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INFESTATION OF FISH BY CRUSTACEAN PARASITES IN RESERVOIRS OF UKRAINE BETWEEN 2017–2023

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Abstract. The problem of diseases caused by parasitic crustaceans is timely. The purpose of this research was to analyze the epizootic situation regarding parasitic crustacean diseases (argulosis, lerneosis, ergasilosis, and synergasilosis) in fish farms and natural reservoirs of Ukraine between the years 2017–2023. Conducting such an analysis will allow one to determine the dynamics and spread of these crustaceans on the territory of Ukraine. During the years 2017–2023, the cases of lesions in carp and Prussian carp caused by *Lernaea* were most often detected, and a decrease in the frequency of cases of argulosis and synergasilosis was observed. During the study period, no cases of parasitism by causative agents of ergasilosis were found. Crustacean diseases (especially lerneosis, and synergasilosis) are diagnosed more often, while parasite carriage is less often diagnosed.

INTRODUCTION

Crustacean diseases are one of the most common groups of parasitic fish diseases. They include argulosis – the causative agent is *Argulus foliaceus*; lerneosis – the causative agent is *Lernaea cyprinacea*; synergasilosis – causative agents are *Sinergasilus major* and *Sinergasilus lieni*; ergasilosis – causative agents are *Ergasilus briani* and *E. sieboldi*.

Crustacean pathogens cause material damage to fish farms, such as fish weight loss, fry mortality and heavy degradation of the condition of saleable fish due to ulcers and hemorrhages. *Ergasilus* and *Sinergasilus* cause damage and destruction of the gill tissue, which leads to difficulty to fish breathing and eventually to death (Prosiana 2006).

The emergence and spread of crustacean diseases are facilitated by environmental factors, in particular, increased temperature, which accelerates the growth and development of parasites. In most fish farms, insufficient attention is paid to disease prevention, timely diagnostic tests are not conducted to identify fish diseases, and specialists do not fully comply with fish farming, technological, veterinary and sanitary requirements.

Crustaceans enter ponds not only with fish but also with water (adult and nauplial forms of *Argulus*). *Lernaea* is introduced into reservoirs with infected fish and from water supply sources. Larvae of crustaceans can be introduced into water bodies located downstream.

Infestation of fish by crustaceans is registered in various European countries: in Austria *Ergasilus sieboldi* was found on *Neogobius melanostomus* and *Neogobius kessleri* from the Danube River (Mühlegger et al. 2009); 12 crustacean species have been recorded in England (Celia and Kennedy 1997).

Lernaea sp. was found in carp farms in Italy (Perantoni et al. 1991). In Ireland, *Argulus foliaceus* was found on salmon (*Salmo salar*), bream (*Abramis brama*), brown trout (*Salmo trutta*), pike (*Esox lucius*), carp (*Cyprinus carpio*), roach (*Rutilus rutilus*), tench (*Tinca tinca*), and perch (*Perca fluviatilis*), and *Ergasilus gibbus* was found on eel (*Anguilla anguilla*) (Celia and Kennedy 1997).

In the north-east of Lithuania, *Argulus foliaceus* was found on the fry of pike (*Esox lucius* (L.)), pike-perch (*Sander lucioperca* (L.)), and bream (*Abramis brama* (L.)) in cages located at a distance of 100 m from the shore (Žiliukienė et al. 2012).

In Macedonia, in lakes and fish farms, *Ergasilus gibbus* was found on eel (*Anguilla anguilla*) (80%); *Ergasilus sieboldi* was found on chub (*Leuciscus cephalus albus*) (3.09%), barbel (*Barbus meridionalis petenyi*) (2.94%), Prespa and Dojran bleak (*Alburnus alburnus*) (2.36%), roach (*Rutilus rubilio*) (13.64%), tench (*Tinca tinca*) (100%), and rudd (*Scardinius erythrophthalmus*) (22.22%); *Lernaea cyprinacea* was found on carp (*Cyprinus carpio*) (20.77%); *Argulus foliaceus* was found on roach (*Rutilus rubilio*) (0.65%) and Prespa and Dojran bleak (*Alburnus alburnus*) (0.79%) (Stojanovski et al. 2006).

In Norway, 6 *Argulus* sp. were found on a cod (*Gadus morhua*) caught off the coast of Finnmark in northern Norway (Schram et al. 2005). In Poland, numerous *Ergasilus sieboldi* – 772 copepods were found on ide (*Leuciscus idus* (L.)) from Lake Dabie, Szczecin, the intensity of infection varied from 1 to 43 parasites on the gills, in the nasal cavity. *Argulus foliaceus* Linnaeus, 1758 was also found on the head and gills of 7 fish only in May (intensity of infection – 1–3 parasites) (Sobecka et al. 2004). *L. cyprinacea* was found on rainbow trout (*Oncorhynchus mykiss*) (Bednarska et al. 2009). In Portugal, *Ergasilus gibbus* Nordmann, 1832 was found on European eel (*Anguilla anguilla* L.) (Saraiva 1996).

In Serbia and Montenegro, *Sinergasilus polycolpus* was found on the bighead carp (*Aristichthys nobilis)* in two places in the Serbian part of the Danube (Cakic et al. 2004). In Hungary, in Lake Balaton in 1994, pike-perch (*Stizostedion lucioperca*) was found heavily infested with *Ergasilus sieboldi* Nordmann, 1832; in addition, infestation with this crustacean was found on *Stizostedion volgense, Abramis brama, Carassius auratus gibelio, Silurus glanis, Pelecus cultratus, Cyprinus carpio, Ctenopharyngodon idella,* and *Tinca tinca*. *Ergasilus gibbus* Nordmann, 1832 was found on *Anguilla anguilla*; *Argulus foliaceus* Linnaeus, 1758 – on *Stizostedion lucioperca* and *Tinca tinca* (Molnár and Székely 1995).

Sinergasilus lieni Yin, 1949 was discovered in Hungary on three-year-old silver carp (*Hypophthalmichthys molitrix*) and three-year-old bighead carp (*Aristichthys nobilis*), both in spring and autumn. Silver carp and bighead carp were affected almost at the same level – from 8 to 27 copepods. Until 2003, many crustaceans were registered in Hungary: *Ergasilus sieboldi, E. nanus, E. gibbosus, Neoergasilus japonicus, Paraergasilus rylowi, Lamproglena pulchella, Lernaea cyprinacea, Achtheres percarum, Tracheliastes polycolpus* and *T. maculatus* (Molnár and Székely 2004).

In Finland, *Argulus coregoni* – a species that can mainly be detected on salmonids, was registered, and *Argulus foliaceus* was found on several species of freshwater fishes (Bandilla et al. 2005). In Croatia, during the examination of seabass (*Dicentrarchus labrax* L.) from the northern part of the Adriatic Sea, *Lernaea* sp. was found in 3.33% (Coz-Rakovac et al. 2002).

In Ukraine, various studies reported species such as *Ergasilus briani* Markewitsch, 1932, *Ergasilus sieboldi* Nordmann, 1832, *Ergasilus tissensis* Djachenko, 1969, *Lernaea elegans* Leigh-Sharpe, 1925, *Argulus foliaceus* Linnaeus, 1758, *Lernaea cyprinacea* Linnaeus, 1758, *Argulus coregoni* Thorell, 1864, *Argulus japonicus* Thiele, 1900, *Ergasilus nanus* Beneden, 1871, *Sinergasilus lieni* and *Sinergasilus major* (Davydov et al. 2011).

The purpose of this research was to analyze the epizootic situation regarding parasitic crustacean diseases in fish farms and natural reservoirs of Ukraine that will allow one to determine the dynamics and spread of these crustaceans on the territory of Ukraine.

MATERIALS AND METHODS

Research was conducted on the basis of the Laboratory of Ichthyopathology of the Institute of Fisheries of the National Academy of Agrarian Sciences of Ukraine during 2017–2023. The object of research was clinically healthy and sick fish of different species and of different age groups caught in fish farms and natural reservoirs of Ukraine (sampling points are shown on the map (Figure 1) and coordinates are indicated in Table 1), in the amount of at least 3 (three) specimens of each species from each water body. A total of 719 fish belonging to 10 species were examined. Parasitological examinations were established in the period from March to November under the methods of Sekretariuk (2001) and Noga (2010): an external examination of the surface of the fish's body, fins, eyes, gills, from which scrapings were made, was carried out. Microscopy was carried out using a light microscope "Biolar-RU PZO" (Poland) at low magnification (10 × 10). The key of Bauer (1984) was used for parasite identification.

All fish handling was carried out in compliance with the rules of bioethics, European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (1986), "On the Humane Treatment of Laboratory Animals", "General Principles of Animal Experiments" and "Regulations on the Use of Animals in Biomedical Experiments" (Hendel 2013), as well as the requirements of Directive 2010/63/EU on the protection of animals used for scientific purposes (Directive 2010/63/EU, 2010). Experiment protocols were approved by Protocol No. 6 of the Bioethics Commission (https://if.org.ua/images/srada/doc/doc_35.pdf) of the Institute of Fisheries of the National Academy of Agrarian Sciences of Ukraine (03.03.2019). Permit No. 17–15 of the Kyiv Regime Commission dated 21 May 2014 for conducting parasitological, bacterial and virological research on fish diseases. Euthanasia of fish with clove oil was carried out in accordance with Council Regulation (EC) No 1099/2009, after which the spine was cut directly behind the head (Council Regulation (EC) No 1099/2009, 2009).

Statistical analysis of data was carried out using the Microsoft Excel program. Variational statistics methods were used for statistical analysis of the results. Prevalence (P, %) and mean intensity of infestation (MI, parasites) were also determined. Statistical significance of differences between indicators was determined by Student's criteria.

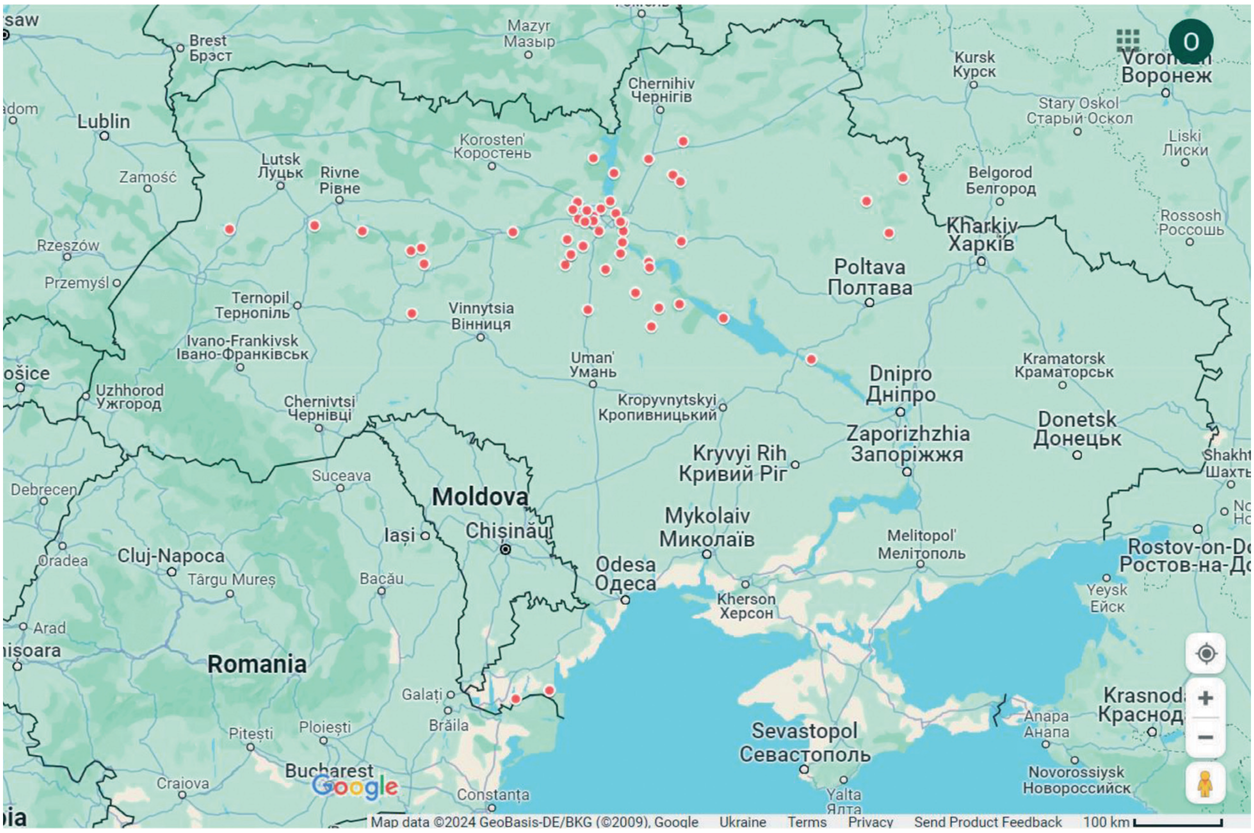

Figure 1. Fish farms and natural reservoirs from which fishes were sampled for examination.

Table 1. Coordinates of water bodies and number of examined fishes in 2017–2023.

Fish species	Coordinates	Number of examined fish
2017		
Carp (*Cyprinus carpio*)	49°32'00.5"N 31°15'54.1"E	5
	49°20'35.8"N 31°09'03.2"E	7
	49°34'01.6"N 31°35'06.1"E	5
	49°58'15.1"N 27°35'26.4"E	4
	50°17'38.8"N 28°58'03.7"E	5
	49°30'32.6"N 30°08'33.9"E	8
	50°23'55.9"N 30°06'19.2"E	5
	50°04'33.9"N 30°40'01.1"E	5
	50°31'05.4"N 29°54'25.2"E	5
	50°11'37.5"N 30°41'12.3"E	7
	50°30'24.2"N 30°08'05.1"E	5
	50°18'16.8"N 30°42'14.7"E	7
	50°19'22.2"N 24°32'23.9"E	9
	50°47'33.0"N 31°35'55.1"E	5
	45°29'05.8"N 29°32'42.7"E	6
	50°49'58.9"N 35°04'42.5"E	5
Tench (*Tinca tinca*)	49°32'00.5"N 31°15'54.1"E	5
Prussian carp (*Carassius gibelio*)	49°20'35.8"N 31°09'03.2"E	8
	50°18'08.8"N 26°37'14.1"E	5
	49°58'15.1"N 27°35'26.4"E	7
	50°17'38.8"N 28°58'03.7"E	5
	49°30'32.6"N 30°08'33.9"E	6
	50°23'55.9"N 30°06'19.2"E	5
	50°04'33.9"N 30°40'01.1"E	5
	50°23'47.7"N 30°39'38.8"E	6
	50°31'05.4"N 29°54'25.2"E	5
	50°35'53.3"N 30°30'00.7"E	5

Fish species	Coordinates	Number of examined fish
Prussian carp (*Carassius gibelio*)	50°30'24.2"N 30°08'05.1"E	6
	50°47'33.0"N 31°35'55.1"E	5
Rudd (*Scardinius erythrophthalmus*)	50°31'05.4"N 29°54'25.2"E	10
Grass carp (*Ctenopharyngodon idella*)	50°23'55.9"N 30°06'19.2"E	5
	50°04'33.9"N 30°40'01.1"E	5
	45°29'05.8"N 29°32'42.7"E	5
	45°23'47.0"N 29°00'48.1"E	5
Bighead carp (*Hypophthalmichthys nobilis*)	45°29'05.8"N 29°32'42.7"E	5
	45°23'47.0"N 29°00'48.1"E	5
2018		
Grass carp (*Ctenopharyngodon idella*)	45°29'05.8"N 29°32'42.7"E	5
Bighead carp (*Hypophthalmichthys nobilis*)	45°29'05.8"N 29°32'42.7"E	5
	50°28'53.1"N 30°35'01.6"E	6
	49°28'05.1"N 27°23'13.6"E	5
	50°35'52.2"N 34°31'10.9"E	7
Bream (*Abramis brama*)	50°52'54.1"N 30°33'19.5"E	5
Carp (*Cyprinus carpio*)	50°35'45.8"N 29°58'58.7"E	5
	50°03'59.4"N 29°52'38.8"E	6
	51°01'52.8"N 30°13'58.7"E	5
	50°28'53.1"N 30°35'01.6"E	7
	50°30'24.2"N 30°08'05.1"E	5
	50°24'23.9"N 30°13'42.4"E	8
	50°18'17.4"N 30°19'34.1"E	5
	50°03'59.4"N 29°52'38.8"E	5

Fish species	Coordinates	Number of examined fish
Carp (*Cyprinus carpio*)	51°00'58.1"N 31°06'17.6"E	5
	51°11'23.1"N 31°38'32.9"E	4
	49°28'05.1"N 27°23'13.6"E	8
	50°35'52.2"N 34°31'10.9"E	5
Rudd (*Scardinius erythrophthalmus*)	50°52'54.1"N 30°33'19.5"E	5
Prussian carp (*Carassius gibelio*)	50°03'59.4"N 29°52'38.8"E	5
	51°01'52.8"N 30°13'58.7"E	5
	49°55'02.7"N 30°25'14.5"E	5
	50°28'53.1"N 30°35'01.6"E	6
	50°30'24.2"N 30°08'05.1"E	6
	50°24'23.9"N 30°13'42.4"E	5
	51°00'58.1"N 31°06'17.6"E	7
Tench (*Tinca tinca*)	50°52'54.1"N 30°33'19.5"E	6
	49°32'00.5"N 31°15'54.1"E	6
2019		
Tench (*Tinca tinca*)	49°32'00.5"N 31°15'54.1"E	5
	49°59'44.9"N 31°06'25.3"E	5
Grass carp (*Ctenopharyngodon idella*)	49°28'05.1"N 27°23'13.6"E	5
	50°27'08.6"N 30°13'44.2"E	8
Prussian carp (*Carassius gibelio*)	49°59'44.9"N 31°06'25.3"E	10
	50°31'31.3"N 30°21'31.8"E	10
	51°01'52.8"N 30°13'58.7"E	12
	50°35'53.3"N 30°30'00.7"E	16
Carp (*Cyprinus carpio*)	49°28'05.1"N 27°23'13.6"E	8
	50°31'31.3"N 30°21'31.8"E	5
	50°27'08.6"N 30°13'44.2"E	7
	51°01'52.8"N 30°13'58.7"E	6
	50°35'53.3"N 30°30'00.7"E	7
2020		
Bighead carp (*Hypophthalmichthys nobilis*)	50°23'55.9"N 30°06'19.2"E	8
Prussian carp (*Carassius gibelio*)	50°23'25.9"N 30°42'21.2"E	6
	49°58'05.5"N 29°47'47.0"E	5
	49°40'46.9"N 30°53'36.5"E	7
	49°55'02.7"N 30°25'14.5"E	5
	50°06'36.9"N 27°22'36.4"E	5
	50°07'47.9"N 27°32'40.5"E	5
Grass carp (*Ctenopharyngodon idella*)	50°23'55.9"N 30°06'19.2"E	5
	45°29'05.8"N 29°32'42.7"E	6
	50°51'23.8"N 31°28'22.1"E	5
Carp (*Cyprinus carpio*)	50°23'10.2"N 30°14'54.1"E	3
	50°23'25.9"N 30°42'21.2"E	5
	49°58'05.5"N 29°47'47.0"E	8
	50°23'55.9"N 30°06'19.2"E	6
	49°40'46.9"N 30°53'36.5"E	5
	50°25'31.3"N 30°00'07.1"E	5
	49°55'02.7"N 30°25'14.5"E	7
	50°12'04.2"N 31°36'52.6"E	8
	50°06'36.9"N 27°22'36.4"E	6
	50°07'47.9"N 27°32'40.5"E	5
2021		
Prussian carp (*Carassius gibelio*)	50°23'43.4"N 30°15'14.4"E	5
	50°31'05.4"N 29°54'25.2"E	7
	50°13'01.4"N 29°49'27.5"E	6
Bighead carp (*Hypophthalmichthys nobilis*)	50°23'43.4"N 30°15'14.4"E	5
	50°13'01.4"N 29°49'27.5"E	6
Pike (*Esox lucius*)	50°31'05.4"N 29°54'25.2"E	5
Bream (*Abramis brama*)	49°25'14.4"N 32°16'40.0"E	6
Grass carp (*Ctenopharyngodon idella*)	45°29'05.8"N 29°32'42.7"E	5
Carp (*Cyprinus carpio*)	48°59'55.6"N 33°38'42.9"E	5
	50°17'10.9"N 34°51'37.7"E	5
	50°21'19.5"N 25°52'28.5"E	7
2022		
Prussian carp *Carassius gibelio*)	50°08'57.7"N 30°04'44.6"E	8
2023		
Carp (*Cyprinus carpio*)	50°35'45.8"N 29°58'58.7"E	5
	49°56'22.7"N 31°06'35.2"E	6
	50°23'55.9"N 30°06'19.2"E	7
	51°01'52.8"N 30°13'58.7"E	5
Bream (*Abramis brama*)	50°52'54.1"N 30°33'19.5"E	5
Prussian carp (*Carassius gibelio*)	50°35'45.8"N 29°58'58.7"E	5
	50°52'54.1"N 30°33'19.5"E	6
	49°56'22.7"N 31°06'35.2"E	7
	50°23'55.9"N 30°06'19.2"E	5
	51°01'52.8"N 30°13'58.7"E	6
Catfish (*Silurus glanis*)	50°52'54.1"N 30°33'19.5"E	5
Pike-perch (*Sander lucioperca*)	50°52'54.1"N 30°33'19.5"E	5

RESULTS AND DISCUSSION

The identified crustacean species were *Argulus foliaceus* Linnaeus, 1758 (the causative agent of argulosis), *Lernaea cyprinacea* Linnaeus, 1758 (the causative agent of lerneosis), *Sinergasilus lieni* Yin 1949 (the causative agent of synergasilosis of the bighead carp) and *Sinergasilus major* Markewitch, 1940 (the causative agent of synergasilosis of the grass carp).

During the period studied, carp and, to a smaller extent Prussian carp, grass carp and bighead carp were most often affected by crustaceans. Individual cases of lesions in tench, rudd, bream, pike, pike-perch and catfish were registered. The examined fish showed pronounced clinical signs of crustacean diseases: on the body surface of carp, Prussian carp, bighead carp and grass carp there were hemorrhages and ulcers of various sizes (result of parasitism by causative agents of argulosis and lerneosis); in addition, live *Argulus* and *Lernaea* were often found on the surface of the fish body (Figures 2, 3), both separately and in the form of a simultaneous parasitism. In some cases, traces of parasitism of *Argulus* and *Lernaea* were found, such as edges of scales damaged by parasites. When examining the gills of herbivorous fish, excessive sliminess and the presence of necrotic areas of various sizes on the gill petals were revealed (Figures 4, 5), and in some cases *Sinergasilus* could be detected with the naked eye.

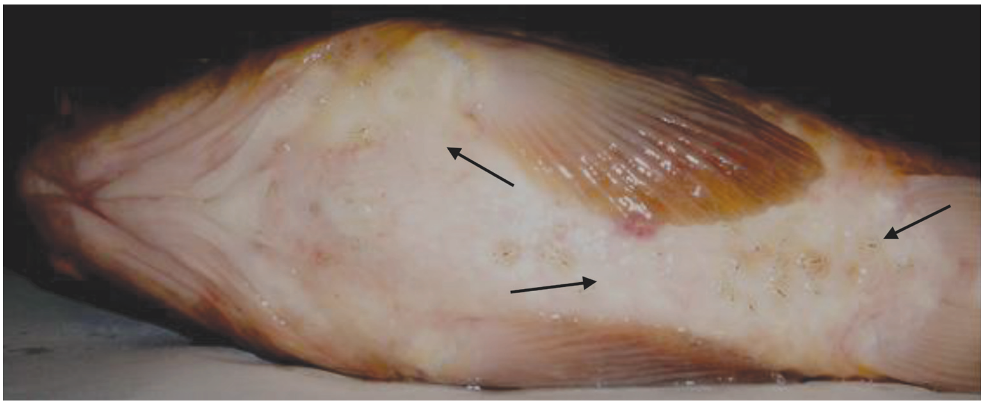

Figure 2. *Argulus foliaceus* on the carp (*Cyprinus carpio*) detected during clinical examination, indicated by arrows.

Figure 3. *Lernaea cyprinacea* detected during a clinical examination on the dorsal and lateral surface of grass carp (*Ctenopharyngodon idella*), indicated by arrows.

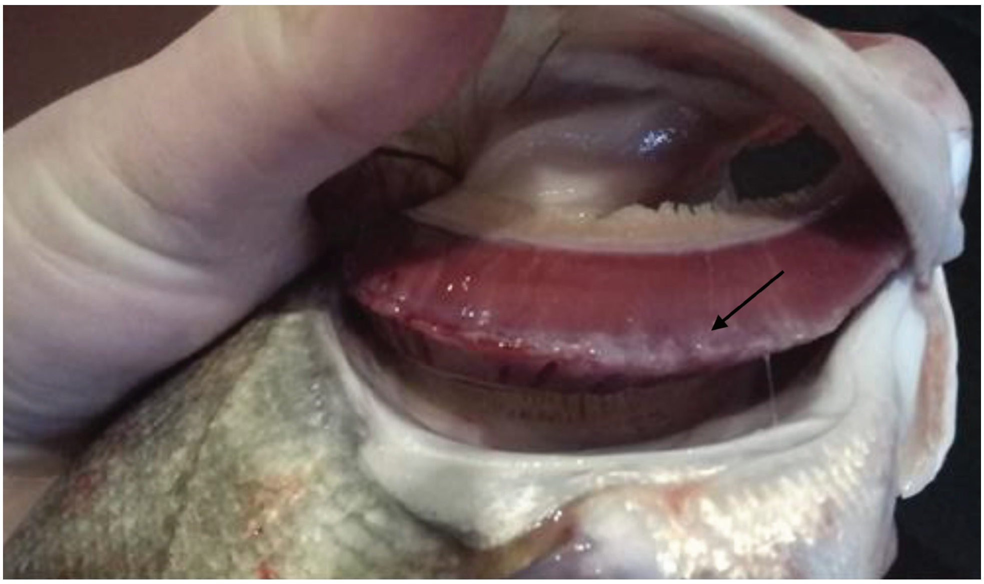

Figure 4. Clinical signs of damage to the gills of the bighead carp (*Hypophthalmichthys nobilis*) by *Sinergasilus lieni*, indicated by arrow.

Figure 5. Clinical signs of damage to the gills of grass carp (*Ctenopharyngodon idella*) by *Sinergasilus major*, indicated by arrow.

Host species and their parasitic crustaceans along with sample size, prevalence (P, %) and the mean intensity of infestation (MI) are presented in Table 2 and Figure 6.

The analysis of the obtained data showed that in 2017 crustaceans mainly affected carp, Prussian carp, tench, grass carp, bighead carp and rudd. At the same time, the causative agent of lerneosis was most often detected on carp, both in the form of parasite carriage and disease. Less common were lesions caused by *Sinergasilus* – 4 cases. At the same time, both parasite carriage and cases of synergasilosis were detected. *Argulus* was detected on carp in the form of parasite carriage and argulosis.

During examinations in 2018, lesions caused by crustaceans were detected on grass carp, bighead carp, bream, carp, rudd, Prussian carp, and tench, i.e. compared to 2017, crustaceans were detected on a larger number of fish species. The epizootic situation regarding lerneosis was as follows: the carriage of causative agents was found on bream and tench. Lesions in carp – parasite carriage and lerneosis (disease) were detected. *Lernaea* was also detected on Prussian carp. The cases of *Argulus* carriage on carp, Prussian carp and rudd were identified. As in 2017, the carriage of *Sinergasilus* was detected on bighead carp and grass carp.

In 2019, as in previous years, during ichthyopathological examinations, the lesions caused by *Lernaea* in carp fish (most often carp, less often tench) were detected. In contrast to previous years, the lesions by *Sinergasilus* were detected only on grass carp – one case of carriage and one case of disease. During the examination of Prussian carp and carp, the lesions by *Argulus* were detected.

In 2020, the carriage of *Lernaea* and lerneosis was revealed on Prussian carp; the lesions were detected on grass carp and carp. Grass carp and bighead carp are carriers of *Sinergasilus*. At the same time, there was no lesion in fish by *Argulus*.

In 2021, Prussian carp, bighead carp, bream, grass carp, carp, as well as pike were affected by crustaceans (pike was not affected in 2017–2020). As in previous years, both carriage and lerneosis were registered: on Prussian carp, bighead carp, pike, bream, and carp. A single case of *Sinergasilus* carriage was found on a grass carp.

In 2022, the carriage of *Lernaea* was registered on carp.

In 2023, in contrast to 2017–2022, the lesions caused by crustaceans were detected in catfish and pike-perch, in particular, lesions by *Argulus*. Carp and Prussian carp were also affected by *Argulus*. In addition to lesions in fish by *Argulus*, the lesions in carp and Prussian carp caused by *Lernaea* were detected. *Lernaea* was also

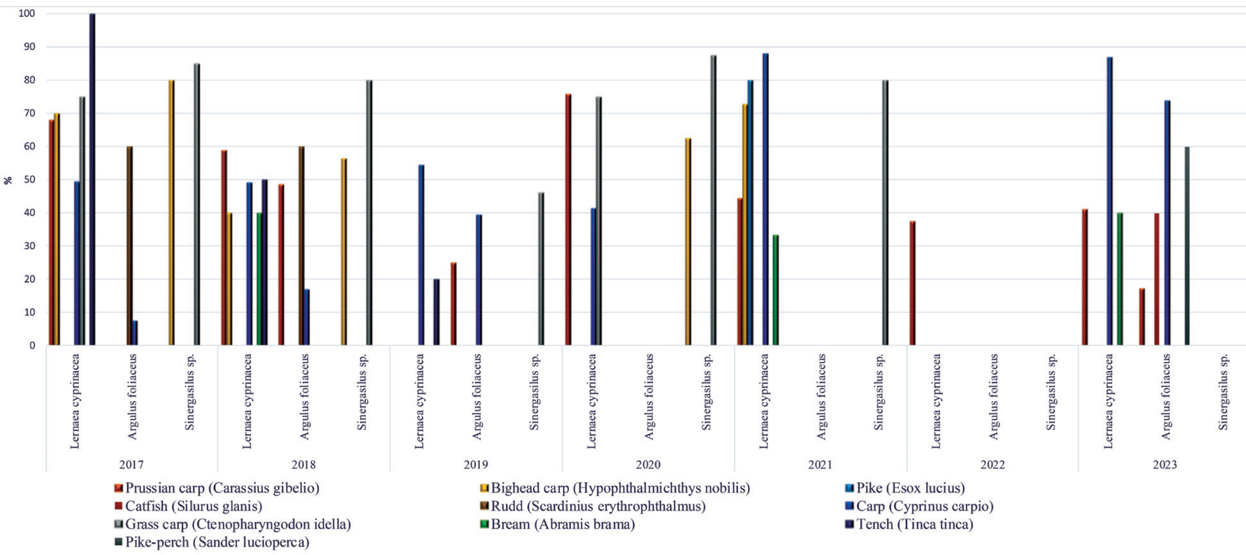

Figure 6. Prevalence of crustacean infestation of examined fishes.

Table 2. Host species and their parasitic crustaceans along with sample size, prevalence (P, %) and mean intensity of infestation (MI) throughout fisheries and reservoirs of Ukraine, sampled between 2017–2023.

Fish species	Parasite species	Number of examined specimens	P, %	MI, parasites
2017				
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	93	49.5	5.12 ± 3.5
	Argulus foliaceus		7.5	14.28 ± 3.5
Tench (*Tincatinca*)	*Lernaea cyprinacea*	5	100	10.6 ± 6.3
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	68	51.5	5.34 ± 3.8
Rudd (*Scardinius erythrophthalmus*)	*Argulus foliaceus*	10	60.0	2.33 ± 0.5
Grass carp (*Ctenopharyngodon idella*)	*Lernaea cyprinacea*	20	75.0	6.60 ± 5.2
	Sinergasilus major		85.0	32.35 ± 16.7
Bighead carp (*Hypophthalmichthys nobilis*)	*Sinergasilus lieni*	10	80.0	24.75 ± 3.2
	Lernaea cyprinacea		70.0	3.57 ± 0.8
2018				
Grass carp (*Ctenopharyngodon idella*)	*Sinergasilus major*	5	80.0	16.50 ± 2.4
Bighead carp (*Hypophthalmichthys nobilis*)	*Sinergasilus lieni*	23	56.5	2.69 ± 0.75
Bream (*Abramis brama*)	*Lernaea cyprinacea*	5	40.0	6.0 ± 1.41
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	68	49.2	5.16 ± 3.69
	Argulus foliaceus		17.0	2.25 ± 1.13
Rudd (*Scardinius erythrophthalmus*)	*Argulus foliaceus*	5	60.0	2.33 ± 0.58
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	39	59.0	8.13 ± 3.46
	Argulus foliaceus		48.7	6.15 ± 1.11
Tench (*Tinca tinca*)	*Lernaea cyprinacea*	12	50.0	6.16 ± 1.94
2019				
Tench (*Tinca tinca*)	*Lernaea cyprinacea*	10	20.0	2.0 ± 1.41
Grass carp (*Ctenopharyngodon idella*)	*Sinergasilus major*	13	46.1	2.66 ± 1.63
Prussian carp (*Carassius gibelio*)	*Argulus foliaceus*	48	25.0	3.66 ± 0.88
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	33	54.5	2.16 ± 1.20
	Argulus foliaceus		39.4	2.92 ± 1.03
2020				
Bighead carp (*Hypophthalmichthys nobilis*)	*Sinergasilus lieni*	8	62.5	7.60 ± 2.96
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	33	75.8	5.56 ± 4.08
Grass carp (*Ctenopharyngodon idella*)	*Lernaea cyprinacea*	16	75	3.25 ± 1.21
	Sinergasilus major		87.5	7.07 ± 1.73
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	58	41.4	3.36 ± 1.82
2021				
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	18	44.4	6.50 ± 3.78
Bighead carp (*Hypophthalmichthys nobilis*)	*Lernaea cyprinacea*	11	72.7	2.37 ± 0.74
Pike (*Esox lucius*)	*Lernaea cyprinacea*	5	80	2.0 ± 1.14
Bream (*Abramis brama*)	*Lernaea cyprinacea*	6	33.3	1.5 ± 0.70
Grass carp (*Ctenopharyngodon idella*)	*Sinergasilus major*	5	80	6.0 ± 1.41
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	17	88.2	3.53 ± 2.32
2022				
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	8	37.5	1.66 ± 0.57
2023				
Carp (*Cyprinus carpio*)	*Lernaea cyprinacea*	23	86.9	6.20 ± 4.59
	Argulus foliaceus		73.9	5.82 ± 0.88
Bream (*Abramis brama*)	*Lernaea cyprinacea*	5	40.0	1.50 ± 0.70
Prussian carp (*Carassius gibelio*)	*Lernaea cyprinacea*	29	41.2	5.50 ± 0.79
	Argulus foliaceus		17.2	7.0 ± 2.91
Catfish (*Silurus glanis*)	*Argulus foliaceus*	5	40.0	10 ± 7.07
Pike-perch (*Sander lucioperca*)	*Argulus foliaceus*	5	60.0	8.66 ± 1.15

detected on bream in the form of parasite carriage.

Thus, we can see the dynamics by year and the spread of crustacean infestation, which is important for predicting disease outbreaks and spread beyond Ukraine. The obtained data are also important for the timely use of preventive measures in fish farms.

During examinations on the territory of Kharkiv, Sumy, Poltava, Mykolaiv, Odesa, and Zhytomyr regions, it was established that the extent of infestation by parasitic crustaceans – *Lernaea*, *Argulus* and *Sinergasilus* – in farms during the period of research ranged from 5.5%, 12.1% and 8.2% in winter to 89.1%, 92.1% and 41.1% in summer, respectively (Yevtushenko et al. 2015).

Silver, bighead and grass carps from the spawning, rearing, feeding, and wintering ponds of specialized fish farms and ponds of Kharkiv, Sumy, Poltava and Donetsk regions were found to have *Lernaea cyprinacea* Linnaeus, 1758, *Argulus foliaceus* Linnaeus, 1758, *Sinergasilus major* Markevich, 1940 (on grass carp); and *Sinergasilus lieni* Yin, 1949 (on bighead carp) (Yevtushenko 2020).

In 2011–2017, *Argulus* sp., *Ergasilus* sp., *Lernaea cyprinacea* Linnaeus, 1758, *Sinergasilus major* Markevich, 1940, and *Sinergasilus polycolpus* Markevich, 1940 were found on fish from Chernihiv, Chernivtsi, Dnipropetrovsk, Kharkiv, Kherson, Kyiv, Lviv, Odesa, Rivne, Zakarpattia and Zhytomyr regions (Matvienko et al. 2020).

In the south of Ukraine (along the coastline of the Dnipro-Buzka estuary and the Dnipro delta, within the administrative boundaries of the Mykolaiv region and in the part of the water area administratively located in the Kherson region), *Argulus* (invasion extensiveness (IE) – 12%, invasion intensiveness (II) – 6–18 crustaceans) and *Ergasilus* (IE – 6.02%, II – 11–26 crustaceans) were detected on perch; causative agents of argulosis were detected on pike (IE – 280.2%, II – 2–63 crustaceans), and causative agents of ergasilosis were detected on pike-perch (IE – 47.2%, II – 7–28 crustaceans) as part of associated infestations (Honcharov 2019).

In 2020, in the industrial reservoirs of the Rivne region (invasion extensiveness (IE), % / invasion intensiveness (II), parasites), *Sinergasilus* was detected on bighead carp (11.4 / 25.4 ± 1.4), *Lernaea* (21.8 / 7.7 ± 0.06) and *Argulus* (24.5 / 8.1 ± 0.14) on Prussian carp, *Lernaea* (30.0 / 15.4 ± 1.2) and *Argulus* (44.5 / 8.6 ± 0.07) on carp, and *Argulus* (6.0 / 2.4 ± 0.04) on perch (Katyukha et al. 2021). In the Kyiv region during 2017–2021, carp, Prussian carp, bighead carp, grass carp and bream were affected by crustaceans (Vashchenko and Matvienko 2022).

The research results obtained by us during 2017–2023 confirm the data of other authors regarding the spread of crustaceans. It should be noted that, according to our data, during the years 2017–2023, not a single case of lesion in fish by *Ergasilus* was registered, and lesions by other parasitic crustaceans often took the form of simultaneous parasitizing.

During the years 2017–2023, the cases of lesions in carp and prussian carp caused by *Lernaea* were most often detected, and a decrease in the frequency of cases of argulosis and synergasilosis was observed. During the period studied, no cases of parasitism by causative agents of ergasilosis were found. Crustacean diseases (especially lerneosis and synergasilosis) were diagnosed more often, while parasite carriage was less often diagnosed.

According to the analyzed data, parasitic crustaceans are quite common both in natural waters and in specialized fish farms in Europe and Ukraine. Thus, during salmon farming in Europe (Faroe Islands, Scotland, Norway) for the period of 2019–2021, sea lice (*Lepeophtheirus salmonis*) caused the main concern. In 2019 and 2020, *Lernathropus kroyeri* was found on a seabass in Greece. In Latvian ponds, argulosis, ergasilosis, and lerneosis were registered in 2019–2021 (Report 2021, 2020, 2019).

By comparing the data we obtained with data from European countries, we can preliminarily conclude that the number of cases of *Ergasilus* parasitism has decreased. The data obtained require further study and clarification of the reasons.

CONCLUSION

During the years 2017–2023, the cases of lesions in carp and Prussian carp caused by *Lernaea* were most often detected, and a decrease in the frequency of cases of argulosis and synergasilosis was observed. During the study period, no cases of parasitism by causative agents of ergasilosis were found. Crustacean diseases (especially lerneosis and synergasilosis) are diagnosed more often, while parasite carriage is less often diagnosed.

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