The structure of planktonic communities in a meromictic coastal lagoon (*Estany del Cibollar*, Majorca)

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The *Estany del Cibollar* (*Albufera d'Alcudia,* Majorca) is a small coastal lagoon (3.99 ha, 8.25 m maximum depth, and 3.30 m average depth). It is characterized by a permanent meromixis due to the presence of seawater at depth. This phenomenon causes thermal inversion during winter and anoxia in the monimolimnion (MOYA *et al.*, 1987). At the chemocline, the concentration of dissolved oxygen increases sharply (up to 24 mg O_2/l and 330% saturation in April). Where oxygen is depleted, H_2S is present, increasing in concentration towards the lake floor. Analysed nutrient values indicate an eutrophic situation. Nitrogen in nitrate form is found in high concentrations at surface levels due to the inflow of a tributary stream whilst at depth, nitrate is replaced by ammonium. Phosphorus shows a progressive increase in the monimolimnion, especially close to the bottom due to its redissolution from the sediment.

Planktonic communities found in the *Estany del Cibollar* were sampled monthly during 1991. A very distinctive pattern of distribution of these communities, in response to the existence of meromixis, may be confirmed (MIRACLE *et al.*,1983).

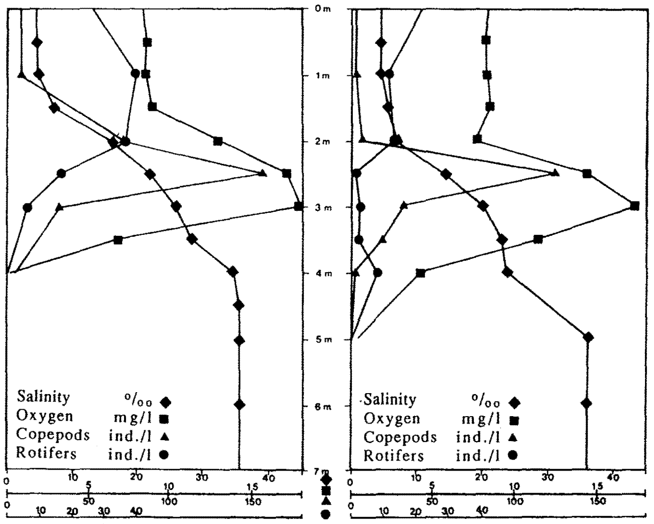
The phytoplanktonic community present in the mixolimnion is basically formed by Cryptophyceae and Chrysophyceae, with densities varying between 1000 and 10 000 cells per millilitre.

There is a significant concentration of cyanobacteria of the genus *Synechococcus*, which shows maximum densities in the metalimnion (up to 17 million cells per millilitre). The high oxygen values registered at this level are the result of the activity of this population and coincide with maximum values of Chlorophyll-a (CRAIG, 1987).

In the upper part of the monimolimnion, a community of phototrophic sulphur-oxidizing bacteria is present which utilises the existing H_2S.

The zooplanktonic community is dominated by copepods and rotifers. Their respective distributions show a different spatial distribution related to physicochemical and biotic factors throughout the vertical profile (FERRARI *et al.*, 1982).

The vertical structure of the planktonic communities and the distribution of the physico-chemical parameters are given in the diagrams and table enclosed. They illustrate two different points in the annual cycle: March and June.



MARCH 1991				JUNE 1991		
Chl. a (mg/m³)	Phytoplankton (cells/ml)	*Synechococcus* (cells/ml)	Depth (m)	Chl. a (mg/m³)	Phytoplankton (cells/ml)	*Synechococcus* (cells/ml)
2.94	1504	----------	0	1.84	9761	----------
2.93	4716	----------	1	1.45	7243	----------
4.25	5882	6.16×10^6	2	1.14	-----	1.03×10^6
4.39	8452	6.19×10^6	2.5	3.76	8856	2.98×10^6
9.83	-----	17.06×10^6	3	6.58	-----	12.05×10^6

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Environmental conditions which determine chrysophyte *Apedinella* development and blooms

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The modificatons of phytoplanktonic community during the last decades (MIHNEA, 1987, MIHNEA *et al.*, 1980) also include the occurence of some new representatives the number and frequency of which are still increasing. One of them is the chrysophyte *Apedinella* (THRONDSEN, 1971) that produces blooms. Our observations were carried out from 1975 to 1989 in the southern part of the Romanian inshore area along the 13 transects, 5, 10, 20 m isobaths. Samples (1,000 ml) were collected monthly at standard depths (0, 5, 10, 20 m), between February and October. On the whole 2,332 phytoplanktonic samples were analysed. Determinations regarding macronutrients and physical parameters were also done. As macronutrients are not limiting within the studied area, a correlation between this new organism and organic compounds produced by *Skeletonema* was found to help partially the explanation of its bloom (MIHNEA, 1992). Although *Apedinella* was present in Spring-Summer and sometimes in Autumn associations (Table 1), its massive development or bloom could be correlated with the large variation of silicium level (Table 2).

Table 1 : The frequency of *Apedinella* sp. population as its maximum density (no cells/l$\times10^3$; underlined values no cells/l$\times10^6$)

Year/ Month	MARCH	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
1975	0	3.5	140.0	33.0	0	0	0	0
1976	0.2	14.5	5.2	8.4	0.2	0	0	10.6
1977	0	1.4	0	0	0	2.1	1.5	0
1978	0	3.4	0	1.7	11.8	36.4	0	0
1979	108.0	132.0	1.5	31.5	0	0	0	3.0
1980	62.4	8.1	0	1.3	0	1.0	0	1.0
1981	0	0	15.8	0	0	0	0	0
1983	0	1.0	21.5	23.0	41.6	915.0	0	7.6
1984	0	23.4	1.0	237.0	4.0	14.0	0	0
1985	0	34.0	2.0	12.0	10.0	15.0	0	0
1986	0	6.0	13.3	38.0	6.0	12.0	6.0	0
1987	0	16.8	151.0	15.7	0	12.6	0	0
1989	49.0	0	0	2.1	14.9	12.8	0	17.0

Table 2 : Silicium level during the whole year within the studied area (CUINGIOGLU, unpubl.)

Year	Total No of samples	Class size/No of samples(N)/ range of $Si-SiO_3$ variation > 1000 µg/l	< 1000 µg/l
1983	349	41 1006-2000	308 0-960
1984	356	37 1017-3740	319 0-904
1985	335	15 1011-4960	320 53-845
1986	260	25 1005-2685	235 78-945
1987	231	69 1005-6125	162 105-990

April and May are the months when this chrysophyte blooms and correspond with the most reduced level of $Si-SiO_3$. If we only consider the 1986 results, when *Apedinella* cell no/l reached respectively 21.5 and 13.3 x 10^6, silicium concentrations varied on one hand from 0 to 400 µg/l in 35.54% and from 400 to 800 µg/l in 53.85% of the samples (N=104), and on the other hand from 0 to 400 µg/l in 54.0% and from 400 to 800 µg/l in 36.78% of the samples (N=87).

The silicium depletion is due to *Skeletonema* and some other co-associate diatoms which previously developed for a long while; this event plays an important role in shifting the species composition from diatoms to algal flagellates supposed to have limited or to have not Si requests. The sequence is very short but *Apedinella* "takes advantage" and begins its intense divisions. Some other factors could be involved, e.g. the total radiant energy. An increase in total rediant energy during the last decade of April and the first decade of May (Table 3) also could be connected to the promoting of an accelerated division rate of *Apedinella* if it is combined with a 6-10°C range of sea temperature (MIHNEA, 1992). The superimposing of : *Skeletonema* bloom, decrease of Si, 6-10°C range of sea temperature and a rapid increase of light (more than 1000 cal cm^{-2}) should be considered the "conditioning" of sea water for the described chrysophyte development.

During 1984, 1985 and 1987 the total radiant energy had increased in first decade of May, temperature was 10-16°C and the silicium level higher than values determined in 1983 and 1986's Spring; in such a "scenario" the bloom of chrysophyte *Apedinella* didn't take place. We cannot omit the concurrence between species as well the physical forces that could be other conditions of mass development. A tight concurrence between *Apedinella* and dinophyte *Heterocapsa triquetra* was observed, too; they both compete for some "excreted substances", or maybe try to impose their own association to medium diatoms which cannot develop in.

If *Apedinella* cannot develop strongly enough in April, windy Spring weather could stop it by dispersion of its patches.

In conclusion, in eutrophicated marine ecosystems, individual species are controlled by a large set of environmental factors. If anyone changes significantly, it upsets the existing balance and induces a new ecological equilibrium. The bloom is caused by the coupling of the physiological capabilities with the environmental conditions.

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