Influence of luminance modeses on the metamorphosis of artemia in aquaculture

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Abstract. The article presents the results of studies of the influence of luminance modes on ontogenesis of artemia cultivated in artificial conditions in a closed cycle. The aim of the work was to study the effect of light on morphological features of artemia at different stages of ontogenesis. During the work, the luminance modes of 1.5 kl, 2.5 kl and 4 kl were used. It was found that the intensity of the light flux differently affects the ontogenesis and development of individual parts of the body of artemia. In one case, during the cultivation of artemia, optimal results were obtained at 2.5 klx, in the other at 4 klx. The luminance mode of 1.5 klx, turned out to be the least effective. Observations of the growth and development of Artemis larvae in an artificial environment revealed that the luminance mode of 4 klx had a more noticeable stimulating effect on the length of the body, abdomen, cephalothorax and furca than the mode of 2.5 klx at the initial stages of postembryonic development of larvae during the first 120 hours. When cultivating sexually mature artemia, as the results of studies have shown, the luminance mode - 2.5 klx had a more pronounced effect on body length, abdominal length, cephalothorax length, abdominal width and the number of bristles on the furc than the 4klx mode. For the first time, the results of morphological studies demonstrating the effect of light intensity on the de-velopment of individual parts of the body of crustaceans in aquaculture have been obtained. The study was supported by the Development Program of the Saratov state university of genetics, biotechnology and engineering named after N.I. Vavilov (Prioritet -2030).

1 Introduction

Artemia is the most famous gill-legged crustacean [1, 2] due to its wide demand in the global aquaculture.

As a feed object, artemia is considered unique due to its chemical composition and high nutritional value. Artemia is characterized by unpretentiousness and resistance to adverse factors. They are capable of reproduction in conditions with low oxygen content, wide temperature fluctuations, as well as salinity. Artemia nauplii, due to their small size and high metabolic energy, are widely used in aquaculture as a starter feed for many species of

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hydrobionts. In addition, artemia cysts can be stored for a long time without loss of quality [3].

Artemia is used not only as food for fish, shrimp, birds, fur-bearing animals. It is also used in the food, pharmaceutical industry, in cosmetology in the production of dietary supplements. In this case, not only artemia nauplia are used, but also cysts, decapsulated eggs, crustaceans of juvenile and adult stages of development [4-6]. The unique chitosan artemiy is especially appreciated.

The aim of the work was to study the influence of luminance modes on the morphological features of artemia at different stages of ontogenesis.

2 Materials and methods of research

Artemia cysts from Altai hypergaline lakes were used for the study. They were cul-tured in a Weiss apparatus, in a NaCl solution, at the rate of 30 g / l of water, under all-day lighting, at a water temperature of 26-280C, pH 8,2 of the medium, planting density 2.5 g/l.

The Micromed microscope 2 var. 3-20, ViBRA HT-224RCE analytical scales with an accuracy of 0.0001 g, Petri dishes, preparation needles, Levenhuk 3ST binocular, Resum AIR-3000 compressor were used in the work.

In the first experiment, which served as a control, the luminance of the cultivated artemia reached 1.5 klx. Luminance in the 2nd and 3rd experiments was provided by blocks with OSRAM L 18w/765 fluorescent lamps, each of which has a luminous flux of 1050 Lm, 5000K. To measure the luminance, a MASTECH MS6610 pho-tometer/luxmeter with a remote light measurement sensor was used.

In the second experiment, the luminance was increased to 2.5 klx. In the third experiment, the luminance was increased to 4 klx. To illuminate the third group, an IEK CDO 06-100 6500K LED light source was used, with a luminous flux of 8000 Lm.

Morphometric indicators were studied according to standard methods [7]. For the study, the crustaceans were fixed in a 4% formalin solution. The measurement was carried out using an MBS-10 microscope equipped with an eyepiece micrometer. Morphometric analysis of artemia crustaceans was carried out according to plastic and meristic signs: body length, abdominal length, furca length, cephalothorax length, eye diameter, distance between eyes, head width, abdominal width, number of bristles.

The reliability of the sample differences was assessed according to the Student's criterion. Calculation of all numerical indicators is made in the Microsoft Excel pro-gram.

3 Research results

The body length of the nauplii 24 hours after hatching in the control was 854 microns. In the second experiment, it was 5.3% more than in the control and amounted to 899 microns. In Experiment 3, it was 9.9% larger than in the control and amounted to 939 microns (Figure 1). The difference in body length in experiment 3-4 was 4.4%.

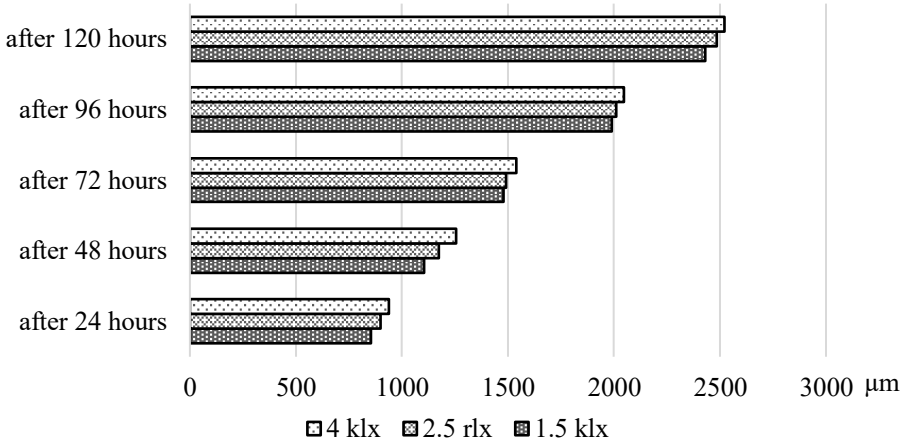

Fig. 1. Body length of the nauplii, micron.

The body length of the nauplii after 48 hours of incubation in the control increased to 1105 microns, in the 2nd experiment it was 6.15% more and amounted to 1173 microns. In 3rd experiments, this indicator was higher than in the control by 13.8%. The body length in the 3rd experiment was 1257 microns and was greater than in the 2nd experiment by 7.2%.

72 hours after hatching, the body length of nauplii in the control was 1478 microns, and in the 2nd and 3rd experiments it increased to 1491 microns and 1541 microns, respectively. In the control and in the second experiment, the body length of nauplii slightly differed, the difference between the control and the 3rd experiment was 4.3%.

The body length of nauplii 96 hours after hatching in control was 1989 microns. In the second experiment, the body length of the nauplii was 2010 microns. There were no significant differences in the length of nauplia body between the control and the second experiment. The difference between the control and the 3rd experiment was 2.9%. There were no significant differences between the experimental groups.

120 hours after hatching, the body length of nauplii in the control was 2432 mi-crons, in 2nd and 3rd experiments - 2484 microns and 2521 microns, respectively. The difference between the control and the 2nd and 3rd experiments was insignifi-cant. No significant differences were found.

According to the results of studies, the illumination of 4 klx (3rd experiment) had an activating effect on the growth of the body of artemia nauplii in the first 48 hours of incubation.

The next indicator that we studied was the length of the abdomen (Figure 2). Observations were conducted from 24 hours to 120 hours. 24 hours after hatching, the length of abdomen of nauplii in the control was 156 microns, in 2 and 3 experiments 167 microns and 180 microns, respectively. The length of the abdomen in the control was 7.05% less than in the 2nd experiment by 15.4% in the 3rd experiment. The dif-ference in the 2nd and 3rd experiments was 7.78%.

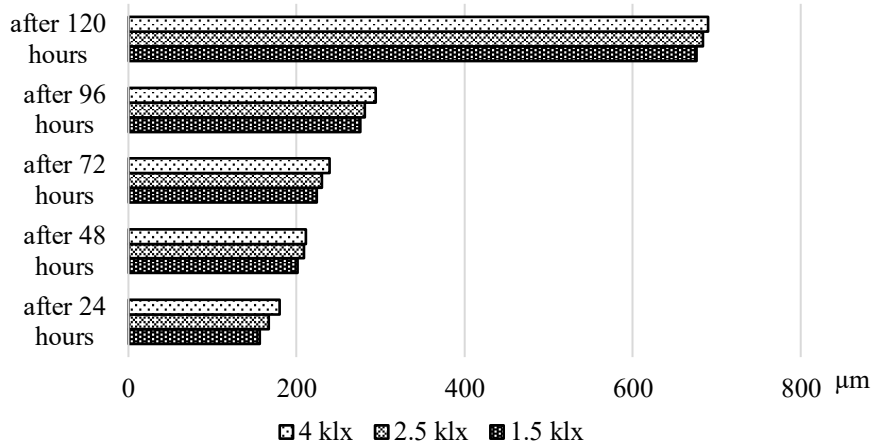

Fig. 2. Abdomen length, micron.

48 hours after hatching, the length of abdomen in the control was 201 microns, in the 2nd and 3rd experiments 209 microns and 211 microns. There was no difference between the control and the experiment. In the 3rd experiment, the length of the ab-domen was 4.97% longer compared to the control, and between the length in the 2nd and 3rd experiments was unreliable.

72 hours after hatching, the length of abdomen in the control was 224 microns, in the 2nd and 3rd experiments 230 microns and 239 microns, respectively. The length of the abdomen in the 2nd experiment was slightly longer than in the control. In the 3rd experiment, more than in the 1st by 6.7%. The difference between the 2nd and 3rd experiments was 3.9% and was unreliable.

96 hours after hatching, the length of abdomen in the control was 276 microns, in the 2nd and 3rd experiments - 281 microns and 294 microns, respectively. The length of abdomen did not differ between the control and the 2nd experiment. The difference between the control and 3 experiments was 6.5%, and between the 2nd and 3rd experiments. The length of the abdomen in 2 and 3 experiments had no significant differences.

After 120 hours of incubation, the length of abdomen in the control reached 676 microns, in the 2nd and 3rd experiments - 684 microns and 690 microns, respectively. The length of the abdomain between the control and the 2 experience did not differ much. Between the 3rd experiment and the control were unreliable, as well as be-tween the 2nd and 3rd experiments.

The obtained results indicate that the illumination of 2.5 klx and 4 klx activated the growth of abdomen within 24 hours by 7.05% and 15.4%, respectively.

When studying the process of furca growth, it was found that its length depended on the level of illumination (Figure 3).

24 hours after hatching, the furca length in the control group was 11.5 microns, in the experimental groups it was 12.1 microns and 13.1 microns. The length of furca in the control was 5.2% less than in the 2nd experiment and 13.91% less than in the 3rd. The difference between the 2nd and 3rd experiments in the length of furca was 8.3%.

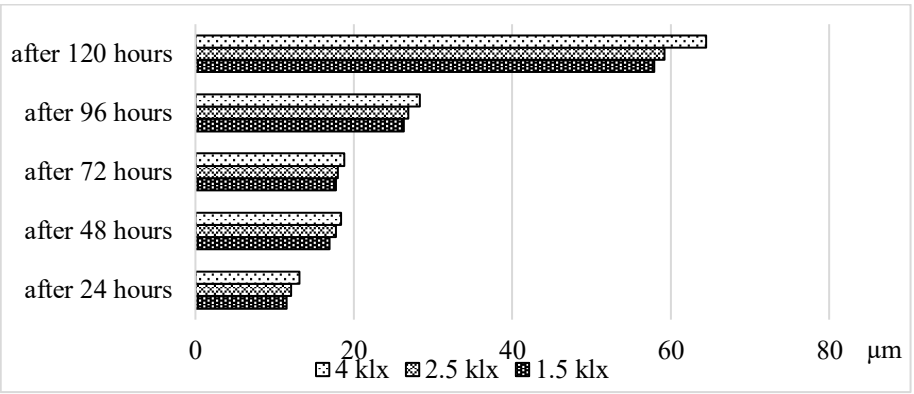

Fig. 3. Length of furka, micron.

After 48 hours of incubation, the furca length in the control was 16.9 microns, in the 2nd and 3rd experiments - 17.7 microns and 18.4 microns. The furca length in the control is 4.7% less than in the 2nd experiment and 8.9% less than in the 3rd, the difference between the 2nd and 3rd experiments was 3,9%.

72 hours after hatching, the furca length of the larvae in the control was 17.7 mi-crons, in the 2nd and 3rd experiments the furca length was 18.01 microns and 18.8 microns. The length of the furca in the control and the 2nd experiment did not differ much. This indicator in the third group was 6.21% higher than in the control.

After 96 hours of incubation, the furca length in the control was 26.3 microns, in the 2nd experiment - 26.9 microns and the third - 28.3 microns. The difference in furca length between the 3rd experiment and the control was 7.6%, between the 2nd and 3rd experiments was 5,2%.

After 120 hours of incubation, the furca length in the control was 57.9 microns, in the 2nd and 3rd 59.2 microns and 64.5 microns. The length of furca in the 2nd exper-iment is 2.24%, and in the 3rd by 11.4% more than in the control. The difference in length between 2 and 3 groups is 8,9%.

It was established that the luminance mode of 4 lux contributed to the growth of furka in length, and 2.5 klx did not have a significant effect.

In the next stage, the development of cephalothorax was studied under different light conditions (Figure 4). The length of cephalothorax after 24 hours of incubation in the control group was 585.5 microns, in the 2nd and 3rd experiments - 719.9 microns and 745.9 microns, respectively. The length of cephalothorax in the 3rd experiment was 27.4% longer than in the control. In the 2nd experiment, this indicator was higher than in the control by 22.95%.

48 hours after hatching, the length of the cephalothorax in the control was 887.1 microns, in the 2nd and 3rd experiments - 946.3 microns and 1027.6 microns, respec-tively. The length of the cephalothorax in the 2nd experiment was 6.7% longer com-pared to the control. This indicator in the 3rd experiment was 15.8% higher than in the control.

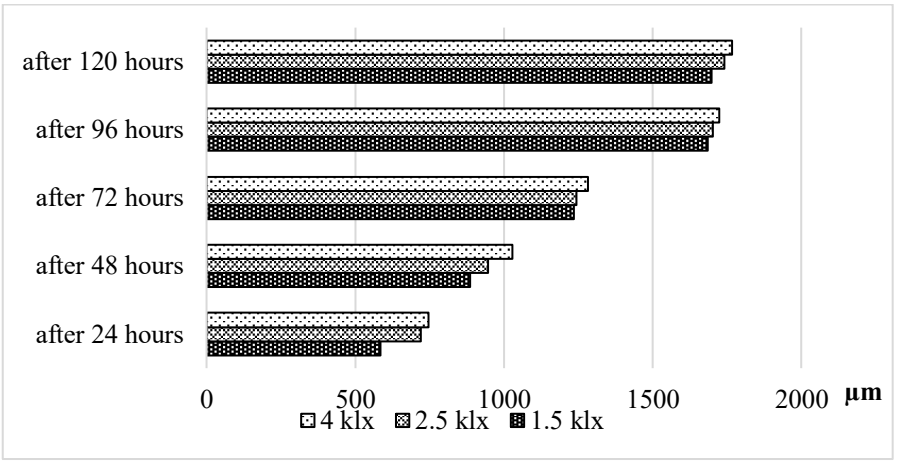

Fig. 4. Development of cephalothorax in artemia larvae depending on luminance.

After 72 hours of incubation, the length of cephalothorax in the control group was 1236.3 microns, in the 2nd and 3rd experiments - 1242.99 microns and 1283.2 mi-crons, respectively. There were no statistically significant differences between the 2nd and 3rd experiments.

After 96 hours of incubation, the length of cephalothorax in the control was 1686.7 microns, in the 2nd and 3rd experiments - 1702.1 microns and 1724.7 microns, respectively. There were no significant differences in this indicator between them.

The length of cephalothorax after 120 hours of incubation in the control increased to 1698.1 microns, in the 2nd and 3rd experiments to - 1740.8 microns and 1766.5 microns, respectively. There were no significant differences in the length of cephalo-thorax between the 2nd and 3rd experiments, as well as between control and 2nd, control and 3rd experiments.

Observations on the growth and development of artemia larvae in vitro using dif-ferent luminance modes showed that the luminance mode of 4 klx had a more pro-nounced stimulating effect on the furka length, head width and eye distance than the 2.5 klx mode at the early stages of postembryonic development of larvae during the first 120 hours.

According to literature sources [8-11], artemia is characterized by fluctuations in morphometric indicators under the influence of environmental factors. The main morphometric features include body length, head width, distance between the eyes, eye diameter, antenna length, furka length, etc.

At the next stage of the work, we studied morphometric indicators of mature arte-misia grown under different light conditions. The results of the research are shown in figure 5.

Body length is one of the main morphometric indicators. The average value of the body length of sexually mature artemia, the ecomorphs available to us, ranged from 8.23–9.48 mm. A comparison of morphometric parameters of crustaceans under different light conditions showed that the largest body length (tl) was noted for crusta-ceans with luminance of 2.5 klx (Figure 5).

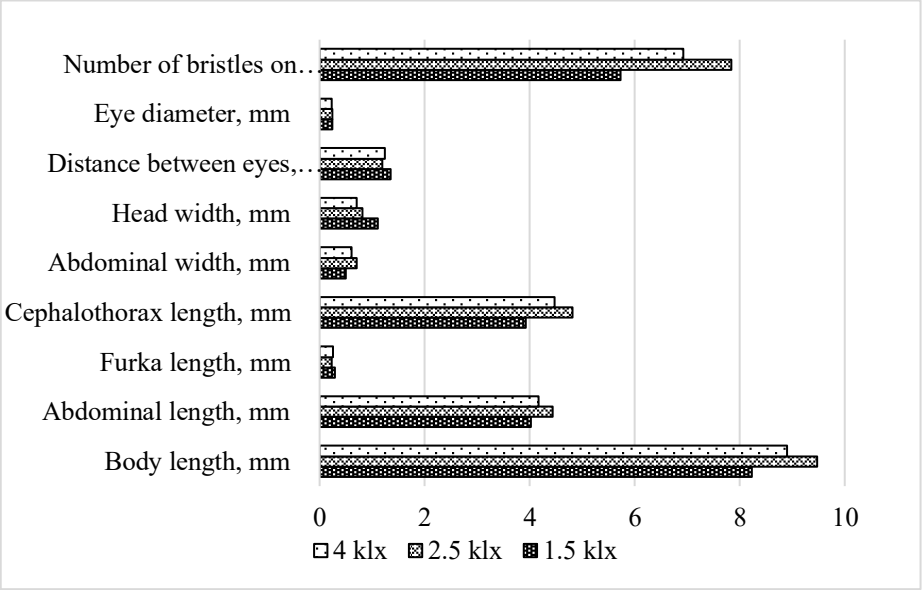

Fig. 5. Morphometric indicators of mature individuals depending on luminance.

The length of abdomen (al) in the control was 4.02 mm, in the 2nd experiment - 4.44 mm, in the 3rd - 4.17 mm. Consequently, the length of abdomen in the 2nd experiment was 10.4% longer than in the control at 1.5 klx luminance and more than at 4 klx.

Furka length (fl) in the control was 0.29 mm. Furka length (fl) in crustaceans in the 2nd and 3rd experiments was less and was 0.23 - 0.25 mm. Furka length in the control compared to the 2nd and 3rd experiments was greater by 26.09% and 16%, respectively.

Cephalothorax length in the 2nd experiment was 4.81 mm, which is 22.7% more than in the control. In the 3rd experiment, the length of the cephalothorax is 4.48 mm, which is 14.28% more than in the control.

The length of body includes: the length of abdomen, the length of furka and the length of cephalothorax. Despite the fact that furka in the control was longer than in the 2nd and 3rd experiments, the total body length of artemia crustaceans was greater in the 2nd and 3rd experiments with luminance of 2.5 klx and 4 klx than the body length of crustaceans in the control.

Abdominal width (aw) in artemia crustaceans in the control was 0.50 mm. In arte-mia in the 2nd and 3rd experiments - 0.7 mm and 0.61 mm, respectively. Thus, the width of the abdomen in the 2nd experiment was 40% greater than in the control. This parameter in the 3rd experiment was 22% higher than in the control. The difference between the indicators of the 2nd and 3rd experiments was 14,75%.

Head width (hw) in the control was 1.11 m, in artemia in the 2nd and 3rd experi-ments - 0.81 mm and 0.70 mm. Head width in the control was 37% higher compared to the values of the 2nd experience, and 58.6% higher compared to the 3rd experi-ence. The difference between the 2nd and 3rd experiments was 15,7%.

Such an indicator as eye distance (de) had differences. In the control it was 1.35 mm, and in artemia in 2 and 3 experiments - 1.19 mm and 1.24. The distance between the eyes in the control was wider by 13.4% compared to the 2nd experience and by 8.9% compared to the 3rd experience. The difference between the experimental groups was 4,2%.

Eye diameter (ed) in the control was 0.24 mm, in the 2nd experiment 0.24 mm, in the 3rd - 0.23 mm. There were no significant differences between the experiments.

The number of chetae on the furcae in the control was 5.73 pcs., in the 2nd exper-iment 7.84 pcs., in the 3rd 6.92 pcs. Thus, the number of chetae in the control was 36.8% less than in the luminance mode of 2.5 klx and 20.8% less than in the lumi-nance mode of 4 klx. The difference between 2 and 3 experiments was 13,3%.

4 Discussion

The results of the studies showed that the morphometric parameters of crustaceans of the genus Artemia varied depending on the luminance. First of all, increased level of luminance provided higher rates of artemia development in the first 120 hours of cultivation. In this age period, the best results were obtained when using luminance of 4 klx, and when using illumination – 2.5 klx, the development indicators were lower.

When cultivating mature artemias, the luminance of 2.5klx was sufficient and stimulated an increase in body length, abdominal length, cephalothorax length, ab-dominal width, eye diameter and the number of chetae on the furca.

Comparative analysis of the results showed that for sexually mature artemia, luminance of at least 2.5 klx is necessary. Such luminance moderately stimulates body growth in length, abdomain and cephalothorax growth in length, abdomain growth in width and the number of chetae on the furca.

According to morphometric indicators, our data are consistent with the data of lit-erature sources [12-15].

Summarizing, it should be noted that when breeding artemia in aquaculture, the luminance mode of 2.5 klx can be taken as a basis, since this mode is more economi-cal than 4 klx.

5 Conclusion

In conclusion, it should be noted that the comparison of morphometric indicators of artemia of the control and experimental groups grown in aquaculture conditions clearly demonstrated the influence of luminance level on the dynamics of their development and growth rate.

For the development of mature individuals, as the results of morphometry showed, the optimal luminance mode was 2.5 klx, and the growth of larvae was stimulated to a greater extent by the illumination of 4 klx.

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