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COMPARATIVE ANALYSIS OF ADAPTIVE POTENTIAL OF RAPA (RAPANA VENOSA VALLENCIENNES, 1846) AND MUSSELS (MYTILUS GALLOPROVINCIALIS LAMARK, 1819) POPULATIONS FROM ONE BIOTOPE

The steadiness of individuals *R. venosa* and *M. galloprovincialis* to anhydrous environmental conditions were determined by the duration of their lives. The specimens of studied species had the same values of the minimum (two days) and maximum (seven days) lifetime in the extreme conditions but the varied pace death. The connection between the stability of mollusks to extreme environmental conditions with their size and weight indicators were shown. For *Rapana* the maximum of adaptive capacity to the extreme conditions manifested at the level of small-sized and younger individuals, in the case of mussels the large-sized specimens were more stable.

Keywords: *Rapana venosa*, *Mytilus galloprovincialis*, adaptive capacity, size and mass parameters

The Black Sea is characterized by a nearly complete set of factors that determine its high vulnerability; these factors contribute to the successful invasion of species - introducents [30]. This led to the emergence to the Black Sea ecosystem considerable number of alien species [8, 30, 32]. The negative consequences of introduction of a number introducents have become visible immediately after the invasion. One of the invasive species,which significantly disrupt the biological balance of the Black Sea ecosystem is Rapana (Rapana venosa Vallenciennes, 1846) [50]. This gastropod has a set of properties which provide him a successful invasion. T. J. Stohlgren and J. L. Schnase [48] and M. O. Son [23] indicate the following features of successful invasive species: 1) particular biology of the species, which helping to accelerate the resettlement, 2) the rapid pace of development and the achievement of reproductive age, and 3) a small number of enemies in the new habitat; 4) high productivity. To this list should be added that the invader usually takes free ecological niche and has high adaptability [7]. Rapa fully possesses all the above properties. The Rapana extreme adaptability and plasticity is evidenced by its resettlement in different regions of the oceans [39]. Rapana is characterized by resistance to hypoxia and polluted environment [28, 50], euryhalinity and eurythermal capabilities [5, 8, 42, 50]. In addition, individuals of this species are capable to prolonged starvation [8], are very resistant to parasitic infections [5] and have a high plasticity in relation to food consumption [29, 31, 46]. In the north-western part of the Black Sea the main power source for Rapana are mussels (*Mytilus galloprovincialis* Lamark, 1819) [16].

There are controversial, in our view, the proposal to use mussel farms for Rapana cultivation [9]. To assess the Rapana impact to the bivalves populations of the Black Sea substantial interest is a comparison of the environmental properties of these molluscs species because they are conjuncted components of trophic chain. In this connection the purpose of the present work was a comparative study of the adaptive capacity of Rapana and mussels, as well as the dependence of the stability of these species to unfavorable environmental conditions from their size and weight indicators.

Material and Methods

It is known that the adaptive capacity of species as a genetically caused ability to adapt to a wide range of environmental factors determines many properties, including biotic potential, ecological plasticity and stability. Qualitative and quantitative assessment of the adaptive capacity of the individuals of definite species can be achieved by investigating the organism's response to adverse (stressful) exposure at the biochemical and physiological levels. Analysis of the organisms' responses to environmental pollution it is widely used in monitoring [40, 41, 45].

In the present study the adaptive potential of mollusks was determined at acute experiment by their resistance to the conditions of the anhydrous medium, as described in [18]. The level of stability established on life expectancy of individuals in the extreme conditions of the experiment. It is well known that adaptation to environmental factors along with specific mechanisms is implemented with the participation of organism' non-specific responses. Used a test of survival, leading to hypoxia, violation of water-salt balance and starvation, can adequately display the total adaptive potential of animals.

Samples of mollusks were collected manually by divers near Small Fontain in Odessa Bay 50 meters away from the shore at the depth of 5-7 m. Rapa whelks and mussels were collected May 20, 2013. Air temperature in the collection day was 23° C, water surface temperatures - 17° C, at a depth at the location of clams - + 11 ° C. In total, to the experiment was taken 100 live specimens of each species inhabiting one biotope. During the experiment the temperature was controlled with an electronic thermal indicator LogTag. The average daily temperature was +22,6 ± 0,05 °C with fluctuations in the range of 20,6° C to 23,7 °C. Status of mussels was determined by the ability to hold the sash shell closed, status of rapa whelks - by reaction to stimulation of the leg muscles and soft body retention in the shell when shaken mollusks. Inspection clams are cleaned once a day. The curves of mortality were constructed based on the results of observations. The time of the experiment started is the day after the mollusks collection and putting them into anhydrous environment. Size and mass parameters of dead shellfish were determined. Linear dimensions were measured with calipers to the nearest 0.1 mm, the weight was measured on an electronic balance with an accuracy of 0.1 g. In mussel shells were measured length (L), the total weight of ($M_{M\text{-}\Sigma}$), the shell mass ($M_{M\text{-}P}$) and the wet weight of the soft body mussels ($M_{M\text{-}MT}$). For rapa whelks were determined height (H) and width (diameter) of the shell (W), the total weight of the shell ($M_{R\text{-}\Sigma}$), mass shell ($M_{P\text{-}P}$) and wet weight of the soft body ($M_{P\text{-}MT}$). To remove the body of Rapa from shells was used method of deep-frozen (-28 ° C up) then clams were thawed and soft body was removed from the shell. To study the habit of mussels used the following indicators: the fatness factor ($K_{fat} = 100 \times M_{M\text{-}MT} / L^3$, where the mass of soft body in grams, shell length - in cm), the ratio of wet weight of the soft body to the total weight of the animal ($M_{M\text{-}MT} / M_{M\text{-}\Sigma} \times 100\%$), ponderosity of shell as ratio of shell weight to its length ($M_{M\ P}$ / L, where the mass of the shell in grams, length - in cm.).

When analyzing the Rapa habit were determined such indicators as the ratio of the width of the shell to its height (W / H × 100%), the ratio of wet weight of the soft body to the total weight of the animal ($M_{P\text{-}MT}$ / $M_{P\text{-}\Sigma}$ × 100%), fatness factor (K_{fat} = 100 × $M_{P\text{-}MT}$ / H^3, where the mass of the soft body in a grams, the height of the shell - in cm) and ponderosity of shell ratio of shall weight to its height ($M_{P\text{-}P}$ / H, where the mass of the shell in grams, height - in cm). Age of mollusks was determined by the annual spawning marks on the shell [27, 28]. Since the first mark formed in spawning age 2+ to shell with a certain number of marks added 2 years.

The comparison of mortality curves of investigated species of mollusks and the dynamics of changes in the size-mass indexes were carried out on the basis of the criterion χ^2 [1]. The conjugacy between morphometric parameters, age of individuals and their exposure lifetime under anhydrous conditions were analyzed on the basis of the calculation of Spearman rank correlation coefficient adjusted for the presence of groups of the same rank [22]. Null hypothesis is rejected at the 0.05 level.

Results and discussion

Specific features of the stability of mollusks in an anhydrous medium. Dynamics of survival under anhydrous conditions of the mussels and rapa whelks taken from one habitat are shown in Fig. 1.

For the both species of mollusks the minimum and maximum lifespan under the specified conditions were the same: 2 and 7 days, respectively. However, death rates of investigated mollusks have been uneven, and significant difference in mortality curves beetween mussels and rapa whelks have been shown (χ^2=13,22; *df*=6; *p*< 0,05). Thus, on the third day 6% of mussels have died, while the mortality of rapa whelks at this point had reached 13%. In the following two days the death of mussels increased sharply and exceeded this index of Rapana. In the step of mass mortality (4-5 days) 73% of the rapa whelks individuals died, while for the mussel this value was 90%. As a result, the time of death of half of the animals (LD50) was 3.8 days for the mussels and 4.1 days for rapa whelks.

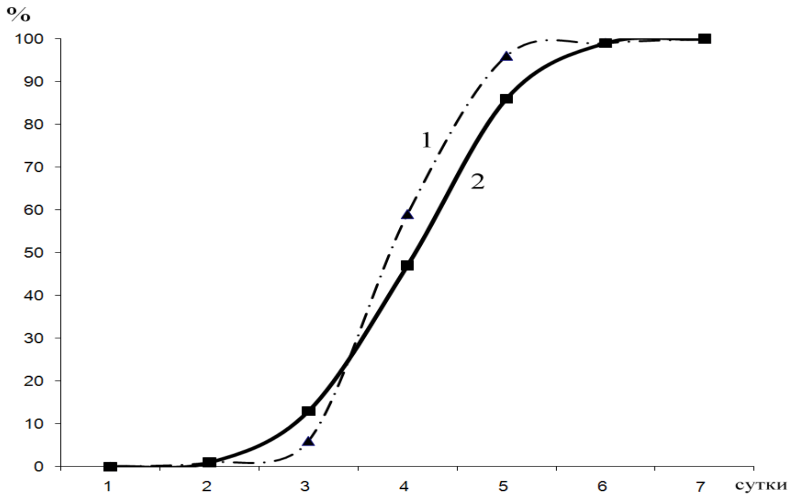

Fig. 1. The curves of mortality clams under anhydrous conditions: 1 - mussels, 2 - brine; on the x-axis - the duration of the exposure of shellfish in anhydrous medium (day),% - the proportion of individuals who died to a certain point of the experiment

Analyzing the results, it should be noted that the lifetime of mussels from investigated biotope under anhydrous conditions is insignificant and occurs at a minimum value (up to 7 days), obtained by other authors [18, 36]. This may be connected both with increased contamination of the Odessa Gulf, and with non-optimal temperature conditions of the experiment. The dependence on environment pollution, physiological condition and stability of mollusks to various adverse conditions has been shown by many authors [13, 14, 18, 24, 36, 44, 49]. The optimum temperature for growth and development of investigated mollusks ranges from 15-18 up to 20 °C [19, 37, 38]; and at a water temperature above 20 ° C the significant inhibition of the physiological activity of the Black sea mussels occurs, which expressed in particular in suppression filtering process [25, 33].

The dependence of the mollusks' mortality in an anhydrous medium on their size and mass parameters. Sex ratio in the initial sample of *Rapana* is statistically consistent with 1: 1 (58 males, 42 females, χ^2= 2,64, p> 0,05). The investigated set of rapa whelks individuals was quite homogeneous by age: mollusks of age 4–4+ were 78%, individuals of age 3–3+ and 5 years were 4% and 18%, respectively. This suggests that the detected patterns are primarily determined by linear-weight indices of individuals and is generally indicative for the mature adult representatives of this type of mollusk.

The correlation analysis between morphometric parameters of mollusks and their survival rates was performed. The correlation coefficient between investigated indices of the mollusks of experimental sample and the life expectancy of individuals under anhydrous conditions was determined (Table 1).

Table 1

The conjugacy between morphometric parameters of mollusks with their survival under anhydrous conditions

Morphometric parameters	The coefficient r_s	The level of significance p
Rapana		
Total weight	– 0,28	< 0,01
The weight of the soft body	– 0,31	< 0,01
The proportion of the soft body on the total weight	– 0,23	< 0,05
The fatness	– 0,23	< 0,05
The height of the shell	– 0,20	= 0,05
The width of the shell	– 0,20	= 0,05
The ratio of the width to the height of the shell	+ 0,20	= 0,05
The ponderosity of the shell	– 0,10	> 0,05, not significantly
Mytilus		
The length of the shell	+ 0,24	< 0,05
Total weight	+ 0,15	> 0,05, not significantly
The weight of the soft body	– 0,01	> 0,05, not significantly
The proportion of the soft body on the total weight	– 0,22	< 0,05
The fatness	– 0,22	< 0,05
The ponderosity of the shell	+ 0,15	> 0,05, not significantly

Note: r_s – Spearman coefficient, p – the probability of the null hypothesis

As can be seen from the data for a number of linear-mass parameters of mollusks were detected a weak but statistically significant correlation with resistance to water-free environment. If reduction of weight and soft body fatness can be attributed to the depletion of mollusks related to the lack of feed, the correlation between the size of shell with a high resistance to water-free environment may indicate adaptation benefits individuals with certain size and weight indicators. And for rapana it was traced the negative correlation between shell size and surviving of mollusk; for mussel, in contrast, a higher resistance to the terms of the anhydrous medium was observed for larger individuals. Many researchers note the adaptive significance of size and mass parameters of the soft body and shell for different kinds of bivalves and gastropods [3, 4, 15, 17, 34, 35, 43].

To confirm our assumptions in addition to the correlation analysis the comparing the variational ranks with the help of the Pearson χ^2 test was performed. In accordance with the dynamics of mortality study population of rapa whelks were divided into three groups: 1 - individuals who died in the initial stages of the experiment (2 and 3 days), 2 - individuals who died in the period of mass mortality (4 and 5 days), 3 - individuals who died in later stages of the experiment (day 6 and 7).

In the 4th and 5th day were died the vast majority of mussels (90%); the groups of individuals who died in the early (2-3 days) and the final stages (6-7 hours) were too small (4 and 6 individuals, respectively). In this regard, for further analysis the investigated population of mussels were divided into two groups. The first group included mussels, died in the first half of the experiment (2-4 days), the second - includes a long-lived bivalves (5-7 days).

For all initial set and for each experimental group were built a variational ranks. The significance of differences between the variational rows were determined at pair-wise comparison of different groups (tables 2, 3).

Statistical analysis of variational ranks generally confirmed the results of the correlation analysis. From Table 2 shows that within the group of the most long-lived Rapana individuals on the majority investigated morphometric parameters increased the proportion of classes with the minimum values.

Table 2

Variational ranks of morphometric parameters of groups of *R. venosa* individuals with different resistance to the conditions of the anhydrous medium

Total weight (g)

Classes	40,1–55,0	55,1–70,0	70,1–85,0	85,1–100,0	100,1–115,0	115,1–130,0	Compared groups of individuals			
							Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	1,0	13,0	**45,0**	**33,0**	7,0	1,0				
1	0,0	7,7	**38,5**	**38,5**	**7,7**	**7,6**	8,38$^{=}$	10,33$^{=}$	**33,71*****	
2	1,4	11,0	**45,2**	**34,3**	8,2	0,0	1,34$^{=}$			**20,61*****
3	0,0	**28,6**	**50,0**	21,4	0,0	0,0	**17,59****			

The mass of soft body (g)

Classes	10,1–20,0	20,1 – 30,0	30,1 – 40,0	40,1 – 50,0	50,1 – 60,0	Compared groups of individuals			
						Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	1,0	25,0	**53,0**	19,0	2,0				
1	0,0	23,1	**38,5**	**30,8**	**7,6**	9,44$^{=}$	**15,68****	**37,01*****	
2	1,4	19,1	**58,9**	20,6	0,0	3,23$^{=}$			**32,69*****
3	0,0	**57,2**	**35,7**	7,1	0,0	**24,41*****			

Ratio of the weight of the soft body on the total weight (%)

Classes	25,1 – 32,0	32,1 – 39,0	39,1 – 46,0	46,1 – 53,0	53.1 – 60.0	Compared groups of individuals			
						Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	3,0	18,0	**67,0**	9,0	3,0				
1	0,0	7,7	**84,6**	7,7	0,0	**12,27***	**12,94***	**38,16*****	
2	2,7	16,4	**65,8**	11,0	4,1	2,02$^{=}$			**24,71*****
3	**7,1**	**35,7**	**57,2**	**0,0**	0,0	**20,27****			

Fatness

Classes	4,1 – 5,4	5,5 – 6,8	6,9 – 8,2	8,3 – 9,6	9,7 – 11,0	11,1 – 12,4	Compared groups of individuals			
							Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	8,0	**35,0**	**40,0**	15,0	1,0	1,0				
1	0,0	**23,1**	**53,8**	**23,1**	0,0	0,0	**16,2****	**12,74***	**45,43*****	
2	6,8	**38,4**	**35,6**	**16,4**	1,4	1,4	0,68$^{=}$			**30,54*****
3	**21,4**	**28,6**	**50,0**	**0,0**	0,0	0,0	**24,89*****			

The height of the the shell (mm)

Classes	65,1– 70,0	70,1–75,0	75,1 – 80,0	80,1 – 85,0	85,0 – 90,0	Compared groups of individuals			
						Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	1,0	21,0	**45,0**	26,0	7,0				
1	0,0	23,0	**46,2**	**15,4**	**15,4**	6,97$^{=}$	**8,33**$^{=}$	**24,2*****	
2	0,0	17,8	**45,2**	**30,1**	6,8	1,56$^{=}$			**22,76*****
3	**7,7**	**30,7**	**46,2**	15,4	0,0	**16,71*****			

The shell width (mm)

Classes	55,1–60.0	60,1–65,0	65,1–70,0	70,1– 75,0	Compared groups of individuals			
					Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	4,0	**38,0**	**43,0**	15,0				
1	0,0	**38,5**	**46,2**	15,3	4,12$^{=}$	4,20$^{=}$	**8,72***	
2	4,1	**37,0**	**43,8**	15,1	0,02$^{=}$			2,09$^{=}$
3	**7,1**	**42,9**	**35,7**	14,3	1,86$^{=}$			

The ratio of the width of the shell to its height (%)

Classes	75,1 – 80,0	80,1 – 85,0	85,1 – 90,0	90,1 – 95,0	Compared groups of individuals			
					Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	11,0	**49,0**	**38,0**	2,0				
1	15,3	**38,5**	**46,2**	0,0	4,76	**9,09***	2,64	
2	9,6	**54,8**	**32,9**	2,7	0,89			**18,36****
3	14,3	28,6	**57,1**	0,0	**11,63****			

The ponderosity of the shell

Classes	3,4 – 4,2	4,3– 5,1	5,2–6,0	6,1 – 6,9	7,0 – 7,8	7,9 – 8,7	Compared groups of individuals			
							Initial group and 1	1 и 2	1 и 3	2 и 3
The initial totality	4,0	13,0	**35,0**	**32,0**	11,0	5,0				
1	0,0	7,7	**30,8**	**38,5**	**15,4**	**7,7**	7,53$^{=}$	2,86$^{=}$	**11,24***	
2	4,1	13,7	**35,6**	**30,1**	12,3	4,1	0,24$^{=}$			**14,45***
3	**7,1**	**14,3**	**35,7**	**35,7**	0,0	7,1	**12,54***			

Note. Here and in the Table 3: a comparison of groups of individuals are indicated in the respective cells obtained values χ^2 and confidence level in the degree of freedom n - 1; = - There is no difference; *, **, *** - P <0.05, 0.01 and 0.001, respectively; the number of individuals in the two groups: the original totality - 100, Group 1 - 13, group 2 - 73, Group 3 - 14; bold marked modal classes of variational ranks and classes, demonstrating a shift of distribution

In the group of more stable Rapana the frequency of the class with a flattened shells increased (the ratio of 85,1-90,0%). The maximum deviation of indicators from the modal values for the whole studied rapa whelks population were observed in the initial period, and particularly in the final stages of animal deaths. The period of mass deaths of individuals covered all size and mass groups about evenly.

Analysis of mussels, different by stability to the terms of the anhydrous environment, showed that the most significant differences were detected between two groups, which were established in experiment - quickly perished and longer-lived organisms (Table 3).

Table 3

Variation ranks of morphometric parameters of the *M. galloprovincialis* groups with different resistance to the conditions of the anhydrous environment

Total weight (g)

Classes	7,1–11,1	11,1–15,0	15,0–19,0	19,1– 3,0	23,1–27,0	Compared groups of individuals	
The initial totality	31,0	**41,0**	20,0	5,0	3,0	Initial group and 1	1 и 2
1	28,8	**42,1**	25,4	3,4	0,0	4,05$^{=}$	**10,67***
2	26,8	**46,3**	14,7	4,9	**7,3**	3,23$^{=}$	

The mass of soft body (g)

Classes	2,1 – 4,0	4,1 – 6,0	6,1 – 8,0	8,1 – 10,0	Compared groups of individuals	
The initial totality	30,0	53,0	13,0	4,0	исходная и	1 и 2
1	27,1	57,6	10,2	5,1	0,81$^{=}$	4,77$^{=}$
2	34,2	46,3	17,1	2,4	1,69$^{=}$	

Ratio of the weight of the soft body on the total weight (%)

Classes	10,1–20,0	20,1–30,0	30,1–40,0	40,1–50,0	50,1–60,0	60,1–70,0	Compared groups of individuals	
The initial totality	1,0	12,0	**63,0**	21,0	2,0	1,0	Initial group and 1	1 и 2
1	1,7	11,9	**55,9**	25,4	3,4	1,7	1,57$^{=}$	**12,04***
2	0,0	12,2	**73,2**	**14,6**	**0,0**	0,0	1,69$^{=}$	

Fatness

Classes	1,0 – 1,7	1,8 – 2,6	2,7 – 3,4	3,5 – 4,2	4,3 – 5,0	5,1 – 5,8	Compared groups of individuals	
The initial totality	16,0	**57,0**	24,0	1,0	1,0	1,0	Initial group and 1	1 и 2
1	13,5	**45,8**	35,6	1,7	1,7	1,7	4,23$^{=}$	**31,17****
2	19,5	**73,2**	**7,3**	**0,0**	0,0	0,0	**14,27***	

The shell length (mm)

Classes	47,1–54,0	54,1–61,0	61,1–68,0	68,1–75,0	75,1–82,0	Compared groups of individuals	
The initial totality	10,0	**51,0**	25,0	13,0	1,0	Initial group and 1	1 и 2
1	**15,2**	**49,2**	27,1	**8,5**	**0,0**	3,13$^{=}$	**16,76****
2	2,4	**53,7**	22,0	**19,5**	**2,4**	6,80$^{=}$	

The ponderosity of the shell

Classes	0,7 – 1,3	1,4 – 2,0	2,1 – 2,7	Compared groups of individuals	
The initial totality	49,0	46,0	5,0	Initial group and 1	1 и 2
1	45,7	50,9	3,4	0,67$^{=}$	3,64$^{=}$
2	53,7	39,0	7,3	1,22$^{=}$	

Note: The number of individuals in the two groups: the original totality - 100, group 1 - 59, group 2 – 41

A significant association of resistance to adverse environmental conditions was detected with the length of the shell, as well as the relative values characterizing the weight (soft body mass fraction and fatness).

Thus, on the basis of the obtained data it can be assumed that mollusks with different morphometric parameters had varied in survival in an anhydrous environment, i.e. had different adaptive potential.

Currently under the influence of primarily human factors many species, including mollusks undergo certain transformations. So, the main manifestations of R. venosa adaptation to modern conditions of the Black Sea are the slowdown in growth, reducing the size of individuals and size at which puberty occurs [3, 21, 27, 28].

I. P. Bondarev [3] notes, that the dwarf form of rapana demonstrates higher level of ability to survive in the current environmental situation than the typical form. For the Black Sea mussels has been shown such form of adaptation as to accelerate the growth and increase in the average length of individuals [34]. This trend can be seen for the recent decades.

Identified in this study distinctions in different Rapana and mussels morphometric parameters and their influence on stability of mollusks in anhydrous conditions are consistent with literature data about the association between mollusks' morphometric parameters and their adaptive capacity in natural environment. in this work were established that the maximum adaptive capacity of Rapana manifested at the level of small-sized individuals in experimental conditions; this fact corresponds the same trend for natural conditions of the Black Sea. Perhaps this explains the high invasiveness of Rapana and expressed depression of other species(oysters and mussels) under the Black Sea.

It is known that the balance in the "predator-prey" is not established instantly and automatically. It is established as a result of long-term adaptation of species to each other and to their environment, so that natural enemies do not destroy completely the population of its prey. When species appear in the ecosystem from the other communities, the balance between populations often becomes impossible. To establish the balance between predator and prey populations must have differences of predators and prey on fertility, adaptive reactivity and the rate of accumulation inadaptive cargo [20]. Comparing the environmental properties of Rapana and mussels following can be noted:

1) Rapana as a predator does not have any competing species in the Black Sea.

2) This gastropod in adulthood has no enemies in the surveyed area (excluding humans); pelagic stage of Rapana is in virtually the same position with the mussels.

3) Rapana biotic potential is comparable with that of mussels. One female of Rapana produces 180-400 thousand of eggs per season [5], the fertility of mussels is 2-10 million of eggs [33]. However, rapa whelks had internal fertilization; mussels had external which greatly reduces effectiveness of their fertilization. As a result, in the northwestern part of the Black Sea the number of surviving juvenile mussels is not more than 5000 individuals from one female [33]. Furthermore, eggs and larvae of the Rapana are protected in the form of purple [28].

4) Rapana, thanks to a sufficiently high mobility, developed muscles for opening the valves of bivalve, the presence of a paralyzing poison, and a drilling apparatus, is a very successful hunter.

5) Rapana, in the case of depletion of the food base, can easily switch to other sources of food.

6) Rapana, like mussels, tolerates to significant variations in salinity. As shown in this study, the resistance to such an important factor in the northwestern part of the Black Sea as a pestilence in Rapana higher than that of mussels. All this testifies to the fact that in general Rapana is not inferior to mussels by its adaptive capacity.

Formal analysis of the famous Lotka-Volterra equations, based on the correlation of predator and prey properties, shows that such a system cannot be a stable equilibrium state [2]. In a system with low species diversity (and such is the north-western part of the Black Sea) with significant biotic potential and high adaptability of the predator arise perturbation with very large amplitude and it is almost impossible to return the system to a stable state. Reality confirms this conclusion. The appearance in the Black Sea such alien species as Rapana not only led to the destruction of the native bivalves in many regions, but also was one of the major causes of the violation of bottom biocenoses [6, 10, 11, 47].

Conclusion

The study of the stability of the Black Sea Rapana to the conditions of an anhydrous environment can be concluded that the introducent not only do not gives mussels their adaptive capacity, but in some ways surpasses it. The combination of high resistance to adverse environmental conditions with great fecundity, voracity and rapid change of food priorities makes *R. venosa* dangerous invader.

Considering the above, it is unlikely to expect that this gastropod predator without scientifically grounded control of its population may start with a stable equilibrium by consumers of a lower order. Consequently the invasion of Rapana causes material breach of existing ecosystems [12, 26, 50].

Studies show that not only in the case of a lack of food base [15], but also in unfavorable abiotic environmental conditions the general adaptive strategy of R. venosa serves reducing the size of individuals. As a result, violating ecological system and realizing the main way of adapting to external conditions, Rapana itself loses value as commercial object.

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