

Full Length Research Paper

Studies on the prospects and some problems of sand dune vegetation at the fragile coastal zones of West Bengal and Orissa, in Eastern India

Tamal Chakraborty¹, Amal Kumar Mondal^{1*} and Sanjukta Mondal Parui²

¹Plant Taxonomy, Biosystematics and Molecular Taxonomy Laboratory, Department of Botany and Forestry, Vidyasagar University, Midnapur- 721102, West Bengal, India.

²Department of Zoology, Lady Brabourne College, P1/2, Suhrawardy Avenue, Kolkata – 700 017 West Bengal, India.

Accepted 10 January, 2012

Sand dunes are natural guard wall at coast line through out the world. The sand dune constitutes different types of plants with different habits but moreover all of the plants having stress tolerance capability and more or less soil binding capacity. The sand dune demands immediate attention for conservation as the vegetation is going towards destruction due to the development and other anthropogenic activities along the coastal areas. The sand dune also needs further study as several morphological, chemo-taxonomical variations are already been observed under different physiological conditions. This paper reports some preliminary study on the species found within the sand dune (including habit, habitat, morphological features, flowering time, floral biology, seed structure, pollen morphology and some biochemical studies) of several places along the coastal line of West Bengal and Orissa. Reasons behind the destruction of the sand dune have been studied and the strategies were also proposed for possible conservation and implementation of sustainable use of sand dune vegetation in coastal areas for the benefit of farmers particularly for food, fodder and health aspects.

Key words: Sand dune, stress, conservation, sustainable use.

INTRODUCTION

The loss of biodiversity is a world wide concern in today's perspective and more often it is accompanied with forest destruction and degradation of wild habitat. Although much effort has been put into restoring and preserving tropical ecosystem such as rainforests, mangrove swamps, and coral reefs, preservation of tropical, costal sandy plant communities has been largely ignored (Condit, 1995, Mulkey et al., 1996, Sheil and May, 1996, Kennish 2001). The dynamics of sand deposition and removal, high levels of salt accumulation along with geomorphologic processes causing havoc environmental stress condition with seasonal occurrence of soil erosion. Constant flow of winds and solar radiation also play a role in decreasing plant water contents (Jefferies et al., 1979).

Several investigations on distribution patterns of dune vegetation clearly revealed the fact of reduction in vegetation recorded earlier. For revealing the clear knowledge about the status of the colonizer species the floral biology, ecology, some biochemical analysis well documented along with the reasons of destruction of these species at this region. To implement conservation activities, studies documenting the biotic components of viable beach communities much first be carried out to provide the necessary data for planning and directing these activities.

MATERIALS AND METHODS

The study was carried out on the zone of Bay of Bengal specifically from the Purba Medinipore district of West Bengal to the end part of Orissa (Figure 1) Which lies in between the latitude 21°36'50"N and 19°48'00"N and longitude ranging from 85°52'40"E to 87°

*Corresponding author. E-mail: amalcaebotvu@gmail.com.

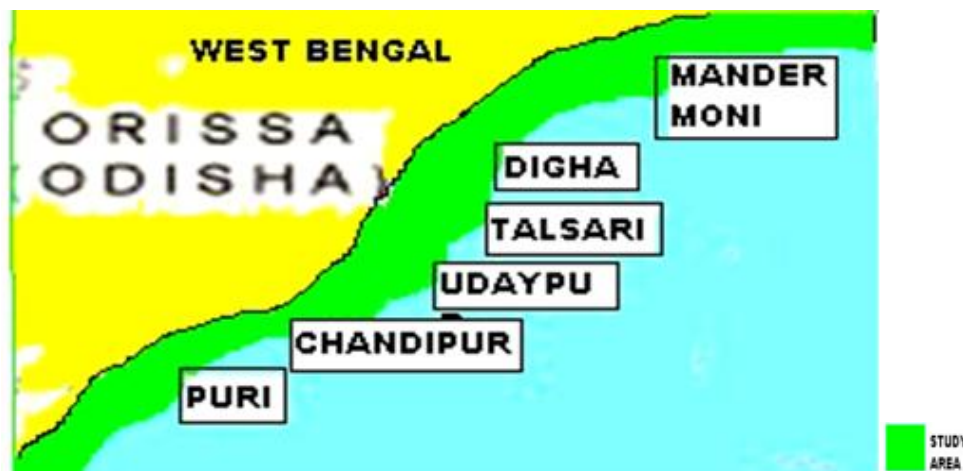


Figure 1. Study area.

Table 1. The soil sample analysis.

State	Coastal site	Sand quality	pH	Organic matter
WestBengal (East Medinipore district)	Mandarmoni	Medium to Fine	7.5 – 7.6	0.07-0.23
	Shankarpur	Medium	7.3-7.4	0.07-0.21
	Digha	Coarse	7.1-7.2	0.01-0.14
	New Digha	Coarse	7.1-7.2	0.02-0.12
Orissa (Jaleswar, Puri District)	Talsari	Medium to Fine	7.5-7.6	0.08-0.21
	Udaypur	Medium	6.8-7.0	0.07-0.15
	Puri	Coarse	7.0 – 7.1	0.01-0.07

37°00"E covering near about 325 km of coast line from Purba Medinipore district of West Bengal to Puri district of Orissa and it is evident that as much as 70 km is vulnerable to severe sea-erosion particularly during the south-west monsoon. After consulting geographical map of this particular area the beaches namely Mandarmoni, Sankarpur, Digha, New Digha of West Bengal and Talsari, Udaypur, Chandbali, Puri-Konarak marine drive, Gopalpur of Orissa were several time visited by our team at different season from August 2006 to June 2010 and the data were well documented including the records of native sand dune species composition.

Free amino acids were extracted from the leaves using the methods of Bielecki and Turner²⁶. 100 mg of the sample was ground at -20°C and 4 ml of methanol: chloroform: water (12:5:3 v/v) was added and vortexed for 2 min, and then centrifuged at 900 g for 10 min. The pellet was re-extracted with 2 ml of methanol: chloroform: water, vortexed and centrifuged for 5 min. The procedure was repeated 2 ml of 80% of ethanol. The supernatant were combined and phase separation achieved by adding 2 ml of Chloroform and 1.5 ml of deionised water followed by centrifugation at 900 g for 10 min. The aqueous extract was dried under vacuum and amino acids resolubilized in 500 ml of 0.01 M HCL. This extract was used both for quantitative and qualitative analysis of free amino acids.

Qualitative analysis of the free amino acids of the leaves of the investigated taxa was done using thin layer chromatography (TLC). DC-Alufolien Kieselgel 60 aluminium sheet (Merck) were used for performing TLC, according to the methods described by Sadashivam and Manickam (1996). The TLC sheets were activated by heating in an oven for 30 min. at 100-120°C, and the amino acids

extract spotted on them and chromatographed using *n* butanol: acetic acid: water (80:20:20 v/v) as eluant and 0.1% ninhydrin in acetone as spraying reagent. The amino acids were detected by heating the sheets at 110°C for 5 min. and the *R_f* values were calculated. The spots were identified by comparing with the *R_f* values of standard amino acids.

RESULTS AND DISCUSSION

Climatic factor

In summer, temperature is as high as 45°C, in winter it goes down at 14-15°C. May and June are the hottest months of a year. Average annual rainfall is 200 to 220 mm, it has been also seen that naturally growing grasses, shrubs and trees like *Pandanus tectorius* are frequently damaged by warm air blow during summer season.

Edaphic factor

There are mainly two types of soil in this region of the coastal zone of Bay of Bengal namely sandy soil and sandy loam. The pH of different soil type is shown in Table 1.

Table 2. Species cover H-High, M-Moderate and L-Low for Different Sites like W-West Bengal, O-Orissa.

Family	Species	W ^M	W ^D	W ND	O ^T	O ^C	O ^G
Rutaceae	<i>Hydrophyllx maritime</i>	M	L	L	M	M	L
Convolvulaceae	<i>Ipomoea pes-caprae</i>	H	L	L	L	M	H
Poaceae	<i>Spinifex squossus</i>	M	N	N	N	L	M
Verbenaceae	<i>Lippia cordifolia</i>	M	L	L	M	M	L
Euphorbiaceae	<i>Jatropha gossypifolia</i>	L	L	L	L	L	L
Pandanaceae	<i>Pandanus fascicularis</i>	H	L	M	L	H	H
Fabaceae	<i>Crotalaria falcate</i>	M	L	L	M	L	M
Fabaceae	<i>Crotalaria pallida</i>	M	L	L	L	M	M
Casuarinaceae	<i>Casuarina equisetifolia</i>	H	M	H	H	H	M
Cuctaceae	<i>Opuntia monocantha</i>	M	L	L	M	M	M
Arecaceae	<i>Phoenix sylvestris</i>	H	M	M	H	M	M
Fabaceae	<i>Alysicarpus homosus</i>	M	L	L	M	M	M
Fabaceae	<i>Dolichos ciliatus</i>	M	N	N	M	L	L
Poaceae	<i>Paspalum distichum</i>	M	L	L	M	M	M
Chenopodiaceae	<i>Salicornia sp</i>	H	L	L	M	L	H
Mimosaceae	<i>Prosopis spicigera</i>	M	L	L	M	M	M
Cyperaceae	<i>Cyperus rotundus</i>	H	M	M	H	H	H
Asclepiadaceae	<i>Calotropis gigantia</i>	M	L	L	M	L	M
Fabaceae	<i>Cannavelia rosea</i>	H	L	L	M	L	M

Abb.- W^M-Mandermoni, W^D-Digha, WND- New Digha, O^T-Talsari, O^C-Chandipur, O^G-Gopalpur

Vegetation

The distribution and diversity of vegetation is mainly controlled by the edaphic and climatic factors. Consideration of community patch size (>25 m x 10 m) and lack of disturbances to the plant community and its surrounding were the main factors used for choosing sites. Several of the sandy coastal sites visited were devoid of vegetation or were sparsely covered with road side grasses that had invaded the regions. This was a direct result of human disturbances such as dumping, footpaths and urban structures.

Vegetation zonation

Typical zonation can be observed easily on the sand dunes. The zonation and the corresponding species are listed in Table 2.

Floristic study

The floristic composition (Figures 2 to 12) of these tropical communities was dominated by some of the larger plant families including Asteraceae, Fabaceae, Poaceae and Convolvulaceae. Although species composition at various sites on the coastal zone of West Bengal and adjacent Orissa, there were similarities among species encountered at sites within this region. Overall, examination of relative cover for the various species present on the different zones indicated a strong

dominance by the self incompatible flowering plant (Devall and Thien, 1991) *Ipomoea pes-caprae* (Figure 15a and b) followed by *Sesuvium portulacastrum* and *Blutaparum vermiculare* (Table 3).

Perennial herbaceous plants dominated growth forms in these sandy communities. Low lying shrubs such as *Vigna lutiola* and *Crotalaria pallida* were less frequently encountered. Two growth forms commonly encountered among the sandy plant communities were succulent perennials (*Ipomoea pes-caprae*, *Sesuvium portulacastrum*) and sclerophyllous grasses (*Sporobolus dirginicus* and *Paspalum vaginatum*). Annual plants, *Heliotropium curassavicum* and *Clotalaria retusa*, encountered at sites examined where not as numerous, with the communities dominated by perennial species. Plant organs (leaves and stems) did not indicate damaged patches of any kind and had no desiccated spots common to plants growing in nutrient-poor or water stressed region. Morphological and structural examination of plants indicated robust, thriving individuals in these undisturbed communities.

Primary pollinating agents

Bees, ants, beetles, wasps, butterflies, moths, fly.

Biochemical study

Qualitative analysis of the free amino acids of the leaves



Figure 2. Mat formation *I.pes-caprae* with beautiful flower at Puri-Konarak Marine drive.



Figure 3. Flower of *Ipomoea pes-caprae* with pollinating agent.



Figure 4. Flower of *Spinifex squarossus* at Mandermoni, West Bengal.



Figure 5. Important sea shore plant *Gisekia pharnaceoides* (Gisekiaceae).



Figure 6. *Pandanus fascicularis* secondary mangrove plant important soil binder.



Figure 7. *Salicornia perennis*, very common in the sea beach.



Figure 8. Effect of warm air blow on *Pandanus fascicularis*.



Figure 9. *Cannavella lineata* an economically edible important sea shore bean.



Figure 10. *Tylophora indica* an important sea shore plant having high medicinal value.



Figure 11. *Sesuvium portulacastrum* (Family: Aizoaceae) an important seashore beautiful medicinally important plant.



Figure 12. *Calophyllum inophyllum* oil yielding plant in the sea shore areas.

of the investigated taxa was done using thin layer chromatography(TLC).DC-Alufolien Kieselgel 60 aluminium sheet (Merck) were used for performing TLC, according to the methods described by Sadashivam and Manickam(1996). It has been observed that dominant present of proline may take a vital role in stress tolerance (Table 4 and Figure 13).

Conservation

Threats to the biodiversity

(1) After the preliminary study we can conclude that the sand dune vulnerability at this area is mainly due to human disturbance. The survey along the coastal line of Purba Medinipore district of west Bengal clearly reveals and proves the aforementioned statement. The stable

Table 3. The floristic succession preliminary found at the coastal part of East Midnapur, West Bengal.

S/N	Edaphic status	pH	Vegetation	Floristic elements
1	Part under direct tidal influence	7.5 -7.9	No vegetation found	No
2	Semi aerated upper tidal zone	7.3 – 7.6	Sparse elements	<i>Hydrophyllax maritima</i>
3	Outer Strand zone (well aerated sandy soil with leached out upper surface)	7.2-7.5	Pioneers species found	<i>Ipomoea pes-caprae</i> , <i>Spinifex squarossus</i> , <i>Lippia</i> sp., <i>Hydrophyllax maritime</i> , <i>spinifex littoreus</i> , etc.
4	Central strand zone	7.0-7.3	Pioneers and associated species found.	<i>Ipomoea pes-caprae</i> , <i>Cyperus</i> sp., <i>Euphorbia</i> sp., <i>Crotalaria</i> sp. <i>Tephrosia</i> sp., <i>Launea</i> sp. <i>Sesuvium portulacastrum</i> . <i>Vigna lutiola</i> , <i>Crotalaria pallid</i> , <i>Paspalum vaginatum</i> etc.
5	Inner strand zone(high humus)	6.8-7.0	Mixed ground vegetation with background trees	<i>Casuarina equasetifolia</i> , <i>Pandanus fascicularis</i> , <i>Phoenix sylvestris</i> , <i>Cocos nucifera</i> , <i>Opuntia monacantha</i> , <i>Calotropis procera</i> , <i>Salicornia</i> sp etc.

Table 4. Qualitative analysis of free amino acids of different vegetative parts of *I. pes-caprae*.

Free amino acids	Particular plant parts			
	Root of seedling	Stem of seedling	Stem of young plant found solitarily at sea shore	Stem of matured plant found in dense area
Alanine	-	-	-	-
Arginine	-	-	-	-
Aspartic acid	+	-	-	-
Glycine	+	+	+	+
Hydroxy praline	+	+	-	+
Leucine	+	+	-	-
Methionine	-	+	-	-
Proline	+	+	+	+
Serine	+	+	+	+
Tryptophane	+	+	-	-
Valine	-	-	-	-

**Figure 13.** TLC plate showing qualitative analysis of free amino acid of different parts of *I. pes-caprae*.

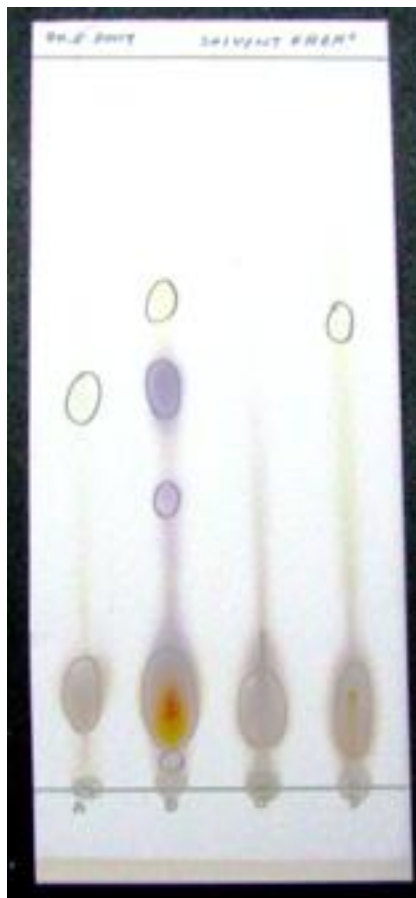


Figure 14. TLC plate showing qualitative analysis of free amino acid of different parts of *I. pes-caprae*

virginity of Mandermoni is still conserved rather the dune vegetation of Digha has already been destroyed due to huge constructions and other anthropogenic activities. The honourable high court of West Bengal (India) has already given stay order to stop the constructions at Mandermoni.

(2) Various natural forces influencing coastal sand dune vegetation include sea level changes, wind regime, worm wind blow and movement of dunes, storms and climatic changes. Global warming and climatic changes (for example, increase in sea level) has direct impact on coastal sand dune vegetation.

(3) Several human interferences (industrialization, pollution, waste disposal, harbours, roads, sand mining, sea-facing, commercial or social forestry, construction of resorts and beach tourism) cause destabilization of coastal sand dune and severely influence the dune ecosystem (Figure 14). As sea erosion is a major problem in temperate and tropical regions, extensive projects have been implemented to avoid beach erosion in West Bengal and adjacent Orissa.

(4) In these places, the vegetation itself is the target of exploitation. It is the source of fuel-wood and charcoal.

Some coastal species were once harvested for their valuable woods (*Casuarina equisetifolia* etc). Wildlife habitats are destroyed as beach ridges and dunes are cleared for planting coconut palms, groundnuts, Grasses are often planted under the palms to serve as pasture for cattle, and wetlands are drained, killing off forests.

(5) Since 2003, tourist has come to regard the Mandermoni seashore as one of the prime vacation spot at the Eastern coast of India. Summer homes and seaside resorts have had a tremendous impact on the vegetation of beaches and sandy coastal plains. Unfortunately, government often provides incentives for developing the areas. The dune vegetation of Digha, new Digha of Purba Medinipore District of West Bengal and Puri in Orissa are completely destroyed and facing a serious erosion problem every year during the Monsoon time.

(6) Stone fencing at different places in eastern coastline reduce the input of nutrients to the sand dunes. These construction activities adversely affected sand dune vegetation specifically disturbing the biogeochemical cycle, microbial activities.

Prospects

(1) Valuable mineral resources are often found in sandy coastal areas. Dunes are mined for heavy metals and diamonds. Dune quarries supply sand for construction and cement manufacture. Intense disturbance by these activities often destroys the vegetation completely. Oil spills at sea may reach the coast, causing severe damage to wildlife and polluting pristine areas.

(2) Since the 2003, tourist has come to regard the Mandermoni seashore as one of the prime vacation spot at the Eastern coast of India. Summer homes and seaside resorts have had a tremendous impact on the vegetation of beaches and sandy coastal plains. Unfortunately, government often provides incentives for developing the areas.

(3) Natural processes also take their toll on coastal plant communities. The first obstacle encountered by hurricanes when they make landfall is beach and coastal vegetation. The predicted rise in sea level resulting from climate change will have a huge effect on coastal communities, as it has in the past.

(4) It provides against storms surges, forming a buffer that helps to protect adjacent farmland or urban areas.

(5) It reduces beach erosion and aid in groundwater replacement.

(6) It provides a backdrop for recreational activities and ecotourism. And it contains a myriad of plant species that are used by traditional fishing communities

(7) Sustainable use of coastal areas will depend largely on involving local communities and governments in the decision-making process so as to effectively manage these areas to the satisfaction of all users.

(8) Ethno-medicinal values -Natural soil binder, leaves



Figure 15a. Construction of hotel which has continuous destroying dune vegetation.



Figure 15b. Construction of hotel destroying dune flora.

and roots of different colonizer species like *Ipomoea pes-caprae* etc are useful for gonorrhoea, rheumatism, skin

infection and stomach-ache and other critical diseases.

RECOMMENDATIONS

Re-vegetation

Among the methods to stabilize the population of *Ipomoea pes-caprae*, *Spinifex littoreus* (Figure 16) like soil binders along with the dune vegetation, revegetation is the best alternative as it is cheap and self sustaining. The plantation of tree species is effective in trapping sand and decreases the wind velocity but the plantation of the exotic species *Casuarina* in this area through out the coastal line has yet not been too much effective from our point of view. Legal protections of the plant species along the coastal line are very necessary. Development of tourism is also required to fulfil the need of civilization but the constructions must be planned apart from the dune vegetation keeping distance sufficiently from the sea shore. Raising public awareness and also to provide programmes and economic support to the local communities for the restoration and protection of the all the flora and the fauna of the coastal line.

Tree species adapted to coastal habitats have greater importance in stabilizing the dune vegetation and habitat restoration. Tree fencing can trapping the sand particles and reduces the wind velocity in their immediate vicinity. Multiple cropping using creepers, grasses, xerophytes, herbs, shrubs, sedges may effectively tolerate wind and wave action and restore the landscape of the sand dune vegetation.

Management

Proper management of natural resource is necessary for its best utilization. As such, grazing should be limited by marking areas left for grazing and other should be kept strict surveillance or a barbed wire used for demarcation of the areas. Census of wild life is also important since it is dependent on the vegetation of the area. Before any number of livestock is allowed to grazing in a particular area the possible number of wild life should also to be taken into consideration. Monitoring of the economic plants of the area is needed. This plant should be allowed to be cut in such a manner that they do not jeopardize the existing bad situation. The parasitic species like *Orobancha* sp. and *Cistanche tubulosa* should be eradicated.

Ecological research

Research on stabilization and protection, dynamics of sand dune including other perspectives as well as documentation of flora and fauna urgently needed.

Implementation of law and legislation properly

The coastal regulation zone notified in 1991 issued under the Environment Protection Act, 1986. But unfortunately the implementation is very poor by the pressure of industrial and development lobbies. Development is also required to enhance the concept of eco-tourism but the dune vegetation should be undisturbed as it is the natural guard wall at sea shore.

ACKNOWLEDGEMENTS

Authors would like to express their deepest gratitude to their teachers honourable Dr. A. K. Mondal, Associate Professor, Department of Botany and Forestry, Vidyasagar University and Dr. S. Mondal (Parui), Associate Professor Department of Zoology (Biochemistry), Lady BraBourne College, Kolkata for their valuable guidance. Authors also convey their gratitude to all teachers and staffs of my department. In this regard authors would like to thank all research scholars of department and our parents and wives for timely support and encouragement due to which this paper has been completed successfully.

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