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Diversity of true mangroves and mangrove associates in Karnataka, south west coast of India

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Abstract
The mangrove diversity was studied from whole Karnataka, Southwest coast of India, for a period of two years from Sep.-2015 to Nov -2017 to documents the species of true mangroves and mangrove associates. The variation in the diversity of mangroves and mangrove associates is seen from place to place due to climate, tidal factors and anthropogenic pressures. Total 16 species of true mangroves were recorded belonging to 11 genera and 7 families. There are mangrove associates comprising 12 species belonging to 12 genera and 10 families. The distribution of Mangroves and mangrove associates has been discussed in the paper.

Keywords: diversity, true mangroves, mangrove associates, Karnataka coast etc

Introduction

Mangroves are typically salt-tolerant trees or large shrubs adapted for survival in sheltered coastlines, shallow-water lagoons, estuaries, rivers or deltoid habitats along coasts of tropics and subtropics. The word "mangrove" has derived from a Portuguese word 'mangue' or Spanish word 'mangle' means swampy soils at the margins of lagoon or estuaries, which is combined with English word 'grove'. Mangroves may be true mangroves or associates. True Mangroves are the simple energy producers with salinity in substratum while Mangroves associates are with different salt tolerance Tomlinson, (1986) [12]; Saenger, (2003) [9]; Duke *et al*., (2007) [4]; Spalding *et al*., (2010) [11]. India with a long coastline of about 7516.6 km, including the island territories Anonymous (1984) [1], has a mangrove cover of about 6,749 km^2, the fourth largest mangrove area in the world Naskar and Mandal (1999) [7]. Mangroves can be found in over 118 countries and Union Territories in the tropical and subtropical regions of the world. About 75% of the world's coastline is covered in between 25° N latitude and 25° S longitude by the Mangroves. There are 110 species of Mangroves worldwide in 118 countries. Mangroves and Mangrove associates are widely found along western coast and eastern coast of Indian mainland, islands viz. Andaman, Nicobar and Lakshadweep Banerjee *et al*., (1989) [2]. Karnataka state having totally 16 species belonging to 11 genera and 7 families have been recognized as true mangrove species Ragavan *et al*., (2016) [8]. Mangroves play a vital role in ecosystem, beneficial for mankind they provide economical and social support to coastal communities. Mangrove have multiple uses viz. fodder, fuel wood, fibers, timber for building material, alcohol production, Seed oil for lighting, perfumes etc Upadhyay *et al*., (2002) [13]; ENVIS (2012) [5]; Wealth of India (1985) [14]; Deshmukh, (1991) [3]; Banerjee *et al*., (1989) [2].

The state of Karnataka in south India forms one of the important coastal states on the west coast is spread Latitude 11^0 12' N to 18^0 12' N and longitude 73^0 48' E to 78^0 18' E, it covers a geographical area of about 1,90,4983 sq.km It is divided into three zones viz. coastal, north interior and south interior. It has a coastline of 320 kms and has ten main rivers and few small ones draining into the Arabian Sea.

The mangrove ecosystems are associated with rich diversity of organisms and are also the nursery and breeding ground of several marine fauna viz. prawns, crabs, fishes and molluscs. The coastal Karnataka is divided into three maritime Districts namely Uttara Kannada, Udupi and Dakshina Kannada. The Uttara Kannada district lies between latitude 13^0 92'to 15^0 52'N and longitude 74^0 08'to 75^0 09' E are extends over an area of 10,327 Sq. km. Udupi district lies between latitude 13^0 04' to 13^0 59' N to 74^0 59.8' to 75^0 06.12 E longitude, while Dakshina Kannada district lies between latitude 12^0 57'to 13^0 50' N to 74^0 00'to 75^0 50' E longitude. From north to south, it is a narrow strip of territory and from east to west, it is a broken low plateau, which spreads from the Western Ghats to the Arabian Sea. In India sundarbans, Muthupet, pichavaram, Honnavar forest, kachchh shows dense vegetation of Mangroves Singh *et al*., (2012) [5, 6, 10]. The main objective of the present study is to understand the diversity, and knowing species of true mangroves and mangrove associates from selected study area of whole Karnataka.

Vegetation of mangroves are spread over three district of Karnataka namely, Uttar kannada, udupi, and dakshin kannada district. The important estuarine areas where mangroves are present in Dakshina Kannada are Mulki-Pavanje, Udayavara-Pangala, Swarna-Sita-Kodi, Netravathi-Gurupur, Chakra-Haladi-Kollur, Baindur hole and Shiroor hole while in Uttara kannada the mangroves are present in the Honnavar, Venkatapur, Sharavathi, Aghanashini, Gangavali and Kali river estuarine complexes. The dense vegetation of Mangroves is present at Kundapura especially in the concurrence zone of three rivers namely, Kollur, Haladi and chakra, exclusively early they open in the Arabian Sea Kumar and Kumara (2012) [6].

Materials and Methods

Frequent field visits were made to collect mangroves and

mangrove associates from coastal Karnataka. The location of each species was recorded by longitude, latitude and altitude to with the help of GPS. The Mangroves and their associates were taken photographs and their vouches specimens were prepared and deposited at BAMU Herbarium.

Table 1: Study sites

Study Sites	Latitude	Longitude
Site-1Kali estuary	13^0 55' to 15^0 31'N	74^0 09' to $75^0$10' E
Site-2Kundapur	12^0 53' to 14^0 00'N	73^0 30' to $75^0$23' E
Site-3Aghanashini estuary	14^0 52' to 14^0 53'N	74^0 35' to $74^0$36' E
Site-4Airody	13^0 27' to 13^0 43'N	74^0 35' to 74^0 36' E
Site-5Kagal	14^0 30' to 14^0 31' N	74^0 23' to 74^0 26' E

Table 2: Site-wise distribution of true Mangroves in Karnataka

Sr/No	Name of the species	Family	Life form	Site- 1	Site- 2	Site- 3	Site- 4	Site- 5
1	*Acanthus ilicifolius* L.	Achanthaceae	S	P	P	P	P	P
2	*Avicennia alba* Blume.	Achanthaceae	T	P	P	P	A	P
3	*Avicennia marina* (Forssk.) vierh.	Achanthaceae	T	P	P	P	A	P
4	*Avicennia officinalis* L.	Achanthaceae	T	P	P	P	P	A
5	*Lumnitzera racemosa* Willd.	Combretaceae	T	P	P	A	A	P
6	*Excoecaria agallocha* L.	Euphorbiaceae	T	P	P	P	P	P
7	*Sonneratia alba* Sm.	Lytharaceae	T	P	P	P	A	P
8	*Sonneratia caseolaris* (L.) Engl.	Lytharaceae	T	P	A	P	P	A
9	*Aegiceras corniculatum* (L.) Blanco.	Myrsinaceae	S	A	P	P	P	P
10	*Acrosticum aureum* L.	Pteridaceae	S	A	P	A	P	P
11	*Bruguiera cylindrica* (L.) Blume.	Rhizophoraceae	T	A	A	P	P	P
12	*Bruguiera gymnorrhiza* (L.)	Rhizophoraceae	T	A	P	A	P	P
13	*Ceriops decandra* (Griff.)Ding Hou	Rhizophoraceae	T	P	P	A	P	P
14	*Kandelia candel* (L.)Druce.	Rhizophoraceae	T	A	P	P	A	P
15	*Rhizophora apiculata* Blume.	Rhizophoraceae	T	A	P	P	P	P
16	*Rhizophora mucronata* Lam.	Rhizophoraceae	T	P	P	P	P	P

Life forms, T= tree, S= shrub, C= climber Se= sedge.

Table 3: Site-wise distribution of Mangrove associates in Karnataka

Sr/No	Name of the species	Family	Life form	Site-1	Site- 2	Site- 3	Site- 4	Site- 5
1	*Derris trifoliata* Lour.	Fabaceae	C	P	P	P	P	P
2	*Millettia pinnata* (L) Panigrahi	Fabaceae	T	P	P	P	P	P
3	*Ipomoea pes-carpae* (L) R.Br	Convolvulaceae	C	P	P	P	A	A
4	*Clerodendrum inerme* (L.) Gaertn.	Verbenaceae	S	A	P	P	P	P
5	*Pandanus tectorius* Parkinson ex Du Roi	Pandanaceae	S	P	P	A	P	A
6	*Hibiscus tiliaceous* L.	Malvaceae	T	P	A	P	A	P
7	*Sesuvium portulacastrum* (L) L.	Aizoaceae	C	P	P	P	A	A
8	*Dolichandron spathacea* (L.f.) Seem.	Bignoniaceae	T	P	P	P	A	P
9	*Salvadora persica* L.	Slavadoraceae	S	A	A	P	P	P
10	*Thespesia populnea* (L.) Sol.	Malvaceae	T	A	P	P	P	A
11	*Aeluropus lagopoides* (L.) Thwaites.	Poaceae	G	P	P	P	A	P
12	*Fimbristylis ferruginea* (L.) Vahl.	Cyperaceae	Se	P	P	P	P	P

Life forms, T= tree, S= shrub, C= climber Se= sedge.

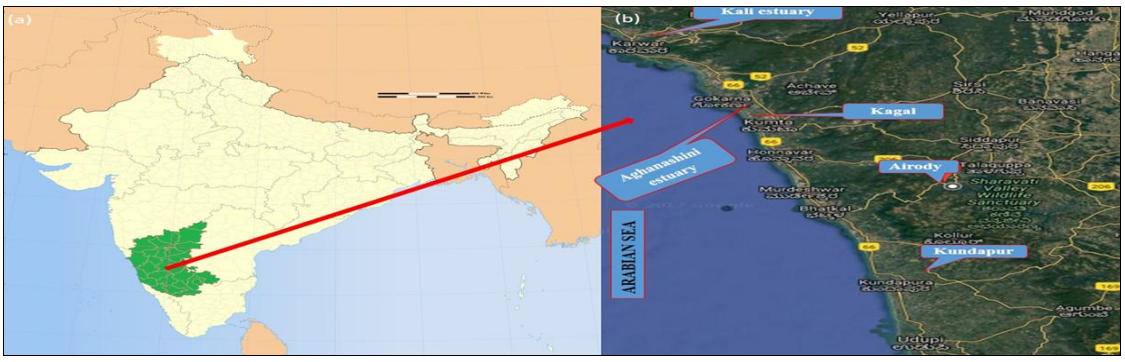

Fig 1: Map of study area

Results and Discussion

Site-1. Kali estuary

'Kali' riverine estuary is one of the most important estuary of Uttara Kannada district of coastal Karnataka, Kali River originating from Western Ghats and ultimately joins the Arabian Sea in north karwar. Uttar Kannada district Situated in latitude 13^0 55' to 15^0 31'N and longitude 74^0 09' to $75^0$10' E. The total length is 184 kms. The diversity and productivity of selected site is very rich gatherings of Mangroves and their associates. The species diversity is occurred in different saline water form viz. high, medium, lesser and bordering of estuary, mouth of river where meets ocean (tidal mouth). The site showing dense population by *Avicennia marina* (Forssk.) vierh., *Avicennia officinalis* L., *Sonneratia alba* Sm., *Sonneratia caseolaries* (L.) Engl., *Excoecaria agallocha* L., *ceriops decandra* (Griff.) Ding Hou is a occurred in high saline areas. *Acanthus illicifolius* L. is undershrub found along or bordering of estuarine complexes, some associates were collected from the estuary like *Derries trifoliata* Lour., climber *Milletia pinnata* (L) panigrahi., *Fymbristylis ferruginea* (L.) vahl. (Se), *Ipomoea pes-caprae* (L.) R.Br., *Pandanus tectorius* Parkinson ex Du Roi., *Hibiscus tiliaceous* L., *Sesuvium portulacastrum* (L) L., *Dolichandron spathacea* (L.f.) Seem., *Aeluropus logopoides* (L.) Thwaites were recorded during the study period. Site wise distribution and occurrence of the species details given in table- 2 and 3.

Site-2. Kundapur

The selected site is group of four small island viz. Uppinakudru, Herikudru, Jaladi and Hemmadi along the back water of river Haldi, the site is a totally under tidal influence. Kundapur forest is a one of the most important forest out of whole selected sites, it has showing the incredible and huge diversity of Mangroves and their associates. The common dominant mangrove are *Rhizophora mucronata* Lam., *Rhizophora apiculata* Blume., which attains 5-6 m height, therefore *Acanthus illicifolius* L., *Avicennia alba* Blume., *Avicennia marina* (Forssk) vierh., *Avicennia officinaliis* L., *Lumnitzera racemosa* Willd., *Excoecaria agallocha* L., *Sonneratia alba* Sm., *Aegiceras corniculatum* (L.) Blanco, *Bruguiera gymnorhiza* (L.)Lam., *Acrosticum aureum* L., *Ceriops decandra* (Griff.)Ding Hou and *Kandelia candel* (L.) Druce, almost total fourteen species of true Mangroves are observed and collected from the site. The close association in between *Clerodendrone innerme* (L.) Gaertn, *Milletia pinnata* (L) Panigrahi, *Derris trifoliata* Lour, *Aeluropes logopoides* (L.) Thwaites and *Fymbrystylis ferruginea* (L.) Vahl, is observed within same site, while *Sesuvium portulacastrum* (L) L., *Ipomoea pes-caprae* (L) R.Br, *Pandanus tectorius* Parkinson ex Du Roi, *Dolichandron spathacea* (L.f.) Seem, *Thespecia populnea* (L.) Sol., is observed on mud flat areas and mouth of estuary. Site wise distribution and occurrence of the species details given in table- 2, 3.

Site-3. Aghanashini estuary

The selected site is a riverine estuary, along the back water of river Aghanashini the area are commonly dominated by *Rhizophora mucronata* Lam., *Rhizophora apiculata* Blume., *Rhizophora mucronata* Lam. is found as a dominant tree species, while the area are totally under tidal influence. The remaining tree species are *Avicennia alba Blume*, *Avicennia marina* (Forssk.) vierh, *Avicennia officinalis* L. *Aegiceras corniculatum* (L.) Blanco, *Sonneratia alba* Sm., *Excoecaria agallocha* L., *Kandelia candel* (L.) Druce, *Sonneratia caseolaris* (L.) Engl. and one mangrove shrub species namely *Acanthus ilicifolius* occurred bordering of esutuary all the mentioned plant species are reported from the present study area. The results are represented in the (table 3).

Site-4. Airody

The selected site is popularly known as Airody Grampanchyayat, a very luxuriant patches and good formation of Mangrove and their associates are recorded. This site having huge diversity of following tree species viz, *Avicennia officinalis* L., *Acanthus illicifolius* L., *Sonneratia caseolaris* (L.) Engl., *Aegiceras corniculatum* (L.) Blanco., *Bruguiera cylindrica* (L.) Blume., *B. gymnorrhiza* (L.) Lam., *ceriops decandra* (Griff.) Ding Hou, *Rhizophora mucronata* Lam., *R. apiculata* Blume., *Excoecaria agallocha* L., is found sparsely. While some Mangroves associates such as *Derris trifoliata* Lour., *Millettia pinnata* (L) Panigrahi, *Clerodendrone inerme* (L.) Gaertn, *Pandanus tectorius* Parkinson ex Du Roi, *Salvadora persica* L., *Thespesia populnea* (L.) Sol., *Fimbristylis ferruginea* (L.) Vahl., were recorded during the study period as per details given in Table.2, 3.

Site-5. Kagal

The study site is an island, completely under the tidal influence of a very big riverine belt Aghanashini, in the situation there is a very good formation with diverse species are recorded were. On the bordering sides of this site are many mature trees of *Avicennia officinalis* L., *Sonneratia caseolaris* (L.) Engl., is also continually. *Excoecaria agallocha* L., with Mangroves leathery fern species *Acrosticum aureum* L. is found sparsely distributed along the sites. *Aegiceras corniculatum* (L.) is found distributed in group association with Mangrove shrub *Acanthus illicifolius* L., as Mangrove associates such *Dolichandron spathacea* (L.f.) Seem, *Clerodendrone inerme* (L.), *Derris trifoliata* Lour, *Hibiscus tiliaceous* L., *Salvadora persica* L., *Aeluropes logopoides* (L.) and *Fymbrystylis ferruginea* (L.) Vahl. (Se), were recorded during the study period.

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