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"Coastal Dunes Formation Due to Fluvial and Wind Reaction, Special Reference to East Coast in India"

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ABSTRACT

A dune is a shape of land formed of an immense volume of windy sand. In deserted ecosystems like the Sahara and close to the beaches, dunes are most natural. A dune system is considered a region of dunes. Wind and water will dynamically drift the dunes, which can have extreme implications. The dune is a hill of free sand constructed by aeolian processes (wind) or water movement in physical geography. The dunes are created by contact with the movement of air or water of various ways and sizes. However, human-made dunes may be artificial. In a stem (up-flow) line, where sand drives the dune has a shorter "slip face" and most forms of dunes are longer in the lee side. The dunes are called a valley or trough. A wide, flat region of shallow sand and/or dunes with little or no vegetation has an erg or sandy shore. Dune fields are considered narrower zones. In certain mountains, inland and around the beaches, dunes take shape. Any marine regions have one or two dunes flowing immediately inland from the ocean parallel to the coastline. The dunes are also necessary to shield the soil from possible ravages from sea storm waves. Though coastal areas are the most commonly spread dunes, inland in dry areas are the greater dune complexes synonymous with old lake or sea beds. Dunes can form on sand or gravel beds of river, estuaries and the sea bed under the action of water flow (in fluvial processes). The coastal sands of dolls are hips and strips created by degraded, terrestrial; oceanic sections of sand and ground rock. This is known as a specialised environment that is marked by living conditions such as high salt, low humidity and low organic matter. However, different species of flora, fauna and microorganisms adapted uniquely to certain conditions still exist in dunes. In the rhizosphere, phyllosphere, and indoor plants that are extremely important for incorporating dunes, microbial classes including fungi, bacteria, and actinobacteria are very abundant. A number of bioactive metabolites, which are essential for agriculture and industry, were found to be generated by microorganisms in this environment. Many species of shrubs and rhizobic fungi associated with dune plants are prolific plant growth producers that encourage biochemical sources such as indole

acetic acid. This study analyses coastal dunes formation due to fluvial and wind reaction with particular reference to East Coast in India.

1. Introduction

Coastal sand dunes are described as mounds and narrow sand strips with distinct borders defined by the sea and land-based sand transportation boundaries. Sand dunes spread all over the world, covering 6 to 106 square kilometres of land. The effect of the sea [3–5] makes the ecosystem unique and different from internal dunes. These are natural obstacles to the sea waves' action, protect the coast and natural habitats or inland developed areas [6]. These structures are also the foundation for important ecosystems that support valuable plant and animal communities. They thus provide aboriginal people with resources and shelters and generate important cultural values today. The sand dunes are now recognised as part of our intrinsic biodiversity beach systems [7]. The sand dunes ecosystem is too hostile to create normal forms of life and does not promote dense and very diversified vegetation. However, this environment has atypical floral, wildlife and microbial diversity [8] because of unusual circumstances. Coastal dunes have shown a wider range of bacteria, fungi, actinomycetes and other groups of microbes of agricultural, industrial and pharmaceutical importance [9–17]. It's alleged that, unlike desert dunes, coastal dunes were generally neglected and researchers had not paid much attention for their biodiversity research. In India, in particular, not much has been made to find the potential of microbial diversity. Despite a coastline of about 480 km, the area was still untouched. Therefore, the bioefficacy of such a novel microbial diversity and its potential role in different fields in an Odisha context is extremely important to emphasise. Furthermore, the "Convention on Biological Diversity" mandate provides for the documentation of microbial resources, aside from the flora, fauna and associated traditional knowledge in accordance with the Biological Diversity Law 2002, implemented by the Indian Government u/s 41. Therefore, the study of microbial potentials in unattended ecosystems such as India's coastal sand dunes becomes significant.

2. Study Area:

The Eastern Coastal Plains are a vast region of India lying between the Bay of Bengal and the Eastern Ghats. The plain spreads from Tamil Nadu in the south to West Bengal in the north through Andhra Pradesh and Odisha [1]. It is a brackish water lake on the eastern coastal plain. It is located in the state of Odisha and branches south of the Mahanadi Delta. [2] Delta of many Indian rivers makes up a significant part of these plains. These plains are drained by the Mahanadi, Godavari, Kaveri and Krishna rivers. The city experiences both north-east and south-west monsoons with annual precipitation varying from 1,000 to 3,000 mm (39 and 118 in). The simple width ranges from 100 to 120 km (62 to 80 miles). It is locally classified as the Utkal plains in the northern portion between the rivers Cossye and Rushikulya, the north circles on the central segment between the rivers Rushikulya and Krishna, and the southern section of the Coromandel Coast between the southern section of the river Krishna and the south tip of the mainland India in Cape Comorin, where it blends into the western coastal plains. The study area has been shown in Figure 1.

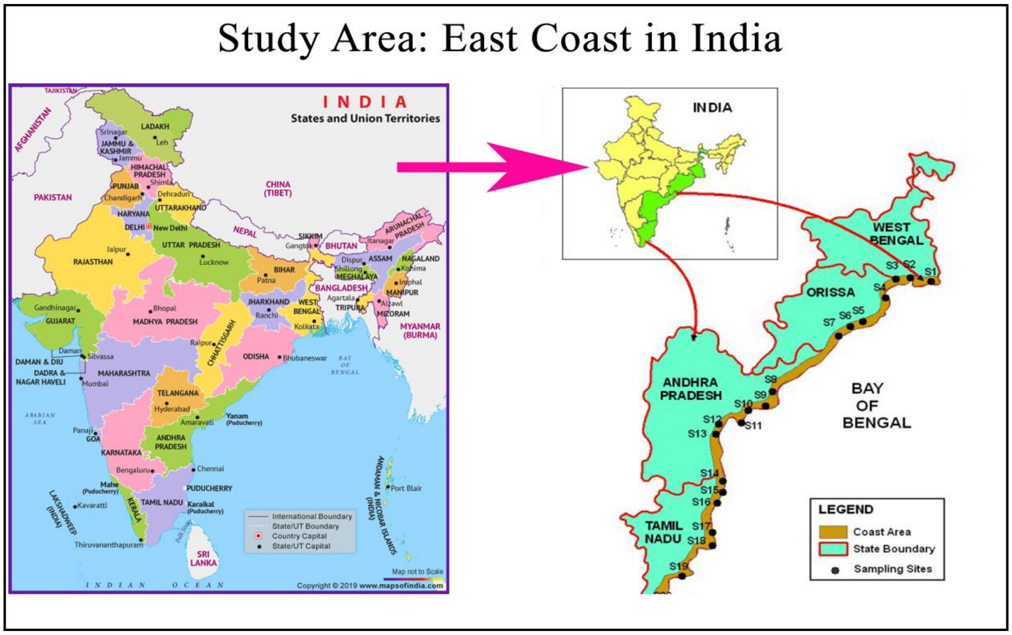

Figure 1: Study Area: East Coast in India

3. Coastal Dunes

When watery sand is collected on the shore and dries out and blooms along the beach, coastal dunes take shape. Dunes take shape where the shore is long enough to collect wind-blown sand and where the waves on the sea move inland. A wide amount of sand, winds to carry the supplies of sand and a location for the sand supply are three main ingredients for the creation of coastal sand dunes. For example, obstacles- vegetation, rocks, etc. — appear to slow the wind down and allow sand grains to deposit. Tiny "incipient dune" or "shadow dune" expands in the vertical direction if the barrier that delays the wind increases in the vertical direction. As a consequence of coastal plants' development by seed or rhizome on the side, coastal dunes often extend in lateral waves.

Coast-wide sand dunes may offer privacy and/or ecosystems to support local flora and fauna. Animals including sand snakes, lizards or mice can reside in coastal sand dunes along with insects of all sorts. Sand dunes are often debated without understanding the value of coastal dunes to animals.

In recent work it has been proposed that coastal dunes appear to evolve toward high or low morphology in conjunction with dune development patterns, compared to storm frequency. In a storm, dunes play a significant role in minimising wave strength when pushed towards the shore. In a storm event, they can be influenced by tropical cyclones or other extreme storm behaviour based on their position.

In certain areas with harsher winter conditions, the beach appears to take on a more convex appearance at its position on the shore and the beach profile during a certain season. It may be more convex in the summer because of gentler waves whereas the same beach may be more concave in the winter. This contributes to coastal dunes across the area.

These coastal habitats are endangered in several parts of the world. For example, some coastal dunes in San Francisco have been entirely altered by urbanization; human dune re-shaping, placing native ecosystems in risk. Another challenge, primarily in California and in locations in the UK, is invasive organisms' presence.

4. Coastal Dunes Formation

Three forces are there which determine how the wind carries the individual grain of sediment. Firstly, Gravity is used to maintain the grain on the surface of the ground. Secondly, there is a drag element that moves the gain along the surface in the wind direction. Thirdly, there is a lifting force created through pressures caused by a movement of the wind on a fixed grain's surface. This lifting force results from a fairly high-speed flow on the top of the particle and lower speeds on the medium and lower sandy grains. A fixed grain begins to vibrate first, and moves after a certain critical value exceed shear stress at the grain surface. This is called the critical shear stress or the threshold speed, which causes the grain to be pumped into the air vertically. Within 2.5 cm of the surface, nearly 90 percent of this movement takes place in almost entirely 0.5 metres of the ground surface. Once the grain is taken, a parabola is carried downwind. The speed and distance of the grain transported will be determined in relation to the drag component according to grain size, form and density. The threshold wind speed is approximately 10 kilometres per hour for fine-grain sand.

Sediment can be transported in one way or a combination of four main means after the threshold value is exceeded: traction or creeping processes, salting, repression and/or suspension (Figure 2).

Traction load: The load of the traction refers to particles which are too large and/or thick to enter through a lifting component, or which are only driven by other kernels which collide with the surface grain and which, due to traction, are 'rolling' through the surface.

Saltation: Saltation refers to sand grains lifting and suspending in the air for a short while before falling back to the surface with a parabolic path. During the lifting and traction force and the turbulence and speed of the wind flow, the height and the time the grains remain suspended are determined by the grain size, the shape and the density.

Reptation: Grains in motion can collide with particles in the soil and move them at lower wind speeds than the ones needed to move them alone by the wind. When this happens, it is called reptation.

Suspension: Very low dust and finest sand particles can be carried by air for a distance without following the typical rush of saltating and repatriating grains. Much higher silt and clay particles may be transported, but this sediment is usually transported beyond sand dunes if present.

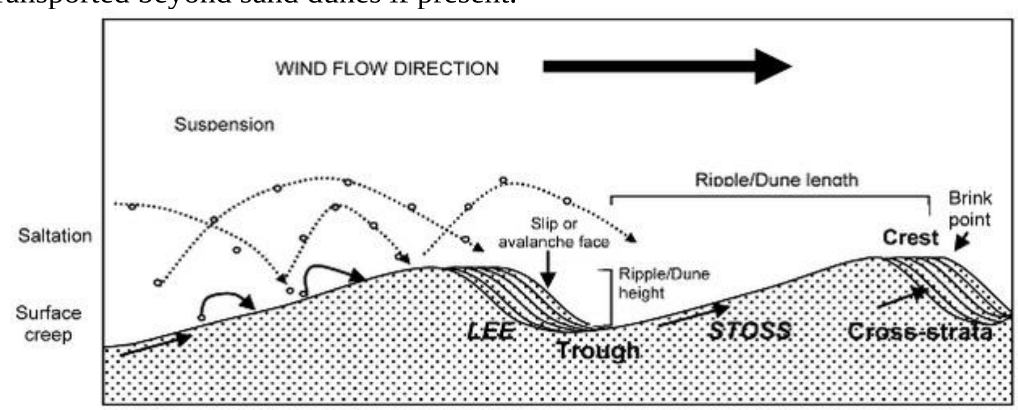

Figure 2: Coastal Dunes Formation Due to Wind.

Regardless of the mechanism, as sediment is transported downwind, it produces beds known as the ripples and dunes. The eolian's rippling and dune shapes have an asymmetrical shape consisting of a longer, lower pitch, (1°–8°) and a steep pitch uphill, known as a stoss pitch (Figure 2). Height difference: The ripples are small sand ridges of less than 4 cm in height (amplitude) with wave-lengths of less than 60 cm (crest to crest) and the dunes of the ripples have the same structure or shape as the ripples but are larger. Sediment is generally transported along the stoss to the crest for both ribs and dunes, and when net accretion is critical, load-sediment avalanches down the lee of the dune (slip face). This produces tabular cross-states with a uniform dip direction parallel to the dominant wind direction. The dune moves downwind in the classical transverse wind dunes — a dune forming at the right angle to the prevailing wind. Due to sediments transport in the near-shore environment, sediments are available for dune buildings. The amount of sediment provided from the beach to the backyard environment Depends upon wind power, wave power, tidal range and the beach type. In general, sediments can be transported to land during periods of beach accretion via wave movement and swash to forestry, beach and backwater environments. This sediment dries. Beside the abundance of sediments supplies, the availability of sediments to the backshore environment is controlled by numerous factors. The main factors are wind speed and direction, moisture content, vegetation and beach morphology.

The humidity of the sand regulates the cohesion of each grain. An increase in moisture will increase sediment cohesiveness considerably and reduce the wind's capacity tocarry. Therefore, deflation (wind erosion) is typically only down to the damp sand level, a certain vertical distance over the water table. Since the water table forms a horizontal, or very gently sloping surface in permeable sand, deflationary basins are usually relatively flat within the dune field and the sand plains at the rear of violent dunes or between sand ridges.

Vegetation is an important controlling factor for coastal dunes' development and morphology. The coastal region can provide a very hazardous environment for high sedimentation rates of flora, low nutrients, salt spray, storm erosion susceptibility and human recreation and farming. Only a small group of plants can colonise in sand dunes. However, as opposed to most desert dunes, vegetation usually has an important role in forming coastal dunes and in their future development. Plants are the most common element of ruggedness in the coastal environment, which can lead to a decrease in wind speed, a reduction of wind capacity and a significant increase of sand capture potential. For example, wind velocities decline rapidly close to the ground: when the soil is vegetated.

On the other hand, area of very low or zero height increases the height of winds from ~0.4 mm to ~10 mm, increasing the sediment capture and dune retention potential. The growth of pioneers is actually encouraged by deposition of sand and the plants type is important in determining the morphology or the shape of dunes. This is why artificial dune grass planting is a common method for promoting dune formation and growth.

Beach morphology plays an important role in supplying and transporting aeolian sediments and their dune formation to the backyard environment. Changes in the slope and morphology of the beach face and back-shore profiles may lead to an increase or decrease in wind speed. Any rugged element can also lead to a wind speed deceleration, causing a turbulence that changes the rate of deflation, transportation, and sediment accumulation. For example, the wider foreshore and low gradient dispersing beaches are less resistant and less likely to carry winds than the steeper reflective beaches to transport an ocean's sand. Dissipative beaches generally include fine sand, requiring a lower threshold to sediment. In contrast, reflective beaches consist of rough grained material, which requires a higher threshold speed for gravity and static friction. In the foreshore, the steeper profile and more irregular nature of the reflective beach also lead to a less conducive wind zone on the back of the forest.

5. Benefits of Sand Dune in East Coast in India

The environmental conditions in the sand- dune habitats improve the competence and capacity for bioactivity of the microorganisms and other life forms. So it is worthwhile bio-prospecting coastal sand dunes. It has already been proven that various group of microorganisms inhabiting coastal sand dunes have the ability to produce numerous secondary metabolites. This fact has already shown the route to use in agriculture, industry and pharmacy.

5.1 Agricultural Importance

Different plant growth groups Rhizobacteria have been isolated in the Chennai coast from sand-dunes that have been identified as producing indole acetic hormone for plant growth. These bacteria have demonstrated the seedling longitude and weight of the seedling wheat, green gram, mustard, black gram and kidney bean through semen growth chamber studies. Isolated from wild vegetables in India's west dunes, the rhizobia increased not only nodulation and nitrogen fixation but also inoculated in cowpea, green gram (vigna radiata), and black gram (vigna mungo), and horse gram, it increased root and shooted mass. Gibberellafujikuroi, Gibberellins collected from sand dunes in Korea could increase Waito-c rice root shot length. Edward and al. A total of 49.5 percent of all isolated plants that were endophytic to dune plants such as the Latheryrus japonica, Vitex rotundifolia, Carexkobomugi, Artemisia fukudo, Messerschewidiasibirica, Glehnialittoralis, etc. made up 65.9 percent of gamma proteobacteria and of Pseudomonas. Amongst them, indole acetic acid (IAA), siderophores were produced in 7 strains, protease was produced by 23, pectinase by 37, and chitinase by 38 strains. More than 85% of the fungal population, in particular sand dunes, maybe promoting fungal growth. The treatment of endophytic extract from phoma species isolated from Tinospora cordifolia and Calotropis procera could improve root and shot length, root and shoot weight of maize plant.

Apart from producing phytohormone growth improvement, root-based microorganisms are able to protect the crop by biologically controlling plant pathogens. The market currently offers 20 different PGPR strains for bio-control. A lot of Pseudomonas spp strains Shin et al. [14] isolated gamma-proteobacteria with this broad-specific activity. Rhizobacteria from plants developing on the coastal sand dunes along the East Coast of India have shown identical traits. Among the 1330 rhizobacteria screened from 11 various plants in this area, 23 strains produced auxin and had an antagonism spectrum to various phytopathogenic microns. Not only that, obligatory endospore forming parasites such as the infiltration of Pasteuria from the European frontal dune Ammophila arenaria demonstrated the ability to regulate hostile nematode, such as that of Meloidogyne spp. Sangeetha has isolated 70 actinobacteria strains, most of which have shown PGP activity and have inhibited Rhizoctonia solani, Fusarium oxysporum and Sclerotium rolfsii mycelial growth. The highest inhibition zone in 9 mm was produced by Strain AMET053, which was identified as Streptomyces roaches and protected tomato plant for greenhouse fusarium wilt disease.

5.2 Production of Industrial Enzymes

Active producers of a large number of extracellular enzymes such as cellulose, pectinase, amylase, protease, tannase, chitinase, etc. are mainly microorganisms such as bacteria, fungi and actuomycets. These enzymes are gold mines for transforming biological waste as agro waste into useful products in various industries. Many of these microorganisms were isolated from the marine environment and the coasts. Some reports also report that coastal sand dunes of such microbial strains could produce those enzymes in vitro and have shown potential for industrial use. Many Neutrophil and Alkaliphil species from the Ipomoea pes-caprae and Spinifex littoreus rhizosphere are especially capable of producing multiple enzymes. The bulk of those neutrophilic bacteria came from Bacillus sp, while Brevibacterium, Brochothrix, Cellolomonas and Microbacterium were irregularly gram-positive rods.

Due to the degradation of shredded leaves, these bacterial populations are higher during the pre-monsoon period. The Chungnam Province of Korea has developed a significant number of endophytic Tae-An-isolated bacteria (Baramarae, Sambong, Shindu, and Hagam) developing big industrial enzymes such as Protease, Pectinase and Chitinasa. These belonged to Pseudomonas spp., Rahnella spp., Rhizobium spp., Xanthomonas spp., Pantoea sp., Erwinia spp., Chryseobacterium spp. Capricot spp. A cellulose enzyme utilising sugarcane waste could be generated from the IS-07 strain, extracted from Brazil's dunes. Trichoderma spp. Another Brazilian strain. The IS-5 produces 564.0 UL^{-1} of cellulase from the Guaibim beach dune soil, obtained from the wheat bran fermentation after two days. In addition to fungi and bacteria, Sangeetha screened for the manufacture of lytic enzymes actinobacteria from the sand dune in rhizospheric soil of India's Chennai coast. Among the 70 distinct morphological strains 34 amylase strains, 11 tannase strains, 30 chitinase strains were found and 61 produced gelatinase, 51 caseinase and 24 pectinase. Sand dune microbes have an extraordinary ability to produce such important enzymes in specific industries, and they can be made commercially via fermentation process.

5.3 Coast, Coastal Dunes and Its Microflora in Odisha

The state of Odisha, centred in India's eastern part, is one of Bengal's four maritime territories. The State spans a coastline that streams from the village of Udaipur (21°31' N; 87°34' E) north of the West Bengal to the Marshlands of Ichapuram and Bahuda, bordering on Andhra Pradesh to the south (19° 02' N; 84°47' E). The state has a 480 kilometres area covering 8 percent of India's coasts. This encompasses the luxuriant mangrove vegetation of Bhitarkanika, Mahanadi delta and Chilika Lake on the sea. Seven Coastal Districts consist of approximately 250 coastal fishing villages and 25 fishing landings along the coastline of Odisha, namely Ganjam, Puri, Khordha, Jagatsinghpur, Kendrapara, Bhadrak and Balasore. This coast provides a number of ecosystems from sand dunes, coastal pools, backwaters, lagoons, estuaries, mangroves and marshes. It has been reported that the state's

Exclusive Economic Zone (EEZ) is 172,000 km2.

Though there have been no detailed scientific studies on the ecology of the Odisha coastal sand dunes, some records have shown that this specialised environment is rich in vegetation, fauna and microbial resources. Some of the larger groups of plants, including Asteraceae, Fabaceae, Poaceae, and Convolvulaceae, dominated the coastline's floristic composition. Pattanaik et al. have described at least 55 species of ethnobotanical used medicinal plants, especially in the dunes. This is necessary to show if the rhizosphere or endophytic mode is rich in microbial diversity. As regards microbial diversity, the different coastal ecosystems of Odisha, such as Bhitarkanika mangrove area, have insulated new fungus and bacterial strains. Such a study has been made pertaining to the dunes on the south coast of Odisha in Anacardium and Casuarina plantations, including arbuscular mycorrhizal (AM) fungi genera Glomus, Acaulospora, Gigaspora, Scutellospora and Entrophospora. The Anacardium Planting Population of Fungi was found to have 45 genera & 114 surface species and 41 genera & 93 surface species. The Casuarina planting sand dune contained on the surface 36 genera & 78 fungi species and on the subsurface there were three genera & 85 species. Barren sand dune had 54 genera & 91 surface animals, 46 generations & 80 surface species. Given the small coastline and dune diversity in Odisha, a broad gap in microbial diversity, especially in sand dunes, could be observed. In order to discover more possibilities in this unexpected ecosystem, unique efforts need to be initiated.

6. Conclusion

Current discussions have shown the immense ability of coastal sand dunes in terms of valuable microbial diversity. These harsh environments are studied worldwide, and various valuable microorganisms that have developed many essential bio-chemicals are isolated and established. Especially in association with plants that can be utilised and introduced in the farming sector, the Arbuscular Mycorrhizal Fungal (AMF) Community was dominant. Given the length and biodiversity of the shore of Odisha, such new microorganisms still need to be studied. Over 60 percent of Odisha's population relies on agriculture. During farming activities, most producers utilise chemicals and pesticides, which are more costly and often farmer-inflated. In this regard, sustainable agriculture is worthwhile to be developed throughout the Odisha region by discovering new microorganisms (fungi, bactéries and actinobacteria) that can provide plant growth-promoting environment with their biological control properties. The production of a range of industrial enzymes will result in the growth, in addition to the use of agricultural waste and other byproducts, of related industries, such as bioethanol, detergent plats, etc.

In addition, the creation of Biodiversity management committees (BMCs), as provided for in U.S. 41 of Biological Diversity Act 2002 of India Government, could help defend successful microorganisms from bio-piracy and provide financial incentives through patent law. Section 2 of the Act says that, in order to encourage protection, sustainable usage and biodiversity recording, each of the local authorities shall establish a biodiversity management committee throughout the region, that would also work in favour of habitat restoration, conservation of landraces, varieties of people and cultivars, domesticated stocks & animal & microorganism animal races, and the chronicling of information. Since microorganisms cannot be perceived naked-eyed, experimental research must be performed to examine the microbe variety and conserve those beneficial for a particular reason. Therefore, a big effort is required to enumerate microbial diversity in Indian coastal sand dunes. Moreover, the bioactive capacity for different applications must be exploited. The Department of Forests of Odisha State recently initiated such research in Bhubaneswar, Odisha Biodiversity Commission. A research on the flora, fauna, and microorganisms of the Odisha coastal sand dunes has been accepted for an extensive review. The Government of India will use the project findings as part of the coastal management programme.

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