FOLIA MALACOLOGICA
Folia Malacol. 3: 149–158
Cracow, 1989
http://dx.doi.org/10.12657/folmal.003.012

POLYMORPHISM AND ANOMALOUS SHELLS IN JUVENILES OF *RAPANA THOMASSIANA* CROSSE, 1861 (GASTROPODA: PROSOBRANCHIA: NEOGASTROPODA) FROM THE BLACK SEA

KRZYSZTOF SMAGOWICZ

Zoological Museum, Institute of Zoology, Jagiellonian University, Gronostajowa 9, 30-387 Cracow, Poland

ABSTRACT: A comparative study of juvenile shells of *Rapana thomassiana* Crosse, 1861 from the coasts of Bulgaria (42 specimens) and Georgia (5 specimens) has shown their morphologic and biometrical distinctness. The young specimens from Bulgaria were markedly different from the adults (10 specimens). The studied shells are described considering their colour variability, regeneration, epizoites, and anomalies (3 anomalous shells).

KEY WORDS: Muricidae, *Rapana venosa*, shell, anomaly, variability

Folia Malacologica 3/1989 was originally published as No. 1216 of Scientific Bulletins of University of Mining and Metallurgy, Cracow. This digitalised version was prepared by the Association of Polish Malacologists and first published on-line on December 30th, 2016.

Ministry of Science and Higher Education
Republic of Poland

This digitalised version of Folia Malacologica is funded by the Ministry of Science and Higher Education, Republic of Poland under the agreement no. 646/P-DUN/2016 allocated to the activities of disseminating science and by the courtesy of the Rector of the AGH University of Science and Technology, Cracow

ZESZYTY NAUKOWE
AKADEMII GÓRNICZO-HUTNICZEJ IM. STANISŁAWA STASZICA

Nr 1216 Folia Malacologica z. 3 Kraków 1989

KRZYSZTOF SMAGOWICZ

POLYMORPHISM AND ANOMALOUS SHELLS IN JUVENILES OF RAPANA THOMASSIANA CROSSE, 1861 (GASTROPODA: PROSOBRANCHIA: NEOGASTROPODA) FROM THE BLACK SEA

Abstract: A comparative study of juvenile shells of Rapana thomassiana Crosse, 1861 from the coasts of Bulgaria (42 specimens) and Georgia (5 specimens) has shown their morphologic and biometrical distinctness. The young specimens from Bulgaria were markedly different from the adults (10 specimens). The studied shells are described considering their colour variability, regeneration, epizoites, and anomalies (3 anomalous shells).

INTRODUCTION

The big, impressive shells of the gastropod Rapana thomassiana Crosse, 1861 have become a popular souvenir brought from the coast of the Black Sea. Such shells are famous for the fact that the shallows of the Black Sea are their only habitat in Europe, as well as for their being the biggest in that sea. In fact, Thericium vulgatum (Bruguière, 1772) and Turritella communis Risso, 1826 - the biggest autochtonous gastropods of the Black Sea-reach up to 50 - 60 mm in height and live at greater depths; in shallower parts only Nassarius reticulatus (Linnaeus, 1758) reaches as much as 32 mm in height, the other species found there being much smaller (Golikov and Starobogatov 1972).

R. thomassiana has been present in Europe since recently. It got there in the forties of this century, having been probably brought together with some fry, and soon became common (Drapkin 1953 and 1956). At present it can be found along both the east (Golikov and Starobogatov 1972) and west (Kochan 1970) coasts.

Ministry of Science and Higher Education Republic of Poland

This digitalised version of Folia Malacologica is funded by the Ministry of Science and Higher Education, Republic of Poland under the agreement no. 646/P-DUN/2016 allocated to the activities of disseminating science and by the courtesy of the Rector of the AGH University of Science and Technology, Cracow

It should be mentioned that in the first records concerning the occurence of the species in the Black Sea (Drapkin 1953, 1956 and Kochan 1970) the name Rapana bezoar (Linnaeus, 1758) was used erroneously. The latter - a Far Eastern species - has its shell smaller (up to eight cm high), the shell colour being whitish or cream (Oliver 1975).

Young specimens coming from the two opposite sea margins (Bulgaria and Georgia - USSR) were found to show some differences. A high and rather incontinuous variation was also observed among juvenile shells from Bulgaria. This morphologic diversity is the main subject of the paper.

MATERIAL AND METHOD

Some of the specimens the paper deals with come from the collections of Mrs. D. Borkowska nad Mr. W. Kochan, to whom the author owes a large debt of gratitude. Most specimens were collected by the author in 1973 and reposited in the Zoological Museum of Jagiellonian University in Cracow. The study is based on 60 specimens of R. thomassiana from the littoral of the Black Sea. All the young specimens studied were collected at Obzor (Bulgaria), several dozen meters from the beach, at a depth of 3 - 5 m, and at Sochi (Georgia, USSR), a dozen or so meters from a rocky shore, at a depth of 2 m. Altogether 10 specimens were adults out of which nine collected in Bulgaria and the remaining one in Georgia. From among 50 young specimens 45 were collected in Bulgaria, the remaining five coming from Georgia.

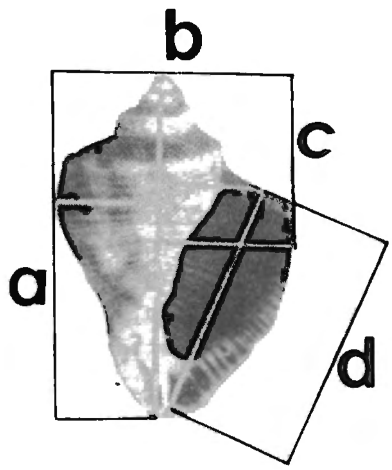

Fig. 1. Shell measurement scheme, letter symbols as in the text and Tab. 1

The measured young specimens from Obzor were divided into three subgroups, apart from those with anomalous shells, which were considered separately. Additionally, the author examined 25 other shells from the locality, but they were not considered in the biometrical analysis since their very thin and delicate body whorls were incomplete.

Each shell was measured according to the scheme presented in Fig. 1: a - height - from outer end of siphonal canal to apex; b - breadth - perpendicular to height; c - spire height - from upper margin of aperture to apex, parallel to height; d - aperture height - from end of siphonal canal to the opposite margin; e - shell wall thickness - at outer aperture margin, 6 - 7 mm from the edge; f - shell weight, with 0.1 g accuracy.

The measurement results are given in Tab. 1 (heights) and Fig. 2 (a diagram of height-weight interrelations). Shell height and spire height, which show a greater variability, are presented in Fig. 3 to illustrate the variability ranges within each group. From each group two shells were selected to draw the profiles of their walls near the apertures (Fig. 4).

RESULTS

Tab. 1 contains the measured values of shell height and shell wall thickness, and the other shell dimensions examined as percentages of shell height. The adult shells from the Bulgarian coast were quite uniform, the only one from Georgia being included within the variability range of the group. On the other hand, that shell was one of the slimmest, its spire being by 0.1% higher than the others.

The juvenile shells from the east coast were approximate to the adult ones more than were the ones from Obzor. The shells from Sochi were quite massive, heavy (in spite of their small heights: Fig 2 and 6,8 - 6,9; Tab. 1), and had their walls thickened by the margins (Fig. 4) Their pink mother-of-pearl layer was poorly developed and translucent so that the streaks of the outer layer could be seen through it. Those shells, excluding the anomalous ones from Obzor, had their spires higher than the remaining ones. The young specimens from the Bulgarian coast (Obzor) were found having their shells markedly distinct from the adults from that habitat. They were divided into three size groups to observe the age variability of particular shell dimensions.

It was found that: (a) differences between the subgroups were very small, the infragroup size variability ranges being much wider than the intervals of the means; (b) the smallest shells were at the same time the

Table 1

Mean and extreme dimensions of measured shells

		a	b	c	d	e
		Height	Width	Spire	Aperture	Wall thickness
		mm	% of height	% of height	% of heigh	mm
Age and locality Adults						
Black Sea (whole) 10 ind	mean min.-max.	87.3- 54.9-121.2	77.0 71.5-82.4	23.8 18.1-28.3	77.5 78.1-83.5	4.08 2.0-6.5
Youngs Georgia (SU) 5 ind	mean min.-max.	35.0 26.4-41.0	72.3 70.0-74.4	27.8 25.6-29.9	73.7 68.6-78.0	1.70 0.9-2.0
Youngs Bulgaria (BG) 14 ind	mean min.-max.	54.9 52.3-63.9	61.3 68.4-74.3	24.3 20.4-26.5	75.3 72.5-78.5	0.66 0.4-1.0
Youngs Bulgaria (BG) 14 ind	mean min.-max.	49.6 47.5-52.0	69.9 65.0-72.7	24.7 21.3-28.6	75.5 69.9-78.4	0.60 0.3-0.8
Youngs Bulgaria (BG) 14 ind	mean min.-max.	41.8 32.9-47.2	69.8 63.7-74.0	25.2 22.6-28.8	75.0 72.2-79.0	0.46 0.3-0.6
Anomalous I*		62.0	50.0	40.3	60.2	0.7
Anomalous II		41.8	62.5	33.0	66.8	0.5
Anomalous III**		39.8	75.5	26.9	70.8	0.6

*) Fig. 7, 22
**)

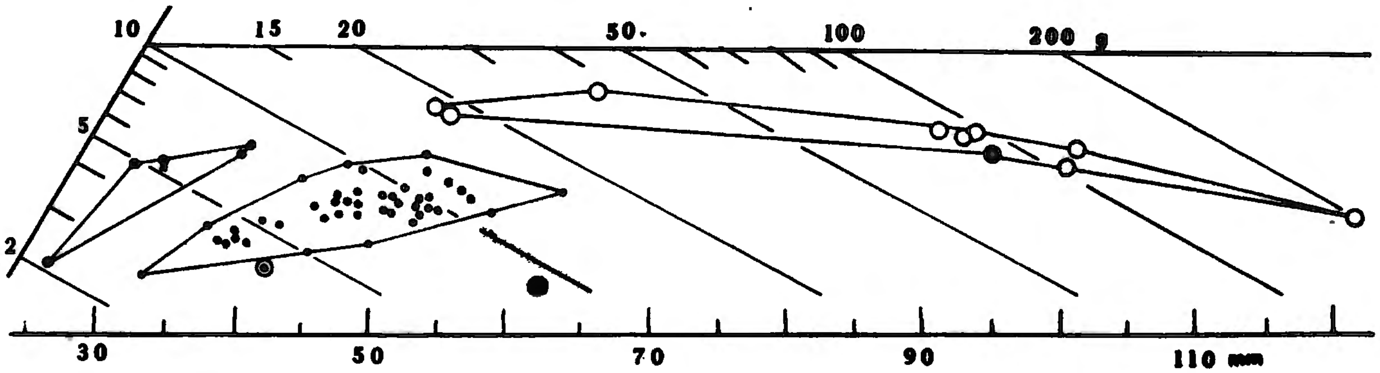

Fig. 2. Shell height and weight of Rapana thomassiana from the Black Sea. Note: to distinguish various origin shell groups the arithmetic scale and the logarithmic scale inclined to the right under the angle of 60° are applied. Light circles - specimens from Bulgaria, dark circles - specimens from Georgia; small circles - young specimens, big circles - adults; duble circles - specimens with anomalous elongated spire

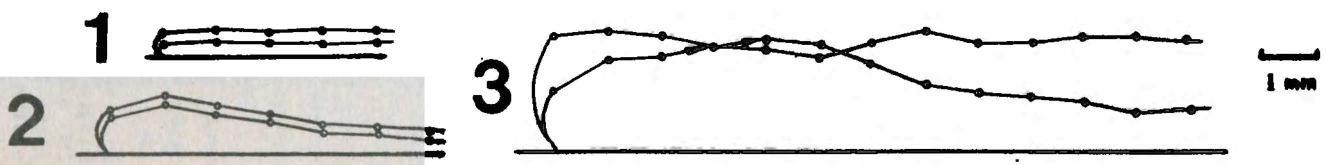

Fig. 4. Shell wall thickness measured in 1 mm intervals from the middle of the aperture margin towards the inside of the shell: 1 - young specimens from Bulgaria, 2 - young specimens from Georgia, 3 - adults

slimmest and had relatively the highest spires, in two successive groups the values of the shell breadth and spire height were approximate to the corresponding values found in adults, there is no correlation between the spire height and shell breadth (γ = 0.24); (c) the juvenile shells from Obzor had their walls thinner by half than those from Georgia and the smallest one from Acheloi; (d) the aperture-to-shell height proportion was the most constant value.

Relations between the height and weight of the studied shells (Fig. 2) confirm the presented results of the biometrical analysis. The studied shells represented three distinct groups. The only ones that could not be included to any of the groups were two specimens from Obzor, having their spires extremely high. One of the groups comprised the young specimens from Obzor. They exhibited a wide range of weight variability, which might have been due to both their considerable shell wall thickness variation and soft part remains left inside the shells. That group was the opposite of another one showing rather no variation. The latter consisted of five young specimens from Sochi, which were heavier than the correspondingly high ones from Obzor (Figs.6,8 - 6,9).

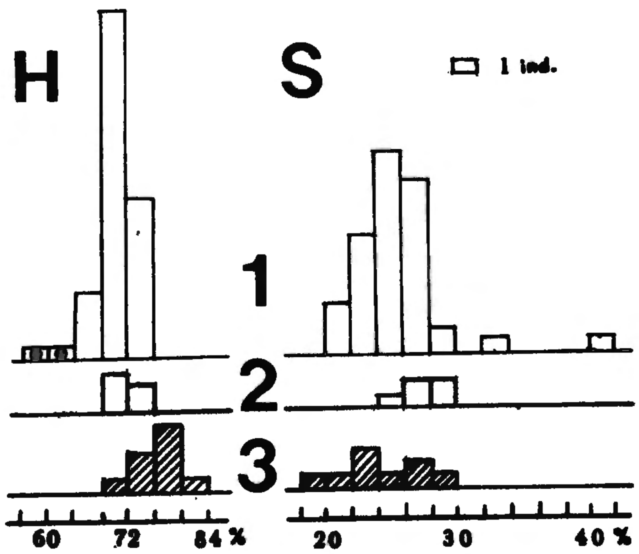

Fig. 3. Diagrams showing the range of the most variable dimensions: shell breadth (H) and spire height (S), as percentages of shell height: 1 - young specimens from Bulgaria, 2 - young specimens from Georgia, 3 - adults; specimens with elongated spire marked with points

The remaining group, consisted of adult specimens, was rather uniform though showing a rather wide weight variability. The size-overlap of the biggest specimens from Obzor showing still some juvenile characters, and the smallest ones of the second group (from Acheloi) - seemingly adult - is worth of attention (Fig. 6,10 - 6,11).

In short, the juvenile shells from Obzor were found to differ from the adult ones from that locality in the following: (a) the weight of a young specimen was 55 - 62% of the shell weight of an adult, the shell height being similar in both; (b) the shell thickness was small and did not get smaller about the very margin; (c) the nacre layer being extremely thin, the shell was striped dark inside; (d) the outer shell surface sculpture was less conspicuous; (e) the aperture appeared higher, because it gradually passed into the siphonal canal, whereas in adults the beginning of the canal being similarly wide as the rest of it was very well marked on the aperture margin.

Outer surface colouring

The juvenile shells are various in colouring: from bearing dense brown stripes (a majority) to albionotic specimens. All adult shells are light brown, with traces of juvenile spotting. The onthogenesis of the shell colouring is probably as follows: the youngest shells are white, when having reached 30 - 40 mm in height they start accumulating pigment which distributes rather evenly. From among 10 of the studied specimens having their shells less than 45 mm high, there were seven white, one light and spotty, and only two dark ones. Out of the young specimens from Obzor, 12 were white while out of those from Sochi there was only one white specimen being at the same time the smallest.

Inner surface colouring

The adults have their endostracum intensive pink orange. The endostracum of the juveniles is varied in colouring: the shells from Georgia had their mother-of-pearl layer orange with dark stripes of the mesostracum being visible through this thin nacre layer, apart from the aperture margin where the latter layer was thicker (Fig. 4,2). In the shells from Obzor nacre occurred in the form of a poorly visible, thin opalescent layer which was translucent so that the streaks of the outer layer were very well discernible (Figs 6,10 and 7,24). However, the latter did not concern albinotic shells in which the outer streaks were poorly marked (Fig. 6,12). The formation of the endostracum begins at the columella, near the siphonal canal.

When examining various age shell longitudinal sections, one can observe that the gastropod after having started to form the nacre layer covers almost all the shell inside with it, beginning at the columella and leaving dark streaking far from the columella within two or three first whorls.

Anomalous shells

From among the juvenile shells from Obzor three were found anomalous (dimensions: Tab. 1). Two of them were much elongated (Fig. 7,22), their proportions being shown in Fig. 3. The remaining one (Fig. 7, 23) had its columella curved and its siphonal canal in the form of a crooked trough with a sharp edge thrown off to the inside, the shape of the aperture being untypical.

Regeneration

Juvenile shells from Obzor were very frigid, especially at the aperture, showing numerous traces of the shell repairing. Even quite deep breaches vere completely regenerated so that the outline of the aperture was unchanged (Fig. 7,15). Usually a repaired fragment did not differ in colour from the rest of the shell, but it was bordered with a "sill" which was sometimes even up to 1.1 mm high (Figs 7,20 - 7,21). In some cases (Fig. 7,18) the regenerated parts were white.

Epizoites

As every solid substrate on the bottom of the sea, shells of R. thomassiana are commonly overgrown with various organisms. The follwing ones were found occurring on both juvenile or adult shells from the Black Sea: the bryozoan Membranipora pilosa (Linnaeus, 1758), it begins overgrowing at the shell apex (Figs 5,2 - 5,3, 7,21and 7,24), in some cases the whole shell surface is covered with it; the barnacle Balanus improvisus (Darwin, 1854), observed only on the several biggest young specimens from Obzor and on most adults.

The following epizoic species were found onlyon adults: red algae, probably from the genus Hildebrandtia, and green spots of Chlorophyta, present on shells having rough surfaces without the periostracum (Figs 5,1 - 5,3); the boring sponge Vioa sp., occurring also on shells without the periostracum (Fig. 5,1); the mussel Mytilus galloprovincialis Lamarck, 1819, being quite common, the typical place it was attached to was the umbilicus. One mussel specimen found at the umbilicus of a big specimen of R. thomassiana (Figs 5,4 - 5,5) was about 12 mm long. Other specimens of the mussel were found attached to the suture, folds on the siphonal canal margin (Fig. 5,5), and even to well developed knobs (Fig. 5,6).

CONCLUSIONS

The presented material reveals some regularities, though it is too poor to give a detailed explantion. This is certain that the young specimens of R. thomassiana from the Black Sea show a high shell variation, perhaps polymorphism.

Ankel (1935, after Cooke 1895) gave a series of shells of Thais lapillus (Linnaeus, 1758), anther representative of the same family, coming from various localities from the Mediterranean to North Sea, to illustrate the polymorphism of the gastropod shell. Golikov and Starobogatov (1972) gave a drawing of a fairly elongated adult specimen of R. thomassiana (breadth 72.5%, spire height 27% of shell height) as a typical form of the Soviet part of the Black Sea.

The character of the two juvenile morphs distinguished in the paper should be studied in future. It can be supposed that they are ecophenotypes connected with various habitat factors. The most important seems calm or wavy water on a locality. The bay opposite to Obzor is less exposed to a strong waving action than the rocky shores of Sochi or Acheloi, hence the gastropods from Obzor can delay strengthening their shells with the nacre layer. On that assumption the smallest specimens from Acheloi would be intermediates between the ones from Sochi and the remaining adults examined.

Kovanda (1956) ascribed the creation of anomalous shells to parasites. The same and other factors were mentioned by Kaltenbach (1962) in a description of anomalous shells of the bivalve Cerastoderma. Jackiewicz (1965) after some authors ascribed anomalies in the Clausiliidae shell to mechanic damage of the juvenile shell. Anomalous specimens of Mytilus from Puck Bay were found by Falniowski and Dyduch (manuscript) who suggested some role of environmental pollution in their origin.

REFERENCES

ANKEL W. E. 1936. Prosobranchia. in: G. Grimpe, E. Wagler (eds.), Die Tierwelt der Nord- und Ostsee, IX, b1, Akad. Verl. Ges., Leipzig.

COOKE A. H. 1895. Mollusca. in: S. F. Harmer, A.E. Shipley (eds.), The Cambridge Natural History, 3. Macmillan and Co., London.

DRAPKIN E. I. 1953. Novyj molliusk v Černom More. Priroda, 9.

DRAPKIN E. I. 1956. Nachoždenie elementov tichookeanskoj fauny v Černom More. Trudy sov. tem. sovešč. ZIN, 6, AN SSSR, Moskva - Leningrad.

FALNIOWSKI A., DYDUCH A. manuscript. Wstępne badania nad zmiennością omułka jadalnego (Mytilus edulis Linnaeus, 1758) z Zatoki Puckiej.

GOLIKOV A. N., STAROBOGATOV Ja. I. 1972. Klass briuchonogije molliuski (Gastropoda). in: F. D. Morduchaj-Boltovskoj (ed.), Opredelitel fauny Černogo i Azovskogo Morej, 3, Naukova Dumka, Kiev.

JACKIEWICZ M. 1965. Regeneracja i anormalności skorupek świdrzyków (Mollusca, Clausiliidae). Pr. Kom. biol. Pozn. TPN, 31, 1: 1-26.

KALTENBACH H. 1962. Missbildungen bei Cerastoderma edule. Arch. Moll., 91, 4/6: 217.

KOCHAN W. 1970. "Kraby" nad Morzem Czarnym. Wszechświat, 3: 66-69.

KOVANDA J. 1956. O skalaridních a anomálnich formách ulit některych našich plžů. Vešmir, 35: 139-141.

OLIVER P. 1975. Der Kosmos-Muschelführer. Kosmos Gesellschaft der Naturfreunde, Franckh'sche Verl., Stuttgart.

Zoological Museum
Institute of Zoology
Jagiellonian University
ul. M. Karasia 6, 30-060 Kraków, Poland

POLIMORFIZM I ANORMALNE MUSZLE OKAZÓW MŁODOCIANYCH RAPANA THOMASSIANA CROSSE, 1861 (GASTROPODA: PROSOBRANCHIA: NEOGASTROPODA) Z MORZA CZARNEGO

Streszczenie: W pracy porównano wymiary (wysokość muszli, szerokość muszli, wysokość skrętki, wysokość ujścia i grubość ścian) oraz wagi 60 muszli czarnomorskiej populacji ślimaka Rapana thomassiana Crosse, 1861. Okazy pochodziły z Soczi (Gruzińska SRR) i z Obzoru, Acheloj oraz Neseber (Bułgaria). Stwierdzono, że młode okazy z Obzoru wyraźnie różnią się od młodych z Soczi i wykazują znaczną zmienność. Różnią się też wyraźnie od okazów dorosłych niemal całkowitym brakiem warstwy perłowej, cienkościennością, słabym urzeźbieniem, innymi proporcjami całej muszli oraz kanałem syfonalnym wybiegającym z ujścia bez wyraźnej granicy. Odnotowano zróżnicowanie ubarwienia okazów młodocianych, trzy okazy anormalne i ślady regeneracji muszli, opisano organizmy epizoiczne spotykane na muszlach.

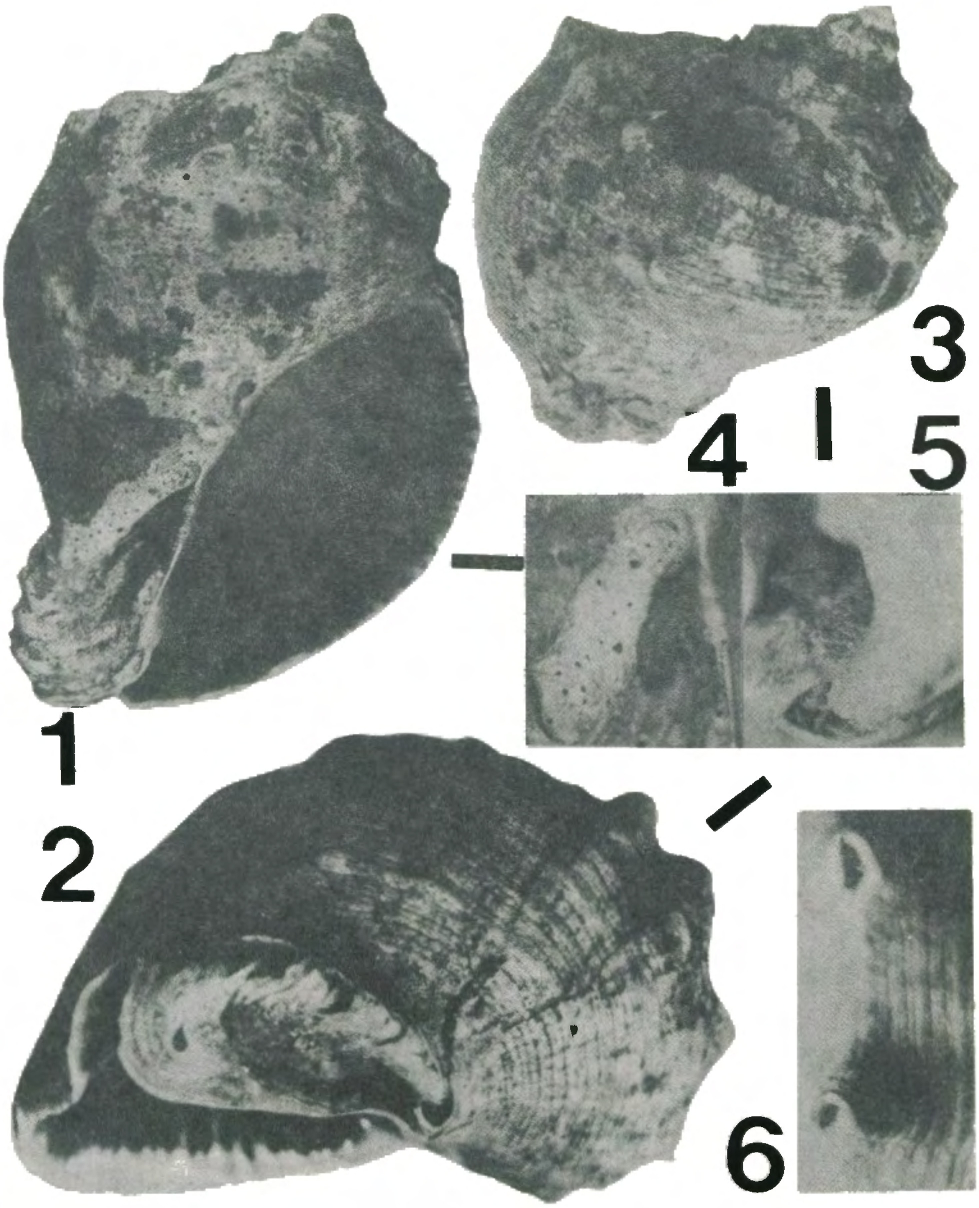

Fig. 5. Shell of Rapana thomassiana adults from the Black Sea: 1 - specimen from Neseber (Bulgaria), 100.6 mm high, outer surface corroded, dots are due to a boring sponge of Vioa sp., spots (dark red) are thali of red algae (Hildebrandtia sp.?); 2 - 2 - specimen from Acheloi (Bulgaria), 91.2 mm high, overgrown with the bryozoan Membranipora pilosa, spots are thali of a chlorophyte; 4 - 5 - fragments of the above specimens, having young mussels of Mytilus galloprovincialis attached to the umbilicus (and in the specimen from Acheloi also to the umbilicus vicinity); 6 - characteristic sculpture of the outer shell surface of a small but adult specimen from Acheloi, 54.9 mm high

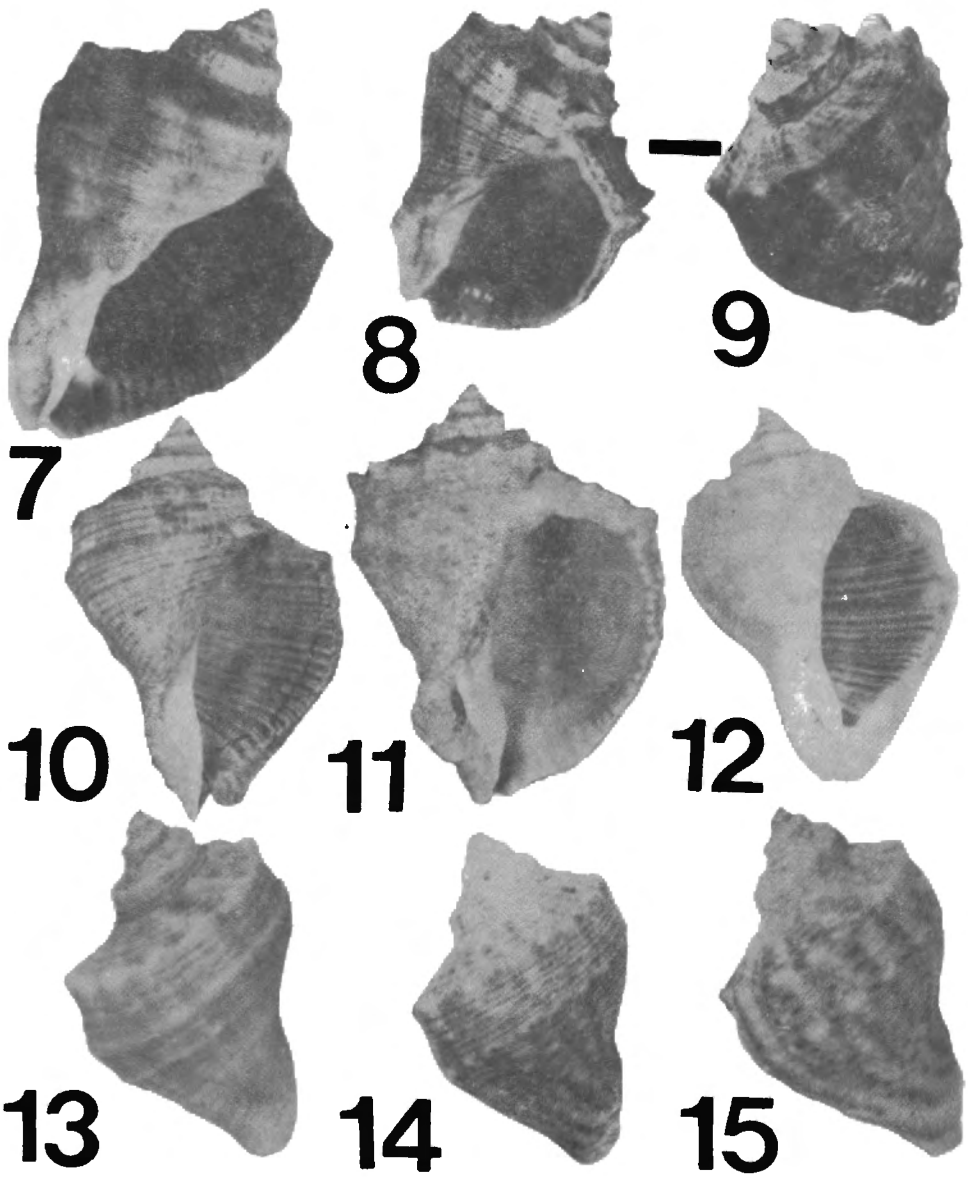

Fig. 6. Habitus and colour variability in young specimens of Rapana thomassiana from two opposite sides of the Black Sea: 7 - 9 - specimens similar in weight but varied in height: 7 - Obzor (Bulgaria), weight 9.4 g, height 53.0 mm; 8 - 9 - Sochi (USSR), weight 8.7 g, height 41.0 mm; 10 - 11 - juvenile and adult specimens similar in height and different in weight: 10 - juvenile from Obzor, weight 17.4 g, height 63.9 mm; 11 - adult from Acheloi, weight 38.0 g; height 66.3 mm; 12 - 15 - young specimens from Obzor, varied in colouring, one of them albinotic

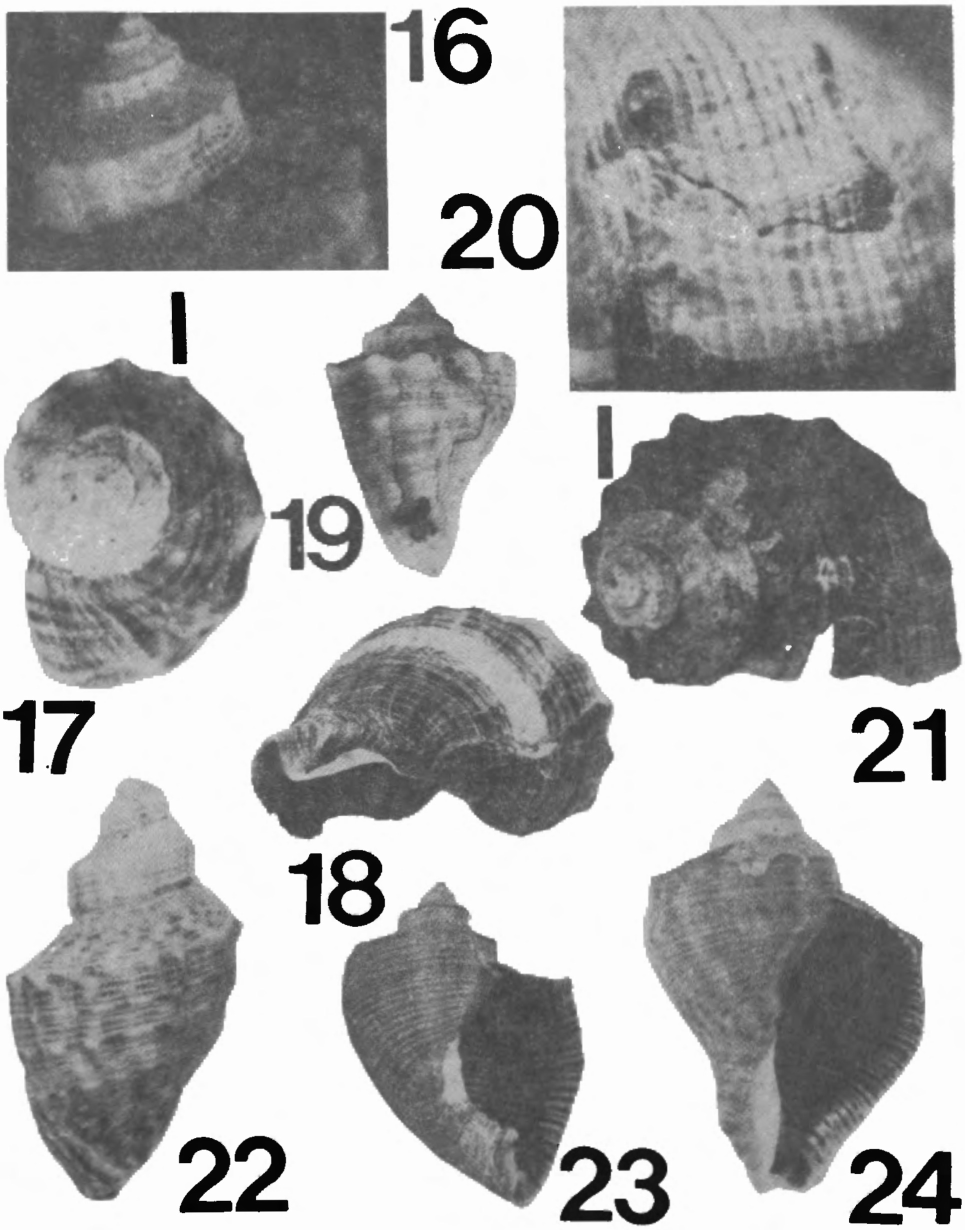

Fig. 7 . Juvenile shells from Obzor: 16 - 17 - colour change when growning; 18 - partial albinism (due to regeneration?); 19 - traces of several successive regenerations; 20 - 21 - regeneration "sill" 1.1 mm high; 22 - anomalous specimen with a very elongated spire, about 62 mm high (the apex broken off); 23 - anomalous specimen with an atypical aperture and siphonal canal, 39,8 mm high; 24 - to compare: a typical shell overgrown with bryozoan Membranipora pilosa.