*	*	*	-	-	-
5		<i>Ceriops tegal</i> (Peer.) C.B. Rob.	*	-	-	**	*	**	-	-	*	-	*
6		<i>Kandelia candel</i> (Linn.)	**	*	**	**	*	*	*	*	*	-	*
7	Myrsinaceae	<i>Aegiceras corniculatum</i> (Linn.) Blanco	**	**	**	**	**	**	**	*	**	***	**
8	Avicenniaceae	<i>Avicennia alba</i>	-	*	-	**	*	**	-	-	*	-	*
9		<i>Avicennia marina</i> (Forsk.) Vierh.	***	***	***	***	***	***	***	**	***	***	***
10		<i>Avicennia officinalis</i> (Linn.)	***	** *	***	***	***	***	***	***	***	***	***
11	Lythraceae	<i>Sonneratia alba</i> J. Smith	**	**	**	**	**	**	**	**	**	**	**
12		<i>Sonneratia caseolaris</i> (Linn.)Engl.	**	*	*	**	*	**	*	-	-	-	#
13	Combretaceae	<i>Lumnitzera racemosa</i> (Jack.) Voigt.	-	-	-	-	-	-	-	-	**	-	-
14	Acanthaceae	<i>Acanthus illicifolius</i> (Linn.)	***	***	**	***	***	***	*	**	***	***	**
15	Euphorbiaceae	<i>Excoecaria agallocha</i> (Linn.)	***	***	***	***	**	***	***	**	**	**	**

extinct; Absent; *Rare; **Common; ***Dominant

RESULTS AND DISCUSSION

During the study mangroves were divided in two categories. 1. true mangroves, 2. associate mangroves. Estuaries of Goa were divided into 3 Sub-stations (mouth, mid-region, upstream region) where station-wise mangrove flora, its distribution and variation of different environmental parameters were studied. Fifteen true mangrove species belonging to 10 genera under 8 families were reported. Fringing type mangroves are common in all the minor estuaries, whereas major rivers have both fringing and mangrove swamps. Mangrove patches with high density and frequencies can be observed in Galgibaga, Mandovi and Zuari estuaries. A wide variation is seen in different stations as far as distribution is concerned. Few species like *Ceriops tegal*, *Bruguiera cylindrica*, *Sonneratia caseolaris* and *Barringtonia racemosa* along with *Lumnitzera racemosa* and *Cynometra*

iripa, which were first time reported from Goa (Cajy & Bhat 2010), have lesser frequency, density, abundance and they are confined to certain sub-stations of estuaries. This indicates that environmental parameters and topography play an important role in dispersal of seeds and survival of seedlings. Species like *Sonneratia caseolaris*, *Acanthus illicifolius* and *Kandelia candel* are found abundantly where salinity is less, and species like *Sonneratia alba*, *Rhizophora mucronata* and *Bruguiera gymnorrhiza* are found in high saline condition. *Avicennia marina* is most salt tolerant species found in rocky shore directly facing the seawater at Vatorem and Galgibaga (Cajy & Bhat 2010). *Ceriops tegal* was found naturally grown in Terekhol, Pallolem and Galgibaga estuaries, and it is planted in Mandovi and Zuari. Maximum RMD (90.62%) was observed in Zuari, Mandovi and Cumbarjua canal, and minimum RMD (68.75) in Tolpona river. The mangrove percentage of different estuar-

Table 3: Diversity of mangroves associate in the different estuaries of Goa.

Family	Scientific names	RT	RC	RB	RM	RCj	RZ	RSI	RSe	RPI	RTp	RGb
Fabaceae	<i>Cynometra iripa</i> (Kosteletzky)	-	-	-	-	-	-	-	-	-	-	*
	<i>Pongamia pinnata</i> (Linn.) Pierre	*	**	-	**	*	**	*	-	**	*	*
	<i>Derris trifoliata</i> (Lour.)	***	***	***	***	***	***	***	*	***	*	**
	<i>Dalbergia spinosa</i> (Roxb.)	**	**	**	***	**	**	**	**	**	**	**
Apocynaceae	<i>Cerbera manghas</i> (Linn.)	*	-	-	*	*	**	-	*	*	-	-
	<i>Barringtonia recemosa</i> (Linn.) Spreng.	-	-	-	-	-	*	-	-	-	-	*
Lecythedaceae	<i>Barringtonia ramiflora</i>	*	*	-	*	*	*	*	-	-	*	*
	<i>Hibiscus tiliaceus</i> (Linn.)	**	**	*	**	**	**	*	*	*	**	**
Verbenaceae	<i>Clerodendrum inerme</i> (Linn.) Gaertn.	**	*	**	***	**	***	**	***	**	***	***
	<i>Vitex niguda</i>	*	*	*	*	*	*	*	*	**	*	*
Lamiaceae	<i>Premna serratifolia</i> (Linn.)	*	*	*	*	*	*	***	*	*	*	***
Poaceae	<i>Porteresia coarctata</i>	*	*	-	*	-	***	-	*	*	*	*
Teridaceae	<i>Acrostichum aureum</i> (Linn.)	**	*	*	***	*	***	**	*	*	*	*
Cyperaceae	<i>Cyperus rotundus</i> (Linn.)	**	***	***	***	***	***	***	***	***	***	***
Convolvulaceae	<i>Ipomoea pes-caprae</i> (Linn.) R.Br.	**	**	**	***	***	**	***	***	**	***	**
Clusiaceae	<i>Calophyllum inophyllum</i> (Linn.)	**	**	**	**	**	***	**	**	**	**	***

- Absent; * Rare; ** Common; *** Dominant

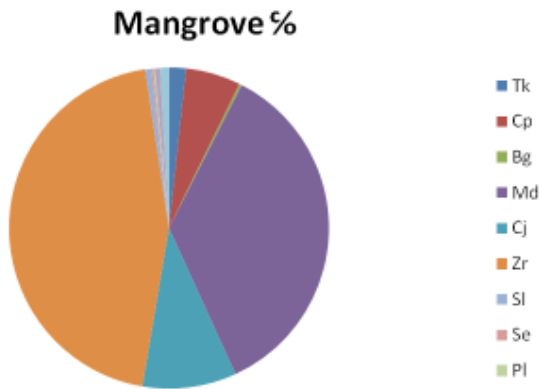


Fig 1. Mangrove percentage of different Goan estuaries.

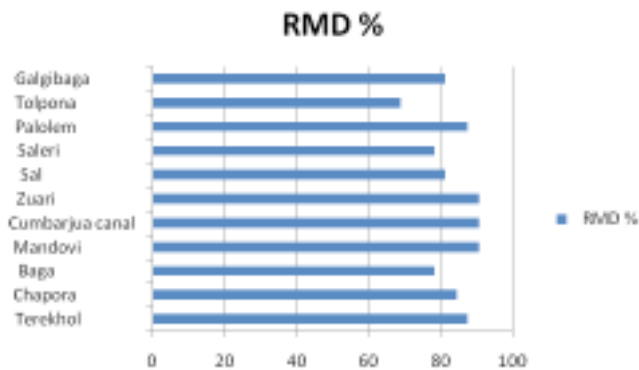


Fig. 2: Relative Mangrove Diversity of different estuaries of Goa.

Table 4: Substratum and salinity preference of mangrove species.

Species Name	Substratum observed	Salinity (%) range
<i>R. mucronata</i>	Sandy-Silty	18-30
<i>R. apiculata</i>	Silty-Sand	18-25
<i>S. alba</i>	Sandy-Silty	25-30
<i>S. caseolaris</i>	Silty-Clay	00-05
<i>A. marina</i>	Sandy-Silty	28-35
<i>A. officinalis</i>	Silty-Sand	05-25
<i>A. alba</i>	Sandy-Silty	18-30
<i>B. gymnorhiza</i>	Sandy-Silty	18-30
<i>B. cylindrica</i>	Sandy-Silty	18-25
<i>Bruguiera</i> spp.	Silty-Sand	05-18
<i>E. corniculatum</i>	Silty-Sand	05-18
<i>A. illicifolius</i>	Sandy-Clay	05-25
<i>E. agallocha</i>	Caly-Silt	05-20
<i>K. candell</i>	Silty-Clay	05-25
<i>C. tegal</i>	Silty-Sand	10-30
<i>B. cylindrica</i>	Silty-Sand	10-25
<i>L. recemosa</i>	Silty-Sand	10-30

Table 5. Relative Mangrove Diversity (RMD) of different estuaries of Goa.

Sr.No.	Name of Estuary	Relative Mangrove Diversity (RMD)
1	Terekhol	87.50
2	Chapora	84.37
3	Baga	78.12
4	Mandovi	90.62
5	Cumbarjua canal	90.62
6	Zuari	90.62
7	Sal	81.25
8	Saleri	78.12
9	Palolem	87.50
10	Tolpona	68.75
11	Galgibaga	81.25

ies is shown in Fig. 1., while the diversity of true mangroves and their associate species is given in Tables 2 and 3 respectively. Salinity preferences by mangrove species are given in Tables 4. The relative mangrove diversity (RMD) is given in Table 5 and Fig. 2.

The variation in water pH recorded was within the range of 4-8, and in rainy season freshwater influx is more at upstream and it starts gradually decreasing from February to May in minor rivers due to which the variation in salinity recorded was 0-34%. There is not much difference in water and air temperature of minor rivers, but in major rivers like Zuari, Mandovi and Chapora there is an increase in water and air temperature at the river mouth compared to the upstream region. When there is increase in dissolved oxygen, there is decrease in carbon-di-oxide and vice versa. The oxygen content and carbon-di-oxide content is in the range of 3.5 to 5 mL/L and 0.75-1.5 mg/L at NTP respectively. Vertical Extinction Co-efficient (V.E.C.) indicated that during monsoon season light penetration is less due to high suspended solid load.

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REFERENCES

- Alongi, D.M. 2009. Introduction to Energetics of Mangrove Forest. Springer Science and Business Media BV, New York.
- Cajy Silva and Bhat, U.G. 2010. Mangrove diversity of Canacona taluka, south Goa, India. *Flora and Fauna*, 16(2): 182-188.
- Duke, N. C. 1992. Mangrove floristics and biogeography. In: Robertson, A. I. and Alongi, D.M. (Eds.) *Tropical Mangrove Ecosystems*. American Geophysical Union, Washington DC., USA.
- Duke, N.C. 2006. *Australia's Mangroves: The Authoritative Guide to Australasia's Mangrove Plants*. St. Lucia Australia, University of Queensland, pp. 29-39.
- FAO 2004. *The Situation and Developments in the Forest Sector (Part 1)*. Assessed October, 2004. <http://www.fao.org/docrep/005/Y7581E/y7581e20.htm#TopOfPage>.
- Hensel, P., Proffitt, E. and Delgado, P. 2002. Mangrove ecology. In: Hoff, R. (Ed.) *Oil Spills in Mangroves: Planning and Response Considerations*, National Oceanic and Atmospheric Administration, NOAA.
- Kathiresank, K. and Bingham, B.L. 2001. *Biology of Mangroves and Mangrove Ecosystem*. *Adv. Mar. Biology*, 40: 81-251.
- Kumaran, K.P.N., Shindikar, M.R. and Mudgal, T.R. 2004. Floristic composition, palynology and sedimentary facies of Hadi Mangrove Swamp (Maharashtra). *J. Ind. Geophys. Union*, 8(1): 55-63.
- Macintosh, O.J. and Ashton, E.C. 2002. *A Review of Mangrove Biodiversity and Conservation Centre for Tropical Ecosystem Research*. University of Aarhus, Denmark.
- Mandal, R.N. and Naskar, K.R. 2008. Diversity and classification of Indian mangroves: A review. *Tropical Ecology*, 49(2): 131-146.
- Tomlinson, 1986. *The Botany of Mangroves*. Cambridge University Press, Cambridge, UK.
- Wilkie, M.L. and Fortuna, S. (Eds.) 2003. *Status and Trends in Mangrove Area Extent Worldwide*. Food and Agriculture Organization, Forest Resources Division, Forest Resources Assessment Working Paper No. 63.