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Research Articles

Distribution of Mangrove Species within Bhitarkanika National Park in Orissa, India

V. P. Upadhyay[1]*, P. K. Mishra[1] and J. R. Sahu[2]

1 Ministry of Environment and Forests, Eastern Regional Office, Bhubaneswar, Orissa, India 751 023, **2** Government College, Bhadrak, Orissa, India, *Author to whom correspondence should be directed

Mangrove forests are extraordinarily diverse coastal communities anchored by salt-tolerant plants along certain tropical seacoasts. Their distinctive aerial roots help to trap sediment, prevent shoreline erosion, and provide habitat for a variety of sea life. Their unique mode of viviparous reproduction (producing seeds that germinate before becoming detached from the parent plant) allows for the rapid dissemination of viable young plants. Mangrove swamps or forests are among the most productive wetlands on the planet. They are also under intense pressure from development, population spread and pollution. The mangroves of Bhitarkanika National Park, in the Kendrapara district of Orissa, India (located at approximately 20°40'N, 87°00'E) make up about 700 of the 2500 sq. km of mangroves on India's east coast. This mangrove forest is home to one of the largest nesting colonies of sea birds in India, including a variety of egrets, cormorants and herons, as well as an enormous diversity of fish, shrimp, prawn, crabs and other larger marine animals including saltwater crocodiles and sea turtles. The following report evaluates species density and relative distribution amongst four sites within the Bhitarkanika reserve, using standard ecological sampling methodology.

Mangrove forests are evergreen estuarine and open systems which receive nutrients, fresh water and sediments from terrestrial environments. Mangroves vary both in their salinity tolerance and the degree to which salinity may be necessary to maintain their growth and competitive dominance (6). Mangroves grow throughout the tropics wherever the average monthly minimum temperature is 20^0C (4). The ecological importance of these ecosystems for maintaining marine life, their high productivity and role in supplying organic material to coastal marine ecosystems have been demonstrated in many studies (12, 14, 17). The mangroves import nutrients, fresh water and sediments from the terrestrial environment and outflow organic matter and water to the marine and estuarine environment. Coastal mangroves perform regulatory functions by reducing coastal erosion and flooding, supplying nutrients, and retarding runoff. They provide vital shelter belts to protect inland homesteads, agriculture, livestock, and other properties located in near-shore environments. Mangroves ensure improved fish catch to coastal communities and thus have great socioeconomic value (1). The mangrove areas provide habitat for spawning and nursery ground for various marine species like fishes, shellfishes, crustaceans and other invertebrates (9, 15, 21). India has deltaic, estuarine, backwater, sheltered and insular bay types of mangrove formations (3). About 56.7% of the total mangrove area of India is found along the east coast, 23.5% on the west coast and 19.8% in the Andaman and Nicobar islands (11). Mangroves are spread over an area of 214 sq. km in Orissa (11). There is an increase of 4 sq. km compared to a 1997 assessment (10, 11) with an increase reported in Bhadrak and Kendrapara districts. However, there is an overall decline in quality and quantity of mangrove cover in Orissa mainly due to shoreline changes, settlements, sediment loading and conversion for agriculture and aquaculture (21).

We carried out a phyto-sociological study in the Bhitar-kanika Mangrove Sanctuary located on the eastern coast of the state of Orissa, India at 4 sites (i.e. Dangmal, Bhitarkanika, Tha-kurdia and Ka-kranasi blocks [Figure 1]). At

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Email: vpupadhyay@hotmail.com
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each site, 30 quadrats of 10 m x 10 m were sampled randomly, thus totaling 120 quadrats with a total area of 12,000 m². *Excoecaria agallocha* was generally the densest species at all sites (Table 1). In Dangmal Block 20 species from 14 families were recorded. *Heritiera fomes* had the highest density followed by *Excoecaria agallocha* and *Cynometra ramiflora,* with *Xylocarpus molluccensis* and *Brownlowia tersa* showing the lowest density. Bhitarkanika Block encompasses a total of 24 tree species belonging to 13 families and has a similar trend of species density. However, *Avicennia alba* and *Thespesia populnea* exhibited lowest density at this site. Sixteen species were found from 11 families in Thakurdia Block. *Excoecaria agallocha* showed the highest density, followed by *Ceriops decandra* and *Lumnitzera racemosa. Xylocarpus granatum* and *Kandelia candel* were observed having the lowest density. In Kakranasi Block 17 tree species from 10 families were recorded. *Excoecaria agallocha* and *C. decandra* exhibited highest density. *B. gymnorrhiza , R. apiculata, S. apetala* and *X. mekongensis* showed lowest density. These mangrove areas and species provide diverse ecological and socioeconomic services to humans and the coastal environment. Several species are used for fuel wood, fodder, and timber purposes and also have medicinal values. The *Heritiera* species is known for the durability and strength of its wood. *Avicennia* is used as fodder. Indigenous medicines are prepared from *Bruguiera gymnorrhiza* (diarrhea and to control blood pressure), *Rhizophora mucronata* (angina), *Acanthus ilicifolius* (asthma, rheumatism), *Lumnitzera racemosa* (herpes and itches), *Cynometra ramiflora* and *Excoecaria agallocha* (Leprosy). Further, these plants are also used to treat various other disorders like headache, abdominal troubles, skin diseases, etc. (21).

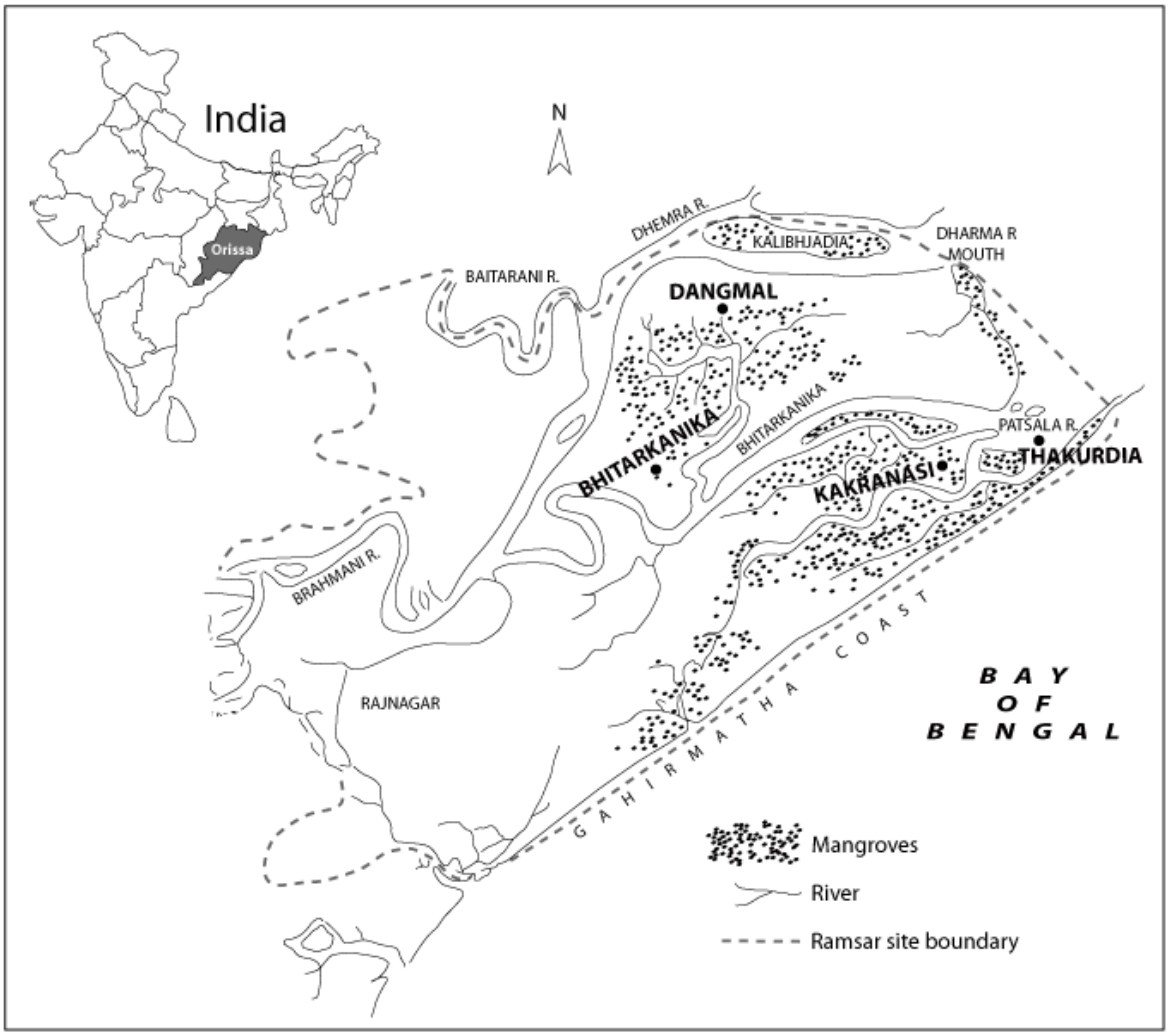

Figure 1: Location of study sites (in bold) in Bhitarkanika Mangrove Sanctuary, on the eastern coast of the state of Orissa, India

Among the 4 study sites, the species number is highest in Bhitarkanika block. This block, along with Dangmal, is a core area of wildlife sanctuary. *Cerbera manghas* is found only in Bhitarkanika and Dangmal forest blocks with a density of 43/ha in Bhitarkanika and 17/ha in Dangmal block. *E. agallocha* is a dominant species at all sites. This species is a characteristic mangrove associate occurring in the back mangal areas (landward zone) (20) and has highest density at Thakurdia block among all species and sites. This species could be a primary mangrove element at the Thakurdia block due to peculiar topography and a higher elevation. Although tidal amplitude in the nearby Baunsagada River is high (2-5 m) most areas do not get regular tidal inundation. It is possible that this forest block has been through the usual successional stages of early colonizers (*Porteresia coarctata, Myriostachya wighitiana*) having a characteristic assemblage of associated species such as *Salvadora persica, Caesalpinia crista,* etc.

Bhitarkanika has the highest species diversity among all study sites (5.33 species per quadrat). Statistical analysis to find the correlation between species diversity and density established that there is a strong positive relationship between the above parameters across all sites with a value of coefficient of determination above 81% ($r = 0.911$-0.932; $p < 0.001$). Species richness is higher (> 30 to 55 species) at latitudes between 0 and 20^0 (N or S) and at longitudes between 70 and 135^0E (7). It is highest in the Indo West Pacific and declines relatively smoothly from the peak species richness of 100^0 E longitude (8)**.** No records are available regarding the changes in the species composition in Bhitarkanika areas. The main reason for changes in species composition is reduction in the periodicity and quantity of fresh water reaching the mangrove environment (18). This system is still not much affected by such factors. The floral components, forest structure, and biomass of the mangrove wetlands are governed at the micro level by soil and water salinity and particularly by the salinity of the water that is present in the pores of the soil (5). The presence and luxuriant growth of salt-marsh succulent species such as *Suaeda spp*. are indicative of an increase in salinity (13) and a degrading mangrove site. However, such luxuriant growth of *Suaeda* is not reported from all the forest blocks in Bhitarkanika and therefore it could be said that an increase in salinity is not a stress factor in the area.

The Biodiversity Conservation Prioritisation Project (BCPP) India and Zoo Outreach Organisation, India through the CAMP (Conservation Assessment and Management Plan) noted 12 (20%) Indian mangrove species Critically Endangered, 40 Endangered (66%), 5 (8%) Vulnerable, 1 at Lower Risk near Threatened (*Salicornia brachiata*), 1 under the category of Lower Risk Least Concern (*Acrostichum aureum*) and 1 species could not be evaluated (16). The IUCN criteria were used for assessing the status of the species. We also categorized the mangrove species of Bhitarkanika following the above criteria.

Species of Bhitarkanika that are Critically Endangered are: *A. alba*, *A. marina*, *B. gymnorrhiza*. Species that are listed as Endangered are: *A. ilicifolius, A. rotundifolia, A. corniculatum, A. cucullata, A. officinalis, B. tersa, C. manghas, C. decandra, H. fomes, K. candel, L. racemosa, M. wighitiana, P. paludosa, S. apetala, S. caeseolaris, T. troupii, X. granatum, X. mekongensis*, and *X. molluccensis*. Species that are identified as Vulnerable are: *E. agallocha, P. coarctata*, and *R. mucronata*.

The vegetation of Bhitarkanika and the adjacent Mahanadi delta is diverse and seems to be among the richest of the world. The estuarine regions of Bhitarkanika do not have species like *Sonneratia griffithii,* which is available in the Sundarbans area of west Bengal. *H. fomes*, *S. griffithii* and *Aegialitis rotundifolia* are endemic to the coastal part of South Asia (2). Although the structural attributes of mangrove vegetation of Bhitarkanika studied during the present investigation do not indicate conspicuous signs of degradation, a conservation and management plan should take note of differences in species number and absence of some species from some sites to develop regeneration strategies. Further, the above classification has established that more species are in the Endangered category, thus requiring special management intervention to increase the species population in this mangrove ecosystem. Research on the reproductive life history of these species, including the knowledge of hydrodynamic functions of the ecosystem, is immediately needed and will be useful to develop scientific conservation and management plans for mangroves of Bhitarkanika Sanctuary.

Table 1: Number of plants per hectare at the study sites

Species	Dangmal	Bhitarkanika	Thakurdia	Kakranasi	Average for the area
Excoecaria agallocha	1568	1772	5814	5188	3586
Heritiera fomes	3267	3080	833	866	2012
Cynometra ramiflora	1199	759			979
Phoenix paludosa	70	23	160		84
Hibiscus tiliaceous	260	83		30	124
Pongamia pinnata	180	67			124
Avicennia officinalis	80	196	50	1212	385
Sonneratia apetala	50	236	13	17	79
Kandelia candel	27	53	10		30
Amoora cucullata	40	123			82
Rhizophora mucronata	40	63	30	40	43
Hertiera littoralis	47				47
Cerebra manghas	17	43			30
Xylocarpus granatum	37	73	10	13	33
Aegiceras corniculatum	176	363	1868	150	639
Bruguiera gymnorrhiza	70	60		7	46
Tamarix troupii	20				20
Ceriops decandra	30	103	4222	3750	2026
Xylocarpus molluccensis	3	40			22
Brownlowia tersa	7	13			10
Intsia bijuga		27			27
Sonneratia caeseolaris		73	17	1012	367
Avicennia alba		10	726	969	568
Thespesia populnea		10	17	7	13
Rhizophora Apiculata		20		10	15
Xylocarpus mekongensis		33		10	22
Aegialitis rotundifolia			203	107	155
Lumnitzera racemosa			1875	150	1014
Avicennia marina			246		246

References

1. Bennett EL and CJ Reynolds (1993). The value of a mangrove area in Sarawak. *Biodiversity Conservation* 2:359-375.
2. Blasco F, M Aizpuru and C Gers (2001) Depletion of the mangroves of continental Asia. Wetlands Ecology and Management 9:245-256.
3. Blasco F and M Aizpuru (2002) Mangroves along the coastal stretch of Bay of Bengal: present status. Indian Journal of Marine Science 31(1):9-20.
4. Chapman VJ (1976) Mangrove Vegetation. J. Cramer, Vaduz, Liechtenstein.
5. Clough BF (1992) Tropical mangrove ecosystems (editors- DM Alongi and AI Robertson), American Geophysical Union, Washington DC, 225-250.
6. Ellison AM and EJ Farnsworth (2001) Mangrove communities. Pages 423-442 in: M. D. Bertness, S. D. Gaines & M. E. Hay, editors. *Marine Community Ecology*. Sinauer Associates, Sunderland, MA.
7. Ellison AM (2002) Macroecology of mangroves: large scale patterns and processes in tropical coastal forests. *Trees* 16:181-194.
8. Ellison AM, EJ Farnsworth and E Merkt (1999) Origins of mangrove ecosystems and the mangrove biodiversity anomaly. *Global Ecology Biogeography* 8:95-115.
9. Fromard F, H Puig, E Mougin, G Marty, J Betoulle and L Cadamuro (1998) Structure, above-ground biomass and dynamics of mangrove ecosystems: new data from French Guiana, *Oecologia* 115:39-53.
10. FSI (1997) State of Forest Report-1997, Dehra Dun, India
11. FSI (1999) State of Forest Report-1999, Dehra Dun, India
12. Hutchings P and P Saengar (1987) *Ecology of mangroves*. University of Queensland Press, St. Lucia.
13. Kathiresa, K (2000) A review of studies on Pichavaram mangrove, Southeast India. *Hydrobiologia* 430:185- 205.
14. Lugo AE, RR Twilley and C Patterson-Zucca (1980) The role of black mangrove forests in the productivity of coastal ecosystems in south Florida, U. S. Environment Protection Agency, Corvallis, Oregon.
15. Ramasubramanian R, L Gnanappazham, T Ravishankar and M Navamuniyammal (2006) Mangroves of Godavari – analysis through Remote sensing approach. *Wetlands ecology and management.* 14:29-37.
16. Rao TA, S Molur and S Walker (Eds), (1998) Mangroves of India: Biodiversity Conservation Prioritisation Project-BCPP, India, Endangered species project, Conservation Assessment and Management Plan workshop, NIO Goa.
17. Rojas-Beltran R (1986) Role de la mangrove comm. Nourricerie de crustaces et de poissons en Guyane. Le Littoral Guyanais, fragilite de l'environment. Sepanguy-Sep-Anrit (editor), ler Congres Sepanguy Nature Guyanaise, Cayenne, 97-110.
18. Selvam V (2003) Environmental classification of mangrove wetlands of India, Current Science. 84(6):757-765.
19. Smith TJ III, (1992) Forest structure in: A. I. Robertson and D. M. Alongi (Eds), *Tropical Mangrove Ecosystems.* American Geophysical Union, Washington 101-136.
20. Tomlinson PB (1986) *The botany of mangroves*. Cambridge Tropical Biology Series, Cambridge University Press, 413 pages.
21. Upadhyay VP, R Ranjan and JS Singh (2002) Human mangrove conflicts—the way out. *Current Science* 83:1328-1336.