

## Mussel *Mytilus galloprovincialis* L a m. (Bivalvia) natural resources along the northern Bulgarian Black sea coast in relation to *Rapana thomasiana* G r o s s e (Gastropoda) distribution

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A peculiarity of some Black Sea benthic animals is the extremely high biofiltration rate. З е н к е в и ч (1947) focuses on the significance of mussels in sea water circulation processes, the most important being the species *Mytilus galloprovincialis* occupying the littoral zone as a ring-shaped strip. According to the same author this powerful biofilter is of enormous capacity with direct impact on Black Sea coastal waters.

The first investigations along the Bulgarian coast figure out a total mussel (*Mytilus galloprovincialis*) biomass of 100000 t (Н е ч а е в, Ч е р н е в, 1938) and later on К њ н е в а - А б а д ж и е в а and М а р и н о в (1967) — 300 000 t. There is enough evidence now that the mussel natural resources have suffered serious changes as a result of the mass development and distribution of their predator *Rapana thomasiana* during the early forties. Registered for the first time in Novorosiysky Bay in 1946 (Д р а п к и н, 1953) it has spread along Kavkaz coast (И в а н о в, 1961a, 1962; Ч у х ч и н, 1961), Crimea (В о р о н ц о в, 1954) along the north-western Black Sea coast (И в а н о в, 1961b) down to the Bulgarian coast (А б а д ж и е в а — К њ н е в а, 1957) and Turkey (F i s h e r, 1960). In some regions of high *Rapana thomasiana* density along ICC coast it has already been registered areas of totally destroyed oyster banks and areas of

seriously reduced both oyster and mussel natural resources.

According to Маринов (1978) in comparison with 1967 the mussel abundance along the Bulgarian Black Sea shelf has undergone about 10 fold reduction the main reason being the *R. thomasiana* invasion together with the oxygen deficiency at the bottom layers in the post blooming periods. As it is known up to now the exploration of mussel natural resources along the Bulgarian shelf were aimed to study the opportunities for commercial exploitation. The present high level of eutrophication and pollution resulting in a disturbance of the biological equilibrium in some ecosystems stress the necessity of clarifying the mussel natural resources in relation to *R. thomasiana* stock abundance, distribution and size composition. The latter being the first goal and the second — to establish the main trends in the evolution of predator/prey relationship, a serie of investigations have been undertaken located in one of the most important for commercial catch region — e.g. between Cape Kaliakra and Varna.

**Material and methods.** The results are based on 55 dredging operations of 15 min. each in June (14, 15 and 16th) 1984 on board of RV „Proff. Al. Valkanov“. Mussel abundance is estimated in kg per dredge (after a preliminary test one plastic box of mussels is considered 20 kg) and *R. thomasiana* density — in exemplars per dredge. In order to make the results comparable to former investigations (М а р и н о в, 1978) the following standart groups were outlined: for mussels — up to 100

kg (per dredge), from 100 to 200 kg (per dredge) and from 200 to 400 kg (per dredge) and for *R. thomasiana* — up to 100 exemplars (per dredge), from 100 to 1000 exemplars (per dredge) and over 1000 exemplars (per dredge) respectively. The size composition was measured on board on 10 mussel and 4 *R. thomasiana* samples of 100 exemplars each. Three mussel samples were processed in laboratory for weight measurements and quantifying the shell:meat:interval liquid ratio.

**Results and discussion.** From a total number of 55 dredges 8 were empty, in 17 — only *R. thomasiana*, in 12 — only mussels and in the rest 18 — both *R. thomasiana* and mussels were registered. The highest abundance of both species was established in the homogeneous monospecies catches — up to 400 kg per dredge and 1720 exemplars per dredge respectively\*. The mussel dredges are dominated by the lowest standart group catches — up to 100 kg. They comprise 67% of the total dredges with mussels registered in them of mean value — 32,5 kg. In 20% of the dredges the weight varies between 100 and 200 kg (on average 142 kg) and only in 13% — from 200 to 400 kg (mean 262 kg) (Fig.9-a).

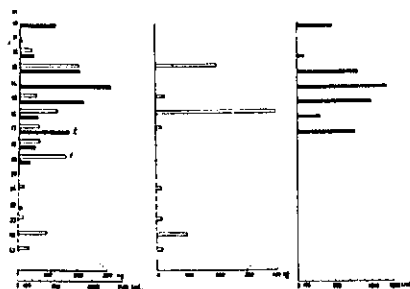


Fig.1. Mussels (kg per dredge) and *Rapana thomasiana* (exemplars per dredge) distribution with depth increase (m)

a — overall dredge average value; b — in the homogeneous mussel catches; c — in the homogeneous *R. thomasiana* catches; 1 — mussels; 2 — *R. thomasiana*

The quantitative *R. thomasiana* catches assesment reveal that they are dominated by the middle abundance group catches — in 60% their number is between 100 and 1000 exemplars (on average 490 exemplars). In about 26% of the dredges they amount to less than 100 exemplars (mean abundance 33 exemplars) and in 14% — to over 1000

exemplars (mean value 1334 exemplars) (Fig.9-b).

It has been established that the shallowest stations (10 m) are dominated mainly by *R. thomasiana* increasing its density towards 13-15 m depth with maximum abundance at 14 m isobath and decreasing towards 18-19 m depth up to total extinction in the deepest off-shore horizons (Fig.1)

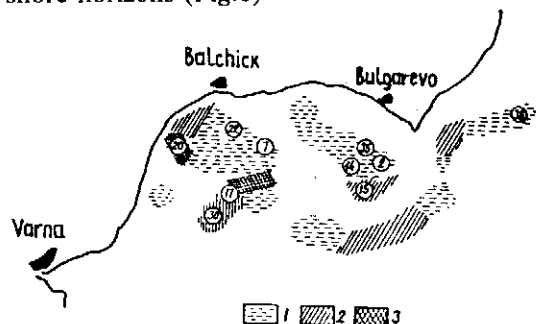


Fig.2. A scheme of mussel natural resources quantitative characteristic and distribution in the region investigated

1 — up to 100 kg per dredge; 2 — from 100 to 200 kg per dredge; 3 — from 200 to 400 kg per dredge

Mussel abundance at 12 to 19 m depth varies almost in inverse proportion to that of *R. thomasiana* with relatively high values at 13, 16 m (the depth where the highest density of 400 kg is registered) and 19 m. With the increase in depth along with the *R. thomasiana* predator press decrease a progressive restoration of mussel population is obvious — from a minimum value (20 kg) at 24 and 33 m up to 100 kg at 40 m depth (Fig.1). It is necessary to explain that the depths pointed in this figure (24, 28, 33, 40 and 43 m) are in fact estimated as a mean between the initial and final depths, e.g. the dredging covers areas with progressively increasing depths between 17 to 40—50 m but nevertheless no *R. thomasiana* was registered in the catches.

The mussel field between Balchick and Varna proves to be the best preserved and of highest mussel abundance (Fig.2). In this shallowest part near the shore (15 m depth, st. 20) the density of mussels is relatively high (240 kg). As it is typical for the predator (594 exemplars, Fig.3 and 4) to prefer the large size

\* As all data (kg — for mussels and exemplars — for *R. thomasiana*) are given per dredge, only kg and exemplars will be marked in the text.

exemplars, even to pray on mussels often exceeding its own size (Иванов, Пуденко, 1969) the mussel population is dominated by small-size individuals of 20 to 40 mm (mean length 31,7 mm). In the north-eastern part of the bank (16-17 m depth) the mussel abundance decreases to 40 kg. In some cases (st.22) the small number of the pray coincides with a small density of the predator (12 exemplars) while in others (st. 7) — the same mussel quantity is registered together with a high *R. thomasiana* abundance (898 exemplars). The main share in the size composition of mussels in the first case is presented by large-size individuals (40-60 mm) resulting in a comparatively high mean length — 46,3 mm, while in the population

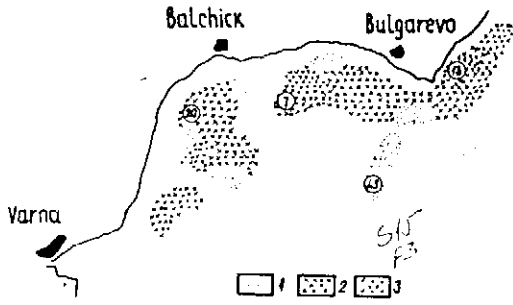


Fig.3. A scheme of *R. thomasiana* natural resources quantitative characteristic and distribution in the region investigated

1 — up to 100 exemplars per dredge; 2 — from 100 to 1000 exemplars per dredge; 3 — over 1000 exemplars per dredge

under the predator press the average length is 35,6 mm, dominated by individuals of 30-40 mm size group. The mean *R. thomasiana* length is 74,15 mm (Fig.4). In the southern part of the mussel bank (st. 17 and 30) another type of predator/pray abundance ratio is registered — in both stations the mussels are of relatively high biomass (220 and 160 kg respectively) while the *R. thomasiana* density in the st. 17 is high (604 exemplars) but in the st. 30 — very low (only 6 exemplars). Again the predator mass development (mean length 68,5 mm) is the reason responsible for the absence of large-size mussels (40-60 mm) at st. 17 and mere abundance — for their presence at st. 30 (mean length 43,8 mm) (Fig. 4).

The bank located in the most southern part of the region being at the same time the

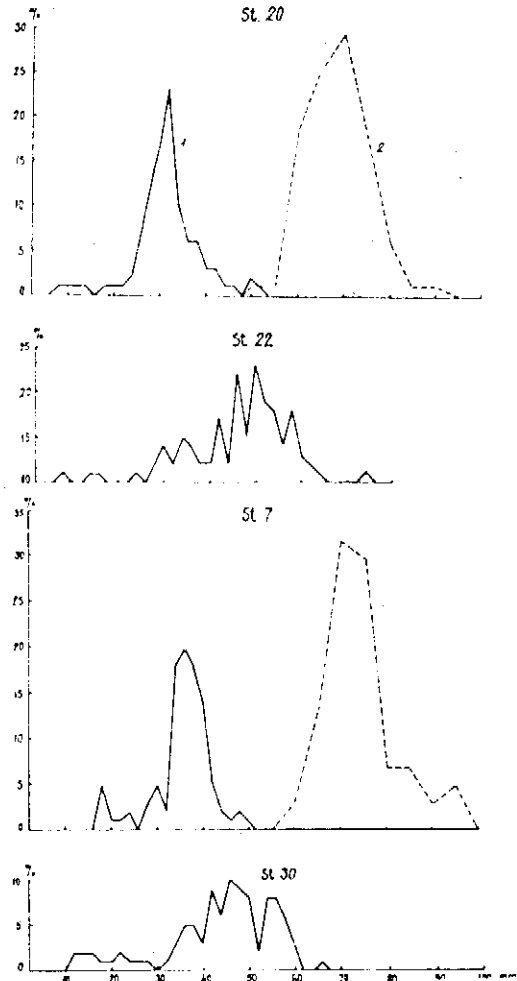


Fig.4. Size composition of mussels (1) and *R. thomasiana* (2) populations in the bank located between Balchick and Varna

deepest one, takes the second place considering the mean overall dredge biomass (Fig.2). The depth increases from 15 to 40 m to the east, the highest mussel abundance in the dredges being registered at the central part of the field, where *R. thomasiana* is found only in one station with a low number (56 exemplars) (Fig. 3).

At Cape Kaliakra the shallow coastal zone to northeast is very density inhabited by *R. thomasiana*, reaching its maximal value (st. 13, Fig. 3) of a mean length 70,7 mm (Fig. 5). The field in the deeper parts of the region is of average biomass 60 kg and is inhabited by

a mussel population of lowest mean length — 26.9 mm (st. 38, Fig. 2). The relatively high percent of young exemplars (10-18 mm) in the size composition give ground to consider this an indicator of mussel recovering after the *R. thomasiانا* invasion in the previous years (Fig. 6).

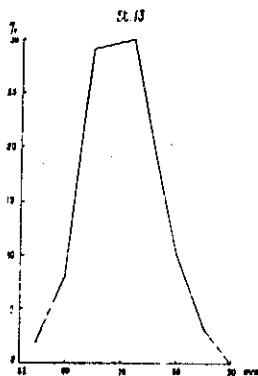


Fig. 5. *R. thomasiانا* population size composition from the field of maximal density (1720 exemplars per dredge)

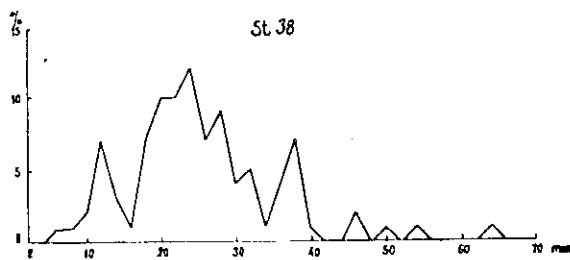


Fig. 6. Size composition of mussels from Cape Kaliakra bank

The bank located between Balchick and Cape Kaliakra is of lowest mussel biomass (average 51 kg) being tally with *R. thomasiانا* bank of highest density (601 exemplars). The mussel mean length does exceed 34-38 mm even at the deeper stations (st. 2 and 15) where the predator is very rare (48-61 exemplars) (Fig. 2 and 3). The large-size mussels (40-60 mm) are merely present but in comparison with that part of the population inhabiting the field between Balchick and Varna they are of greater share (Fig. 7). Possibly it can be related to the fact that in the former investigations (Маринов и др., 1976) here the highest mussel biomass has been

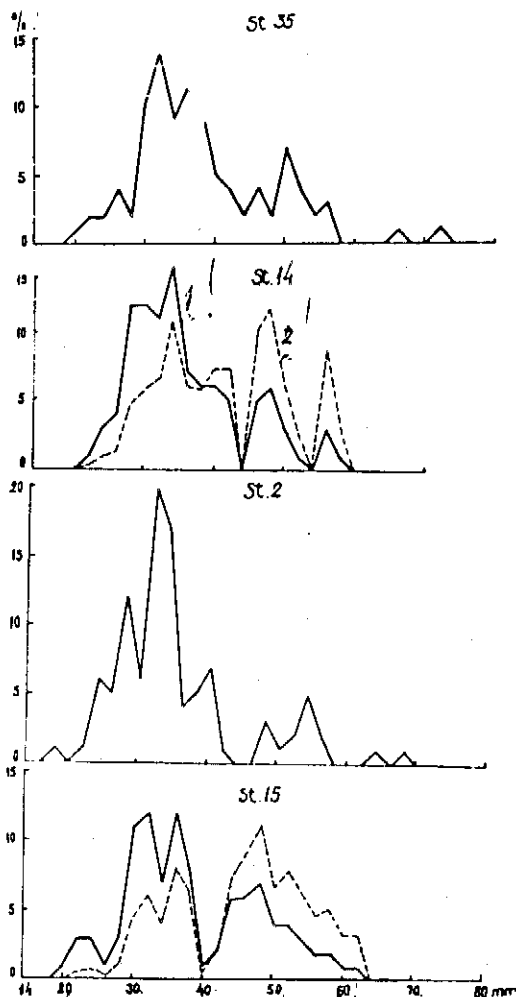


Fig. 7. Mussels size (1) and weight (2) composition from the bank located between Balchick and Cape Kaliakra

registered thus supporting the survival of a part of the population overriding the predator press.

The individual weight and yield of mussels depend mainly on their size. So at st. 7 where no exemplars of length over 50 mm are found mean individual weight is low — 4,3 g while at st. 115 it increases up to 6,0 g (Fig. 4 and 7). The yield variation trend is inverse to that of the weight: it is higher for the small-size mussels, e.g. 21,8% (row meat) at st. 15 and 24,5% at st. 7 respectively.

The comparison between the present data

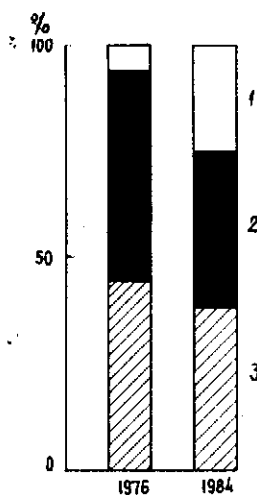


Fig. 8. Share of homogeneous and heterogenous (mussels and *R. thomasiana*) catches according to 1976 and 1984 data

1 — mussels only; 2 — *R. thomasiana* only; 3 — mussels and *R. thomasiana*

and that of М а р и н о в и др. (1976) for the same region reveal that on one hand the percentage share of the homogeneous mussel catches has increased mainly on the account of a corresponding increase of the homogeneous *R. thomasiana* catches (Fig. 8). on the other hand considering the percentage share of the catches with different quantitative characteristics (e.g. the main standart groups) totally opportunistic trends are outlined for the mussels: in 1976 prevail the higher biomass catches, while in 1984 — the lower (Fig. 9-a). At the same time the *R. thomasiana* catches are dominated by the mean abundance standart group in both periods despite the fact that in 1984 the average quantitative characteristic of the different groups is higher (Fig. 9-b).

All this data reveal that the rate of mussel banks destruction and the dominant species of this zooecoenose *M. galloprovincialis* stock reduction has far exceeded the rate of *R. thomasiana* density increase. Consequently if we assume that the first stage of a predator/prey relationship development is characterised by a birst of *R. thomasiana* density, the second — by a dynamic equilibrium with the components of the *M. galloprovincialis* zooecoenose (a fact registered already along

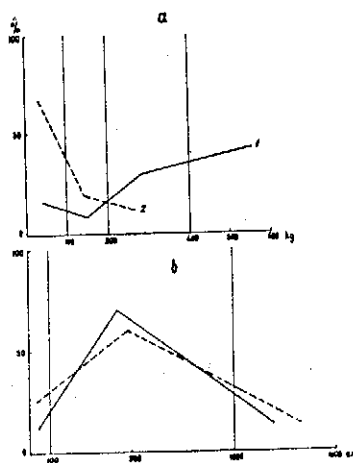


Fig. 9. Mean value and percentage share of mussels (kg per dredge) (a) and *R. thomasiana* (exemplars per dredge) (b) different standart groups from the total catches in the 1976 (1) and 1984 (2)

ICC coast in the early 60, И в а н о в, 1961) it can be considered that the region under investigation goes into the second stage — a typical restoration of the mussel population mainly in the deepest zones. On the other hand the *R. thomasiana* agregation towards the shore in the shallow waters as a result of food insufficiency corresponds to one of the peculiarities of the third stage — a supressed predator status. Usually the latter is accompanied by a clearly expressed size reduction and shell fouling with Briozoa, Algae and other epifaunal organisms — features not registered during the present observations, wich proves that the predator is not yet in a supressed status.

**Conclusions.** *R. thomasiana* presence and density is of basic significance for the abundance and size composition of natural mussel population in the area investigated.

*R. thomasiana* inhabits mainly the shallower zone of the region and is of 71,1 mm mean length. The decrease of the predator press with depth results in a progressive mussel stock restoration.

In comparison with 1976 data the present results reveal that the mussel field deterioration rate far exceeded the rate of *R. thomasiana* density increase.

The development of predator/pray relationship goes into a stage of dynamical equilibrium but the registered peculiarities give ground to admit that during the next few

years *R. thomasi* will enter the stage of depression mainly because of insufficient food supply.

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Състояние на естествените находища от черна мида (*Mytilus galloprovincialis* L. a m) в северната част на българския черноморски шелф във връзка с развитието на рапана (*Rapana thomasi* Grosse)

Ценка Х. Консулова

(Резюме)

В тази статия се интерпретират резултатите от 55 драгирания в района между нос Калиакра и Варна за изследване разпределението, количествената характеристика и размерния състав на естествената популация миди и рапани. Установено е, че количеството и размерният състав на мидите зависят основно от наличието и гъстотата на рапаните, които са разпространени предимно в по-плитките участъци на района и имат средна дължина 71,1 mm. В дълбочина се наблюдава постепенно възстановяване на мидите и изчезване на рапана.

В сравнение с данни от 1976 г. за същия

район резултатите от тези изследвания показват, че процесът на деструктиране на мидените полета и на редуциране на запасите на основния вид в тази зооценоза — *Mytilus galloprovincialis*, се е осъществявало с много по-бързи темпове, отколкото нарастването числеността на рапана.

Развитието на взаимоотношенията хищник-жертва навлиза във фаза на установяване на динамично равновесие между тях, но някои характерни белези дават основание да се допусне, че в близките години рапанът ще се окаже в следващата фаза — угнетено състояние, главно поради недостатъчната трофична обезпеченост.

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