CYANOPHYTA IN HYPERSALINE SOLAR SALTERN PONDS (EBRO DELTA, SPAIN)

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Microbial mats develop in hypersaline environments. One category of these mats are solar saltern ponds used for salt exploitation. This paper describes the cyanophyta assemblages thriving at the Salinas de La Trinitat, located at the Ebro delta (40°35'N, 0°40'E, South Catalonia, Spain). The structure of the sediment of these mats has been reported elsewhere (CLAVERO *et al.*, 1994; DE WIT *et al.*, 1994). Ponds are generally fully flooded in April. Seawater enters and is stored in the "deposits" and then transits through a series of shallow water pools in which the salinity of the water increases due to evaporation. Field observations and sampling were made sporadically from 1991 to 1993 and monthly in 1994. Four zones, distinctly different in salinity, were chosen for sampling and examination. Salinities and the dominant microbiota distribution are given in Fig. 1.

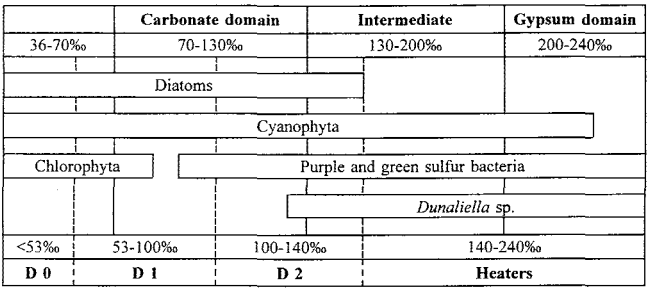

Fig. 1. Salinity of the different sampled pools and microbiota distribution

Deposit 0. The low salinity did not allow mat establishment. However, in spring and summer, in the sand floor rooted *Ruppia maritima* L. and green filamentous alga developed. Among them grew *Chroococcus minutus* (Küt.) Näg., *C. turgidus* (Küt.) Näg., *Gomphosphaeria salina* Komárek et Hindák, *Johannesbaptistia pellucida* (Dick.) W.R. Taylor *et* Drouet, *Phormidium hypersalinum* Campbell *et* Golubic, *Lyngbya aestuarii* Liebm. and *Merismopedia glauca* (Ehrh.) Näg. The temporarily flooded sides were colonized in spring by a distinct laminated mat of a few mm; the upper layer was orange in colour and was formed either by sand and diatoms or sand and filamentous degraded sheaths, depending on the salinity of the evaporating water cover. The second layer was made up by *L. aestuarii* and *L. martensiana* Menegh., *Oscillatoria limosa* Ag. and *Hydrocoleus lyngbyaceus* Kütz., and the third layer was built mainly by *Microcoleus chthonoplastes* Thüret. When a shield was provided by stones or remains, a bright green layer of *M. chthonoplastes* stood on the surface and the other layers did not develop. As summer went on the flat slime covering dried and was broken into leathery desiccation polygons.

Deposit 1. There were very different populations, depending on the water column depth and the turbulence. In the margins that alternately were flooded and dried a compact layered green, grey and black mats were built, almost exclusively by *M. chthonoplastes*. On the inundated inner ring, a community began to develop in March which was mainly composed by diatoms and detrital particles that were associated with *C. turgidus* and scarce filaments of *L. aestuarii, M. chthonoplastes, Phormidium valderianum* (Delp.) Gom. and *Spirulina subsalsa* Gom. over a black sulfate-reduced layer. In summer they were substituted by a white and green dirty bed of *L. aestuarii* and *Beggiatoa* ssp., whereas the flooded sediment was coated by a thin mat dominated by *L. aestuarii* and *O. limosa*. Additional species were *Oscillatoria lacus-solaris* Campbell *et* Golubic, *Aphanotece cohenii* Campbell *et* Golubic, and *A. krumbeinii* Campbell *et* Golubic. This thin mat trapped oxygen bubbles, was detached and floated although none of the forming species had gas vesicles. Some Cladophora bulks were mixed up mainly with *L. aestuarii* ***and*** *L. martensiana*. In August, entrance of Deposit 0 water favoured mass development of dinoflagellates and *Tetraselmis* sp. Although at the end of the year (1991-93) *M. chthonoplastes* was dominant, a mat was not established.

Deposit 2. In November of the previous years a thick mat of *M. chthonoplastes* covered the pool. Changes in salinity and the storms of 1994 winter destroyed it, and in the spring small colonies of *A. cohenii* and *A. krumbeinii* were attached to the nude sand floor, along with filaments of *S. subsalsa*. The sizes of *A. cohenii* and *A. krumbeinii* individuals did not overlap. In summer the green-yellow colonies formed a discontinuous thin slime cover with some *M. chthonoplastes* and *O. lacus-solaris* filaments. Orange patches of mineral phases of oxidized iron and green layers of *M. chthonoplastes* were present in the reflooded margins, related to the seasonal changes in water level.

Heaters. In the spring of 1992 and 1993, with salinities between 120-140‰ the mat was mainly built by *P. valderianum* whereas in fall it was substituted by *M. chthonoplastes* and *S. subsalsa* overlaying red dots of Chromatium and a green lamina of sulfur bacteria. As the salinity increases up to 200‰ only soft yellow-brown flocculent mats of *A. krumbeinii* were attached to the saline calcareous substrate. This form is abundant in summer, even at lower salinities.

The entrance of water of low salinity to replace the loss by evaporation, in these man controlled environment, caused alterations on the community structure and composition. The thin established mats, especially those dominated by *L. aestuarii*, became detached from the sediment upon temporal flooding. At the onset of the inundation period some organisms show a rapid colonisation rate upon the establishment of the favourable conditions. They formed blooms that decreased in a few days leaving only a minor signal in the sedimentary record.

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