UDC 595.373:574.5:639.3

ECOLOGICAL CHARACTERISTICS OF *GAMMARUS LACUSTRIS* (AMPHIPODA: GAMMARIDAE) AND PERSPECTIVES FOR ITS LABORATORY AQUACULTURE: AN OVERVIEW

Firdavs G. Fazliddinov[1], Farrukh U. Umarov[1], Khayrulla Kh. Solijonov[1,2]

The article analyzes the ecological characteristics of Gammarus lacustris and its nutritional importance in aquaculture based on a review of the literature. The species' role in the trophic chain, its broad ecological adaptability, and its high protein and carotenoid content determine its value as a feed organism. It is shown that ensuring optimal temperature, aeration, and photoperiod under laboratory conditions enables the formation of a stable colony and reduces pressure on wild populations.

Keywords: *Gammarus lacustris, aquaculture, ecology, laboratory culture, reproduction, feed.*

В статье на основе обзора литературы анализируются экологические характеристики Gammarus lacustris и его пищевая ценность в аквакультуре. Положение вида в трофической цепи, широкая экологическая адаптация, а также высокое содержание белка и каротиноидов определяют его ценность в качестве корма. Показана возможность создания стабильной колонии и снижения нагрузки на дикие популяции путем обеспечения оптимальной температуры, аэрации и фотопериода в лабораторных условиях.

Ключевые слова: *Gammarus lacustris, аквакультура, экология, лаборатория, репродукция, корм.*

INTRODUCTION

Gammarus is a genus of small freshwater amphipods commonly referred to as "scuds." Species of *Gammarus* are ecologically significant, inhabiting lake and river ecosystems as benthic organisms and occupying an important position in the food web. In water bodies lacking predatory fish, their population density increases considerably, whereas in lakes with abundant predators, their numbers remain naturally regulated. This indicates that *Gammarus* serves as one of the primary food sources for numerous fish species, aquatic birds, and water-dwelling insects [5. P. 1327; 20. P. 245]. In addition, amphipods of this genus are also widely used as indicator organisms for assessing water quality and in various toxicological investigations [3. P. 255; 10. P. 5].

Among the representatives of this genus, *Gammarus lacustris* G.O. Sars, 1863 is widely distributed across Eurasia and North America, occurring in both lowland and high-mountain lakes, and even in some slightly saline water bodies [9. P. 5]. This species exhibits a high degree of ecological adaptability, inhabiting a wide range of hydrological conditions – from mineral-rich, warm lowland lakes to cold alpine lakes.

In recent years, the volume of various fish species produced in aquaculture has been steadily increasing. Under such conditions, *Gammarus lacustris* amphipods have gained great importance as a source of live feed. They are rich in protein and can serve as a nutritious food for fish larvae and other aquatic organisms. For example, the dry mass of *G. lacustris* contains approximately 40–45% protein and 5–10% lipids, and is also rich in essential amino acids. Studies have shown that fish fed diets supplemented with *Gammarus* exhibit enhanced immune responses and increased growth rates (e.g., in *Rutilus caspicus*) [15. P. 4].

The biomass of *G. lacustris* also contains high levels of β-carotene and other antioxidants, which have been observed to enhance fish coloration and

[1] Andijan State University, Andijan, 170100, str. University, 129 (Uzbekistan). E-mail: agsu_info@edu.uz

[2] Research Institute of Environment and Nature Protection Technologies, Tashkent, 100043, str. Bunyodkor, 7a (Uzbekistan). E-mail: ecoilm@umail.uz

improve immune function [11. P. 84]. Therefore, the use of *Gammarus* as live feed or as a dry feed additive represents a promising direction in aquaculture.

Currently, available *Gammarus* products on the market (live, dried, or powdered) are predominantly harvested from natural habitats and sold at relatively high prices, with 1 kg of dried material costing approximately 50–80 USD [6. P. 7]. However, no widely implemented method for large-scale intensive cultivation has yet been established [16. P. 75]. Cultivating *G. lacustris* under laboratory conditions would allow for the stable year-round production of high-quality nutritional feed while also reducing the costs associated with harvesting from natural ecosystems. The purpose of this literature review is to highlight the significance of *Gammarus lacustris* in aquaculture, describe methods for its cultivation under laboratory conditions, and outline its comparative advantages over other *Gammarus* species occurring in Central Asia.

MATERIALS AND METHODS

For laboratory maintenance of *Gammarus lacustris*, the initial stock is collected with a hand net from springs or the shores of mountain lakes, after which larger individuals are selected.

Gammarus lacustris is a small amphipod typically measuring 12–22 mm in length, with a laterally compressed, segmented body (Fig. 1). The head bears compound eyes, paired antennae, and a complex mouthpart structure. The thorax carries seven pairs of walking legs, while the abdominal segments possess swimming-adapted uropods. The pleon is markedly curved, giving the body the characteristic “C-shaped” form typical of *Gammarus*. In females, a brood pouch (marsupium) develops on the ventral side of the abdomen, where embryos are incubated. The body surface is covered with a firm chitinous exoskeleton, which is renewed periodically through molting. Body coloration varies depending on environmental conditions and may appear greenish, brown, or dark reddish-brown. These morphological traits contribute to the species’ ecological adaptability and its suitability for maintenance under laboratory conditions.

For breeding *Gammarus*, aquaria or plastic containers with a volume of 50–100 liters are typically used. In this field, Sedova and Nasonova developed a specialized aquarium apparatus designed for the cultivation of Locusto*Gammarus* locustoides [16. P. 86]. In our study, we propose a slightly improved version of this design (Fig. 2). Specifically, we incorporated inlet and outlet siphons for regular water renewal, a circulation paddle to ensure continuous water movement, and a special mesh module designed to support the growth of aquatic plants.



Figure 1. *Gammarus lacustris* G.O. Sars, 1863 (Artdatabanken, 2025).

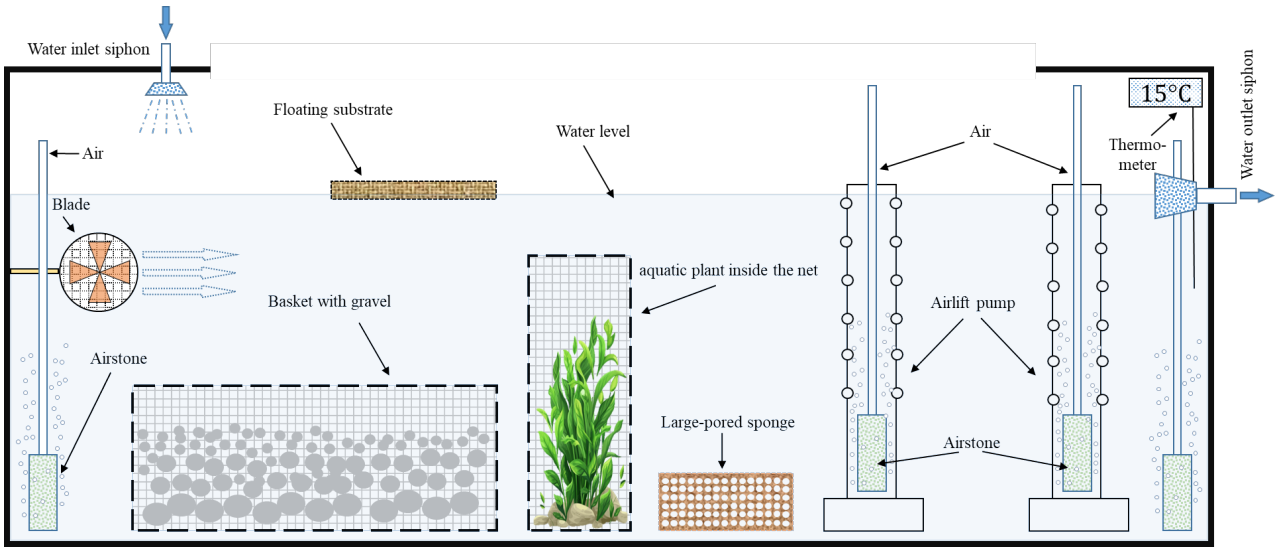


Figure 2. A specialized aquarium apparatus designed for the cultivation of *Gammarus* (capacity: 50 L).

To provide sufficient living surfaces in each container, a layer of fine gravel (substrate) and several large porous sponges are placed at the bottom. Additionally, biofilter sponges or mesh separators can be installed in the aquarium to create extra attachment surfaces for *Gammarus* individuals. For aeration and water movement, each container is equipped with a low-power air pump and several sponge filters. This setup ensures continuous oxygen exchange in the water and allows *Gammarus* to distribute themselves across different layers, facilitating respiration even at high densities. The water flow rate is maintained at a moderate level without creating strong currents, since *G. lacustris* is naturally capable of living in calm lake waters. At the same time, gentle circulation helps maintain elevated dissolved oxygen levels (0.5–1.0 L/min of air). The temperature regime is kept stable at +14 to +18 °C, as this range is considered optimal for *G. lacustris*. Scientific sources indicate that the species' "preferred temperature" is approximately 15 °C, and it can survive for long periods even in waters cooled to +6 °C [17].

During maintenance, the temperature is controlled using thermostats and air conditioners to prevent it from rising above +20 °C. The pH level should be kept close to neutral or slightly alkaline (7.0–8.0), as natural *Gammarus* populations typically inhabit waters with such characteristics and are known to be sensitive to acidic conditions. Water hardness must be moderate, with sufficient mineral content, because an adequate supply of calcium is essential for *G. lacustris* to perform regular molting and to ensure proper hardening of the new exoskeleton. According to studies, when calcium concentration in the water is low, the molting interval in *Gammarus* becomes prolonged, which can lead to increased mortality [12. P. 13]. In laboratory conditions, the water must be kept well-oxygenated (≥5 mg/L), which is ensured by continuous aeration using air diffusers. Regarding illumination, the natural life cycle of *G. lacustris* should be considered, with particular attention paid to the photoperiod. A light regime of 10–12 hours of daylight and 12–14 hours of darkness per day is applied. Studies indicate that reduced day length and dim lighting stimulate sexual maturation and reproduction in *G. lacustris*. In the experiments of De March (1982), *G. lacustris* kept under constant light did not reproduce for several weeks, whereas reducing the daylight period to 12 hours triggered copulation and the onset of egg carrying in females [2. P. 2962]. Therefore, to ensure continuous reproduction of *G. lacustris* in the laboratory, a shortened photoperiod or dim lighting is recommended. During the daily light phase, aquarium lamps or diffused natural light may be used, while the dark phase should be maintained without room illumination.

G. lacustris is an omnivorous detritivore, meaning that it feeds on decomposed plant material, aquatic macrophytes, small invertebrates, and various organic residues [8. P. 11]. For laboratory culture, a mixed feeding regime is recommended. As the primary food source, finely ground fish feed granules or floating feed pellets were provided 3–4 times per week. This type of feed serves as a rich source of protein and energy for *Gammarus*. In each feeding session, an amount is provided such that all feed is

consumed within approximately 1–2 hours – this prevents excess food from remaining in the tank and polluting the water. As a plant-based supplement, small pieces of vegetables (e.g., zucchini, cucumber, potato) subjected to brief heat treatment are added to the aquarium once a week. These plant fragments are grazed upon and consumed by the *Gammarus* within 24–48 hours, after which any remaining residue is removed. Additionally, leaf litter is occasionally supplied to the population: cleaned and pre-fermented leaves (birch or oak) that have been soaked in water for 1–2 weeks are placed into the container in small quantities. Experiments have demonstrated that soft leaves processed through bacterial "conditioning" serve as highly palatable and nutritious food for *Gammarus*.

To maintain a healthy *G. lacustris* population, the water in each container is partially renewed (20–30%) twice per week. Detritus and accumulated waste on the aquarium bottom are carefully removed on a regular basis.

It is critically important to ensure that no predators or competitors are present in the aquarium. *Gammarus* should be maintained exclusively as a monoculture, without adding fish or other organisms, as their numbers may quickly decline otherwise. In some experiments, filter-feeding plankton such as *Daphnia* have been introduced alongside *Gammarus* to help maintain ecological balance in the system. In such cases, *Daphnia* consume the fine leftover particles from *Gammarus* feed, thereby improving water clarity. However, it must be taken into account that as *Gammarus* grow larger, they may also begin to prey on *Daphnia*.

In the laboratory, the sexual maturation and reproductive parameters of *G. lacustris* are monitored regularly. Female individuals develop a brood pouch on the ventral side of the abdomen, and after mating, they carry the fertilized eggs for 2–3 weeks. Newly hatched juveniles emerge from the maternal brood pouch and transition to an independent lifestyle. During colony development, inspections conducted every 2–3 weeks allowed the observation of empty egg membranes released by females after hatching, as well as the presence of young individuals within the aquarium.

RESULTS AND DISCUSSION

As a result of successfully establishing a *G. lacustris* colony in the laboratory, it becomes possible to create a continuous source of high-quality live feed for juvenile fish. Observations showed that *Gammarus* can adapt to life in a closed system for several generations; that is, females from the first generation are capable of producing subsequent generations. Over a 12-month period, the population maintained steady growth. At temperatures around +15 °C and under sufficient feeding conditions, a single female *G. lacustris* was observed to reproduce up to twice per year, whereas in natural environments reproduction typically occurs once per year, mainly during the spring period [12. P. 13]. This indicates that, under laboratory conditions, manipulation of seasonal factors (such as photoperiod and temperature) can accelerate or extend the reproductive cycle of *G. lacustris*. From an aquaculture perspective, the bioecological characteristics of *G. lacustris* offer several advantages.

Nutritional value. G. lacustris contains high levels of protein (approximately 40% of dry mass) and essential fatty acids (Tab. 1).

Table 1.

Seasonal chemical composition of *G. lacustris* (Mathias *et al.*, 1982)
(expressed as percentages of dry mass)

Seasons	Protein	Lipid	Ash	Carbohydrates	Chitin	Energy (cal/g)
May–Jun	41	13,8	27.4	8.9	7.3	3200
Jul–Aug	41,6	8.7	31.8	6.3	7.8	2700
Sep–Oct	39,2	9.8	27.8	10.9	6.8	2900

The proteins in *G. lacustris* are rich in essential amino acids such as methionine, lysine, and tryptophan, which play a crucial role in fish growth and disease resistance. The biochemical composition of *G. lacustris* has been reported to fully meet the protein and lipid requirements of rainbow trout (*Oncorhynchus mykiss*) at the fingerling stage [11. P. 83]. However, for very small (<3 cm) fish larvae, *Gammarus*-based feed may not entirely satisfy the required protein levels, and additional enriched diets may be necessary at this developmental stage.

Source of carotenoids and vitamins. The bright orange pigment of *Gammarus* indicates its richness in β-carotene and other carotenoid compounds. When included in fish diets, these substances enhance the coloration of the skin and fins and act as antioxidants, thereby positively influencing fish health.

Digestibility. When *Gammarus* is dried and incorporated into feed in powdered form, it retains its beneficial properties; however, its relatively high chitin content (6–8%) and ash (mineral) content (25–35%) may influence digestibility. Nevertheless, the inclusion of *Gammarus* meal at levels of 10–20% in fish diets has shown good results and did not negatively affect growth performance, as demonstrated in multiple studies. For example, Egyptian researchers tested replacing up to 50% of grey mullet feed with *G. pulex* meal and reported that normal growth was maintained [1. Pp. 1–15].

Reproductive characteristics under laboratory conditions. As a result of photoperiod manipulation, the *G. lacustris* colony continued reproducing throughout the entire year. Shortening the daylight period during the autumn–winter months stimulated reproductive activity in females a pattern also observed in Arctic subspecies [18. P. 585]. Other observations showed that the average number of eggs carried by a *G. lacustris* female per brood ranged from 10 to 15, which closely corresponds to values reported under natural conditions. For comparison, females of *G. aequicauda*, a species inhabiting the brackish waters of the Southern Caspian region, carry an average of about 37 eggs per brood, while *Obesogammarus acuminatus* can carry up to approximately 50 eggs, representing the highest values among the species mentioned. In contrast, the spring-dwelling species *G. komareki* produces significantly fewer eggs, with females carrying only around 9 eggs per brood [12; 13]. A comparative summary of the reproductive characteristics of selected Amphipoda species from Central Asia and adjacent regions is presented in Table 2.

Table 2.

Reproductive characteristics of Amphipoda species

Species	Habitat	Natural breeding season	Average number of eggs	Feasibility of laboratory cultivation
Gammarus lacustris	Mountain freshwater lakes (occasionally brackish)	Restricted (only during spring–summer months)	~10–15 eggs (up to 20 in large females)	**Good** (tolerant to temperature and salinity; high nutritional value)
Gammarus pulex	Freshwater streams and springs	Several generations in temperate climates (spring and autumn)	15–40 eggs (depending on female size)	**Good** (requires water flow and clean environmental conditions)
Gammarus aequicauda	Brackish lakes and coastal zones (Caspian region)	Prolonged (throughout most of the year)	~38 eggs	**Difficult** (requires brackish water; rarely used in aquaculture)
Gammarus komareki	Freshwater springs (Central Asia, Iran)	Potentially year-round	~9 eggs	**Good** (small brood size, but continuous reproduction)
TurkoGammarus aralensis	Brackish waters (Aral Sea basin)	Limited (seasonal cycle of the Aral Sea)	No data (estimated 20–30 eggs)	**Difficult** (requires saline water; population status uncertain)

From the comparative table above, it is evident that among the representatives of *Gammarus*, *G. lacustris* stands out due to its high ecological adaptability and nutritional value. For example, *G. lacustris* is an euryhaline species, tolerant to fluctuations in salinity, and capable of living both in freshwater and slightly brackish environments. In contrast, *G. pulex* occurs exclusively in freshwater and typically inhabits running waters (rivers). For successful laboratory cultivation, *G. pulex* requires stronger water flow and higher levels of dissolved oxygen. Species such as *G. aequicauda* and *T. aralensis* are adapted to saline waters and require specific salt regimes [4. P. 101, 14. P. 38]. Creating and maintaining such

conditions artificially can be difficult and economically inefficient. Therefore, the cultivation of *G. lacustris* is advantageous in several respects:

- its natural range is wide, and local populations are readily available, making the collection of initial stock easy;
- being a freshwater species, it does not require additional adaptation when introduced into fish farms;
- it has high biological and nutritional value;
- under optimal conditions, it matures rapidly and reproduces continuously.

Protocols proposed by various authors for laboratory cultivation of *Gammarus* species, including *Gammarus lacustris*, have demonstrated positive outcomes in practical applications. When the recommended parameters in the literature – such as temperature, feed composition, water chemistry, and aeration regimes – are aligned with the physiological requirements of *Gammarus*, colonies transition to a stable growth phase within a short period. Several studies report that after 2–3 months, the total biomass may increase by an average of 15–25% per month, and that multiple generations (up to 4–5) may be produced within a single year.

According to literature data, low levels of disease and mortality in laboratory systems are primarily associated with maintaining high dissolved oxygen concentrations, limiting pollution, and regularly removing excess feed residues. Conversely, in containers with insufficient aeration, high organic load, and poor water exchange, increased mortality and a sharp decline in reproductive activity have been reported within several weeks. Some studies indicate that under optimized laboratory conditions – where temperature, light regime, and water quality are strictly controlled – the frequency of egg carrying in *G. lacustris* females increases, and the proportion of reproductively active females becomes higher. In contrast, such reproductive activity is almost never observed in low-oxygen or contaminated water conditions.

The literature also reports that laboratory-produced biomass of *G. lacustris* and other *Gammarus* species has been tested as live feed for various aquaculture organisms. When small carp species, salmon, and trout were fed live *Gammarus*, their growth rate and feed conversion efficiency were higher compared with control groups that received only dry formulated feed. Several authors note that the inclusion of live or dried *Gammarus* in the diet enhances body coloration in fish, attributing this effect to the natural carotenoids and other pigments present in *Gammarus*. Historical and modern sources additionally describe the use of *Gammarus* not only in fish farming but also as a high-nutritional supplement for poultry chicks and certain domestic animals for fattening purposes [19. Pp. 1–23]. This further confirms the versatility and nutritional value of this organism as a feed resource.

Ecological significance. The ecological characteristics outlined above make *G. lacustris* an exceptionally suitable organism for laboratory cultivation. This species is distinguished by its ability to tolerate wide ranges of temperature and water mineralization; in other words, it is both eurythermal and euryhaline, capable of actively surviving even in near-freezing waters. In natural ecosystems, *G. lacustris* populations expand rapidly and reach high biomass levels in habitats where predatory fish are absent, whereas in water bodies containing predators, their numbers remain naturally regulated.

Cultivating *G. lacustris* in the laboratory for aquaculture purposes not only creates a stable source of live feed but is also ecologically significant. The development of artificial breeding technologies reduces pressure on wild populations by preventing unnecessary harvesting from natural habitats, thereby contributing to the preservation and stability of natural ecosystems.

Therefore, establishing a stable laboratory colony requires maintaining *G. lacustris* specimens in predator-free, isolated containers and ensuring optimal ecological parameters – namely, appropriate temperature, continuous aeration, and a balanced diet. Such conditions support rapid and efficient reproduction of the species and allow for year-round, continuous production of high-quality live feed for aquaculture needs.

CONCLUSION

The present study on the laboratory cultivation of *Gammarus lacustris* demonstrates that this organism possesses exceptionally high potential as a source of live feed in aquaculture. According to research findings, the high levels of proteins, lipids, and various microelements in *G. lacustris* characterize it as a highly suitable, nutritious, and biologically rich food source for fish larvae and juvenile stages. Incorporating *Gammarus* into the diet has been shown to significantly enhance growth rates, strengthen immune responses, and improve the overall physiological condition of fish.

Studies have shown that when specific laboratory conditions are maintained – such as a temperature of

15–18 °C, a 12/12-hour photoperiod, continuous aeration, and a balanced diet consisting of detritus and protein-rich feeds – *G. lacustris* is capable of continuous reproduction over multiple generations in a closed system. This makes it possible to produce high-quality live feed consistently throughout the year.

The technological advantages of *G. lacustris* are particularly noteworthy, as the species possesses both eurythermal and euryhaline characteristics, enabling it to successfully adapt to a wide range of ecological conditions. For example, this species is capable of surviving in cold waters, even at temperatures near freezing, while also demonstrating active growth at around +20 °C. By comparison, *G. pulex* requires strictly freshwater, fast-flowing environments, whereas *G. aequicauda* is adapted to brackish habitats. *G. lacustris*, however, surpasses these local species in its ability to tolerate both conditions, making it more versatile and advantageous for controlled cultivation.

From an economic perspective, cultivating *Gammarus* under farm conditions can significantly reduce the demand for expensive imported Artemia cysts. In addition, controlled propagation of *Gammarus* provides a stable feed source for the domestic market without overexploiting natural populations. Economic assessments indicate that if large-scale production of *Gammarus* is established, the market price of its dried or frozen product is expected to decrease substantially, thereby expanding its applicability in large-scale aquaculture operations.

Overall, the findings of this study scientifically and practically confirm that *G. lacustris* is a highly suitable, economically advantageous, and biologically valuable live feed organism for aquaculture under the conditions of Central Asia. Further improvement of its laboratory cultivation technologies may yield significant benefits for supplying fish farms with high-quality live feed in the future.

References:

1. Ashour, M., Abo-Taleb, H.A., Hassan, A-KM., Abdelzaher, O.F., Mabrouk, M.M., Elokaby, M.A., Alzahrani, O.M., Mahmoud, S.F., El-feky, M.M.M., Shaban, W.M., Mansour, A.T. (2021). Valorization use of amphipod meal, *Gammarus pulex*, as a fishmeal substitute on growth performance, feed utilization, histological and histometric indices of the gut, and economic revenue of grey mullet. *Journal of Marine Science and Engineering*. Vol. 9. Iss. 12. Pp. 1-15.

2. de March, B.G.E. (1982). Decreased day length and light intensity as factors inducing reproduction in *Gammarus lacustris* lacustris Sars. *Canadian Journal of Zoology*. Vol. 60. Iss. 11. Pp. 2962-2965.

3. Berezina, N.A. (2004). Prichiny, osobennosti i posledstviya rasprostraneniya chuzherodnykh vidov amfipod v vodnykh ekosistemakh Yevropy [Causes, features, and consequences of the spread of alien amphipod species in European aquatic ecosystems]. In: *Biologicheskie invazii v vodnykh i nazemnykh ekosistemakh* [Biological invasions in aquatic and terrestrial ecosystems]. Sankt-Peterburg: KMK Scientific Press Ltd. Pp. 254–268.

4. Copilaș-Ciocianu, D., Sarmanov, A., Sergaliyev, N., Sidorov, D. (2022). *TurgoGammarus aralensis* (Uljanin, 1875), a relict pontogammarid amphipod crustacean from the Aralo-Caspian paleobasin: redescription, phylogenetic position and biogeography. *Zootaxa*. Vol. 5219. No. 2. Pp. 101-120.

5. Harlıoğlu, M.M., Farhadi, A. (2018). Importance of *Gammarus* in aquaculture. *Aquaculture International*. Vol. 26. Pp. 1327-1338.

6. “Algova” online retail store. URL: https://algova.com (Date of Access: 15.11.2025).

7. “Yandex Market” online retail store. [Online]. URL: https://market.yandex.ru (Date of Access: 15.11.2025).

8. Kozlov, O.V., Sadchikov, A.P. (2016). Ozyornyy bokoplav *Gammarus lacustris* v vodoyomakh Zapadnoy Sibiri i Bashkirii [Lake amphipod *Gammarus lacustris* in the water bodies of Western Siberia and Bashkiria]. In: *Materialy po flore i faune Respubliki Bashkortostan* [Materials on the flora and fauna of the Republic of Bashkortostan]. No. 10. Pp. 11–15.

9. Kruglova, O.Yu. (2014). Klass Crustacea – Rakoobraznye: metod. Rekomendatsii [Class Crustacea – Crustaceans: Methodological guidelines]. In 2 parts. Part 2. Vysshie rakoobraznye. Minsk: Belarusian State University. 43 p.

10. Lyubina, O.S., Sayapin, V.V. (2008). Amfipody (Amphipoda, Gammaridea) iz razlichnykh geograficheskikh rajonov: vidovoi sostav, raspredelenie, ekologiya [Amphipods (Amphipoda, Gammaridea) from various geographic regions: species composition, distribution, and ecology]. Apatity: Kolskii nauchnyi tsentr RAN. 182 p.

11. Mathias, J.A., Martin, J., Yurkowski, M., Lark, J.G.I., Papst, M., Tabachek, J.L. (1982). Harvest and nutritional quality of *Gammarus lacustris* for trout culture. *Transactions of The American Fisheries Society.* Vol. 111. Pp. 83-89.

12. Mirzajani, A., Sayadrahim, M., Sari, A. (2011). Reproductive traits of some amphipods (Crustacea: Peracarida) in different habitats of Iran and Southern Caspian Sea. *International Journal of Zoology*. Article ID 598504. 10 p.

13. Mirzajani, A.R., Heidari, O., Khodaparast Sharifi, H. (2011). Some biological aspects of *Gammarus lacustris* Sars, 1863 in Neur Lake Ardebeel province, Iran. *Iranian Journal of Fisheries Sciences*. Vol. 10. Iss. 2. Pp. 242-253.

14. Azimov, J.A. (ed.). (2019). *O'zbekiston Respublikasining Qizil kitobi. 2-jild: Hayvonlar* [The Red Book of the Republic of Uzbekistan. Vol II: Animals]. Tashkent: Tasvir.

15. Rufchaei, R., Hoseinifar, S.H., Mirzajani, A., van Doan, H. (2017). Dietary administration of *PontoGammarus maeoticus* extract affects immune responses, stress resistance, feed intake and growth performance of Caspian roach (*Rutilus caspicus*) fingerlings. *Fish & shellfish Immunology*. Vol. 63. Pp. 196-200.

16. Sedova, N.A., Nasonova, N.E. (2014). Kultivirovanie bokoplava *LocustoGammarus locustoides* (Brandt, 1851) v neprotochnoy morskoy vode [Cultivation of the amphipod *LocustoGammarus locustoides* (Brandt, 1851) in non-flowing seawater]. *Vestnik Kamchatskogo gosudarstvennogo tekhnicheskogo universiteta*. No. 29. Pp. 75-80.

17. Vereshchagina, K., Kondrateva, E., Mutin, A. et al. Low annual temperature likely prevents the Holarctic amphipod *Gammarus lacustris* from invading Lake Baikal. *Scientific reports*. Vol. 11. 10532. 14 p.

18. Weslawski, J. M., Opalinski, K. and Legezynska, J., 2000. Life cycle and production of *Onisimus litoralis* (Crustacea Amphipoda): The key species in the Arctic soft sediment littoral. *Polish archives of hydrobiology*. Vol. 47. Iss. 3-4. Pp. 585-596.

19. Yemelyanova, A.Y. (2003). *Nekotorye aspekty ekologii i pitaniya bokoplava Gammarus lacustris Sars iz ozera Shira (Khakasiya)* [Some aspects of the ecology and feeding of the amphipod *Gammarus lacustris* Sars from Lake Shira (Khakasia)]. Abstract of the thesis for the degree of Candidate of Biological Sciences. – Borok.

20. Yemelyanova, A.Y., Temerova, T.A., Degermendzhy, A.G. (2002). Distribution of *Gammarus lacustris* Sars (Amphipoda, Gammaridae) in Lake Shira (Khakasia, Siberia) and laboratory study of its growth characteristics. *Aquatic ecology*. Vol. 36. Pp. 245–256.

GAMMARUS LACUSTRIS (AMPHIPODA: GAMMARIDAE)NING EKOLOGIK XUSUSIYATLARI VA UNI LABORATORIYA SHAROITIDA AKVAKULTURADA KO'PAYTIRISH ISTIQBOLLARI: ADABIYOTLAR SHARHI

F.G. Fazliddinov[1], F.U. Umarov[1], X.H. Solijonov[1,2]

Ilmiy xabarnoma. Seriya: Biologik tadqiqotlar – Scientific Bulletin. Series: Biological Research. 2025. 8(92). 57-65.

[1]Andijon davlat universiteti, Andijon, 170100, Universitet ko'chasi, 129 (O'zbekiston). E-mail: agsu_info@edu.uz

[2]Atrof-muhit va tabiatni muhofaza qilish texnologiyalari ilmiy tadqiqot instituti, Toshkent, 100043, Bunyodkor ko'chasi, 7a (O'zbekiston). E-mail: ecoilm@umail.uz

Maqola qo'yilgan muammoga oid mavjud ilmiy adabiyotlar, nashrlar, monografiyalar va eksperimental tadqiqotlar tahliliga asoslangan bo'lib, *Gammarus lacustris* G.O. Sars, 1863 turining ekologik xususiyatlari va laboratoriya sharoitida akvakultura maqsadlarida ko'paytirish imkoniyatlari bo'yicha mavjud ma'lumotlarni jamlab, tizimli sharh ko'rinishida taqdim etadi. Tadqiqotning asosiy maqsadi – *G. lacustris* haqidagi ilmiy manbalarda keltirilgan ekologik, fiziologik va biotexnologik ma'lumotlarni birlashtirish,

uning yem sifatidagi ozuqaviy qiymati hamda Markaziy Osiyo sharoitida foydalanish istiqbollarini umumlashtirilgan tahlil asosida yoritishdan iborat.

Material sifatida so‘nggi yillardagi xalqaro va mintaqaviy ilmiy adabiyotlar, *G. lacustris*ning tarqalishi, morfologik va fiziologik belgilari, biokimyoviy tarkibi, ko‘payish parametrlari, akvakultura amaliyotida qo‘llanishi va boshqa *Gammarus* turlari bilan solishtirma baholashga bag‘ishlangan nashrlar ishlatilgan. Maqola original tajriba natijalariga emas, balki metodik taqqoslash va analitik umumlashtirishga asoslanadi. Foydalanilgan usul – ko‘p manbali adabiyotlar sharhi, ekologik va ozuqaviy ko‘rsatkichlarning taqqoslovchi tahlili hamda joy va ko‘payish parametrlarining integrativ baholanishidir.

Adabiyotlar sharhi *G. lacustris*ning keng ekologik diapazonga ega ekanini ko‘rsatadi: u sovuq tog‘ ko‘llaridan tortib, biroz sho‘rxok pasttekislik suv havzalarigacha bo‘lgan muhitlarda yashashi mumkin. Quruq massadagi oqsil (~40–45%), yog‘ (5–10%) va karotinoidlarning yuqoriligi uning akvakulturada yem sifatidagi ahamiyatini tasdiqlaydi. Adabiyotlarda *G. lacustris*ning jonli va quritilgan shaklda ko‘plab baliq turlarida o‘sish sur’ati, yemdan foydalanish samaradorligi hamda immunitetni yaxshilovchi yuqori ozuqaviy yem komponenti sifatida qo‘llanishi keng tasdiqlangan. Manbalar shuni ko‘rsatadiki, laboratoriya sharoitida optimal harorat (14–18 °C), neytralishqoriy pH, doimiy aeratsiya va 10–12 soatlik fotoperiodda *G. lacustris* koloniyalari bir necha avlod davomida barqaror ko‘payishi mumkin.

Sharhda *G. lacustris* boshqa turlardan ekologik moslashuvchanligi va texnologik qulayligi bilan ajralib turishi ta’kidlanadi. Xususan, *G. pulex* oqimli chuchuk suvni, *G. aequicauda* esa sho‘r muhitni talab qilishi tufayli laboratoriyada ko‘paytirish murakkab bo‘lsa-da, *G. lacustris* har ikki sharoitga nisbatan chidamliroq ekani aniqlangan. Manbalarda *Gammarus* unini baliq yemiga qo‘shish natijasida o‘sish sur’atlari va immun ko‘rsatkichlar oshgani qayd etilgan.

Xulosa sifatida adabiyotlar sharhi *G. lacustris*ning Markaziy Osiyo akvakultura tizimlarida istiqbolli jonli yem manbai ekani, laboratoriya sharoitida ko‘paytirish texnologiyalarining rivojlanishi yovvoyi populyatsiyalarga bosimni kamaytirishi, import yemlar o‘rnini bosishi va iqtisodiy samaradorlikni oshirishi mumkinligini ko‘rsatadi. Maqola mavjud ilmiy manbalarni tizimli tahlil qilish orqali ushbu turdan foydalanish bo‘yicha ilmiy asoslangan umumiy xulosalarni beradi.

Mualliflar haqida ma’lumot:

FAZLIDDINOV Firdavs G‘ayratjon o‘g‘li– Andijon davlat universiteti Ekologiya va barqaror rivojlanish kafedrasi tayanch doktoranti. E-mail: firdavsbiologist@gmail.com.

UMAROV Farrux Ulug‘bekovich – biologiya fanlari bo‘yicha falsafa doktori, Andijon davlat universiteti Ekologiya va barqaror rivojlanish kafedrasi dotsenti. E-mail: eco_umarov@mail.ru.

SOLIJONOV Xayrulla Habibulla o‘g‘li – biologiya fanlari bo‘yicha falsafa doktori, Andijon davlat universiteti Ekologiya va barqaror rivojlanish kafedrasi dotsenti; Atrof-muhit va tabiatni muhofaza qilish texnologiyalari ilmiy tadqiqot instituti doktoranti. E-mail: khsolijonov1991@gmail.com.