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RESEARCH ARTICLE

DIVERSITY OF TRUE AND MANGROVE ASSOCIATES OF BHITARKANIKA NATIONAL PARK (ODISHA), INDIA.

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Abstract

In the present study, an attempt has been made to distinguish and separated the true mangroves from mangrove associates. The characteristics chosen for true mangrove identification were presence of aerial roots, viviparous or crypto-viviparous embryo development, tidal dispersal of propagules, ability to form pure stands, absence of understory, highly efficient mechanisms for nutrient retention and physiological mechanisms to tolerate salt. The present investigation which was carried out between the periods from September 2014 to July 2016 had recorded a total 29 true mangrove species and 72 associate species from various regions of Bhitarkanika National Park. The recorded true mangroves belong to 11 families and 15 genera and the associates recorded from 39 family and 56 genera. Among the studied true mangrove families, Rhizophoraceae showed maximum richness both at species and generic level with 10 true mangrove species. The present study will solve the confusion about actual number of true mangrove species of Bhitarkanika Wildlife Sanctuary & Mangrove National Park (Odisha), India and will help for conservation of the endemic and diverse flora of this internationally important mangrove wetland.

Introduction:-

Mangroves are diverse group of trees and shrubs that flourish in flooded and saline habitats (Hogarth, 2015) and share a common ability to live in waterlogged saline soils subjected to regular tidal flooding (Kathiresan and Bingham, 2001). The mangrove habit is the complex of physiological adaptations enabling survival and success. The mangroves thrive in such environment where normal flora can't exist due to their highly specialized morphological and physiological adaptations; most striking adaptations are various forms of aerial root (Hogarth, 2015). Mangroves act as nutrient sinks and protect offshore ecosystems and often referred to as bio-shields or natural sea defense (Roy *et al*., 2009). Mangroves are quite old, possibly arising just after the first angiosperms, around 114 million years ago (Duke, 1992). The mangrove ecosystems are widely recognized as providers of a wide variety of goods and services to people, including storm abatement, sediment trapping, land accretion, nutrient uptake & transformation and provision of a variety of plant and animal products (Badola and Hussain, 2003).

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However, across the globe, the world's mangroves are threatened (Arunprasth and Gomarhinayagam, 2014; Rao *et al*., 2015). The continued decline of the mangrove forests is due to conversion to agriculture, aquaculture, tourism, urban development and overexploitation (Alongi, 2002; Giri *et al*., 2008; Latiff, 2012). Reduced mangrove area and health will increase the threat to human safety and shoreline development from coastal hazards such as erosion, flooding, storm waves and surges, and tsunami (Danielsen *et al*., 2005; Chaudhuri *et al*, 2015).

Along the Orissa coast, mangroves are present on the Mahanadi delta & Brahmani- Baitarani delta between 86° 48′ - 86° 58′ E longitude and 20° 30′ - 20° 50′ N latitude (Nayak and Bahuguna, 2001). The mangrove area in Odisha is nearly 200 sq.km in extent and its degradation was placed at 20 sq.km over ten years, as percent estimates (Arunprasth and Gomarhinayagam, 2014). The Brahmani-Baitarani delta is enriched with rich mangrove genetic diversity and has been declared as the Bhitarkanika Wild Life Sanctuary (650 sq.km deltaic area of major rivers like Brahmani, Baitarani & the Dhamra, many creeks, mudflats and mangrove forests) in 1975 (Nayak and Bahuguna, 2001; Upadhyay and Mishra, 2008). The Bhitarkanika mangrove vegetation is very thick, difficult to penetrate and legally protected (SAC, 2012).

The 'true' or 'exclusive' mangroves are those that occur only in mangrove habitat (Santisuk, 1983; Tomlinson, 1986; Duke, 1992 and Giesen et al., 2007) or only rarely elsewhere and the 'mangrove associates' or non-exclusive mangroves are those which comprise a large number of species typically occurring on the landward margin of the mangal and often the non-mangal habitats such as rainforest, salt marsh, peat swamp or low land fresh water swamps (Santisuk, 1983 and Hogarth, 2015). According to Tomlinson (1986), the following criteria are required for a species to be designated a "true or strict mangrove": complete fidelity to the mangrove environment, major role in the structure of the community and has the ability to form pure stands. The exclusive mangroves show the characteristics like aerial roots, viviparous or crypto-viviparous embryo development, tidal dispersal of propagules, absence of understory and growth rings, highly efficient mechanisms for nutrient retention and physiological mechanisms to tolerate salt (Alongi, 2009).

Adaptation to salt tolerance is of three types i.e., salt excluders, salt secretors and salt accumulators (Ong and Gong, 2013). The salt excluders are from the members of the genera like, *Rhizophora, Bruguiera* and *Ceriops* of the family Rhizophoraceae. The species in the genera *Acanthus, Aegialitis, Aegiceras* and *Avicennia* have salt-secreting glands on the leaf surface. The species like *Sonneratia*, *Xylocarpus* and *Excoecaria* are the salt accumulators. Various types of root adaptations of mangroves in the habitat are lenticels (*Bruguiera spp.*), pneumatophores (*Sonneratia spp.* & *Avicennia spp.*), knee roots *(Bruguiera spp.)*, cable roots (*Avicennia spp.*), and stilt roots (*Rhizophora spp*.) (Ong and Gong, 2013).

A total 114 species of mangroves and associates were found in the world (Tomlinson, 1986) which includes 54 true mangroves found exclusively only in the mangrove habitats. But, Chapman (1975) described 11 families comprising of 55 species as true mangroves found exclusively in the mangrove swamps. Hogarth (2015) described occurrence of around 70 true mangrove species in 28 genera and belonging to 20 families. Giesen *et al*. (2007) described 52 species in Southeast Asian countries as true mangrove species which includes 42 trees and shrubs. Mangrove associates are usually not immersed by high tides. They comprise of herbs, ferns, creepers, vines, shrubs, trees and orchids and are mostly found in the landward margin (Giesen *et al*., 2007). Wang *et al*. (2010) based on leaf trait and salt content classified the controversial mangrove species like *Acrostichum aureum*, *Acrostichum speciosum*, *Excoecaria agallocha, Heritiera littoralis* as mangrove associates, the species like *Acanthus ilicifolius*, *Acanthus ebracteatus*, *Xylocarpus granatum, Pemphis acidula* as true mangroves. Mangrove region of India constitutes major forests area with rich diversity of flora and fauna but with uneven distribution (Rajendran and Sanjeevi, 2004). The actual true mangrove species of India is a matter of controversy as there exists a difference in the definition of true species and the mangrove associates. Various taxonomists/authors have worked extensively on this topic yet there is no consensus on the agreement of true mangroves versus mangrove associates. Indian mangroves are diverse and variously estimated due to the addition of associate species, 82 species (Mandal and Naskar, 2008), about 125 species, comprising of 39 mangroves and 86 mangrove associates (Kathiresan, 2010). The review of Ragavan *et al*. (2016) on Indian mangroves showed 46 true mangroves which consists of 42 species and 4 natural hybrids. About 26 true mangrove species and 58 mangrove associates, giving a total of 84 species have been recorded from Sundarbans (Banerjee, 1998), while 24 pure mangroves are reported from Kerala (Mahandas, 2012).

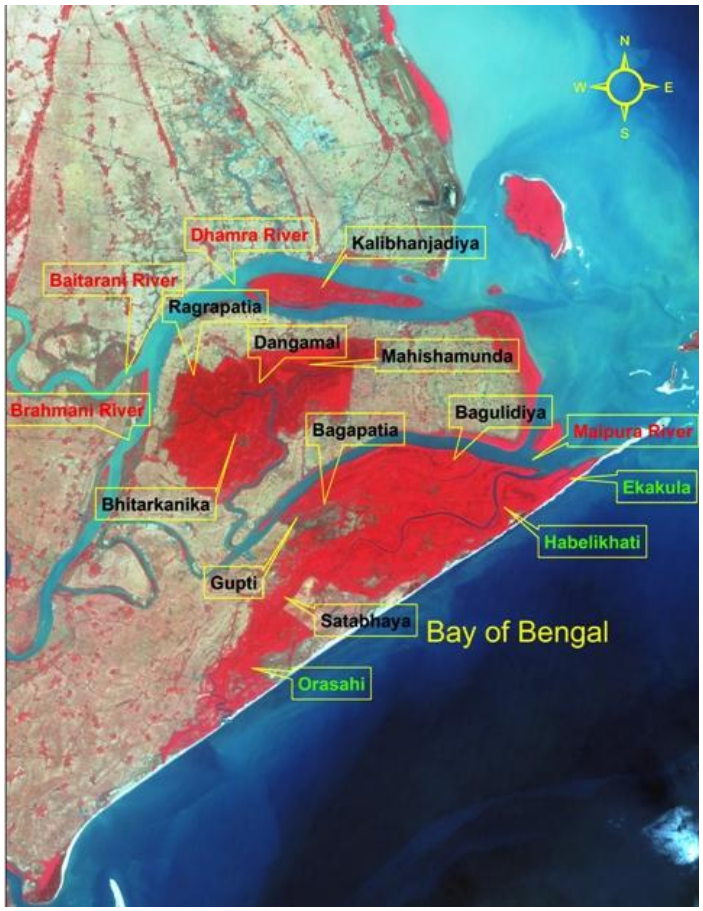
The number of mangrove species of Bhitarkanika is varied in opinions and thought to be about 55 (Banerjee and Rao, 1990), 62-67 (Nayak and Bahuguna, 2001), 51 (Pattanaik *et al*., 2007), 57 (Mandal and Naskar, 2008), 64

(Hussain and Badola, 2010). The Bhitarkanika NP with such diverse species of mangroves is considered as the third important mangrove habitat among the Indian mangals with respect to mangrove species diversity (SAC, 2012). The number of true mangrove species of Bhitarkanika NP is also varies, 28 (Hussain and Badola, 2010), 35 (Raghvan *et al*., 2016). The flora of Bhitarkanika is typical of the Sundarbans (Barik and Chowdhury, 2014), and Indo-Malesian type (Banerjee and Rao, 1990).

The present investigation tried to give a detail mangrove species list of Bhitarkanika Wildlife Sanctuary & National Park, separated the true mangroves from associates based on the characteristic features like viviparous and crypto-viviparous seed germination, salt adaptation strategies, ability for tidal dispersal of propagules, root modifications like pneumatophores, stilt roots, buttress and knee roots, horizontal spreading roots & presence of lenticels, whether the species can form pure stand or not and formation of understory or not, etc.

Study Area:-

The present study was carried out inside the mangrove forests which is a part of Bhitarkanika Wildlife Sanctuary and situated between 20° 30′ to 20° 47′ N latitude and 86° 39′E to 87° 04′ E longitudes in Kendrapara district of Odisha along the east cost of India. It occupies an area of 672 sq km. Bhitarkanika mangrove ecosystem flourishes in the deltaic region, formed by the rich alluvial deposits of Brahmani, Baitarani & the Dhamra River.



Map 1:- Study sites of Bhitarkanika Wildlife Sanctuary & National Park (Odisha), India.

The river, Brahmani played major role for the establishment of mangrove forests. The river, Brahmani is branched one at Hansina bridge and another at Khola and both enters to Bhitarkanika Wildlife Sanctuary and National Park with different names. Both these river again meet at Gupti and one flows towards Ekakula and meets Bay of Bengal with the name of Pathasala river and Maipura river, the other flows towards Bhitarkanika and Dangmal forest blocks by the name of Bhitarkanika River.

Materials and Methods:-

Intensive field study to different locations within Bhitarkanika National Park was carried out during, September-2014 to July-2016. The sites covered for data sampling were Dangmal, Bhitarkanika, Ragarapatia, Habelikhati, Ekakula, Mahishamunda, Kalibhanjadiya island, Khola, Gupti, Orasahi, Satabhaya, Bagulidiya, Krishnapriyapur and other riverine sites which come under reserve forests of the Bhitarkanika National Park. The present mangrove species and associate flora of each forest sites were recorded, photographed and identified with available literature, Hains (1921-25), Saxena and Brahamam (1994-1996), Santisuk (1983), Tomlinson (1986), Banerjee and Rao (1990), Naskar (2004), Rajendran and Sanjeevi (2004), Selvam *et al*., (2004), Singh and Odaki (2004), Spalding *et al*., (2010), Panda *et al*.,(2013), Giesen *et al*., (2007) and Roy *et al*., (2009). The identified mangrove species are categorized into true or exclusive and mangrove associate as the characters used by Santisuk (1983), Tomlinson (1986), Hutchings and Saenger (1987), Duke (1992), Spalding *et al*., (1997), Singh and Odaki (2004), Giesen *et al*., (2007) and Wang *et al*., (2010) with consideration of local physiological adaptations of these mangroves.

The species of contention for present classified true or associate mangroves were also justified by comparing the literature explained by different workers. A check list of mangrove species and their associates has been prepared for Bhitarkanika mangrove National Park.

Results and Discussion:-

Present study recorded a total of 29 true mangrove species (Table 1 and Plate 1) and 72 mangrove associates from different reserve mangrove forest sites of the Bhitarkanika National Park (Table 2 and Plate 2). The classified true mangroves have adaptation mechanisms to resist the physiologically dry surrounding environment and they generally form pure stands in Bhitarkanika National Park.

True or exclusive Mangroves:-

The recorded true mangroves belong to a total of 11 angiosperm family and 15 genera (Table 1 and Fig. 1). Highest number of true mangrove species were recorded from the family Rhizophoraceae i.e., 10 species. The family Meliaceae, Avicenniaceae and Sonneratiaceae were found to have 3 true mangrove species each. Another three family Acanthaceae, Arecaceae, Sterculiaceae were found to have 2 true mangrove species each. Single species of true mangrove were recorded from four familiies, i.e., Combretaceae, Euphorbiaceae, Plumbaginaceae and Myrcinaceae. The study also noted that the species *A.ilicifolius* L., *A.officinalis* L., *A.marina* (Forsk.) Vierh., *E.agallocha* L., *H.fomes* Buch-Ham., *H.littoralis* Dryand ex Ait., *P.paludosa* Roxb., *R.mucronata* Lamk., *C.decandra* (Griff.) Ding Hau, *K. candel* (L) Druce, *S.apetala* Buch.-Ham., *X.granatum* Koenig. as the frequently occurring true mangrove species of Bhitarkanika National Park. Other species showed site specific restricted distribution and rare type of occurrences. The species like *R. apiculata* Blume is restricted to Khola and Habelikhati, *B.sexangula* (Lour.) Poir. and *B.gymnorhiza* (L.) Lamk. were recorded from forest blocks of Dangmal, Bhitarkanika, Khola and Krishnapriyapur sites, *C.tagal (Perr.)* C.B. Rabinson was recorded from Ranahansua and Habelikhati reserve forests. The species like, *R.stylosa* Griff., *A.corniculatum* (L.) Blanco, *A.alba* Blume were recorded as the riverine mangroves of Maipura river and its branch Angari at Satabhaya. The mangrove species, *L.racemosa* Willd. and *A.rotondifolia* Roxb. were only recorded from Kalibhanjadiya island, Habelikhati and Ekakula reserve forest sites which are situated close to Bay of Bengal. *A.ebracteatus* Vahl. is of rare occurance and recorded only from Ragrapatia and Khola reserve forests. *X.mekongensis* Pierre and *X.moluccensis* (Lamk.) Roem., mostly confined to Dangmal and Bhitarkanika forest blocks. *S.alba* J Smith was found at Ekakula and *S.caseolaris* (L.) Engler was recorded to occur at Khola jetty and as a riverine mangrove of Bhitarkanika and Maipura river. The recorded exclusive and true mangrove species were of three growth forms in habit (i.e., tree, shrub and herb). Out of 29 true species, 26 species were trees, 2 species were herbs, (*A.ilicifolius* L., and *A.ebracteatus* Vahl.) and one species (*P.paludosa* Roxb.) was recorded as shrub (Fig. 3). All the present listed true mangrove species showed their prominent morphological and physiological adaptations like presence of one or more type of aerial roots, ability to resist long term saline water inundation, all form pure stands and lack understory vegetation, most of them have viviparous or crypto-viviparous embryo development and the species of family Rhizophoraceae with long distance seed or propagule dispersal abilities.

Associate mangroves:-

The mangrove associate flora study listed a total of 72 plant species which belongs to 39 families and 56 genera (Table 2 and Fig. 2). Highest number of species recorded from the families Fabaceae & Asclepiadaceae, i.e., 8 species each. The second highest numbers of mangrove associate species, (i.e., 5) were recorded from the family

Poaceae. Five families were found to bear 3 associate species each, i.e., Caesalpiniaceae, Salvadoraceae, Pandanaceae, Malvaceae and Chenopodiaceae. Another five families were found to bear 2 associate species each and these families were Pteridaceae, Verbenaceae, Amarylidaceae, Convolvulaceae and Aizoaceae. A total of 26 families were found to have one species each and these families were Acanthaceae, Meliaceae, Apoceanaceae, Bignoniaceae, Cyperaceae, Flagillariaceae, Colchicaceae, Boraginaceae, Rubiaceae, Anacardiaceae, Asteraceae, Rutaceae, Lythraceae, Celastraceae, Goodeniaceae, Solanaceae, Blechnaceae, Tamaricaceae, Combretaceae, Loranthaceae, Araceae, Ebenaceae Opuntiaceae, Tiliaceae, Leguminaceae and Euphorbiaceae (Table 2 and Fig. 3). The growth habit study of the recorded associate species resulted, Herb (20 spp.), Shrub (16 spp.), Tree (14 spp.), Climber (17 spp.), Fern (3 spp.), Creeper (2 spp.) (Fig. 4). All the recorded mangrove associates lack the adaptation characters to be a true mangrove and depend on true mangrove species for their own existence on this mangrove wetland. The comparison of growth habit of the recorded mangrove associates showed 58 species as non tree plants and generally found understory or hanging on the surface of true mangrove species.

Besides associate mangrove flora, Bhitarkanika Wildlife Sanctuary and National Park was found to host many non-mangroves of purely terrestrial angiosperms and cryptogams but present study excludes listing of them.

Species of Contention:-

A total of 17 mangrove species were found to be in a position of controversy and various opinions exists whether they are true or mangrove associates (Table 3).

The mangrove species like, *Acanthus ebracteatus* Vahl., *Nypa fruticans* (Thumb.) Wurmb., *Heritiera littoralis* Dryand ex Ait., *Kandelia candel* (L) Druce, *Phoenix paludosa* Roxb., *Xylocarpus moluccensis* (Lam.) Roem., are presently classified as true mangroves due to their physiological and morphological adaptations and mostly supported the work of Santisuk (1983) and Singh and Odaki (2004). Other species, *Acanthus volubilis* Wall., *Acrostichum aureum* L., *Acrostichum speciosum* Willdenow, *Aglaia cucullata* (Roxb.) Pellegrin, *Brownlowia tersa* (L.) Kostern, *Cerbera odollam* Gaertn., *Cynometra iripa* Kostel, *Dalbergia spinosa* Roxb., *Dolichandrone spathacea* K.Schu., *Excoecaria indica* (Willd.) Mull. and *Suaeda maritima* L. (Dumort) are classified as mangrove associates due to the lack of adaptation modifications, poor capability of toleration to long term saline water inundation and most of them found as the understory vegetation.

Latiff (2012) included the mangrove species like *Nypa fruticans* (Thunb.) Wurmb., *Intsia bijuga* (Colebr.) Kuntz. and *Heritiera littoralis* Dryand ex Ait. as non exclusive mangroves. Wang et al., (2010) classified the species like *E.agallocha* L. and *H.litoralis* Dryand ex Ait. as mangrove associate although they have wide range of salinity tolerance and both physiological and morphological adaptation modifications. Similarly, the species *Pemphis acidula* Forst. is described as true mangrove by different workers (Table 3) but our present classification included it into mangrove associate due to lack of adaptation modifications, like aerial roots, viviparous or crypto viviparous seed development and salt resisting abilities etc. *Pemphis acidula* Forst is an understory mangrove with succulent leaves and the species need freshwater input. The species, *Acanthus volubilis* Wall. being having viviparous embryo development, classified as mangrove associate due to absence of required characters to be a true mangrove and the important one, this species is a climber and grow on the surface of other true mangrove species (i.e., most frequently on *E.agallocha* L.) and lack forming pure stands.

The previously recorded species *Heritiera kanikensis* (Majumdar and Banerjee, 1985) and *Sonneratia griffithii* Kurz., *Cynometra ramiflora* L. (Selvam, et al., 2004; Upadhyay, 2008) were not recorded during our present study. The mangrove species *Excoecaria indica* (Willd.) Mull. Arg. is commonly known as *Sapium indicum* Willd. in Bhitarkanika NP. But our present classification explained it as *E.indica* (Willd.) Mull. Arg. due to the presence of characters like spiny stem and trunk, leaf morphology etc. and the name is globally used. *H.fomes* Buch-Ham. is a globally threatened species of extinction but this is one of the dominating species of Bhitarkanika NP. Another species, *Brownlowia tersa* (L) Kosterm. which is in the category of near threatened (Kathiresan, 2010) is abundantly found at the sites like Ragrapatia and river banks close to Dangmal, Bhitarkanika and Mahisamunda reserve forests of Bhitarkanika NP.

The recorded flowering period of each mangrove species favors the work done by (Upadhyay and Mishra, 2010) with small variation. The phenological study of mangrove species showed most of the mangrove species go flowering during winter or late winter but before start of monsoon rain due imposed stress of nutrient scarcity and high water and soil salinity.

Many mangrove species of Bhitarkanika are endemic and not found elsewhere in India. The species like *C.iripa* Kostel, *I.bijuba* (Colebr.), *Dolicandron spathecia* (L.f.) K.Schum., *A.volubilis* Wall., *A.ebracteatus* Vahl. etc. are endemic to Bhitarkanika NP and only found in some part of Sundarbans and Andaman mangrove ecosystem (Rajendran and Sanjeevi, 2004; Raghvan *et al*., 2014). *E.indica* (Willd.) Mull. Arg. is only found close to Khola creek in Bhitarkanika NP and not elsewhere in India. The global trend of *E.indica* (Willd.) Mull. Arg. is decreasing. The mangrove plant, *N.fruticans* (Thumb.) Wurmb, was extinct from Bhitarkanika NP but it has been reintroduced to the site from Sundarban to maintain the diversity of the ecosystem (Panda *et al*., 2013). Many associate flora are also endemic to this site and not found elsewhere in India. The number of true mangroves and dominating mangrove species of Bhitarkanika and Sundarban is of similar (Selvom, 2003). The present recorded mangrove diversity of Bhitarkanika ecosystem shows it is one among the most diversified mangrove ecosystems of world (Kathiresan and Rajendran, 2005) and if the mangrove associate flora is taken into consideration, then Bhitarkanika mangrove ecosystem will be the most species diversified ecosystem of India.

Conclusion:-

Our present work classified two groups of mangroves (i.e., true or associate mangroves) based on individual species adaptation and not divided the exclusive or true mangroves further into 'major' and 'minor' as done by Tomlinson (1986). Mangroves have great ecological role and provides resource to the coastal livelihoods of Odisha. The past conditions favored the luxuriant growth of *E.agallocha* L. and *H.fomes* Buch-Ham. inside Bhitarkanika National Park but both are low saline tolerating species. The study noted many mangroves of Bhitarkanika National Park had site specific distribution. The sites with more freshwater inputs and water inundation, housed more number of species than the site with less fresh water input. But still there are some areas (i.e., Habelikhati, Ekakula) where many riverine mangroves (i.e., *Rhyzophora spp*.) were found towards land in number of patches. The global climate change induced sea level rise may become a critical factor (Gilman, *et al*., 2008) for the present existing dominating species of Bhitarkanika mangrove reserve forests and for change in mangrove habitat (Selvom, 2003; SAC, 2012 and Rao, *et al*., 2015). The study of Upadhyaya and Mishra (2008), showed that more than 80% of death and damages of mangrove trees have been due to anthropogenic (human induced) disturbances. The mangroves and associates are likely to become vulnerable in near future due to both man-made and natural threats (Kathiresan, 2010). The Coastal Vulnerability Index (CVI) study also showed that some part in coastal area of Kendrapara district (close to Dhamara mouth) has high risk of vulnerable to coastal change (Kumar, *et al*., 2010). Many species of this wetland is under pressure of extinction (Panda *et al*., 2013) and must be conserved before the genetic erosion. Many mangrove species in Bhitarkanika were found as rare of occurrence (i.e., *C.tagel* (Per.) Rob., *B.parviflora* Wt. & Arn., *B.gymnorhiza* (L.) Lamk, *R.stylosa* Griff., *A.ebracteatus* Vahl., *A.volubilis* Wall., *E.indica* (Willd.) Mull. Arg., *I.bijuga* (Colebr.) Kuntz, *Tylophora spp*. and *Sarcobolobus spp*.) and these species should be given priority for conservation.

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Table 1:- List of recorded true mangrove species of Bhitarkanika mangrove forest and their phenology (Odisha), India.

Sl No.	True mangrove species	Family	Flowering period	Adaptation	Seed devel-opment	IUCN status	Habit
1	*Aegiceras corniculatum* (L.) Blanco	Myrcinaceae	April	Cable roots	CV	LC	Tree
2	*Aegialitis rotondifolia* Roxb.	Plumbaginaceae	March	Peg like roots	CV	NT	Tree
3	*Acanthus ilicifolius* L.	Acanthaceae	April	Cable &Stilt roots	CV	LC	Herb
4	*Acanthus ebracteatus* Vahl.	Acanthaceae	March	Cable &Stilt roots	CV	LC	Herb
5	*Avicennia alba* Blume	Avicenniaceae	May	Knee root & Pneumatophores	CV	LC	Tree
6	*Avicennia marina* (Forsk.)Veierh	Avicenniaceae	April/May	Pneumatophores	CV	LC	Tree
7	*Avicennia officinalis* L.	Avicenniaceae	April	Pneumatophores	CV	LC	Tree
8	*Bruguiera cylindrica* (L.) Blume	Rhizophoraceae	January	Buttress, Knee & Stilt roots	V	LC	Tree
9	*Bruguiera gymnorhiza* (L.) Lamk.	Rhizophoraceae	February	Buttress, Knee & Stilt roots	V	LC	Tree
10	*Bruguiera parviflora* Wt. &Arn.	Rhizophoraceae	August	Stilt & Knee roots	V	LC	Tree
11	*Bruguiera sexangula* (Lour.) Poir	Rhizophoraceae	March	Stilt & Knee roots	V	LC	Tree
12	*Ceriops decandra* (Griff.) Ding Hou	Rhizophoraceae	November	Buttress, Knee & Stilt roots	V	NT	Tree
13	*Ceriops tagal* (Per.)Rob.	Rhizophoraceae	May/June	Buttress, Knee & Stilt roots	V	LC	Tree
14	*Excoecaria agallocha* L.	Euphorbiaceae	April	Spreading horizontal root	NV	LC	Tree
15	*Heritiera littoralis* Dryand ex Ait	Sterculiaceae	April	Peg & Buttress root	NV	LC	Tree
16	*Heritiera fomes* Buch.-Ham.	Sterculiaceae	September	Peg & Buttress root	NV	EN	Tree
17	*Kandelia candel* (L) Druce	Rhizophoraceae	November	Stilt roots	V	LC	Tree
18	*Lumnitzera racemosa* Willd.	Combretaceae	December	Knee & Stilt roots	NV	LC	Tree
19	*Nypa fruticans* (Thumb.) Wurmb.	Arecaceae	----------	No aerial roots	V	LC	Tree
20	*Phoenix paludosa* Roxb.	Arecaceae	December	Pneumatothodes	V	NT	Shrub
21	*Rhizophora apiculata* Blume	Rhizophoraceae	November	Prop & stilt roots	V	LC	Tree
22	*Rhizophora mucronata* Lamk.	Rhizophoraceae	September	Prop & stilt roots	V	LC	Tree
23	*Rhizophora stylosa* Griff.	Rhizophoraceae	September	Prop & stilt roots	V	LC	Tree
24	*Sonneratia alba* J. Smith	Sonneratiaceae	March	Pneumatophores	NV	LC	Tree
25	*Sonneratia apetala* Buch. – Ham.	Sonneratiaceae	February	Pneumatophores	NV	LC	Tree
26	*Sonneratia caseolaris* (L.) Engler	Sonneratiaceae	December	Pneumatophores	NV	LC	Tree
27	*Xylocarpus granatum* Koenig	Meliaceae	November	Buttress	NV	LC	Tree
28	*Xylocarpus mekongensis* Pierre	Meliaceae	November	Plank root	NV	LC	Tree
29	*Xylocarpus moluccensis* (Lamk.) Roem.	Meliaceae	November	Buttress & Pneumatophores	NV	LC	Tree

Table 2:- List of recorded mangrove associate flora of Bhitarkanika mangrove forest and their phenology (Odisha), India.

Sl. No.	Mangrove associates	Familly	Flowering period	Habit
1	Acanthus volubilis Wall.	Acanthaceae	April	Climber
2	Acrostichum aureum L.	Pteridaceae	……	Fern
3	Acrostichum speciosum Willd	Pteridaceae	……	Fern
4	Aeluropus lagopoides (L.) Trin.	Poaceae	December	Herb (Grass)
5	Aglaia cucullata (Roxb.) Pellegrin	Meliaceae	March	Tree
6	Allophlus serratus (Roxb.) Kurz	Verbenaceae	December	Shrub
7	Azima tetracantha Lam.	Salvadoraceae	October	Shrub
8	Brownlowia tersa (L.) Kostern.	Tiliaceae	May	Shrub
9	Caesalpinia bundoc (L.) Roxb.	Caesalpiniaceae	January	shrub
10	Caesalpinia crista L.	Caesalpiniaceae	March	Shrub
11	Canavalia maritime (Aubl.) Thouars	Fabaceae	December	Climber
12	Cerbera odollam Gaertn	Apoceanaceae	Year	Tree
13	Clerodendron inerme (L.) Gaertn	Verbenaceae	April	Shrub
14	Crinum asiaticum L.	Amarylidaceae	December	Herb
15	Crinum defixum Ker Gawl.	Amarylidaceae	December	Herb
16	Cryptocoryne ciliata (Roxb.) Fisch. ex Wydler	Araceae	July	Herb
17	Cynometra iripa Kostel	Caesalpiniaceae	November	Shrub
18	Dalbergia candenatensis (Dennst.) Prain	Fabaceae	May	Shrub
19	Dalbergia spinosa Roxb	Fabaceae	October	Shrub
20	Derris heterophylla (Willd.) K. Heyne	Fabaceae	April	Climber
21	Derris scandens (Roxb.) Benth.	Fabaceae	April	Climber
22	Derris trifolia Lour.	Fabaceae	February	Climber
23	Dendrophthoe falcate (L.f.) Etting.	Loranthaceae	August	Tree
24	Diospyros melanoxylon Roxb.	Ebenaceae	November	Tree
25	Dolicandrone spathacea (L.f.) K.Schum.	Bignoniaceae	January	Tree
26	Excoecaria indica (Willd.) Mull. Arg.	Euphorbiaceae	March	Tree
27	Fimbristylis ferruginea (L.) Vahl	Cyperaceae	August	Herb
28	Flagilaria indica L.	Flagillariaceae	September	Climber
29	Finlaysonia obovata Wall.	Asclepiadaceae	November	Climber
30	Gloriosa superba L.	Colchicaceae	October	Climber
31	Heliotropium curassavicum L.	Boraginaceae	March	Herb
32	Hibiscus tiliaceus L.	Malvaceae	November	Tree
33	Hoya parasitica (Roxb.) Wall	Asclepiadaceae	August	Climber
34	Hydrophylax maritime L.f.	Rubiaceae	February	Herb
35	Intsia bijuba (Colebr.) Kuntz.	Caesalpiniaceae	March	Tree
36	Ipomoea pes-caprae (L.) R. Br.	Convolvulaceae	February	Creeper
37	Ipomoea tuba (Sch.) G. Don	Convolvulaceae	January/February	Creeper
38	Lannea coramandelica (Houtt.) Merr	Anacardiaceae	March	Tree
39	Launea sarmentosa (Willd.) Schultz-Bip.	Asteraceae	April	Herb
40	Macuna gigantean (Willd.) DC.	Fabaceae	September	Climber
41	Merope angulata (Willd.) Swingle	Rutaceae	May	Shrub
42	Myriostachya wighitiana (Nees ex Steud) Hook. F	Poaceae	February	Herb (Grass)
43	Opuntia dillenii (Ker-Gawl.)Haw.	Opuntiaceae	April	Herb (Succulent)
44	Pandanus fascicularis Lam.	Pandanaceae	April	Shrub
45	Pandanus foetidus Roxb.	Pandanaceae	February	Shrub
46	Pandanus odoratissmus L.f.	Pandanaceae	February	Shrub
47	Pemphis acidula Forst.	Lythraceae	April	Shrub

48	Pentotropis capensis (L.f.) Bullock	Asclepiadaceae	April	Climber
49	Phragmites karka (Retz.) Trin.	Poaceae	January	Herb
50	Pongamia piñata (L.) Pierre	Fabaceae	March	Tree
51	Porteresia coarctata (Roxb.) Takeoka	Poaceae	July	Herb (Grass)
52	Salacia prinoides DC	Celastraceae	October	Climber
53	Salicornia brachiata Roxb.	Salvadoraceae	February	Herb
54	Salvadora persica Linn.	Salvadoraceae	Novenber	Shrub
55	Sarcobolobus carinatus Wall.	Asclepiadaceae	July	Climber
56	Sarcobolobus globosus Wall.	Asclepiadaceae	October	Climber
57	Scaevola plumieri Vahi.	Goodeniaceae	September	Shrub
58	Sesuvium portulacastrum (L.) L.	Aizoaceae	November	Herb (Succulent)
59	Solanum trilobatum L.	Solanaceae	February	Herb
60	Spinifex squarrosus L.	Poaceae	November	Herb
61	Stenochlaena palustre (Burm. f.) Bedd	Blechnaceae	----------	Herb (Fern)
62	Suaeda maritima (L.) Dumort	Chenopodiaceae	October	Herb (Succulent)
63	Suaeda monoica Forssk. Ex Gmel.	Chenopodiaceae	September	Herb (Succulent)
64	Suaeda nudiflora (Wild.) Moq.	Chenopodiaceae	December	Herb (Succulent)
65	Tamarix troupii H.	Tamaricaceae	January	Tree
66	Terminalia catappa L.	Combretaceae	December	Tree
67	Thespesia populnea (L.) Sol. Ex Corr.	Malvaceae	November	Tree
68	Thespesia populneoides (Roxb.) Kostel	Malvaceae	November	Tree
69	Trianthema portulacastrum L.	Aizoaceae	August	Herb
70	Tylophora fleuxosa R. Br.	Asclepiadaceae	Oct./Nov.	Climber
71	Tylophora indica (Burm. f.) Merr.	Asclepiadaceae	Oct./Nov.	Climber
72	Tylophora tenuis Blume.	Asclepiadaceae	Oct./Nov.	Climber

Table 3:- The mangrove species of controversy in position (Justification by comparing the work of various authors and present classified mangrove type)

Sl. No.	Mangrove species	True Mangrove	Mangrove Associate	Present Classification
1	*Acanthus ebracteatus* Vahl.	Santisuk (1983), Singh & Odaki (2004), Kathiresan & Rajendran (2005), Giesen et al., (2007), Balachandran et al. (2009), Polidoro et al (2010), Wang et al. (2010)	Tomlinson (1986), Spalding et al. (2010)	True mangroves
2	*Acanthus volubilis* Wall.	Naskar (2004), Ravishankar et al. (2004), Singh &Odaki (2004), Giesen et al (2007), Polidoro et al (2010)	Tomlinson (1986), Naskar (2004)	Mangrove Associate
3	*Acrostichum aureum* L.	Tomlinson (1986), Ravishankar et al. (2004), Selvam et al. (2004), Kathiresan & Rajendran (2005), Giesen et al (2007), Polidoro et al (2010), Sakthive (2014), Donoso (2016), Wang et al. (2010)	Santisuk (1983), Naskar (2004), Singh & Odaki (2004), Spalding et al. (2010)	Mangrove Associate
4	*Acrostichum speciosum* Willdenow	Tomlinson (1986), Kathiresan & Rajendran (2005), Giesen et al (2007), Polidoro et al (2010), Donoso (2016), Wang et al. (2010)	Santisuk (1983), Singh & Odaki (2004), Naskar (2004), Spalding et al. (2010)	Mangrove Associate
5	*Aglaia cucullata (Roxb.) Pellegrin*	Naskar (2004), Ravishankar et al. (2004), Selvam et al. (2004),	Santisuk (1983), Spalding et al. (2010)	Mangrove Associate

		Kathiresan & Rajendran (2005), Polidoro et al (2010), , Bark & Chowdhury (2014)		
6	*Brownlowia tersa (L.) Kostern.*	Naskar (2004), Selvam et al. (2004), Giesen et al (2007), Polidoro et al (2010), Donoso (2016)	Santisuk (1983), Ravishankar et al. (2004), Singh & Odaki (2004)	Mangrove Associate
7	*Cerbera odollam Gaertn.*	Ravishankar et al. (2004)	Santisuk (1983	Mangrove Associate
8	*Cynometra iripa* Kostel	Selvam et al. (2004), Singh & Odaki (2004), Kathiresan & Rajendran (2005), Polidoro et al (2010)	Santisuk (1983), Naskar (2004) Spalding et al. (2010)	Mangrove Associate
9	*Dalbergia spinosa*Roxb.	Balachandran et al. (2009)	Naskar (2004), Rao (2015)	Mangrove Associate
10	*Dolichandrone spathacea* (L. f.) K.Schum.	Tomlinson (1986), , Ravishankar et al. (2004), Kathiresan & Rajendran (2005), Polidoro et al (2010)	Santisuk (1983), Naskar (2004), Singh & Odaki (2004), Spalding et al. (2010), Wang et al. (2010)	Mangrove Associate
11	*Excoecaria indica* (Willd.) Mull.	Kathiresan & Rajendran (2005), Polidoro et al (2010)	Santisuk (1983), Spalding et al. (2010)	Mangrove Associate
12	*Heritiera littoralis*Dryand ex Ait.	Sakthive (2014), Singh & Odaki (2004), Polidoro et al (2010), Tomlinson (1986) Ravishankar et al. (2004), Kathiresan & Rajendran (2005)	Santisuk (1983), Spalding et al. (2010), Wang et al. (2010)	True mangroves
13	*Kandelia candel* (L) Druce	Naskar (2004), Ravishankar et al. (2004), Selvam et al. (2004), Singh &Odaki (2004), Kathiresan & Rajendran (2005), Giesen et al (2007), Polidoro et al (2010) Spalding et al. (2010), Bark & Chowdhury (2014)	Santisuk (1983)	True mangroves
14	*Nypa fruticans* (Thumb.) Wurmb.	Santisuk (1983), Selvam et al. (2004), Singh & Odaki (2004), Kathiresan & Rajendran (2005), Giesen et al (2007), Polidoro et al (2010), Bark & Chowdhury (2014)Donoso (2016)	Spalding et al. (2010)	True mangroves
15	*Pemphis acidula* J.R.Forst. and G.Forst	Tomlinson (1986), Selvam et al. (2004), Kathiresan & Rajendran (2005), Giesen et al (2007), Polidoro et al (2010), Wang et al. (2010)	Santisuk (1983), Singh & Odaki (2004), Spalding et al. (2010)	Mangrove Associate
16	*Phoenix paludosa* Roxb.	Santisuk (1983), Singh & Odaki (2004), Polidoro et al (2010), Bark & Chowdhury (2014), Donoso (2016)	Ravishankar et al. (2004)	True mangroves
17	*Suaeda maritima*L. (Dumort)	Santisuk (1983)	Untawale (1986), Naskar (2004),Ravishankar et al. (2004), Sakthive (2014), , Rao (2015), Balachandran et al. (2009)	Mangrove Associate

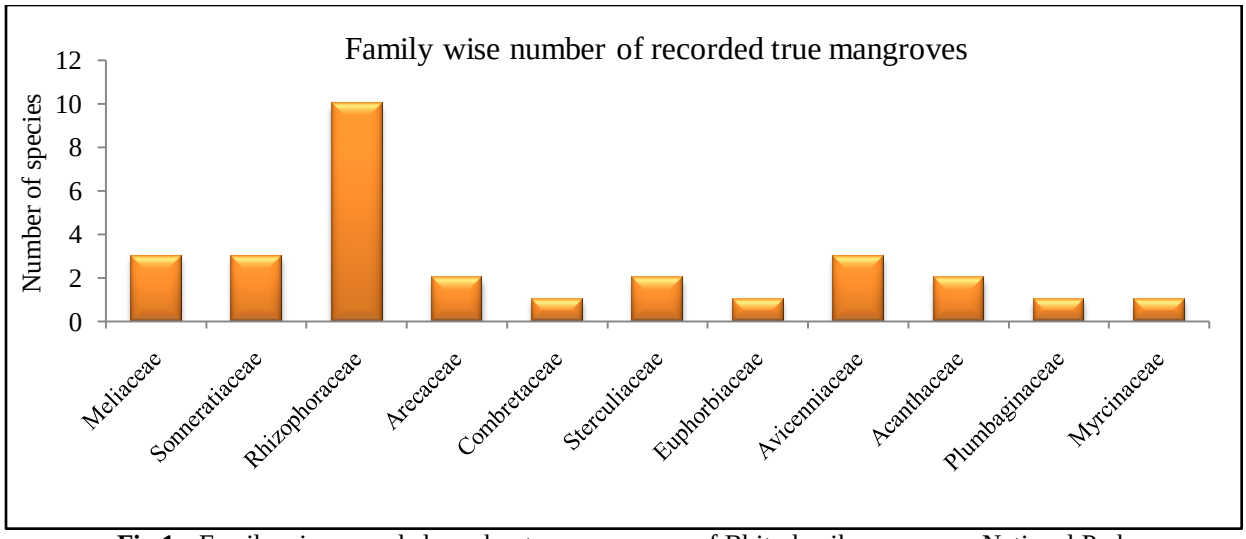

Fig 1:- Family wise recorded number true mangroves of Bhitarkanika mangrove National Park

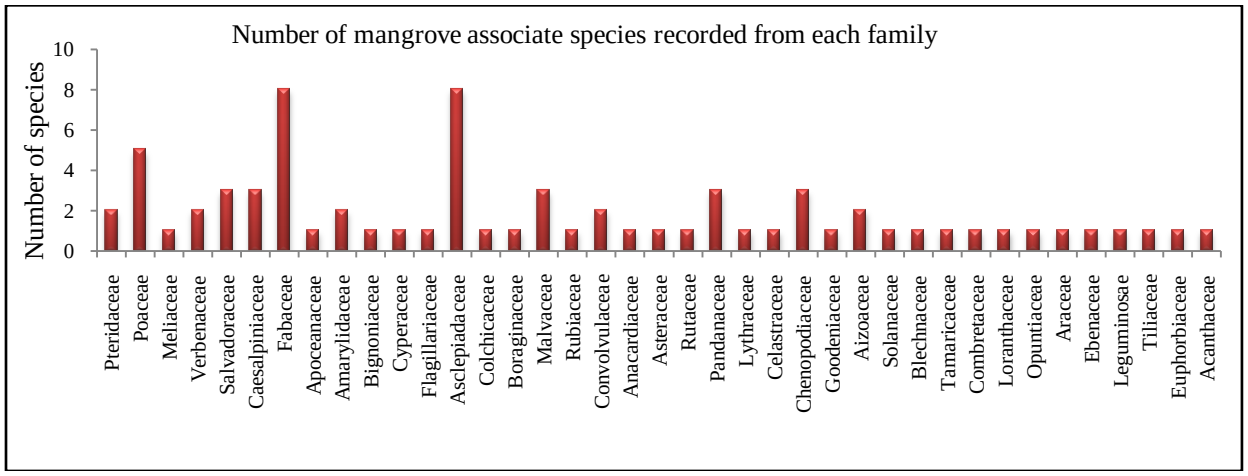

Fig 2:- Family wise recorded number of mangrove associate species of Bhitarkanika mangrove NP (Odisha), India

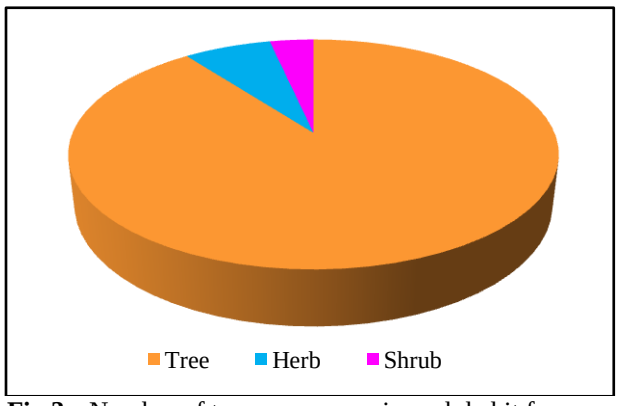

Fig 3:- Number of true mangroves in each habit form

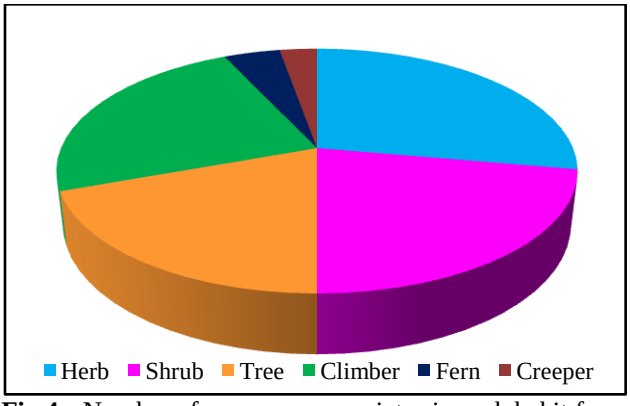

Fig 4:- Number of mangrove associates in each habit form

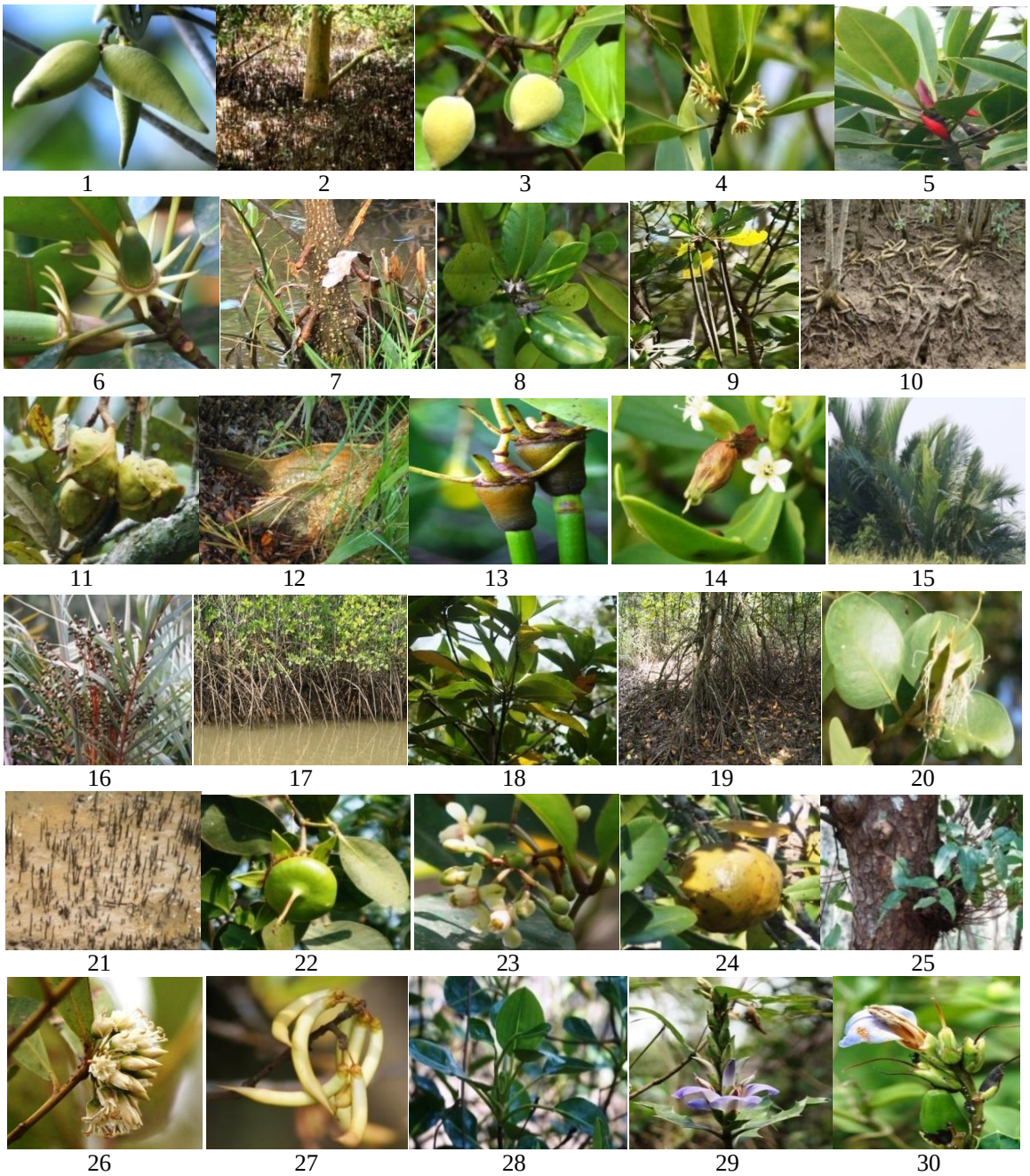

Plate 1:- The true mangrove flora of Bhitarkanika National Park (Odisha), India

Note: 1: Fruit of Avicennia alba 2: Pneumatophore of Avicennia marina 3: Fruit of Avicennia officinalis 4: Flower of Bruguiera cylindrical 5: Flower bud of Bruguiera gymnorhiza 6: Propagules of Bruguiera sexangula 9: Propagules of Ceriops tagel 10: Spreading horizontal roots of Excoecaria agallocha 11: Fruit of Heritiera littoralis 12: Buttress root of Heritiera fomes 13: Propagules of Kandelia candel 14: Flower and seed of Lumnitzera racemosa 15: Nypa fruticans 16: Fruiting branch of Phoenix paludosa 17: Rhizophora mucronata with stilt root 18: Rhizophora stylosa 19: Stilt root of Rhizophora apiculata 20: Sonneratia alba 21: Pneumatophores of Sonneratia apetala 22: Fruit of Sonneratia caseolaris 23: Inflorescence of Xylocarpus granatum 24: Fruit of Xylocarpus granatum 25: Xylocarpus mekongensis 26: Flower of Aegiceras corniculatum 27: Fruit of Aegiceras corniculatum 28: Aegialitis rotundifolia 29: Inflorescence of Acanthus ilicifolius 30: Fruit of Acanthus ilicifolius

Plate 1:- Some mangrove associate flora of Bhitarkanika National Park (Odisha), India

Note: 1:- Acanthus volubilis 2 & 3: Excoecaria indica 4: Suaeda monoica 5: Suaeda nudiflora 6: Suaeda maritima 7: Cynometra iripa 8: Dolicandrone spathacia 9: Aglaia cucullata 10: Cerbera odollam 11: Tylophora indica 12: Intsia bijuga 13: Acrostichum speciosum 14: Acrostichum aureum 15: Finlaysonia obovata 16: Flagillaria indica 17: Porteresia coarctata 18: Macuna gigantea 19: Derris scandens 20: Pongamia pinnata 21: Derris candenatensis 22: Opuntia dilleni 23: Stenochlaena palustre 24: Salvadora parsica 25: Ipomoea pes-caprae 26: Caesalpinia crista 27: Sesuvium portulacastrum 28: Tamarix troupii 29: Thespesia populnea 30: Cryptocoryne ciliata 31: Hibiscus tiliaceus 32: Canavalia maritima 33: Clerodendrom inerme 34: Fimbristylis ferruginea 35: Diospyros melanoxylon 36: Allophylus serratus

References:-

1. Alongi, D.M. (2002): Present state and future of the world's mangrove forests. Environmental Conservation, **29**: 331–349.
2. Alongi, D.M. (2009): The energetics of mangrove forests. Springer Science + Business Media B.V., 1-6.
3. Arunprasath, A. and Gomathinayagam, M. (2014): Distribution and Composition of True Mangroves Species in three major Coastal Regions of Tamilnadu, India. International Journal of Advanced Research, 2(10): 241-247.

4. Badola, R. and Hussain S.A. (2003): Valuation of the Bhitarkanika Mangrove ecosystem for ecological security and sustainable resource use. Study Report. Wildlife Institute of India. Dehra Dun, 1-101.
5. Balachandran, N., Kichenamourthy, S., Muthukumaran, J., Jayakanthan, M., Chandrasekhar, S., Punetha, A and Sundar, D. (2009): Diversity of true mangroves and their associates in the Pondicherry region of South India and development of a mangrove knowledgebase. Journal of Ecology and The Natural Environment 1(5): 099-105.
6. Banerjee, L.K. (1998): Species diversity and distribution of Mangroves in India. In: Anonymous, An Anthology of Indian Mangroves. Environmental Information System Centre, Centre of Advanced Study in Marine Biology, Annamalai University, Annamalainagar.
7. Banerjee, L.K. and Rao, T.A. (1990): Mangroves of Orissa coast and their ecology. Bishen Singh Mahendra Palsingh, Dehradun, India.
8. Barik, J. and Chowdhury, S. (2014): True Mangrove Species of Sundarbans Delta, West Bengal, Eastern India. Check List, 10(2): 329–334.
9. Chapman, V.J. (1975): Mangrove biogeography. In G.E. Welsh, S.C. Snedaker et H.J. Taes, (éds). Proc. International Symposium on Biology and Management of Mangroves, Vol. 1. Gainesville, Etats-Unis, University of Florida Press.
10. Ghosh, S., Bakshi, M., Bhattacharyya, S., Nath, B. and Chaudhuri, P. (2015): A Review of Threats and Vulnerabilities to Mangrove Habitats: With Special Emphasis on East Coast of India. J Earth Sci Clim Change, 6: 270.
11. Clough, B. (2013): Continuing the Journey Amongst Mangroves. ISME Mangrove Educational Book Series No. 1. International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, and International Tropical Timber Organization (ITTO), Yokohama, Japan.
12. Danielsen, F., Sorensen, M.K., Olwig M.F., Selvam, V., Parish, F., Burgess, N.D., Hiraishi, T., Karunagaran, V.M., Rasmussen, M.S., Hansen, L.B., Quarto, A. and Suryadiputra, N (2005): The Asian tsunami: a protective role for coastal vegetation. Science, 310: 643.
13. Donoso, A.B. (2016): Floristic Composition of the Mangroves in Siargao Island. International Journal of Agriculture Innovations and Research, 4(4): 661-664.
14. Duke, N.C. (1992): Mangrove Floristics and Biogeography, Chapter 4 (p63-100) in: Tropical Mangrove Ecosystems (Volume 41), A.I. Robertson and D.M. Alongi, (Eds.), Coastal and Estuarine Studies Series, American Geophysical Union, Washington, D.C., 329.
15. Duke, N.C., Ball, M.C. and Ellison, J.C. (1998): Factors influencing biodiversity and distribution gradients in mangroves. Global Ecology and Biogeography Letters, 7: 27-47.
16. Ellison, A.M., Mukherjee, B.B. and Karim, A. (2000): Testing patterns of zonation in mangroves: scale dependence and environmental correlates in the Sundarbans of Bangladesh. Journal of Ecology, 88: 813-824.
17. Giesen, W., Wulffraat, S., Zieren, M. and Scholten, L. (2007): Mangrove Guidebook for Southeast Asia. FAO and Wetlands International.
18. Gilman, E.L., Ellison, J., Duke, N.C. and Field, C. (2008): Threats to mangroves from climate change and adaptation options. Aquat. Bot, 89(2): 237-250. doi:10.1016/j.aquabot.2007.12.009.
19. Giri, C., Zhu, Z., Tieszen, L.L., Singh, A., Gillette, S. and Kelmelis, J.A. (2008): Mangrove forest distributions and dynamics (1975–2005) of the tsunami-affected region of Asia. Journal of Biogeography, 35: 519–528.
20. Hains, H.H. (1921-25): Botany of Bihar and Orissa (Ed.1961), Botanical survey of India, Calcutta.
21. Hogarth, P.J. (2015): The biology of mangroves and Seagrasses. Oxford University Press, New York.
22. Hussain, S.A. and Badola, R. (2010): Valuing mangrove benefits: Contribution of mangrove forests to local livelihoods in Bhitarkanika Conservation Area, East Coast of India. Wetlands Ecol Manage, 18: 321–331.
23. Hutchings, P. and Saenger, P. (1987): Ecology of mangroves. University of Queensland Press.
24. Kathiresan, K. (2010): Importance of Mangrove Forests of India. Jour. Coast. Env., 1(1):11-26.
25. Kathiresan, K. and Bingham, B.L. (2001): Biology of Mangroves and Mangrove Ecosystems. Advance in marine biology, 40: 81-251.
26. Kathiresan, K. and Rajendran, N. (2005). Mangrove ecosystems of Indian Ocean region. Indian Journal of Marine Science, 34(1): 104-113.
27. Kumar, T.S., Mahendra, R.S., Nayak, S., Radhakrishnan, K. and Sahu, K.C. (2010): Coastal Vulnerability Assessment for Orissa State, East Coast of India. Journal of Coastal Research, 26(3): 523-534.
28. Latiff, A. (2012): Conservation strategies for endangered mangrove swamp forests in Malaysia. Pak. J. Bot., 44: 27-36.
29. Rajendran, N. and Sanjeevi, S.B. (2004): Flowering Plants and Fern in Mangrove Ecosystems of India (T. Balasubramanian and S. Ajmal Khan, eds.). ENVIS Publication Series, 1: 110.
30. Rao, M.K., Krishna, P.V. and Kumar, H.V. (2015): Mangrove flora diversity and necessity for conservation of Interu mangrove swamp of River Krishna estuaries regions of Andhra Pradesh, India. International Journal of Advanced Research, 3(6): 829-839.
31. Majumdar, N.C. and Banerjee, L.K. (1985): A new species of Heritiera (Sterculiaceae) from Orissa. Bulletin of Botanical Survey of India, 27: 150-151.

32. Mandal, R.N. and Naskar, K.R. (2008): Diversity and classification of Indian Mangroves: a review. Tropical Ecology, 49(2): 131-146.
33. Mohandas, M., Lekshmy, S. and Radhakrishnan, T. (2012): Kerala Mangroves– Pastures of Estuaries – Their Present Status and Challenges. International Journal of Science and Research (IJSR), 3 (11): 2804-2809.
34. Naskar, K. (2004): Manual of Indian Mangroves. Daya Publishing House, Delhi.
35. Nayak, S. and Bahuguna, A. (2001): Application of remote sensing data to monitor mangroves and other coastal vegetation of India. Indian Journal of Marine Sciences, 30: 195- 213.
36. Ong, J.E. and Gong, W.K. (ed.) (2013): Structure, Function and Management of Mangrove Ecosystems. ISME Mangrove Educational Book Series No. 2. International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, and International Tropical Timber Organization (ITTO), Yokohama, Japan.
37. Panda, S.P., Subudhi, H. and Patra, H.K. (2013): Mangrove forests of river estuaries of Odisha, India. International Journal of Biodiversity and Conservation, 5(8): 446-454.
38. Pattanaik, C., Reddy, C.S., Dhal, N.K. and Das, R. (2007): Utilisation of mangrove forests in Bhitarkanika Wildlife Sanctuary, Orissa. Indian Journal of Traditional Knowledge, 7(4): 598-603.
39. Polidoro, B.A., Carpenter, K.E., Collins, L., Duke, N.C. et al. (2010): The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern. PLoS ONE 5(4): 1-10.
40. Ragavan, P., Saxena, A., Jayaraj, R.S.C., Mohan, P.M., Ravichandran, K., Saravanan, S. and Vijayaraghavan, A. (2016): A review of the mangrove floristics of India. Taiwania, 61(3): 224–242.
41. Ravishankar, T., Navamuniyammal, M., Gnanppazham, L., Nayak, S.S., Mahapatra, G.H. and Selvam, V. (2004): Atlas of Mangrove Wetlands of India. Part 3-Orissa, M. S. Swaminathan Research Foundation Chennai, India.
42. Roy, S.D., Krishnan, P., George, G., Kaliyamoorthy, M. and Bharthi, M.P.G. (2009): Mangroves of Andaman and Nicobar Islands. Central Agricultural Research Institute, ICAR- Port Blair.
43. Sakthive, K., Thirunavukkarasu, P. and Kathiresan, K. (2014): Mangroves and associates in the estuaries of Tamil Nadu coast of India, International Journal of Marine Science, 4(58): 1-7.
44. Santisuk, T. (1983): Taxonomy and Distribution of Terrestrial Trees and Shrubs in the mangrove formations in Thailand. Nat.Hist. Bull. Siam Soc., 31(1): 63-91.
45. Saxena, H.O. and Brahamam, M. (1994-96): The flora of Orissa, vol. I-IV, RRL. & OFDC Ltd., BBSR.
46. Selvom, V. (2003): Environmental classification of mangrove wetlands of India. Current science, 84 (6): 757-765.
47. Selvam, V., Eganathan, P., Karunagaran, V.M., Ravishankar, T. and Ramasubramanian, R. (2004): Mangrove Plants of Tamil Nadu. M.S. Swaminathan Research Foundation Chennai.
48. Singh, V.P. and Odaki, K. (2004): Mangrove ecosystem: Structure and function. Scientific publishers (India), Jodhpur.
49. SAC (2012): Coastal Jones of India. Ahmedabad, India.
50. Spalding, M.D., Blasco, F. and Field, C.D. (1997): World Mangrove Atlas. The International society for mangrove ecosystem, Okinawa, Japan.
51. Spalding, M., Kainuma, M. and Collins, L. (2010): World Atlas of Mangroves. Earthscan, London, UK and Washington DC, USA.
52. Tomilinson, P.B. (1986): The Botany of mangroves. Cambridge University Press.
53. Untawale, A.G. (1986): India, Country Report: Asia.In. Mangroves in Asia and Pacific: Status and management, Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and Pacific (RAS/79/002), Quezon City, Metro, Manila, 51-87.
54. Upadhyay V.P. and Mishra P.K. (2008): Population status of mangrove species in estuarine regions of Orissa coast, India. Tropical Ecology, 49(2): 183-188.
55. Upadhyay, V.P. and Mishra, P.K. (2010): Phenology of mangroves tree species on Orissa coast, India.Tropical Ecology, 51(2): 289-295.
56. Upadhyay, V.P., Mishra, P.K. and Sahu, J.R. (2007): Vegetation Structure and Species Distribution Pattern of Mangrove Species in Bhitarkanika Ecosystem, Orissa, India. Asian Journal of Water, Environment and Pollution, 5(4): 69-76.
57. Wang, L., Mu, M., Li, X., Lin, P. and Wang, W. (2010): Differentiation between true mangroves and mangrove associates based on leaf traits and salt contents. Journal of Plant Ecology, 1–10.