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Diversity of mangroves and mangrove associates from Purna Estuary, South Gujarat

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Abstract
The mangrove vegetation covers an area about 1,103 sq. km along the 1,600 km long coastline area including its island territories of Gujarat State. The mangrove cover of the state is distributed over four regions, Kachchh (Kori creek and Sir Creek area), Gulf of Kachchh, Gulf of Khambat and South Gujarat. The present investigation was carried out from purna estuary from south Gujarat during 2014-2017 with the extensive field survey during which 19 species were collected of which 09 species were collected as true mangroves and 10 species were as mangrove associates. The present paper provides the first hand information on density, frequency and occurrence of the mangroves and their associate species from the Purna estuary, South Gujarat.

Keywords: mangroves, mangrove associates, diversity, Gujarat, India

Introduction

Mangroves are trees or large shrubs which are salt-tolerant and grow in intertidal zones in tropical and subtropical regions of the world. True mangrove (Halophytes) species means those species are exclusive to the inter-tidal mangrove habitats, while those that occur in mangrove and other wetland habitats are called the associates of mangrove (Glycophytes) species. The term 'Mangrove' referred by Tomlinson (1986) [24] to both the trees and woody shrubs that occupy tropical inter-tidal forest communities and the communities themselves. The mangroves species are dominant along the coastline of sea with approximately 75% of the world's coastline between 25° N and 25° S (Wong and Tam, 1995). There are approximately 70 species of mangroves plants distributes worldwide, divided into 20 genera (Splading *et al.* 1997, 2010). In India, about 46 true mangroves (42 species and 4 natural hybrids) belonging to 14 families and 22 genera were recorded along the seashore out of them about 40 species of true mangroves belonging to 14 families and 22 genera from east coast, while about 27 species 11 families 16 genera were recorded from west coast (Ragvan *et al.*, 2016).

Gujarat has the longest coastline among all the maritime states of the country, which makes it strategically serving as natural gateway to India. The coastline of Gujarat state facing seashore of Arabian Sea with about 16,00 km (i.e. 21% of the total coastline of India) length and situated within the 68° E and 73° E longitude and 20°10' N and 23°10' latitude.

The diversity of mangrove species were studied from Gujarat state by various authors though few and scattered publications. A total of 15 mangrove species have been recorded from the Gujarat state (Kathiresan, 2008) [9]; Bhatt et al., 2009 [1], reported that, 22 species of mangroves and mangrove associate were recorded lonely in Purna estuary. However, in 2009 a survey of the diversity and regeneration of mangroves in South Gujarat was carried out by GEER (Gujarat Ecological Education and Research) Foundation founds a remarkable floristic diversity and rich growth of mangroves in this area. The diversity and distribution of mangrove forests in Gujarat have been studied by various authors viz., Shah (1978) [20], Untawale (1980) [25], Chavan (1985) [2], Untawale and Jagatap (1992) [26], Kothari and Singh (1998) [8], Singh (2002) [21], GEER (2000, 2004, 2009), Naskar, (2004), Bhatt and Shah (2009) [1], Mandal and Naskar (2008), Pandey and Pandey (2009 a, b), Sanjappa *et al.* (2011) etc. Despite the large mangrove cover, the diversity of mangroves and mangrove associates species found very low in the state. The present paper deals with the distribution and diversity of 9 species of true mangroves and 10 mangrove associates species in Purna estuary, South Gujarat.

About Study Area

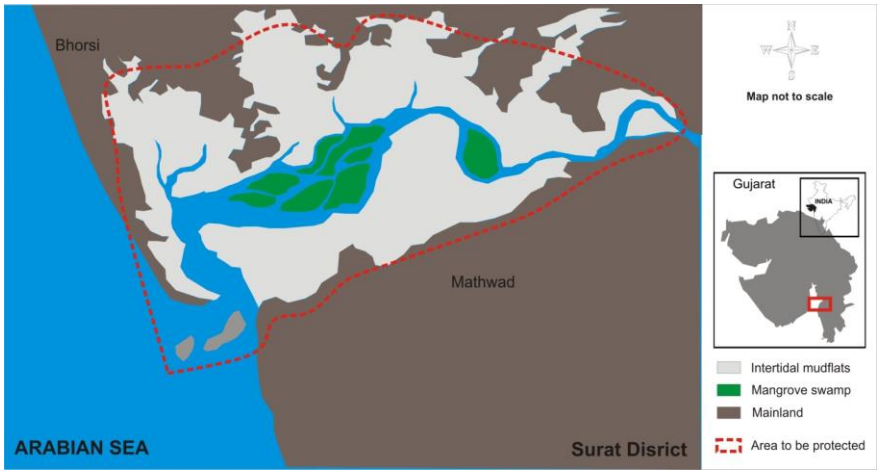

Fig 1: Site Map of Purna Estuary, South Gujarat State showing the Mangroves swamp

Gujarat is the north western state of India and the total length of the coast line, facing the Arabian Sea is about 1600 km; situated within the longitude 68º E and 73º E and latitude 20º 10' N and 23º 10' N. The Gujarat coast extends from Western Ghats in Valsad to Kori-Creek on the coast of Kachchh in north. Gujarat had the highest continental shelf area, amounting about 1, 84,000 sq. km. followed by the state of Maharashtra. Out of the three Indian gulfs, The Gulf of Kachchh and The Gulf of Khambhat are situated in Gujarat State. Extent of the inter tidal and high tidal mudflats in the Gulf of Kachchh, The Gulf of Khambhat and the Rann of Kachchh and Bhal region are exceptionally large. The major part of the coastal wetlands cover by mudflats, mangroves forests, marsh vegetation, coral reefs and saltpans. The climatic conditions are highly variable along the coastline area of Gujarat State. Mangroves areas are present mainly in the Indus Deltaic region. The coastal wetland of Purna river is located on the southern part of Gujarat state on the western coast of India. It extends between the longitude 72º 44' E to 72º 55' E and latitude 20º 53' N to 21º 01' N. The study area is covered in the Survey of India (SOI) topographical maps 46D/ 9 & 46 D/ 13. Purna is a perennial river of Navsari district in South Gujarat which originates from the Satpuras range and debouches into the Arabian Sea near Navsari. It has a mouth span of approximately 1.5 km with the tidal influence up to 26.2 km upstream (as per the SOI topographical map, 1965). The mean annual rainfall received in this region is 2492 mm (measured at Navsari station) during the year 2004 (Anon. 2005a).

Materials and Methods

The Mangroves vegetation has been studied from geographical region (Purna estuary, South Gujarat). Extensive and frequent field visits of 5-10 days were arranged for the collection and ecological survey of mangroves and their associates. During the ecological survey author has collected primary and first hand data for the calculation of the quantitative analysis such as density, frequency, and abundance of tree species, shrubs and herbs were determined by standard line transect method by 10 m. randomly sampling. Thus, species wise abundance and respective diversity was estimated. At the same time two to three flowering twigs of the common species and photographs of rare species were collected from the different sites of the study region. After the collection, the identities were confirmed by direct comparison of collected species with specimens deposited in various authentic herbaria like, BSI, and BAMU Herbarium and very few and scattered publications. Thus, species wise herbarium was made and submitted to BAMU herbarium. The species were identified by the and earlier published literature. Thus, Species wise herbariums were prepared and earlier published literature submitted to BAMU Herbarium. For the better study of mangrove ecology the Frequency, Density and Abundance were calculated by using standard formulas or ecological parameters.

Frequency

Frequency, as introduced by Raunkiaer (1934) [18], indicates the number of sampling units in which a given species occurs (Mishra, 1968) [13]. Frequency of mangrove vegetation refers to the degree of dispersion of individual species in an area and is usually expressed in terms of percentage of occurrence.
Frequency of species in the study area measured by using the formulae of Curtis (1933), which are given below.

$$\text{Frequency}(\%) = \frac{\text{Total Number of segments in which species occurred}}{\text{Total Number of segments Studied}} \text{X } 100$$

Table 1: Raunkiaer's (1934) [18] Five Frequency classes

S. No	Frequency (%)	Frequency class
1	0-20	A
2	21-40	B
3	41-60	C
4	61-80	D
5	81-100	E

Density

Density represents the numerical strength of a species in a

community. The number of individuals in the species in any unit area is its density.

$$\text{Density} = \frac{\text{Total number of individuals of Species}}{\text{Total number of Segments studied}}$$

Abundance

Abundance is the number of individuals of any species per sampling units of occurrence.

$$\text{Abundance} = \frac{\text{Total number of individuals of Species}}{\text{Total number of segments in the which Species occured}}$$

The abundances are grouped to assign abundance-categories, as Suggested by Dagar *et al*. (1991) and are detailed below:

> 25	d	Dominant
15 - 25	Va	Very abundant
10 - 15	a	Abundant
6 - 10	f	Frequent
3 - 6	o	Occasional
1 - 3	r	Rare
<1	Vr	Very rare

Results and Discussion

In the Purna estuary of South Gujarat, 7 genera and 9 species of 4 families of true mangroves (Table-2) and 9 genera and 10 species of 8 families of mangrove associates (Table-3) are recorded from the Purna estuary South Gujarat coastal area.

Table 2: List of True Mangrove occurs in the study region

S. No.	True Mangrove	Family
1	*Avicennia marina* (Forsk) Vierh.	Acanthaceae
2	*Avicennia alba* Blume	Acanthaceae
3	*Acanthus ilicifolius* L.	Acanthaceae
4	*Aegiceras corniculatum* (L.) Blanco	Myrcinaceae
5	*Bruguiera gymnorhiza* (L.) Lam.	Rhizophoraceae
6	*Bruguiera cylindrica* (L.) Blume	Rhizophoraceae
7	*Ceriops tagal* (Perr.) C.B. Rob	Rhizophoraceae
8	*Rhizophora mucronata* Lam.	Rhizophoraceae
9	*Sonneratia apetala Buch.-Ham*	Lythraceae

Table 3: List of Mangrove associates occurs in the study region

S. No.	Mangrove Associates	Family
1	*Aeluropus lagopoides* (L.) Thwaites	Poaceae
2	*Clerodendrum inerme* (L.) Gaertn.	Lamiaceae
3	*Derris trifoliata* Lour.	Leguminosae
4	*Ipomea pes-caprae* (L.) R.Br.	Convolvulaceae
5	*Porteresia coarctata* (Roxb.) Tateoka	Poaceae
6	*Salvadora persica* L.	Salvadoraceae
7	*Sesuvium portulacustrum* (L.) L.	Aizoaceae
8	*Suaeda nudiflora* Moq.	Amaranthaceae
9	*Suaeda fruticosa* Frossk.	Amaranthaceae
10	*Thespesia populnea* (L.) Sol.ex Correa	Malvaceae

Sonneratia apetala Buch. - Ham.

*Avicennia marina (*Forsk) vierh.

Bruguiera gymnorhiza (L.) Blume

Rhizophora mucronata Lam.

Ceriops tagal (Perr.) C. B. Rob.

Aegiceras crniculatum (L.) Blanco

Thespesia populnea (L.) Sol. ex Correa

Salvadora persica L.

Fig 2: Photographs of Some interesting Mangroves

Sesuvium portulacustrum (L.) L.

Ipomea pes-caprae (L.) R. Br.

Clereodendrum inereme (L.) Gaertn.

Aeluropus lagopoides (L.) Thwaites.

Fig 3: Photographs of Some interesting Mangrove associates

Table 4: Details of frequency, density and abundance of True Mangrove

S. No	Species	Line drawn 10 m			Density	Frequency (%)	Frequency class	Abundance
		1	2	3				
1	*Avicennia marina* (Forsk) Vierh.	27	55	35	39	86.6	E	4.48
2	*Avicennia alba* Blume	-	-	-	-	-	-	-
3	*Acanthus ilicifolius* L.	52	39	48	46.33	80	D	6.06
4	*Aegiceras corniculatum* (L.) Blanco	-	-	-	-	-	-	-
5	*Bruguiera gymnorhiza* (L.) Lam.	-	-	-	-	-	-	-
6	*Bruguiera cylindrica* (L.) Blume	2	-	3	1.6	20	A	2.5
7	*Ceriops tagal* (Perr.) C. B. Rob.	-	-	-	-	-	-	-
8	*Rhizophora mucronata* Lam.	-	-	-	-	-	-	-
9	*Sonneratia apetala* Buch. – Ham.	06	17	06	9.66	60	C	1.52

Table 5: Details of frequency, density and abundance of Mangrove associates

S. No	Species	Line drawn 10 m			Density	Frequency (%)	Frequency class	Abundance
		1	2	3				
1	*Aeluropus lagopoides* Trin.ex Thwaites	140	109	121	123.3	96.66	E	12.73
2	*Clerodendendrum inerme* (L.) Gaertn.	08	11	08	27	40	B	2.28
3	*Derris trifoliata* Lour.	-	-	-	-	-	-	-
4	*Iopmea pes-caprae* (L.) R. Br.	-	-	-	-	-	-	-
5	*Porteresia coarctata* (Roxb.)Tateoka	134	-	145	93	100	E	13.95
6	*Salvadora persica* L.	13	21	11	15	46.66	C	3.16
7	*Sesuvium portulacastrum* (L.) L.	115	45	56	72	76.66	D	9.65
8	*Suaeda nudiflora* Moq.	84	30	-	38	55	C	9.75
9	*Suaeda fruticosa* Forssk.	-	-	-	-	-	-	-
10	*Thespesia Populnea* (L.)Sol. ex Correa	-	-	-	-	-	-	-

Mangroves and Mangrove associates distribution

Density: The density analysis reveals that *Acanthus ilicifolius* L. is the highest densest species having the value 46.33, *Bruguiera cylindrica* (L.) lowest density 1.6.

The highest density of mangrove associate species *Aeluropus lagopoides* Trin. ex Thwaites. Were density values 123.3. The lowest density value of *Salvadora persica* L. value 15.

Frequency: The percent frequency was higher in, *Avicennia marina* (Forsk) Vierh. 100% having frequency class E. The lowest Frequency is *Bruguiera gymnorhiza* (L.) Lam. was 20% positioned in frequency class A.

On analyzing the highest frequency of the Mangrove associate species, *Porteresia coarctata* (Roxb.) Tateoka shows 100% were positioned in class E. Lowest frequency *Clerodendrum inerme* (L.) Gaertn. was 40 % positioned in frequency class B.

Abundance: Study on the true mangroves *Acanthus ilicifoilus* L. *was the highest abundant species with value 6.06* and lowest abundant species *Sonneratia apetala* Buch. - Ham value 1.52. and mangrove associates *Porteresia coarctata* (Roxb.) Tateoka was the highest abundant species with value 13.95 and lowest abundant species *Clerodendrum inerme* (L.) Gaertn. 2.28.

Discussion

During the present investigation, 9 species are collected as true mangroves species and 10 species are considered as mangrove associates. The frequency, density and abundance of the mangrove species were calculated for the study of ecology and distribution from the geographical region of Navsari district. *Avicennia marina* (Forsk) Vierh. was found to be dominant in true mangroves among all species of mangroves all over Coastline of Gujarat. *Sonneratia apetala* Buch. - Ham. Species is found in the upstream intertidal zone and grows profusely along the creeks. The very rare species *Avicennia alba* Blume, *Bruguiera gymnorhiza* (L.) Lam., *Bruguiera cylindrica* (L.) Blume and *Ceriops tagal* (Perr.) C. B. Rob. were found after the mangrove afforestation. The highest diversity of mangroves and mangrove associates within the Purna estuary was found as most within the Gujarat state.

Conclusion

The Diversity of mangroves has ecologically important role to control the balance of mangrove ecosystem. From the investigation in Purna estuary, south Gujarat 7 genera 9 Species of 4 families of true mangroves and 9 genera and 10 species of 8 families of mangrove associates were identified. During the mangroves area field visits, diversity of mangroves and mangrove associates within the Purna estuary is found to be degrading; hence there is an urgent need to afforestation of mangroves and conserve mangrove ecosystem.

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