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THE CONTRIBUTION TO THE KNOWLEDGE OF BOGUE'S *(Boops boops L.)* NOURISHMENT IN THE BAY OF KAŠTELA

PRILOG IZUČAVANJU ISHRANE BUKVE *(Boops boops L.)* U KAŠTELANSKOM ZALJEVU

STJEPAN JUKIĆ

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THE CONTRIBUTION TO THE KNOWLEDGE OD BOGUE'S *(Boops boops L.)* NOURISHMENT IN THE BAY OF KAŠTELA

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INTRODUCTION

The ecology of many benthonic commercialy fishes is in the Adriatic known very poorly. Especially poorly are known the relations and the changes which occur between fish, biotic and abiotics factors of the sea environment in the process of nutrition. Studies (Šoljan and Karlovac, 1932; Zei, 1961; O. Karlovac, 1959; Županović, 1961; Čanađija, 1951, 1956, 1959, 1964; Rijavec and Županović, 1965; Županović, 1968) about the nourishment of particular bethonic fish in the Adriatic, of specimens of genus Scorpenidae hake, pandora and various Chondrichthyes are mainly.

In order to enlarge the knowledge of ecology of benthonic fish in the Adriatic we have chosen bogue, due to its fundamental and applicable significance, to investigate its feeding in the bay of Kaštela (figure 1):

1. The general structure of seasonal changes of nourishment in qualitative and quantitative aspect;
2. The influence of temperature changes on the intensity of feeding.

By better knowledge of the above mentioned aspects of nourishment it will probably be possible to describe also some phenomena from the dinamycs of bogue population such as is the oscilations of population abundance and the behaviour (vertical and horizontal migrations), and which are closely connected with biological and physical changes of the sea environment and from which the effect of fishery depends.

THE MATERIAL AND METHOD

The material for study of bogue nourishment was collected in the bay of Kaštela in the period staring from September 1963 till August 1964. Taking of samples was done once a month on the station 83 »Hvar« (figure 1). The material was gathered with the help of a trawler.

An attempt was made to collect material in the interval of one month and at the same time of the day i. e. from 8 to 10 o'cloch a. m. in order that the abtained data would be comperable.

Before dragging the net hydrographyc data for temperature and salinity were taken on the sea bed and surface layer. The results obtained are shown in the fig. 2 and 3.

To the caught species of bogue's (Table I) after taking biometric data by horizontal section, the alimentary canal has been taken out and put in 10% formalin. The analysis of the stomach ingredients has been carried but in the laboratory, usually 2—3 days after. Found food in the stomachs was mainly well perserved which in the most of the cases entabled to determine the dominant groups and species.

Tabela I

Tabela I. Struktura lovina bukve u Kaštelanskom zalivu tokom 1963/64 god.
Table I. The structure of catch in the bay of Kaštela during 1963/64

Date Hour No. exomples lenght (cm)	21. X 0835-0935 20	19. XI 0927-1027 20	18. I 0920-1020 10	18. II 0915-1015 9	24. III 1005-1105 6	20. IV 0925-1025 13	18. V 0835-0935 4	18. VII 0930-130 8	Total
5									
6									
7									
8	1	4		3		2	1		11
9	1								1
10	3	4		3		2	1		13
11	1		1	1		6			9
12	1			1		1			3
13	5	3	2	1	2		1		14
14	2	3	3		1				9
15	1	3	3		1			1	9
16	1				2	2	1	3	9
17		1	1					2	4
18	2	1							3
19	1	1						1	3
20									1
21								1	1
22	1								
23									
24									
25									90

The quantitative examination of the stomach fullness was estimated visually the degree of fullness according to which the sizes (A. B. C. D. E.) show:

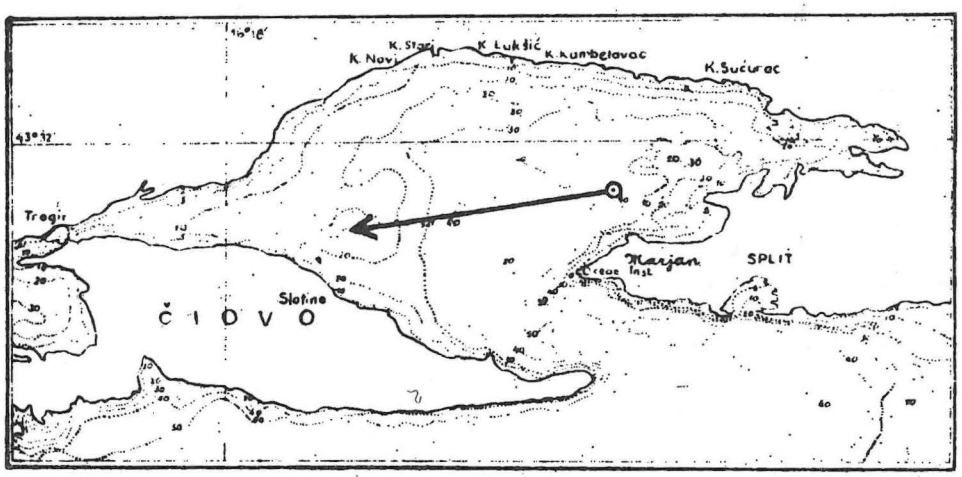
A — empty stomach
B — small amount of food in the stomach
C — plenty of food in the stomach
D — stomach full with food
E — the walls of the stomach very thin owing to the abundance of food.

The same values were used as the indicators of the food intensity for a single month.

We want to express herewith our gratetude to Mr. Juri Huri and to dr. Tamara Vučetić for the given scientific help and advice. We also express our gratitude to Mr. Miroslav Kožuh the laboratory assistent of the Institute and to the crew of m/b »Predvodnik« who helped us on the site work.

RESULTS
COMPOSITION AND SEASONAL FOOD CHANGES

In the qualitative analysis of the bogue stomach composition in the bay of Kaštela (table II) the following groups were found: Decapoda larvae, Copelata, Chaetognatha, Ostracoda, Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces, Spermatophyta and Thallophyta. The largest number of the indentified organisms belongs to the zooplanktons organisms from the groups of Copepoda and Copelata. Twenty-two strains of Copepoda were determined and of Copelata only three. Among Copepoda the most numerous were the



Slika 1 — Položaj postaje (43°31' N; 16°22,5' E) i pravac povlačenja mreže

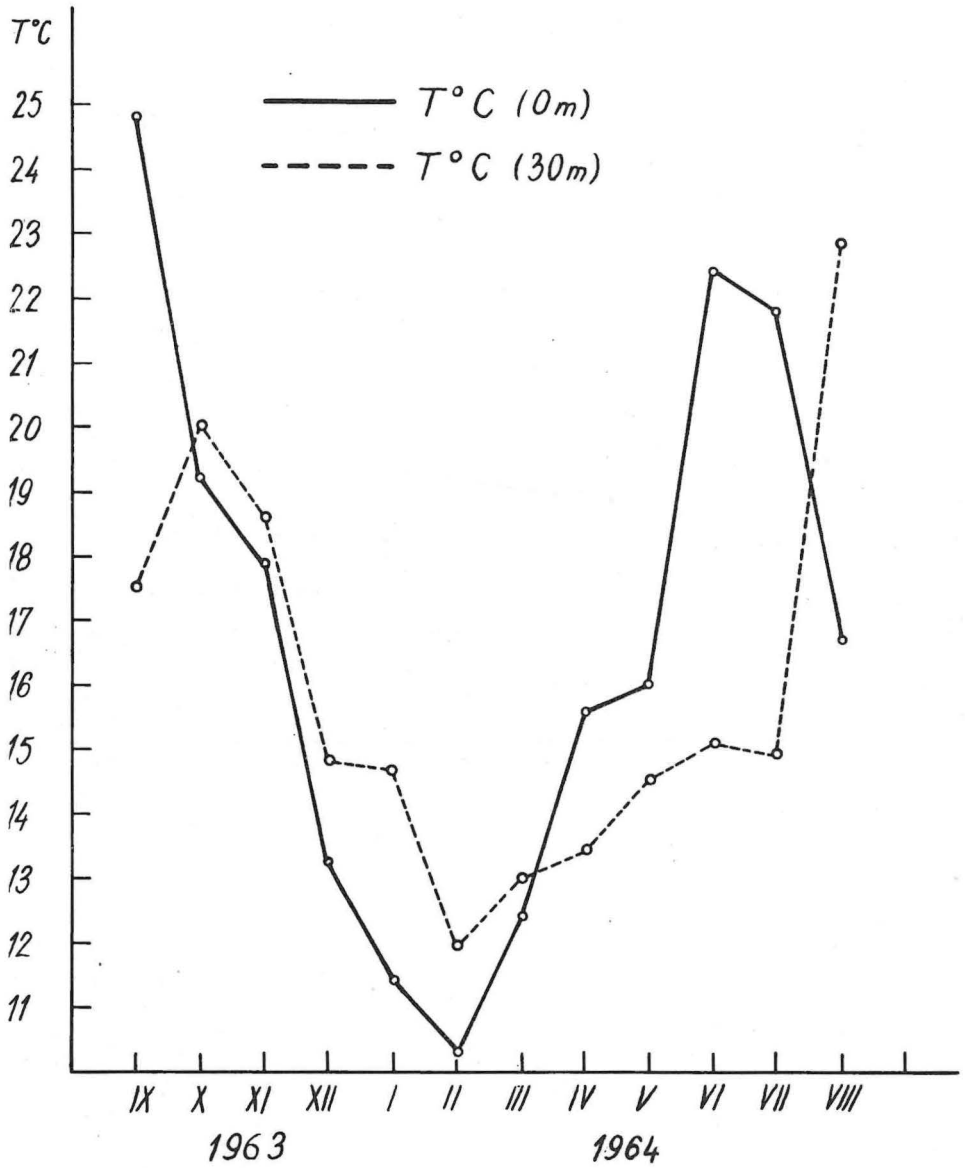
Fig. 1. The position of the station (43°31' N, 16°22,5' E) and the direction of towing the net.

following sorts: *Temora stylifera, Centropages typicus, Cetropages kroyeri, Acartia, clausi, Candacia armata, Isias clavipes.* The following species were determined in a considerable lower number: *Temora longicornis, Sapphirina sp., Oncaea media, Oncaea mediterranea, Clausocalanus furcatus, Clausocalanus arcuicornis, Ctenocalanus vanus, Calocalanus pavo, Meacynocera clausi, Calanus tenuicornis, Calanus helgolandicus, Corycaeus brehmy, Corycaeus gicsbrechty, Corycella rostrata, Podon intermedia, Euterpina acutifrons.*

During the year in the food of the bogue were found the species from the sorts *Chaetognatha (Sagitta setosa* and *Sagitta minima), Qstracoda* Conchocecia spinirostris, and from the other groups Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces Spermatophyta and Thallophyta single species.

As far as quantitative aspect is concerned and on the basis of the total material it has been determined that (Table III) in the bogue's food compo-

sition 55,7% Copepoda were presented, Copaleta: 38,3% Chaetognatha 1,5%, Decapoda larvae 1,7%, Isopoda 0,5%, Pisces 0,7%, Mysida 0,5%, Amphipoda 0,2%, Nemertina 0,2%, Pteropoda 0,1% and Algae 0,6%.

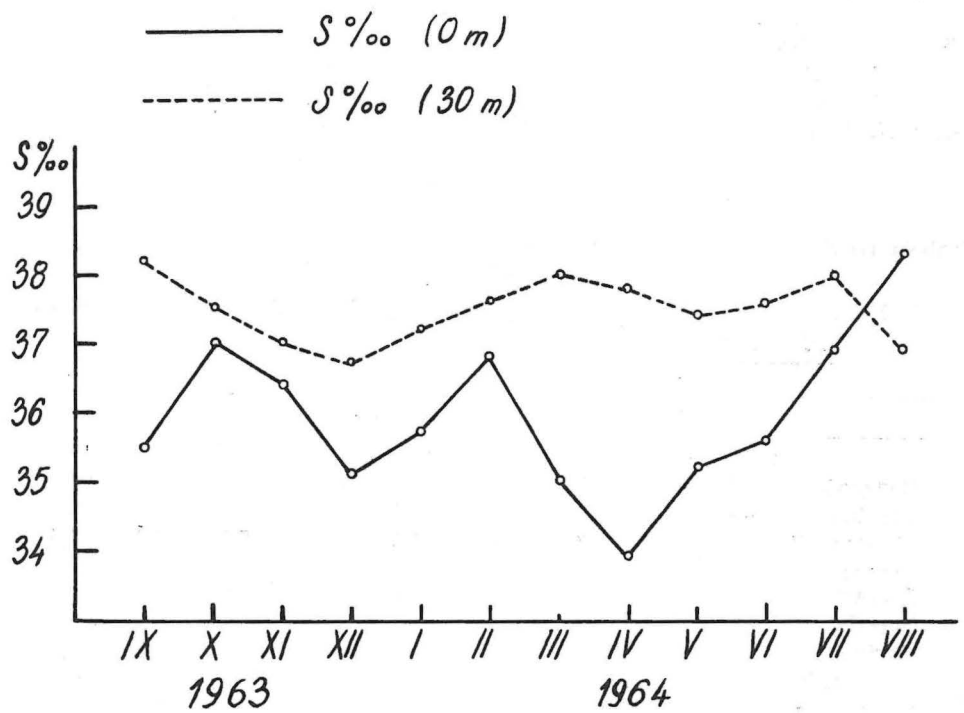


Slika 2 — Kretanje temperature u Kaštelanskom zalivu tokom 1963/64. godine, u površinskom sloju i sloju od 30 m

Fig. 2. The trend of temperature in the bay of Kaštela during 1963/64 in the surface layer and in the layer of 30 m.

By following the seasonal bogue's food structure changes in the bay of Kaštela (fig. 4), it results that the group of Copepoda were represented in all seasons during a year with expressed maximum values in autumn (October) and during spring (May) period. During the winter months less Copepods are found in the food, and are replaced by Copelata especially with higher values in January. In the spring months the values of Copelata are decreased and in the bogue's food appear greater quantity of Copepoda again together with a small amount of Chaetognatha and Decapoda larvae. In the winter months (October, November) in the bogue's food structure small qantitiy of Spermatophyta *(Zostera sp,)* and two kinds from the group of Thallpphyta *(Polysiphonia sp., Chaetomorpha area)* were registered. Pisces have been found in the autumn and spring months.

The fluctuation of Copepoda values from the bogue's stomach food structure and the oscillation of copepods quantity values from zooplankton caught in the bay of Kaštela (T. Vučetić), for the same period show regularity (fig. 4A and B). So, the maximum quantitiy of Copepoda in the bogue's stomachs have been found in the same seasons when this group *reached its* maximum in the bay of Kaštela.



Slika 3 — Kretanja saliniteta u Kaštelanskom zalivu tokom 1963/64. godine, u površinskog sloju i sloju od 30 m

Fig. 3. The trend of salinity in the bay of Kaštela during 1963/64 in the surface layer and in the layer of 30 m.

Table II. Identified organisms in the bogue's (Boops boops L.) stomach in the bay of Kaštela an their numeral amounts

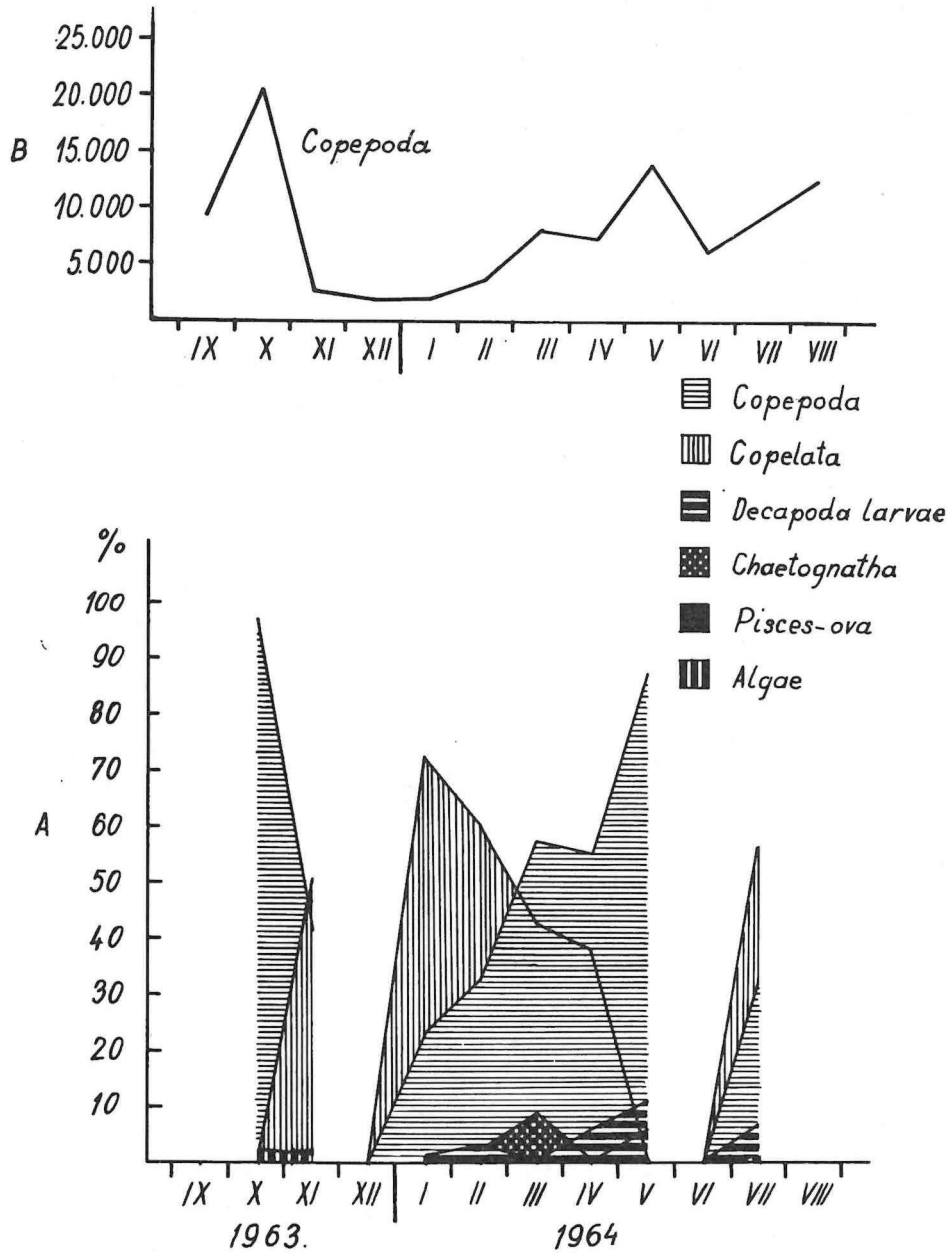
Tabla II — Indentificirani organizma u želucima bukve (*Boops boops* L.) Kaštelanskog zaliva i njihovi brojčani iznosi

COPEPODA:		*Euterpina acutifrons*	9
Temora stylifera	186	*Copepoda diversa*	154
Temora longicornis	1	DECAPODA LAVRAE	47
Centropages typicus	41	COPELATA:	
Centropages kroyeri	56	*Oicopleura longicauda*	250
Sapphirina sp.	2	*Oicopleura dioica*	363
Oncaea mediterranea	2	*Fritillaria pellucida*	2
Onceaea media	7	CHAETOGNATHA:	
Acartia clausi	17	*Sagitta setosa*	9
Candacia armata	48	*Sagitta minima*	5
Clausocalanus furcatus	8	OSTRACODA:	
Clausocalanus arcuicornis	7	*Conchoecia spinirostris*	3
Ctenocalanus vanus	5	ISOPODA	5
Calocalanus pavo	2	AMPHIPODA	9
Macynocera clausi	1	NEMERTINA	19
Calanus tenuicornis	1	PTEROPODA	2
Calanus helgolandicus	9	PISCES-OVA	7
Corycaeus brehmy	1	SPERMATOPHYTA:	
Corycaeus gisbrechty	2	*Zostera sp.*	10
Corycella rostrata	1	THALLOPHYTA	
Podon intermedia	7	*Polysiponia* sp. (Rhodophyta)	3
Isias clavipes	89	*Chaetomorpha aerea* (Cholorophyta)	2

Tabela III Sastav hrane bukve (Boops boops L.) u Kaštelanskom zalivu tokom 1963/64 (vrijednosti u postotcima)

Table III. The composition of bogue's (Boops boops L.) food in the bay of Kaštela during 1963/64
Values in percentage

	1963			1964					
	21/X	19/XI	18/I	1/II	24/III	20/IV	18/V	18/VII	Ukupno
Copepoda	96,8	40,9	22,9	33,3	56,5	54,8	86,8	32,0	55,7
Copelata	—	49,6	72,4	59,8	42,3	38,1	—	55,5	38,3
Chaetognatha		0,3	1,7	—	8,6	—	5,2	0,7	1,5
Decapoda (larvae)	0,3	—	1,1	3,4	—	5,5	10,5	6,6	1,7
Isopoda	0,3	—	—	—	—	—	—	0,2	0,5
Mysida	—	—	—	—	—	0,6	—	0,2	0,5
Amphipoda	—	—	—	—	—	—	—	0,2	0,2
Nemeretina	—	0,6	1,6	—	—	—	—	0,2	0,2
Pteropoda	—	—	—	—	—	0,6	—	0,2	0,1
Pisces-ova	—	1,7	—	1,7	—	0,6	2,5	—	0,7
Algae	1,9	1,1	1,6	—	—	—	—	1,0	0,6

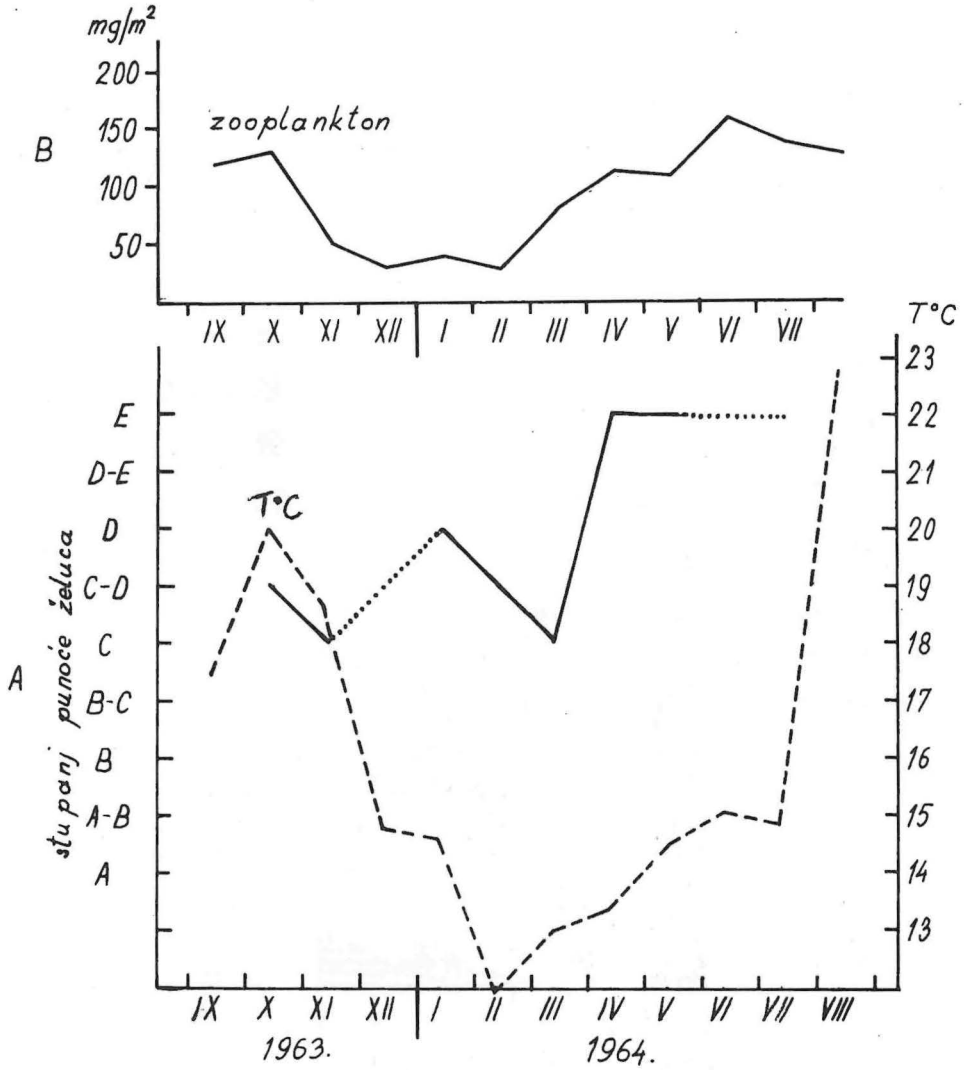


Slika 4 — A — Sezonske promjene sastava želučanog sadržaja bukve B — Kretanje količina Copepoda (prema Vučetić, M. S. u Kaštelanskom zalivu tokom 1963/1964.

Fig. 4. A — Seasonal shanges of the structure of the bogue's stomach composition.
Fig. 5. B — The movement of the quantity of Copepods (according to Vučetić M. S.) in the bay of Kaštela during 1963/64.

FEEDING INTENSITÝ AND THE TEMPERATURE

Since the temperature directly or indirectly determines the conditions of nourishment and the speed of digestion proces (Blaxter and Holliday, 1958) we were interested to examine the relation between the stomach food amount and the temperature changes in the condition of bogue nutrition.



Slika 5 — A Količina hrane u želucu bukve (————) i hod pridnene temperature (— — — —)
B — Kretanje zooplanktona-suha težina (prema Vučetić) u Kaštelanskom zalivu tokom 1963/1964.

Fig. 5. A Amonut of food in the bogue's stomach (————) and the movement of bottom temperature (— — — —)
B. The movement of zooplankton — dry weight (acoording to Vučetić) in the baz of Kaštela during 1963/1964

The data about the amount of food in the bogue stomachs have shown that feeding of the bogue is very high in the conditions of the bay of Kaštela during the whole year (fig. 5). In no part of the year were the values of stomach fullness lower then the value (c); which means that there was always plenty of foond in. Also, by the lowest registered temperature, February (11,9° C), no empty stomachs were found.

Following the curve of the food quantity and the temperature one can see a certain correlation. In the winter period (October) there has been a relatively high value of nutrition found (C—D). In the winter period, a decrease of temperature was followed by decrease nutrition, and by increase temperature in spring—summer period resulted increased nutrition.

The high values of the quantity of food in the bogue's stomach in the bay of Kaštela during the whole year, perhaps could be explained by the high productivity of the bay (Gamulin 1939, Vučetić 1961 a, b). The state of stomach percentage fullness seems to coordinate with the fluctuation of the values of the dry weight (Vučetić, M. S.) zooplanktons' of the bay of Kaštela for the same period (fig. 5A and B). In the months when larger quantities of zooplankton organisms were observed, at the same time conditions were better for the peeding of bogue and it could reflect the movement of the feeding intensity, Meanwhile ,the differences of the stomach fullness between the autumn (October) and spring—summer period (April, May, July), one can explain as a difference which happened owing to the different degree of speed of digestion due to the change of temperature in the mentioned period.

DISCUSSION

According to our findings we could assume that the bogue is a plonctophag since we have found during the whole year more frequntly zooplankton organisms.

Meanwhile, in spite of the dominant position which zooplanktons species have in the nutrition of bogue in the bay of Kaštela, in a smaller amount we ecounter during the year (October, November) the parts of sea plants *Zostera sp., Polysiphonia sp., Chaetomorpha aerea.*

Although, the composition of food contains a very small quantity of single specimens of Spermatophyta and Thallophyta in the bay of Kaštela, perhaps it directs to the conclusion that the bogue in its choise of food is orientated to the substantial vertical migration. According of the found parts of sea plants one can suppose that the bogue during feeding a certain period of time keeps to the very bottom. Such bogue's behaviour in the bay of Kaštela could be important since it makes bogue accesible to different fishing gears. Regarding the bogue food structure this species can be considered as semipelagic species.

Analising the nutrition of the adult bogue on the Adriatic coast of Spain Camba (1964) has come to the conclusion that the main food of the larger bogue specimens (19,5—22,5 cm) in that sea is formed besides the sea plants, crabs and fish, and in considerably smaller amount copepods, amphipods and diatomeae. He had registered in the stomach composition in a larger quantity the follwing sorts of algae: *Laurentia obtusa, Enteromorpha compressa, Enteromorpha ramulosa, Gelidium* sp., and the species from the origin of *Dictyota.*

The difference in the composition of the bogue's food in the bay of Kaštela and those on the coast of Spain are very likely the result of the different lenght composition of the catch (with us mainly from 11—20 cm), but also because of different structure of flora and fauna of the mentioned regions, and different changes of hydrographyc factors of the sea environment. In the bay of Kaštela e. g. one could establish how the changes in the structure of fauna reflect to the change of the food structure of bogue. The seasonal changes of zooplanktons quality and quantitiy, too (dry weight of zooplanktons) reflect on the composition of food and degree of stomach fullness (fig. 4 and 5).

Hela and Lavaevastu (1961) have ascertained that the degree of nutrition and with it the conditions for accelerated or retarded growth of fish, are not dependant only upon availability of food (quality and quantitiy) in the sea but upon the temperature and also to the very important factor of the methabolism. Examining the influence of the temperature to the intensity of food of benthonic fisch of the tropic seas (Siera Leone) Longhurst (1957) has found out that the annual oscillation of the temperature in the interval of 3—4° C have not considerably influenced the change of food intensity. In our case where the difference of temperature is during the year abt. 10° C it has not brought a halt in the nutrition, but one can establich a certain relationship between the changes of temperature and the movement of the food intesity. Generally we could say that by the increase of temperature also increase the intensity of nutrition i. e. by higher temperature the larger amount of food in the stomach is registered.

With certainity one can say that the amount of food found in the stomach, without weight index of fullness and the knowledge of the daily rhythm of the nutrition is not the proper measurement of the food intensity. Šorigin (1952) and Lipskaja (1959) write than on the occasion when estimating the intensity of food by measuring the degree of stomach fullness one has to be very cautious, since the degree of the stomach fullness and the digestive tract is only the measure of nutrition of fish at the given moment.

Lipskaja (1959) writes that to the minimum index of fullness, by the higher sea temperature, can correspond the maximum physiological development. The process of digestion quickness considerably so that the fish perhaps is not able to make up the digestive food by a new one.

Blaxter and Holliday (1958) had under acquarium conditions examined the speed of food passing trough the digestive tract of herring. By changing the temperature of the sea water, they have found out that it took 22hours for the of herring to pass trought the digestive tract at the temperature of ° C. At the temperature of 13° C the food required 15 hours to pass trough the digestive tract. The similar data were obtained for adult sardine in the Adriatic (Vučetić, 1955).

In this way perhaps one can explain the fact that in spite of the high sea temperature in the bay of Kaštela October (20,1° C), some lower values of bogue stomach fullnes were determined in comparison with spring months when the values of the sea temperature were within limits of 13—15° C. fareu9)52(1zgnefsiotncgnihangJ

For the sake of better acquaintance of the character and intensity of nutrition of benthonic fish, in future one would have to supliment its research under natural conditions with investigations under acquarium conditions.

CONCLUSION

According to the results of investigations of the nutrition of bogue in the bay of Kaštela for the period 1963/64 year one could find out the follwing:

1. On the ground of the qualitative — quantitative composition of bogue's (Boops boops L) food in the bay of Kaštela from the group having a lenght from 8 up to 22 cm, it has been found out that the bogue during the year feeds with organisms from the following specias: Copepoda, Decapoda, larvae, Copelata, Chaetognatha, Ostracooda, Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces. In the composition of food the presence of sea plants were also found from the group of Spermatophyta (*Zostera sp.)* and Thallophyta *(Polysiphonia* sp. and Chaetomorpha aerea). Out of Copepods prevail nerit sorts *Temora stylifera, Centropages typicus, Centropages kröyeri, Candacia armata and Isais clavipes.* From Copelata *Ooicopleura longicauda, Oicopleura didica* and from Chaetognatha *Sagitta setosa, Sagittam inima.* On the basis of such structure of food one can draw a conclusion that the bogue in the bay of Kaštela is mostly planctophag.

2. As far as quantitative aspect is concerned Copepoda are present 55,7 per cent, Copelata, 38,3 per cent and all other groups such as Chaetognatha, Decapoda larvae, Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces and Spermatophyta and Thallophyta are registered in a considerable smaller quantities in total 6 per cent.

3. The seasonal changes of food have been established. Cepepods dominate in the spring — summer and autumn period, while Copelata in winter.

4. It has been found out that the quality and quantitiy of zooplanktons in the composition of the digestive tract corresponds to the state of zooplankton in the bay of Kaštela.

5. The amount of food found in the stomach of the bogue to the relationship to the change of sea temperatur in the bay of Kaštela during the year shows partly the positive realitonship.

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PRILOG POZNAVANJU ISHRANE BUKVE (*Boops boops* L.) U KAŠTELANSKOM ZALIVU

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KRATAK SADRŽAJ

Na osnovu kočarskih lovina u Kaštelanskom zalivu tokom 1963/64. godine, u devedeset ulovljenih primjeraka bukve studirana je ishrana. Ulovljenim primjercima totalna dužina tijela se nalazi u rasponu od 8 do 22 centimetra.

Studirajući ishranu ulovljenih primjeraka, nastojali smo utvrditi opći sastav hrane, sezonske promjene, u kvantitativnom i kvalitativnom pogledu, te utjecaj temperature na kvantitativne promjene hrane.

Kvalitativnom analizom sastava hrane u bukve utvrdili smo, da se bukva u Kaštelanskom zalivu tokom godine hrani slijedećim skupinama morskih organizama: *Copepoda, Copelata, Decapoda larvae, Chaetognatha, Ostracoda, Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces juv., Spermatophyta* i *Thallophyta*. Od navedenih skupina, najbrojniji su predstavnici dviju planktonskih grupa: *Copepoda* i *Copelata*. Od 22 determinirane vrste skupine *Copepoda*, brojčanom frekventnosti, ističu se slijedeće vrste: *Temora stylifera, Centropages typicus, Centropages kröyeri, Candacia armata, Isias clavipes*. U skupini *Copelata*, najbrojnije su vrste: *Oicopleura dioica* i *Oicopleura longicauda*.

Na osnovu kvalitativnog sastava hrane u Kaštelanskom zalivu može se zaključiti, da je bukva uglavnom p l a n k t o f a g.

Kvalitativnom analizom, brojčanom frekventnosti registriranih vrsta u sastavu hrane, utvrdili smo da skupina *Copepoda* čini 55.7 posto hrane, *Copelata* 38.3 posto i ostale grupe: *Chaetognatha, Decapoda larvae, Isopoda, Mysida, Amphipoda, Nemertina, Pteropoda, Pisces juv. Spermatophyta* i *Thallophyta* svega 6.0 posto.

Sezonske promjene sastava hrane također su registrirane. *Copepoda* su utvrđene tokom čitave godine, ali sa višim vrijednostima u jesenskom razdoblju, osobito u oktobru mjesecu, te u proljeću mjesecu maju. Tokom zimskih mjeseci, u januaru, u ishrani dominira skupina *Copelata* Osim navedenih skupina, u proljetnim mjesecima manje količine *Chaetognatha, Decapoda larvae* i u zimskim mjesecima alge, skupina *Spermatophyta (Zostera sp.)* i *Thallophyta (Polysiphonia sp., Chaetomorpha aerea)* su nađene.

Utvrđeno je također, da kvantitativne i kvalitativne promjene sastava u bukve, odgovara sezonskim promjenama sastava zooplanktona morske sredine Kaštelanskog zaliva.

Poređenjem kretanja temperature mora Kaštelanskog zaliva i promjena količine sastava hrane u bukve, utvrđena je podudarnost. Pri višim temperaturama mora, punoća želudaca bila je veća, i vice versa.