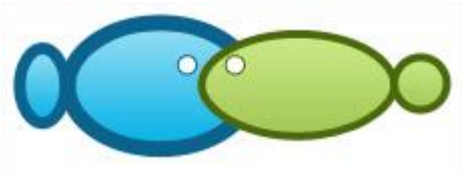

The parasite fauna in fish from the Kazakhstan portion of the Caspian Sea

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Abstract. The purpose of this work was to evaluate the extent of parasitization of various fish species from the Kazakhstan part of the Caspian Sea. 3133 fish from 30 species were collected between 2008 and 2017, and 31 parasite species were identified (apart from *Myxosporidia* species) by using the compression technique. Among the species, 11 were free of parasites. The extensity of the parasite infestation for the studied fish ranged from 0.4% - *Mazocraes alosae* (Hermann, 1782) in freshwater bream (*Abramis brama*) - to 97% - *Contracaecum rudolphii* (Hartwich, 1964) in the bersh (*Sander volgensis*). To our knowledge, this is the first report on *Dactylogyrus cornu* (Linstow, 1878) and *Hemiurus appendiculatus* (Rudolphi, 1802) inhabiting fish in the area researched. Moreover, the ide (*Leuciscus idus*) as a carrier of *Opisthorchis felineus* (Rivolta, 1884) in the Caspian Sea basin is described for the first time. Some of the fish were infested with potentially zoonotic parasites, which indicates the need for regular monitoring of the extensity of parasite infestation in the fish fauna of the Caspian Sea, to further prevent parasitic diseases in the human population.

Key Words: helminth, monitoring, parasite infestation, trematode, zoonotic parasites.

Introduction. The introduction of parasites modifies ecosystem processes and degrades biodiversity, thus inflicting damage to commercially important fisheries and causing considerable financial losses. An example of a disruptive impact on native fish population caused by the intrusion of alien parasite species into their habitat is the decline in *Acipenser nudiventris* (Lovetski, 1928) population by the monogenean *Nitzschia sturionis* (Abildgaard, 1794) introduced to the Aral Sea with the beluga *Huso huso* (Linnaeus, 1758) in the 1930's (Vignon & Sasal 2010).

In 1984, losses of wild Norwegian salmon (*Salmo salar*) induced by the invasion of *Gyrodactylus salaris* (Malmberg, 1957) amounted to 520 tons. The parasite has completely destroyed salmon population in 6 rivers and jeopardized the survival of the fish in 34 other rivers (Bakke et al 2007).

Cestodes of the family Ligulidae dwelling in the northern part of the Caspian Sea are causative agents of a lethal fish disease, ligulidosis. In the body of juvenile bream (*Abramis brama*), Ligulidae cause dystrophy and dysfunction of internal organs, skeleton deformation, abdominal rupture, and consequently, the death of infested fish (Kon'kova 2015).

Fish farms have good possibilities to influence the welfare of fish and its environment, which is important in the prevention of diseases (Austin & Austin 2007; Rahkonen et al 2013).

When the fish are infested with various parasites, they begin to release pathogenic bacteria into the environment, further increasing the infectious pressure (Austin & Austin 2007).

Freshwater fish serve as the primary epidemiological reservoir for *Diphyllobothrium latum* (Linnaeus, 1758) and *Opisthorhis felineus* (Rivolta, 1884). It has

been empirically proven that gull-tapeworm *Diphyllobothrium dendriticum* (Nitzsch, 1824) is infectious for humans as well, but this parasite is usually removed from fish during gutting (Rahkonen et al 2013).

The momentousness of detailed research on the parasitic fauna of fish has long been recognized under constantly increasing anthropogenic pressure (Bauer et al 2002; Morley 2007; Sheath et al 2015). The purpose of this study was to investigate the prevalence of internal parasites in fish caught from the Kazakhstan portion of the Caspian Sea.

Material and Method

Description of the study sites. This investigation was carried out from 2008 to 2017 in the Kazakhstan sector of the Caspian Sea (Figure 1). Research expeditions with scientists from the Republican Veterinary Laboratory (Nur-Sultan), National Center for Monitoring, Referencing, Laboratory Diagnostics and Methodology in Veterinary Medicine (Nur-Sultan), Kazakh Research Institute of Fisheries Fishery (Almaty), Saken Seifullin Kazakh Agrotechnical University (Nur-Sultan), Zhangir khan West Kazakhstan Agrarian Technical University (Uralsk), and Kazakh National Agrarian University (Almaty) were conducted.

Figure 1. Study sites (in pink) in the Caspian Sea, Kazakhstan.

Fish and parasite identification. Fish were captured by means of monofilament casting and gill nets. Small fish were preserved in 70% ethanol as non-dressed, whereas the rest were dissected on board and various body components were placed in 70% ethanol for safe shipping. All the samples were brought to the Republican Veterinary Laboratory (Nur-Sultan, Kazakhstan) and evaluated for the presence of parasites through the compression method as described by Khalil et al (2014). The extensity (E) of the parasite infestation was calculated using the equation:

$$E\ (\%) = n/N \times 100$$

Where: n - number of fish of a given species infested with a parasite species; N - total number of fish of a given species. *O. felineus* metacercariae were obtained by digesting the muscles of fish in artificial gastric juice. The species of metacercariae were determined according to Sudarikov et al (2002). The fish were identified to species level based on Myagkov (1994).

Results and Discussion. 3133 fish representing 30 species were detected in the Kazakhstan part of the Caspian Sea (Table 1).

Table 1

Species and quantity of fish collected from the Kazakhstan section of the Caspian Sea in 2008-2017

Fish species	*N*	*Fish species*	*N*
Atherina boyeri (Risso, 1810)	5	*Sander lucioperca* (Linnaeus, 1758)	3
Sander volgensis (Gmelin, 1789)	34	*Perca fluviatilis* (Linnaeus, 1758)	1
Ballerus sapa (Pallas, 1814)	62	*Acipenser persicus* (Borodin, 1897)	5
Neogobius fluviatilis (Pallas, 1814)	94	*Acipenser gueldenstaedtii* (Brandt & Ratzeburg, 1833)	28
Rutilus caspicus (Yakovlev, 1870)	894	*Vimba vimba* (Linnaeus, 1758)	2
Blicca bjoerkna (Linnaeus, 1758)	92	*Cyprinus carpio* (Linnaeus, 1758)	26
Leuciscus aspius (Linnaeus, 1758)	77	*Acipenser stellatus* (Pallas, 1771)	13
Syngnathus abaster (Risso, 1827)	11	*Alosa saposchnikowii* (Grimm, 1887)	99
Carassius carassius (Linnaeus, 1758)	12	*Alosa caspia caspia* (Eichwald, 1838)	50
Mugil cephalus (Linnaeus, 1758)	19	*Alosa braschnikowi* (Borodin, 1904)	553
Scardinius erythrophthalmus (Linnaeus, 1758)	11	*Silurus glanis* (Linnaeus, 1758)	19
Clupeonella cultriventris (Nordmann, 1840)	97	*Sander marinus* (Cuvier, 1828)	55
Rutilus frisii (Nordmann, 1840)	8	*Ballerus ballerus* (Linnaeus, 1758)	40
Abramis brama (Linnaeus, 1758)	685	*Pelecus cultratus* (Linnaeus, 1758)	134
Tinca tinca (Linnaeus, 1758)	1	*Leuciscus idus* (Linnaeus, 1758)	3

A total of 31 species of parasites were recorded apart from *Myxosporidia* species. They are indicated in Table 2 along with the fish parasite extent per species.

Table 2

Parasitic fauna of fish from the Kazakhstan portion of the Caspian Sea, with the extensity of the parasite infestation (%)

Parasite species \ Fish species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Anisakis schupakovi (Mosgovoi, 1951)	-	14.7	4.8	-	9	7.6	59.7	-	-	-	-	-	-	9	-	-	-	20	21.4	-	-	-	57	-	-	52.6	67.3	15	44	-
Amphilina foliacea (Rudolphi, 1819)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-
Argulus coregoni (Thorell, 1865)	-	-	-	-	2	-	-	-	-	-	-	-	-	2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bucephalus polymorphus (von Baer, 1827)	-	-	9.7	-	6	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cucullanus sphaerocephalus (Rudolphi, 1809)	-	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-
Caryophyllaeus fimbriceps (Annenkova-Chlopina, 1919)	-	-	-	-	5.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.7	-	-	-	-	-	-	-	-	-
Caryophyllaeus laticeps (Pallas, 1781)	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	19.2	-	-	-	-	-	-	-	-	-
Caligus lacustris (Steenstrup & Lütken, 1861)	-	-	-	-	-	5.4	32.5	-	-	-	-	-	-	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contracaecum rudolphii (Hartwich, 1964)	-	97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.1	-	-	-	-	8	76	10.5	-	-	-	-
Caspiobdella caspica (Selensky, 1915)	-	-	-	-	-	5.4	2.6	-	-	-	-	-	-	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplostomum clavatum (Nordmann, 1832)	-	5.9	33.9	-	-	20.7	-	-	-	-	18.2	-	-	23	-	-	-	-	10.7	-	-	-	-	-	16	-	9.1	12.5	-	-
Diplostomum spathaceum (Rudolphi, 1819)	-	-	-	-	23	23.9	-	-	-	-	-	-	-	8	-	-	-	-	10.7	-	19.2	-	-	48.5	-	-	-	-	-	-
Dactylogyrus cornu (Linstow, 1878)	-	-	9.7	-	4.3	5.4	-	-	-	-	-	-	-	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dactylogyrus wunderi (Bychowsky, 1931)	-	-	-	-	-	9.8	-	-	-	-	9.1	-	-	8	-	-	-	-	-	-	7.7	7.7	-	-	-	-	-	17.5	-	-
Dactylogyrus simplicimalleata (Bychowsky, 1931)	-	-	9.7	-	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.4	-
Dactylogyrus sphyrna (Linstow, 1878)	-	-	-	-	7	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Digramma interrupta (Rudolphi, 1810)	-	-	1.6	-	2.4	28.3	-	-	-	-	-	-	-	7.9	-	-	-	-	10.7	-	-	-	-	-	-	-	-	-	-	-
Diplozoon paradoxum (von Nordmann, 1832)	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eustrongylides excisus (Jägerskiöld, 1909)	-	-	-	-	-	-	5	-	-	-	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eubothrium crassum (Bloch, 1779)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.3	-	-	-	-	-	-	-	-	-	-	-
Henneguya psorospermica (Thelohan, 1895)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	-	-	-
Hemiurus appendiculatus (Rudolphi, 1802)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.6	-	-	-	-	-	-
Leptorhynchoides plagicephalus (Westrum, 1821)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.3	-	-	-	-	-	-	-	-	-	-	-
Ligula intestinalis (Linnaeus, 1758)	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myxobolus musculi (Keysselitz, 1908)	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	10.7	-	-	15.4	-	-	-	-	-	-	-	-
Mazocraes alosae (Hermann, 1782)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Myxosporidia spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	7.7	7.7	-	2	-	-	-	-	-	-
Nitzschia sturionis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	10.7	-	-	-	-	-	-	-	-	-	-	-
Porrocecum reticulatum (Baylis & Daubney 1922)	-	61.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	10	47.4	9.1	-	14.9	-
Posthodiplostomum cuticola (Nordmann, 1832)	-	-	40.3	-	10	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.7	-	-	-	-	-	17.5	-	-
Pomphorhynchus laevis (Zoega, 1776)	-	-	19.4	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	10.7	-	-	-	-	-	-	-	-	-	-	-
Opisthorchis felineus	-	-	-	-	10	-	-	-	-	-	9.1	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	33.3

Note: 1 - big-scale sand smelt (*Atherina boyeri*); 2 - Volga pikeperch (*Sander volgensis*); 3 - white-eye bream (*Ballerus sapa*); 4 - monkey goby (*Neogobius fluviatilis*); 5 - Caspian roach (*Rutilus caspicus*); 6 - white bream (*Blicca bjoerkna*); 7 - asp (*Leuciscus aspius*); 8 - black-striped pipefish (*Syngnathus abaster*); 9 - crucian carp (*Carassius carassius*); 10 - flathead grey mullet (*Mugil cephalus*); 11 - rudd (*Scardinius erythrophthalmus*); 12 - Black and Caspian Sea sprat (*Clupeonella cultriventris*); 13 - kutum (*Rutilus frisii*); 14 - bream (*Abramis brama*); 15 - tench (*Tinca tinca*); 16 - pike-perch (*Sander lucioperca*); 17 - Eurasian perch (*Perca fluviatilis*); 18 - Persian sturgeon (*Acipenser persicus*); 19 - Danube sturgeon (*Acipenser gueldenstaedtii*); 20 - vimba bream (*Vimba vimba*; 21 - common carp (*Cyprinus carpio*); 22 - starry sturgeon (*Acipenser stellatus*); 23 - Caspian marine shad (*Alosa braschnikowi*); 24 - Saposhnikovi shad (*Alosa saposchnikowii*); 25 - Caspian shad (*Alosa caspia caspia*); 26 - Wels catfish (*Silurus glanis*); 27 - estuarine perch (*Sander marinus*); 28 - zope (*Ballerus ballerus*); 29 - sichel (*Pelecus cultratus*); 30 - ide (*Leuciscus idus*).

Thus, the extensity of parasite invasion for the studied fish has ranged from 0.4% to 97%. *M. musculi* microsporidia cause microsporidiosis, a widespread fish disease. Regarding the present research, they have been recovered from *R. caspicus*, *A. gueldenstaedtii*, and *A. stellatus* (Figure 2). This is in line with the findings of Mamedova (2009). However, the author just claims the presence of the fish species among those experimentally caught in the Caspian Sea between 2002 and 2006, also giving a list of parasite species (including *M. musculi*) discovered in the fish, but it is not specified which parasites were found in which fish species.

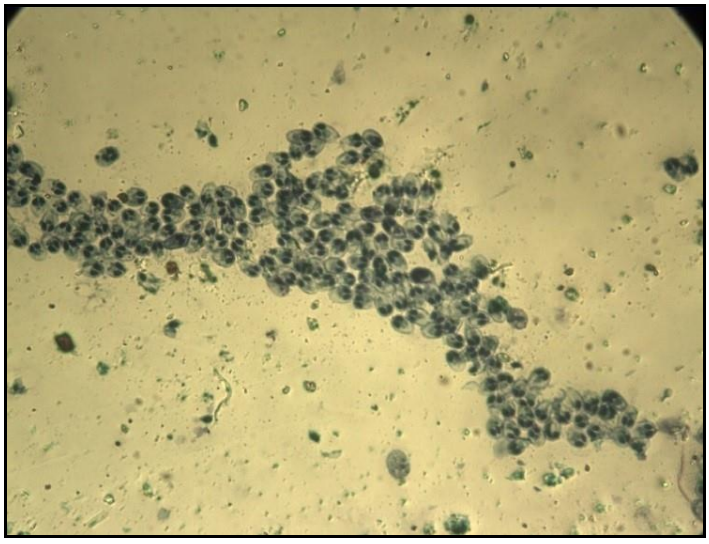

Figure 2. *Myxobolus musculi* from compressed fish tissue.

Among *Dactylogyrus* (Diesing, 1850) (Figure 3), *D. simplicimalleata* has shown the highest infestation extensity (for *P. cultratus*) in this study. Contrary to our findings, Pazooki et al (2011) stated *D. sphyrna* dwell in *B. bjoerkna* collected from Anzali Lagoon situated at the Caspian Sea. *D. wunderi* has been recently detected in Cypriniformes (Bleeker, 1859) from the Kazakhstan part of the Caspian Sea (Abdybekova et al 2020). To our knowledge, *D. cornu* and *H. appendiculatus* (Figure 4) have not been yet reported to infest fish in the Caspian Sea. Furthermore, we have failed to find any research describing *O. felineus* (Figure 5) obtained from *L. idus* in the Caspian Sea basin. As of the current study, the ide was the most affected by it.

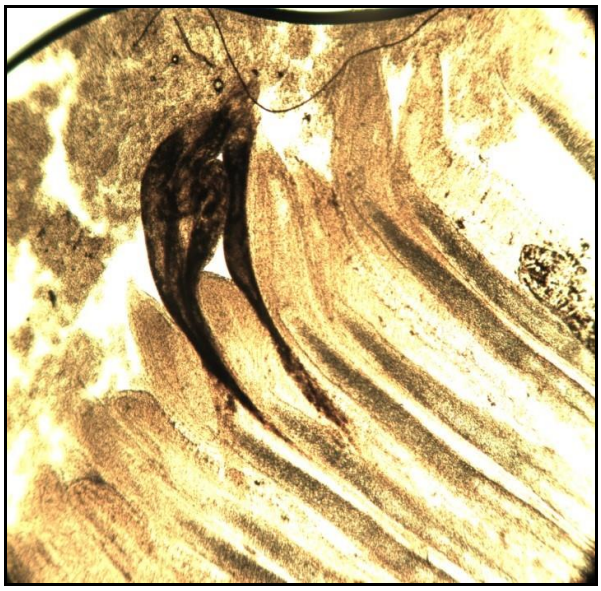

Figure 3. *Dactylogyrus* between gill lamellae.

Figure 4. *Hemiurus appendiculatus* in the pylorus.

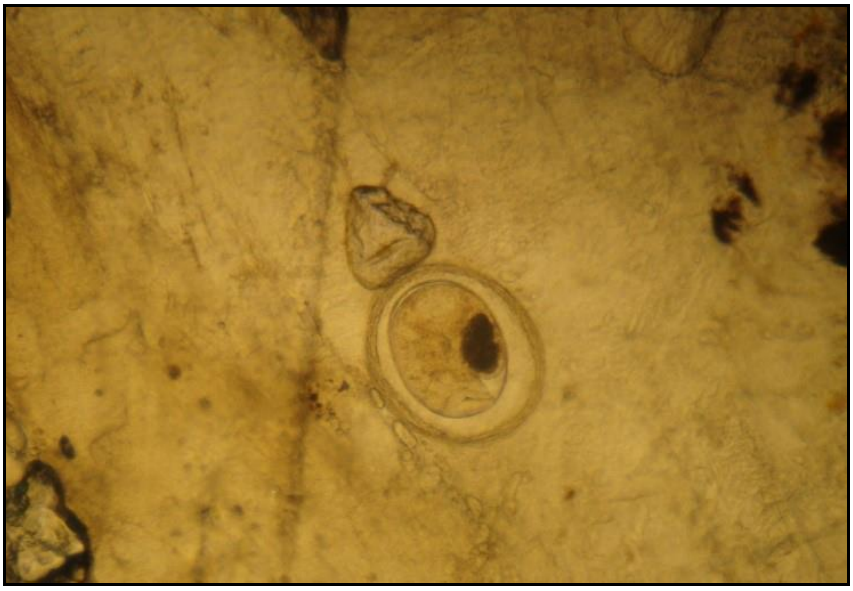

Figure 5. *Opisthorchis felineus* in the muscles of *Leuciscus idus*.

Overall, the maximum extensity of infestation (with *C. rudolphii*, 97%) was recorded in the population of *S. volgensis*. To date, no other studies were found to document the nematode in the bersh. Khasbulatova & Ataev (2019) claimed to observe *Contracaecum rudolphii* (Hartwich, 1964) in *V. vimba* inhabiting the Agrakhan Bay of the Caspian Sea. By contrast, the vimba bream was free from *C. rudolphii* in the present research.

In support of previously reported data (Abdybekova et al 2020), *Anisakis schupakovi* was the most frequently identified helminth in our survey. It was obtained from 14 of the 30 fish species under study, with the infestation rate up to 67.27% in *Sander marinus*.

Conclusions. In summary, this investigation has identified over 30 parasite species across 30 fish species. Some of the fish were infested with parasites that are potentially zoonotic, which indicates the need for regular monitoring of the extensity of the parasite infestation in the fish fauna of the Caspian Sea in order to prevent parasitic diseases in the human population. The trematodes *D. cornu* and *H. appendiculatus* were found as new parasites infesting the Caspian Sea fish.

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