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Notes and Discussions

Seagrass Wrack-induced Dune Formation on a Tropical Coast (Banc d'Arguin, Mauritania)

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The Banc d'Arguin (Mauritania) is a shallow water area with mudflats bordering on the Sahara desert. Mass depositions of seagrass litter were observed on some parts of the shore. Soil profiles of the low dune formations separating the flood debris zone from the desert showed that layers of seagrass detritus, in various stages of decay, extended under the dune formations. The tentative mechanism of dune formation, involving the interacting processes of beaching of seagrass litter and wind-blown transport of desert sediment in a seaward direction, is described. This role in dune formation adds a new element to the significance of seagrass vegetation for the coastal environment.

Introduction

Seagrass vegetation is a common feature of shallow marine waters in temperate and tropical regions of the world (Den Hartog, 1970). The ecological role of this vegetation in the marine environment has been the subject of numerous investigations. The seagrass beds provide a habitat which is important for the life-cycle of many benthic and pelagic species (Kikuchi, 1980; Pollard, 1984; Stevenson, 1988). Their ecological role, however, is not restricted to the beds proper. Because of their high productivity, and the formation of large amounts of detritus which partly may be transported to adjacent systems, seagrass vegetation in terms of nutrient fixation and regeneration may also be important on the larger scale of the shallow water system (Pellikaan & Nienhuis, 1988; Zieman *et al.*, 1979; Whitfield, 1988). Furthermore, such vegetation may contribute to the maintenance of the shoreline, as leaf canopies reduce water-flow velocities and attenuate wave energy, while the root mat stabilizes the bottom and protects the sediment surface from erosion (Scoffin, 1970; Ward *et al.*, 1984; Fonseca & Fisher, 1986).

In the present paper we describe a hitherto unknown role of seagrasses in coastal genesis: the formation of dunes by the interacting processes of onshore transport of seagrass debris and the seaward transport of desert sands.

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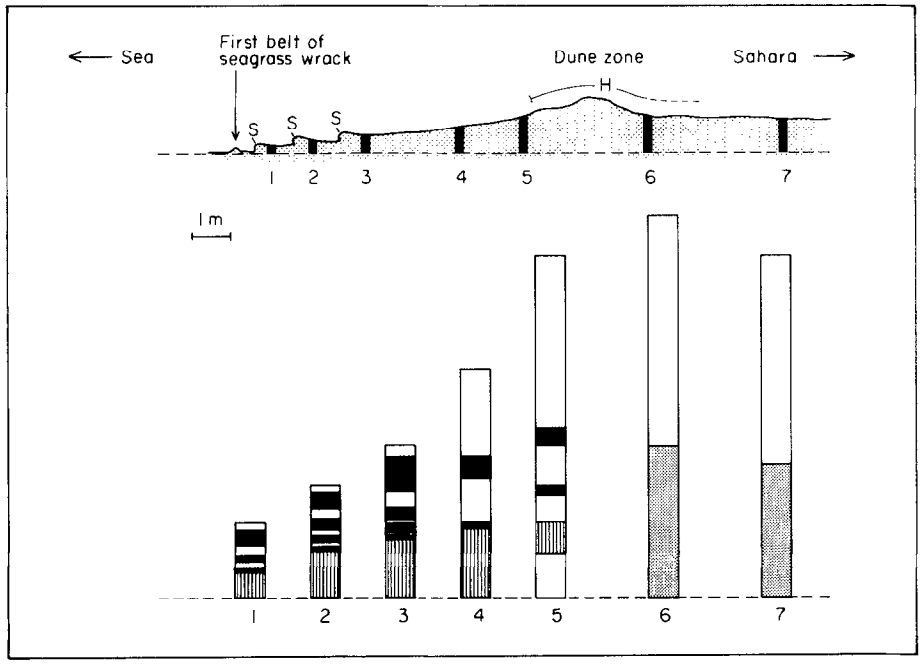

Figure 1. Transect through flood debris and low dune zones 1·5 km north of Iouik. The black vertical bars indicate the sites where soil profiles were investigated. S, Exposed bundles of seagrass litter; H, zone of halophyte growth. The scale bar applies both to the horizontal and vertical axes. The dotted line is an arbitrary base line. □, Sand; ■, recognizable seagrass litter; ▥, mixture of sand layers and particulate organic material; and ▩, sand enriched in organic substances.

Methods

Observations were carried out during an expedition to the Banc d'Arguin on the Atlantic coast of Mauritania (West Africa) in May 1988. The Banc d'Arguin is a shallow water area directly adjacent to the Sahara. Prolific seagrass beds occur on the numerous mudflats and in the subtidal gullies and channels of the area.

The observations on dune formation were made on a 10-km stretch of the coastline, between the villages of Iouik and Ten Alloul. At several locations soil profiles were investigated, in lanes normal to the shore, from the flood debris zone to the low dune zone. After exposing the profiles, the thickness of the various layers was measured. Samples of the layers were taken for visual inspection of the organic material present. In some cases soil samples were freeze-dried and the organic carbon content of the samples was measured.

Results and discussion

Seagrass wrack is present in a nearly continuous belt between the villages of Iouik and Ten Alloul. Inspection of the material showed that it consisted mostly of *Zostera noltii* leaves; and to a lesser extent leaf material of *Cymodocea nodosa* was present. In many places the belt of seagrass litter gradually changed into a narrow band of low dune formations, which separated the tidal area from the barren desert. Figure 1 shows an example of a transect through the seagrass wrack and dune zone. On the seaward side of the transect, there is a

stepwise increase in height of the formation. The edge of each plateau is formed by exposed seagrass litter. Beyond these plateaus the formation increases in height in a more gradual way. Profiles of the formation on the seaward side showed alternating layers of sand and seagrass litter. The upper organic layers consisted of clearly recognizable seagrass leaves which showed little evidence of decay. With increasing depth, the litter was more fragmented to the point that only small, unrecognizable organic particles were present, indicating progressive stages of decomposition (cf. Pellikaan, 1982). In general, alternating layers were not observed in the soil profile on the landward end of the dune zone. As in the example shown, the basis of these profiles was often formed by brown-coloured layers of sand, contrasting with the light yellow colour of the covering sand layer. Analyses of the carbon content of this type of layer in three different transects gave values of 0·28, 0·22 and 0·36% carbon on a dry weight basis, whereas the covering sand layers contained 0·09, 0·13 and 0·17% carbon, respectively. These dark-coloured layers therefore are enriched in organic substances; most probably these substances are derived from seagrass detritus and they represent the final traces of the decomposition process. A gradual change in the decay condition of the leaves was also found in the horizontal plane: with increasing distance from the sea, the material is in a more advanced state of decay. It is reasonable to assume that the vertical and horizontal gradients in decay condition reflect the decomposition of the seagrass wrack with time and point to a gradual extension of the dune formations in a seaward direction.

The sand covering the seagrass litter probably is not of marine origin since, with rising tides, the low energy beaches of this area are gently flooded by clear water with a low particle content. The sand most probably originates from the Sahara: the almost continuous and frequently strong winds in the area carry large amounts of sediment particles from the desert to the Banc d'Arguin (Altenburg *et al.*, 1982). Also the fact that the sand layer on top of the upper organic layer clearly decreases in thickness in the seaward direction (Figure 1) points to a gradual covering of the seagrass wrack starting from the desert side. We therefore propose the following mechanism of dune formation. Seagrass wrack deposited on the beach acts as a trap for sediment particles blown in from the desert. Gradually a surface layer of sand will cover the litter. As soon as this layer has formed, the kinetic energy of incoming saltating and suspended sand grains will no longer be dissipated within the litter bundles, but will be transferred to sand grains of the surface layer, resulting in their forward movement and the gradual seaward creep of the front of this layer. Connected with the direction of sand transport, the layer decreases in thickness in a seaward direction. Newly arriving seagrass wrack will be deposited against the existing belt; moreover, deposition of a new layer of flood debris may occur on top of the preceding deposition as the thickness of the older layer shrinks as a result of decomposition processes and the compressing effect of the top layer of sand. The interacting processes of massive beaching of seagrass litter and the seaward transport of desert sediment particles therefore result in a dynamic process of dune formation, with the tendency of this process to shift in a seaward direction. Halophytes may ultimately colonize the higher parts of the formations, enhancing their stability.

A role of seagrasses in the formation of dunes has not been reported before; moreover, we are not aware of any paper describing dune formation as the result of the coinciding processes of massive beaching of marine macrophyte material and terrestrial sand transport. The presence of extensive seagrass beds in shallow coastal water directly adjacent to the bare sediments of a vast desert area dominated by strong winds, as found on the Banc d'Arguin, apparently offers the rare combination of factors required for this phenomenon.

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