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# FRESHWATER SHRIMP MACROBRACHIUM NIPPONENSE AS A POTENTIAL SPECIES FOR AQUACULTURE DEVELOPMENT IN UZBEKISTAN

Kim S. I.
Astrakhan State Technical University
Tashkent Region Branch, Republic of Uzbekistan

Normyrzayeva N. B.
Astrakhan State Technical University Tashkent
Region Branch, Republic of Uzbekistan

**Abstract**
The freshwater shrimp Macrobrachium nipponense, which is an accidental introduction, inhabits the waters of Uzbekistan.
It has now successfully acclimatized and become a vital component of our aquatic ecosystems. However, the species remains understudied and is not used for breeding in our republic.

**Keywords**: Freshwater shrimp Macrobrachium nipponense, maintenance conditions, biological characteristics of the species.

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## Introduction

# ПРЕСНОВОДНАЯ КРЕВЕТКА MACROBRACHIUM NIPPONENSE КАК ПОТЕНЦИАЛЬНЫЙ ОБЪЕКТ РАЗВЕДЕНИЯ В АКВАКУЛЬТУРЕ УЗБЕКИСТАНА

Ким С. И.
Филиал Астраханского технического государственного университета в Ташкентской области Республики Узбекистан

Нормырзаева Н. Б.
Филиал Астраханского технического государственного университета в Ташкентской области Республики Узбекистан

## Introduction

Shrimp farming and cultivation is one of the most profitable aquaculture businesses globally. However, shrimp production remains largely unknown in the Central Asian region. Shrimp belong to the order Crustacea (Decapoda). Like crabs, lobsters, crayfish, and crayfish, their meat is highly nutritious, containing high amounts of protein (up to 25%), essential amino acids, valuable micronutrients (phosphorus, iron, calcium, potassium), and vitamins (A, D, B), all while remaining low in calories. Shrimp occupy a position between delicacy and mass-market consumer goods. The introduction of shrimp into aquaculture could open up a new sector in the republic's agriculture.

The freshwater shrimp Macrobrachium nipponense, which is an accidental introducer, lives in the waters of Uzbekistan (Fig. 1).

**Figure 1 – Freshwater shrimp Macrobrachium nipponense**

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It has now successfully acclimatized and become a vital component of our aquatic ecosystems. However, the species remains understudied and is not used for breeding in our republic.

During 2006-2008, the Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan and the Uzbek Research Center for the Development of Fish Farming conducted studies on the biological characteristics of this species of shrimp with the aim of further developing industrial technology for growing freshwater shrimp in Uzbekistan and the subsequent use of this technology by farms.

In this regard, we were tasked with the following: studying the biology of the local acclimatized shrimp species, optimal temperature and salinity conditions, developing optimal stocking density standards, studying the conditions of maintenance, reproduction, feeding, diseases, and also studying other shrimp species to identify promising species for cultivation in Uzbekistan.

The study focused on freshwater shrimp populations from various water bodies in Uzbekistan. The diversity of water bodies in terms of hydrological and hydrochemical conditions, including lakes, ponds, rivers, canals, and reservoirs, was a key factor.

During the first phase of the project, the taxonomic status of shrimp from various bodies of water in Uzbekistan was clarified, their morphology, developmental biology, optimal temperature and salinity conditions, and fecundity were studied, and a study of international practices in freshwater shrimp cultivation was initiated. Shrimp populations from the Aydar-Arnasay lake system were studied in various seasons, from canals and ponds of the Yangiyul District Shrimp Farm, and from the ponds of the Aquaculture Joint Venture (Tashrybopitomnik, Tashkent Region).

A comparative analysis of morphometric parameters, size, age, and sex composition of various populations was conducted. Spawning timing was determined, and fecundity in the wild was studied.

Shrimp belong to the order Decapoda—ten-legged crustaceans. The classification of crustaceans has undergone significant changes in recent years and is still under development. The taxonomy of freshwater shrimp from

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Uzbekistan was determined using Dorothy E. Bliss's classification of modern crustaceans, as presented in her book "The Biology of Crustacea" (NY, London: 1982).

Phylum, Subphylum, or Superclass Crustacea, Pennat 1977.
Class MALOCOSTRACA ; Latreille, 1800.
Subclass EUMALACOSTRACA ; Grobben 1892.
Superorder SYNCARIDA; Packard, 1985.
Order DECAPODA; Latreille, 1803.
Suborder PLEOCYEMATA; Bunkenrodd, 1963.
Infraorder CARIDA; Dana, 1852.
Superfamily PALAMONOIDEA; Rafinesque.
Family PALAEMONIDAE; Rafinesque, 1815.
Genus MACROBRACCHIUMBate, 1868
Species MACROBRACHIUM NIPPONENSE; De Haan, 1849

The oriental shrimp M. nipponense was first described from Japanese waters in1849. V. De Haan, where it inhabits all the islands of the country except the northernmost, Hokkaido. It is currently a common aquaculture species in China, Japan, and Vietnam. This species is listed as a commercial shrimp species by the Food and Agriculture Organization (FAO). Its distribution range has recently expanded due to exports (primarily from China) and accidental introductions. Its presence has been recorded in Iran (near the Caspian Sea), Pakistan, India, Singapore, Ukraine, and Central Asia.

Morphologically, the oriental shrimp differs from other species of the genusMacrobrachium Long legs of the second pair and the structure of the rostrum. The rostrum is a serrated, pointed plate. It is well developed, immobile, and oriented vertically. Typically, the upper edge of the rostrum has 11–15 teeth, the lower edge has 2–3 teeth. The eyes are large and pigmented. The body is transparent and speckled. The body length does not exceed86 mm(males) and 75 mm (females), averaging 40–50 mm. Sexual dimorphism is expressed by the larger size of males compared to females, the proportions of the second walking legs, and the structure of the abdominal legs. Males have an additional appendage

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on the second pair of abdominal legs, which is important during copulation (Fig. 2).

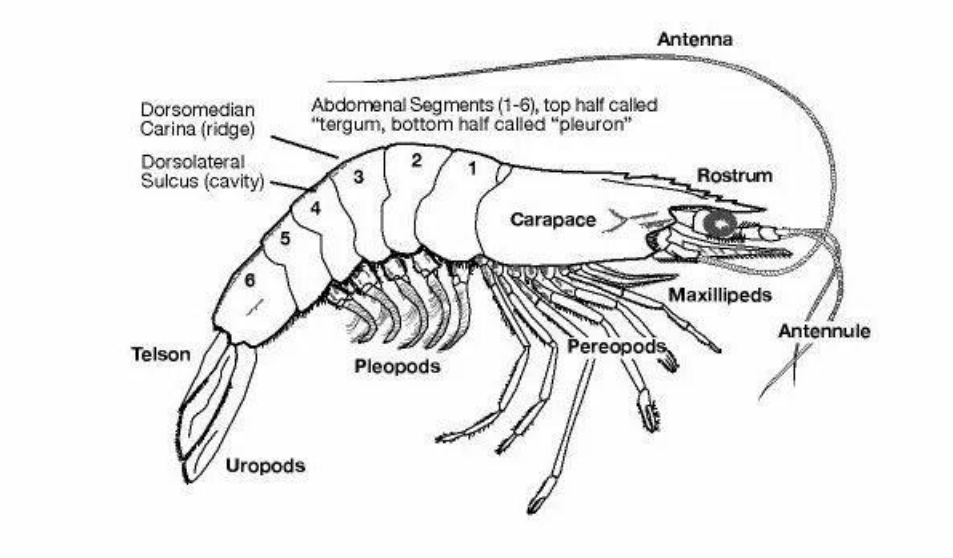


**Fig. 2 - General diagram of the structure of shrimp**

One of the most important biological characteristics of a species, determining its breeding strategy, is fecundity. This study aimed to determine the fecundity of Macrobrachium nipponense shrimp in certain water bodies in Uzbekistan and to identify the possible impact of environmental factors on it.

Material for research was collected in the Aidar-Arnasay system of lakes (AASO) in lakes Tuzkan and Aidar in May2006The catch was made using homemade plastic traps. A total of 42 females were caught and measured. The shrimp were collected at the Aquaculture joint venture (Tashkent region) in August.2006Selective fishing was conducted using nets and traps with different mesh sizes. A total of 28 females were captured and measured.

The studied shrimps were conditionally divided into several weight groups, in which absolute and relative fecundity, egg parameters (their diameters and volume) were determined (Tables 1, 2)

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**Table 1. Fecundity of the shrimp Macrobrachium nipponense Aydar-Arnasai lake system.**

| Weight group (mg) | Length of the female (mm) | IN (mg) | Aabs. (pcs) | Aotn. (pcs/mg) | M (mg) | m (mg) | d (mm) |
|---|---|---|---|---|---|---|---|
| 1000-1500 n= | 50 | 1255 | 739 | 0.58 | 148 | 0.2 | 0.6 |
| 1500-2000 | 55.5 | 1762 | 1133 | 0.64 | 204 | 0.18 | 0.58 |
| 2000-2500 | 63 | 2292 | 1355 | 0.59 | 271 | 0.2 | 0.6 |
| 2500-3000 | 66 | 2820 | 1850 | 0.66 | 370 | 0.2 | 0.6 |
| >3000 | 70 | 3230 | 1925 | 0.6 | 385 | 0.2 | 0.6 |

It was found that egg mass and absolute fecundity increase with increasing shrimp body weight. For the shrimp populations of Lakes Aydar and Tuzkan studied, for every 500 mg increase in body weight, egg mass increases by an average of 26%. It is also worth noting some differences between the females of the Lake Aydar and Lake Tuzkan populations, which we attribute to differences in the hydrochemical regimes of the lakes. For example, the total mineralization of Lake Tuzkan (Kly mouth), where the material was collected, is 5 g/L, while that of Lake Aydar (central part) is 7 g/L (unpublished data). A comparison of the fecundity of shrimp from these populations in corresponding weight categories revealed that the fecundity of females from Lake Aydar in a certain category is approximately 4% lower.

With increasing mineralization, the fecundity of Macrobrachium nipponense shrimp decreases; we find confirmation of this opinion in the work of K. Mashiko [2]. We also attribute the low fecundity of shrimp from lakes Tuzkan and Aydar to this, compared with the fecundity of females sampled from the ponds of the Aquaculture joint venture, whose water is fresh (up to 1 g/l). Thus, while the average absolute fecundity of AASO females is 1,400 eggs, this figure is 2,900 in the ponds of the Aquaculture joint venture, i.e., the latter is more than twice as high.

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**Table 2. Fecundity of the shrimp Macrobrachium nipponense from the ponds of the Aquaculture joint venture (Tashrybpitomnik)**

| Weight group (mg) | Length of the female (mm) | B (mg) | M (mg) | m (mg) | Aabs. (pcs) | Aotn. (pcs/mg) | d eggs (mm) |
|---|---|---|---|---|---|---|---|
| 2500-3000 | 63 | 2850 | 408 | 0.17 | 2400 | 0.84 | 0.6 |
| 3000-3500 | 67 | 3288 | 520 | 0.17 | 3058 | 0.93 | 0.6 |
| > 3500 | 69 | 3930 | 566 | 0.17 | 3329 | 0.84 | 0.6 |

The weight of shrimp from the ponds of the Aquaculture joint venture is greater than in AASO, where we did not find shrimp with a similar weight (more than 4000 mg).

The main indicators of shrimp fertility of AASO and SP "Aquaculture" are given in Table 3.

**Table 3. Fecundity of shrimp in the AASO and ponds of the Aquaculture Joint Venture**

| Indicator | AASO | JV "Aquaculture" |
|---|---|---|
| Average shrimp weight (mg) | 1974 | 3295 |
| Maximum shrimp weight (mg) | 3315 | 4400 |
| Absolute fertility (pcs) | 1278 | 2960 |
| Max. absolute fertility (pcs) | 2687 | 4330 |
| Relative fecundity (pcs/mg) | 0.61 | 0.87 |

Table 3 shows that, in all 5 indicators, shrimp from the ponds of the Aquaculture joint venture differ significantly from shrimp caught in the AASO.

As a result, the following conclusions were made:

1. Female shrimp from the pond population of the Aquaculture joint venture, compared to AASO females, have a number of advantageous qualities:

- have greater mass and fatness;
- their absolute fertility exceeds the fertility of AASO females by more than 2 times;

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- The relative fertility of females from the Aquaculture joint venture also exceeds this indicator for females from the AASO.

2. Differences in fecundity are likely related to different environmental conditions, specifically water salinity. As salinity increases, the fecundity of Macrobrachium nipponense shrimp decreases.

3. In the matter of selecting a shrimp population for the purpose of selecting females to create a broodstock, from the point of view of the fertility rate, undoubted preference should be given to the population of the ponds of the Aquaculture joint venture.

The study of the sexual structure of populations allowed us to draw the following conclusions:

- the sex structure of different populations differs significantly from each other, the difference is especially great between natural and artificial reservoirs;
- The following size groups were most fully represented in the studied material: 31–40 mm, 41–50 mm, 61 –70 mm;
- individuals measuring 31 –40 mmare not yet sexually mature;
- the largest number of large females (size group 61 – 70 mm – 15 females; 71 – 80 mm - 13 females with mature eggs were caught in artificial reservoirs (ponds);
- Lake Tuzkan stands out in terms of the number of males and their size.

Therefore, if you plan to artificially produce offspring from Macrobrachium nipponense, you should catch females in the ponds of the Aquaculture joint venture and males in Lake Tuzkan, which will undoubtedly improve the genotype of the population.

**Maintenance and breeding of freshwater shrimp Macrobrachium nipponense in artificial conditions**

The next stage of the study was to identify the optimal conditions for maintaining and breeding the freshwater shrimp Macrobrachium nipponense in aquariums. To this end, several experiments, lasting from one to several months, were conducted to determine the optimal temperature and hydrochemical conditions for the growth and reproduction of this species, food preferences and diets, spawning

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timing and duration of egg development, and, most importantly, the feasibility of producing offspring in artificial conditions.

NutritionBased on literature data and our own stomach content studies of the caught shrimp, it was concluded that while they are quite flexible in their choice of food, they are nevertheless selective in their diet, a finding confirmed by further research. The following foods were offered: meat, fish, cereals, and fruit—both raw and cooked; as well as dry vitamin-enriched foods (Tetramin), special shrimp foods with added spirulina (12%), and live foods of animal and plant origin available to aquarists—bloodworms (Chironomus plumosus), tubifex, horny spool (Planorbis corneus), Java moss (Vesicularias dubyana), heleocharis acicularis, and cryptocoryne (Cryptocoryna affinis).

Since shrimp are predators, they preferred to eat live food. They ate foods uncommon in their natural habitat, such as rice, dried apricots, and vermicelli, only when animal food was unavailable and refused them when they were regularly fed.

We also recorded:

1. reaction to each type of food (time in seconds and minutes);
2. the percentage of individuals that reacted to the food and refused it;
3. amount of food eaten (as a percentage of the one-time feeding volume)

Hydrochemistry and temperature regime.During the experiments, the following features of shrimp keeping were established:

1. the ability of representatives of the species Macrobrachium nipponense to live in artificial conditions without additional aeration, but only within a certain temperature range;
2. The optimal conditions for keeping this species are a temperature of 24-27°C, which requires additional aeration, and the aerator should ensure water circulation.
3. Cleaning of water and bottom should be done systematically; food remains should be removed immediately.

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4. Transportation of individuals (especially breeders) should be carried out as quickly as possible, without allowing a sharp temperature jump in the transport container.

Reproduction. Several aquariums were set up for the breeding of Macrobrachium nipponense shrimp. In some, pairs were created randomly, while in others, pre-formed breeding pairs were introduced, and females with ready-to-eat eggs were kept separately. The following observations were made:

1. spawning periods;
2. number of clutches per season and their frequency;
3. the ability to regulate the caviar maturation process by changing the temperature;
4. the number of larvae obtained from one female.
5. The frequency of molting, which indicates the growth of the individual and is one of the factors confirming the readiness of females for fertilization.

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