SEASONAL VARIABILITY OF PHYTOPLANKTON IN EUTROPHIC AND OLIGOTROPHIC ENVIRONMENTS IN SARONIKOS GULF, GREECE, 1983-1985

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From June 1983 to December 1985 and several times a year, surface water samples were collected with a 1.3 l N.I.O. bottle at two locations in the western Saronikos Gulf. Station S1 (38°00.3 N - 23°26.9 E), located in Elefsis Bay, is typical of a strong eutrophic environment and station S2 (37°44.8 N - 23°22.1 E), located in the outer Saronikos, is characterized by almost oligotrophic conditions (FRILIGOS, 1985). Phytoplankton samples, after fixation with Lugol's solution, were examined under an inverted microscope. The aim of this study is to present the seasonal phytoplankton abundance and species composition in these two different environments. At station S1, diatoms, dinoflagellates and μ-flagellates (flagellates with cell diameter less than 5 μm) were always present in large amounts (Table 1 and Fig. 1). Coccolithophores afforded very few species, but gave a bloom in July 1983 and July 1985. Silicoflagellates appeared only occasionally and always in very small quantities. On the average, the microplankton (total of all phytoplankton groups with cell diameter larger than 5 μm) had the lowest cell density in February (2.7×10^4 cells.l-1) and the highest in July (4.1×10^6 cells.l^{-1}). The μ-flagellates tended to have a minimum abundance in December (4.0×10^4 cells.l^{-1}) and a maximum in May (6.8×10^6 cells.l^{-1}). The number of species was by far more constant (average: 30 species per 10-ml sample). It did not display any pronounced seasonal trend or correlation with the number of individuals. Station S2 differs, as the phytoplankton density was at least one order of magnitude lower than it was at S1 (Table 1 and Fig.1), with average values of microplankton and μ-flagellates 4.6×10^4 cells.l^{-1} and 1.4×10^5 cells.l^{-1}, respectively. Also, the microplankton tended to have the normal seasonal cell variation, with a minimum in December-January and also in May, and a maximum in March.The abundance of μ-flagellates had a minimum in September and a maximun in spring months. Furthermore, the number of species displayed the usual trend of increasing with the number of individuals. The concentration of total dissolved inorganic nitrogen ΟΝ (nitrite, nitrate, ammonium) is higher at S1 (aver.: 2.94 μM.l^{-1}) than at the S2 (aver.: 1.03 μM.l^{-1}). Based on the species that were most important in abundance during the study period, five different assemblages were distinguished in phytoplankton community at station S1. The first assemblage, comprising the species *Coscinosira polychorda, Chaetoceros curvisetus, Thalassiosira rotula, Thalassiothrix mediterranea, Chaetoceros socialis* and *Chaetoceros didymus* was detected in December and February. From March to April, phytoplankton consisted of the species *Eucampia zodiacus, Scrippsiella trochoidea, Prorocentrum micans, Nitzschia seriata, C. curvisetus* and *Phalacroma pulchellum*. The third assemblage appeared in May-June and was made up of the algae *Gymnodinium sp., Leptocylindrus minimus, Nitzschia closterium, Leptocylindrus danicus* and *Skeletonema costatum*. In July 1983 and July 1985, a bloom of *Emiliana huxleyi* was observed, with densities of 2.1×10^6 cells.l^{-1} and 3.1×10^6 cells.l^{-1}, constituting 70.5% and 76.4% of the whole microplankton population, respectively. By the end of August to November, phytoplankton mainly consisted of the species *N. closterium, L. minimus, Rhizosolenia fragilissima, C. curvisetus, Chaetoceros glandazii* and *E. huxleyi*. At station S2, for most of samplings, the species composition and succession resembled those at S1. Also, the variations in diversity were quite intensive at S1, where the lowest values were recorded during the Coccolithophore blooms, while at the outer station S2, the diversity values were relatively high,reaching values of 3.4 bits/indiv.

	STATION S1		STATION S2	
TAXONOMIC GROUP	RANGE	AVERAGE	RANGE	AVERAGE
DIATOMS	2.0×10^4-1.1×10^6	3.4×10^5	5.0×10^2-1.9×10^5	4.1×10^4
DINOFLAGELLATES	1.8×10^3-3.8×10^5	1.0×10^5	2.0×10^2-1.4×10^4	3.8×10^3
COCCOLITHOPHORES	2.0×10^2-3.1×10^6	3.1×10^5	0-3.3×10^3	6.3×10^2
SILICOFLAGELLATES	0-1.2×10^3	1.2×10^2	0-1.0×10^3	1.4×10^2
MICROPLANKTON	2.7×10^4-4.1×10^6	7.6×10^5	8.0×10^2-2.0×10^5	4.6×10^4
μ-FLAGELLATES	4.0×10^4-6.8×10^6	1.4×10^6	4.8×10^3-4.7×10^5	1.4×10^5

Table 1. Ranges and average values of phytoplankton (cells.l^{-1}) at S1 and S2, from June 83 to Dec. 85.

In conclusion, the impact of human activity resulted in that the peak of microplankton abundance occurred in summer and not in March. Furthermore, pollution tended to reduce the number of species when the abundance soared, while, in natural conditions, the number of species increases with the number of individuals. In addition, *E. huxleyi* and *R. fragilissima*, predominating at S1, do not appear among the first five species at station S2, which presented about one tenth of diatoms and microplankton and about half the number of the species in comparison to S1, among which *N. closterium* and *L. danicus* predominated. This suggests that pollution causes the bloom of few species, which depend on the local conditions and are scanty in clean waters. The above mainly quantitative differences between the two stations, which are also qualitative in several cases, confirm the eutrophic character of the Elefsis area, but also the oligotrophic conditions which dominate at the western Saronikos. Similar results have been reported by MORAITOU-APOSTOLOPOULOU & IGNATIADES (1980), and PAGOU (1986) in similar studies of Saronikos Gulf.

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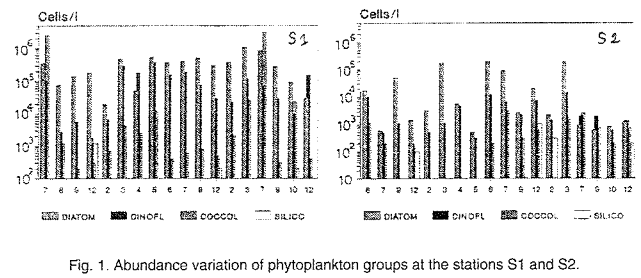

Fig. 1. Abundance variation of phytoplankton groups at the stations S1 and S2.

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FAUNISTIC STUDY OF THE MESOZOOPLANKTON FROM THE SOUTH-WEST OF MALLORCA (BALEARIC ISLANDS)

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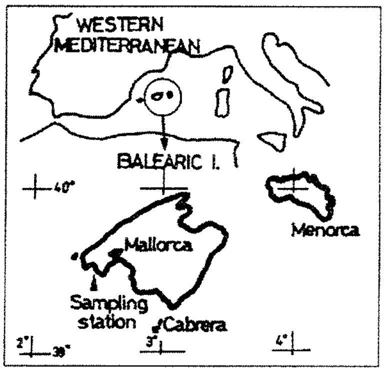
This paper shows the faunistic results of the HERCULE project planktonic study carried out in a sampling station placed south-west of Mallorca (Fig.). This study tries to contribute to the project goal, bringing information about hydrography and planktonic dynamics from whole Mediterranean Sea. The hydrographical and phytoplanktonic results are showed in the other two papers (FERNÁNDEZ DE PUELLES *et al.*, 1995; GOMIS and FERNÁNDEZ DE PUELLES, 1995). The zooplankton samples were got using Bongo net hauls provided with a 20 cm mouth diameter and 250 μm mesh-size. The sampling was done every ten days during an annual cycle (April 93-April 94). Two kinds of hauls were carried out in each sampling : a horizontal-superficial and an oblique (from -75 m approximately to surface). The collected organisms are fixed in a 4% formaldehyde solution buffered with hexamethylenetetramine. The use of sub-sampling methods makes easy the zooplankton identification and count (Table 1):



Location of the sampling station

- 1. The highest qualitative and quantitative participation of total occurs in the summer, when the availability of phytoplankton persists.
- 2. The zooplanktonic community is characterized by the presence of a perennial species group: copepods *Paracalanus parvus, Clausocalanus spp., Acartia clausi, Oithona nana, Oithona helgolandica*, immature individuals of the chaetognath *Sagitta* and the larvacean *Oikopleura dioica*. Every one of them is quoted as common epiplankton of the Western Mediterranean Sea.
- 3. Seasonal organisms add to the community in the course of the year : **summer:** case of cladocerans and the copepod *Temora stylifera* (observed during the longer part of the year, their presences are scarce in the winter samples), the doliolid *Doliolum nationalis* and molluscs (holo- and meroplanktonic species). Their observations occur in summer preferably because they are thermophile organisms; **autumn and spring** : the larger part of meroplanktonic larvae (decapods and polychaete larvae), in accordance with their planktotrophic characteristics; **winter** : abundance of the copepods *Centropages typicus* and *Isias clavipes*.
- 4. And a occasional species group is observed in the community. Their presences depend on the kind of haul (deep organisms such as ostracods *Conchoecia* in the oblique haul and Pontellidae hyponeustoniccopepods in the surface haul) and climatic conditions (allochtonous species coming from oceanic holoplankton carried away by the storms, case of amphipods Hyperiidea). In this way, the larvae of brief planktonic live can be considered occasional, such as the Phoronids Actinotrocha.

	FAUNISTIC GROUP	ZOOPLANKTONIC SPECIES	S		M		A		W	
			o	h	o	h	o	h	o	h
HOLOPLANKTON	Cladocerans	Penilia avirostris Dana, 1849	4	3	4	4	4	3	1	1
	Cladocerans	Evadne spinifera Müller, 1868	4	4	4	4	4	3	1	1
	Copepods	Calanus helgolandicus (Claus, 1863)	2	1	1	1	2	2	3	3
	Copepods	Paracalanus parvus (Claus, 1863)	4	4	3	3	4	4	3	3
	Copepods	Clausocalanus spp.	4	4	3	3	4	4	3	3
	Copepods	Temora stylifera (Dana, 1848)	3	3	3	3	3	3	2	2
	Copepods	Centropages typicus Kröyer, 1848	3	3	2	2	3	3	3	3
	Copepods	Isias clavipes Boeck, 1864	2	2	-	-	2	2	3	3
	Copepods	Labidocera wollastoni (Lubbock, 1857)	1	2	-	2	1	1	-	-
	Copepods	Acartia clausi Giesbrecht, 1889	3	3	3	2	3	3	2	2
	Copepods	Oithona nana Giesbrecht, 1892	3	3	3	2	3	3	2	2
	Copepods	Oithona helgolandica (Claus, 1863)	3	3	3	2	3	3	2	2
	Ostracods	Conchoecia spp.	1	-	1	-	1	-	2	-
	Amphipods	Hyperiidea	1	-	-	-	-	-	1	-
	Molluscs	Creseis acicula Rang, 1828	2	2	3	3	2	2	-	-
	Molluscs	Limacina spp.	3	3	3	3	3	3	1	-
	Chaetognaths	Sagitta spp. (immature individuals)	2	2	2	2	2	2	2	2
	Larvaceans	Oikopleura dioica Fol, 1872	3	3	2	2	3	3	2	2
	Doliolids	Doliolum nationalis Borgert, 1894	2	2	3	3	2	2	-	-
MERO	Polychaete	Nectocheta Larvae	2	2	-	-	2	2	1	1
	Decapods	Zoea Larvae	3	2	2	1	2	2	-	-
	Molluscs	Veliger Larvae	3	3	3	2	2	2	-	-
	Phoronids	Actinotrocha Larvae	1	-	-	-	1	-	-	-

Table 1. Participation of the most common zooplanktonic organisms.

Abundance groups: **1**/ 0 – 10 individuals/10 m^3; **2**/ 10 – 100 individuals/10 m^3; **3**/ 100 – 1 000 individuals/10 m^3; **4**/ more than 1 000 individuals/10 m^3.

Legend: **S**, spring. **M**, summer. **A**, autumn. **W**, winter. **o**, oblique haul. **h**, horizontal and superficial haul.

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