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THE OSCILLATIONS OF COPEPOD DENSITY IN THE KAŠTELA BAY AS INFLUENCED BY SOME ENVIRONMENTAL FACTORS

OSCILACIJE GUSTOĆE KOPEPODA U KAŠTELANSKOM ZALJEVU U ODNOSU NA NEKE FAKTORE SREDINE

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The paper reports the results of the investigations of the relationship between the copepod number and some abiotic factors (temperature, salinity, sea water density) as well as between the copepod number and some biotic factors (number of phytoplankton organisms, number of fish eggs) at the station Kaštela Bay in the 1970—1974 period.

1. INTRODUCTION

Even though the investigations of the copepod ecology in the Kaštela Bay have been of large extent (Gamulin, 1939; Regner, D. 1970, 1971, 1973, 1974, 1975, 1976b, 1977a, 1978, 1979a, Regner and Vučetić, 1980; Homen and Regner, 1977; Marasović and Regner, 1979; Vučetić and Regner, 1973 and some others) the statistically worked out data on the relationship between the copepod group and some abiotic and biotic factors of environment may only be found in the paper by Regner, D. (1977). This paper gives the values of correlation coefficient between the total number of copepods on the one side and the sea water salinity, chloroplyl a, the number of phytoplankton organisms and the number of fish eggs on the other.

Since these first results were obtained after only a year cycle it was assumed to be necessary to observe the relation between the copepod quantity and the above mentioned factors by seasons and over a longer period. Thus, the results in this paper cover the period of five years.

The material was collected from the permanent station of the Institute of Oceanography and fisheries »The Kaštela Bay« (43° 31' N; 16° 19' E) by vertical hauls of a Hensen plankton net (73/100, slik No. 3) on monthly basis, in 1970—1974.

2. STUDY AREA

The Kaštela Bay station — 42 metres depth — is located in a markledly closed coastal area exposed to the strong and direct influence of the land (Fig. 1).

The Bay of Kaštela is situated between the Kozjak mount, the northern part of the Čiovo Island and the northern side of the Marjan peninsula. A very narrow strait is near Trogir, and a cosiderably wider one to the Brač Channel.

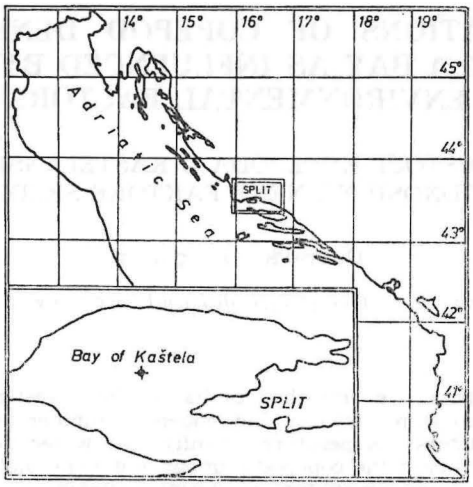

Fig. 1. Study area

The bottom is muddy, somewhere rocky with an average depth of 23 metres. Maximum depth recorded in the middle and the deepest part of the bay does not exceed 47 metres.

The freshwater runoffs are coming from the Jadro River, Pantan stream and springs along the coast, some of which are submarine.

Due to the small depths and strong runoffs from the land the variations in temperature and salinity are of considerable extent. Their maximum and minimum values occur here earlier than in the open sea. Maximum temperature during the five years period of investigations was recorded in August 1972. In the 0—10 m layer it was 20.47°C. Minimum temperature was recorded from the same layer in March 1970 (B u l j a n, unpublished data). It was 11.05°C.

Salinity maximum recorded in November 1973 amounted to 37.88‰. The lowest salinity value of 34.04‰ was found in May 1974.

Maximum sea water density of 28.48 was recorded from the same layer in January 1974, and the minimum one of 24.72 in July of that year.

Lower values of temperature and salinity recorded along the northern coast of Čiovo Island are indicative of the fact that the cooled water of lower salinity leaves the Bay to the Split Channel near the eastern cape of this island.

Sea currents vary to a considerable extent. This is probably due to the relatively small depths and poor tidal currents as well as to the strong local wind forcing. W direction is prevalent in winter, NW in spring and early summer, E in summer, particularly in the surface layer, and S in autumn (Z o r e - A r m a n d a, 1974). The outgoing flow along the Čiovo Island is most

pronounced in September and November. In winter and summer, however, the ingoing flows are prevalent. It is of importance to add that the water enters the Kaštela Bay mainly in the surface layer and leaves it in the intermediate and bottom ones.

Mean resultant current speed is 6 cm s^{-1} at surface, 4 cm s^{-1} in the intermediate layer and 3 cm s^{-1} in the bottom one, i. e. it decreases from surface to bottom. The greatest speeds occur in the autumn and winter months — from November to February, when the exchange of water with the adjacent Brač channel and the fresh water inflows into the Kaštela Bay are more intensive.

Wind forcing studies show that it is most pronounced in the summer months since only the surface layer is exposed to the air motions owing to the summer stratification. In the Split Channel the wind forcing accounts for about 40% of the sea current directions.

Tidal currents were also measured in the Split area (Zore-Armanda, 1975). They are particularly pronounced in the intermediate and bottom layers. Tidal wave is of N — S direction, i.e. it proceeds directly from the open sea perpendicular to the coast.

According to the most recent investigations and on the basis of the current roses constructed by seasons, Zore-Armanda (1975) calculated that the exchange of water with the Brač Channel takes part twice in a mont's period. The fact that the inflow slightly exceeds the outflow may be indicative of that this phenomenon is compensated by the outflow through the Trogir Strait. However, this exchange is far less strong than the one with the Brač Channel.

3. RESULTS AND DISCUSSION

3.1. Variations in the copepod number as influenced by some abiotic environmental factors (temperature, salinity, sea water density)

Since the five year series of data on temperature, salinity and sea water density were available among the abiotic environmental factors (Buljan, unpublished data) we tried to observe in a more detail the variations in the number of copepods in relation to these factors. We want to point out that the data on all the mentioned factors cover the same period of five years.

Thus the data for 1970 (Fig. 2) show that the annual minimum copepod number occurred in January, at low values of sea temperature (12.33°C) and salinity (35.27‰). Unfortunately, the data from March and April of this year were not available. However, the graphs show that the number of copepods was increased in the spring period. During summer, i.e. from July on, the sea temperature increased and reached the maximum in September. Salinity increased with the sea water heating and its values were high as far as to the end of the year, reaching the maximum in December. The sea water density was lowest during summer (from July to September). The number of copepods started to increase in August. At time of maximum temperatures it reached the second annual maximum in September, and even though it remained rather high till the end of the year. The third annual maximum was recorded in November (during high salinity).

In 1971 three copepod density maxima were observed, as well. The first

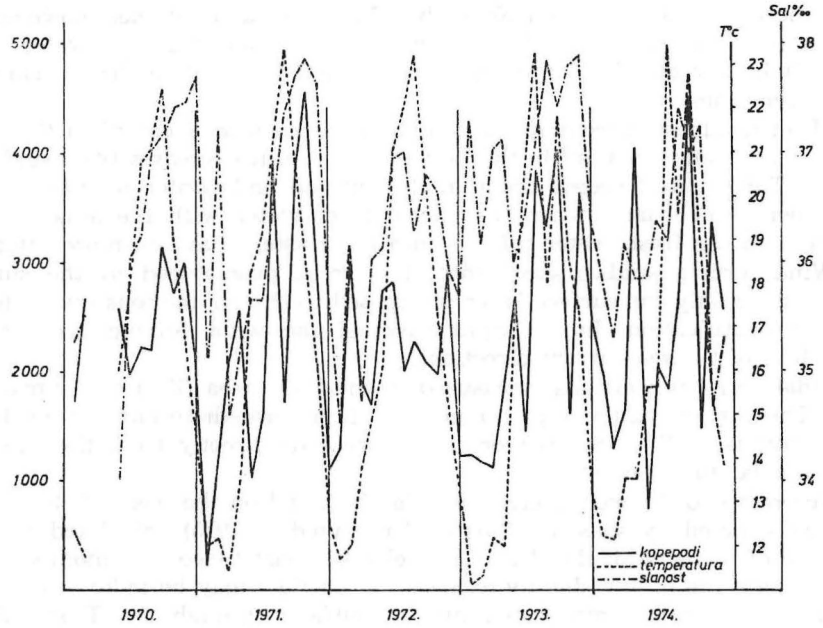

Fig. 2. Oscillations in the copepod number, temperature and salinity of the sea at the »Kaštela Bay« station in 1970—1974 period

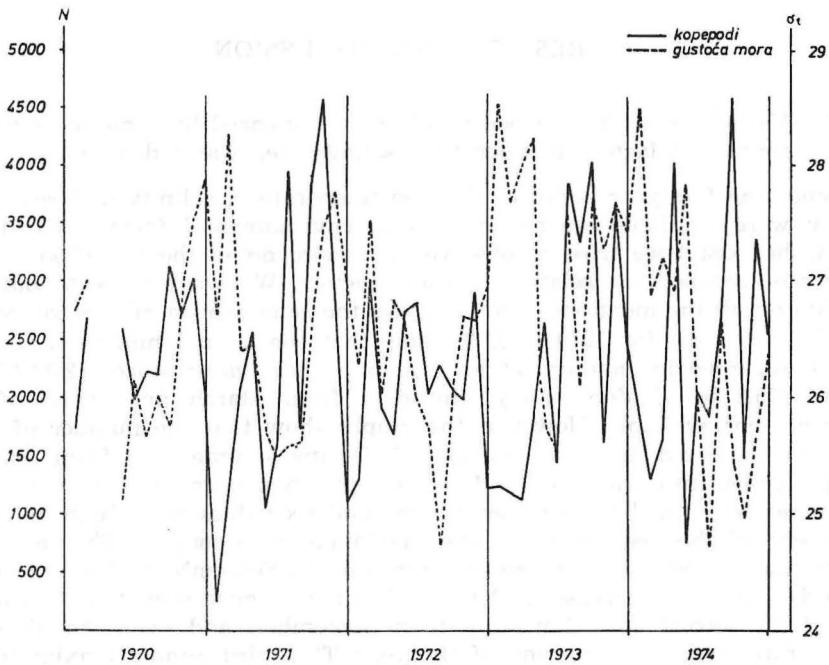

Fig. 3. Oscilations in the copepod number and the sea water density at the »Kaštela Bay« station in 1970—1974 period

the third and the higest one in autumn, in October. Except for the spring maximum, recorded at a temperature of 15°C, both the summer and autumn maximum copepod numbers recorded occured parallel to the higest annual temperature and salinity values recorded from March to October. The sea water density was lowest in summer of this year, as well (from May to August).

In 1972 the number of copepods was low in january, to increase rapidly with the sudden increase in salinity and reach its first annual maximum in February. The number of copepods decreased with the gradual increase in temperature and salinity and then increased to the second maximum in July, decreased once again and increased till November when the third annual maximum was recorded. Afterwards the number of copepods was reduced to its lowest value recorded in this year following the rapid fall of temperature and reduction of salinity. The sea water density was highest in February and lowest in summer.

In 1973 minimum copepod number was recorded in spring, even as late as March. However, the sea temperature was rather low at that time. With an increase of temperature and salinity the number of copepods gradually increased to reach the autumn maximum in July at time of the higest annual temperature and very high salinity. The curve of the number of copepods decreased slightly thereupon, and afterwards reached the highest annual maximum in September with the rather high values of temperature and salinity. This maximum was preceded by the low values of the sea water density, which were low during summer of this year, as well. The third increase was noted in October, like in the preceding year.

The year 1974 slightly differs from the rest of the years with respect to the variations in the number of copepods.

Winter minimum occured in February. A sudden increase in the number of copepods followed by the spring maximum, was recorded in April at relatively low temperature (13.55°C and salinity 35.84‰). The sea water temperature was rather high throughout this year. The same was with salinity, while the sea water density values were lowest between June and October. The summer maximum shifted to September, and the autumn one occurred in October.

Since all the data mentioned above, as well as the graphical representation of the trend in copepod density during the year and the variations in temperature, salinity and density, show that these factors are interdependent, their relationship was attempted to be calculated and given statistically. Namely, the regression lines which give the relationships between the copepod numbers and temperature (Fig. 4), salinity (Fig. 5), and the sea water density (Fig. 6) already show the positive correlation with temperature and salinity, and the negative one with the sea water density. Therefore, the coefficients of correlation were calculated for these parametres. The r value is higest for the relationship between the number of copepods and temperature of the sea being $r = 0.413$, and $p < 0.001$, which means that it is significant for more than 99.9%.

Positive correlation also established between the number of copepods and salinity, with the correlation coefficient value $r = 0.312$, significant for $p < 0.05$, i.e. for more than 95%. Poor negative correlation was, howeever, obtained between the number of copepods and the sea water density. This was already shown by the regression line. The correlation coefficient value $r = 0.139$, was insignificant.

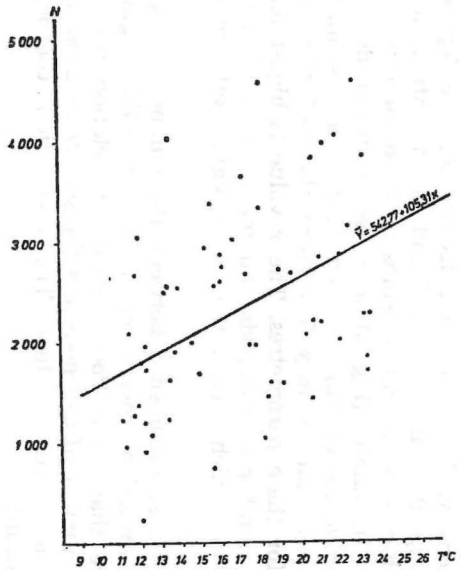

Fig. 4. The relation between the copepod number and temperature of the sea at the »Kaštela Bay« station

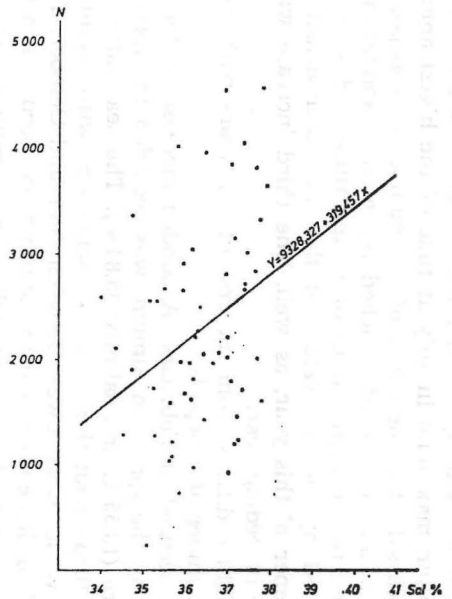

Fig. 5. The relation between the copepod number and salinity of the sea at the »Kaštela Bay« station

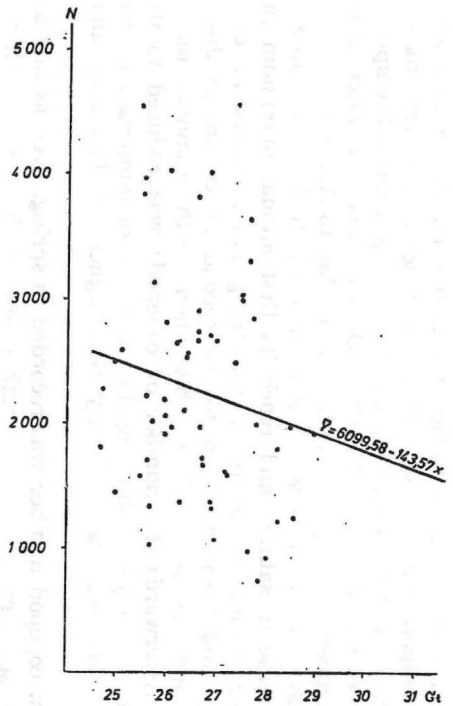

Fig. 6. The relation between the copepod number and the sea water density at the »Kaštela Bay« station

Values of the correlation coefficient between the number of copepods and the already mentioned parameters are given in Table 1.

Table 1. Correlation coefficients between the number of copepods and temperature, salinity and sea water density

T°C	Sal‰	σt
$r = 0.413$ $P < 0.001$	$r = 0.312$ $P < 0.05$	r = —0,139

As it may be seen fom the above Table, the influence of the sea water temperature and salinitiy on the total number of copepod specimens is not only evident but statistically significant, as well. This is another proof of the importance of the direct influence of factors on copepod group as a whole. Inspite of significant coefficients of correlation obtained, figures 4 and 5 clearly show that relationship between the number of copepods and temperature or salinity is not linear. The future investigations would be mathematical analysis of this nonlinearity. We would also like to mention that all the studies carried out up to now included only the influence of different abiotic environmental factors on individual copepod species (Gamulin, 1939; Regner, D., 1971, 1979; Vučetić, 1961a, 1966, Regner, D. and Vučetić, 1980). These long-term data comprising the whole group are the first ones of this kind.

The more recent researches in the central Adriatic (Zore-Armanda, 1969; Buljan, 1969) show that the long-term fluctuations of meteorological factors (wind, atmospheric pressure) cause the changes of the Adriatic hydrografic properties (temperature, salinity). The intensified inflow of intermediate Mediterranean water (like in 1963, 1964, and 1965) by which the sea is enriched in nutrients and oxygen and the bilogical production and values of phyto and zooplankton (1961—1966) increased (Pucher-Petković, 1966, 1968, 1969; Vučetić, 1965, 1969) is also due to the changes of meteorological factors.

Therefore the total number of copepods by years will be observed here with respect to the annual values of temperature and salinity of the sea water in 1970—1974 period.

Thus, the increase in the number of copepods at the investigated station coincided with the slight increase in temperature and salinity in 1971 (Table 2). In 1972, the total number of copepods was somewhat lower, as well as

Table 2. Total number of copepods by years and annual mean values of temperature and salinity of the sea

year	T°C	Sal ‰	total copepod number
1970	16,53	35,74	24260
1971	16,55	*36,34*	26770
1972	*16,80*	36,08	25980
1973	16,39	36,13	27895
1974	16,35	36,09	*28165*

salinity, while temperature was slightly increasing. In 1973, the number of copepods increased with the increase in salinity. Finally, in 1974 the number of copepods increased, and temperature and salinity decreased.

The differences in numbers between years are not, as seen from the Table, as high as they might have been expected in the coastal area. Earlier investigations carried out at the same station in 1960—1969 period (Regner, D. 1970; and Vučetić and Regner, D., 1973) showed the increases which considerably exceeded those in this period. They could be accounted for by the already mentioned general changes in the hydrographic properties of the Adriatic water. These changes exerted positive effects on the total organic production of the central Adriatic.

Thus marked changes of hydrographic factors were not recorded in 1970—1974 period. No regularity was found in the increase of the total copepod number either. Therefore, it may be said that in the 1970—1974 period no qualitatively significant changes took place in the coastal central Adriatic under the intensified influence of the Mediterranean (Buljan, unpublished data) like it was in 1962—1964 period. Increased values of temperature and salinity, established above, would certainly cause a long-term increase in the total number of copepods. The variations in the number of copepods found did not show any significant rapid increase during the period of investigations. On the contrary, the number of copepods in the Kaštela Bay is alternatively increased or decreased with the slight increase trend in 1970—1974 period

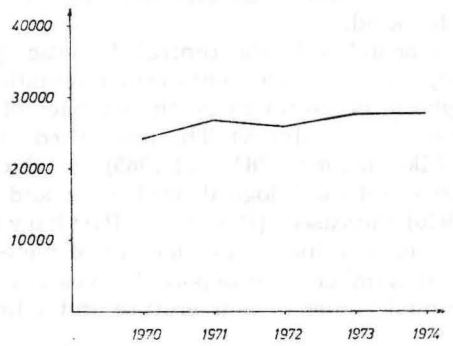

Fig. 7. The total copepod number at the »Kaštela Bay« station in 1970—1974 period

2.2. Changes in the number of copepods with respect to some biotic environmental factors (phytoplankton, zooplankton, fish)

The data on the total number of phytoplankton organisms as the main food of copepods, the data on primary production expressed as the carbon quantity in mg/m²/day, the data on the total number of zooplankton organisms among which the copepods are quantitatively best represented group, as well as the data on the total number of fish eggs are selected among the biotic factors to be considered in this paper.

The investigations of the relations between the phytoplankton and individual zooplankton groups (Vučetić, 1965) and those between the primary production and standing crop of the total zooplankton in the same area (Vučetić and Pucher-Petković, 1969; Pucher-Petković and Vuče-

tić, 1969) showed the nature of connection between these two plankton communities (producers and predators). Both these and other investigations carried out later established anual variations in phytoplankton and zooplankton not to coincide by months. However, this was accounted for by the different number of productive periods of phytoplanton and zooplankton in the course of the year. Pucher-Petković and Vučetić found mean seasonal values of zooplankton to coincide with the mean seasonal values of primary production »which means that the quantity of produced food mainly determined the magnitude of zooplantkon populations« (Karlovac et al., 1974).

Further, a tendency of increase in the total number of phyto and zooplankton organisms was established for a longer period, with maxima in 1965 and 1966. It was also found that the long-term changes of zooplankton biomass are of the same order of magnitude, i. e. with the same maximum and minimum deviations from the long-term means.

The results of these comprehensive investigations were stuided against the total changes that took place in the Adriatic hydrography. This rendered possible an assessment and prediction of the fish production for a longer period (Karlovac et al., 1974).

The data on the number of copepods, quantitatively best represented group of zooplankton organisms were therefore compared with the data on total phytoplankton (Pucher-Petković, unpublished data) for the period 1970—1972.

The graphs have already showed (Fig. 8) the similarity in the seasonal variations in the number of individuals of both components compared. This is particularly evident for 1971. This interdependence of copepods and phytoplankton, which is copepod principal food, was proved statistically, as well, by the strong positive correlation with the correlation coefficient $r = 0.67$, significant for more than 99%.

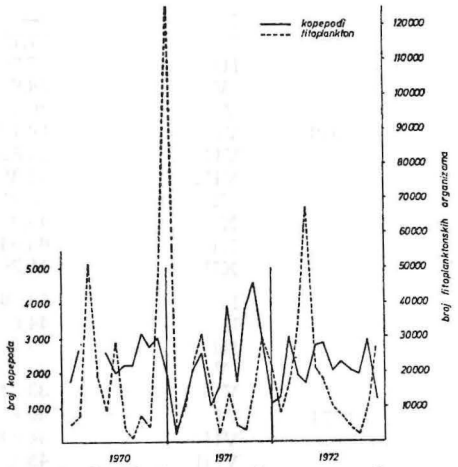

Fig. 8. Oscilations in the copepod number and the number of phytoplankton organisms at the »Kaštela Bay« station in 1970—1972 period

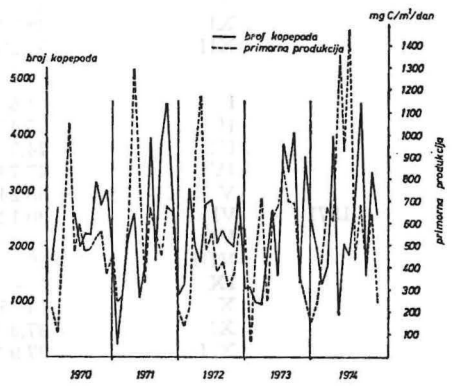

Fig. 9. Oscilations in the copepod number and primary production at the »Kaštela Bay« station in 1970—1974 period

Further, the studies of the feeding of the dominant copepod species in the Kaštela Bay showed that these species took phytoplankton all the year round. The contents of their digestive tract are abundant in all the seasons. This at the same time proved that there was enough phytoplankton at their disposal. They took phytoplankton with no selectivity (Homen, B. and Regner, D., 1977) Regner, D., 1978; Marasović and Regner, D., 1978). Thus, markedly dominant species of the Kaštela Bay: *Acartia clausi, Centropages typicus, Centopages kröyeri,* and *Temora stylifera* take as their food the phytoplankton species which are predominant in the adjacent sea in the respective season. Therefore, the relations between the number of copepods and the density of phytoplankton organisms we obtained here are that as clear and prove their interdependence.

The results obtained by the comparison of the total number of copepods and primary production expressed as the quantity of produced carbon in mg/m²/day slightly differ from the above mentioned ones. This, however, may be understood since the above comparison refers to the biomass of individuals of phytoplankton and copepods expressed as the number of individuals per

Table 3. Percentage of the copepod number in the total zooplankton at the »Kaštel Bay« station

		%			%
	I	99,43	1972	VI	—
	II	—		VII	—
	III	—		VIII	—
	IV	—		IX	—
	V	42,72		X	—
1970	VI	27,13		XI	—
	VII	25,61		XII	—
	VIII	27,66		I	—
	IX	18,92		II	27,71
	X	45,79		III	27,76
	XI	38,62		IV	38,85
	XII	51,23		V	26,89
			1973	VI	18,72
	I	41,67		VII	26,82
	II	35,47		VIII	45,35
	III	74,30		IX	43,21
	IV	47,73		X	35,07
	V	36,24		XI	65,04
1971	VI	30,12		XII	51,26
	VII	—		I	63,30
	VIII	19,24		II	44,66
	IX	—		III	29,89
	X	64,75		IV	33,65
	XI	37,30		V	33,24
	XII	37,93	1974	VI	30,69
				VII	34,84
	I	—		VIII	45,25
	II	—		IX	53,91
	III	—		X	38,78
	IV	—		XI	44,95
	V	—		XII	41,46

unit space, and this comparison to the number of copepods and the process of production of organis matter. Fig. 9 gives the relation between the total number of copepods and produced carbon. It may be seen that these two parameters behave less similar than the preceding two. Even though the positive correlation was found on this occassion as well, the correlation coefficient value is not significant ($r = 0.157$).

Further, we tried to observe the relation of copepods to the total zooplankton from the data on seasonal and long-term variations in the number of copepods, as well as from the seasonal and long-term fluctuations of the total number of zooplankton organisms in the studied area (Vučetić, unpublished data). Percentage of copepods is given in Table 3. Seasonal and long-term fluctuation in the number of copepods were observed for the 1970—1974 period and the extent of these fluctuations studied.

Percentage of copepods varies from 18.72 to 99,43% at the Kaštela Bay Station. The highest values occur in November, January and March. The long-term variations showed also the frequency of copepods to vary from one year to another. Maximum number of copepods which dominated among the other zooplankton groups, was recorded in 1974.

After the earlier published data by Vučetić (1970a), copepod group made up 50—80% of the total zooplankton at the station observed. We found this proportion of copepods somewhat to exceed 40% in the period of five years .However, in the most recent works of Vučetić (1974) the percentage of copepods was somewhat lower, i. e. more similar to ours. It is difficult to say whether this is the results of the changes in the environmental factors or of the natural fluctuations of the density of zooplankton groups. Values of copepods did not, however, changed significantly, but the relations between individual zooplankton groups, what is not within the scope of this paper.

With respect to such a significant quantitative presence of copepods in the total zooplankton, the number of copepods was statistically compared with the number of zooplankton organisms. Positive correlation with the coefficent $r = 0.673$, significant for $p < 0.001$, was obtained, what proved their strong interrelations. The total number of zooplankton is due to the number of copepods by the following equation:

$$y = 1374{,}04 + 2{,}05568\,x$$

on the basis of which we may predict the number of copepods if the total number of zooplankton ogranisms is known and reversely.

Since the zooplankton is the principal food to a large number of fish species, and particularly to the pelagic fish, the zooplankton relations with its predators are the complex ones. Therefore, the relation between the number of copepods and the total number of fish eggs will be considered here. Namely, the data on these relations are very poor for the Adriatic since mainly the sardine feeding was studied due to their importance to the Yugoslav marine fisheries.

The works by Steuer (1908), Mužinić, S. (1936) and Ercegović (1940) provided the data on the composition of food and rhythm of sardine feeding, Gamulin (1954) reported their spawning to take place at time of the maximum zooplankton quantity.

In addition to the observations of the diurnal and annual rhythm of sardine feeding (V u č e t i ć, 1955) particular attention was given to a detailed quantitative and qualitative analysis of food in relation to fishing gear and part of the day. Copepods were found to constitute the main part in the stomach contents of sardine caught with four different nets (about 30%). The differences in the qualitative composition of the rest of zooplankton groups proved to be considerable (V u č e t i ć, 1963c). The biomass of zooplankton (dry weight) was compared with the statistical data on sardine catch and an inverse relationship established.

For the area of the central Adriatic (Kaštela Bay/Stončica) seasonal distribution of the zooplankton wet weight was shown to coincide with the quantity of echo-signals i. e. fish. By a comparison of individual zooplankton groups a positive correlation between the echo-sounds and copepod numbers was established for the open sea (Stončica) ($p = 0.001$). High values of the coefficient of correlation between the echo-signals and decapod larvae (V u č e t i ć and K a č i ć, 1973, 1973a) were obtained for the Kaštela Bay.

V u č e t i ć (1975) observed the synchronism of the sardine and anchovy spawning (number of eggs) and standing-crop (dry weight) of zooplankton. This author found the most intensive sardine spawning to precede the zooplankton maximum and the most intensive anchovy spawning to follow the annual zooplankton maximum. Further, the same author found that the quantity of anchovy eggs in the course of the year coincided best with the number of copepod *Euchaeta hebes* and the development stages of decapods and that the maximum quantites of sardine eggs preceded the maximum of copepod group. The significant correlation between the density of echo-sounds of the adult sardine and anchovy and the variations in the zooplankton quantity in the course of the year was reported in the same paper.

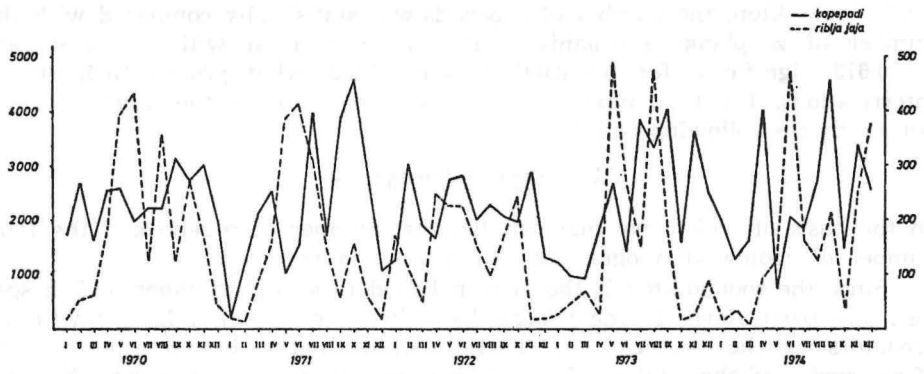

Fig. 10. Oscilations in the copepod number and the number of fish eggs at the »Kaštela Bay« station in 1970—1974 period

In this paper, as mentioned above, an attempt was made to observe the relation between the total number of copepods and the total number of fish eggs. This is given in Fig. 10. Even though these two plankton groups are very different as to their quantities, a positive correlation ($r = 0.07$) was found in

the Kaštela Bay with the insignificant value of the correlation coefficient. Therefore, further investigations should give more attention to the relations between the quantitatively predominant groups and observe through this the predator-prey relation which was only established here.

Accordingly, even though more complex, the influence of biotic factors is, to a larger extent, significant, what is evident from Table 4.

Table 4. Coefficients of correlation between the number of copepods and number of phytoplankton organisms, primary production, zooplankton and fish eggs

phytoplankton	primary production	zooplankton	fish eggs
r = 0,670	r = 0,157	r = 0,673	r = 0,07
P < 0,001		P < 0,001	

All the results obtained through the five year period at the Kaštela Bay Station, show that the number of copepods is due to a relationship which is that evident that it might even be statisticaly recorded in such a closed coastal area. This also indicates that the Kaštela Bay area is very suitable for this kind of studies. Since being in itself an entity of the coastal Central Adriatic it reflects well all the changes occuring in a much larger entity of which it forms a part.

3. CONCLUSIONS

1. A positive correlation was established between the number of copepods and temperature and between the copepod number and salinity, as well as a negative regression between the copepod number and sea water density at the Kaštela Bay Station.

2. The correlation coefficient value is high for the relation between the copepod number and sea temperature where $r = 0.413$ and $p < 0.001$, i. e. significant for more than 99.9%. A positive correlation was also established between the copepod number and sea water salinity with the correlation coefficient $r = 0.312$ significant for $p < 0.05$, i. e. for more than 95%. Values of the relation between the copepod number and sea water density showed, however, poor negative correlation with an insignificant correlation coefficient value $r = -0.139$.

3. The observations of the copepod number in 1970—1974 with the mean annual values of temperature and salinity showed only slight annual variations. This might be indicative of the fact that no significant qualitative annual changes of hydrographic properties of the Adriatic took place in this period.

4. A postive correlation with the high correlation coefficient value $r = 0.670$, $p < 0.001$ was found for the relation betveen the copepod number and phytoplankton as their principal food.

5. Results obtained by a comparison of the total number of copepods and primary production given as the quantity of produced carbon in mg/m²/day show a positive correlation but with the insignificant correlation coefficient value $r = 0.157$.

6. Percentage of occurrence of copepods in net zooplankton varies from 17.72 to 99.43% at the Kaštela Bay Station. This shows to significance of copepods as the quantitatively predominant group. This is also proved by the high value of coefficient of correlation between the total number of copepods and total zooplankton $r = 0.673$, $p < 0.001$.

7. The relation between the copepod number and fish eggs also shows a positive correlation with insignificant correlation coefficient $r = 0.07$.

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OSCILACIJE GUSTOĆE KOPEPODA KAŠTELANSKOG ZALJEVA U ODNOSU NA NEKE FAKTORE SREDINE

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KRATKI SADRŽAJ

U radu se donose prvi rezultati proučavanja odnosa broja kopepoda i nekih abiotskih (temperatura, slanost i gustoća mora) i biotskih (broj fitoplanktonskih organizama, primarna produkcija, ukupni broj zooplanktonskih organizama, broj ribljih jaja) faktora sredine, dobiveni na osnovu petogodišnjih istraživanja.

Materijal za ova istraživanja uziman je jednom mjesečno od 1970. do 1974. godine, na permanentnoj postaji »Kaštelanski zaljev« (43° 31' N; 16° 19' E), vertikalnim potezima »Hensen«-ove planktonske mreže (73/100, svila N°3).

Ispitivanjem odnosa broja kopepoda i abiotskih faktora sredine nađena je pozitivna korelacija sa temperaturom mora ($r = 0{,}413$; $P < 0{,}01$) i slanošću ($r = 0{,}139$), uz nesignifikantnu vrijednost koeficijenta korekcije.

Odnos broja kopepoda i biotskih faktora sredine izražen je pozitivnom korelacijom sa brojem fitoplantonskih organizama ($r = 9{,}670$; $P < 0{,}001$). Odnos broja kopepoda i primarne produkcije predstavljene količinom proizvedenog ugljika, također je pozitivan, ali sa nesignifikantnom vrijednošću koeficijenta korelacije ($r = 0{,}157$, nesignifikantno). Sa ukupnim zooplanktonom dobivena je pozitivna korelacija ($r = 0{,}673$; $P < 0{,}001$), a sa brojem ribljih jaja pozitivna i nesignifikantna ($r = 0{,}07$, nesignifikantno).