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Helminth parasites of fish of the Kazakhstan sector of the Caspian Sea and associated drainage basin

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Summary

The northern section of the Caspian Sea is an important fishery for Kazakhstan. In the present study, a total of 606 individuals of 13 fish species were collected. For each of *Abramis brama*, *Alosa saposchnikowii*, *Atherina boyeri caspia*, *Carassius auratus*, *Clupeonella cultriventris*, *Cyprinus carpio*, *Liza aurata*, *Leuciscus aspius*, *Rutilus rutilus caspius*, *Sander lucioperca*, *Sander marinus*, and *Sander volgensis* 50 individuals were examined whilst 6 individuals of *Siluris glanis* were examined. The nematode parasite *Anisakis schupakovi* was found in all fish species except *Liza aurata, Carassius aurata*, *Cyprinus carpio* and *Rutilus rutilus* at intensities ranging from 1 to 1197 parasites per infected fish. Trematodes of family Diplostomidae were also isolated from all fish except *Alosa saposhnikowii, Clupeonella cultriventris* and *Sander marinus* at intensities ranging from 1 to 242 parasites per infected fish. Other parasites found included the nematodes *Porrocaecum reticulatum, Contracecum sp, Camallanus* sp and *Eustrongylus excisus;* the cestodes *Neogryporhynchus cheilancristrotus, Bothriocephalus opsariichthydis;* the monogenean parasites *Mazocraes alosa, Ancyrocephalus paradocus, Gyrodactylus spp, Ligophorus vanbenedenii* and *Dactylogyrus spp;* and the crustacean parasites *Ergasilus sp.* and *Synergasilus sp.* In addition one unidentified species of nematode and a bivalve of the genus *Unio* was recovered from *Rutilus rutilus caspius.* There was no association between Fulton's condition index and intensity of parasite infection.
Keywords: Caspian Sea; Fish; Parasites; Kazakhstan

Introduction

The Caspian Sea with the lower reaches of the rivers flowing into it are Kazakhstan's most important fisheries. Here there are about 0.3 million tons of fish caught annually. Fish parasitoses act as a potential factor restraining the growth of fish productivity. Some helminths of fish may also be zoonoses and therefore represent a public health problem. Therefore the study of parasites presently infecting fish in the Caspian Sea basin may provide important information to reduce the risk of spreading economically important diseases of fish in the region. Such studies may also contribute to ameliorating the public health risk of some helminths. Furthermore we aimed to identify potential pathogenic effects by analyzing the association of Fulton's condition index with the intensity of infection with parasites identified.

The Caspian fisheries are of commercial importance. There are a number of studies from the southern sectors of the Caspian, mainly from Iran (eg Khara *et al*., 2011; Sattari *et al.,* 2008; Mazandarani *et al*., 2016) and some regional reports from Turkey (eg Çolak, 2013; Özer & Kirca, 2013). Studies of fish parasites in the Soviet

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sector of the Caspian sea were first carried out in 1931 – 1932 by Dogel and Bykhovsky (1939) and more recently by Tokpan and Rakhimov (2010).

The purpose of the work is to study the distribution of *Anisakis* spp and other possible zoonoses together with other helminths infecting fish in the north-eastern part of the Caspian Sea. In total the infection of 13 species of Caspian fish from 6 families was studied.

Materials and Methods

To determine the infection with anisakidosis and other potentially zoonotic parasites, 606 fish were investigated from the Kazakhstan sector of the Caspian Sea (Fig. 1). For each of 12 species, 50 fish were examined (Tables1 – 4). For one species, the European catfish *Sirulis glanis* only 6 specimens were available for examination (Table 5).

The species composition of the fish was determined on the basis of a taxonomic descriptions according to Berg (1949), Kazancheyev (1981) and Reshetnikova (2002). A complete biological analysis of the fish was carried out with the determination of the length, mass, sex, maturity stages of the gonads (Pravdin 1966). The age of the fish were determined by rings on the scales or otoliths or by cuts of the marginal rays of the pectoral fins (Chugunova, 1959; Konoplev, 1975). The body length of all fish was measured from the top of the snout to the end of the scaly cover and to the end of the caudal fin. Fish were weighed on an electronic scale with an accuracy of 1 g. For small fish (atherin and common sprat) this was with an accuracy of 0.1 g. Fulton's condition index (F) was calculated for each fish as:

$$F = 100*W/L^3$$

where W = the weight in grams and L is the length in cm (Nash and Valencia 2006)

In the field, a complete parasitological dissection of fish was carried out according to the standard classical method (Skrabin, 1928; Dogel, 1933; Bykhovskaya – Pavlovskaya, 1985). The results of the autopsies of the fish were recorded. These included the fish species, the place of investigation, sex, age, weight of the fish, and the number, species and localization of detected parasites.

With a complete parasitological study, fish muscles and all internal organs were examined under a KRUSSMSZ5000 stereomicroscope with a range of 7 – 45x. Parasites were fixed in various fixatives: monogeneans, trematodes, cestodes, and parasitic crustaceans in 700 alcohol, and nematodes in Barbagallo fluid. For species identification, nematodes were placed in a solution of glycerol with water (1: 1) in order to clear them and then view the internal structure of helminths. This therefore enabled the taxonomic identification based on the morphological features of the parasites.

To investigate any affects of parasitism on the fish, a multivariable generalised linear model was used to analyse the association of the intensity of infection of each individual fish with the Fulton's condition index. A backward selection method was used with all variables included in the initial model with each non significant variable with a p >0.15 being removed sequentially, with only significant variables remaining in the final model. In addition and associations in the intensity of infection with individual parasites were analysed. All analyses were undertaken in R (R Core Team, 2019).

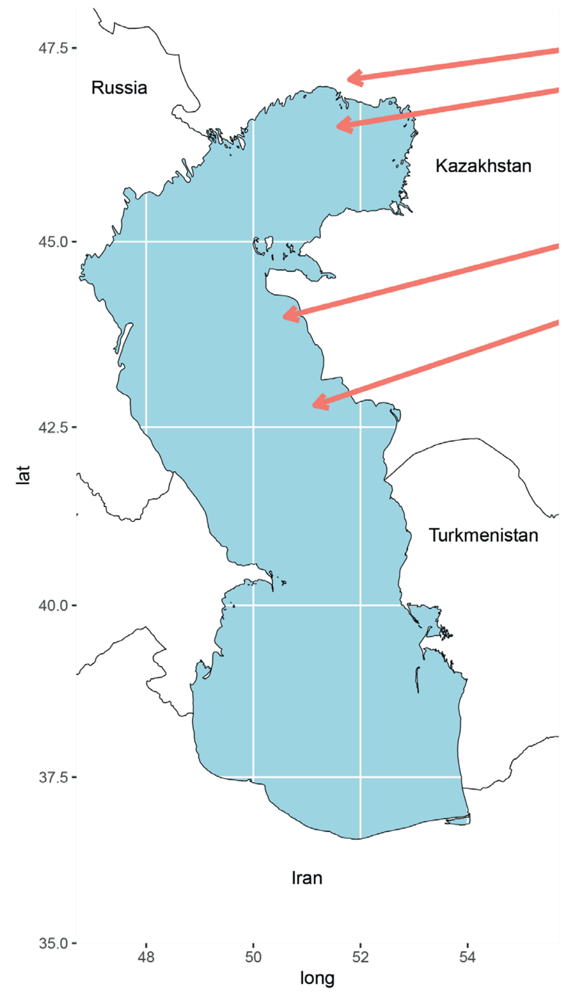

Fig. 1. Study sites in the Caspian Sea. Top arrow indicates lower reaches of the Ural river, whilst the other sites were within the Caspian Sea.

Ethical Approval and/or Informed Consent

For this study formal consent is not required.

Results

A total of 656 fish belonging to 13 different species representing 6 orders were examined. In the present study 25 species of parasites were identified. These included 5 species of nematode, 8 species of trematodes, 6 monogean species, 2 cestode and 2 crustacea. In addition one unidentified species of nematode was

Table 1. The number of fish infected and range of intensity of infection of parasites in fish of order Clupeiformes.

Fish host	Parasite	Number infected (prevalence, confidence intervals)	Development stage of parasite recovered and localization	Range of intensity	Mean abundance	Parasite Taxon
Alosa saposchnikowii	*Anisakis schupakovi* Mozgovoi, 1951	1 (2, 0.1 – 11)	Third stage larva (Abdominal cavity, muscle, serous membrane)	2	0.04	Nematoda: Anisakidae
	Porrocaecum reticulatum Linstow, 1899	6 (12, 5 – 24)	Third stage larva (Abdominal cavity)	1 – 4	0.2	Nematoda: Ascaridoidea
	Neogryporhynchus cheilancristrotus Wedl, 1855	1 (2, 0.1 – 11)	Metacestode (Abdominal cavity)	14	0.28	Cestoda: Dilepididae
	Mazocraes alosae Hermann, 1782	42 (84, 71 – 93)	Adult (Gills)	1 – 276	36.5	Monogenea: Mazocraeidea
Clupeonella cultriventris	*Anisakis schupakovi*	12 (24, 13 – 38)	Third stage larva (Muscle)	1 – 6	0.6	Nematoda: Anisakidae

recovered and one molusc. The number of fish infected with each parasite identified; abundance and range of intensity of infection; prevalence; developmental stage of the parasite recovered, and the organ of the fish from which the parasite was recovered are presented in Tables 1 – 5. Figures 2 – 6 illustrate some of the parasites recovered during this study.
There were 2 fish species from the order Clupeiformes and 4 different parasite species were found infecting these fish. These included 2 nematode one cestode and 1 Trematode species. Details are given in Table 1.
There were 3 fish species from the order Perciformes and 11 different parasite species were found infecting these fish. These included 2 nematode, 7 monogenean and 1 crustacean species (Table 2)
Liza aurata (syn Chelon aurata) was the only fish species from the order Mugiliformes and this was infected by one monogenean and one trematode parasite (Table 3).
Atherina boyeri was the only fish species from the order Atheriniformes. Only one parasite was detected in this species: *Anisakis schupakovi*. In total 5 fish were infected with a range of intensity of 1 – 2 parasites per infected fish.
There were 5 fish species from the order Cypriniformes and 14 different parasite species were found infecting these fish. These included 2 nematode, 11 monogenean and 1 cestode species.

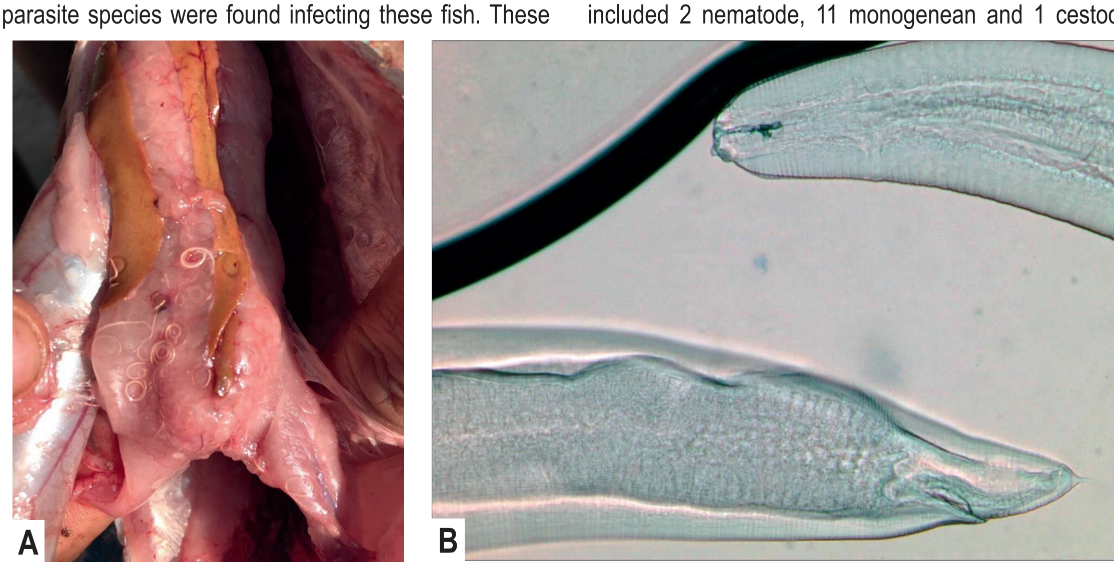

Fig. 2. *Anisakis schupakovi*. A – third stage larvae in the abdominal cavity of the Sander lucioperca.
B – head and tail of 3rd stage larvae recovered from *Abramis brama orientalis*.

Table 2. The number of fish infected and range of intensity of infection of parasites in fish of order Perciformes.

Fish host	Parasite	Number infected (prevalence, confidence intervals)	Development stage of parasite recovered	Range of intensity	Mean abundance	Parasite Taxon
Sander lucioperca	*Anisakis schupakovi*	42 (84, 71 – 93)	Third stage larva (Muscle, serous membrane)	7 – 161	27.0	Nematoda: Anisakidae
	Contracecum sp.	9 (18, 9 – 31)	Third stage larva (Abdominal cavity, serous membrane)	7 – 121	6.8	Nematoda: Anisakidae
	Ancyrocephalus paradocus Creplin, 1839	6 (12, 5 – 24)	Adult (Gills)	1 – 17	0.62	Monogenea: Ancyrocephalidae
	Diplostomum spathaceum Rudolphi, 1819	10 (20, 10 – 33)	Metacercaria (Eyes)	2 – 20	1.46	Trematoda: Diplostomidae
	Gyrodactylus cernuae Malmberg, 1957	2 (4, 0.5 – 14)	Adult (Gills)	2 – 5	0.14	Monogeneas: Gyrodactylidae
	Tylodelphys clavata Diesing, 1850	2 (4, 0.5 – 14)	Metacercaria (Eyes)	1 – 4	0.1	Trematoda: Diplostomidae
	Synergasilus major Markevitsch, 1940	17 (34, 21 – 49	Adult (Gills)	1 – 19	1.72	Crustacea: Ergasilidae
Sander marinus	*Anisakis schupakovi*	6 (12, 5 – 24)	Third stage larva (Abdominal cavity, serous membrane)	1 – 12	0.4	Nematoda: Anisakidae
	Gyrodactylus luciopercae Gusev, 1962	2 (4, 0.5 – 14)	Adult (Gills, skin)	14 – 29	0.86	Monogeneas: Gyrodactylidae
	Ergasilus briani Markewitsch, 1993	2 (4, 0.5 – 14)	Adult (Gills)	2	0.04	Crustacea: Ergasilidae
Sander volgensis	*Anisakis schupakovi*	27 (54, 39 – 68)	Third stage larva (Abdominal cavity, muscle, serous membrane)	1 – 19	3.0	Nematoda: Anisakidae
	Diplostomum gobiorum Shigin, 1965	3 (6, 1.3 – 17)	Metacercaria (Eyes)	6 – 42	1.2	Trematoda: Diplostomidae
	Diplostomum mergi Dubois, 1932	1 (2, 0.1 – 11)	Metacercaria (Eyes)	4	0.08	Trematoda: Diplostomidae
	Diplostomum spathaceum	19 (38, 25 – 53)	Metacercaria (Eyes)	2 – 64	4.36	Trematoda: Diplostomidae
	Tylodelphys clavata	8 (16, 7 – 29)	Metacercaria (Eyes)	2 – 8	0.64	Trematoda: Diplostomidae

Table 3. The number of fish infected and range of intensity of infection of parasites in fish of order Mugiliformes.

Fish host	Parasite	Number infected (prevalence, confidence intervals)	Development stage of parasite recovered	Range of intensity	Mean abundance	Parasite Taxon
Liza aurata syn Chelon aurata	*Ligophorus vanbenedenii* Parona & Perugia, 1890	9 (18, 8.6 – 31)	Adult (Gills)	1 – 8	0.56	Monogenea: Ancyrocephalidae
	Tylodelphys clavata	1 (2, 0.1 – 11)	Metacercaria (Eyes)	10	0.2	Trematoda: Diplostomidae
	Ergasilus sieboldi Kaletskaia 1970	1 (2, 0.1 – 11)	Adult (Gills)	1	0.02	Crustacea: Ergasilidae

There was also 1 further unidentified nematode species (Table 4). *Silurus glanis* was the only fish species from the order Siluriformes and this was infected by two nematode and 1 monogenean parasites (Table 5).

There was no association between Fulton's condition index and the intensity of parasite infection for any of the fish species. For *Cyprinus carpio* and *Rutilus rutilus,* Fulton's index increased with age (p=0.0026 and p=0.043 respectively). For *Sander lucioperca* male fish had significantly higher intensity of infection with trematodes compared to females (p=0.008). There was also a positive association between the intensity of infection with nematode larvae and monogeans (p=0.04).

Discussion

This study aimed to identify important parasitic pathogens and zoonoses of fish from the Kazakhstan sector of the Caspian Sea and associated river basin. The fish studied also represent important species for commercial fisheries in this region and therefore this information makes a contribution to understanding parasitic diseases that may affect such stocks.

Anisakis schupakovi was the most frequently identified parasite. It was found in 8 of the 13 fish species we examined, with prevalences of up to 84 % found in the asp (*Leuciscus aspius)* and individual intensity of infection of up to1197 parasites. *Anisakis* spp. are known zoonoses and a food safety issue (Nieuwenhuizen & Lopata, 2013). The definitive host of *A. schupakovi* is the Caspian seal *Phoca caspica* (Davey, 1971; Popov *et al*., 1989, Bilska-Zając *et al*., 2015). This seal is only found in the Caspian Sea which is the world's largest inland body of water with no connection to the sea. Thus *A. schupakovi* is believed to be found only in Caspian Sea basin*.* A *Contracecum sp.* is also an anisakid parasite and hence a potential fish borne zoonoses and this was recovered from 9 zander (*Sander lucioperca).* Therefore these findings are of potential public health significance and indicate that fish from this region should be cooked or frozen prior to consumption.

Diplostomum spathaceum was frequently recovered from a number of the fish species examined. This is a rare zoonosis causing dermatitis in humans when cercariae attempt to invade the skin and occasionally have penetrated the eye and have been associated with cataracts (Smyth, 1995). However, the public health risk is not from consuming fish but from swimming or bathing in water where there are cercariae.

Alosa saposchnikowii, or the saposhnikovi shad, is a species of fish in the clupeid genus *Alosa*. *Anisakis, Porrocaecum, Neogryporhynchus* and *Mazocrase* spp were found in this fish species. Studies from the southern Caspian identified 3 parasitic species infecting this fish: *Pronoprymna ventricosa* (Trematoda,Faustulidae), *Anisakis simplex* and *Eustrongylides* sp. (Mazandarani *et al*., 2016). In the Kazakh sector previous studies have found A*nisakis*

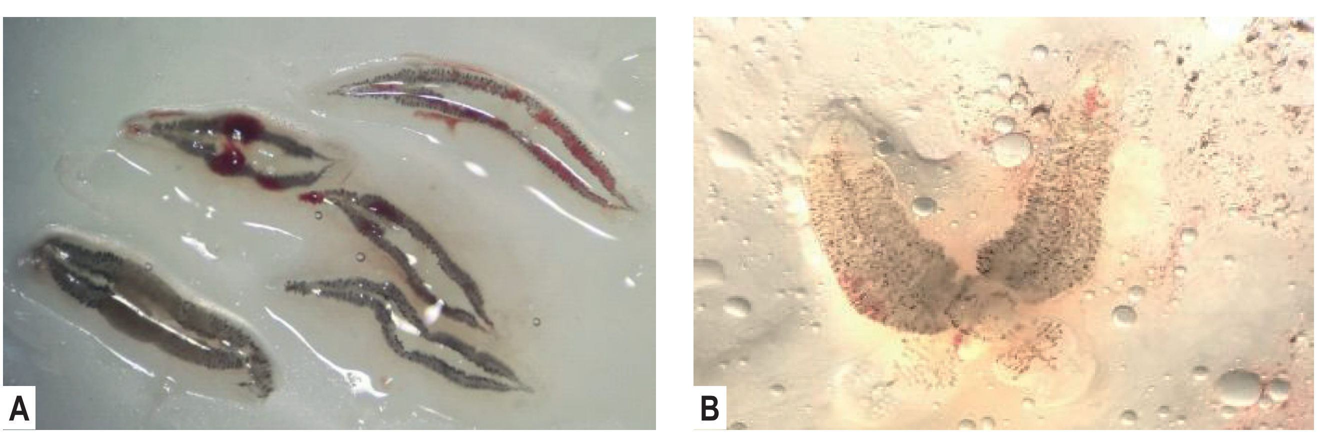

Fig. 3. Mongeneans recovered. A – *Mazocraes alosae* from the branchial arces of *Alosa saposchnikowii*.
B – *Diplozoon paradoxum* from the branchial arches of *Abramis brama orientalis*.

Table 4. The number of fish infected and range of intensity of infection of parasites in fish of order Cypriniformes

Fish host	Parasite	Number infected (prevalence, confidence intervals)	Development stage of parasite recovered	Range of intensity	Mean abundance	Parasite Taxon
Abramis brama	*Anisakis schupakovi*	1 (2, 0.1 – 11)	Third stage larva (Abdominal cavity)	1	0.02	Nematoda: Anisakidae
	Diplostomum gobiorum	15 (20, 18 – 45)	Metacercaria (Eyes)	2 – 14	1.7	Trematoda: Diplostomidae
	Diplostomum spathaceum	25 (50, 36 – 64)	Metacercaria (Eyes)	1 – 39	6.26	Trematoda: Diplostomidae
	Tylodelphys clavata	3 (6, 1.3 – 17)	Metacercaria (Eyes)	3 – 6	0.24	Trematoda: Diplostomidae
	Dactylogyrus wunderi Bychowsky, 1931	2 (4, 0.5 – 14)	Adult (Gills)	1	0.04	Monogenea: Dactylogyridae
	Bothriocephalus opsariichthydis Yamaguti, 1934	1 (2, 0.1 – 11)	Adult (Intestines)	6	0.64	Cestoda:Bothriocephalidae
Leuciscus aspius	*Anisakis schupakovi*	42 (84, 71 – 93)	Third stage larva (Abdominal cavity, muscle, serous membrane)	3 – 1197	87.8	Nematoda: Anisakidae
	Porrocaecum reticulatum	13 (26, 15 – 40)	Third stage larva (Abdominal cavity, serous membrane)	12 – 356	32.8	Nematoda: Ascaridoidea
	Diplostomum gobiorum	2 (4, 0.5 – 14)	Metacercaria (Eyes)	6 – 10	0.32	Trematoda: Diplostomidae
	Diplostomum helveticum Shigin, 1977	1 (2, 0.1 – 11)	Metacercaria (Eyes)	6	0.12	Trematoda: Diplostomidae
	Diplostomum mergi	5 (10, 3.3 – 22)	Metacercaria (Eyes)	2 – 6	0.44	Trematoda: Diplostomidae
	Diplostomum spathaceum	24 (48, 34 – 63)	Metacercaria (Eyes)	2 – 20	3.06	Trematoda: Diplostomidae
	Dactylogyrus tuba Kaletskaia 1969	2 (4, 0.5 – 14)	Adult (Gills)	3 – 8	0.22	Trematoda: Diplostomidae
	Diplostomum volvens Nordmann, 1832	1 (2, 0.1 – 11)	Metacercaria (Eyes)	7	0.14	Trematoda: Diplostomidae
	Tylodelphys clavata	2 (4, 0.5 – 14)	Metacercaria (Eyes)	3 – 4	0.14	Trematoda: Diplostomidae
	Ergazilus sieboldi	1 (2, 0.1 – 11)	Adult (Gills)	1	0.02	Crustacea: Ergasilidae
Carassius auratus	*Dactylogyrus anchoratus* Wagener, 1857	2 (4, 0.5 – 14)	Adult (Gills)	4 – 18	0.44	Monogenea: Dactylogyridae

	Diplostomum gobiorum	2 (4, 0.5 – 14)	Metacercaria (Eyes)	2 – 8	0.2	Trematoda: Diplostomidae
	Diplostomum mergi	2 (4, 0.5 – 14)	Metacercaria (Eyes)	2 – 4	0.12	Trematoda: Diplostomidae
	Diplostomum spathaceum	66 (12, 5 – 24)	Metacercaria (Eyes)	2 – 12	0.64	Trematoda: Diplostomidae
	Tylodelphys clavata	1 (2, 0.1 – 11)	Metacercaria (Eyes)	3	0.06	Trematoda: Diplostomidae
Cyprinus carpio	*Diplostomum gobiorum*	3 (6, 1.3 – 17)	Metacercaria (Eyes)	6 – 12	0.48	Trematoda: Diplostomidae
	Diplostomum spathaceum	19 (38, 25 – 53)	Metacercaria (Eyes)	4 – 18	2.24	Trematoda: Diplostomidae
	Diplostomum volvens	5 (10, 3.3 – 22)	Metacercaria (Eyes)	2 – 4	0.32	Trematoda: Diplostomidae
	Gyrodactylus cyprini Diarova 1964	5 (10, 3.3 – 22)	Adult (Gills)	2 – 3	0.26	Monogenea:Gyrodactylidae
	Tylodelphys clavata	6 (12, 5 – 24)	Metacercaria (Eyes)	2 – 36	1.28	Trematoda: Diplostomidae
Rutilus rutilus caspius	*Anodonta sp*	7 (14, 5.8 – 27)	Glochidium (larva) (Gills)	1 – 13	0.5	Bivalvia: Unionidae
	Nematode sp	9 (18, 8.6 – 31)	-	1 – 4	0.4	Nematoda:
	Camallanus sp.	3 (6, 1.3 – 17)	Adult (Intestines)	1 – 2	0.08	Nematoda: Camallanidae

Table 5. The number of fish infected and range of intensity of infection of parasites in fish of order Siluriformes.

Fish host	**Parasite**	**Number infected (prevalence, confidence intervals)**	**Development stage of parasite recovered**	**Range of intensity**	**Mean abundance**	**Parasite Taxon**
Silurus glanis	*Anisakis schupakovi*	4 (67, 22 – 96)	Third stage larva (Abdominal cavity)	12 – 563	114.3	Nematoda: Anisakidae
	Eustrongylus excisus Jägerskiöld, 1909	2 (33, 4.3 – 78)	Third stage larva (Abdominal cavity, serous membrane)	72 – 254	54.33	Nematoda: Dioctophymatidae
	Diplostomum mergi	1 (17, 0.4 – 64)	Metacercaria (Eyes)	4	0.67	Trematoda: Diplostomidae
	Silurodiscoides magnus	2 (33, 4.3 – 78)	Adult (Gills)	4 – 6	1.67	Monogenea:Ancyrocephalidae

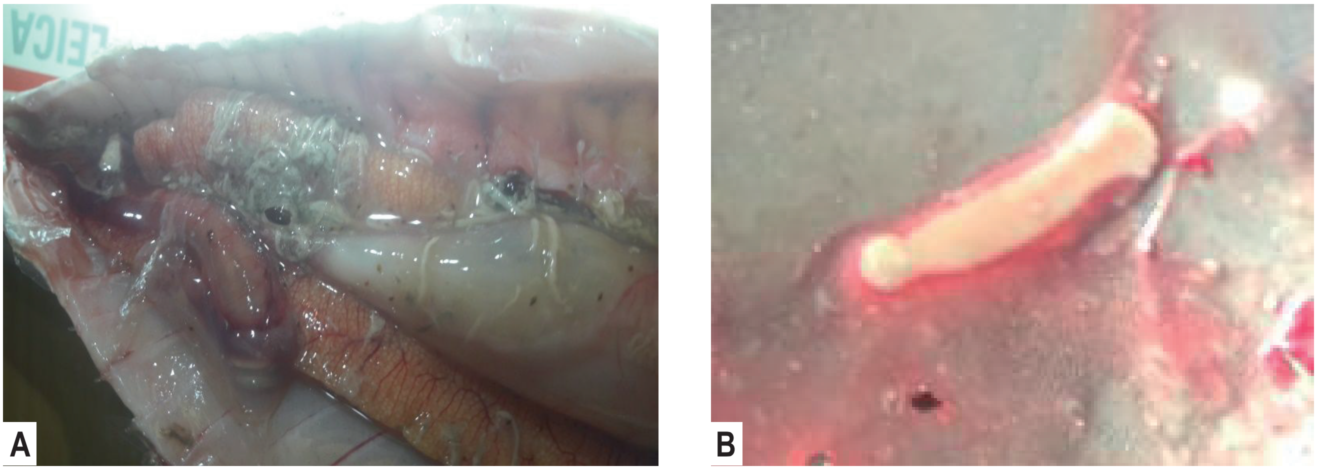

Fig. 4. cestodes recovered. A – *Neogryporhynchus cheilancristrotus* from the abdominal cavity of *Alosa saposchnikowii*. B – Khawia sinensis from the abdominal cavity of *Cyprinus carpio.*

schupakovi, Porrocaecum reticulatum and *Mazocraes alosae* (Tokpan & Rakhimov, 2010) and additionally *Contracoecum spiculogerum* and *Hemiurus appendicularis*. Our studies also describe the cestode *Neogryporhynchus cheilancristrotus*. Whilst a small proportion of fish were infected with the nematode and cestode species, most fish were infected with the monogean (Table 2).

Clupeonella cultriventris or the Caspian and Black Sea sprat is a species of fish in the family Clupeidae. It is found in the Caspian Sea and in the lower reaches of the rivers Volga and Ural. Previously *Corynosoma strumosum (*Acanthocephala), *Pseudopentagramma symmetricum* (Trematoda); *Contracaecum* sp. (Nematoda) and *Unio* sp. (Molusc) have been described from this fish (Habibi & Shamsi, 2018; Voronina, 2019). The present study indicates that this fish species is also infected by *Anisakis schupakovi*.

The zander is a species of fish from freshwater and brackish habitats in western Eurasia. *Anisakis schupakovi* was found in the majority of fish examined as well as many of the other species of fish. Zhokhov and Molodozhnikova (2008) list the zander as a host for this parasite and for *Contracecum* sp. Tokpan and Rakhimov (2010) previously reported *Anisakis schupakovi*, and *Tylodelphys clavata* in the zander from the Caspian region.*Ancyrocephalus paradoxus* has been previously reported in zander from Poland (Bielat *et al*., 2015) and *Diplostomum spathaceum* has been recovered previously from zander in Iran (Movahed *et al*., 2016). No previous information on *Gyrodactylus* and *Synergasilus* infection of the zander was found.

No previous information was found on the parasites of *Sander marinus*, the estuarine perch, also called the sea pike perch or sea zander. But the overlapping habitat with the Caspian seal would explain the presence of *Anisakis schupakovi.* We recovered a number of parasites from *Sander volgensis*, the Volga pike perch or Volga zander which is also present in the Caspian Sea basin in

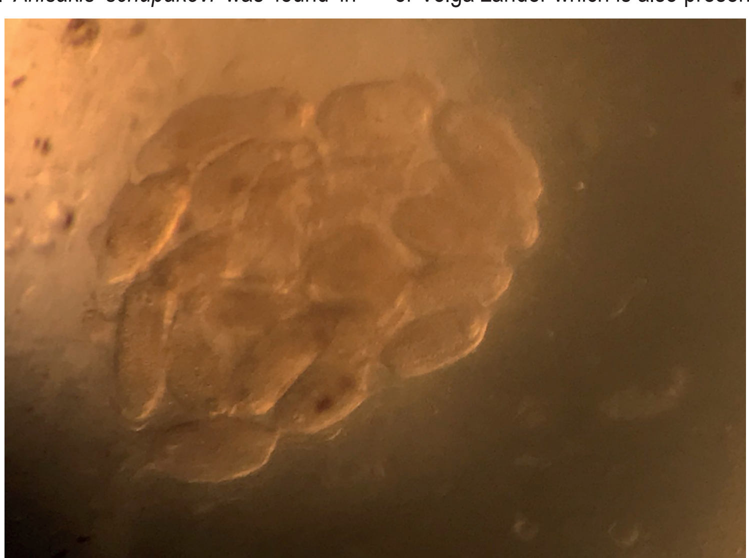

Fig. 5. The eye trematode *Tylodelphus clavata* from the lens of the eye of *Abramis brama orientalis.*

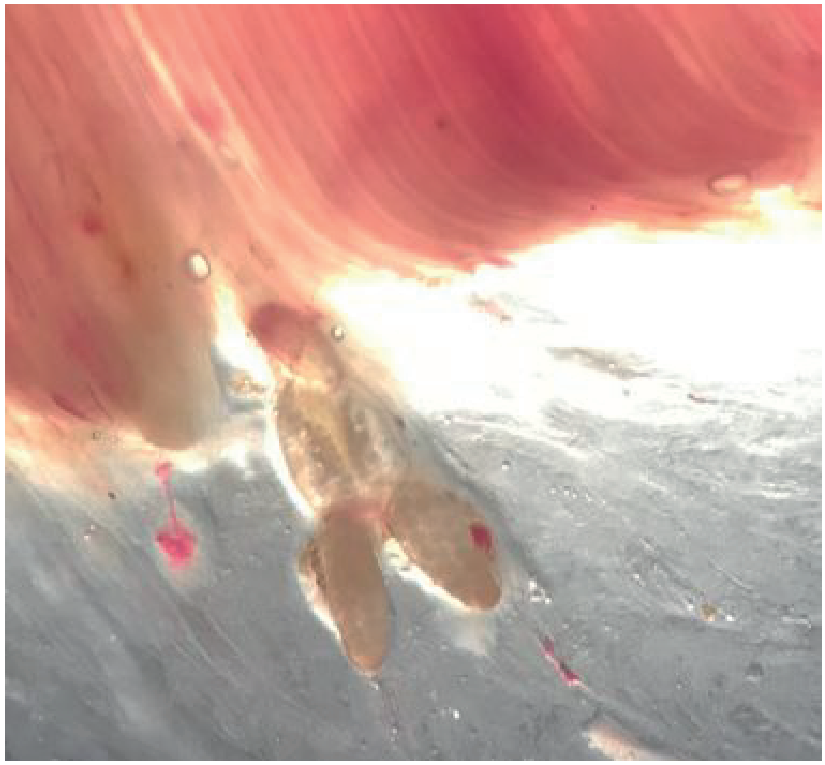

Fig. 6. Parasitic copepod Ergasilus sieboldi in the lamellae of the gill apparatus of Sander lucioperca.

the Volga River and Ural River drainages. We were unable to find previous information on the helminths of this species.

The golden grey mullet (*Liza aurata* syn *Chelon aurata*) is an introduced species into the Caspian Sea. There is little previous information on the parasitic fauna infecting this fish in the Caspian, although there are reports of various monogenean and trematode species from Turkey (Özer & Kirca, 2013; Öztürk, 2013) with *Ligophorus vanbenedenii* being isolated from fish from the Black Sea (reviewed by Özer & Kirca, 2013). *Tylodelphys clavata* has also been reported from *Liza aurata* in Turkey (Özer & Kirca, 2013).

Six species of helminths were found in the bream (*Abramis brama*). Of these *Anisakis chupakovi,* two species of ophthalmic trematodes *(Diplostomum spathaceum,* and *Tylodelphys clavata) and* one species of the monogenetic fluke *Dactylogyrus wunderi* have been previously described by Tokpan and Rakhimov (2010) whilst *Anisakis* was reported by Sattari *et al* (2005). Our studies add the opthalmic trematode *Diplostomum gobiorum* and the cestode *Bothriocephalus opsariichthydis* to the list of parasites known to infect the bream in the Caspian Sea basin.Various *Diplostonum* and *Dactylogyrus* spp have been recovered from bream from other locations (eg Germany: Rückert *et al*., 2007).

The carp (*Cyprinus carpio*) parasitofauna is represented by 5 species, of which 4 species are ocular trematodes: monogenetic flukes *Gyrodactylus cyprini*, trematodes represented by 2 genera *Tylodelphys* and *Diplostomum* (*Diplostomum spathaceum, Diplostomum gobiorum, Diplostomum volvens. Previously* In 2008 – 2010 2 species of parasites were found in the common carp: metacercariae of *Diplostomum spathatum* and *Caryophyllaeus laticeps* (Tokpan & Rakhimov 2010). Only *Diplostomum spathaceum* was found in carp, both in the previous study and the present study. *Carassius auratus* and *Gyrodactylus cyprini* have also been described in carp in the Russian sector of the Caspian (Pazooki & Masoumian, 2012).

Five species of parasites were found in silver crucian car*p Carassius auratus* (Table 5). *Diplostomum* and *Tylodelphys* spp have been described in *Carassius auratus* from the Caspian sea region previously (Pazooki & Masoumian, 2012).

We have described 9 helminth species parasitizing the Asp (*Leuciscus aspius*) and one crustacian (Table 5). Previous studies in the Caspian described 6 species of parasite: *Anisakis schupakovi*, *Diplostomum spathaceum*, *Contracoecum spiculogerum*, *Caligus lacustris*, *Eustrongylides excisus* and *Caspiobdella caspica.* Only 2 of these were found in the present study (Tokpan & Rakhimov 2010).

Diplostomum has been descriped in the Asp from Norway (Sterud & Appleby, 1996).

We were not able to identify the parasites we recovered from *Rutilus rutilus caspicus* species level so it is not possible to discuss further, *Anisakis schupakovi, Eustrongylus excisus* and *Diplostomum spp* have previously been found in *Silurus glanis* in the Caspian region or in Turkey (Pazooki & Masoumian, 2012) (Daghigh Roohi *et al*., 2014; Çolak, 2013).

There was no relationship between Fulton's condition score and the intensity of parasitic infection. This may indicate that the parasites have a low pathogenicity for the fish species investigated or that the intensity of infection was insufficient to cause any effects in the fish. We did find an increase in Fulton's condition score with age in Carp and the Caspian Roach indicating an improvement in condition as the fish mature. Male zander were significantly more intensely infected with trematodes compared to females which may indicate a gender associated increased susceptibilities to infection or gender associated behavior resulting in an increased parasite burden. The associated between intensity of infection with monogeans and nematode larvae could be consistent with certain individuals having increased susceptibility to polyparasitsim or a statistical error as the p values was 0.04.

In summary this study has identified parasite species across 13 fish species that are endemic to the north Caspian Sea and drainage basin. A high proportion of the fish are infected with parasites of a zoonotic potential and therefore appropriate controls in the food chain should be considered to prevent human infection.

Conflict of Interest

Authors state no conflict of interest.

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