COMMENTARY

A DIFFERENT DUTCH 'DIKE'?

by Bernard Dixon

One of the most handsome books in my collection is *De Nederlandse Delta*, a beautifully illustrated account of the unrelenting battles which the Dutch people wage to prevent their homeland from being consumed by the North Sea. As anyone knows who has flown into Schipol Airport, Amsterdam, there is a good deal of water inside Holland itself. Less obvious is the fact that the people of this picturesque land of tulips and cheese live their entire lives below sea level. With some parts of the country already sinking by 20 centimeters per century, they more than most Europeans have cause for concern over global warming.

Milliards of guilders have been invested in the dams, dikes, and other contrivances necessary to safeguard the Netherlands against oceanic power. As early as the 16th century, Dutch dike and polder builders had mastered techniques for conquering the seas and draining lakes and fens. In modern times, applied biology has complemented increasingly huge hydraulic engineering works, as dunes have been encouraged to form natural barriers between the sea and the mainland. Marram and other grasses are planted, colonising the dunes so that the sand is held together rather than being eroded away on the wind. But there is a continuing need to increase further the resistance of sand dunes to the destructive forces of wind and tides—not least because some reclamation schemes actually enhance erosion, by altering the direction and pressure of tidal waters.

De Nederlandse Delta has little to say about microorganisms, other than plankton in coastal waters and their relationship to temperature, dissolved oxygen, and food chains. Certainly there was no suggestion, when this book was published as recently as 1982 to mark the 25th anniversary of the Delta Institute for Hydrobiological Research, that microbial life played any role in promoting the stability of sand dunes in Holland and the other aptly-named "low countries." Now, thanks to research at the University of Amsterdam, supported by the Foundation for Geographical Research, the picture is changing rapidly. Recent studies have begun to show that bacteria and algae are key contributors: to identify the species concerned, including previously unrecognised isolates, and to suggest that their growth and activities could be encouraged for practical benefit in the future.

Working out of the Laboratory for Microbiology at Amsterdam, Luuc Mur and colleagues have been characterising organisms that form crusts in the coarse silica sand that forms dunes along the Dutch North Sea coast. These generally consist of the eukaryotic green alga *Klebsormidium flaccidum* and certain cyanobacteria, including species of *Oscillatoria* and *Microcoleus*. Two years ago, Mur and co-workers began to realise that in the early stages of crust formation the microbial association often was dominated by an unusual and apparently unknown filamentous cyanobacterium with elliptical cells. Gradually, it has become clear that colonisation of sand with the

combination of algae and cyanobacteria plays a major role in protecting dunes against erosion.

Particular attention focuses on the cyanobacteria. These are oxygen-generating phototrophs, which photosynthesise in a manner similar to that of green plants. Some of them fix nitrogen too. Usually abundant in rivers and lakes that are lush with nutrients, they also often occur in environments low in nutrients. Although only a few cyanobacteria seem to have adapted to life in the oceans, they often comprise the dominant population under extreme environmental conditions.

Sand dunes need to withstand periodic soakings, but during much of the year they are exposed to lengthy periods of drought. The Amsterdam researchers have been keen to determine, therefore, what are the specific adaptations of crust-building phototrophic organisms that fit them to withstand near-desiccation. Especially interesting is the newly discovered cyanobacterium, which has elliptical rather than circular cells. As described by Ben de Winder, Lucas Stal, and Luuc Mur in the current issue of the *Journal of General Microbiology* (136:1645, 1990), it has been called *Crinalium epipsammum*.

The new species is unusual among cyanobacteria not only in the shape of its cells but also in having an extremely thick cell wall consisting of poly- β -(1,4)glucan (cellulose). Both of these qualities seem to be important in fitting the organism for life in dune sand, where lack of water and light pose intermittent problems of survival. Pure cellulose has a high capacity to retain water, making the cell wall even more efficient in taking up moisture after desiccation than the mucilaginous sheaths that surround many terrestrial cyanobacteria. The hydrophilic properties of the cell wall also appear to enhance the ability of *C. epipsammum* to retain water.

Still in doubt is the precise mechanism(s) by which this and other cyanobacteria, together with green algae, help to stabilise dune sand from being washed or blown away by the natural elements. Presumably the answer lies in the hydrophilic nature of the cell wall, in the organism's habit of growing as thread-like, non-tapering trichomes (and of reproducing by random breakage of these filaments), and in physico-chemical interactions between these surfaces and those of sand grains and other organisms. *C. epipsammum* has the additional advantage, unlike most other cyanobacteria, of being non-motile.

One should treat with considerable caution the prospect of cyanobacteria being manipulated genetically to promote their anti-erosion capabilities, and then being released into the environment. Not too many years ago the cord grass *Spartina anglica*, planted to reclaim land, was proving to be a considerable nuisance by narrowing waterways and causing other environmental damage: Nevertheless, Luuc Mur's work in the North Sea dunes could well lead to novel tactics to encourage and exploit the previously unknown powers of microorganisms to combat coastal erosion.