Shell Color Allelic Lines of *Rapana venosa* (VALENCIENNES, 1846)

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**Abstract** *Rapana venosa* shell outer background color and color patterns variation were investigated. It is stated that color diversity spectrum is produced by combination of two different genes and their alleles. Dominant and recessive alleles are determined by proportional frequency of associated shell color type reflection.

**Keywords** Allele; *Rapana venosa*; Shell color patterns

Distribution of pigment in the *Rapana* shell matches its distribution in the epithelial cells of outer surface of mantle, which is clearly visible as pigment bands going perpendicular to the edge of the mantle. Accordingly, the characteristic element of the *Rapana* shell outer part pigment pattern are spiral dark brown (dashed) lines located on the shell spiral ridges (Bondarev, 2010). Based on the images and descriptions of the characteristic form of native *Rapana* (Bogdanov, 1993, Habe, 1975; Kira, 1965) and *Rapana* from recently occupied areas (Bogdanov, 1993, Bondarev, 2010; Cossignani, 2011; ICES 2004; Kantor, 2006; Kerckhof et al, 2006; Lanfranconi et al., 2009), we can conclude that this color pattern element, combined with gray-beige or brown in different shades and color intensity of the background, creates *Rapana venosa* typical color form. Data from our present study also confirms this statement.

*Rapana venosa* shows a wide range of color and pattern on the shell outer part of expressed melanism to albinism. This phenomenon is inherent for the Black Sea metapopulation (Bondarev, 2010), and known from the native *R. venosa* range also (Kira, 1965). There is a genetically determined individual potential of a certain color type formation. Adult individuals’ color type coincides with the intensity of the larval shell color: the darkest protoconch corresponds negroid color form and the most light colored - to albinist form; and the color intensity of the typical color form specimens matches the protoconch color intensity (Bondarev, 2010). During the shell growing process the protoconch use to be lost, and the spire top use to be discolored and destroyed. Therefore, it is impossible to show the connection between the initial potential and the mature shell color.

Meanwhile, analysis of adult individuals’ color variability from a large amount of data also provides some interesting results as presented below.

More the 2 000 specimens from different regions of the Black Sea, several from Azov Sea (Photo slide 1) and 15 specimens from Sea of Japan were examined. Specimens from other regions pictured in the referenced literature compared with the available ones.

To ensure the accuracy, the research was carried out mainly on the basis of analysis of mollusk shells from one and the same population. For this purpose, on summer of 2012 the author studied and collected *R. venosa* among local Blue Bay population in the vicinity of Sevastopol. Sampling author (Photo slide 2) held during snorkeling in a mask and flippers at depths of 5–8 m. The population living on sandy bottom is characterized with low degree of shells’ surface encrustation, which makes the cleaning of shells surface to be with the least possible effort. Of about 600 specimens collected and analyzed, up to 300 were selected for photography. The most informative pictures are illustrated in this paper. Photographing objects and their layout on the plateau were made. The images
on the plates brought to one scale. Captions to images contain the following information about specimen illustrated: sampling sight, sex (f: female; m: male; (?): sex unknown); age (years); shell height in mm.

As for *R. venosa*, obviously, the Blue Bay population can be divided into two fundamentally different groups based on the color patterns’ character: 1. with dark color of the spiral ribs from light brown to black (D-line), 2. with almost white spiral patterns, contrasting with the background color to varying degrees (W-line). We consider the color as character, and color variants as its state. Character is controlled by a gene, and the character states, by its alleles. The W-line and D-line allelomorphs background color can range from very dark to very light, which indicates that the background color and pattern are controlled by different genes. Based on the frequency of occurrence, we can conclude that the D-line specimens are correlated to a dominant allele and W-line, correlated to the recessive one. This could apply not only to the gene that determines the color of the spiral patterns, but also to the shell outer surface background. Despite the fact that the color of the background and the color of the spiral patterns (lines and stripes) are regulated by different genes, they primarily "work" in a similar mode. This is realized in the benefit connection of melanistic specimens with dominant (A) D-line alleles, and albinistic - with recessive (a) W-line allele.

Our studies allow asserting that typical form of the native range predominates in most populations of the Black Sea area (Photo 3). Among the Blue Bay population, more than 50% of individuals are the typical form, which represent the dominant (A) allele (Photo 4–6), another 25% are intermediate phenotype (Photo 7). Recessive (a) allele is responsible for the coloration of the spiral ridges, which was less than 25% of the total population (Photo 8). In other populations of the Black Sea, such individuals may be less or absent. Nevertheless, such individuals are present in most populations (Photo 9, 10). At present one specific dwarf population consisting only albinistic specimens was found in Azov Sea (Photo 1). The largest specimen (32.8 mm) of this population is shown on Photo 9 B. The finding of albinist dwarf population in the Sea of Azov suggests that a certain type of dwarfism associated with recessive color allele. In the Black Sea populations albinists generally were found among dwarf specimens, which also confirms the suggestion above.

The earlier albinism phenogenesis studies (Wright, 1916) shows that the basis of allelic changes are continuous gradation of the same morphogenetic factor (for example, the amount of matter or the reaction rate), operating with a threshold effect. Now our present research may serve as a confirmation of these conclusions.

All varieties of *R. venosa* shell outer part coloration and patterns are produced by two different genes, each of which has two (A, a) alleles.

**Annotation for photos:**

_**Photo 1:** Rapana venosa sampling sites (white stars): 1, Romanian coast; 2, northwestern Black Sea shelf; 3, Mezhvodnoye Bank; 4, Domuzlav region; 5, Sevastopol vicinity (Blue Bay, Lermontov Cap); 6, Laspee Bay; 7, Karadag mountains coast; 8, Kerch Strait region; 9, South Azov offshore

_**Photo 2:** The Author is ready to rapana sampling on Blue Bay shore, Sevastopol vicinity, Crimea.
Photo 3: *R. venosa* typical color form from different locations of the Black Sea: A: Romanian coast, (?)9; 107.5 mm; B: NW Black Sea, m6; 74 mm; C: Mezhvodnoye Bank, f5-6; 79.5 mm; D: Donuzlav, m9; 105 mm; E-F: Kerch Strait region; E: (?)5; 98 mm; F: (?)7; 99 mm; G: Karadag(?) 12-14; 135 mm

Photo 4: *R. venosa*, Blue Bay, “A”- line: A: f6; 75 mm; B: m4; 64.2 mm; C: m3; 64.2 mm; D: m3; 66.3 mm; E: m3; 75.2 mm; F: m3; 58 mm

Photo 5: *R. venosa*, Blue Bay, “A”- line: A: f3; 50.5 mm; B: f3; 66 mm; C: f2; 46 mm; D: f3-5; 67 mm; E: f3-4; 54 mm; F: f3; 59 mm; G: f6; 75.6 mm

Photo 6: *R. venosa*, Blue Bay, “A”- line: A: m5; 68 mm; B: m2; 47 mm; C: f3; 67 mm; D: m4; 70 mm; E: m4; 64.5 mm; F: m3; 62 mm; G: m3; 72.5 mm

Photo 7: *R. venosa*, Blue Bay, “intermediate” (A, B, E) & “mixed” (C, D, F, G) color forms: A: f3; 55 mm; B: f3; 59 mm; C: f4; 65 mm; D: m4; 54.5 mm; E: m5; 72.5 mm; F: f3; 72 mm; G: m4; 57 mm

Photo 8: *R. venosa*, Blue Bay, “a”- line: A: m3; 63 mm; B: m3; 64.5 mm; C: m4; 62 mm; D: m4; 63.5 mm; E: m4; 54 mm; F: m5; 49.2 mm; G: f3; 58.5 mm; H: m5-6; 66.5 mm; I: m8; 67 mm; J: m10; 67 mm; K: m4; 40 mm

Photo 9: *R. venosa*, different Black Sea regions, “a”- line: A: Kerch, m7; 92 mm; B: Azov, m8; 32.8 mm; C: G – Karadag: C: f3; 43.2 mm; D: m3; 77.5 mm; E: m3; 49.5 mm; F: m5; 45 mm; G: f3; 75 mm; H: Lermontov Cap: H: m4; 55.8 mm; I: f5; 44.5 mm; J: K: Laspee Bay: J: f3; 39 mm; K: f4: 38.5 mm

Photo 10: “a”- line large specimens: A: Crimea, m10–11; 135 mm; Far East, Sea of Japan, Posjet Bay (Russia), 155 mm

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