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ECOLOGICAL OBSERVATIONS ON THE JELLYFISH *Aurelia aurita* (L.) POPULATIONS FROM THE BLACK SEA

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ABSTRACT:

On the basis of the data obtained during the 64th expedition of the R/V "Vitjaz" in the Black Sea, the author presents the structure of jellyfish Aurelia aurita populations per size-classes and the importance of these populations in the energetics of the pelagial ecosystem.

The jellyfish Aurelia aurita in the Black Sea, although one of the most characteristic macrozooplanktonic forms, has been less studied and known from the ecological point of view, particularly because of some difficulties concerning its quantitative sampling.

Numerous observations made by BORCEA on the Romanian littoral dating even from 1924-1928 (1,2), pointed out that Aurelia aurita appeared in the seashore zones in spring and summer, under the conditions in which warm water masses (20-23°C) were suddenly replaced by cold water masses (16-17°C) from the deeper zones, as a consequence of the action of winds blowing from land; in the cold waters the jellyfish usually accompanied two species of fish, Mullus barbatus ponticus ESSIPOV (red mullet) and Scomber scombrus L. (mackerel). From BORCEA's notes we can quote, in order to

exemplify,the conditions in which cold water species appear close to the shore in summer, real conditions of upwelling: "Lorsqu'un vent violent soufflant en tempête vient de terre,l'eau réchauffée de la surface est emportée vers le large et est remplacée à la côte par de l'eau froide qui vient des plus grands fonds et, dans ces courants d'eau froide qui sont poussés vers le rivage, il y a des Rougets qui, le plus souvent, sont accompagnés de la méduse d'eau froide: Aurelia aurita" (2, p.711).

Aurelia aurita populations in the Black Sea have long been considered as being quite scarce and consequently as having little importance in the structure and functioning of the pelagic ecosystem. In a valuable work concerning some aspects of the feeding of medusa Aurelia aurita,MIRONOV (8) shows that the degree of consuming zooplankton depends on the density of the jellyfish populations, but in consequence of the low average density in the whole basin of the Black Sea (0.000033 individuals/m^2 in the inshore water zones and 0.000013 individuals/m^2 in the off-shore water zones) the global value of jellyfish for the economy of the water basin is generally not too great. Besides that, about 10 years ago, a very important work, that has become in time a reference work to the structure of trophic web,utilization and energy flux at various trophic levels in planktonic communities, shows that various species of jellyfish, especially carnivorous forms, have rarely been found in the Black Sea and consequently they are of little importance (10).

In the last few years the jellyfish Aurelia aurita has been observed to form extremely abundant populations in the whole basin of the Black Sea during almost all the seasons; that must be considered a very great ecological event among others that have appeared in the Black Sea in the last decade.

MIRONOV (9), in an early quantitative study for the Black Sea, showed that in 1949 - 1962 the biomasses of jellyfish Aurelia aurita,that were evaluated for the whole sea in the water layer of 0-80 m, oscillated from 93 to 1,603 thousand tons (Fig. 1, A), the multiannual average being 672 thousand tons; the curve of the monthly average variations for the period 1949-1962 points out that the greatest biomasses were registered during the cold months of the year (Fig. 1,B). The seasonal average values of the

jellyfish biomass, calculated on the basis of the data obtained during those 14 years of research were as follows: 764 thousand tons in winter, 701 thousand tons in spring, 449 thousand tons in summer and 589 thousand tons in autumn.

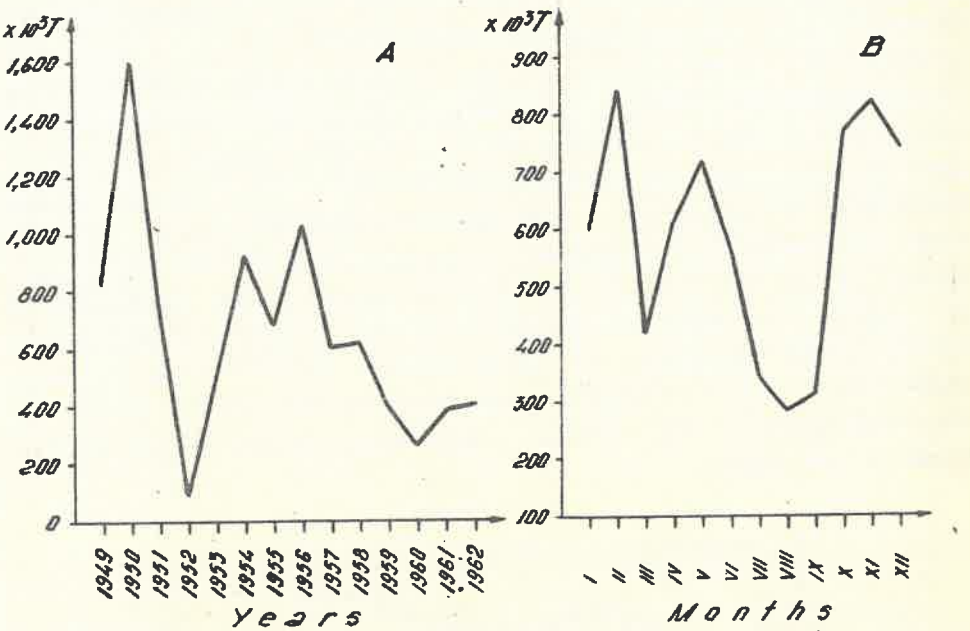

Fig. 1 - Annually (A) and monthly (B) fluctuations of the jellyfish Aurelia aurita biomasses in the Black Sea recorded by MIRONOV (9)

BEREMBEIM (3) shows that at the Crimean and Caucasian coast of the Black Sea in winter (January, February and March of 1953) jellyfish agglomerations occur in the form of huge shoals about 1,000 m long and 18 m thick; the author presumes that these winter agglomerations of Aurelia populations in the Black Sea precede their reproduction. It is worth mentioning that the places where the winter agglomerations of Aurelia populations occur in the Black Sea, approximately coincide with the wintering places of the Azov anchovy (Engraulis encrasicholus maeoticus PUSANOV) and of other fish too (Engraulis encrasicholus ponticus ALEXANDROV, Trachurus mediterraneus ponticus ALEEV).

Among the latest quantitative valuations of the jelly-

fish Aurelia aurita we mention the one made by ZAITEV (13) which shows that in 1978 there were 47 mil. tons of medusa only in the surface water layer of the sea, 10 m thick.

It was in 1978 too, during the early days (September 27-October 16) of the 64th expedition of the famous Soviet research vessel "VITYAZ", when we used the underwater TV camera to make some quantitative observations on the Aurelia aurita populations in Eastern Black Sea (Fig.2), determining their quantity and vertical distribution. The preliminary results of the research (5) published together with the engineer S.KUPRIANOV - the designer of the underwater TV camera (6), shows that the Aurelia aurita populations are particularly abundant at present (up to 134 individuals under 1 m^2, in the water column of 0-55 m), but their distribution is uneven. The minimum densities of the jellyfish (0.03 specimens/m^2) were registered at depths greater than 40 m, and the maximum ones (12 specimens/m^2) above thermocline; usually 75 % of the individuals of the medusa populations occur in the surface layer of the water.

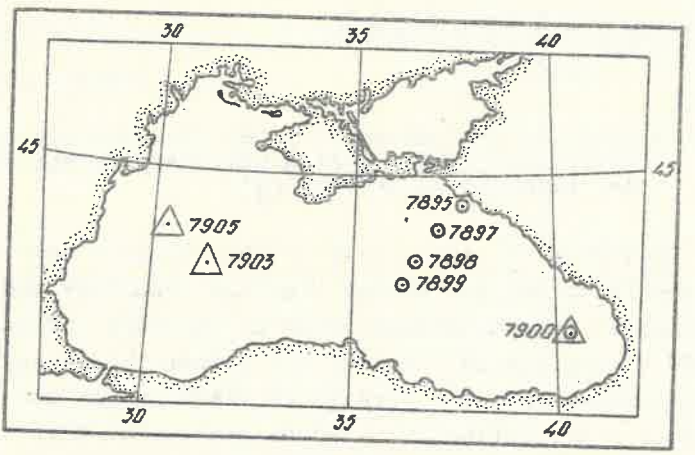

Fig. 2 - The map of stations where the populations of the jellyfish Aurelia aurita have been recorded (⊙ - TV observations; △ - BR net samples)

While making observations with the underwater TV camera, in St.7900 we also began to collect samples of jellyfish by using

a large-sized planktonic net (the net BR - BOGOROV-RASS, opening - 1 m^2); the jellyfish collected with the net at St.7900 were used to establish an average dimension of medusa, as the basis for evaluating the biomass in stations where only densities had been determined by using the underwater TV camera. As, in the second part of the expedition we could not make use of the TV camera any longer, only the BR planktonic net was used for estimating the quantities of jellyfish at St.7903 and St.7905 (Fig.2). We mention that at St.7900 we concluded that the value of the density of jellyfish obtained on the basis of the net sampling is usually half the density determined on the basis of TV observations.

In order to have a global view of the quantities of jellyfish registered in the Black Sea during the autumn of 1978, we draw a parallel between the results obtained with TV camera (only values of numerical densities - maxima, minima and media per stations) and the ones obtained with the BR net (Table 1). Likewise, in the following lines we will make reference to the structure of Aurelia aurita populations per size classes and to the importance of these populations for the whole pelagial ecosystem.

Table 1

Densities (individuals/m^2) and biomasses (g/m^2) of the jellyfish Aurelia aurita populations from the Black Sea in the autumn of 1978

Station	Date	Method	individuals/m^2 Maximum	Minimum	Medium	g/m^2 Medium
7895	27.09.78	TV	-	-	42.4	
7897	04 - 06.10.78	TV	119.1	78.4	93.5	
7898	06 - 09.10.78	TV	134.4	9.0	56.7	
7899	11 - 12.10.78	TV	87.1	57.6	68.0	
7900	15 - 16.10.78	TV	114.2	54.5	77.1	
7900	16.10.78	BR net	-	-	24.3	251.65
7900	16.10.78	BR net	-	-	27.0	423.50
7903	25.10.78	BR net	-	-	15.7	179.50
7903	25.10.78	BR net	-	-	16.7	209.33
7905	29.10.78	BR net	-	-	42.0	1448.67
7905	29.10.78	BR net	-	-	32.0	882.00

1. THE STRUCTURE OF THE *Aurelia* POPULATIONS PER SIZE CLASSES

All the jellyfish belonging to the quantitative samples collected with the BR net were measured; on the basis of the measurements performed upon 414 jellyfish from St.7900, St.7903 and St.7905 we have concluded that in the autumn of 1978 the medium diameter of their disc was of 61.18 mm and their medium weight 21.5 g/specimen (the weight was agreed to be the volume of water dislocated).

At St.7900 the great majority of jellyfish were small-sized ones, the diameter of the disc being less than 50mm (Fig.3); the class +40 mm forms 22.8 % of the population and only 4.8 % of the jellyfish have a diameter bigger than 100 mm, so that in accordance with MIRONOV's data (8) they are over 3 months old.

At St.7903 most jellyfish belong to class +50 mm diameter (16.5 %); in descending order of abundance there follow classes + 40 mm - 15.5 %, + 30 mm - 14.4 %, +60 mm - 11.3 % a.s.o. (Fig. 3); the jellyfish whose disc diameter is bigger than 100 mm represent here 7.3 % of the population.

At St.7905, which is nearest to the Western coast of the Black Sea (Fig. 2) and where, by means of the BR net, the most numerous population was registered, the jellyfish are fairly big-sized one. The most abundant class was that of +50 mm diameter - 14.4 %; the individuals with the disc under 50 mm were few- 18.4%, while the specimens belonging to classes +60 - 100 mm represented 38.4% of the population; 23.2 % of the individuals were more than 3 months old, the diameter of their disc was bigger than 100 mm (Fig. 3).

On the basis of the results of the measurements we have established the following relation between the value of the disc diameter of the jellyfish *Aurelia aurita* (D - mm) and that of its volume (or of its weight, G - grams):

$$G = 8.744 \cdot 10^{-4} D^{2.3646816} \quad \text{(where } r=0.995\text{)}.$$

The values of the weights we registered are quite near to MIRONOV's ones (8).

2. THE ROLE OF *Aurelia aurita* POPULATIONS IN THE PELAGIAL ECOSYSTEM

On the basis of the data obtained from the TV observations particularly, we could estimate roughly that the total wet

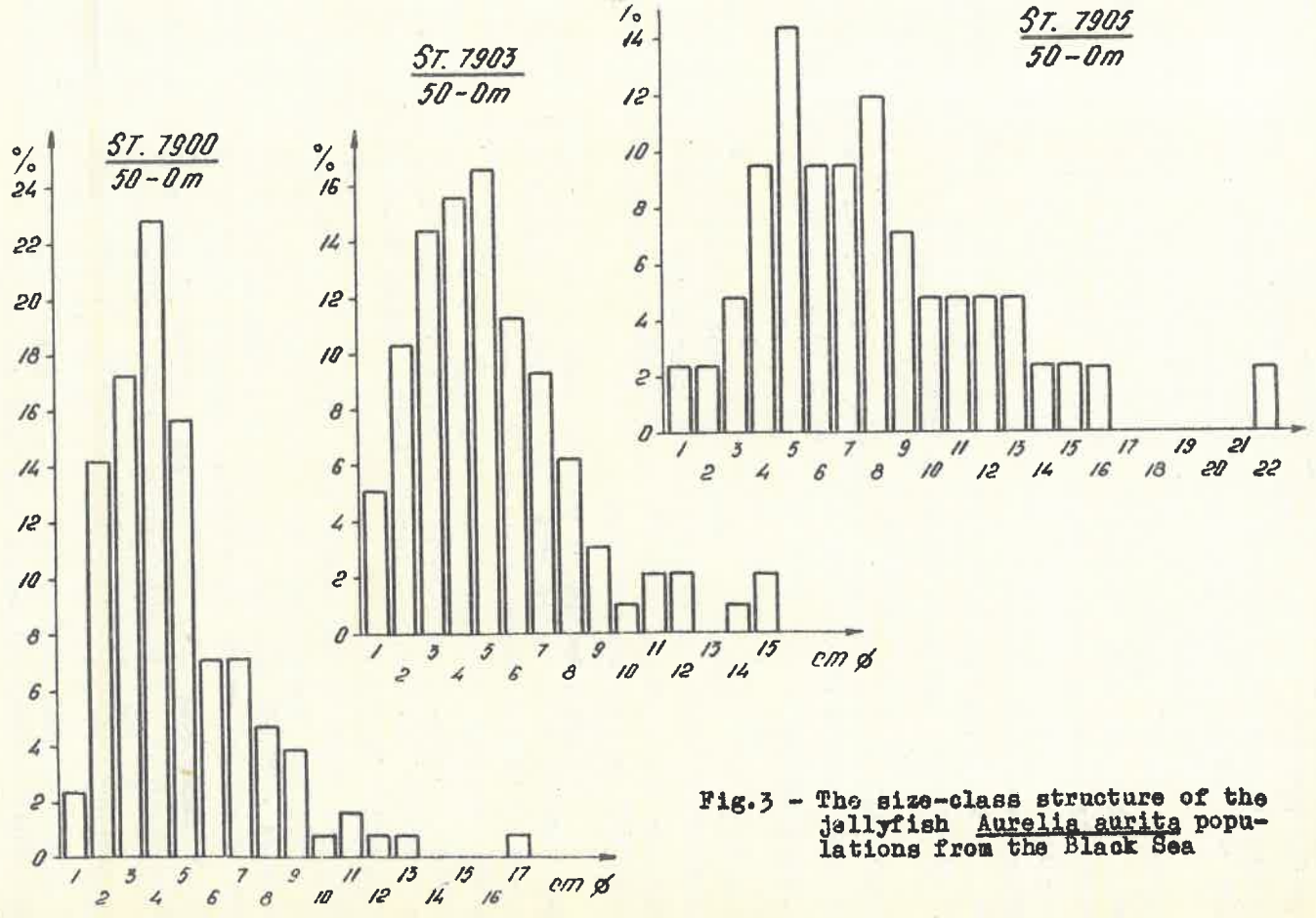

Fig.3 - The size-class structure of the jellyfish Aurelia aurita populations from the Black Sea

biomass of the jellyfish Aurelia aurita rises to 300-450 mil.tons in the pelagial of the Black Sea. Certainly, this high biomass cannot be neglected when discussing the structure and functioning, the energetics of the planktonic community.

The studies concerning the feeding of Scyphomedusa in general and of Aurelia aurita species especially (4, 7, 11) have shown that the food of these organisms consists of species of microphytes, particulate organic matter - detritus, of small-sized planktonic animals - tiny crustaceans, larvae of molluscs and polychaets, small jellyfish a.s.o.; the main food of Aurelia aurita in the Black Sea can be considered to include all the small-sized zooplanktonic organisms living at different trophic level (7,8).

The great quantity of jellyfish could not exist and be maintained in the pelagic ecosystem but for high energy coming through several channels. The necessary food for one individual of Aurelia aurita in its whole life, at a temperature of 8°C, is of 17.88 Kcal out of which 14.41 Kcal for weight growing and 2.41 Kcal for energetic losses (8); that corresponds to 88.51 g zooplankton which is assimilated in proportion of 70 %. The temperature being raised from 8°C to 20°C, the necessary food for the jellyfish can be twice as much.

Aurelia aurita, a species that does not select animal and vegetal food, represents the terminal link of some trophic chains of varied length (Fig. 4). The short trophic chain defined by the relation "phytoplankton - Aurelia" is of small account, the vegetal organisms, as MIRONOV (8) shows, represent less than 1% of food weight. The longer trophic chains, those including the zooplanktonic herbivores or carnivores, or those with mixed-food consumers (Fig. 4) are much more important in the energetics of the pelagial communities. The crustaceans are of the first importance - 50.6%; the main groups of organisms form the necessary food of the jellyfish as follows: Copepoda - 32.9 %, Cladocera - 16.7 %, Noctiluca - 31.7 %, veliger larvae of Mollusca - 13.9 %, Appendicularia - 2.9%, Chaetognata - 1.6%, Tintinnoidea - 0.3% (8).

Our data concerning the abundance of the medusae Aurelia aurita in the off-shore waters of the Black Sea (5) have contributed to estimating the role of this species in the planktonic community (12). The following elements have been considered:

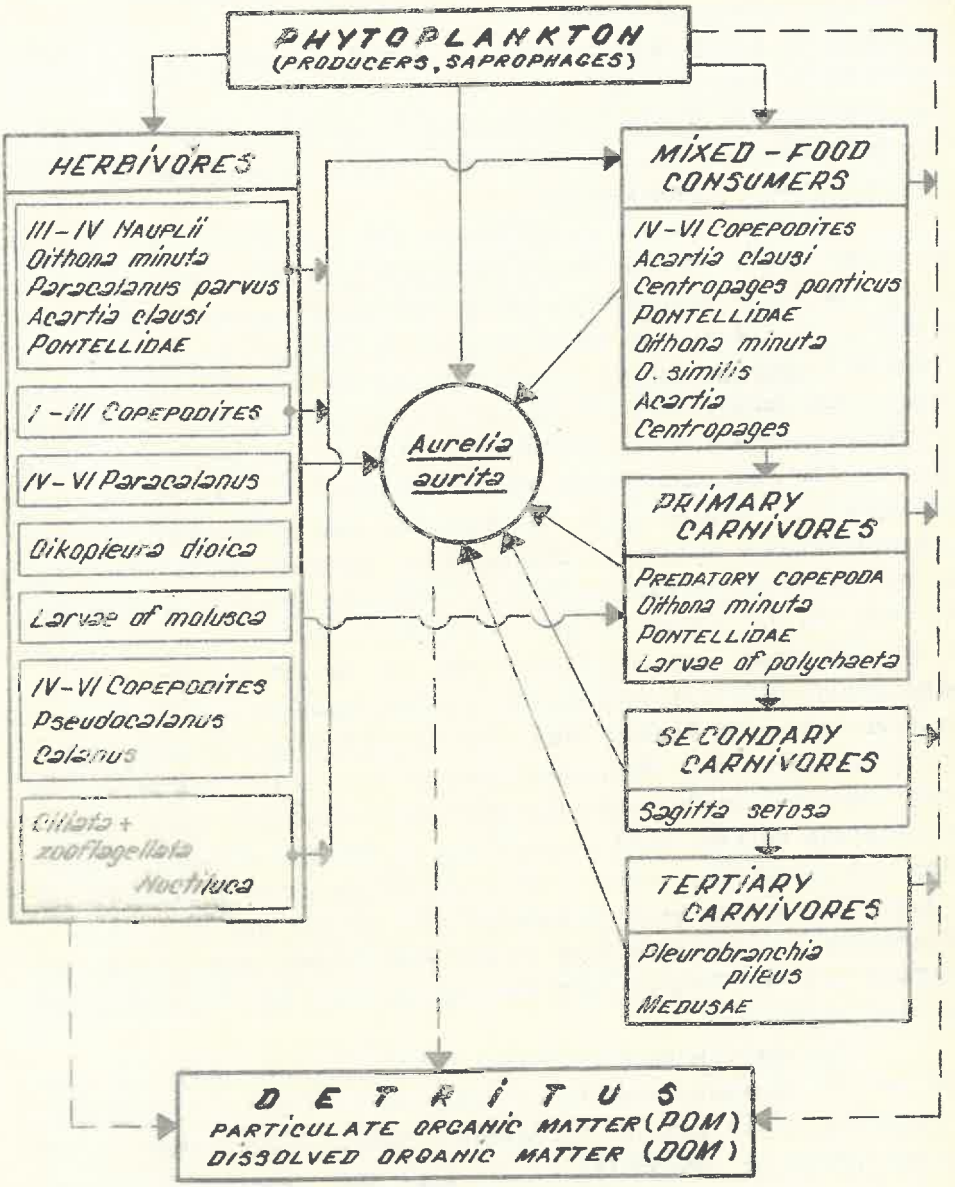

Fig. 4 - Pelagic food chains ending with the jellyfish Aurelia aurita from the Black Sea

- caloric value of the jellyfish (0.03 cal/mg wet weight);
- metabolic intensity (2 %);
- capacity of assimilating food (U^{-1} = 0.7, as well as for other zooplanktonic predators);
- the coefficient of the maximum growth efficiency ($K_2^{max} = \frac{P}{P+R}$ = 0.6 - percentage of the assimilated ration, changed into growth; P - growth and R - respiration).

In some places (St.7903) the wet biomass of the jellyfish (1,560 g/m^2) exceeds by 30 times approximately the wet biomass of the whole zooplankton (55 g/m^2); represented in calories, the biomasses had values quite near to 48 Kcal/m^2 as compared to 33 Kcal/m^2. Aurelia aurita consumes up to 30 % of the zooplankton biomass. The consumption of the mesozooplankton by the jellyfish exceeds 3 - 6 times their production. This causes an important decrease of the real production and intensifies the process of the diminishing of biomass (12). For example, the production of the mesozooplankton + medusae, calculated in various conditions (12) had the following values: 0.29 Kcal/m^2/day in St.7900 without registering the jellyfish, -0.12 - -0.57 Kcal/m^2/day also in St.7900 but the jellyfish were registered with the BR net and TV camera respectively, 0.84 Kcal/m^2/day in St.7903 without registering jellyfish and -0.98 Kcal/m^2/day, the jellyfish having been registered with the BR net. The production of the whole planktonic community (the real production) for the above mentioned example had the following values: 0.53 Kcal/m^2/day in St.7900 without registering the jellyfish, 0.29 - 0.05 Kcal/m^2/day also in St.7900 but the jellyfish having been registered with BR net and TV camera respectively, -2.5 Kcal/m^2/day in St.7903 without registering the jellyfish and -4.2 Kcal/m^2/day also in St.7903, the jellyfish having been registered.

The shallow waters in the North-Western part of the Black Sea are characterized by medusae whose zize and quantities are usually twice and the biomasses 4 times bigger than in the stations quoted by SHUSHKINA et al. (12) and consequently their role in the energetics of the planktonic community is obviously much more important.

The conclusion resulting from the above mentioned things is that under the increasing conditions of eutrophication,

the populations of the jellyfish Aurelia aurita hold an extremely important role in the pelagial ecosystem of the Black Sea. In order to completely know the actual energetics of the pelagial system, other elements defining planktonic communities should be quantified and analysed, and first of all bacteria, protozoa (zooflagellates and ciliates) and naturally fishes.

Taking into consideration the role of the jellyfish in the structure and functioning of the actual pelagial system in the Black Sea, we suggest that the quantitative evaluation of these organisms should be permanently made with a large-sized net in all the stations where the study of the zooplankton is performed by means of usual methods. When the net is used, the quantity of jellyfish is usually underestimated (contrary to the results obtained with the TV camera); however, these orientative data will draw us nearer to reality than the absence of any data.

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