

## Age and size characteristics of alien mollusks *Viviparus viviparus* L. in the coastal thanatocoenosis of Novosibirsk reservoir

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*Viviparus viviparus* L. is the most numerous alien species of the Novosibirsk reservoir. In some parts of the reservoir *V. viviparus* creates settlements with a very high density. After the death of mollusks in the bottom sediments and on the banks of the reservoir, large areas of accumulation of empty shells are formed. Due to their strong structure, the shells are poorly decomposed and can serve as a generalized indicator of the state of the mollusk population over a long time. We analyzed the size and age characteristics of the *V. viviparus* shells in thanatocenoses of the Novosibirsk reservoir coast. Empty shells of river snails were collected on the shores of the middle (near the village of Chingis, Ordynskoye and in the Karakansky Bay) and the lower (near the village of Borovoye, Bystrovka, Leninsky and in the Berdsky Bay) parts of the Novosibirsk Reservoir in May, 24–26, 2018. Shells height and width were measured with an electronic caliper with an accuracy of 0.1 mm. Age of mollusks was determined by the marks of a winter growth stop on the shell. It is shown that in the thanatocenoses of the middle part and in the bays of the reservoir, shells of young mollusks (the second and third years of life) prevailed. In the lower part of the reservoir, the coastal thanatocoenosis contained larger shells of adult mollusks (fourth and fifth years of life). In general, the most of *V. viviparus* individuals in the Novosibirsk reservoir die before they reach the age limit. It is suggested that the premature death of most river snails can be caused by significant seasonal fluctuations in the water level of the reservoir, during which the littoral is drained.

**Key words:** Invasion; River basin of the Ob; Mollusk; Shells; Thanatocenoses

### Introduction

*Viviparus viviparus* L. is a West-Palaearctic species with a wide distribution area in Europe. In the water bodies of the Ob-Irtysh river basin *V. viviparus* was first noted in 1994, in the Bukhtarma reservoir (Devyatkov, 2009). In subsequent decades, river snails actively dispersed in the Ob-Irtysh basin. In the late 1990s, *V. viviparus* was noted in the Novosibirsk reservoir, in 2003 in the Shulba reservoir, in 2009 it was found in a small reservoir of Irtysh river basin near Tobolsk, in 2015 in the river Tura near Tyumen (Devyatkov, 2004; Andreev et al., 2008; Vinarsky et al., 2015; Babushkin and Vinarsky, 2017). All of these habitats of the *V. viviparus* (except for the Bukhtarminsky and the Shulba reservoirs) are not connected by water. Most likely, *V. viviparus* was dispersed in the Ob River basin by water transport (Yanygina, 2017).

The establishment of alien species in new waterbodies can be accompanied by a sharp increase in the abundance of invader (Biological ..., 2004). These "environmental explosions" are associated with consumption by invaders a trophic resources, which are not unclaimed by native species, as well as it associated with weak biotic interactions with aboriginal species (for example, weak competition or lack of parasites). When biotic relationships become aggravated, the abundance of an alien species decreases, and the population stabilizes at a new level (Karpevich, 1975).

The establishment of *V. viviparus* in the Novosibirsk reservoir was also accompanied by a sharp increase in abundance and biomass. In the central part of the reservoir, biomass of *V. viviparus* reached 16,000 g/m<sup>2</sup> (Yanygina, Vizer, 2018), and its average values were 811 g/m<sup>2</sup> in 2018 (Yanygina, 2019). *V. viviparus* is characterized by a relatively long life cycle: according to various literature, it ranges from 4 to 10 years (Jakubik, 2007; Berezkina, Arakelova, 2010). With the death of part of the *V. viviparus* population and the decomposition of zoomasses, a significant amount of organic substances gets into the water.

In addition, a large number of *V. viviparus* individuals die annually with a periodic reduction of the water level in the reservoir and drying of the littoral. To predict local changes in water quality associated with the entry into the reservoir of organic and biogenic substances during the decomposition of *V. viviparus* L., it is necessary to know about the dimensional characteristics of dead mollusks. The purpose of this work was to analyze size and age characteristics of *V. viviparus* L. shells, which washed up on the shore of the Novosibirsk reservoir.

### Materials and Methods

Novosibirsk Reservoir is the only reservoir on the Ob river. It's a large lowland reservoir with a length of about 200 km. Its area is 1,070 km<sup>2</sup> and its volume is 8.8 km<sup>3</sup>. Its average depth is 8.3 m. One of the tasks of the reservoir is the seasonal regulation of the Ob river drain. Declining water level in the reservoir occurs in the autumn-winter period, while about 30% of the reservoir is drained (Long-term dynamics ..., 2014). The material for this work was collected on May 24–26, 2018 in Novosibirsk reservoir near the villages of Chingis, Ordynskoye, Borovoe, in the island near the village of Bystrovka and as well as in the Karakan and Berdsky bays (Table 1). During the period under study the water temperature in different parts of the reservoir varied from 8.6 to 11.0° C. Empty

shells of *V. viviparus* were collected on the banks of the reservoir. At each site, we selected three points (in the center, on the left and right side of the coast), from which all mollusks were collected. The shell height and width were measured using an electronic caliper. When analyzing the dimensional structure, the shells of *V. viviparus* were sorted into 7 size classes: 1 class – with the shell height less than 10.0 mm; 2 class – 10.1–15.0 mm; 3 class – 15.1–20.0 mm; 4 class – 20.1–25.0 mm; 5 class – 25.1–30.0 mm; 6 class – 30.1–35.0 mm and 7 class – with the shell height more than 35.1 mm.

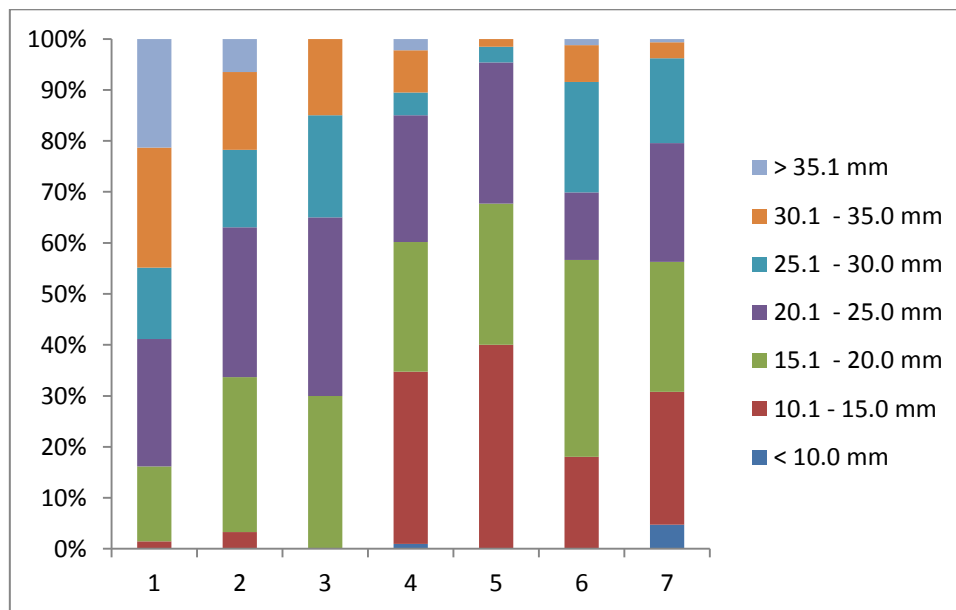
Age of mollusks was determined by the marks of a winter growth stop on the shell. A total of 1028 shells of *V. viviparus* were examined.

**Table 1.** Coordinates of sampling sites and data regarding the number of collected shells

Nº	Sampling sites	GPS coordinates	Number of shells
1	Borovoe	54°39'34N 89°82'34E	136
2	Leninskoe	54°49'21N 82°53'15E	92
3	Island near the village of Bystrovka	54°30'30 N 82°24,26E	20
4	Chingis	54°07'45N 81°35'38E	314
5	Karakan bay	54°29,50N 82°25'00E	65
6	Berdsy bay	54°47'39N 83°04'30E	83
7	Ordynskoye	54°21'27N 81°55'41E	318
<b>A total number of shells</b>			<b>1028</b>

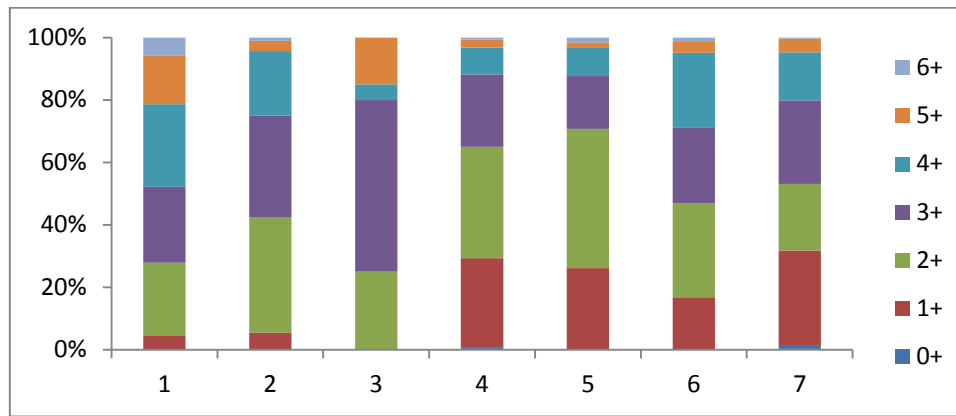
## Results and Discussion

The shell height of *V. viviparus* in thanatocenoses of the Novosibirsk Reservoir varied from 8.8 mm to 46.2 mm. Shells of the first size class (< 10.0 mm) composed 1.75% of the total number of shells (Figure 1). They were noted only in the areas located in the middle part of the reservoir (near the villages of Chingis and Ordynskoye). Shells of the second size class (10.1–15.0 mm) were also widely represented in the middle part of the reservoir and in the bays, where their share reached 22.9–25.8% of the total number of shells. Larger shells (6–7 size class) were found mainly in the lower part of the reservoir (near the villages of Borovoye, Bystrovka and Leninskoe). On the sandy beach near the village of Borovoe fraction of large shells reached 45%. In general, in the thanatocenoses of the middle part of the reservoir and in the bays, small shells (2–3 size classes) reach the largest numbers, while in the lower part of the reservoir larger shells (4–7 size classes) were dominated.



**Figure 1.** Size structure of *Viviparus viviparus* L. in the thanatocoenosis of Novosibirsk reservoir

Analysis of the age structure of the collected shells showed that the maximum life span of *V. viviparus* in the Novosibirsk reservoir is 6 years, which corresponds to the literature data of other authors for this reservoir (Kuzmenkin, 2014) and for reservoirs in the European part of Russia (Berezkina & Arakelova, 2010). In general, the age structure of *V. viviparus* in the thanatocenoses of the Novosibirsk reservoir corresponded to the size structure. In all sampling sites of the reservoir, the minimal fraction (0–1.6%) were mollusk shells of the first year of life (Figure 2). This may be due to the collection of shells in spring at a relatively low temperature of water, which led to low reproduction rates of *V. viviparus* during this period. In addition, the shells of mollusks of the first year of life are very fragile, they are easily frayed even on sandy soils; therefore, shells of only recently dead individuals are found in thanatocenoses. In general, shells of young mollusks (second (1+) and third (2+) years of life) prevailed in the thanatocenoses of the upper part of the reservoir and bays. *V. viviparus* can reproduce at the beginning of the third year of life (Berezkina & Arakelova, 2010), respectively, about 20–30% of individuals in these areas die before achieving the reproductive age. Shells of more adult mollusks (age 3+ – 4+) predominate on the coast of the reservoir lower part.



**Figure 2.** Age structure of *Viviparus viviparus* L. in the thanatocoenosis of Novosibirsk reservoir

Based on the data obtained in the course of studies on the life span of *V. viviparus*, it should be noted that only a small part of the population of mollusks lives up to its age limit. In the middle part of the reservoir near the village of Chingis and in the Karakan Bay, the share of mollusks that died at the age of 4 years or more is only 12%. And only in the thanatocoenoses of the lower part of the reservoir near village of Borovoe the proportion of such mollusks reaches 47.8%. A high proportion of young shells in the thanatocoenoses may be associated with a significant decrease in the reservoir water level during the fall-winter empty. In the spring, after the snow melts and before the reservoir is filled to the normal maximum operating level, these parts of littoral dry out, and the mollusks located on them partially die (Vizer, 2011).

## Conclusion

Age and size structure of *V. viviparus* shells in thanatocoenosis of various parts of the Novosibirsk reservoir indicates about death of a significant part of the population of mollusk didn't reaching the age limit. In the middle part of the reservoir and in the bays, about 20–30% of dead mollusks are individuals who have not reached the reproductive age. Premature death of mollusks may be associated with significant seasonal fluctuations in the water level of the reservoir, which leads to the draying of the littoral.

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