Cercetări marine	I.R.C.M.	Nr. 4	169 - 180	1972

SOME ECOLOGIC DATA ON THE GASTROPOD RAPANA THOMASIANA CROSSE ALONG THE ROMANIAN BLACK SEA SHORE

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ABSTRACT

The present paper reports the results of the observations made directly, by diving, and in aquariums, as well as the biometrical measurements of 390 Rapana thomasiana specimens, collected on the beaches of Mamaia and Agigea. The data found, as compared to those in the literature, show that the predator gastropod Rapana is now gradually invading the Romanian shore, representing a danger for bivalves, especially for rocky mussels.

Rapana thomasiana Crosse, reported for the first time in the Black Sea waters along the Caucasus coastline in 1947, but considered to have settled in the Pontic basin somewhat earlier in the 1930 - 1940 rapidly advanced in the shallow water areas of the Northern coast. In 1949 it was found the oyster bank of Gudautsk, in 1954 at Yalta and Sebastopol and finally, in 1963, along the Romanian shores (BACESCU, 1963; CIUHCIN, 1961 ; DRAPKIN, 1953; EBERZIN, 1951).

The species is a rapacious predator and its rapid advance

along the Caucasus coastline, where it appeared for the first time in the Black Sea, thence to the Krimea, the Romanian and Bulgarian shores, might be firstey accounted for as an invasion dictated by trophic requirements - the search for food.

Rapana, which mainly feeds on oysters and mussels, completely destroyed within a rather short period the entire stock of these molluscs in the Gudautsk bank, completely changing in this way the faunistic pattern of the biocenosis (STARK, 1957). Such cases are well known in the history of the Black Sea; in the geological layers the disappearance of certain bivalve species can be clearly followed up, such as: Pseudomussion denudatum REUSS., Ostrea cochlear POLI, Ostrea gripholdes SCHLOTH. var. sarmatica FUCHS, a disappearance which may be attributed to the rapacity of such gastropods as, for instance Murex subclavatus BASTEROT or species of the Natica and Nassa genera (EBERZIN, 1951).

Having destroyed the big-size species (Ostrea edule taurica SIEMASCHKO, Mytilus galloprovincialis LAM., Modiolus adriaticus LAM.) prefered as food, Rapana was obliged to attack the smaller-size species (Chione gallina L., Pitar rudis POLI, Paphia rugata (B.D.D.), Spisula subtruncata triangula (RENIER), etc.), migrating Westward along the coastline from Gudautsk in its search for oysters and mussels, and thus rapidly populating new zones.

In 1954, BACESCU, speaking of foreign animals that had recently penetrated into the Black Sea basin, showed that "Rapana bezoar" a Muricide snail, had penetrated during the last decade in the Soviet pontic waters and although not yet found to have settled along the Romanian shore one should expectit to reach it. Means should be found to prevent this scourge.

Less than ten years have passed since that prediction and since 1963 Rapana was ever more frequently met with along the Romanian and Bulgarian coastlines (BACESCU, 1963; GROSSU, 1970; GROSSU & LUPU, 1964; ILIESCU RADULESCU, 1968; POPESCU-MARINESCU PALADIAN, 1971).

The species first appeared at the mouth of the Danube river

and rapidly spread Southward becoming a common element in shallow waters, both on sandy and rocky bottoms.

The large number of specimens thrown upon the Romanian beaches of the by the storms in the last 2-3 years is an eloquent proof of the potential danger this rapacious gastropod represents for the littoral malacofauna ; the fact also requiring a closer study of the species for its control, in view of protecting the stock of mussels.

Material and method

It is well known that the organisms actively moving on the substrate cannot be collected by the usual methods and that the only method to be used for ecologic and especially for ethologic studies of a mobile species should be sampling out in the nature, into the sea, by diving. Diving is particularly necessary for the study of all organisms living on rocky bottoms, where quantitative collection of benthos samples still remains a problem.

The first part of the paper deals with the results obtained during innumerable underwater observations carried out in the shallow water zones along the Romanian seashore, from Cape Midia to Vama Veche. Our observations were confronted with and completed by those of my colleague. Dr. G. J. MÜLLER, an excellent biologist and diver, who was kind enough to give us a series of data on Rapana, and to whom we wish to express our gratitude.

For biometrical measurements and observations in aquariums, two lots of Rapana thomasiana were collected from the beaches where they had been thrown up by storms :

- lot 1, 141 specimens collected on Decembr 8, 1970 at Mamaia, on a beach about 500 m long ;

- lot 2, 249 specimens collected on January 28, 1972, at Agigea, on a beach about 200 m long.

All the specimens were collected on the next day after the storm deposited them on the beach.

The following biometrical measurements were made : height of shell (AB), height of spires (AC), height of aperture (CB), breadth of shell (DE), breadth of aperture (FE) (fig. 1) total weight (g).

Discussion of results.

Until now, the gastropod Rapana had bees reproted on the Romanian coastline of the Black Sea based on the only evidence of the empty shells found on the beaches North of Cape Midia (BACESCU, 1963; GROSSU&LUPU, 1964; ILIESCU & RADULESCU, 1968; POPESCU-MARINESCU & PALADIAN, 1971). Diving in the shallow waters South of Cape Midia supplied the first ecologic and ethologic elements concerning the species along the Romanian coastline ; these data may be summed up as follows :

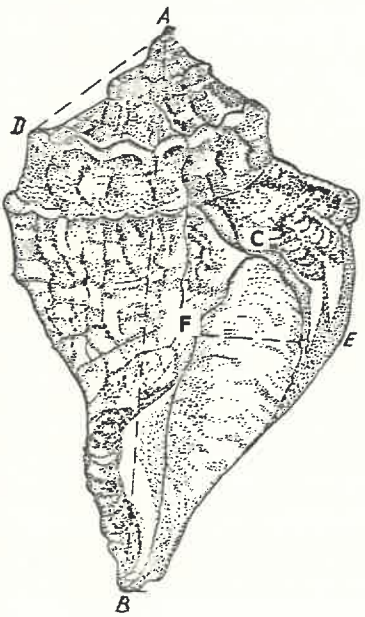

Fig. 1 - Rapana thomasiana Crosse shell and the linear biometrical measurements made.

Rapana thomasiana is found along the shores up to 10 m depth, both in sandy and rockey bottoms, as is shown by the great numbers of empty-shells thrown upon the beaches along the whole coastline.

It is of interest to mention that the species can also live at greater depths. Thus, in two of mare than 500 dredgings performed in 1970 and 1971 on the Romanian continental shelf between 15-45-50 m depths, Rapana was found at 17 m, North of Cape Midia (2 small specimens) and at 30 m depth, East of Portiţa (one small specimen). In the rocky zone of Agigea, between 10 and 20 m depths, only big-size specimens may be found but rather seldom.

On fine sandy bottoms, in the coenosis of the bivalve Corbula mediterranea (COSTA), on the submerged beaches of Mamaia and Mangalia, Rapana was found at depths of 3 to 8 m. Against the monotonous uniformity of the sandy landscape, the gastropod can be very clearly discerned ; two specimens may be usually seen together actively moving upon the substrate. The abundance of Rapana is rather poor here; the estimated average value of its density being 1 to 2 specimens/100 m^2.

Along the Bulgarian coast, at Cape Emine, Rapana was found by our colleague Dr. MÜLLER at a depth between 18 and 28 m, on a shelly bottom, in the subcoenosis of Modiolus adriaticus - Chlamys glabra pontica (B.D.D.) (four adult specimens measuring +60 - +80 mm height of shell were found).

In the harbour at Cape Midia, on bottoms 1-2 m dep, covered by fine sediments with Zostera, Rapana was rarely found, and even then as very small specimens (less than 30 mm height).

During the divings carried out in Sozopol Bay MÜLLER found an abundant Rapana population in fields of Zostera, even at a one depth of half a meter.

On rocky bottoms the gastropod occurs most abundantly and is frequently encountered in the zones delimited by the 4 m and 10 m isobaths, exhibiting a maximum density at depths between 8-10 m (up to 10 - 12 specimens/m^2). In sheltered places, as for instance among the pier stones at Mangalia, Rapana may be found even in shallower places at 30-50 cm depth. In the rocky infralittoral, Rapana usually lives in sheltered places, under the angles of the stones, of the rocky thresholds. On denuded stone platforms the species was never observed.

In areas with a low mussel density, Rapana is more abundant (2 - 4 specimens/m^2) than in the areas with compact mussel colonies (1 - 2 specimens/m^2) ; as a rule, these rapacious gastropds live at the border of mussel colonies upon which they feed.

Along the rocky infralittoral the highest density was observed towards the end of summer (August - September) when the species appears to cluster together, crowding on deeper bottms towards the isobaths of

10 - 8,m, the lower limit of the stone platforms. For example, at Agigea, within an area of about 2 hectares, located at the stone edge, in autumn, there may be found 10 to 12 Rapana specimens/m^2. Therefore it may be asserted that Rapana performs a true seasonal migration due to temperature changes.

The divings performed point out thet the species prefers the shadowy places to the strongly sunlit. ones. When a diver comes near, Rapana reacts immediately, drawing back into its shell.

We had numerous occasions to watch the gastropod feeding at the edge of mussel colonies. With the sole of its foot it envelops a mussel as if it wanted to suffocate the bivalve, and then using its fore part it penetrates in between the valves and eats up the entire content.

At Mangalia, on the sandy bottom, a Rapana was seen to hold tight under the sole of its foot three Chione gallina specimens upon which it was just feeding.

The egg-capsules of the Rapana can be recorded along the Romanian coastline after mid June and can be encountered all through the summer until September. The egg-capsules are set down on the largest specimens of living mussele, or on mussels, or on mussel shells and, in sandy places, on the shells of Mya arenaria. The colour of the egg-capsules after rhey are laid is milky-white ; after 7-14 days the colour turns yellowish-brown, then bluishviolet.

As concerns the size of the Rapana shells, the noticeable fact is that, generally at depths smaller than 4-6 m, there live specimens whose shells are up to 50 mm high; at depths of 8 - 10 m, larger Rapana specimens, measuring more than 50 mm in height, are found.

The 249 specimens collected on the beach of Agigea on the next day after the storm had deposited them, were introduced in aquariums ; all Rapana were alive and fed on mussels. Therefore, during the storm, the shell, which is very resistant and perfectly closed by its operculum, protects safely the animal.

With several lots, comprising 10 specimens each, of the +60 - +70 mm class (height of shell) several exprlments were carried out :

1. Four lots were kept in the open air, at 10 - 14°C, for 1, 2, 3 and respectively 4 days; all Rapana specimens kept in the dry condition survived ; introduced again in the water they moved about and fed actively.

2. Two lots fed on living mussels of the +40 - +50 mm class (height of shell). For three days the gastropods were kept in inanition; then they began to feed actively, consuming a mussel in the course of 2 - 3 days (about 2 g of fresh meat, i.e. 14 - 15% of the weight of the gastropod without shell).

3. One lot of Rapana was kept without food in a tank communicating with another one through an open window in the upper part of the wall at about 30 cm from the bottom (the connecting threshold was at ? cm under the water level) I, the second tank Mya arenaria L. specimens were put ; part of them were buried into the sand, others remained on the surface of the sediment. After 3 days, four Rapana specimens began climbing up the vertical glass wall of the tank, passed into the second tank with Mya and began attacking the bivalves on the surface of the sand. A few days later they began to dig up the Mya specimens dwelling in the sediment, removing the upper sand layer 7 - 8 mm thick and devouring the bivalves. Repana attacks and feeds on Mya, in the same manner it does on Mytilus, but within much shorter interval.

The biometrical measurements carried out on the 390 speciment of Rapana collected on the beaches of Mamaia and Agigea allowed us to ascertain the following :

L. On Agigea beach, the Rapana specimens encountered are of the largest size reported on Romanian seashore (the maximum height of shell reaches the value of 112,9 mm).

The +90 and +100 mm class (height of shell) corresponding to an 5 - 6 years of age (CIUHCIN, 1961b), comprise almost 8% of the population (table 1). The fact shows that the penetration of the rapacious gastropod into the rocky beds of Agigea area began during 1966-1967.

On Mamaia beach, the maximum size of Rapana specimens (height of shell 72,0 - 87,8 mm) points to an age between 3 and 4

Table 1

Size - class pattern for the populations of Rapana thomasiana encountered on the Romanian Black Sea shore

Beaches and date of collecting		Size-classes (height of the shell)							Total	Mean height in mm
		under 50 mm	+50 mm	+60 mm	+70 mm	+80 mm	+90 mm	+100 mm		
Mamaia	no.	35	69	34	2	1	-	-	141	50.42
8. XII. 1970	%	24.8	79.0	24.1	1.4	0.7	-	-	100	
Agigea	no.	1	25	85	93	26	12	7	249	67.36
28. I. 1972	%	0,4	10.0	34.0	37.4	10.4	5.0	2.8	100	
Perişor -	no	7	42	78	144	63	6	-	340	66.81
Periteaşca[1)]	%	2.1	12.4	22,9	42.3	18.5	1.8	-	100	
Zăton -	no	2	18	28	2	-	-	-	50	56.00
Periteaşca[2)]	%	4.0	36.0	56.0	4.0	-	-	-	100	

[1)] after ILIESCU & RADULESCU (1968) ;

[2)] after POPESCU-MARINESCU & PALADIAN (1971)

years of the gastropod. Therefore, both at Mamaia and Agigea, Rapana seems to have appeared beginning with 1966 - 1967.

2. The structure of the populations as to size classes (size classes being established according to the height of the shell for every 10 mm - table 1), as well as the maximum heights of the shells found pove that the appearance of Rapana species within the neighbouring areas of Mamaia and Agigea began during the same time.

On December 8th, 1970, on Mamaia beach there were found 5 size - classes only. The specimens under 50 mm represent nearly one fourth of the population. The predominant size-class is that of +50 mm which comprises half of the specimens measured; the remaining 25 cer cent of the populations is represented by individuals belonging to the +60 to +80 mm size-classes. This size-class pattern established for the population on Mamaia beach was recorded at the end of 1970 and points out that Rapana population is of early settlement and the individuals are quite young.

On January 28th, 1972, the size-class pattern of Rapana population at Agigea was much more complex, its individuals belonging to 7 size-classes (table 1). The most of Rapana specimens belonged to the +60 - +70 mm size-class, a proof that the population was adult. The same adult populations have been also recorded by ILIESCU & RADULESCU (1968) and by POPESCU-MARINESCU & PALADIAN (1971) (table 1).

The mean height of a Rapana specimen established by us or by other authors (ILIESCU & RADULESCU, 1968 ; POPESCU-MARINESCU & PALADIAN, 1971) reaches the highest value (67.36 mm) with the population at Agigea (table 1). It proves that at Agigea, under the good trophic conditions represented by mussels (a particularly preferred food by the rapacious gastropod) the growing of Rapana develops normally. CIUHCIN (1961c) reports that, under lack of proper food, Rapana has a very low rate of growth and therefore its size is much more smaller.

3. The ratios between the different linear measurements determining the shape of the shell are generally similar for all the populations encountered along the Romanian seashore but, for the specimens dwelling

in the neighbourhood of the Danube river mouths (POPESCU-MARINESCU & PALADIAN, 1971) the variations are much higher than for those living at Mamaia and Agigea (table 2).

Table 2

The variation of the ratio between the different linear measurements of the Rapana thomasiana specimens encountered along the Romanian Black Sea shore

Ratio :	Range of variation	
	Populations at Mamaia Agigea	Populations at Perişor-Periteaşca
AC/AB	33.81 - 39.47	26.92 - 43.75
CB/AB	67.42 - 79.30	66.12 - 90.60
DE/AB	60.86 - 75.12	62.66 - 83.33
FE/AB	31.90 - 45.69	32.60 - 48.68
FE/DE	50.65 - 62.33	41.17 - 69.23

4. Analysing the correlations between the different geometric parameters, which define the shape of the Rapana shells and also provide information on the gastropod's growth we assume that there are certain linear connections that may be expressed by the general equation :

$$y = a.x + b$$

where y and y are the different linear measurements (AB, AC, CB, DE, EF), and a and b are specific constants characterrzing each species taken apart.

Our analyses showed that for every size-class, the relations between the height of shell and height of spire or the breadth of aperture with Rapana, can be expressed by the following values :

$$BC = 0.787\ AB - 1.85$$

$$AC = 0.370\ AB$$

The relation between the height of shell and breadth of aperture is also a linear type one, but during the gastropod's growth, the proportionality ratio between these measurements changes. Thus, with all classes smaller than +70 mm

$$FE = 0.280\ AB + 5$$

and with classes higher than +70 mm

$$FE = 1.050\ AB - 31$$

The changes recorded during the growing of the shell with the +70 mm size-class can be also observed within the relation between the height of the shell and the total weight of the animal, a relation of dependence of exponential type according to the equation :

$$q = b \cdot L^{a}$$

where q is the weight, L is for instance the height of the shell and a and b are constants. Thus, with all size-classes smaller than 70 mm.

$$q = 2.4 \cdot 10^{-4}\ AB^{2.81}$$

and with size-classes higher than 70 mm

$$q = 1.05 \cdot 10^{-9}\ AB^{5.60}$$

These formulas. notwithstanding our reserve concerning the size-classes higher than 70 mm where we had but few specimens for analysis, indicate that the specimens more than 3-4 years old have an extraordinary growth in their total weight per height unity.

This marked growth in weight is due to the assimilation of the calcium carbonate which brings about a strong thickening of the shell.

Our data concerning the ecology of Rapana thomasiana from Romanian Black Sea shore are certainly, preliminary. Having in view that this gastropod is not only a new element on the Romanian Black Sea shore, which must be known in all its aspects but is also a predacious enemy for the littoral malacofauna (especially for Mytilus and Mya arenaria), extensive researches are necessary in the future to elucidate the species ethology and ecology.

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