Θαλασσογραφικά- Thalassographica	(1984)	7	27-38

ZOOPLANKTON COMPOSITION OF SOUTH EUBOIKOS (AEGEAN SEA, GREECE) DURING FEBRUARY AND JULY 1982

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ABSTRACT

Two oceanographic cruises were performed during 1982 (February and July) in South Euboikos (Greece). The quantitative and qualitative studies of zooplankton showed that the gulf can be divided in to two parts: a northern one (28°12'–28°22'N) and a southern one (28°00'–28°12'N). The north part of the gulf is near to the city and the industrial area of Chalkis and showed abundant zooplankton when compared with the southern part. Species tolerant to eutrophic conditions were abundant in the northern part of the South Euboikos. The increase of Copepoda and the decrease of Appendicularia, within the zooplankton population, which was observed along the gulf, is also discussed.

INTRODUCTION:

Amongst the Greek gulfs, Euboikos helds an important position due to its special hydrographic conditions. The gulf is separated by Euripus channel into the South and North Euboikos. The channel (40m wide, 60m long and 8m deep) is characterized by a tidal current, a unique phenomenon in the Mediterranean, which reverses its course every 6 hours in 24 hours period; the force of this current, up to 8 miles/h, decreases rapidly away from the channel (Variagin, 1972).

North Euboikos is a semiclosed gulf which has good communication with the North Aegean Sea, through the Oreos channel. South Euboikos can be divided into two main parts. The northern part is elongated and communicates with the North Euboikos by Euripus channel. The southern part is much wider and is directly connected with the South Aegean Sea, through the gulf of Petali.

Few studies have been carried out on the fauna and flora of South Euboikos and are limited to the two extreems of the gulf (Petali gulf and Euripus area) («T.G. Tompson» R/V. Cruise 47, 1971; Yannopoulos & Yannopoulos 1973; Blasco, 1974; Ignatiades, 1974; Becakos-Kontos, 1977; 1981).

Recently (1979-1981) the Hellenic Hydrographic Service had made an extensive oceanographic study in the area of South Euboikos.

The present is the first study of the composition and distribution of zooplankton in the South Euboikos and has been carried out in winter and summer 1982.

MATERIALS AND METHODS:

Two oceanographic cruises were performed during February and July 1982, in which physical and chemical parameters were measured and biological samples were collected from nine stations along the gulf (Fig. 1).

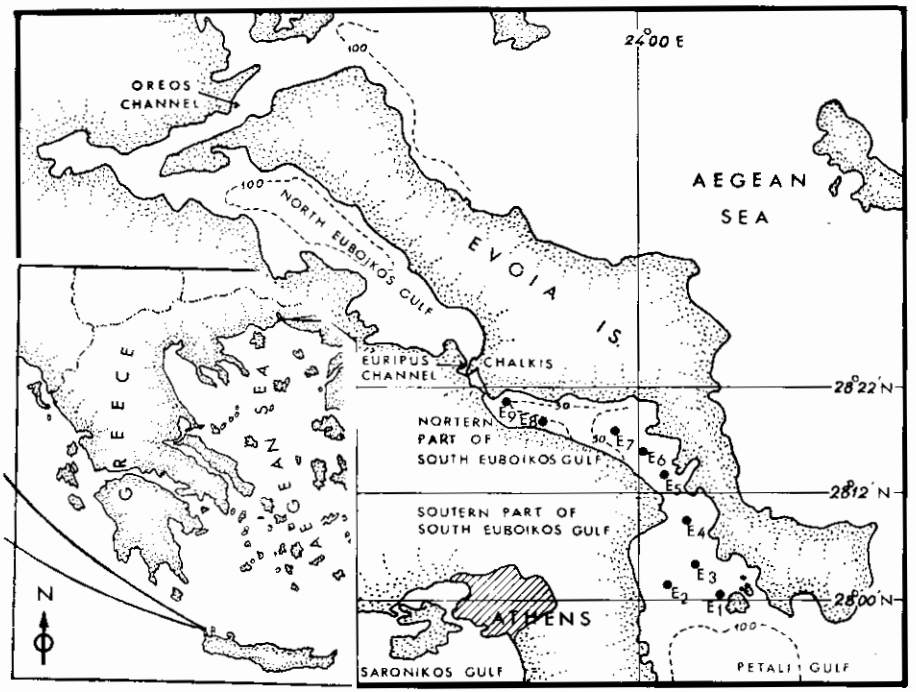

Fig. 1. Station location in South Euboikos

Zooplankton samples were taken by a WP-2 nylon net with 280 μm mesh size. The samples were collected by means of vertical hauls, which were made from bottom-to-surface, fixed in 4% neutralized formalin and stored in plastic jars. Subsamples were obtained by using a Folson plankton splitter and these

subsamples were used to estimate the zooplankton quantity. The latter was calculated as a number of individuals per cubic meter (indiv./m^3), in which all larval stages of the species present were added. Qualitative studies were usually made by examing the whole sample, sorting out the species, which were counted.

RESULTS:

a) Environmental conditions

South Euboikos has the characteristics of a semiclosed gulf and showed generally a gradient from station E_1 to station E_9. The depth, which is more than 50 meters in stations E_1, E_2, E_3, E_4, E_5, E_6 and E_7, becomes less than 30 meters in stations E_8 and E_9. The transparancy of sea water generally decreased from southern to northern stations; Secchi disc readings varied from 13-15 meters in the south to only 5 to 7 meters in the northern part of the gulf.

During the winter cruise the temperature was 12 ± 1°C (the northern part of the S. Euboikos retalively cooler by 1°C), the salinity was 38‰, (the northern part of the S. Euboikos had a salinity of about 37,5‰) and the water mass did not exibit any stratification.

During the summer cruise there was a very well defined thermocline of depths varying between 20 and 30 meters in deepstations (E_1 to E_7). The sea water temperature was 23 ± 1°C at the surface and 15 ± 1°C near the bottom. The northern part of the gulf was almost 1°C warmer than the southern part. Salinity during this period was almost constant at 37.5‰.

For both cruises the nutrient concentrations were low, when compared with values of nutrients found in other Greek gulfs (Friligos, 1977), but very similar to those reported for the open Aegean Sea (Friligos, 1981). The quantity of phytoplankton was greater during February especially in stations located at the northern part of the gulf. The mean phytoplankton values were $180X10^3$ cells/1, and $100X10^3$ cells/1, in the northern and the southern parts respectivelly (Siokou-Frangou et al, 1982).
During summer, however, these values showed a reduction of about 65%.

b) Zooplankton:

The total number of individuals per cubic meter, at all stations, is shown on Table I. Table II exibits the percentage values of different systematic groups during both oceanographic cruises. Copepoda was the most important group and constitute from 66.8% to 87.2% in the composition of zooplankton during winter. These values, however, decreased during summer and copepods were about the 33.5% to 58.1% of the planktonic community. Copepodites represent

Table I.

Total number of individuals per cubic meter at all stations during both oceanographic cruises.

	Stations	Individuals per cubic meter			
		February	Mean value	July	Mean value
Southern	E_1	246		555	
part of	E_2	988	794	217	461
the gulf	E_3	668		661	
	E_4	1273		409	
	E_5	1074		728	
Northern	E_6	–		415	
part of	E_7	2848	2596	1137	915
the gulf	E_8	–		1381	
	E_9	3867		915	

a large percentage in the total number of Copepoda in both cruises. These values are also shown on Table II.

Cladocerans, as expected, have very small contribution in the composition of zooplankton during winter but there was a remarkable increase during summer with percentage values varying between 10.5% and 53.5%.

The presence of appendicularians during winter cruise showed a definite gradient. In stations located at the southern part of the gulf appendicularians constitute the 15-20% of zooplankton, but very few individuals were recorded at northern stations (Table II). During summer cruises their contributions in the composition of zooplankton was only at average of about 6% of the total number of individuals.

During the winter cruise Thaliacea showed very small contribution to the planktonic population (1.7% of the total number of individuals), while during summer cruise, due to the great number of Doliolidae, the percentage values were increased and varied from 19.5% in the southern stations to 1.1% in the northern stations (Table II).

Chaetognatha represented in both cruises less than 10% of plankton and their variation had not been orientated. The rest of the systematic groups (Siphonophora, Medusae, Decapod larvae, etc.) did not constitute high population numbers and showed very few variation from station to station.

Qualitative studies were made from Crustacea (Copepoda, Cladocerans), Tunicata and Coelenterata. From these groups sixty four species were counted (Table III).

During winter cruise the composition of zooplankton population showed the following pattern:

Table II.

Percentage values of different systematic groups during both cruises.

STATIONS		E_1	E_2	E_3	E_4	E_5	E_6	E_7	E_8	E_9
	Month	%	%	%	%	%	%	%	%	%
COPEPODA	Febr.	67.0	66.8	72.9	73.2	81.2	–	87.2	–	86.0
	July	49.4	58.1	40.7	37.4	39.6	42.6	41.6	33.5	36.5
CLADOCERA	Febr.	0.6	0.6	0.5	0.4	0.2	–	0.1	–	0.3
	July	10.5	17.9	18.5	33.5	30.6	32.1	25.8	53.5	44.7
APPENDICULARIA	Febr.	15.9	18.9	11.7	4.8	2.8	–	0.2	–	0.1
	July	8.3	3.8	8.8	4.1	8.0	6.1	8.6	5.3	6.6
THALIACEA	Febr.	1.4	2.1	2.2	3.4	1.0	–	2.0	–	0.1
	July	19.5	14.9	19.2	13.6	8.2	7.1	8.6	2.0	1.1
CHAETOGNATHA	Febr.	2.0	3.8	3.9	3.8	7.0	–	5.6	–	3.9
	July	5.3	1.7	4.8	6.3	5.6	5.8	9.0	2.1	3.0
SIPHONOPHORA	Febr.	2.1	1.8	3.8	2.9	1.4	–	3.1	–	2.8
AND MEDUSAE	July	3.3	2.9	4.6	3.6	2.3	2.7	4.8	1.7	3.1
DECAPOD	Febr.	3.8	2.0	1.6	4.7	1.6	–	0.5	–	0.2
LARVAE	July	1.1	0.4	0.8	0.6	3.2	1.0	0.6	0.6	2.6
MISCELLANEOUS	Febr.	7.2	4.2	3.4	6.8	4.8	–	1.3	–	6.6
	July	2.6	0.3	2.6	0.9	2.5	2.6	1.0	1.3	2.2
COPEPODITES	Febr.	41.4	35.5	42.5	34.4	52.5	–	52.5	–	46.7
	July	55.6	73.1	51.3	27.4	57.1	35.7	55.8	51.9	67.0

Table III.

Species found during both cruises in South Euboikos.

COPEPODA

Acartia clausi Giesbrecht
A. negligens Dana
Aetideus armatus (Boeck)
Calanus helgolandicus Claus
C. minor (Claus)
C. tenuicornis Dana
Calocalanus pavo Dana
C. styliremis Giesbrecht
Calocalanus sp.
Candacia armata (Boeck)
C. simplex Giesbrecht
Clausocalanus arcuicornis (Dana)
C. jobei Frost and Fleminger
C. furcatus (Brady)
Centropages typicus Kroyer
C. violaceus Claus
Clytemnestra rostrata (Brady)
C. scutellata Dana
Corycaeus spp.
Ctenocalanus vanus Giesbrecht
Diaixis pygmoea Scott.
Euaetideus giesbrechti Cléve
Eucalanus attenuatus Dana
E. crassus Giesbrecht
Eucheta marina Prestandrea
Euterpina acutifrons Dana
Isias clavipes Boeck
Lucicutia flavicornis Claus
L. ovalis Wolfenen
Mecynocera clausi Tompson
Microsetella norvegica Boeck
M. rosea Dana
Oithona nana Giesbrecht
O. plumifera Gaird
Oncaea media Griesbrecht
Oncaea spp.
Paracalanus denudatus Sewell
Paracalanus parvus (Claus)
Scolecithricella dentata Giesbrecht
Scolecithricella spp.
Temora stylifera Dana

CLADOCERA

Evadne spinifera Müller
E. tergestina Claus
Penilia avirostris Dana
Podon intermedius Lilljeborg

APPENDICULARIA

Appendicularia sicula Fol
Fritillaria borealis Lohmann
F. messanensis Lohmann
F. pellucida Buch
Fritillaria spp.
Oikopleura cophocerca (Gegenbaur)
O. dioica Fol
O. fusiformis Fol
O. fusiformis f. cornutogastra (Aïda)
O. graciloides Lohmann and Bückmann
O. longicauda Vort.
Oikopleura spp.

SIPHONOPHORA AND MEDUSAE

Aglaura hemistoma Peron and Lesuer
Chelophyes appendiculata Eschssholtz
Eudoxoides spiralis Bigelow
Lensia campanella (Moser)
L. subtilis (Chun)
Muggiaea kochi (Will)
Obelia spp.

In the southern part of South Euboikos the most common species found were *Oncaea media, Clausocalanus arcuicornis, Ctenocalanus vanus, Centropages typicus, Oithona plumifera, Corycaeus* spp. from copepods and the appendicularian *Fritillaria pellucida*. In the northern part of the gulf, in addition to the above species, *Euterpina acutifrons, Oithona nana, Calocalanus* spp. and *Paracalanus parvus* were the dominant species, while there was the disappearance of *F. pellucida* (Fig. 2).

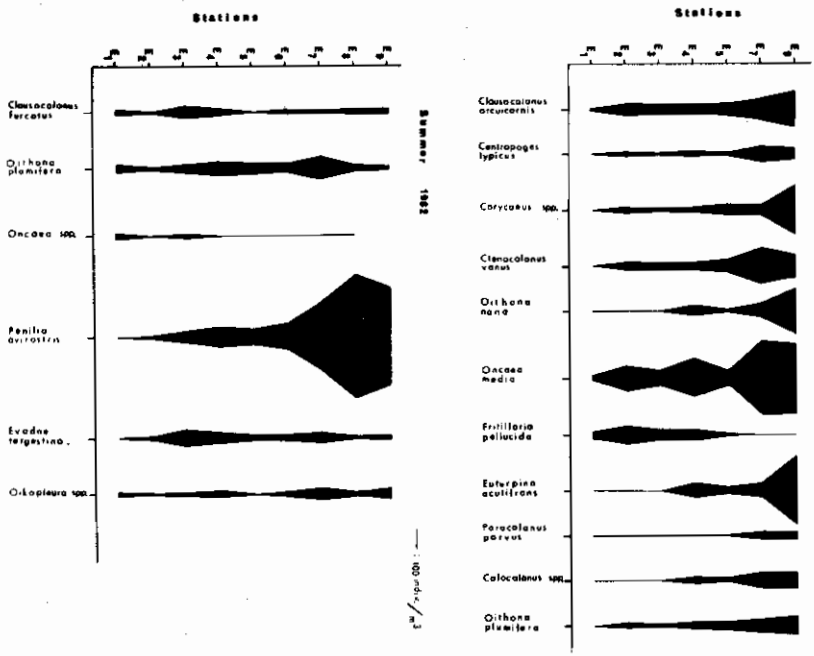

Fig. 2. Dominant species variations during borh cruises, for the nine stations along the South Euboikos gulf.

During summer cruise the zooplankton composition, between the southern and northern part of the gulf, had insignificant fluctuations. The dominant copepod species were *Clausocalanus furcatus, O. plumifera,* and *Oncaea* spp. From cladocerans and appendicularians the most common species were *Penilia avirostris, Evadne tergestina* and *Oikopleura* sp. respectively (Fig. 2).

DISCUSSION:

Temperature and salinity, along the South Euboikos, had very small fluctuations during both cruises, which were not considered to be of a direct biological significance. Zooplankton population, showed an increase from southern to northern stations, which in winter cruise, was in the form of a constant gradient. The explanation for this increase in the zooplankton population is uncertain. However, the eutrophic conditions, which were confirmed during February by a definite phytoplankton gradient, could suggest a relation between zooplankton and eutrophication.

The gradual increase which was observed in the number of Copepod species during the winter cruise, could be attributed to a predator-pray relationship similar to the one described before for Saronikos gulf (Moraitou-Apostolopoulou and Ignatiades, 1980). Another stricking feature during winter cruise was the reduction of appendicularians from southern to northern stations. This phenomenon could be a result of filter clogging in the house of appendicularians due to the great phytoplankton density in the northern stations (Siokou-Frangou et al, 1982). In support to this Alldredge and Madin (1982) suggested that when planktonic tunicates encounter very high concentrations of particles, their filters clog and ingestion stops.

The southern part of South Euboikos had a zooplankton density of 200-1200 indiv. /m^3. The quantity of zooplankton resembles that of Saronikos gulf (Moraitou-Apostolopoulou, 1974) and that of North Euboikos gulf (Matsakis et al, 1978). In constrast to this, the northern part of the gulf had a greater density with 1000-4000 indiv. /m^3 (Table I), and thus showed a higher zooplankton density compared with the neighbouring gulfs. It should be mentioned, however, that these values represent only the results of a first approach to this subject, since the study of South Euboikos on monthly bases has not been accomplished.

Differences were observed in the composition of zooplankton between stations located in the northern and the southern part of the gulf. These could well be attributed to eutrophic conditions that northern stations (E_8 and E_9) had, due to the vicinity of this part with the city and the industrial area of Chalkis.

Thus, during winter cruise, copepods like *E. acutifrons* and *O. nana* were found in high numbers in stations E_8 and E_9. These species are well known to be tolerant species in a polluted environment (Benon et al, 1979).

The Oikopleuridae and Fritillariidae showed different distribution, with Oikopleuridae being mostly on the northern part of S. Euboikos gulf. The fact that this family has more tolerant species in eutrophic waters (EPOPEM, 1979) could be the reason of their differences in the spatial distribution.

Similar differences were observed, during summer, for Cladocera. The species *P. avirostris* was abundant in stations located in the northern part of the gulf. This could be explained by the positive correlation that this species

has with turbidity (Della Croce, 1950) as well as its abundance in eutrophic and semiclosed areas in the Mediterranean (Moraitou-Apostolopoulou, 1981; Valero et al, 1981).

Acartia clausi, one of the most well known pollution indicator species (Blanc et al, 1975), was very rare in the samples, taken by vertical hauls. This species has been reported mainly near the surface (Verriopoulos, 1979) and this could be the reason for the few individuals found in the samples. This suggestion is supported by the fact that in samples collected by a horizontal net near the area of Chalkis the most abundant species was *A. clausi*.

Thus, results show that South Euboikos can be divided into two parts, according to their morphology and hydrographic conditions. The north and the south part of South Euboikos exibited quantitative as well as qualitative differences which could be attributed to eutrophication. More studies are needed, however, in order to evaluate the gulf productivity, the relation between nutrients and primary production and zooplankton biomass.

ACKNOWLEDGEMENTS:

We wish to express our gratitude to the Hellenic Hydrographic Service which offered us the opportunity to participate on both cruises.

ΠΕΡΙΛΗΨΗ

Δύο ωκεανογραφικά ταξίδια πραγματοποιήθηκαν το 1982 (Φεβρουάριος, Ιούλιος), στον Ν. Ευβοϊκό κόλπο. Η ποσοτική και ποιοτική μελέτη του ζωοπλαγκτού έδειξαν ότι ο κόλπος μπορεί να χωρισθεί σε δύο τμήματα: ένα βόρεια (28°00′ – 28°12′N) και ένα νότιο (28°12′ – 28°22′ N).

Το ζωοπλαγκτό του βόρειου τμήματος του κόλπου που γειτνιάζει με την αστική και βιομηχανική περιοχή της Χαλκίδας, είναι αφθονότερο σε σύγκριση με το νότιο τμήμα και χαρακτηρίζεται από είδη ανθεκτικά στη ρύπανση.

Κατά μήκος του κόλπου, από το νότιο τμήμα προς το βόρειο, παρατηρήθηκε μια βαθμιαία αύξηση των κωπηπόδων με παράλληλη ελάττωση των κωπηλατών. Το φαινόμενο αυτό συσχετίσθηκε με την αυξανόμενη πυκνότητα του φυτοπλαγκτού από νότο προς βορά.

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