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Topographic control of mat-surface structures evolution: Examples from modern evaporitic carbonate (Abu Dhabi) and evaporitic siliciclastic (Tunisia) tidal flats.

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In terms of optimal light utilization, mat surfaces ideally are flat. In nature, however, flat mat surfaces are observed rarely or in restricted patches only. Rather they are shaped by a variety of linear and subcircular to irregular protrusions at various scales, including overgrown upturned crack margins, bulges ('petees'), domes ('blisters' and 'pustules'), reticulate networks with tufts and pinnacles etc. These features are so characteristic that 'mat types' have been established according to their prevalence, e.g., film, flat, smooth, crinkle, blister, tufted, cinder, mammilate, pustular and polygonal mats (Kendall and Skipwith, 1969; Logan et al., 1974).
Responsible for the development of such mat surface features are environmental (physical and chemical) factors and, in reaction, the opportunistic growth behaviour of the participating bacterial taxa. Theoretically, a 'juvenile' mat may be assumed as being flat, evolving into various forms with typical surface morphologies according to environmental impacts and respective bacterial reactions.
Observations in the Abu Dhabi evaporitic carbonate tidal flats and Tunisian evaporitic siliciclastic tidal flats demonstrate that topography plays a fundamental role, both on the large scale of the tidal flat and on the small scale of mat surface morphology. It controls, together with related factors like, e.g., frequency of tidal flooding; duration of water cover; frequency and duration of subaerial exposure, the spatial distribution and the temporal evolution of mat surface structures.
On the tidal flat scale, topographic differences result a priori from its seaward gradient and may arise additionally from physical processes which may modify the substrate surface and produce in the intertidal and lower supratidal zones narrow creeks and shallow depressions meandering perpendicular to the slope. Within a wide tidal flat without local topographic changes in the tidal zones, mat surface structures display a typical shore-parallel zonality. In contrast, in tidal flats with slight changes in topography, the typical shore-parallel zonality appears disturbed mainly along the intertidal and lower supratidal zones. The mat surface structures within each tidal zone show local and lateral transitions but all evolve from an incipient flat or polygonal mat.
On the mat scale, microtopographic differences are created by the mats themselves, e.g., in the form of upturned crack margins, bulges and domes. All these are small-scale topographic highs that influence the distribution of microbial activity and mat growth dynamics. In the Abu Dhabi area it is observed that smooth or polygonal mats may grade temporally into mammilate, cinder or pustular and tufted mats along an evolutionary path controlled by preferred growth along bulges and upturned crack margins. A similar temporal evolution appears in the intertidal and supratidal zones in Tunisia where local changes on mat-surface induce a variety of mat-growth struc¬tures on and along upturned crack margins, gas domes and isolated to polygonal bulges and petee ridges.

References

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