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ORIGINAL CONTRIBUTION

Studies on the floristic structure, zonation pattern and some problems of sand dune vegetations in the coastal belt of Digha and Mandarmani, West Bengal, India

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ABSTRACT

Sand dunes are significant integral part of our coastal ecosystem. This paper highlights the salient features of sand dunes, floristic structure, zonation pattern of sand dune vegetation, species association, topographic diversity, probable causes of destruction and some proposal for conservation of sand dunes of Digha and Mandarmani. During field study, it is observed that the dune floral diversity is maximum in the back side of fore dune areas. The species association is highest as recorded in the transition zone between sand dunes and inter-dunal wet lands. Topographically dune ridges, dune furrow, dune slope, dune flat are very distinct in terms of vegetation diversity and zonation patterns. The creeper plants, long rooted grasses and other scrubs and shrubs stabilize the dune sediments from erosive forces in the coastal belt. But, due to some anthropogenic activities and natural calamities, these dunes areas are presently under severe stress. In these circumstances the sand dunes demand immediate attention for conservation of floristic structures to protect the landscape ecological diversity.

Keywords: Coastal sand dune, Zonation pattern, Floral diversity, Stress, Conservation.

1. INTRODUCTION

Coastal sand dunes which are common in different parts of coastal region of India and identified as highly valued ecosystems in terms of ecology, environments and defenses are threatened everywhere. The coastal regions of Digha and Mandarmani are no exception [1]. Vegetation plays a significant role in the formation of sand dunes in the coast [2]. These sand dunes constitute a variety of microenvironments due to high substrate mobility and physical processes. Dunes are very important to coastal environment as they act as a natural barrier to protect coast from the damaging action of wind, tide, storm, wave etc, thus assuming a significant role in the

environmental rescue. Today, the major threats to coastal zone come from the maritime disaster particularly resulting from estuarine pollution, marine pollution, over exploitation of natural resources at the sea and high magnitude of the cyclones. Coastal resources and economy of the people are affected directly by such disaster. As developmental activities of man such as unplanned urbanization, agricultural expansion, shrimp farming, unregulated waste disposal, building hotels and resorts etc. increase or extant into vulnerable areas of the coast, the potential impact of hazards increases. As a result the geomorphological configuration and ecofloristic structure i.e. microclimate of the dune regions

get degraded. So, in this circumstances, this area of research needs an in-depth study as there is an urgent need to protect the coastal environment and sand dunes.

2. MATERIALS & METHODS

2.1. Location

The Study was carried out on the zone of Bay of Bengal specifically on Digha and Mandarmani which are a part of Contai coastal area of PurbaMedinipur district, West Bengal. The study

different dune fields by the quadrat method and in each quadrat, individual species number was counted. The collected plant specimens were then preserved for herbarium. Topographic cross sections by total station survey had been done in three stations for an overall primary data collection. Executing these data in GIS software contour plan maps was prepared. During field observations at different times, both the physiographical and ecological problems of the sand dunes were also studied. In addition to field work, a



Fig. 1: Location Map of Study Areas.

areas (Fig. 1) lie in between the latitudes $21^{\circ} 37' N$ & $21^{\circ} 42' N$ & longitudes $87^{\circ} 30' E$ & $87^{\circ} 45' E$ respectively. These areas include both of urban and rural areas. These areas were observed by our team at several times at different season and the data were documented significantly along with the records of native sand dune species.

2.2. Pattern of Survey

A floristic survey was conducted on the sand dune habitats at Digha and Mandarmani. During the survey, species were recorded at various regions (i.e. dune ridge, dune slope, dune furrow, dune flat) of sand dunes and photographed. The plant samples were randomly collected in

comprehensive literature survey was attempted for the documentation of the biodiversity of coastal sand dune flora using published data in journals, reports & books [3-7].

3. FIELD DESCRIPTION

The entire sand dunes complex can be categorized under two types: fore dune or mobile dune and back dune or stabilize dune. The main features of these dunes are described below.



Fig. 2: Fore dunes with vegetal cover.

3.1. Fore Dune

Fore dunes are the shore-parallel dune ridges generated on the top of the backshore through aeolian sand deposition within vegetation [8]. These dunes are in general younger in age. During the summer months and warm stormy weather, these dunes become very active. Their mobility is largely controlled by the prevailing wind, tide, wave etc. The fore dunes (Fig. 2) have characteristic gentle seaward slopes, while the lee sides are steeper and comparable to bare barchans of the inland arid regions [9]. The unstable stratum and very poor fertility status of 'soil' (sand) are not suitable for normal plant life. The pioneer species mainly sand binding creeper plants and grasses like *Ipomoea pes-caprae*, *Launaeasarmentosa*, *Cynodondactylon*, *Cyperusarenarius* are the predominant species on this type of dunes.

3.2. Back Dune

Mobile dunes, once fixed by heaths, give rise to stabilized and immobile dunes (Fig. 3) in course of time. These dunes assume inland position away from the sea [10-12]. The erosive forces of high winds, tide, and wave cannot freely shift sands and



Fig. 3: Fragmented back dune with vegetal cover.

thus become stabilized. These dunes vary in size and shape assuming 10-15 m. above the general level. The microenvironments and micromorphology are also varied on stabilized dunes. In general this area has moderate to strongly undulating slopes. The interdunal depression areas or slacks of these dunes store all the run off and drainage from surrounding areas of which some of them dry up during summer months while some become source of irrigation. The immobile dunes besides sharing some of the herbaceous and grass species of mobile dunes, harbour ground flora of their own type. They contain various scrubs and trees also. Among them *Cassia sophera*, *Cyperus sp.*, *Lantana camara*, *Pandanus sp.*, *Opuntia sp.*, *Casuarinaequisetifolia*, *Anacardiumoccidentale*, *Cocosnucifera* are predominant. The various regions of sand dunes such as dune

ridge, dune slope, dune furrows, dune flats are topographically very distinct in terms of vegetation diversity and zonation patterns. (Fig. 4)

4. The description of vegetation

Coastal sand dunes have a wide range of vegetation (Figs. 5 - 7). Vegetation varies from small herbs of about 2 cm high to a woody plant of 20 m. high or more [2]. The dune ridges of coastal sand dunes of Mandarmani are mainly dominated by creepers plants and grasses. *Ipomoea pes-caprae*, *Launaeasarmentosa* are

8) from a network of close – set vegetation on sand surface. Their dense colonization reduces the soil erosion and stabilizes freshly deposited, uncovered mobile dunes. This species later alters the substrate in a way that renders the habitat less favourable for its own survival, but more congenial for the development of other species. But now a day this species has almost totally disappeared from the vicinity of Digha. The grasses have also high sand binding capacity. Such important grasses of the sandy shores are *Cynodondactylon*, *Panicum sp.*,

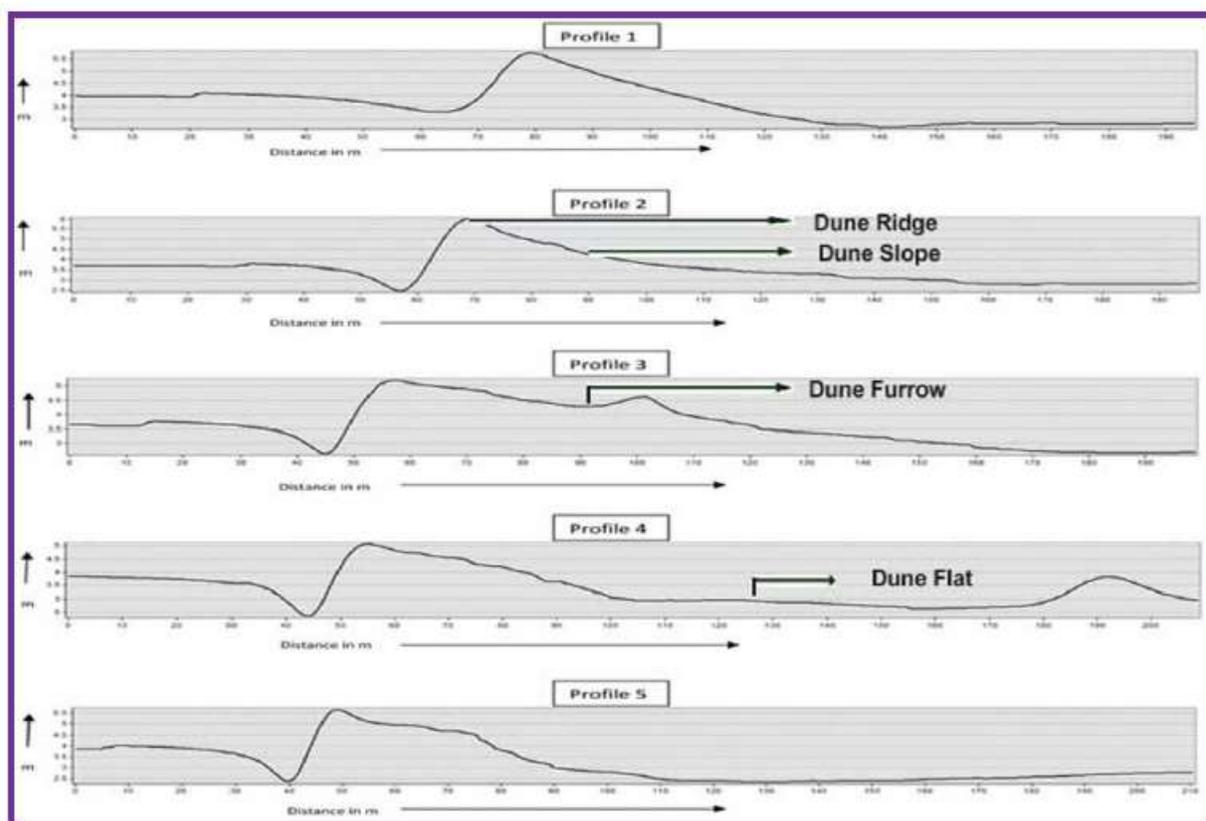


Fig. 4: Topographical cross Section of the coastal stretch of Mandarmani.

the important creeper plants. The long creeping stems i.e. long surface stolones and much branched surface roots of the *Ipomoea sp.* (Fig.

Aeluropuslagopoides, *Cyperus sp.* etc. Recently, it is observed that the patches of the very important pioneer soil

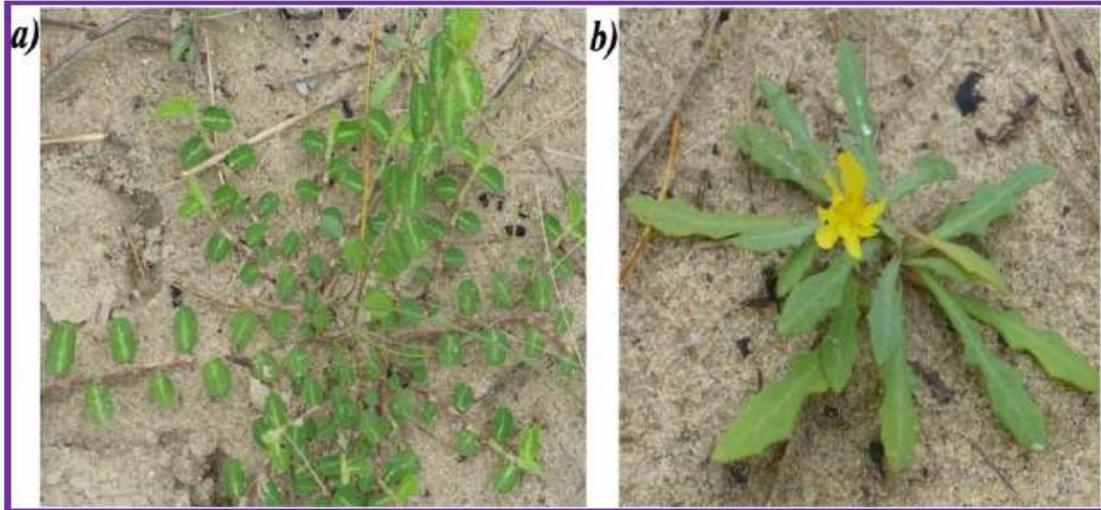


Fig. 5: (a) *Alysicarpus indica*; (b) *Launaeasarmentosa*.

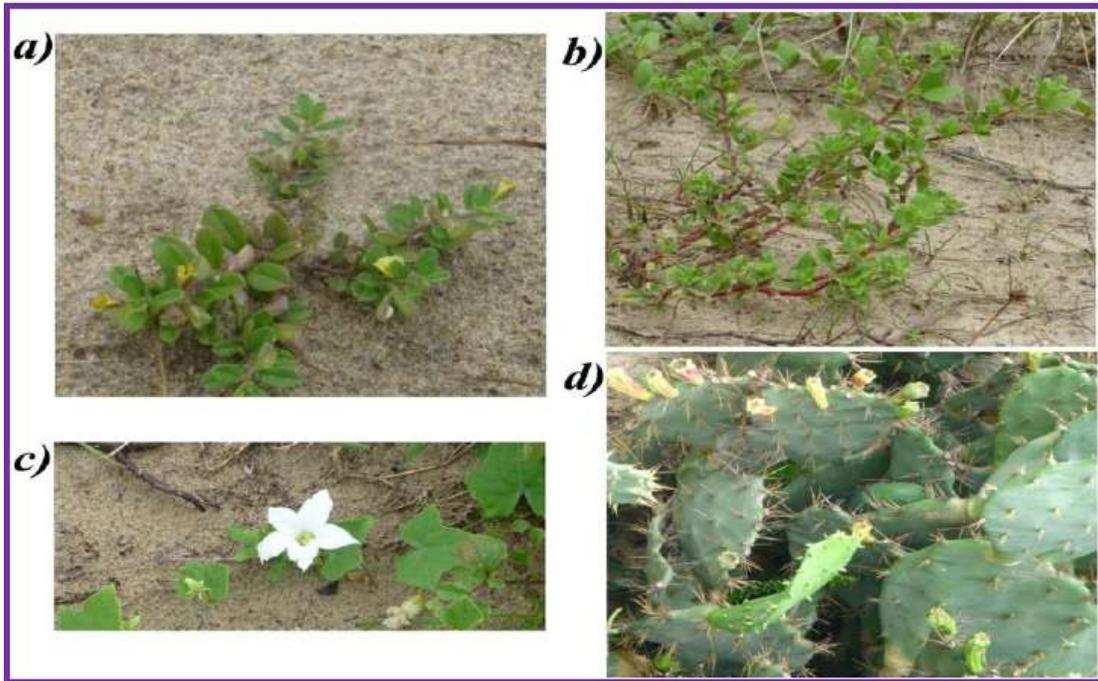


Fig. 6: (a) *Sesuvium portulacastrum*; (b) *Borreria articularis*; (c) *Coccinia cordifolia*;
(d) *Opuntia sp.*

binding grass *Spinifex littoreus* is degrading gradually at Mandarmani. Further inland the sand dune tops are covered by *Borreria articularis*, *Sesuvium portulacastrum*, *Deris sp.* Different herbs, shrubs are grown on the dune flats, dune furrow,

dune slopes. Some areas of dune flats dominated by fine sands are covered by luxuriant growth of *Cyperaceae*. In association with *Cyperus sp.*, *Sida rhombifolia*, *Croton bonplandianum*, *Calotropis*, *Cassia sp.*, *Pandanus*, *Opuntia*,

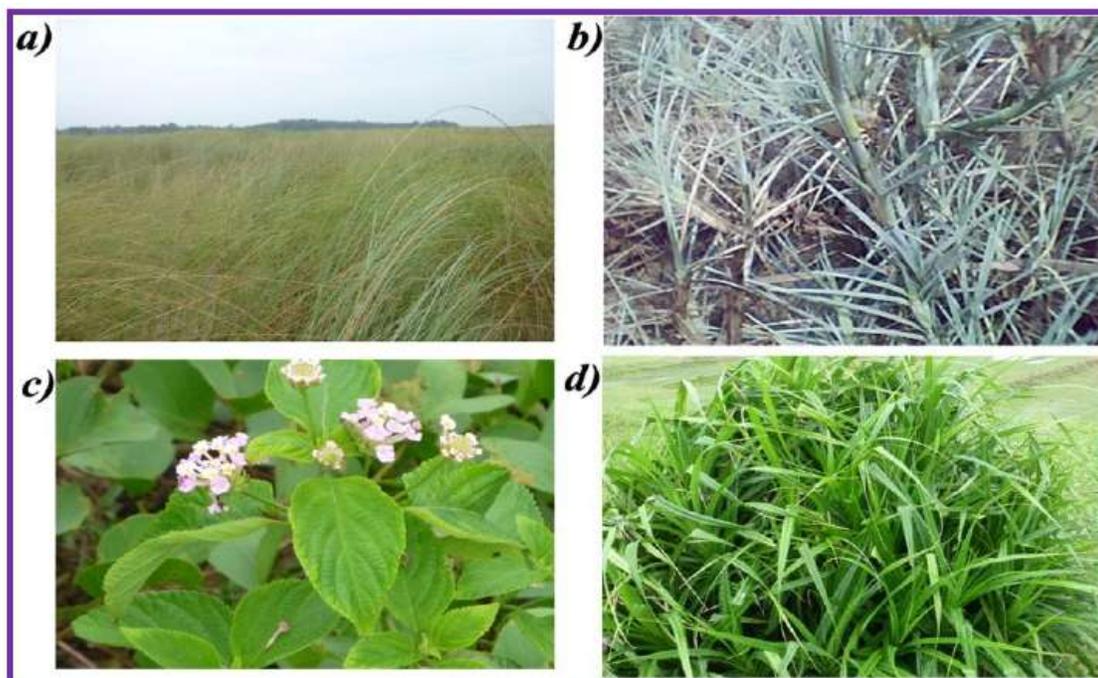


Fig. 7: (a) *Cyperus sp.*; (b) *Spinifex littoreus*; (c) *Lantana camara*; (d) *Pandanus sp.*

Cocciniacordifolia, *Lantana camara*, various types of grasses are also present in this region. The majority of dune slopes were found to be densely covered with *Trianthem pentandra*, *Sesuvium portulacastrum*, *Borreria articularis*, *Alysicarpus indica*. An overall appraisal of the dune slope habitat indicates slightly less plant coverage due to unfavourable microenvironments. The microenvironments of dunes are mostly favourable in dune ridges and dune furrows to support the concentration and diversity of vegetation. In dune furrow, the predominant species are *Commelina sp.*, *Polygonum sp.*, *Eragrostis tenella*, *Lippia alba*, *Aeluropus lagopoides*, *Borreria articularis*, *Sida cordifolia*, *Cassia sp.*, *Pandanus sp.*, *Phyllanthus niruri* etc. It is observed that the species association is highest in the transitional zone between sand dunes and interdunal wet lands. The scrubs formation later gives rise to

woodland which represents the natural climax vegetation of the area. Tree dominated inland dunes of Digha & Mandarmani coast have *Casuarina equisetifolia*, *Cocos nucifera*, *Anacardium occidentale*, *Acacia nilotica* etc. More recently in Digha *Prosopis juliflora*, *Leucaena sp.* are also found. During survey, it was seen that the naturally occurring soil binding vegetation of Mandarmani is still conserved rather the dune vegetation of Digha which has already been destroyed due to huge constructions and other anthropogenic activities.

5. CAUSES OF DUNE DEGRADATION

(I) Natural disasters like periodic cyclonic storms which may recur 2 to 3 times in a year, cause dune degradation and destroy the dune vegetation.

Table 1.A list of plants growing on different dune regions of different dune-types of the study areas:

| Sl. No. | Plants | Dune ridge | | Dune slope | | Dune furrow | |
|---------|-------------------------------|------------|------|------------|------|-------------|------|
| | | Fore | Back | Fore | Back | Fore | Back |
| 1. | <i>Ipomoea pes-caprae</i> | ++ | + | + | + | + | + |
| 2. | <i>Launaeasarmentosa</i> | ++ | + | + | ++ | + | - |
| 3. | <i>Sesuviumportulacastrum</i> | + | - | ++ | ++ | + | - |
| 4. | <i>Borreriaarticularis</i> | - | ++ | + | + | ++ | + |
| 5. | <i>Aeluropuslagopoides</i> | - | ++ | + | ++ | + | ++ |
| 6. | <i>Deris sp.</i> | ++ | + | + | - | - | - |
| 7. | <i>Panicumrepens</i> | - | + | - | ++ | + | ++ |
| 8. | <i>Lippia alba</i> | - | - | - | + | ++ | + |
| 9. | <i>Phyllanthusniruni</i> | - | + | - | + | + | + |
| 10. | <i>Eragrostristenella</i> | - | - | - | + | + | + |
| 11. | <i>Anaisomelis ovate</i> | - | - | - | + | + | + |
| 12. | <i>Dentella sp.</i> | - | + | - | + | ++ | + |
| 13. | <i>Cyperus sp.</i> | + | ++ | + | ++ | + | ++ |
| 14. | <i>Alysicarpusindica</i> | + | - | ++ | + | ++ | - |
| 15. | <i>Commelina sp.</i> | - | + | + | ++ | - | ++ |
| 16. | <i>Polygonum sp.</i> | - | - | - | ++ | - | ++ |
| 17. | <i>Opuntia sp.</i> | + | + | - | + | + | ++ |
| 18. | <i>Sidacordifolia</i> | - | - | + | + | + | ++ |
| 19. | <i>Cassia sp.</i> | - | + | - | ++ | + | ++ |
| 20. | <i>Pedaliu murex</i> | - | + | - | ++ | - | + |
| 21. | <i>Trianthemapentandra</i> | - | + | ++ | + | - | + |
| 22. | <i>Sidaromboidea</i> | - | - | - | + | + | |
| 23. | <i>Pandanus sp.</i> | - | ++ | - | ++ | - | ++ |
| 24. | <i>Croton bonplandianum</i> | - | - | - | ++ | + | ++ |
| 25. | <i>Abutilon sp.</i> | - | - | - | + | + | + |
| 26. | <i>Cynodon sp.</i> | + | - | ++ | + | + | + |
| 27. | <i>Cocciniacordifolia</i> | - | + | - | - | + | + |
| 28. | <i>Lantana sp.</i> | - | - | - | ++ | + | ++ |

Abbreviation: "++" –Present in large amount, "+" -Present in small amount, "- "- Absent

(II) Rip currents and alongshore currents transport sand at mutually right angle directions. These are seasonal reversals of NE winter to SW summer winds which play a significant role for transporting the dry sand of the subaerial beach causing mobilization and remobilizing of dunes and in spilling sand from the dunes to the intertidal zone [13].

(III) At present day, Digha and Mandarmani, both are the most important tourist spots of West Bengal. For this reason,

several human interferences such as industrialization, unplanned urbanization,

mining and transportation of beach sand (Fig. 9), constructions of hotels and resorts, unregulated waste disposal on the embankment, excessive grazing etc. provoke erosion and ultimately destabilize the coastal

sand dunes. Thus the vegetations on sand dunes get destroyed. It is evident that, the pioneer soil binding native species like *Ipomoea pes-caprae*, *Spinifexlittoreus*, are degrading gradually and rapid increase of invasive species like *Calotropis*, *Lantana camara* etc. takes place.

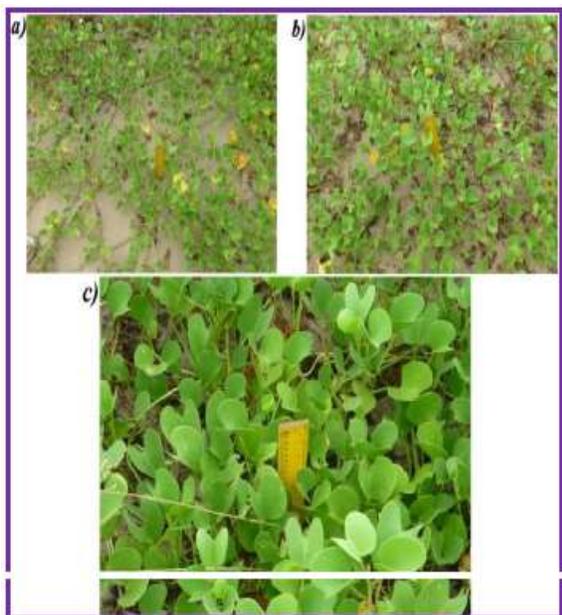


Fig. 8.(a) *Ipomoea pes-caprae*, showing maximum surface stolones with little vertical growth having large open sand space; (b) *Ipomoea pes-caprae*, showing intensive vertical growth with moderate sand space; (c) *Ipomoea pes-caprae* showing condensed zone without having open space.

6. Possible conservational strategies

It is high time to think about the protection and conservation of Digha–Mandarmani coast, which must involve scientific planning. Following are some suggestions.



Fig. 9: Mining and transportation of beach sand.

- (I) Revegetation with native coastal species like *Ipomoea sp.*, *Spinifex sp.* etc. is established to restore and maintain biodiversity as it is self-sustaining with minimal maintenance required. They prevent wind erosion by decreasing winds speed at ground level and by providing a protective cover over dune. The plantation of tree species like *Casuarina* is also effective in trapping sand, protecting wind and thus acts as a buffer against erosion.
- (II) Beach mining and transportation of beach sand are to be stopped by legislation
- (III) Dune vegetation is mainly susceptible to damage from pedestrain and vehicular traffic. To preserve both revegetated and naturally vegetated areas, fences are commonly used in the dune areas [14].
- (IV) Urbanization should be planned apart from the dune vegetations.
- (V) Public awareness programme to protect and restore the coast is advocated as a measure of conservation strategy.

7. CONCLUSION

In conclusion, a large number of plants with different habits like herbs, shrubs, trees etc have been observed in sand dunes of Digha and Mandarmoni. The most of the fore dune ridges are more or less protected by extensive colony development of pioneer creeper plants and grasses. Some areas of dune flats are colonized by prolific growth of Cyperaceae with other associated species. *Casuarina* trees are planted as the natural climax of vegetation on the shoreline dunes. These floras of coastal dunes have an important effect in the stabilization and restoration of dunes. But during field survey, several observations on distribution patterns of dune flora clearly disclosed the fact of

diminution in vegetation due to the several human activities and natural causes. In this situation, the sand dune demands an urgent attitude of attention and care for conservation.

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