

PAPER • OPEN ACCESS

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To cite this article: M L Kalayda and I A Bogatyrev 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **288** 012045

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Crayfish in the reservoirs of the Republic of Tatarstan

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Abstract. Among the few commercial invertebrates in Europe, the most valuable resource species of crustaceans are representatives of the genus *Astacus*, primarily broad-fingered crayfish (*Astacus astacus* L.), which lives in inland waters - lakes, rivers, reservoirs. Crayfish are an integral part of the trophic chain of freshwater ecosystems, performing sanitary functions, utilizing animal and plant remains, thereby improving the epizootic situation and hydrochemical regime of water bodies. In the Republic of Tatarstan, before the regulation of the Volga River, there were 2 species of the genus *Astacus* - narrow-fingered crayfish (*A. leptodactylus* Esch.) and broad-fingered crayfish (*A. astacus* L.), and in the 30s of the 20th century, only the narrow-fingered crayfish in consequence of epizootics plague of crayfish. Presently, both species of crayfish are represented in crayfish populations, and in the Kuibyshev reservoir zone the ratio of narrow-fingered to broad-fingered crayfish is 3: 2, in the zone of the Nizhnekamsk reservoir - 1: 1. In the catches there are individuals from 8 cm to 17 cm with a body weight of 20 to 100 g. The females of narrow-fingered crayfish were 27.8%, and females of broad-fingered crayfish - 20% of the total number. In connection with the worldwide trend in the growth of the popularity of crayfish in food use, the importance of research of natural populations as a potential breeding stock for the tasks of industrial crayfish farming grows.

Introduction

Aquaculture rapidly developing around the world, providing for the development and cultivation of commercial species of hydrobionts under controlled conditions, is a promising direction of applied hydrobiology. Among the few commercial invertebrates in European countries, the most valuable resource species of crustaceans are representatives of the genus *Astacus*, primarily broad-fingered crayfish (*Astacus astacus* L.), inhabiting inland water bodies - lakes, rivers, reservoirs. Crayfish are an integral part of the trophic chain of freshwater ecosystems, performing sanitary functions, utilizing animal and plant remains, thereby improving the epizootic situation and hydrochemical regime of water bodies. Broad-fingered crayfish are recognized as bioindicators of environmental cleanliness and are currently under the scrutiny of international environmental organizations. Broad-fingered crayfish is included in the lists of protected species of the Berne Convention and the European Community Directive on species and habitats. Having the status of a protected species in European countries, broad-fingered crayfish are of great commercial value. Not only meat of crayfish used for food, but also a shell has applications in medicine and cosmetology [1, 2, 3].



Results and discussion

River crayfish as components of water ecosystems of the Republic of Tatarstan

Information on the status of the population of crayfish in the territory of the Republic of Tatarstan before 1932 is absent [5]. Prior to the regulation of the Volga River, practically on all small rivers, there were mill ponds in which river crayfish could be found. By the 30th of the 20th century, the populations of crayfish began to recover after the epidemic of crayfish plague that exterminated them in Volga and Kama [5]. Most crayfish survived in mill ponds on small rivers.

In the European part of Russia, there are 15 species of crayfish belonging to 3 genera: *Astacus*, *Pontoastacus*, *Caspiastacus* [1]. In the Republic of Tatarstan there were 2 species of the genus *Astacus* - narrow-fingered crayfish (*A. leptodactylus* Esch.) and broad-fingered crayfish (*A. astacus* L.) [6].

By the time of regulation of the Volga River, a study on the biology of crayfish revealed that the ratio in the catches of females to males was 30%: 70% in summer catches and 44%: 62% in autumn. Dimensions of crayfish according to [5] in spring catches are shown in Figure 1.

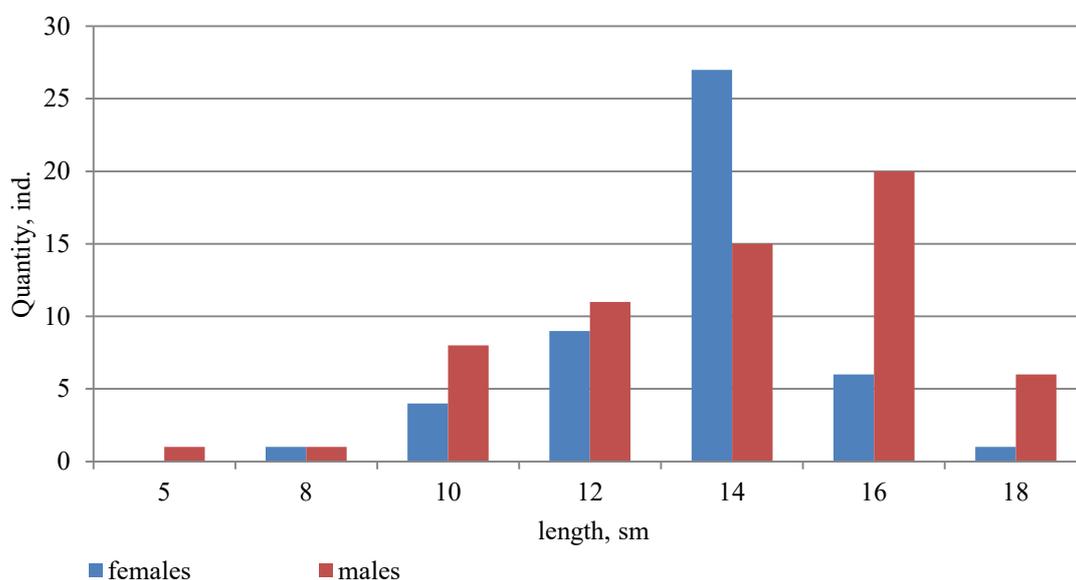


Figure 1. The size of broad-fingered crayfish in the reservoirs of the Republic of Tatarstan prior to regulation the Volga River according to [5].

In the studies of M S. Stroikova [5] it was shown that in the reservoirs of the Republic of Tatarstan in the 30s of the XX century there was only a narrow-fingered crayfish – *Astacus leptodactylus*. It is noted that at the beginning of life, females and males of crayfish grow at the same rate, and then at puberty the rate of growth of females decreases. One-year-old crayfish had a length of about 4 cm, two-year females and males on average - 10.5 cm, three-year-old males - 14.5 cm, females - 13.5 cm. Four-year-olds were met about 17.5 cm in size and all male. The rate of growth of crayfish in floodplain lakes of the Volga River was higher than in small rivers (Table 1).

Relation between the weight of a narrow-fingered crayfish and the length under conditions of the river Volga taken from the net catches is presented in Table 2.

Sexual maturity occurred for female crayfish in the third year of life and is related to the growth rate. In organizing the fishery, the fishing length of crayfish for small rivers was not less than 8.0-8.5 cm, for productive lakes - more than 10.5-12.5 cm [5]. Crayfish over 4 years old have not occurred.

Table 1. Growth rate of narrow-fingered crayfish in reservoirs of the Republic of Tatarstan according to [5].

Water body	Age, years			
	1	2	3	4
Floodplain lake Long	5,5	10,5	14,0	17,5
River Nurma	4,21	6,48	8,25	11,93
River Ik			11,5	16,0

Table 2. Size and weight composition of narrow-fingered crayfish from net catches in the Volga River [5].

Mass, g	Fish size, sm									N, ind.
	8 - 9	10 - 11	12 - 13	14 - 15	16 - 17					
10-20	4	1	-	-	-	-	-	-	-	5
20-30	1	15	9	1	-	-	-	-	-	26
30-40	-	-	10	1	-	-	-	-	-	11
40-50	-	-	-	7	8	-	-	-	-	15
50-60	-	-	-	2	10	3	-	-	-	15
60-70	-	-	-	-	7	10	1	-	-	18
70-80	-	-	-	-	1	10	5	-	-	16
80-90	-	-	-	-	-	6	4	1	-	11
90-100	-	-	-	-	-	2	2	2	-	6
100-110	-	-	-	-	-	-	2	1	1	4
110-120	-	-	-	-	-	-	1	2	-	3
120-130	-	-	-	-	-	-	1	3	2	6
n	5	16	19	11	26	31	16	9	3	136

In studies of the first half of the 20th century, there was a high degree of infection of crayfish with trematodes. Crayfish larger than 43 cm were infected in 82.4% of cases. The number of parasites varied in different individuals from 4 specimens to several hundred. Places of localization of parasites – common liver fluke were: sexual glands, abdominal muscles, gill covers, cephalothorax cavity, muscles and side walls, liver, intestinal walls, genital ducts, heart [7]. With the presence of parasitic growth *Astacotrema tuberculatum* (*A.cirrigerum*) and *Distomum isostomum* the crayfish plague was associated, which destroyed crayfish in many parts of Europe. It was suggested that crayfish are the second intermediate hosts for the genus *Astacotrema*.

While regulating the Volga River in the Republic of Tatarstan, crayfish were not considered as an essential objects of pasture aquaculture. Currently, there is no commercial catch of crayfish in the Republic of Tatarstan. At the same time, in the European part of Russia at the present time, the Lower Volga region, the Azov-Black Sea basin, the reservoirs of the Middle Volga, the Northwest (Pskov and Leningrad oblasts) are the main crayfish fishing areas. The distribution of crayfish stocks by regions of the European part of Russia and the volumes of possible catch of crayfish in water bodies are presented in the Table 3.

In connection with the worldwide trend in the growth of the popularity of crayfish in food use, the importance of research of natural populations as a potential breeding stock for the tasks of industrial breeding grows. To date, aquabiotechnologies for the artificial reproduction of broad-fingered cancers have been developed [8], for which there is an uneven, sporadic nature of distribution within the range of its area, caused mainly by epizootics of crayfish plague, pollution of reservoirs and destruction of natural biotopes [3].

Table 3. Reserves and total allowable catches of crayfish in the crayfish fishing reservoirs of the European part of the Russian Federation no [4].

Region	Area, ha (useful for crayfish)	Stock, t	Total allowable catches ,t
Reservoirs of the North-West:			
Pskov region	46800	107	41
Leningrad region	26100	71	17
Tver region	6960	96	24
Reservoirs of the Middle Volga:			
Gorky Reservoir	36800	13,5	3
Cheboksary Reservoir	53600	19,7	5
Kuibyshev Reservoir	170000	100	25
Reservoirs of the Lower Volga:			
Saratov Reservoir	40900	58	15
Volgograd Reservoir	126664	176,5	40
Reservoirs of the Volga-Akhtyubinsk floodplain and the Volga delta	8880	167	44
Reservoirs of the Azov- Black Sea basin	5700	1200	210
Tsimlyansk Reservoir	2700	740-760	140-150
Reservoirs of the Ural Bcero	28050	380	50
		2390	475

Current status of crayfish populations in the Kuibyshev and Nizhnekamsk reservoirs

Currently in the Republic of Tatarstan there are two types of crayfish: broad-fingered and narrow-fingered (Figure 2). In the spring catches in the Kuibyshev reservoir, the ratio of narrow-fingered and broad-fingered crayfish was 60%: 40%. At a number of sites in the Nizhnekamsk reservoir, the ratio was 50%: 50%. In this case, females of narrow-fingered crayfish were 27.8%, and females of broad-fingered crayfish - 20% of the total number of crayfish of this species.

**Figure 2.** Crayfish from the catches on the Volga, Kama and Belaya rivers in 2017.

Broad-fingered crayfish in the lifestyles are classed as "K-strategists", which are characterized by relatively low fertility, slow growth and long (up to 20 years) life expectancy [8].

In the conditions of the Middle Volga, crayfish were found in catches at different depths: from the beginning of February - from 2 to 3 m, at the end of February they were not caught at any depths, in March they were caught at depths of more than 3 m and from the middle of March even deeper - up to 6 m.

The distribution of crayfish (%) in the reservoirs and rivers of the Republic of Tatarstan is shown in the Figure 3.

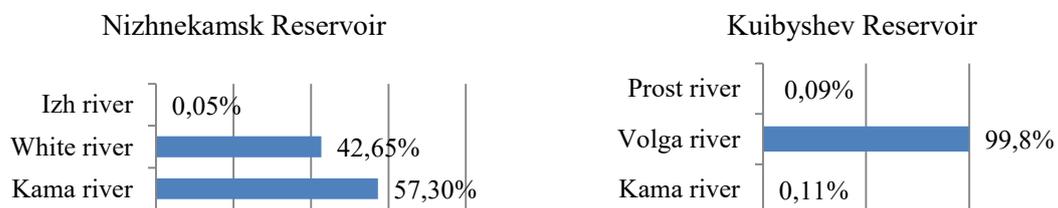


Figure 3. Distribution (%) of crayfish from catches in 2017 in the Republic of Tatarstan.

In Europe, the maturity of females occurs at the end of the 4th summer of life, at the age of 3+, with a body length of about 8 cm [3]. In the studied materials, female crayfish with caviar were found in catches only from 10 to 20 May. The copulation of broad-fingered crayfish usually occurs in late autumn (October-November) at a water temperature of less than 10 ° C and lasts for 2-3 weeks. Sexually mature males mate each year and are able to fertilize several (more than 3) females. The period of embryogenesis of broad-fingered crayfish occurs within 8 months (November-June) in a wide range of temperatures and is about 1300 degree-days. The timing of hatching depends on the thermal regime at the end of the incubation period. The working fecundity of females of broad-fingered crayfish increases with sizes and ranges from 90 to 260 eggs [8]. Crayfish belong to omnivorous animals, they feed on detritus, aquatic vegetation, animal food: crustaceans, insect larvae and mollusks. Their favorite food is fish. The nutritional components of juveniles of broad-fingered crayfish are detritus, filamentous algae, protozoa, rotifers, crustaceans, larvae of chironomids and caddisflies. The daily diet for mature broad-fingered crayfish varies between 0.3-1%, for young - 1-4% of their body weight [3]. The length of the body for juveniles of broad-fingered crayfish varies depending on the season and the water content of the pond in the range from 15 to 23 mm.

In the Volga river in the catch in February-March were caught individuals aged 2 to 4 years. The maximum mass of crayfish in February was 60 g with a body length of about 13 cm, in March, there were individuals up to 100 g with a body length of 17 cm. Taking into account that large males of broad-fingered crayfish reach a body length of 15 cm from the rostrum to the end of the abdomen and sometimes there can be met larger specimens, 17-25 cm in size and weighing 270-300 g [8], can be noted that adult crayfish in the Kuibyshev and Nizhnekamsk reservoirs smaller and at a length of 17 cm have a mass of no more than 100 g.

Conclusions

Crayfish farming can become an important component in the structure of aquaculture in the Middle Volga region. At present, natural populations of crayfish in the reservoirs and rivers of the Republic of Tatarstan include 2 species of the genus *Astacus* - narrow-fingered crayfish (*A. leptodactylus* Esch.) and broad-fingered crayfish (*A. astacus* L.) [6]. The ratio of narrow and broad-fingered crayfish in the zone of the Kuibyshev reservoir was 3:2, and in the Nizhnekamsk reservoir - 1:1. Adult individuals reach 17 cm at a mass of up to 100 g. Sexually mature females with caviar at the age of 4 years were met in catches in May. The most significant crayfish populations are found in the Volga, Kama, Belaya, Izh, Prost rivers.

The development of aquabiotechnologies makes it possible to use natural crayfish populations for the tasks of creating industrial breeding farms.

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