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Assessment of Floristic Diversity of Mangrove Vegetation in Bagagahan Heronry of the Bhitarkanika National Park, Odisha, India

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Abstract: The study describes the assessment of species diversity of the plant community of Bagagahan Heronry in the Bhitarkanika National Park, Odisha. Specific attention was made on the mangrove species of the study area based on flora data obtained during December 2013 and January in 2014. A total of 10 plant species belonging to 9 families were recorded from the study site, of which 4 plant species were from the core zone and 10 plant species from the non-core zone of the Bagagahan Heronry. In the core zone of the Bagagahan Heronry there highest importance value index (IVI) (237.92) was recorded for Excoecaria agallocha and in the non-core there the highest IVI was also recorded for Excoecaria agallocha (153.08) and least IVI was recorded for Hibiscus tiliaceus (4.37) in the core zone and Salacia prinoides (2.47) in the outer non-core zone. In sapling layer there Excoecaria agallocha had the maximum IVI in the core zone (288.57) and the same had also maximum IVI in non-core zone (276.83) and least IVI was recorded for Cynometra iripa (11.42) in core zone and Heritiera fomes (23.16) in the non-core zone. In seedling layer there higher seedling density was found in the non-core zone than the core zone. In seedling layer Excoecaria agallocha had the maximum IVI in core zone (219.35) and in non-core zone (240.79) and least IVI in core zone was recorded for Cynometra iripa and Hibiscus tiliaceus (3.373) in core zone and for Cynometra iripa, Ceriops decandra and Xylocarpus granatum (3.77) in the non-core zone. The highest dominance (D = Simpson Index of Dominance) was recorded for sapling (1) followed by trees (0.83) and seedlings (0.747) in the core and in the non-core zone there highest dominance was recorded for sapling (0.992) followed by seedling (0.951) and trees (0.82). The species diversity (H = Shanon Diversity Index) was recorded highest for seedling (0.458) followed by trees (0.378) and saplings (0.014) in the core zone and in the non-core zone the it was highest for trees (0.949) and lowest for saplings (0.028). The mean height of mangroves in the core zone was found to be 3.12m and in the non-core zone it was 5.25m. Plant community of both core and non-core zone are unstable and the unstable plant community of core zone is surrounded by a less unstable plant community of non-core zone of the Bagagahan heronry.

Key words: Heronry · Floristic Diversity · Importance value index (IVI) · Simpson Index of Dominance · Shannon Diversity Index · Pielous Evenness index · Bhitarkanika National Park

INTRODUCTION

Heronries the roosting, feeding and breeding ground of Herons, Egrets and other aquatic bird species are one of the integral components of nature that plays a key role for survivability of birds. Successful conservation programmes for the water birds in general and threatened species in particular requires better understanding of the ecology of these heronries [1].

Bhitarkanika is a paradise for birds. The Bagagahan heronry in the sanctum sanctorum of the Bhitarkanika National Park is one of Asia's largest heronries. Its secure abode in mangroves surrounded by crocodile prone the Bhitrakanika River and the Suajor creek is house of eleven species of migratory and resident herons providing a safe roosting, nesting and breeding ground. These birds congregate in large numbers with the onset of monsoon and use the mangrove trees for

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nesting. The stay in the heronry up to the arrival of winter until their nesting process gets over by the end of November [2].

Asian Open bill stork (Anastomus oscitans), Little Cormorant (Phalacrocorax niger), Little Egret (Egretta garzetta), Intermediate Egret (Egretta intermedia), Large Egret (Ardea alba), Purple Heron (Ardea purpurea), Night Heron (Nycticorax nyctiocorax), Grey Heron (Ardea cinera), Darter (Anhinga rufa), Black headed Ibis (Threskiornis aethiopica)and Cattle Egret (Bubulcus ibis) are seen to be nesting in the Bagagahan heronry. The mangrove host plants which support nesting of these birds include Excoecaria agallocha, Heritiera fomes, Cynometra iripa, Hibiscus tiliaceous and Tamarix troupii etc. Among them Excoecaria agallocha is the most common tree species on which these birds prefer to nest. The nesting activity area in Bagagahan is usually confines to 4 to 5 Ha of the area covered with mangroves and associates. Population wise, though the relative abundance of various species of nesting birds varies every year, the Asian Open bill storks are the dominant species which constitute 60 to 70% of the total population of the nesting birds of all species taken together (1)[3].

The highly productive detritus food chain of the Bhitarkanika Mangroves provides and ensures a supply of sufficient food for the nesting birds and their chicks for survival. Availability of suitable nesting material and safety due to less biotic and abiotic interference the Bagagahan heronry of Bhitarkanika attracts huge number of birds to breed and nest in its mangrove ecosystem. The extensive agricultural field within and periphery of the Bhitarkanika Sanctuary is also a primary source of food for these birds [4].

Over the years the birds use the same area for nesting and cut the tip of the nesting plant causing stunted growth of plants in that nesting area. The repeated use of the nesting site over the years by the heronry birds leads to change in vegetation structure of the site. Therefore the present effort is an analytical presentation of collected data on floristic diversity assessment and vegetation analysis of the Bagagahan heronry in the Bhitarkanika National Park [5].

MATERIALS AND METHODS

Study Site: The Bagagahan heronry is located within Bhitarkanika National park 20° 4' - 20° 8' N and 86° 45' - 87° E.), Odisha, India. The national park is 145 sq. km in area having dense virgin mangrove forest with crisscrossing tidal rivers and creeks. The Bagagahan heronry is situated in the Bhitarkanika Proposed Reserve Forest block surrounded by the Bhitarkanika River on the south and the Shuajor Creek on the north. The nests are formed on wide and strong canopy of mangroves covering an area of about 4 to 5 Ha. The mangrove stand in the heronry gets inundated regularly with tidal brackish water from the Shuajor creek and the ground remains submerged in tidal water during the monsoon at the time of nesting. The study site comes under tropical monsoon climate. Average annual rainfall is around 1600 cm, of which maximum rainfall is received during monsoon in between June to September. The site is a prevalence of tropical cyclones [6].

The study site was categorised into two parts. The nesting portion where the nesting herons build their nests, was designated as the core of the heronry and non-nesting portion, the periphery of the nesting area, adjacent to the core where the nesting herons do not build nests and do not use the tree canopy but occasionally roost on mangroves, was designated as non-core of the heronry. Both the zones were demarcated by earmarking the boundary of core with temporary paint and both the core and the non-core zone were delimited. The non-core zone surrounds the core zone of the heronry[7].

For the vegetation analysis of the core and non-core zone, there 15 quadrates were laid down in each category and floristic survey was carried out. There total of thirty 10 x 10 m quadrates each for trees (with a diameter more than 10 cm at breast height), 5 x 5 m quadrates for saplings (with a diameter less than 10 cm and more than 5 cm at breast height), 1 x 1m quadrates for seedling (with a diameter less than 5 cm) were laid. The DBH (Diameter at Breast Height = Diameter at 1.30 m above the ground) and height of all trees having diameter greater than 10 cm in each quadrate were measured and recorded. From the collected data, with deliberate computation of analysis the features such as density, frequency, abundance, basal area relative density, relative frequency, relative dominance and importance value index (IVI) were determined following standard phytosociological methods as given by …..(7). The importance value index (IVI) for the plant species was determined as the sum of the relative density, relative frequency and relative dominance (8,9). The tree species diversity was determined by using Shannon-Wiener information function (H) (10). Concentration of dominance was measured by Simpson's index (D) (11). The evenness of the plant community was measured by Pielous Evenness index (J)[8].

RESULT AND DISCUSSION

Floristic Diversity: A total of 10 plant species belonging to 9 families were recorded. Among the families Leguminosae had 2 species and all other families, i.e. Euphorbiaceae, Hippocrateaceae, Malvaceae, Meliaceae, Rhizophoraceae, Salvadoarceae, Sterculiaceae, Tamaricaceae were monospecific in this habitat i.e. represented by one species each. Among these plants species four plants species Excoecaria agallocha, Xylocarpus granatum, Ceriops decandra and Herotoera fomes are true mangroves whereas rest Hibiscus tiliaceaous Salacia prinoides, Pongamia pinnata, Salvador persica, Cynometra iripa and Tamarix troupii are mangrove associates [9].

Compositional Features: In the core of the Bagagahan Heronry there only 4 plant species were found at the time of survey of which highest IVI (237.92) was recorded for Excoecaria agallocha followed by Heritiera fomes (35.23), Cynometra iripa (22.49) and Hibiscus tiliaceus (4.37).

In the non-core zone there 10 plant species were recorded. Here too the highest IVI was recorded for Excoecaria agallocha (153.08) followed by Heritiera fomes (88.44), Cynometra iripa(25.75) and Hibiscus tiliaceus (13.96), Pongamia pinnata (4.96), Salvadora persica (3.18), Xylocarpus granatum (3.04), Tamarix troupii (2.60), Ceriops decandra (2.54), Salacia prinoides (2.47)[10].

Samplings: For saplings, in the core zone there two species Excoecaria agallocha and Cynometra iripa were recorded, of which Excoecaria agallocha had the maximum IVI (288.57) (Table 2). In the non-core zone there two species Excoecaria agallocha and Heritiera fomes were recorded of which Excoecaria agallocha (276.83) had the maximum IVI. (Table 2).

Seedlings: In case of seedlings there higher seedling density is found in the non-core zone than core zone. In the core zone there seedlings of 5 species were found of which Excoecaria agallocha (219.35) had the highest IVI followed by Tamarix troupii (65.553), Heritiera fomes (8.367) and Cynometra iripa (3.373) and Hibiscus tiliaceus (3.373) had the lowest IVI (Table 2).

In non-core zone there seedlings of 7 species were found of which Excoecaria agallocha (240.79) had the highest IVI followed by Heritiera fomes (32.98), Tamarix troupii (9.83), Cynometra iripa (5.06) and Ceriops decandra, Xylocarpus granatum and Hibiscus tiliaceus each had lowest IVI (3.77) (Table 2)[11].

Table 1: Plant diversity in the Bhagagana Heronry

Sl. No.	Plant Species	Family
1	Excoecaria agallocha	Euphorbiaceae
2	Salacia prinoides	Hippocrateaceae
3	Cynometra iripa	Leguminosae
4	Pongamia pinnata	Leguminosae
5	Hibiscus tiliaceus	Malvaceae
6	Xylocarpus granatum	Meliaceae
7	Ceriops decandra	Rhizophoraceae
8	Salvadora persica	Salvadoraceae
9	Heritiera fomes	Sterculiaceae
10	Tamarix troupii	Tamaricaceae

Table 2: Importance value index (IVI) and density of different species at different layers for both the core zone and non-core zone of the Bagagahan Heronry

		Core of Heronry	Non-Core Zone of Heronry
Sl. No.	Plant	IVI	IVI
Tree Layer			
1	Excoecaria agallocha	237.92	153.08
2	Heritiera fomes	35.23	88.44
3	Cynometra iripa	22.49	25.75
4	Hibiscus tiliaceus	4.37	13.96
5	Tamarix troupii	-	2.6
6	Pongamia pinnata	-	4.96
7	Ceriops decandra	-	2.54
8	Xylocarpus granatum	-	3.04
9	Salvadora persica	-	3.18
10	Salacia prinoides	-	2.47
Sapling Layer			
1	Excoecaria agallocha	288.57	276.83
2	Heritiera fomes	-	23.16
3	Cynometra iripa	11.42	-
Seedlings Layer			
1	Excoecaria agallocha	219.35	240.79
2	Heritiera fomes	8.367	32.98
3	Cynometra iripa	3.373	5.06
4	Hibiscus tiliaceus	3.373	3.77
5	Tamarix troupii	65.533	9.83
6	Ceriops decandra	-	3.77
7	Xylocarpus granatum	-	3.77

Table 3: Species Diversity Index and Dominance Index of plants communities' core zone and non-core zone of the heronry. D= Simpson Index of Dominance, H = Shannon Diversity Index, J=Pielous Evenness index

	Core Zoneof Heronry			Non-core Zone of Heronry		
	D	H	J	D	H	J
Tree	0.83	0.378	0.273	0.82	0.949	0.412
Sapling	1	0.014	0.020	0.992	0.028	0.040
Seedling	0.747	0.458	0.285	0.951	0.134	0.064

Table 4: Mean height of mangroves in the core zone of heronry and non-core zone of the heronry and their standard deviations

	Core Zone of Heronry	Non-Core Zone of Heronry
Plants' Mean Height in meter	3.12	5.25
Standard Deviation	0.72	1.71

Species Diversity Index and Dominance Index: The species Diversity Index and Dominance Index of core and non-core are Provided in Table 3. The highest dominance (D = Simpson Index of Dominance) was recorded for sapling (1) followed by trees (0.83) and seedlings (0.747) in the core and in the non-core zone it is highest for sapling (0.992) followed by seedling (0.951) and trees (0.82).

The species diversity (H = Shanon Diversity Index) was recorded highest for seedling (0.458) followed by trees (0.378) and saplings (0.014) in the core zone and in the non-core zone the species diversity was highest for trees (0.949) and lowest for saplings (0.028).

The Pielous Evenness index was more for tree layer and sapling layer in the non-core zone than the core zone but it was reversed in layer of seedlings [12].

Height of the Plants: The mean height of mangroves in the core was found to be 3.12m with a standard deviation of 0.72m and in the non-core zone the mean height of mangroves was 5.25m with a standard deviation of 1.71m (Table 4).

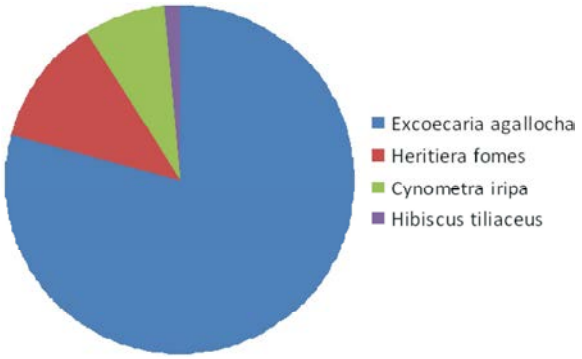

Fig. 1: Pi Chart showing the IVI of plant communities in core zone of the Bagagahan Heronry

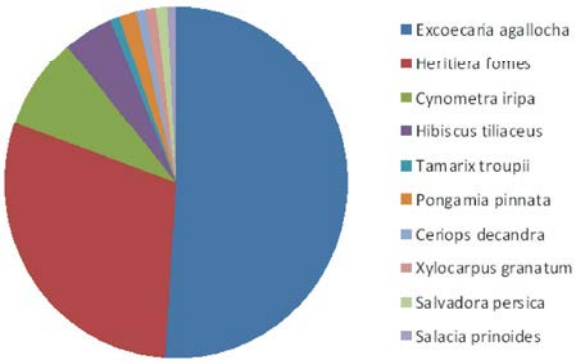

Fig. 2: Pi Chart showing the IVI of plant communities in non-core zone of the Bagagahan Heronry

DISCUSSION

In the Bagagahan heronry, both the core zone and the non-core zone differ in species composition, dominance and species diversity. Data presented in Table 2 shows that the non-core zone is more diverse compared to the core zone. In both the zones Excoecaria agallocha is dominant plant species followed by Heritiera fomes, Cynometra iripa and Hibiscus tiliaceus. In the non-core zone the species richness is more compared to the core zone. The dominance of Excoecaria agallocha decreases with increase in species diversity in the non-core zone with compare to the core zone taking the IVI as the measurement of dominance. With an increase in species diversity in the non-core zone the IVI of Heritiera fomes, Cynometra iripa and Hibiscus tiliaceus also increases in comparison to the core zone. Excoecaria agallocha is the dominant tree species in both core and non-core zone of the Bagagahan Heronry.

Map 1: Location of Bagagahan, Bhitarkanika National Park

Map 2: Location of Bagagahan, Bhitarkanika National Park

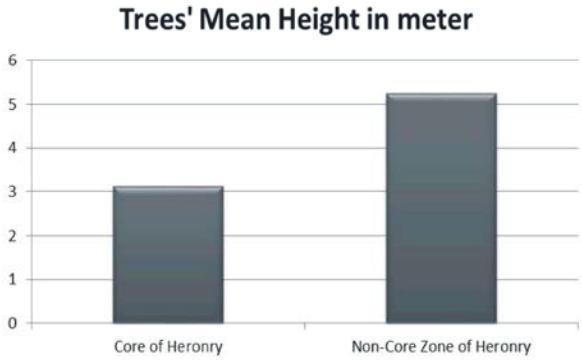

Fig. 3: Tree means height in meter bagagahan, Bhitarkanika national park.

From the above findings it can be concluded that with the increase in species richness and diversity, the IVI of the dominant plant species particularly Excoecaria agallocha, which is dominant in both the zones decreases. The IVI of Excoecaria agallocha is found to be less in the non-core zone than the core zone is due to increase in species richness in non-core zone compare to the core zone. The increase of IVI value of Heritiera fomes, Cynometra iripa and Hibiscus tiliaceus in the non-core zone than the core zone is due increase in plant diversity.

In case of saplings there Excoecaria agallocha is dominant in both the zones having highest IVI (Table 2). In core zone the IVI value of Excoecaria agallocha (288.57)

Fig. 4: Panaromic view of Bagagahan in Bhitarkanika National Park

Fig. 5: Nest of Asian Openbill storks in Bagagahan, Bhitarkanaika National Park

is more as compare to its IVI value in the non-core zone (276.83). It can be inferred that with increase of species diversity in this habitat the dominance of Excoecaria agallocha decreases. In the layer of seedlings the dominant plant species in both the core and the non-core zone is Excoecaria agallocha.

The heronry's non-core zone has more plant species diversity than the core zone in tree and sapling layers but its reverse for seedling layer. The Shannon Diversity Index for trees is higher in the non-core zone than the core zone, which clearly indicates that the plant community of the core zone is disturbed over the year due nesting of the herons. In the plant community of non-core zone there a greater number of species present. The Simpson's dominance indices obtained from the study reveals that there is minute difference in dominance of the plant community in both tree and sapling layers. The plant community of the core zone and the non-core zone is dominated by Excoecaria agallocha but the core zone containing even amounts of 3 others species and the non-core zone containing even amounts of 9 other species and hence both the zones are considered to be communities of less diversity.

The Pielous evenness index obtained from the study is higher for the non-core zone than the core zone for both trees and sapling layers but, this is not happening in case of seedlings where it is higher in the core zone than the non-core zone. The mature and stable plant communities always have a higher evenness index i.e. in between 0.6 to 0.9 on a zero to one scale (12). Here the core zone and non-core zone have Pielous Evenness index 0.273 and 0.412, both much lower than the evenness index of a stable plant community. The plant community of both core zone and the non-core zone are unstable but the inner core zone is more unstable than the outer non-core zone. This provides safety and security to the nesting birds in the heronry.

This is due to repeated use of the same trees over the years as nesting trees by the nesting herons. During nesting time, the birds cut the tip of the branches and build nests over them resulting in breaking off growth of branches resulting in stunted growth of the tree. In the core zone of the heronry all the trees have a similar fate, having stunted growth due to regular nesting of herons on them. The plants of the surrounding non-core zone have usual growth as these are not being used by the birds for the nesting purpose. This leads to the formation of a saucer shaped concave depression in canopy structure of the heronry which can be clearly visualised in panoramic view.The unstable plant community of the core zone is surrounded by a more stable and heighted plant community of non-core zone. This provides a safety to the nesting birds and their nests from normal winds as well as from cyclonic threats as this area is a prevalence of tropical cyclones during September and October.

Successful conservation of herons and other aquatic birds need an improved understanding of ecology of heronries, the paradise of breeding population of herons, egrets and other aquatic birds.

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