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Ecological peculiarities and food spectrum research of non-fish water products in Mingachavir and Varvara reservoirs in Azerbaijan

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ABSTRACT

The present study evaluates the ecological features and food spectra of non-fish water products in Mingachevir and Varvara reservoirs in Azerbaijan. It is established that ecological peculiarities and food spectrum of long-toed river crayfish depend and change not only on the place and living conditions, but also on its age. In addition to environmental features, changes in the nutritional spectrum of long-toed river crayfish at different stages of ontogenesis have also been studied.

Keywords: Environmental features, Crayfish, Nutrition, Water reservoir, Azerbaijan.
Article type: Short Communication

INTRODUCTION

It is known that in natural conditions river crayfish are inhabitants of quiet flowing waters, settling rivers, channels, canals, large lakes and reservoirs with shady shores, where crayfish settle in burrows, under snags, roots of large trees growing on the banks of reservoirs, as well as under large stones on the bottom. Crayfish breath is carried out by rather complicated gills, but in a very humid atmosphere river crayfish are able to breathe air for some time. Crayfish are very demanding on the quality of water, and when it is contaminated or blooms, i.e. when the concentration of dissolved oxygen in the water decreases, the crayfish leave these areas of the reservoir. However, according to our data, under the conditions of the Mingachevir reservoir, the river crayfish clearly prefers shallow, small bays overgrown with higher aquatic vegetation. The density of long-edged crawfish in such habitats is tens of times higher than in the coastal zone without higher aquatic vegetation. For example, in Mingachevir reservoir, the density of the crawfish population in overgrown bays sometimes reaches 30-40 ind. m^{-2} in autumn, and in a few meters along the coastline without vegetation the density of crawfish does not exceed 3-7 ind. m^{-2}. In our opinion, the distribution of crawfish is dominated not by the substrate of the water body, because in both the overgrown bay and the rest of the coastal zone the soil was muddy and trophic. In overgrown bays, there are always rotting organic residues of plant and animal organisms. If in other parts of Varvara reservoir the length of crawfish was 11-14 cm on average, the individuals caught in the lithophilic biotope had a length of 15-17 cm. Apparently, lithophilic biotope is preferred by adults of crawfish. We have not found any similar data in the literature. Some authors (Vinot & Pihan 2005; Popov 2021) note a certain selectivity of long-toothed crawfish in relation to dense soils of different types: for example, in Kizovsky reservoir the density of the crawfish population on stony soils is 160 times higher than on clayey soils. However, this example is noted in a relatively recent water body during the period of population growth. For noble crayfish, in contrast to other species, the construction of dens is not necessary, but it can use the unevenness of the bottom, the roots of plants, as a shelter (Prensner & Chinnaiyan 2011; Zuckerzis, 1989: Arekhi *et al.* 2020). Noble crayfish is a diclinous animal with external fertilization. Males and females differ relatively easily (Fig.1). As can be seen in Fig. 1, the male is slightly larger than the female of the same age; the genital pores in each floor are in different places: in the case

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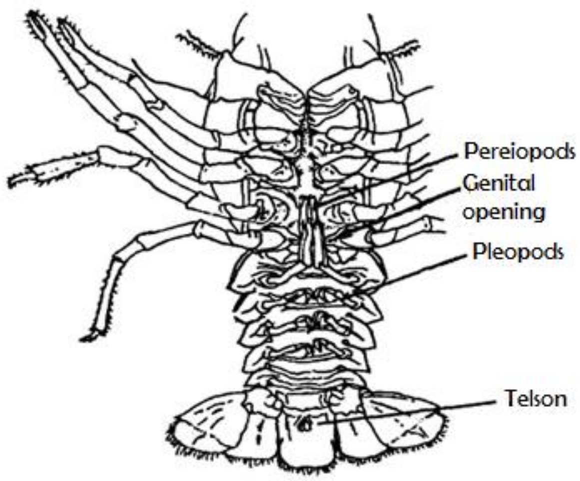
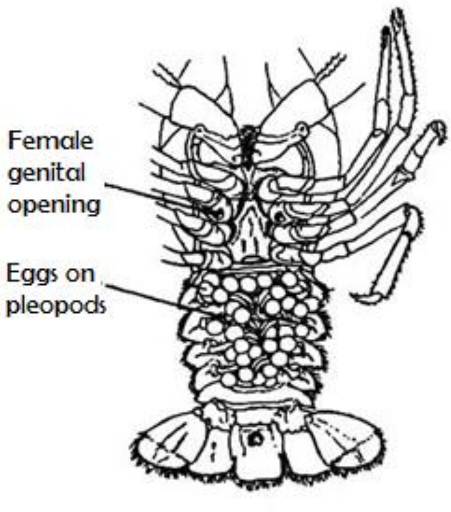
of male at the base of the fifth pair of legs, and that of female at the base of the third pair of legs. Below the legs of the crayfish there are pleopods: male has the first two pairs of them most strongly developed and directed to the head, female pleopods are either completely absent or look like soft appendages. Male's whip is relatively narrower than female's. The mating process of crayfish is as follow: the male chases the female and, having grabbed her legs, is pressed against the lower side of the female by its lower side and through the genital pores pours semen into the female's internal reproductive organs. So, caviar fertilization in crayfish occurs inside the body. When mating, the female resists strongly, trying to get rid of the male, and, if the male is not strong enough, leaves him. So, this behavior ensures the fertilization of the females by the strongest males, which plays a role in the survival and evolution of the next generation. Coral (eggs) develop in the follicles of females, and after the maturation of the follicles, the eggs burst and then fall into the ovarian cavity and then into the oviduct. Crayfish eggs are centrocellular. After 15-20 days after the spermatophores of the male, the female begins to lay eggs. It bends the abdomen under the head and forming a closed space,



A



B

Fig. 1. Sexual dimorphism in noble crayfish.
A – male, B – female.

Which contains a ferrous liquid that dissolves the gluing agent of spermatophores. The eggs are then hatching outwards and fertilized. On the lateral areas of female sternites there are outlet ducts of cement glands, which release mucous liquid, hardening in the form of threads gluing the eggs to the swimmerets of the female (Petutschnig 1998; Rice *et al.* 2018). This is the most difficult and difficult period in the life of females. For the full evolution of caviar requires constant washing with oxygenated water, so the female continuously ventilates

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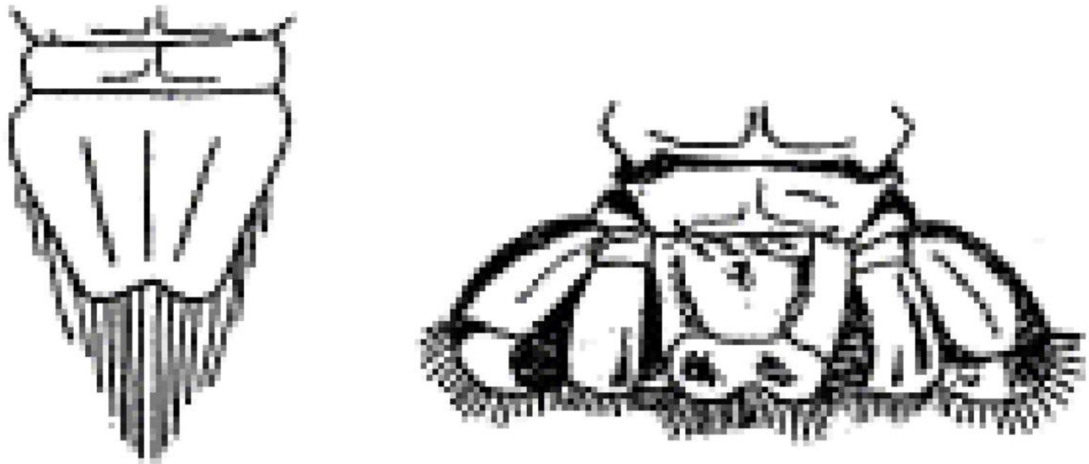
the caviar, creating water flow, bending and unbending the end of the tail. Very often, in calm water, without ducts, especially if the female sits in the hole, the water stagnates, depleting oxygen and getting rich in harmful products of metabolism, because of which the eggs die) Momeni 2018, Adejoke 2019; Naderi 2021; Saadatmand 2021). We conducted a special study of the dependence of the fecundity of noble crayfish on various biotopes of Mingachevir and Varvara reservoirs on the size of females and water temperature. The obtained results showed that the number of fully developed eggs is 12-17% higher in females with larger (15-17 cm) size than in young of 1.5-2 year olds, usually not exceeding 9-10 cm. On the other hand, it turned out that the highest percentage of fertilized eggs was observed both in the middle section of Mingachevir reservoir and in the upper section of the Varvara reservoir, which has a lithophilic biotope with a sufficiently strong (1.0-1.5 m sec^{-1}) water flow. The smallest number of eggs was observed on females captured in the upper and Khanabad sections of the Mingachevir reservoir (45-70 eggs), as well as on females captured in the middle and lower sections of Varvara reservoir (38-65 eggs) in the wastewater discharge area of Mingachevir. Thus, in addition to the biotope factor, the full evolution of crayfish caviar is also affected by the quality of the environment. Thus, for example, the minimum amount of developing caviar in the conditions of the upper and Khanabad sections of Mingachevir reservoir is, in our opinion, due to higher pollution of these sections, especially in spring and early summer.

Under conditions of the Mingachevir and Varvara reservoirs, we have observed adult species once or twice a year, and each time a young person grows and develops actively, we have seen them grow from about 4 to 7 times a year. The timing of moulting varies and depends on climatic conditions. Adult species moult for the first time in our conditions in spring, usually in late April and May. Females that carry eggs begin moulting immediately after the larvae become independent and leave it. Usually we observed the second moulting in adults in autumn - from mid-September to October. We noted that in case of cold weather in autumn moulting of adult long-toed crayfish is delayed and the moulting process is less intensive and can continue until November. Our full-scale observations and laboratory experiments with noble crayfish eggs in aquariums have shown that larvae usually hatch in late spring. During this period they differ morphologically from adult crayfish (Fig. 2).



A B

Fig. 2. Age-related changes in the shape of the pupae in larvae of noble crayfish
A - telson larvae I, B - telson larvae II.

It is possible to determine the sex of young ones after 20 days after the transition to exogenous nutrition. Day larvae are up to 1-1.5 mm long. At first, they remain attached under the mold in the female. After a week or two, depending on the water temperature, they begin to swim beside the female, but at the slightest danger they quickly hide under the mold. Fully larvae leave the female usually at the age of 1-1.5 months and move to an independent way of life. The data we obtained do not coincide in some details with the results given in Khalilov & Akhmedov (1983) and Kheisin (1962). At First, the timing of caviar incubation indicated by us in June-July was not confirmed in our studies. Under the conditions of the well-warmed Varvara reservoir, as noted above, the eggs are extinct and their hatching by females begins in May. Secondly, these authors believed that on live females caviar

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withdrawal before larval emergence is almost absent. Immediately after hatching, the larvae average size is 1 mm with a mass of 9-11 mg. Hatching and evolution of crayfish occurs as follows. The crustaceans hatch from the eggs, tearing the egg shell along the lower body of the embryo by the movement of the abdomen and limbs. The hatched larva hangs on the hyaline thread and after 2-3 days the hyaline thread breaks off, but the larva is attached to the stem or egg shell by pincers having pointed hooks at the ends. In this position, the larvae arrive from 1 to 4 days (depending on the water temperature), feeding on the yolk from the yolk sac, which is under the dorsal plate of the head chest. The larval shell of this 1st stage is still soft, so its linear size and body weight increase. At this stage the larvae still have a number of differences from adult crayfish (Fig. 2). The so-called stage II evolution of the larva begins immediately after its first moulting, which occurs on the fifth day after hatching. The yolk sac disappears by this time, the vertigo chest lengthens, the shell becomes more rigid than that of the first stage larvae, the rostrum is straightened out, and the larvae eat the shell of the egg. Fan-shaped bristles appear on the expanded telson (Fig. 2). Larvae become very mobile, often in search of food they go far away from the female, but in case of danger they hide under her thigh. After the second moulting the larvae move to the 3rd stage and metamorphosis is completed. The larvae acquire the appearance of adult crayfish, lead an independent lifestyle and finally leave the female. Larvae of the 3rd stage grow until the shell hardens completely. Their linear size at this time is usually 1.1-1.3 cm with a mass of 32.0-34.5 mg (Table 1).

Table 1. Stages of crayfish evolution in ontogenesis.

Evolution stage	Duration of evolution (days)	Linear size	Mass
I stage	1-5	1.0-1.3 mm	0.4-1.0 mg
II stage	5-8	7.8-8.6 mm	12-15 mg
III stage	8-15	1.1-1.3 cm	32-34.5 mg
Underyearling	90	5-6 cm	16-20 g
Two years period	---	8.8-10 cm	28.1-32 g
Nobilous	2.5-3 years	10-12 cm	32-38 g
Nobilous	5 years	14-16 cm	46-54 g

As already noted, the growth and evolution, and therefore the number of molts in noble crayfish, directly correlates with water temperature. For example, under the conditions of the Mingachevir and Varvara reservoirs, young fish have been growing mainly for 2.5-3.5 months. Usually during this period there are 7-10 molts. Usually in the middle of autumn the larvae of the 3rd stage pass into the stage of the current year and reach 5-6 cm in length with a mass of about 30 g. Notably, once good nutrition in experimental conditions, the mass of small crayfish sometimes reaches significantly higher values (38-43 g). Two-year-old young crayfish moult 8-9 times during the warm season and usually reach commercial sizes, i.e., about 10 cm in length and 32 g in weight by autumn. Noteworthy, according to our observations, the survival rate of these cells in natural conditions usually does not exceed 15-27%, while in the experimental conditions, with a good forage base, the survival rate is much higher (40-90%). Under the conditions of Mingachevir and Varvara reservoirs, the sexual maturity of noble crayfish usually occurs in the third year of life at the minimum size of females (6.5-7.5 cm). The timing of mating depends on the conditions in the water body and water temperature. It is known that river crayfish are omnivorous animals and eat first of all those fodders, which are more often found in a given pond. Of the plants, the highest aquatic and water-related plants, rich in lime, play the most important role in the nutrition of noble crayfish: hornblende, redest and hara. The frequency of occurrence of harlequin ladybirds in the stomachs of noble crayfish in the Mingachevir reservoir is much lower (8-11%) than in Varvara reservoir (18-65%) and directly correlates with the biotope. In macrophytes and algae, respectively, the share of plant food in the diet of noble crayfish is significantly higher (47-85%) than in other habitats devoid of aquatic vegetation (Fig. 3.4). In the case of noble crayfish, some plant qualities, such as hardness, and in some cases the phytoncides emitted by some species, are less important than for small crustacean species. The structure of the mouthpiece allows noble crayfish to be used as food for both soft plants and hard ones. According to our observations, they readily eat cane stems and rhizomes, reeds and sedges, and notably, noble crayfish can eat all parts of these plants. Experimentally, in aquariums, we found that the daily ration of crayfish is about 2.5% of the live weight of an adult. It is known that the natural enemies of river crayfish in nature are predatory fish, primarily the widespread pike and perch, and pike-perch to a lesser extent. In addition, many naked birds, as well as foxes, jackals and water rats also hunt noble crayfish very actively. However, river crayfish in the food chains of fresh water bodies serve not only as food for predatory fish, birds and animals, but also as food for animals themselves. According to our data on autopsy of the stomachs of

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noble crayfish, the diet of the crayfish includes small molluscs, mainly common representatives of Limnea. Water worms, larvae of many insects, primarily brooks, tadpoles and, in some cases, small fish. However, according to our experimental data, crayfish are mainly crayfish with lower mobility.

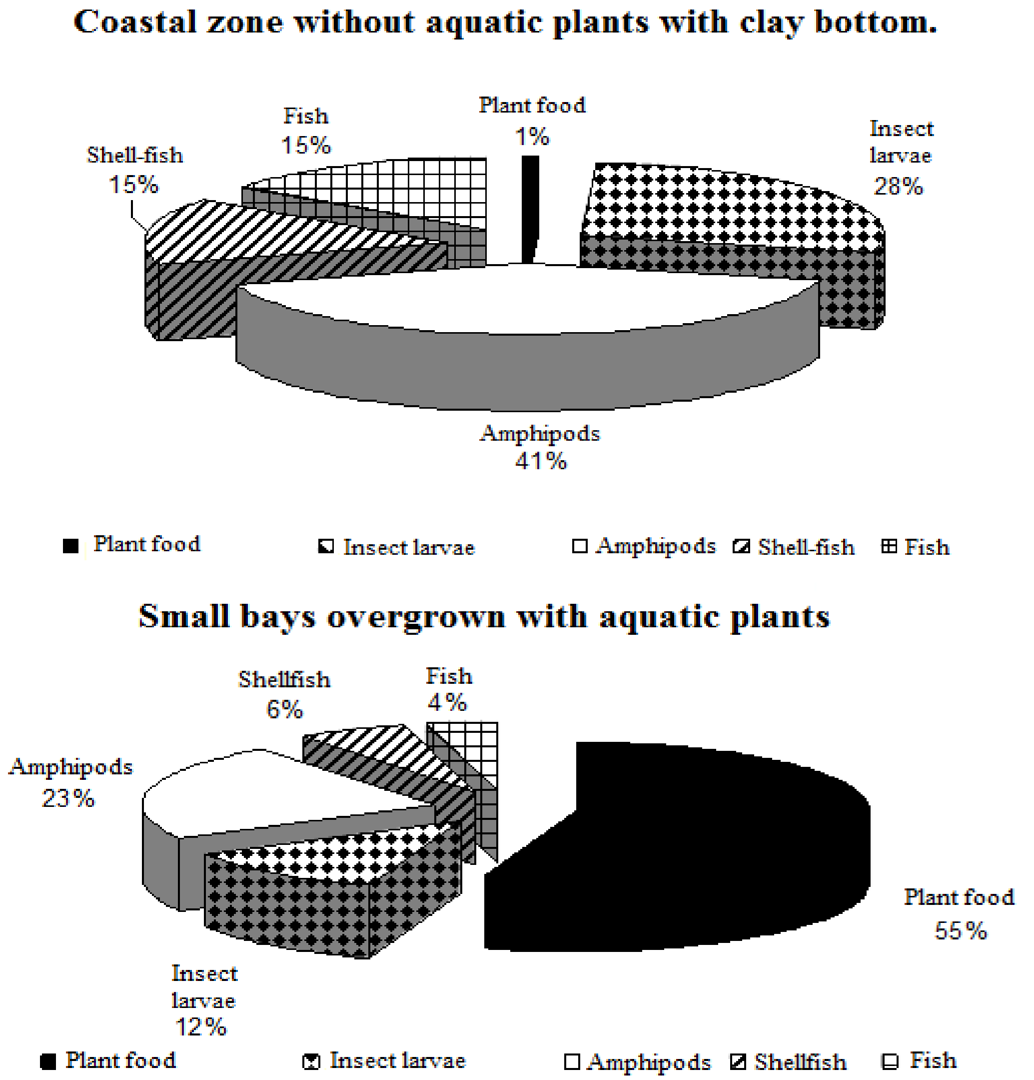
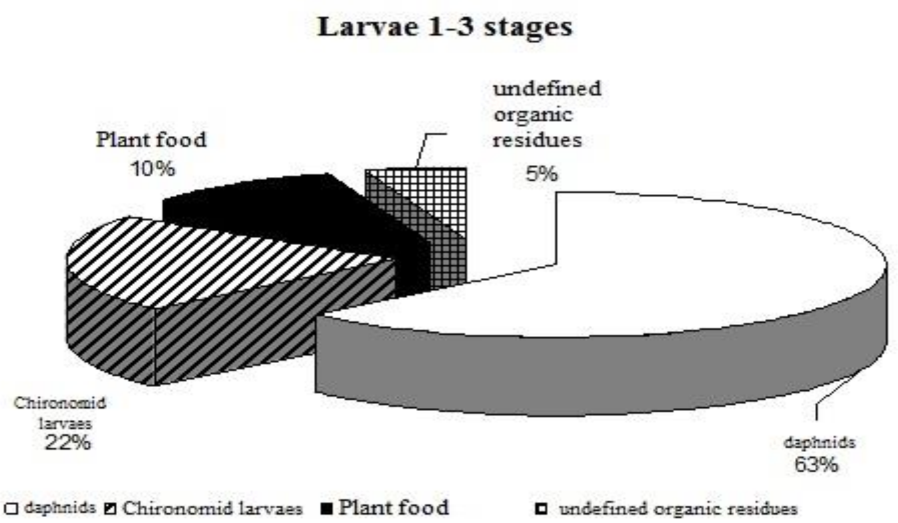


Fig. 3. Changes in the range of adult noble crayfish in Mingachevir reservoir depending on the type of biotope.



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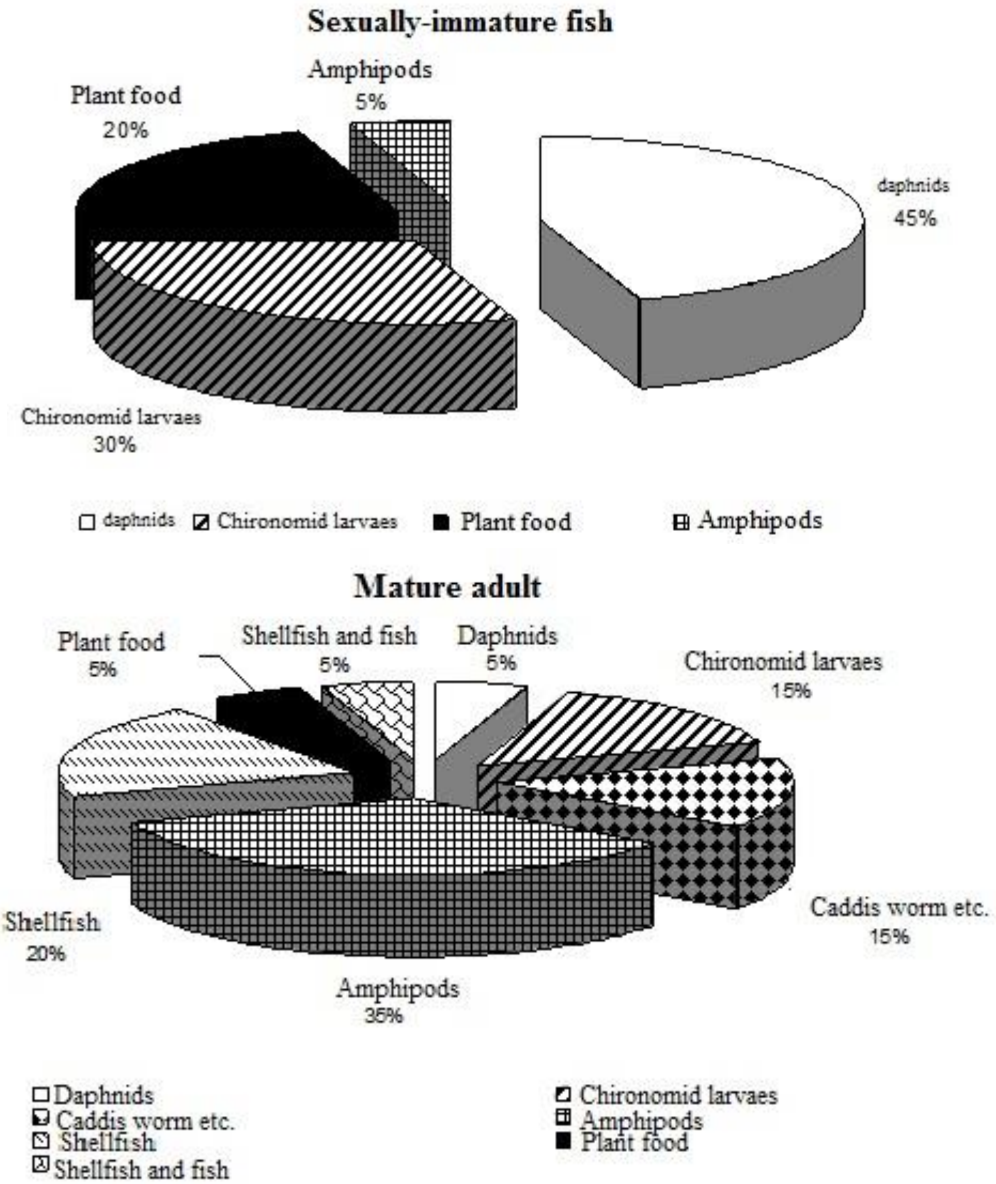

Fig. 4. Changes in the diet of noble crayfish depending on age in Varvara reservoir.

Noteworthy, the nutritional spectrum of noble crayfish depends and changes not only on the place of residence, but also on its age (Brodsky 1954; Borisov 1999). For example, larvae of noble crayfish, according to our data, eat up to 70-85% of animal food. Immediately after the transition to an independent lifestyle, small crayfish larvae of 1.2-2 mm length eat mainly daphnia (63%) and chironomides (22%). As crayfish grows, the proportion of daphnia in the diet drops sharply to 5%, and at the age of 2 years the long-lasting noble crayfish almost ceases to eat daphnia. Young individuals of all different sizes actively use chironomide (25-30%) for larvae. When young individuals reach the linear size of 2 cm, they start to eat larvae of other insects - brooks, ducks, freckles, etc. With the further growth and development of young river crayfish to linear sizes of 8-10 cm in their diet, the share of consumption of amphipods increases from 4.5-6% to 68%. We have noted the consumption of shellfish in the current year, when their length reaches 2.6-3 cm, and the eating of fish crayfish is noted by us at the linear sizes of the current year 3.7-4.5 cm. So, similar conditions are typical for many areas of the Mingachavir and especially Varvara reservoirs. In our opinion, the availability of optimal natural conditions contributes to the production of large quantities of high-value, delicious food products at minimal economic costs. In the vicinity of the studied reservoirs it is possible to create a cascade of small flowing ponds for the organization of highly profitable shell-farming with the use of a number of natural reservoirs. Organization of such a farm would give an opportunity to provide jobs to the local population and bring financial profit to the region and the whole republic. Further with

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the development and expansion of this economy it would be expedient to build a canning plant, which would dramatically increase the profitability of the entire production.

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