Prospects for the cultivation of Australian red claw crayfish Cherax quadricarinatus on warm waters of energy facilities

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Abstract. River crayfish - a delicious food product. On the caloric content (72kcal/100g), the content of fats (2.83%), protein (17.13%) and vitamins of group B (thiamine, riboflavin, etc.), crayfish are not inferior to freshwater fish, and by a number of parameters exceed them. Meat of crayfish is rich in sulfur, phosphorus, iron, cobalt, magnesium, fluorine, potassium, selenium, chromium, calcium and vitamins of group B (B12, B6, B2, B1, B9,), C, E, K, PP and D. There is practically no cholesterol in it, but there are a lot of organic acids. A promising target of cultivation, both in Russia and abroad, is currently the Australian red-cheeked crayfish Cherax quadricarinatus. It is cultivated in such countries as: China, Brazil, Ecuador, America, and others. Currently, in spite of the presence of active crayfish farms in Russia, the biotechnology of growing Cherax quadricarinatus is not sufficiently developed. The main advantages of Cherax quadricarinatus over crayfish that live in our region (Astacus leptodactylus, Astacus astacus, etc.) are: high growth rate, tolerance to water quality, lack of pelagic larva stage. It is advisable to use cooler reservoirs of energy objects for growing valuable warm water aquaculture objects, since the water temperature of these reservoirs is higher than the natural. Energy can contribute to the development of warm water crayfish farming both in the Republic of Tatarstan and in Russia as a whole. Due to the excessive heat that enters the natural reservoirs from energy facilities, an excellent opportunity appears in the absence of the cost of expensive equipment, to grow valuable products. According to expert estimates, the cultivation of crayfish is 5-6 times more profitable than fish.

Introduction
River crayfish – a delicious food product. On the caloric content (72 kcal/100g), the content of fats (2.83%), protein (17.13%) and vitamins of group B (thiamine, riboflavin, etc.), crayfish are not inferior to freshwater fish, and by a number of parameters exceed them. Meat of crayfish is rich in sulfur, phosphorus, iron, cobalt, magnesium, fluorine, potassium, selenium, chromium, calcium and vitamins of group B (B12, B6, B2, B1, B9,), C, E, K, PP and D. There is practically no cholesterol in it, but there are a lot of organic acids [10, 12]

Meat of crayfish is used as food as well, as their skeletal parts. Hard outer cover of crayfish contains a large amount of calcium and phosphorus, so it is used to make medicines, for example, chitosan is widely used in medicine and in cosmetology.

Due to the high nutritional value, crayfish is traditionally in high demand in many countries. So, in Sweden annual consumption is 2000-3000 tons of crayfish, in France - more than 2000 tons, the demand for crayfish in Spain reaches 12,500 tons [2]. For highly developed countries, crayfish is an exquisite delicacy food product, for countries that are economically less developed - the object of
exports and additional income. In the markets of Scandinavian countries, France, Spain, the purchase price of 1 kg of crayfish reaches 35 US dollars and above (Astacus astacus and some local crayfish) [3]. The high value of crayfish as objects of farming also determines the high interest in the development of aquabiotechnology for their cultivation.

When choosing the objects of crayfish cultivation, the limiting factors are temperature, water quality, the presence of shelters. Among the promising objects of cultivation on warm waters of energy objects - Australian red claw crayfish Cherax quadricarinatus. It is cultivated in such countries as: China, Brazil, Ecuador, America, and others. [4].

The shell is blue, and there may also be colored spots. A distinctive feature of the males is a bright orange spot on the outside of the claw. It is assumed that stains are used in communication between individuals of the population, including information about the physiological state of the individual [5]. In the natural environment, the length of the red claw Australian crayfish can reach 20-25 cm. Weight up to 500 g for males, for females - up to 400 g [6].

Figure 1 shows the layout of the structure Cherax quadricarinatus.

![Figure 1](image_url)

**Figure 1.** A, B – structure Cherax quadricarinatus (von Martens, 1868): 1 – telson and uropods; 2 – abdomen; 3 – carapace; 4 – rostrum; 5 – antennules; 6 - antennas 7 – pereiopods (the first 3 pairs in the form of claws); 8 – pleopods.

**Results and discussion**

The quality of water required for cultivation Cherax quadricarinatus

The temperature of effective intensive cultivation of Australian crayfish is 25-30 °C [13, 14]. Lethal are temperatures below 10 °C and above 36 °C [6]. At a temperature below 20°C there is a decrease in activity, growth rate, resistance of individuals to diseases. For juveniles, the critical temperature is below 20 °C and above 32-34 °C [7].

Possibilities of using the potential of natural reservoirs of the Volga region are extremely limited, since the suitable water temperature for the cultivation of Cherax quadricarinatus lasts about 2-3 months. This time period is not enough for the young Cherax quadricarinatus to reach commercial
size. This makes it especially promising to use warm waters of thermal power facilities for the cultivation of red claw crayfish. In accordance with environmental requirements, the water temperature in reservoirs with discharges of warm waters of energy objects may rise in winter by 5 °C, and in summer - by 3 °C above the natural maximum temperature [1]. Thanks to the dumping of warm waters by thermal power stations into cooler reservoirs, it becomes possible and promising to locate industrial breeding farms for the cultivation of valuable aquaculture objects of Australian red claw crayfish (Cherax quadricarinatus).

Features of cultivation Cherax quadricarinatus

The main advantages of Australian red claw crayfish in comparison with the crayfish living in the middle regions of Russia (Astacus leptodactylus, Astacus astacus, etc.) are: high growth rate, tolerance to water quality, absence of pelagic larva stage. Under optimal growing conditions, the Australian red claw crayfish can reach a commodity weight of 100-120 g in 1 year, while a Astacus leptodactylus crayfish reaches these sizes in more than 6 years [11]. Preliminary calculations show that when creating a crayfish farm on the basis of a reservoir-cooler of a power plant for one season (May-September), it will be possible to grow commodity crayfish with a weight of 70 to 150 g.

Since the red claw crayfish is a new aquaculture object for Russia, at present the biotechnology of the cultivation of Cherax quadricarinatus is not sufficiently developed and requires research. The factor that reduces the results of commodity cultivation of crayfish is cannibalism. It is believed that for Australian red claw crayfish cannibalism is less pronounced [8].

We conducted studies on establishing the values, causes, and methods of reducing mortality associated with cannibalism of red claw crayfish.

At the first stage of the experiment, young Australian crayfish with linear sizes from 1 to 1.5 cm were grown for 30 days with a density of 93.75 exemplars/m² at different feeding rates. In biotechnological standards for the cultivation of these crayfish, the recommended density of planting is 250 g/m² for juveniles up to 5 grams [2].

Since in the industrial cultivation of aquaculture objects the main component of the cost is the cost of feed, it is important to minimize its quantity. At the same time, the lack of food can lead to an increase in the manifestation of cannibalism, which refers to the biological characteristics of red claw crayfish. The results of cannibalism for juvenile crayfish at different feeding rates (in % of body weight) are shown on the Figure 2.

As can be seen from the data shown in Figure 2, when the recommended rate of feeding is reduced from 2% [2] to 1% of the mass, manifestation of cannibalism begin from the first week. With an increase in the feeding norm by 2%, the amount of elimination in the first stages decreases, but by the end of the second month of cultivation the survival rate of crayfish at the feeding norms of 2 and 4% of the body weight becomes the same.

The conducted experiments revealed that if the feeding is insufficient, the amount of elimination increases. With an increase in the norm of feeding, the level of cannibalism does not decrease. Experiments have shown that when growing juveniles of Australian red claw crayfish in the presence of shelters and providing feed, a decrease in the numbers due to cannibalism over a period of 30 days is 20%.

At the second stage of the experiment Australian crayfish with initial linear sizes from 3 to 4.9 cm at the age of 4 months were grown for 50 days at a planting density of 0.16 ind./m² at varied feeding rates. The value of elimination as a result of cannibalism was - 30.3%.

As a result of the experiment it was shown that cannibalism is a significant factor in the cultivation of Australian red claw crayfish. In the presence of shelter, optimal temperature, manifestations of cannibalism are associated with the norm of feeding and age of crayfish. Average minimum elimination values for juveniles of red claw crayfish were 20%, for crayfish at the age of 0.5 years - 33%. Despite the manifestations of cannibalism and the observed elimination, according to expert estimates, the cultivation of crayfish is 5-6 times more profitable than fish [9].
Conclusions

Efficiency of secondary use of warm waters of power objects can be increased due to the development of a breeding with the use of acclimated Australian red claw crayfish both in the Republic of Tatarstan and in Russia as a whole. Due to the excessive heat that enters the natural reservoirs from energy objects, it becomes possible, in the absence of the cost of expensive equipment for heating water, to grow freshwater crayfish. According to expert estimates, the cultivation of crayfish is 5-6 times more profitable than fish. When planning commodity cultivation of crayfish, cannibalism must be considered. Value of the elimination for juveniles in conditions of complete provision with feed is 20%, for crayfish of the older age group - 33%.

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