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THE STATE OF STUDY OF PARASITES AND SYMBIONTS OF CRAYFISH

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The article analyzes the available literary sources that highlight the issue of studying parasites and symbionts of crayfish in the reservoirs of Ukraine and Europe. Crayfish (of the genus Astacus) are an integral part of the Dnieper-Buzka estuary.

These are the only edible invertebrates in the freshwater reservoirs of the region. High taste qualities put them in the category of delicacies and determine a stable demand on the world market.

Until the middle of the 20th century, crayfish were a traditional object of fishing in the reservoirs of Europe. It was concluded that high taste qualities put them in the category of delicacies and determine a stable demand on the world market, but currently many industrial areas have lost their importance due to a significant decrease in the number of these hydrobionts for various reasons.

Crayfish are unstable species, and their numbers can change dramatically over time. For this reason, studies aimed at identifying the factors that determine the dynamics of the number of crayfish in reservoirs, especially under the influence of diseases of various etiologies, are of great importance.

Scientifically based fishing is impossible without a preliminary study of questions about the size of crayfish stocks, the dynamics of its number, features of distribution, distribution among them parasites and symbionts of other aspects of its biology. In this regard, studies of the ecological and morpho-physiological variability of crayfish depending on living conditions, the level of parasitemia, as well as the density, number and size-sex structure of the population are of considerable interest, the study of which has received relatively little attention until now.

Knowledge of the regularities of these relationships will allow, on the basis of relatively simple methods of morpho-physiological and parasitological indicators, to quickly assess the state of the population exposed to any adverse conditions, in particular, intensive fishing.

Based on the study of literature data on the fauna of crayfish parasites and symbionts, morpho-physiological variability and ecology of long-finned crayfish populations, separate scientifically based bases of rational fishing for the region were proposed.

Key words: crayfish, population conditions, pathogens, crayfish symbionts, crayfish diseases, crayfish parasites, microsporidia, pathogen fungi, crayfish bacteria.

Relevance of the task. Crayfish (from the genus *Astacus*) are an integral part of the Dnieper-Bug estuary. These are the only food invertebrates in the freshwater reservoirs of the region.

High palatability puts them in the category of delicates and determines the stable demand in the agricultural market. Until the middle of the 20th century, crayfish were traditional object of fishing in the waters of Europe.

At present, many industrial areas have lost their importance due to a significant decrease in the number of these hydrobionts. In the lower reaches and the Dnieper there are natural reserves that allow for the extraction of crayfish, but the volume of catches over the years of catfish repeatedly removed.

V. D. Rumyantsev [3], who was engaged in the study of crayfish, noted that they belong to non-stable species, and their number can change significantly over time. The number of crayfish in the water is important.

The solution of this problem is the starting point for the development of measures for the conservation and increase of crayfish stocks in the region, while maintaining the number and population at a level sufficient for fishing.

Long-toed crayfish are valuable objects of fishing due to the exceptionally high taste and nutritional value of meat, which contains up to 16 % protein, 0.5 % fat, all essential amino acids, as well as lipids, biologically active substances and trace elements [4].

The taste of the meat of the crayfish, which includes the long-clawed crayfish, surpasses the taste of the meat of marine crustaceans (lobsters, crabs, lobsters). The hard outer integuments of cancer have a significant amount of calcium salts (46 % calcium carbonate, 1 % calcium phosphate) and can be used for the preparation of fodder meal. Adding this flour to chicken feed increases its egg production by 20 % [5].

In the areas of traditional fisheries: North-Western Europe, Belarus, Ukraine – the production of crayfish in recent years has a downward trend, which is caused by a decrease in stocks as a result and excessively intensive exploitation. individual populations of crayfish, as well as the integrated use of water bodies by industry and agriculture (water intake, discharge of industrial effluents), which leads to their shallowing, pollution and overgrowth. All this necessitated research on the biology of these invertebrates in regions where cancer had not been mined before, and its reserves remained unused [6–8].

Conducting a scientifically based fishery is impossible without a preliminary study of the size of long-clawed crayfish stocks, the dynamics of its numbers and, the peculiarities of the distribution, distribution of parasites and symbionts among them, another aspects of its biology.

Of great interest, in this regard, are the studies of the ecological and morpho-physiological mortality of crayfish depending on the living conditions, the

level of parasitism, as well as the size, number and size of the population. The study of which has received comparatively little attention so far.

Knowledge of the laws of these relationships will allow, on the basis of a relatively simple method of morpho-physiological and parasitological indicators, to quickly assess the state of the population, which is exposed to the influence of any unfavorable conditions, in particular, intensive fishing.

Research analysis. River crayfish have long been a classic object of zoological researchers.

Huxley's monograph [1] "Cancer. Introduction to the Study of Zoology". It contains data on the taxonomy, anatomy, physiology of crayfish, which have not lost their importance at the present time. The taxonomy and classification of crayfish was carried out by outstanding scientists Kassler, Shishkovich, Skorikov.

Detailed studies of the state of crayfish populations as objects of industrial use in the water bodies of Ukraine were carried out 30–40 years ago [32, 33, 35, 37], when crayfish were considered as a separate element of the raw material base of the fishery. More modern, modern studies, since the industrial use of crayfish was de facto carried out in the by-catch mode in fishing, relate mainly to the problems of artificial reproduction and rearing of crayfish in aquaculture [32, 36].

The crustacean plague, which devastated many crustacean reservoirs at the turn of the century, attracted the attention of many researchers both in Ukraine and abroad [12, 13]. In recent years, the problem of the crustacean plague was dealt with: Kamoe K., Karafazlieva R., Kovacheva N. P., Kozlov V. I.

The largest number of studies is devoted to the classification, biology, and distribution of crayfish in various regions of the USSR and abroad. Of the foreign ones, it should be noted the work of André "Crayfish of France", which contains a number of original data [15].

Statement of the task. We have made an attempt to analyze the available literature on parasites and symbionts of freshwater crayfish in the waters of Europe. The analysis is actually a retrospective, since scientific research in this area is currently almost not carried out.

Based on the study of the literature data on the fauna of parasites and symbionts of the crayfish, morphophysiological variability and ecology of long-clawed crayfish populations, separate scientifically grounded bases of rational fishing for the region were proposed.

To achieve this goal, the following tasks were set:

1. To conduct morphometric and morphophysiological from the populations of long-clawed crayfish in the Lower Dnieper region.

2. To carry out an analysis of parasitological studies of cancer in order to determine the species composition of parasites and symbionts.

3. To give proposals and recommendations for the safe development of industrial stocks of crayfishing veterinary and sanitary terms.

Research results. Various diseases of crayfish, primarily fungal, cause epizootics in them, undermining their reserves and leading to complete death. The most dangerous disease of crayfish is the crustacean plague, which causes enormous damage to their population and has completely destroyed crayfish in a number of reservoirs in Western and Eastern Europe.

Crayfish plague entered the territory of Ukraine in the 80s of the nineteenth century (the mouth of the Danube), and in the early 90s, the death of crayfish on the Dnieper, Neman was noted [18].

The second outbreak of plague was observed in the 20s of the last century. In some reservoirs, this disease periodically occurs at the present time. Crayfish plague has been repeatedly recorded in the reservoirs of Lithuania, Estonia, and Latvia.

The plague of crayfish is mentioned by V. O. Mikha, Y. V. Kuchin, I. A. Podyapolskaya, K. N. Budnikov, F. F. Tretyakov, A. V. Ivanov, Y. M. Zuckerzis, report on the spread of cancer plague in the reservoirs of Western and Eastern Europe, describe the symptoms and course of the disease, precautions related to the prevention of the disease.

The causative agent of crayfish plague is the fungus *Aphanomyces astaci Sohikora,* 1903, which parasitizes the shell, joints of walking legs, and the nervous system of cancer.

Sick crayfish move on characteristically straightened limbs, convulsively twitching them, stand on outstretched legs and abdomen, fall on their sides, roll over on their backs. Penetrating the nervous system, the fungus often grows outward through the eye or other openings of the body. On the eyes and joints of the limbs of the cancer patient, white growths of mycelium appear, visible to the naked eye. About eight days after infection, the cancer dies.

However, despite the enormous damage caused by the plague to the crayfish population, the study of the causative agent of the disease and the development of measures to combat it is still not given enough attention.

Another fungal disease common in many areas of Ukraine is rust-spotted crayfish disease.

For the first time, the causative agent of this disease was isolated – the fungus *oidium astaci and the* rusty-spotted disease in crayfish of water bodies in Estonia was described in detail by scientists E. Gappich and B. Grimm [28].

Järvekülg notes that this disease has been registered in more than 75 % of water bodies in Estonia (the extensiveness of infection ranged from 0.7 to 53.5 %) and indicates that the extensiveness of the invasion depends on the frequency of cancer molts, and the highest infection begins after the transition of crayfish to one or two molts per year [29, 30].

Mazhilis A. A., Šeštokas I. A. register rusty-spot disease in water bodies of Latvia; V. P. Koval, E. G. Boshko, A. S. Pashkevičiūtė – in some reservoirs of the Dnieper basin in Ukraine [7].

The causative agent of rusty-spotted disease is the fungi *Oidium astaci Happich*, 1900; *Septocylindrium eriochier, Menn et Pieplow*, 1938; *Ramularia astaci Mann et Pieplow*, 1938 – y broad-clawed crayfish and *Cephalosporium leptodaotyli, Menn,* 1940, y long-clawed.

Fungal hyphae grow in the thickness of chitin, forming channels in it, and permeate the muscles of the animal.

Externally, the disease manifests itself in the development of rounded, brown or black spots (up to 3 cm) on the carapace, the upper side of the claws, and on the abdomen, often colored red edges, In the center of the spot, chitin softens, collapses and exposes muscles.

According to experts, rusty-spot disease rarely causes mass death of crayfish [17, 21], but A. D. Järvekülg [29, 30] notes the high pathogenicity of the disease for crayfish in Estonian water bodies.

Due to its relatively slow spread, it does not cause rapid and mass death of crayfish in water bodies, but weakens them, causes them serious functional disorders, reduces fertility.

K. M. Budnikov and F. F. Tretyakov, G. K. Petrushevsky [8] describe in detail the clinic of rusty-spotted disease. In addition to plague and rust-spotted disease, cancers are often susceptible to diseases caused by microsporidia *Thelohania contejeeni Henneguy*, 1892.

Microsporidia parasitize the skeletal muscles, heart muscle and ovary of crayfish. The affected muscles and organs acquire a milky white color, due to the fact that the ripe spores of the parasite strongly refract light. Hence, cancer microsporidiosis is often called porcelain disease.

Microsporidiosis, a chronic disease of cancers with obvious signs of disease (white muscles), lives for a long time and sheds, but the disease is constantly progressing and as a result leads to the death of cancers [9].

Porcelain crayfish disease was first diagnosed in Lithuania by I. A. Šeštokas [21], who reports that the average extensiveness of infection of crayfish with microsporidia here was 0.28 %.

V. N. Voronin describes in detail the life cycle of the parasite, its pathogenic effect on the host and the ways of infection with it.

According to V. N. Voronin [10], the extensiveness of invasion of river crayfish by microsporidia in most reservoirs ranged from 0.35 to 2.75 %, depending on the place and year of the study.

L. K. Grapmane, A. J. Brenze, L. D. Kairi, Z. Mazitis [15] register porcelain disease of crayfish in the water bodies of Latvia, and A. A. Mazhilis – in the water bodies of Lithuania.

Methods for diagnosing river crayfish diseases are indicated by L. K. Grapmane and A. Y. Brenze [11].

In addition to the above-mentioned pathogens, a number of parasites and symbionts belonging to systematic groups of invertebrates, the impact of which on the host has not yet been sufficiently clarified or not clarified at all, have been found in river crayfish of water bodies of Ukraine.

In the works of domestic authors, as well as in the world literature, there is most information about the presence of four species of oligochaetes of the *family Branchiobdellidas* in *crayfish – Branchiobdella paraeita* (Braun, 1805, Henle, 1835); *B. astaci* (Odier, 1923); *B*. *pentodoata* (Whitman, 1882); *B. hexodonta* (Gruber, 1883).

Branchiobdella parasita lives on the shell, limbs, antennae and antennules of crayfish, registered in the water bodies of Estonia, Lithuania, and the western regions of Ukraine [12, 14].

A. Grigialio [12], J. Zuckerzio [19], A. A. Mazhilis [23, 24] register *Branchiobdella astaci* in crayfish of Lithuanian water bodies, and according to A. A. Mazhilis [25, 26], the infestation of crayfish with this oligochaete in different water bodies ranges from 20 to 83 %.

Järviekülg [28, 30, 31] reports on *Branchiobdella astaci* in crayfish of water bodies of Estonia, Z. Mazitis, I. Pekarevich, N. Sloka, L. K. Grapmane found this species in crayfish of lakes of Latvia. According to the latest authors, the extensiveness of infection of river crayfish with *Branchiobdella astaci* was 54.9 and 73.0 % with an average infestation intensity of 0.9 to 2.6 per individual.

Branchiobdella astaci has a great pathogenic effect on the body of crayfish. Adult parasites feed on the host's blood; Cocoons, fixed on the gill filaments, cause suppuration of the latter, which often leads to the almost complete destruction of the gills. *Branchiobdella pentodona* usually lives on the shell of crayfish and its limbs, less often in the gill cavity, where it lays cocoons.

In Ukraine, *Branchiobdella pentodona* was found in crayfish of the Kakhovka reservoir and the Southern Bug [3, 7] with an extensiveness of invasion of 75.2 and 46.6 %, respectively. A number of features in the morphological structure of oligochaetes of this species have been noted, which distinguish them from the descriptions available in the literature.

In addition to the species of the genus *Branchiobdella,* oligochaetes of the family *Aeroionomatidae* were found in river crayfish of water bodies of Ukraine*,* which were assigned to a new species of the genus *Aeroionoma – A. markewitschi* Boscbko et Peechkewit*,* 1975 [3–7].

It has been established that these oligochaetes live in the gill cavity of long-toed crayfish in huge numbers. The maximum number of parasites in one crayfish in the Kakhovka reservoir reached 1241 ind. with an extensiveness of infestation of 91.7 % [6, 7].

The average number of oligochaetes of this species in different water bodies of Ukraine ranged from 16.5 to 255 ind. [3–7].

The pathogenic effect of *A. merkewitachi* on the host organism has been noted [7]. In the literature there is information about the detection of ciliates, spore moths, trematodes, nematodes, rotifers, copepods, ticks, flyfish in crayfish.

In cancer larvae, *A. merkewitachi* covers the antennae, oral appendages, ventral legs, abdomen, caudal fin, and even eyes. On an antenna 5 mm long in one of the larvae, these authors counted 2396 specimens. ciliates.

The strong development of "fouling" with ciliates prevents crustaceans from moving and feeding normally. The molting of crayfish takes place with this disease with a lot of care. In the river crayfish of some water bodies of Ukraine, round-ciliates of the genus *Sothurnie,* Ehrenberg, 1832 [4, 5] and representatives of the genus *Sothurnie* were found *Urceolariidas* [7].

Spore moths *Psorospermium haeckelli*, Hilgendorf in crayfish have been recorded in water bodies of Lithuania [20] and Ukraine [5].

According to A. A. Mazhilis, spore cells are found in the hindgut, antennal glands, muscles, gills, gonads, hepatopancreas, cardiac sac and eye stalks.

In crayfish, trematodes of the genera *Astacotrema, Minarorohipedium u Meritreme* have been found. These trematodes occur mostly in an encysted state in the gonads, muscles, and connective tissue of the abdomen, cephalothorax, and legs, as well as in the walls of the intestines, stomach, and heart.

The most common species is *Astacotrema tuberoulatum* (Zawedowsky). There is no consensus on the pathogenic effects of aotacotreme on the host.

Trematodes belonging to the genus *Maritrema micoll*, 1907 were registered in river crayfish of water bodies of Ukraine [4, 5]. These trematodes are found in the gill cavity of crayfish in an encysted state.

According to E. G. Boshko nf others [5], 80 % of the studied crayfish of the Sula River (left tributary of the Dnieper) contained *Maritrema metacercariae* in the gills and the average intensity of their invasion was 20.3 ind.

In the above literature, there is information about the presence of nematodes, rotifers, copepods and ticks localized in the gill cavity of crayfish. Nematodes are found in the gill cavity of crayfish quite rarely (the extensiveness of their invasion in different reservoirs ranged from 4 to 13.3 %).

Rotifers of the genus *Lepedella* (Borry de St. Vincent), 1826 were recorded in crayfish of the Kakhovka reservoir [7], the rivers Sluch [4] and Sula [5] (Dnieper basin). In the crayfish of the last two reservoirs, rotifers *Dicranophorus hauerianue*, Wiszniewski, 1939 were found.

Copepods of the genus *Nitocrella,* Chappuls, 1924, which are ubiquitous in the gills of crayfish of the Dnieper basin [3–5, 7]. In 100 % of the studied crayfish, they were found in the Sula River [5]. The number of copepods in one individual of crayfish ranged from 4 to 17 specimens.

In some water bodies of Ukraine, parasitic hydrachnelles at the imaginal stage of development, and those in the nymph stage were found in the gills of crayfish [4].

According to the available literature data of domestic authors, sometimes large colonies of bryozoans develop on crayfish, which are the cause of the weakening and death of old crayfish that do not molt.

Conclusions. In conclusion, it should be noted that the establishment of the species composition of parasites and symbionts of river crayfish of industrial water bodies, in particular in Ukraine, makes a significant theoretical and practical sense. Of great interest should be studies on the study of life expectancy, life cycle, seasonal and age dynamics of the number of branchiobdella and hair, the role of individual species in the pathology of crayfish. Very rich in species that belonged to different taxonomic groups. But there is almost no scientific research in the field, with some exceptions [38].

Taking into account the ever-growing interest in the industrial extraction of crayfish (in 2015 their fishing was resumed in the Kyiv reservoir, since 2017 in the Kremenchuk reservoir), a comprehensive study of the river crayfish as an object of special use of aquatic bioresources is becoming relevant.

СТАН ВИВЧЕНОСТІ ПАРАЗИТІВ ТА СИМБІОНТІВ РАКІВ

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У статті зроблено аналіз доступних літературних джерел, які висвітлюють питання вивчення паразитів та симбіонтів річкових раків у водоймах України та Європи.

Раки (з роду *Astacus*) є невід'ємною частиною Дніпровсько-Бузького естуарію. Це єдині харчові безхребетні в прісноводних водоймах регіону.

Високі смакові якості ставлять їх в розряд делікатесів і визначають стабільний попит на Світовому ринку. До середини 20 століття річкові раки були традиційним об'єктом промислу в водоймах Європи.

Зроблено висновок, що високі смакові якості ставлять їх в розряд делікатесів і визначають стабільний попит на Світовому ринку, але в даний час багато промислових районів втратили своє значення через значне зниження чисельності цих гідробіонтів з різних причин. Раки відносяться до нестабільних видів, і їх чисельність здатна різко змінюватися в часі.

З цього приводу дослідження, спрямовані на виявлення факторів, що визначають динаміку чисельності раків у водоймах, особливо під впливом хвороб різної етіології мають важливе значення.

Ведення науково-обґрунтованого промислу неможливо без попереднього вивчення питань про величину запасів довгопалого раку, динаміці його чисельності, особливостей поширення, розповсюдження серед них паразитів та симбіонтів інших сторін його біології.

Значний інтерес, в зв'язку з цим, представляють дослідження екологічної та морфо-фізіологічної мінливості раків в залежності від умов проживання, рівня паразитоносійства, а також щільності, чисельності та розмірно-статевої структури популяції, дослідження яких до теперішнього часу приділялося порівняно мало уваги.

Знання закономірностей цих зв'язків дозволить, на основі порівняно нескладної методики морфо-фізіологічних та паразитологічних індикаторів оперативно оцінити стан популяції, що піддається впливу будь – яких несприятливих умов, зокрема, інтенсивного промислу.

На підставі вивчення літературних даних що до фауни паразитів і симбіонтів річкового рака, морфо-фізіологічної мінливості та екології популяцій довгопалого раку в були запропоновані окремі науково обґрунтовані основи раціонального промислу для регіону.

Ключові слова: раки, стану популяції, патогени, симбіонти раків, хвороби раків, паразити раків, мікроспоридії, патогенні гриби, бактерії раків,

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