

Some Biological Characteristics of the Primorsky Scallop Cultivated in the Area of the Oil Terminal in Kozmino Bay (Nakhodka Bay, Sea of Japan)

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Abstract. Monitoring of the impact of the production activities of oil ports on the water area in general and on the hydrobionts living there, in particular, is a subject of the great attention. Some biological characteristics of the Primorsky scallop, grown by the hanging method at the experimental site in the conditions of the Kozmino bay were studied. Individuals of the same age of different generations were subjected to biological analysis. A comparative study of the size and weight characteristics showed that in the 2016 generation, the average shell height was higher, but the average total mass was higher in the 2015 generation of mollusks, which is due to the uneven growth of the shell of mollusks. Based on the research, it can be concluded that the size and weight characteristics correspond to the standard growth indicators for the scallop of the studied age groups, which indicates favorable living conditions for cultivated mollusks.

1 Introduction

Special marine oil port Kozmino Ltd. is located in the water area of the Kozmino bay of the Sea of Japan and, in terms of environmental impact, is a potentially hazardous facility that requires regular monitoring in order to timely identify and eliminate possible pollution. The monitoring program of the impact of the oil port's production activity on the natural ecosystem of Kozmino bay included monitoring of the state of the Primorsky scallop, which allows monitoring the state of the environment and is one of the methods for assessing and controlling the industrial pollution [1-7]. Marine invertebrates are known to be influenced by pollution and other unfavorable environmental factors throughout their entire life cycle [8-22].

In October 2010, to conduct biomonitoring in the water area of Kozmino bay, an experimental test farm was built in 250 meters from the oil terminal for the cultivation of marine hydrobionts [1]. 10,000 Primorsky scallops were planted in the cages, which became the basis for the future mariculture site. The planting of the scallop and the installation of the ridges of the landfill were carried out by specialists from the Pacific Institute of Bioorganic

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Chemistry, Far Eastern Branch of the Russian Academy of Sciences. They also carried out the first study in 2010 to assess the ecological state of the water area, taking samples of soil, sea water, and scallop tissues (after a month's exposure in the cages of the landfill) [1]. Monitoring of the state of the water area of the Kozmino bay is carried out regularly [1, 3, 6, 7].

A goal of the research was to study some biological characteristics of the Primorsky scallop, grown by the hanging method in the conditions of the Kozmino bay in 2015 – 2018.

To achieve this goal, it was necessary to study the size and weight composition, to characterize the dependence of shell height - total mass, to study the gender ratio and to compare some biological parameters of the scallop of the studied generations.

2 Research materials and methods

This study is based on the data collected in part by the author and employees of the OGBTS Transneft “Port-Kozmino” service area, at the experimental training ground for growing the hydrobionts, located in the Kozmino bay. Kozmino bay juts out into the eastern shore of Nakhodka Bay between Kozmino and Krylov capes, which protrude 1.9 and 2.8 miles northwest of Petrovsky cape, respectively. Nakhodka Bay is a bay in the eastern part of the Peter the Great Bay (in the Sea of Japan), located between Sredny and Krylov capes.

In the Kozmino bay, at the mariculture site, two hydro-biotechnical installations with cages for growing a scallop, were mounted near the port oil pier taking into account the current biotechnologies [23-30].

100 individuals of two generations - 2015 and 2016 - were taken for biological analysis. The shell height, total mass of the mollusk, shell mass, and age were determined for the samples of the coastal scallop.

Linear data were measured with a vernier caliper with an accuracy of 1 mm. The mass of the scallop was determined using a balance with an accuracy of 1 g.

3 Research results

Within the framework of monitoring the scallop condition, in response to changing environmental conditions, a comparison is usually made of individuals of the same age of different generations. For this, individuals of each generation are selected annually and their size and weight characteristics are determined. Based on the data obtained, the average values of the shell height and weight of the individual are calculated.

3.1 Dimensional composition

In 2015, the size of the yearlings of the Primorsky scallop from Kozmino bay varied in the range of 31-51 mm; the average value of the shell height was 41.5 mm, individuals with a size of 39–43 mm prevailed in the modal class (Table 1), they accounted for 38%. In the 2015 generation, the shell sizes of two-year-old scallops were 67–93 mm; the modal class was dominated by individuals with a shell height of 74–79 mm (36%) (Table 1). Three-year-olds had shell heights of 85-126 mm. Mollusks with a size of 105-114 mm predominated, accounting for 52%. (Table 1).

In the 2016 generation of the coastal scallop, individuals with a shell sizes of 37-51 mm were observed among yearlings. The modal class consisted of mollusks of 44-48 mm, 57% (Table 1). The shell sizes of two-year-olds of the same generation were 59-94 mm, the average value was 82.9 ± 0.51 mm. Mollusks with a heights of 80-84 mm (38%)

predominated. Three-year-olds had shell heights of 90-132 mm, about 50% of the total number of mollusks accounted for individuals with a size of 105-114 mm (Table 1).

Table 1. Primorsky scallop shell height, mm.

Generation of 2015	n, ind.	X max	X min	$\bar{x} \pm mx$
	100	52	31	41,5±0,29
	100	93	67	78,9±0,5
	100	126	85	109,7±0,69
Generation of 2016	100	51	37	43,6±0,21
	100	94	59	82,9±0,51
	100	132	90	111,4±0,68

3.2 Weight composition

The weight composition of the yearlings of the Primorsky scallop from Kozmino bay in the 2015 generation varied from 20 to 43 g, the modal class was formed by mollusks weighing 35–39 g (28%) (Table 2). In two-year-olds, the weight varied from 54 to 135 g, individuals with a weight of 80-99 g (26%) dominated (Table 2). Three-year-olds had a mass of 79-287 g, the modal class included mollusks weighing 170-199 g (41%).

In the 2016 generation, yearlings weighed from 21 to 40 g, mollusks with a weight of 20-34 g dominated (36%) (Table 2). Two-year-olds of the same generation, weighed from 43 to 103 g. The modal class was represented by specimens of 70-79 g, they accounted for 47%. The weights of three-year-olds varied in the range of 118-332 g, the dominant size group was represented in weight from 170 to 199 g (37%).

Table 2. Total mass of Primorsky scallop, g.

Generation of 2015	n (ind.)	X max	X min	$x \pm m$
	100	43	20	31,9±0,4
	100	135	54	87,2±1,3
	100	287	79	190,1±3
Generation of 2016	100	40	21	30,9±0,3
	100	103	43	80,8±0,6
	100	332	118	202,5±3

3.3 Shell height - total mass dependence

The dependence of shell height - total mass in the studied generations is described by power equations with a high approximation coefficient (Fig. 1-6).

The overwhelming majority of yearlings of the 2015 generation with a shell heights of 30 to 50 mm had a mass of 25 to 40 g (Fig. 1), two-year olds - from 66 to 90 mm with a mass of 60 to 120 g (Fig. 3). Three-year-olds with shell heights of 98 to 128 mm had a mass of 120 to 280 g (Fig. 5).

The generation of 2016 was dominated by yearlings, whose weight varied from 25 to 40 g at a shell height of 40 to 50 mm (Fig. 2). Among two-year-olds, mollusks with shell heights of 70 to 98 mm prevailed (Fig. 4), weighing from 70 to 100 g, and three-year-olds of the same generation had heights of 100 to 130 mm and a mass of 150 to 275 g (Fig. 6).

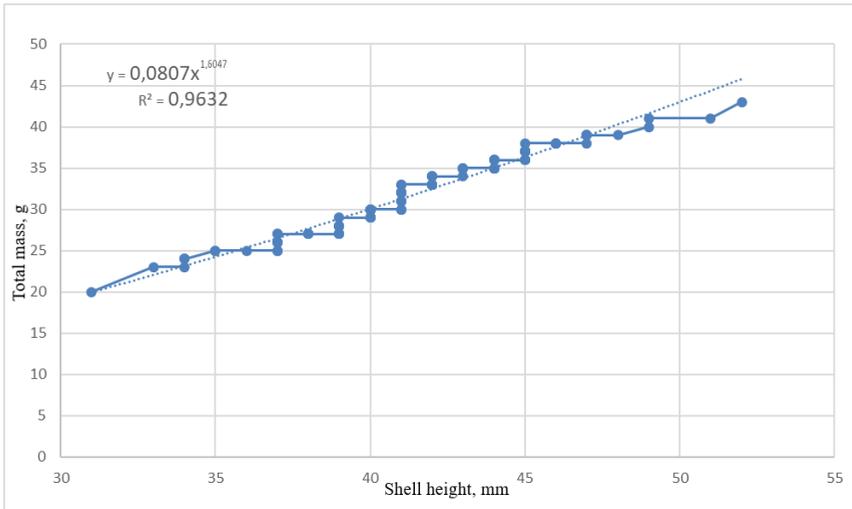


Fig. 1. Dependence of shell height - total mass of the scallop of the 2015 generation (yearlings)

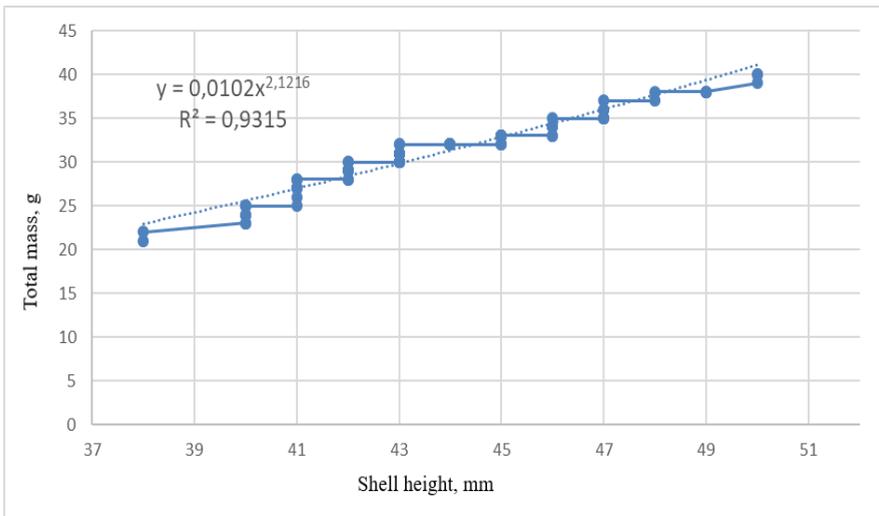


Fig. 2. Dependence of shell height - total mass of the scallop of the 2016 generation (yearlings)

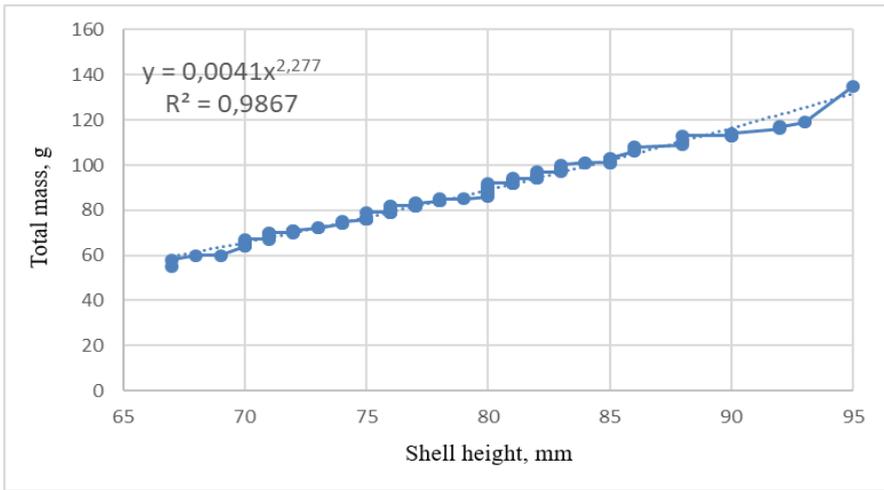


Fig. 3. Dependence of shell height - total mass of the scallop of the 2015 generation (two-year-olds)

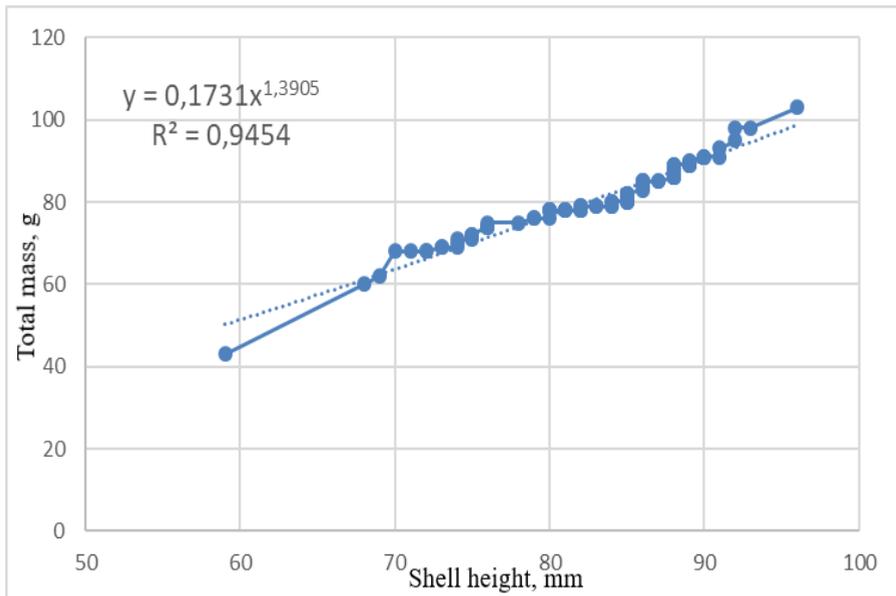


Fig. 4. Dependence of shell height - total mass of the scallop of the 2016 generation (two-year-olds)

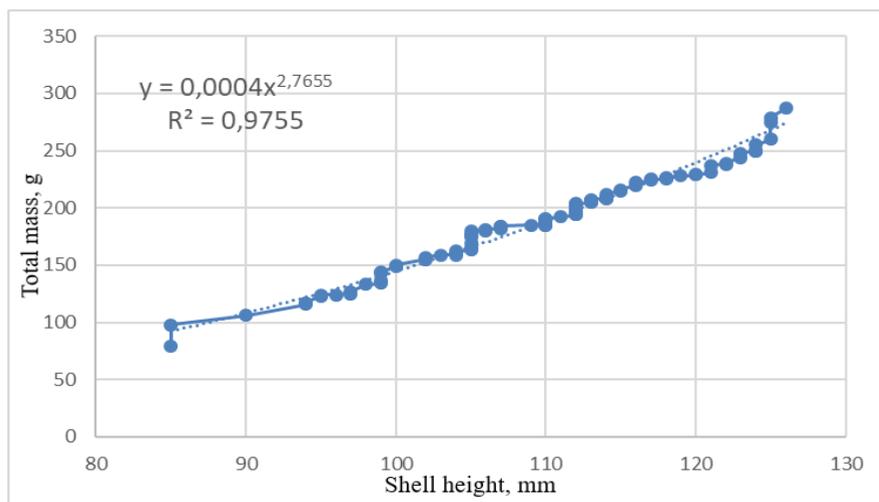


Fig. 5. Dependence of shell height - total mass of the scallop of the 2015 generation (three-year-olds)

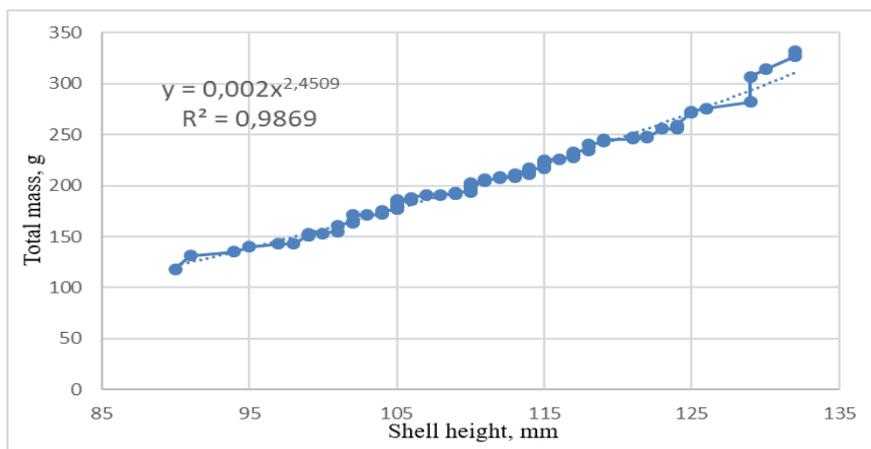


Fig. 6. Dependence of shell height - total mass of the scallop of the 2016 generation (three-year-olds)

3.4 Gender ratio

Gender was not determined in the yearlings of the Primorsky scallop; therefore, the ratio was analyzed only for two- and three-year-olds of both generations. In the 2015 generation, males prevailed in two-year-olds (60%); among three-year-olds, females dominated, they accounted for 80%. In the 2016 generation, among two-year-olds, most individuals were males (60%), among three-year-olds, females prevailed, they also accounted for 60%.

3.5 Comparison of some biological parameters of the Primorsky scallop of the studied generations

Comparative analysis of some size and weight indicators of the Primorsky scallop in Kozmino bay showed that the higher values of the shell height in yearlings were in the 2016 generation; they exceeded the average value by 4 mm (Fig. 7, Table 1). Two-year-olds were also higher in the 2016 generation, they exceeded two-year-olds of the 2015 generation by 4 mm (Fig. 8, Table 1). In comparison, according to the average indicators of three-year-olds,

the shell height was also dominated by mollusks of the 2016 generation, their height exceeded the three-year-olds of the 2015 generation by 1.7 mm (Fig. 9, Table 1).

Despite the fact that the shell height of the yearlings of the Primorsky scallop was higher for individuals of the 2016 generation, the difference in weight between generations was insignificant, only 1 g (Fig. 10, Table 2). Also, with a lower shell height of two-year-olds of the 2015 generation, according to the average indicators of the total mass, they turned out to be 6.4 g more (Fig. 11, Table 2). Comparative characteristics of the average values of the total mass of three-year-olds of the studied generations showed that in the 2016 generation, mollusks were heavier by 12.7 g (Fig. 12, Table 2).

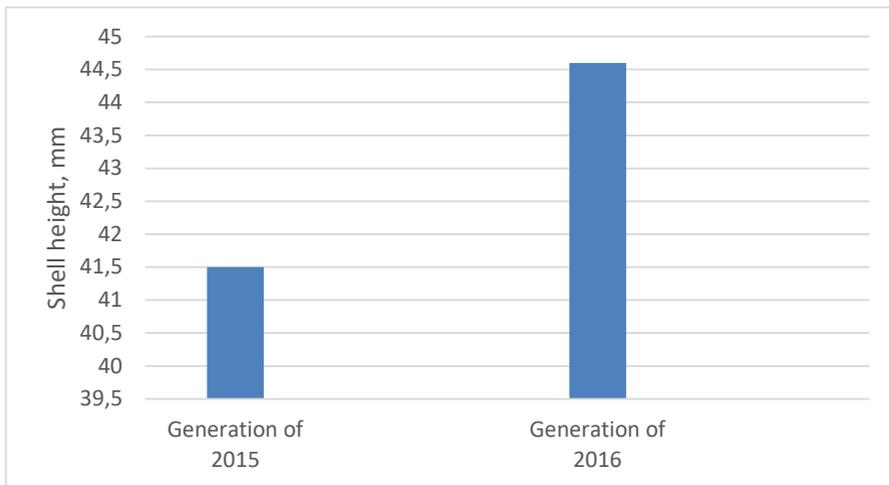


Fig. 7. Average shell heights of the scallop yearlings

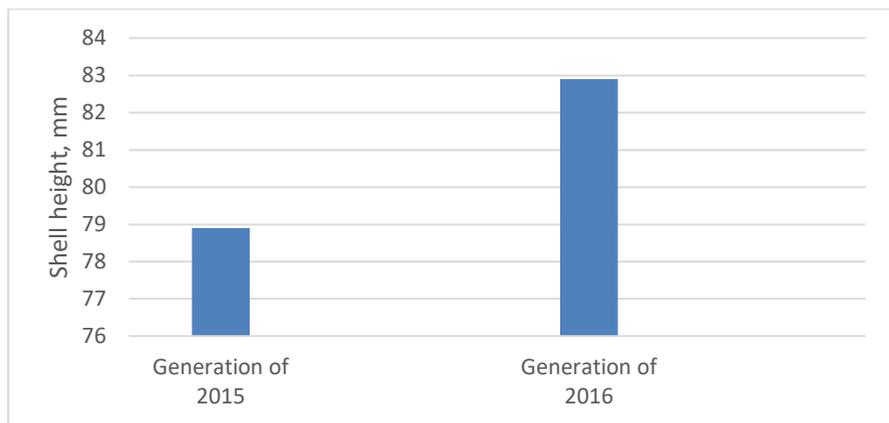


Fig. 8. Average shell heights of two-year-old scallops

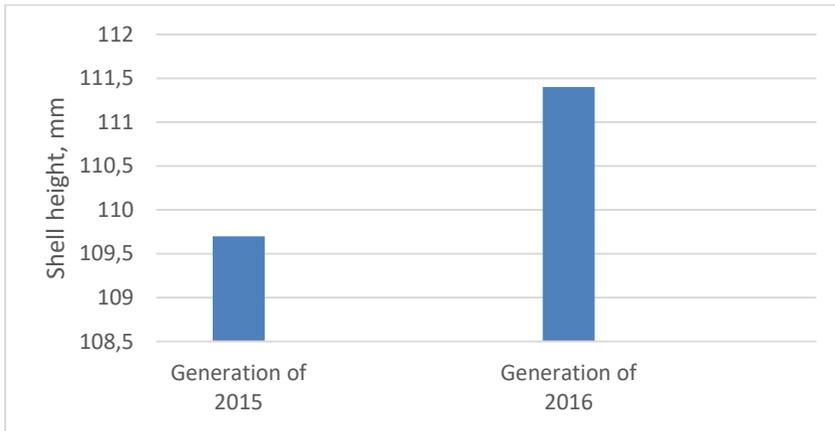


Fig. 9. Average shell heights of three-year-old scallops

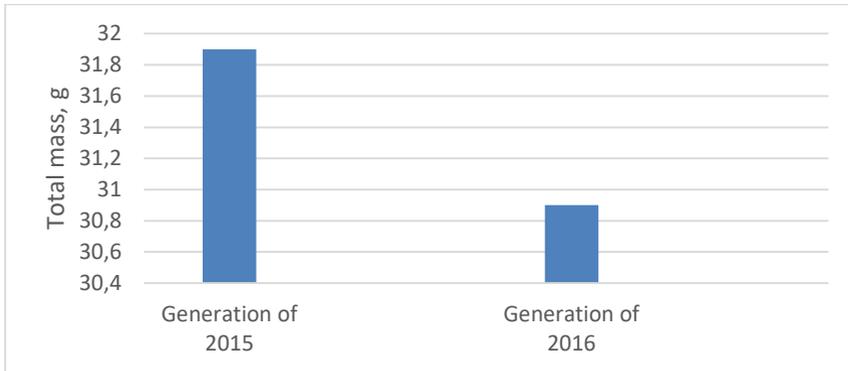


Fig. 10. Average values of the total mass of the Primorsky scallop yearlings

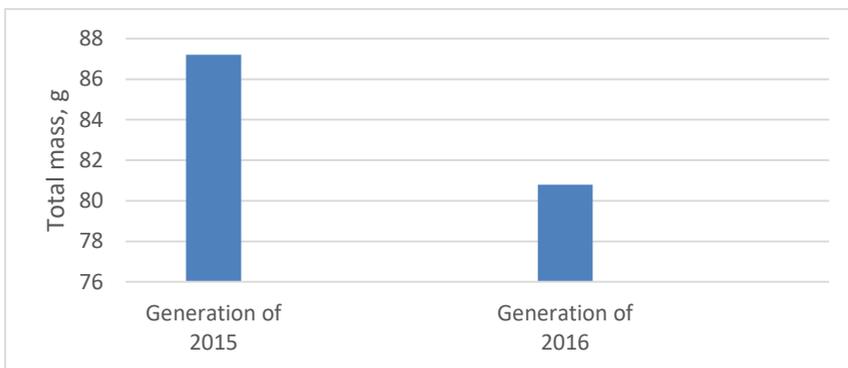


Fig. 11. Average values of the total mass of the Primorsky scallop two-year-olds

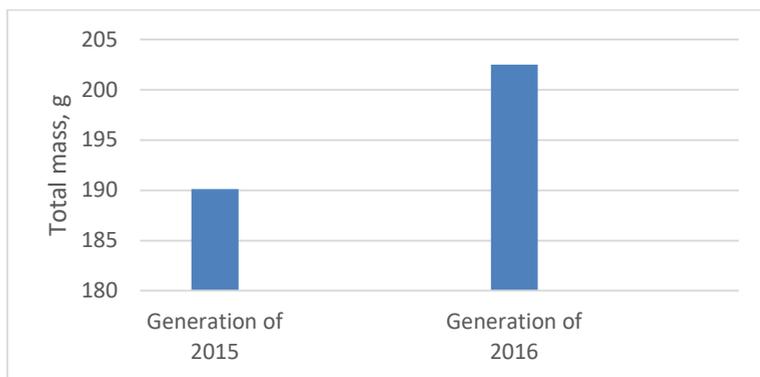


Fig. 12. Average values of the total mass of the Primorsky scallop three-year-olds

In general, the size and weight characteristics of the Primorsky scallop of studied generations correspond to the normative indicators of growth, which indicates favorable living conditions for cultivated mollusks.

4 Conclusions

As a result of the research, the following conclusions can be made. The size composition of the Primorsky scallop from Kozmino bay of the 2015 generation varied from 31 to 126 mm; the average shell heights were 41.5 ± 0.29 mm for yearlings, 78.9 ± 0.5 mm for two-year-olds, and 109.7 ± 0.69 mm for three-year-olds. The 2016 generation included specimens with shell heights of 37 to 132 mm. The average value for yearlings was 43.63 ± 0.21 mm, for two-year-olds - 82.9 ± 0.51 mm, for three-year-olds - 111.4 ± 0.68 mm.

The weight composition of the Primorsky scallop from Kozmino bay of the 2015 generation varied from 20 to 287 g. The average value of the total weight for yearlings was 31.9 ± 0.4 g; for two-year-olds 87.2 ± 1.3 g, for three-year-olds 190.1 ± 3 g. For the 2016 generation, there were individuals with total weights of 21 to 332 g. The average value for yearlings was 30.9 ± 0.3 g, for two-year-olds - 80.8 ± 0.6 g, for three-year-olds - 202.5 ± 3 g.

The dependence of shell height - total mass of the Primorsky scallop is described by the equations of a power function with a high approximation coefficient: for the generation of 2015, 2016: for yearlings $y=0,0807x^{1,6047}$ $R^2=0,9632$; $y=0,0102x^{2,1216}$ $R^2=0,9315$. For two-year-olds: $y=0,0041x^{2,277}$ $R^2=0,9867$; $y=0,1731x^{1,3905}$ $R^2=0,9454$. For three-year-olds: $y=0,0004x^{2,7655}$ $R^2=0,9755$; $y=0,002x^{2,4509}$ $R^2=0,9869$.

Among the mollusks of both generations, males prevailed in two-year-olds, and females in three-year-olds.

A comparative analysis of some size and weight characteristics of individuals of the same age of different generations showed that in the 2016 generation, the average shell height was slightly higher, but at the same time the average value of the total mass was higher for mollusks of the 2015 generation.

Studies carried out in Kozmino bay under the program of integrated ecological monitoring show the species diversity of marine biota, the absence of disturbances in the development of hydrobionts, and the presence of types of indicators of pure water [1, 3, 6, 7]. Every year in the bay there is a massive spawning of scallop kept in cages, which indicates a favorable ecological situation in the water area. The biochemical parameters of the Primorsky scallop from Kozmino bay do not differ from those of mollusks that live in relatively clean waters with no anthropogenic load [1, 3, 6, 7]. The results of our study

indicate that the activity of the oil-loading enterprise does not adversely affect the main biological indicators of the Primorsky scallop cultivated in Kozmino bay.

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