Occurrence and intensity of parasites in Wels catfish, *Silurus glanis* L. 1758 from Amirkelayeh wetland, southwest of the Caspian Sea

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Abstract Amirkelayeh international wetland with a surface area of 1,230 hectares and fifteen fish species is an important water resource in the southern part of the Caspian Sea. There is few reports on fish parasites of this area. In the present study, a total of 80 Wels catfish, *Silurus glanis*, were collected from April through July 2011. After recording biometric characteristics, common necropsy and parasitology methods were used. In the present study, a total of 441 individuals of seven parasite species consisting of one nematode: *Raphidascaroides* sp., one cestode: *Triaenophorus crassus*, two digenean trematodes: *Aphanurus stossichi* and *Diplostomum spathaceum*, two monogenean trematodes: *Silurodiscoides vistulensis* and *Silurodiscoides siluri*, and one crustacean: copepodid stage of *Lernaea cyprinacea* was found in the catfish. The occurrence of copepodid stage of *L. cyprinacea*, *Raphidascaroides* sp. and *T. crassus* are reported for the first time from *S. glanis* in Iran.

Keywords Fish · Parasite · *Silurus glanis* · Amirkelayeh wetland · Caspian sea

Introduction

Amirkelayeh international wetland (37°20'N, 50°11'E) with a surface area of 1,230 hectares and 15 fish species is

located around the southwest of the Caspian Sea (Guilan province, Iran) (Nejatsanati 1994). One of these fifteen species is *Silurus glanis* which is a nocturnal predator, foraging near bottom and in water column. Larvae and juveniles are benthic, feeding on a wide variety of invertebrates and fish. Adults prey on fish and other aquatic vertebrates. Wels catfish distributes in Europe and Asia. North, Baltic, Black, Caspian and Aral Sea basins, as far north as southern Sweden and Finland, Aegean Sea basin in Maritza and from Struma to Sperchios drainages, Turkey. Absent from the rest of Mediterranean basin. Now widely introduced and translocated through Europe and Lake Balkhash basins of invertebrates and fish. Adults prey on fish and other ecological Kazakhs after stan. Several cothias species inhabit large and medium size lowland rivers, backwaters and well vegetated lakes. Also, it occurs mainly in large lakes and rivers, though occasionally enters brackish water in the Baltic and Black Sea and found in deep waters of dams constructed on the lower reaches of rivers.

Parasites of bony fish species in the Caspian Sea and its basin have been reported by several authors (Eslami and Kohneshahri 1978; Sattari 1996, 1999, 2004; Pazooki and Aghlmandi 1998; Sattari et al. 2002, 2005; Daghigh Roohi and Sattari 2004; Khara et al. 2011), but there have been few reports of fish parasites in Amirkelayeh wetland. Sefidkar-Langeroudi (1965) reported seven parasite species from intestine of *S. glanis* in Anzali wetland consisting of *Proteocephalus osculatus*, *Pomphorhynchus perforator*, *Aphanurus stossichi*, *Corynosoma strumosum*, *Cucullanus sphaerocephalus*, *Anisakis* sp. larvae and *Bunocotyle cingulata*. In the other studies, Sattari (1996) recovered *E. excisus* larvae from one specimen of *S. glanis* and Jalali Jafari (1998) reported two monogenean species including *Silurodiscoides siluri* and *S. vistulensis* from *S. glanis*. But

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there is no report about the parasite communities of Wels catfish and epizootiological aspects of these parasites in Amirkelayeh wetland.

In the present study, we studied the parasites of *S. glanis* in Amirkelayeh wetland as well as their prevalence, intensity, abundance and dominance.

Materials and methods

A total of 89 Wels, *S. glanis*, were collected from Amirkelayeh international wetland in the southwest of the Caspian Sea (Guilan province, Iran) on eight separate occasions from April through July 2012. Fish were trapped with Gill net and transported to the laboratory of Fish Diseases in Faculty of Natural Resources, University of Guilan, Iran. Water temperature was determined at collection site. Upon arrival, fish were weighed and measured and then examined externally for gross signs of parasitism. If no gross signs were observed, skin biopsies were prepared from the entire length of the left lateral body wall. The Wels (80 in number) averaged 1,008.3 g (± 968.7 g, range 200–6,896 g) in weight and averaged 50.8 cm (± 13.4 cm, range 32.8–120 cm) in total length. A gill biopsy was collected from the specimens left second arch. A fin biopsy was collected from the specimen's caudal fin. Wet mounts of all biopsied tissues were prepared for further analysis.

Common necropsy and parasitology methods (Stoskopf 1993) were used for finding parasites. All organs of the fish were examined except for blood. Live trematodes were relaxed in distilled water at 4 °C for 1 h and fixed in 10 % hot buffered formalin. Live nematodes were fixed in hot 70 % ethanol and cleared in hot lactophenol. All specimens fixed in 10 % formalin were stained with aqueous acetocarmine, dehydrated and mounted in Permount. The worms were identified using parasite identification keys (Yamaguti 1961; Bykhovskaya-Pavlovskaya et al. 1962; Moravec 1994) and then were deposited at the Laboratory of Fish Diseases, Faculty of Natural Resources, and University of Guilan, Iran.

Classical epidemiological variables (prevalence, intensity and abundance) were calculated according to Bush et al. (1997). Mean intensity of infection was determined dividing the total number of recovered parasites by the number of infected fish samples, while calculating abundance was carried out dividing the total number of recovered parasites by the number of (infected and uninfected) fish samples. Prevalence was also calculated dividing the number of infected fish samples by the total number of examined ones and expressed as a percentage. The dominance of a parasite species was calculated as N/N sum (where N = abundance of a parasite species and N

sum = sum of the abundance of all parasite species found) and expressed as a percentage (modified after Leong and Holmes 1981). The dominance values were used for classification of parasites as eudominant (>10 %), dominant (5.1–10 %), subdominant (2.1–5 %), recedent (1.1–2 %) and subrecedent (<1.0 %) of given species (Niedbala and Kasparzak 1993). Mean intensity of infection and abundances of parasite species (with prevalences >10 %) among seasons, age classes and sexes were tested by the Kruskal–Wallis test (KW, multiple comparisons) and Mann–Whitney U test (MW, pairwise comparisons). Results were considered significant at the 95 % level ($p < 0.05$). Computations were performed using the SPSS programme as installed by the University of Guilan Computer Services.

Results

In the present study, a total of 441 parasites of 7 species were found in Wels catfish (*S. glanis*) consisting of one nematode: *Raphidascaroides* sp., one cestode: *Triaenophorus crassus*, two digenean trematodes: *Aphanurus stossichi* and *Diplostomum spathaceum*, two monogenean trematodes: *Silurodiscoides vistulensis* and *S. siluri* and one crustacean: copepodid stage of *Lernaea cyprinacea* were found in the catfish. The occurrence of copepodid stage of *L. cyprinacea*, *Raphidascaroides* sp. and *T. crassus* are reported for the first time from *S. glanis* in Iran.

The prevalence (P), mean intensity of infection (MI), range and abundance (MA) of the parasites are presented in Table 1. As shown in this Table, monogenean parasites, *S. vistulensis* and *S. siluri* had the highest prevalence, mean intensity, dominance and abundance. It was also found that the prevalence, mean intensity, dominance and abundance of *Raphidascaroides* sp. were higher than those of the other parasites. 31.25 % of the fish were devoid of parasite, 32.5 % were infected with 1 parasite species, 27.5 % with 2 species and 8.8 % with three species. Fish harboring fewer than 10 worms made up 48.8, 12.5 % had 10–20 worms, 3.8 % harbored 20–30 worms and 3.8 % had more than 30 worms.

The eudominant parasite of the catfish (Table 1) was monogeneans and *Raphidascaroides* sp. (Dominance = $D = 54.7$ and 23.4 % respectively). The dominant parasite were copepodid stage of *L. cyprinacea* and *T. crassus* ($D = 9.1$ and 7.7 % respectively). The subdominant parasite was *A. stossichi* ($D = 3.4$ %). The recedent parasite was *D. spathaceum* ($D = 1.8$ %).

According to Table 2, *D. spathaceum* was not found in males and also its prevalence and mean intensity of infection in females had low values. The prevalence and mean intensity of other parasites in males and females had

Table 1 The prevalence, mean intensity of infection, range and abundance and dominance of some parasites in *S. glanis* (N = 80)

Characteristic parasite	Prevalence (%)	Mean $\pm$ SD	Range	Abundance	Dominance (%)
Monogeneans N = 44	33.8	8.9 $\pm$ 11.7	1–49	3.01 $\pm$ 7.9	54.7
<i>L. cyprinacea</i> N = 40	25	2.5 $\pm$ 2.0	1–7	0.5 $\pm$ 1.3	9.1
<i>A. stossichi</i> N = 15	12.6	1.5 $\pm$ 1.3	1–5	0.2 $\pm$ 0.7	3.4
<i>Raphidascaroides</i> sp. N = 103	29.7	5.4 $\pm$ 5.5	1–18	1.3 $\pm$ 3.4	23.4
<i>T. crassus</i> N = 34	17.2	3.1 $\pm$ 2.7	1–8	0.4 $\pm$ 1.4	7.7
<i>D. spathaceum</i> N = 8	3.1	4.0 $\pm$ 2.8	2–6	0.1 $\pm$ 0.7	1.8

Table 2 The prevalence, mean intensity of infection and range of some parasites of *S. glanis* (N = 80) in male and female

Sex	Parasite					
	<i>Lernaea</i>	Monogens	<i>Aphanurus</i>	<i>Raphidascaroides</i>	<i>T. crassus</i>	<i>Diplostomum</i>
	Prevalence (%)	Prevalence (%)	Prevalence (%)	Prevalence (%)	Prevalence (%)	Prevalence (%)
	mean $\pm$ SD	mean $\pm$ SD	mean $\pm$ SD	mean $\pm$ SD	mean $\pm$ SD	mean $\pm$ SD
	range	range	range	range	range	range
Male	17.95	38.46	12.82	25.64	12.82	0
N = 49	2.7 $\pm$ 2.2	7.1 $\pm$ 12.2	1 $\pm$ 0	4.7 $\pm$ 4.9	1.8 $\pm$ 1.79	
	1–6	1–49	1	1–15	1–5	
Female	14.8	22.2	14.8	29.63	22.2	7.4
N = 40	1.75 $\pm$ 0.96	8.2 $\pm$ 11.5	2.25 $\pm$ 1.89	6.5 $\pm$ 6.12	4.17 $\pm$ 2.93	4.0 $\pm$ 2.83
	1–3	1–31	1–5	1–18	1–8	2–6

different values, but the differences between them were not significant (Z test and MW test respectively, $p > 0.05$).

As shown in Table 3, occurrence of parasites was different in various seasons, monogenean parasites were found in spring, summer and autumn, but not in winter, and also their mean intensity of infection in various seasons was significantly different (KW test, $X^2 = 12.336$, $df = 2$, $p < 0.05$). Copepodid stage of *Lernaea* was just found in spring and summer, but not in autumn and winter. *A. stossichi* was found in summer and winter, *Raphidascaroides* sp. found in autumn and winter, *T. crassus* and *D. spathaceum* were found in winter. It was also found that the abundance of all the six parasites (except for *D. spathaceum*) in various seasons was significantly different (KW test, $df = 2$, $p < 0.05$).

According to Table 4, the prevalence and mean intensity of parasites in various age groups had different values, but the differences between them were not significant (Z test and KW test respectively, $p > 0.05$). It was also found that the abundance and mean intensity of parasites in various length and weight groups had different values, but the differences were not significant (KW test, $p > 0.05$).

Discussion

Sefidkar-Langeroudi (1965) reported seven parasite species from intestine of *S. glanis* in Anzali wetland consisting of

Proteocephalus osculatus (prevalence = $P = 4\%$), *Pomphorhynchus perforator* ($P = 2\%$), *Aphanurus stossichi* ($P = 2\%$), *Corynosoma strumosum* ($P = 2\%$), *Cucullanus sphaerocephalus* ($P = 2\%$), *Anisakis* sp. Larvae ($P = 2\%$) and *Monocotyle cingulata* ($P = 4\%$). In the other studies, Sattari (1996) recovered *E. excisus* larvae from one specimens of *S. glanis* and Jalali Jafari (1998) reported two monogenean species including *S. siluri* and *S. vistulensis* from *S. glanis*. However, in the present study, 7 parasite species were recovered from *S. glanis* in Amirkelayeh wetland consisting of *Lernaea cyprinacea*, *Aphanurus stossichi*, *Raphidascaroides* sp., *T. crassus*, *D. spathaceum*, *S. siluri*, and *S. vistulensis*. The occurrence of copepodid stage of *L. cyprinacea*, *Raphidascaroides* sp. and *T. crassus* are reported for the first time from *S. glanis* in Iran.

Comparing the results of the present study with those of Sefidkar-Langeroudi (1965) showed that the composition of parasite species in *S. glanis* of Amirkelayeh wetland is to some extent different from Anzali wetland. It may be due to some different environmental conditions in these two wetland such as increasing discharge of effluent, eutrophication and salinity of the former comparing to those of the later wetland. Amirkelayeh wetland receives less quantity of effluent.

In the present study, found in all four of the tissues examined, monogeneans were responsible for the highest prevalence recorded in this study, 33.8 % in the gill and

Table 3 The prevalence, mean intensity of infection and range of some parasites of *S. glanis* (N = 80) in different seasons

Parasite season	<i>Lernaea</i> prevalence (%) Mean $\pm$ SD Range	Monogens prevalence (%) Mean $\pm$ SD Range	<i>Aphanurus</i> prevalence (%) Mean $\pm$ SD Range	<i>Raphidascaroides</i> prevalence (%) Mean $\pm$ SD Range	<i>T. crassus</i> prevalence (%) Mean $\pm$ SD Range	<i>Diplostomum</i> prevalence (%) Mean $\pm$ SD Range
Spring N = 22	31.82 2.43 $\pm$ 1.62 1–5	45.45 6.1 $\pm$ 7.3 1–25	0	0	0	0
Summer N = 27	50 2.56 $\pm$ 2.35 1–7	61.11 15.45 $\pm$ 14.75 3–49	22.2 1.25 $\pm$ 0.5 1–2	0	0	0
Autumn N = 14	0	42.86 1.67 $\pm$ 0.82 1–3	0	35.71 2.2 $\pm$ 1.3 1–4	0	0
Winter N = 26	0	0	23.08 1.67 $\pm$ 1.63 1–5	53.85 6.57 $\pm$ 5.68 1–18	42.31 3.09 $\pm$ 2.66 1–8	7.69 4.0 $\pm$ 2.83 2–6

Table 4 The prevalence, mean intensity of infection and range of some parasites of *S. glanis* (N = 80) in different age groups

Parasite age	<i>Lernaea</i> prevalence (%) Mean $\pm$ SD Range	Monogens prevalence (%) Mean $\pm$ SD Range	<i>Aphanurus</i> prevalence (%) Mean $\pm$ SD Range	<i>Raphidascaroides</i> prevalence (%) Mean $\pm$ SD Range	<i>T. crassus</i> prevalence (%) Mean $\pm$ SD Range	<i>Diplostomum</i> prevalence (%) Mean $\pm$ SD Range
<2 YO	24.32	40.54	8.11	27.03	8.11	2.7
N = 39	2.67 $\pm$ 2.35 1–7	9.4 $\pm$ 13.43 1–49	1.33 $\pm$ 0.58 1–2	5.9 $\pm$ 6.32 1–18	1.3 $\pm$ 0.58 1–2	6 $\pm$ –0 6
3 YO	13.04	26.09	17.39	17.39	21.74	0
N = 27	1.67 $\pm$ 0.58 1–2	9.17 $\pm$ 10.68 1–30	1.0 $\pm$ 0 1	4.75 $\pm$ 3.30 1–8	4.6 $\pm$ 3.05 1–8	
>4 YO	20	30	15	25	15	5
N = 23	2.75 $\pm$ 2.06 1–5	7.5 $\pm$ 9.14 1–25	2.33 $\pm$ 2.31 1–5	5.0 $\pm$ 4.95 1–13	2.33 $\pm$ 2.31 1–5	2.0 $\pm$ 0 2

skin of sampled fish (Table 1). Intestine necropsies yielded the greatest diversity of parasites with three taxa represented in this organ. *S. glanis* is a nocturnal predator, foraging near bottom and in water column. Larvae and juveniles are benthic, feeding on a wide variety of invertebrates and fish. Adults prey on fish and other aquatic vertebrates. So, the type of its diet depends on the food availability and the age of the catfish. The very wide diet spectrum facilitates the transmission of the parasites of complex life cycle.

The occurrence of *D. spathaceum* metacercariae, a digenean trematode, has been reported from several fish species in the southern part of the Caspian Sea consisting of *T. tinca*, *C. gibelio*, *C. carpio*, *A. brama orientalis*, *E. lucius*, *P. fluviatilis* and *Hypophthalmichthys molitrix* (Sattari 1996), *Vimba vimba persa*, *Chalcalburnus chalcoides* from Anzali wetland (Sattari et al. 2005), *Rutilus rutilus caspius*, *Abramis bjoerkna*, *Scardinius erythrophthalmus* from Boojagh

wetland (Khara et al. 2011). In the present study, this parasite was found in the eyes of *S. glanis*, but its prevalence in the catfish of Amirkelayeh wetland was low ($p = 3.1\%$, $MI = 4.0 \pm 2.8$, $MA = 0.1 \pm 0.7$).

Triaenophorus crassus is a worm of moderate size, with externally poorly marked segmentation of body. Head rounded usually truncated at tip, armed with four tridentate hooks disposed symmetrically in pairs on dorsal and ventral sides laterally to pseudobothridium. Adult worms develop in intestine of common and Amur pike, Plerocercoids are found in musculature, occasionally viscera, of pikes, whitefish, some sculpins (bigmouthed sleeper, sand sculpin), procercoids develop in coelom of copepods (*Cyclops strenuous*, *C. vicinus*, *Macrocyclus bicuspidatus*). The parasite has been reported from pike, *Esox lucius* in Anzali and Amirkelayeh wetlands in Iran (Sattari 1996; Khara et al. 2005). In Anzali wetland, the parasite was recovered from one specimen of pike. The prevalence, mean intensity of infection $\pm$ SD and

abundance $\pm$ SD of the parasite in the pike of Amirkelayeh wetland were low (9.4 %, 2.7 ± 2.2 and 0.2 ± 0.2 respectively) (Khara et al. 2005).

Raphidascaroides sp. (L) has been reported from *Carassius carassius* in Anzali wetland (Pazooki and Masoumian 2001). In the present study, it was found in *S. glanis* of Amirkelayeh wetland. The larvae encysted in yellowish cysts in body cavity of the fish. *Raphidascaroides* sp. (L) is reported for the first time from *S. glanis* (new host record).

Aphanurus stossichi is an extremely small worm with very greatly reduced or absent caudal process. Annulation of cuticle is usually distinct, reaching posterior end of body. Folds of cuticle extend in oblique instead of transverse rows, so that they lie somewhat higher on dorsal surface than on ventral. Cuticle covered with small spines in absence of annulation. It is found in intestine and stomach of herring and Salmonids in basins of Baltic, Black and Caspian Seas and the Sea of Japan. Sefidkar-Langeroudi (1965) reported it for the first time from *S. glanis* in Anzali wetland with the prevalence value of 2 %. In the present study, it was found in the intestine of *S. glanis* in Amirkelayeh wetland. The prevalence, mean intensity of infection $\pm$ SD and abundance $\pm$ SD of the parasite in the Wels catfish of Amirkelayeh wetland were also low (12.6 %, 1.5 ± 1.3 and 0.2 ± 0.7 respectively).

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