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Original Article

Parasitic worms and their histopathological effects in four sturgeon species from the southwest shores of the Caspian Sea

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Abstract: This study conducted to provide the status of parasite communities of four sturgeon species viz. *Acipenser stellatus*, *A. gueldenstaedtii*, *A. nudiventris*, and *Huso huso* in the southwest of the Caspian Sea and their histopathological effects on the examined fishes. For this purpose a total of 93 individuals of four sturgeon species were caught in two fisheries regions from the southwest of the Caspian Sea (Guilan Province, Iran) from March 2010 to May 2011. The histological slides of the infested tissues of the examined fishes were prepared for study of the histopathological effects of the parasites. Classical epidemiological variables, including mean intensity, prevalence, abundance and dominance were calculated for overall samples, grouped by season, geographical region, and sex. Five worm species, including two nematodes (*Cucullanus sphaerocephalus* and *Eustrongylides excisus* larvae), one cestode (*Bothrimonus fallax*), one acanthocephalans (*Leptorhynchoide plagicephalus*) and one digenean trematode (*Skrjabinopsolus semiarmatus*) were found in examined sturgeons and their histopathological effects on the fish tissues were assessed. Based on the results, the diversity of the parasites (including freshwater ones) in the southern part of the Caspian Sea have decreased since the time of the first study in 1972. This may be related to unfavorable conditions in freshwater ecosystems.

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Introduction

Sturgeons are evolutionary relicts with a wide distribution in the northern hemisphere (Holcik, 1989). Their status as basal actinopterygian fish, unique benthic specializations, and variation in their basic diadromous life history make sturgeons interesting biological and biogeographical subjects (Holcik, 1989). Extensive studies on Eurasian sturgeons indicate that they are also unique among fishes in possessing a markedly diverse assemblage of host-specific parasites. The parasites of sturgeons have been studied in several works (Dogiel and Bykhovskiy, 1939; Dubinin, 1952; Shulmann, 1954; Nechaeva, 1964; Mokhayer, 1972; Skryabina, 1974; Sattari and Mokhayer, 2006; Sattari et al., 2007, 2008, 2009; Khara et al., 2009: Mousavi Sabet and Sattari, 2013; Daghigh Roohi et al., 2014a, b; Khara and Sattari, 2014). However, there are only a few reports about their parasites in the southern part of the Caspian Sea. Mokhayer (1972) studied the parasites of three sturgeon species, namely *A. stellatus*, *A. gueldenstaedtii*, and *Huso huso* from the Caspian Sea, and reported 17 parasite species, including *Trichodina reticulata*, *Polypodium hydriforme*, *Skrjabinopsolus skrjabini*, *S. acipenseris*, *Amphilina foliacea*, *Bothrimonus fallax*, *Eubothrium acipenserinum*, *Ascarophis ovotrichuria*, *Cyclozone acipenserina*, *Cucullanus sphaerocephalus*, *Contracaecum squalii*, *Anisakis schupakowi*, *Eustrongylides excisus*, *Leptorhynchoides plagicephalus*, *Pomphorhynchus laevis*, *Corynosoma capsicum* and *Pseudotracheliastes stellatus*. Gorogi (1996a) studied the parasites of *A. persicus* and reported three parasite species,

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including *C. sphaerocephalus*, *S. semiarmatus* and *L. plagicephalus*. In another study, Gorogi (1996b) reported five parasite species viz. *C. sphaerocephalus*, *Anisakis schupakovi*, *S. semiarmatus*, *Corynosoma strumosum* and *E. acipenserinum* from *H. huso*. There are also other reports regarding the parasites of the sturgeons from the Caspian Sea (Sattari and Mokhayer, 2006). Therefore, this study attempts to provide the status of parasite communities (prevalence, mean intensity of infection, abundance and dominance) of four sturgeon species *viz.* stellate sturgeon, *Acipenser stellatus* Pallas, 1771, Russian sturgeon, *A. gueldenstaedtii* Brandt, 1833, Ship sturgeon, *A. nudiventris* Lovetsky, 1828, and great sturgeon, *Huso huso* in the southwestern of the Caspian Sea and their histopathological effects on the examined fishes.

Materials and Methods

A total of 93 individuals of four sturgeon species, namely *A. stellatus* (n=60), A. gueldenstaedtii (n=12), *A. nudiventris* (n=9), and *Huso huso* (n=12) were collected from March 2010 to May 2011. The samples includes sturgeons caught in fisheries regions 1 (region 1: western coast of Guilan Province) and 2 (region 1: eastern coast of Guilan Province) along a shore line of more than 200 km. The stellate sturgeons (60 fish) had a mean weight of 8.725 kg (±2.735 kg, range=4-15 kg) and fork length of 129.57 cm (±18.11 cm, range=83-170 cm). The Russian sturgeons (12 fish) had a mean weight of 19.417 kg (±6.007 kg, range=12-32 kg) and fork length of 135.33 cm (±15.20 cm, range=110-155 cm). The Ship sturgeons (9 fish) had a mean weight of 28.444 kg (±11.304 kg, range=11-41 kg) and fork length of 156.78 cm (±29.28 cm, range=112-190 cm). Great sturgeons (12 fish) had a mean weight of 119.500 kg (±71.008 kg, range=22-271 kg) and fork length of 207.5 cm (±41.097 cm, range=144-274 cm). Since the samplings of this study were restricted by the governmental fishing program (i.e. for artificial propagation and then exporting their flesh), therefore, age determination was not possible.

After recording biometric characteristics of fishes, common necropsy and parasitology methods (Bykhovskaya-Pavlovskaya, 1985; Stoskopf, 1993) were used for finding parasites. Live trematodes and acanthocephalans were relaxed in distilled water at 4°C for 1 hrs and fixed in 10% hot buffered formalin. Live nematodes were fixed in hot 70% ethanol and cleared in hot lactophenol. Frozen specimens were thawed in water, and then fixed with 10% formalin (trematodes and acanthocephalans) or 70% ethanol (nematodes). All fixed specimens in 10% formalin were stained with aqueous acetocarmine, dehydrated and mounted in Permount. After fixation of the infested tissues of the examined fishes for 24 hrs, they were processed based on Eagderi et al. (2013), embedded in paraffin and subsequently cut (with a thickness of 5 μm) with a microtome (Model 1130 Rotary Microtome, Reichert-Jung) for preparing histological slides. Then, they were stained with haematoxylin-eosin for study of the histopathological effects of the parasites. The worms were identified using parasite identification keys (Yamaguti, 1961; Bykhovskaya-Pavlovskaya et al., 1962; Avdeyev, 1987; Moravec, 1994) and then were deposited at the Laboratory of Fish Diseases, Faculty of Natural Resources, University of Guilan, Iran.

Statistical analysis: Classical epidemiological variables (prevalence, intensity and abundance) were calculated according to Bush et al. (1997). Mean intensity of infection was determined by dividing the total number of recovered parasites by the number of infected fish samples, while calculating abundance was carried out by dividing the total number of recovered parasites by the number of (infected and uninfected) fish samples. Prevalence was also calculated by dividing the number of infected fish samples by the total number of the examined fishes 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). Mean

Table 1. The prevalence, mean intensity, range, abundance and dominance of some parasites in *A. stellatus*.

Parasites	Prevalence (%)	Mean intensity±SD	Range	Abundance±SD	Dominance (%)
S. semiarmatus N=269	18.33	24.45±62.41	1-212	4.48±27.4	42.63
L. plagicephalus N=313	45	11.59±17.06	1-71	5.22±12.7	49.6
C. sphaerocephalus N=22	17.26	2.44±2.30	1-8	0.37±1.22	3.49
B. fallax N=12	1.66	12± 0	12	0.2±1.55	1.9
E. excisus larvae N=15	5	5.0±3.61	1-8	0.25±1.28	2.4

Table 2. The prevalence, mean intensity and range of some parasites of *A. stellatus* in various seasons.

Season \ Parasite	*C. sphaerocephalus* Prevalence (%) Mean±SD Range	*S. semiarmatus* Prevalence (%) Mean±SD Range	*L. plagicephalus* Prevalence (%) Mean±SD Range	*E.exisus* Prevalence (%) Mean±SD Range	*B. fallax* Prevalence (%) Mean±SD Range
Spring N=37	16.22 2.8±2.7 (1-8)	27.02 26.4±65.4 (1-212)	45.95 14.29±20.58 (1-71)	2.70 1 8	2.70 12 12
Autumn N=16	12.5 2±1.4 (1-3)	0	37.5 5.5±7.23 (1-20)	0	0
Winter N=7	14.29 1 1	14.29 5 5	57.14 9.25±7.27 (2-19)	28.57 3.5±3.53 (1-6)	0

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). The results were considered significant at the 95% level ($P<0.05$). Data analysis were performed using SPSS software (IBM SPSS Statistics, IBM Corporation).

Results

A total of 762 parasite belonging to five species, including two nematodes *viz. Cucullanus sphaerocephalus* Rudolphi, 1809 and *Eustrongylides excisus* Jagerskiold, 1909, one cestode species, namely *Bothrimonus fallax* Luhe, 1900, one acanthocephalans, namely *Leptorhynchoides plagicephalus* Westrumb, 1821, and one digenean trematode, namely *Skrjabinopsolus semiarmatus* Molin, 1858 were found in the examined sturgeons, including *A. stellatus*, *A. gueldenstaedtii*, *A. nudiventris* and *H. huso*. The prevalence, mean intensity, range, abundance and dominance of the collected parasites are presented in Tables 1 and 5-7.

A total of 631 worms belonging to five species were found in *A. stellatus*. *Leptorhynchoides plagicephalus* had the highest prevalence (45%), abundance (5.22) and dominance (49.6%), while *S. semiarmatus* had the highest mean intensity of infection (24.45) (Table 1). These two parasites constituted up to 92.23% of parasite communities in *A. stellatus*.

The prevalence of *C. sphaerocephalus* and *S. semiarmatus* in *A. stellaus* was higher in spring (16.22 and 27.02) than that of winter and autumn, respectively, whereas the prevalence of *L. plagicephalus* was higher in winter than that of spring and autumn, respectively (Table 2). The mean intensity of infection of these three parasites was higher in spring than winter and autumn, respectively, but the differences between seasons were not significant (KW, χ^2=0.778, df=2, P=0.678 for *C. sphaerocephalus*; KW, χ^2=0.00, df=1, P=1.00 for

Table 3. The prevalence, mean intensity and range of some parasites of *A. stellatus* in two sampling regions.

Parasite / locality	*C. sphaerocephalus* Prevalence (%) Mean± SD Range	*S. semiarmatus* Prevalence (%) Mean±SD Range	*L. plagicephalus* Prevalence (%) Mean±SD Range	*E. excisus* Prevalence (%) Mean±SD Range	*B. fallax* Prevalence (%) Mean±SD Range
Location 1 N=27	18.52 3.6±2.61 (1-8)	18.52 8.8±6.1 (2-17)	40.74 10.73±15.25 (1-54)	3.70 8± - 8	3.70 12± - 12
Location 2 N=33	12.12 1.00± - 1	18.18 37.5±85.5 (1-212)	48.48 12.19±18.67 (1-71)	6.06 3.5±3.54 1-6	0

Table 4. The prevalence, mean intensity and range of some parasites of *A. stellatus* in males and females.

Parasite / Sex	*C. sphaerocephalus* Prevalence (%) Mean±SD Range	*S. semiarmatus* Prevalence (%) Mean±SD Range	*L. plagicephalus* Prevalence (%) Mean±SD Range	*E. excisus* Prevalence (%) Mean±SD Range	*B. fallax* Prevalence (%) Mean±SD Range
Female N=36	16.66 2.8±2.7 (1-8)	16.66 39.3 ± 84.7 (1-212)	44.44 13.8±18.03 (1 - 71)	5.56 3.5±3.53 (1-6)	0
Male N=24	12.5 1.67±1.15 (1-3)	20.83 6.6±6.35 (1-17)	45.83 8.36±15.8 (1-54)	4.17 8 8	4.17 12 12

S. semiarmatus; and KW, χ^2=1.606, df=2, *P*=0.448 for *L. plagicephalus*). The same results were found regarding the abundance of these three parasites in various seasons (KW, χ^2=0.098, df=2, *P*=0.952 for *C. sphaerocephalus*; KW, χ^2=5.374, df=2, *P*=0.068 for *S. semiarmatus*; and KW, χ^2=1.524, df=2, *P*=0.467 for *L. plagicephalus*).

The prevalence of *C. sphaerocephalus* and *S. semiarmatus* in *A. stellatus* in region 1 was higher, but the prevalence of *L. plagicephal*us in region 2 was higher (Table 3). The mean intensity of infection of *C. sphaerocephalus* in region 1 was significantly higher (KW, $\chi 2$=4.8, df=1, *P*<0.05, but no significant differences were found between these two regions concerning to *S. semiarmatus* and *L. plagicephalus* (KW, χ^2=1.457, df=1, *P*=0.224 for *S. semiarmatus*; and KW, χ^2=0.223, df=1, *P*=0.637 for *L. plagicephalus*). Also, no significant differences were found regarding the abundance of these three parasites between regions (KW, χ^2=0.685, df=1, *P*=0.408 for *C. sphaerocephalus*; KW, χ^2=0.031, df=1, *P*=0.806 for *S. semiarmatus*; and KW, χ^2=0.166, df=1, *P*=0.684 for *L. plagicephalus*).

The prevalence of *C. sphaerocephalus* in females of *A. stellatus* (16.66) was higher than males (12.5), but the prevalence of *S. semiarmatus* and *L. plagicephalus* in males (20.83 and 45.83, respectively) was higher (Table 4). The mean intensity of the infection of these three parasites in females was higher than males, although the differences between males and females were not significant (KW, χ^2=0.333, df=1, *P*=0.564 for *C. sphaerocephalus*; KW, χ^2=0.009, df=1, *P*=0.926 for S. semiarmatus; and KW, χ^2=4.054, df=1, *P*=0.054 for *L. plagicephalus*). The same results were found regarding the abundance of these three parasites in males and females (KW, χ^2=0.179, df=1, *P*=0.673 for *C. sphaerocephalus*; KW, χ^2=0.153, df=1, *P*=0.695 for *S. semiarmatus*; and KW, χ^2=0.326, df=1, *P*=0.568 for *L. plagicephalus*) (Table 4).

The prevalence of *C. sphaerocephalus*, *S. semiarmatus* and *L. plagicephalus* in higher length groups of *A. stellatus* were higher than in lower length groups. The mean intensity of the infection of these three parasites in higher length groups were higher than lower length groups, but the differences were

Table 5. The prevalence, mean intensity, range, abundance and dominance of some parasites in *A. gueldenstaedtii*.

parasites	Prevalence	Mean intensity ± SD	Range	Abundance± SD	Dominance
L. plagicephalus N=37	8.33	1	1	0.08±0.01	2.32
C. sphaerocephalus N=1	50	6.17±4.02	1-12	3.08±0.13	86.04
E. excisus larvae N=5	16.66	2.5±2.12	1-4	0.41±0.02	11.63

Table 6. The prevalence, mean intensity, range, abundance and dominance of some parasites in *A. nudiventris*.

parasites	Prevalence	Mean intensity ± SD	Range	Abundance± SD	Dominance
L. plagicephalus N=37	8.33	1	1	0.08±0.01	2.32
C. sphaerocephalus N=1	50	6.17±4.02	1-12	3.08±0.13	86.04
E. excisus larvae N=5	16.66	2.5±2.12	1-4	0.41±0.02	11.63

Table 7. The prevalence, mean intensity, range, abundance and dominance of some parasites in *Huso huso*.

parasites	Prevalence (%)	Mean intensity ± SD	Range	Abundance± SD	Dominance (%)
S. semiarmatus N=4	8.33	4	4	0.33±0.11	10
C. sphaerocephalus N=35	41.67	7±7.65	1-19	2.92±0.1	87.5
E. excisus larvae N=1	8.33	1	1	0.08±0.01	2.5

not significant (KW, χ^2=6.667, df=7, *P*=0.464 for *C. sphaerocephalus*; KW, χ^2=9.119, df=8, *P*=0.332 for *S. semiarmatus*; and KW, χ^2=15.750, df=15, *P*=0.399 for *L. plagicephalus*). The same results were found regarding the abundance of these three parasites in various length groups (KW, χ^2=18.789, df=27, *P*=0.878 for *C. sphaerocephalus*; KW, χ^2=25.993, df=27, *P*=0.519 for *S. semiarmatus*; and KW, χ^2=20.508, df=27, *P*=0.809 for *L. plagicephalus*). In addition, the prevalence of *C. sphaerocephalus* and *S. semiarmatus* in higher weight groups of *A. stellatus* was more than lower weight groups. The mean intensity of infection of these two parasites in higher weight groups was also more than lower weight groups, but the differences were not significant ((KW, χ^2=6.667, df=5, *P*=0.247 for *C. sphaerocephalus*; KW, χ^2=6.103, df=5, *P*=0.296 for *S. semiarmatus*). The same results were found regarding the mean intensity of infection of this parasite, but the differences were not significant (KW, χ^2=4.769, df=5, *P*=0.782). No significant differences was found concerning to the abundance of these three parasites in various weight groups of *A. stellatus* (KW, χ^2=12.681, df=11, *P*=0.315 for *C. sphaerocephalus*; KW, χ^2=14.596, df=11, *P*=0.202 for *S. semiarmatus*; and KW, χ^2=13.111, df=11, *P*=0.767 for *L. plagicephalus*).

A total of 43 worms belonging to three species were found in *A. gueldenstaedtii* (Table 5). In this species, *C. sphaerocephalus* had the highest prevalence (50%), mean intensity of infection (6.17), abundance (3.08), and dominance (86.04%). *Eustrongylides excisus* larvae had the second highest prevalence (16.66), mean intensity of infection (2.5), abundance (0.41,) and dominance (11.63%). These two parasites were constituted up to 97.67% of parasite communities in the examined specimens of *A. gueldenstaedtii* (Table 5).

A total of 48 worms belonging to four species were found in the specimens of *A. nudiventris* (Table 6). Based on the results, *C. sphaerocephalus* had the highest prevalence (55.5%), abundance (3) and

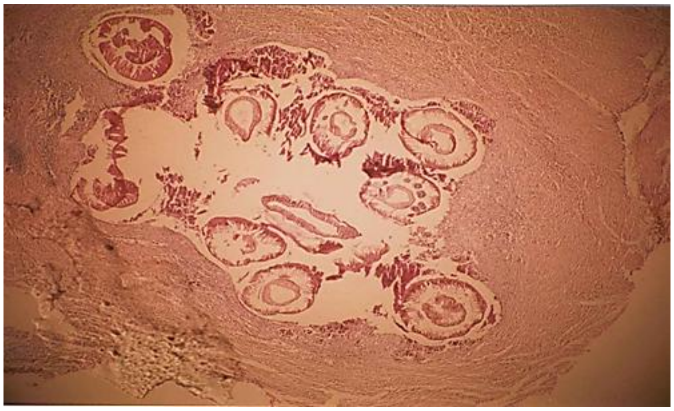

Figure 1. Histopathologic section of the infested tissues by *E. excisus* larvae in the gut of *H. huso* (H&E, 40X).

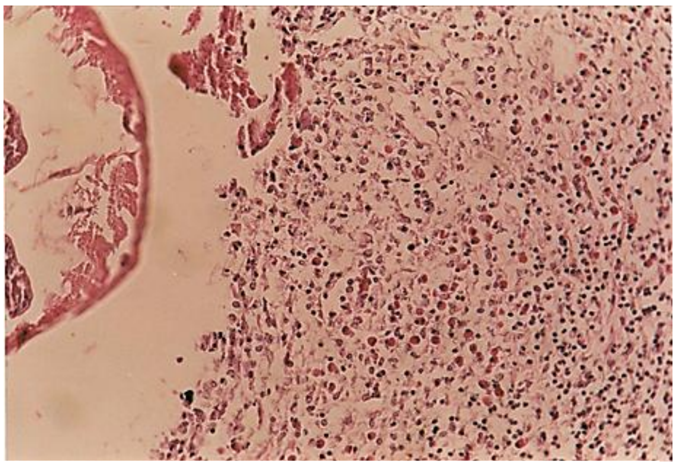

Figure 2. Histopathologic section of the infested tissues by *E. excisus* in the gut of *H. huso* (H&E, 400X).

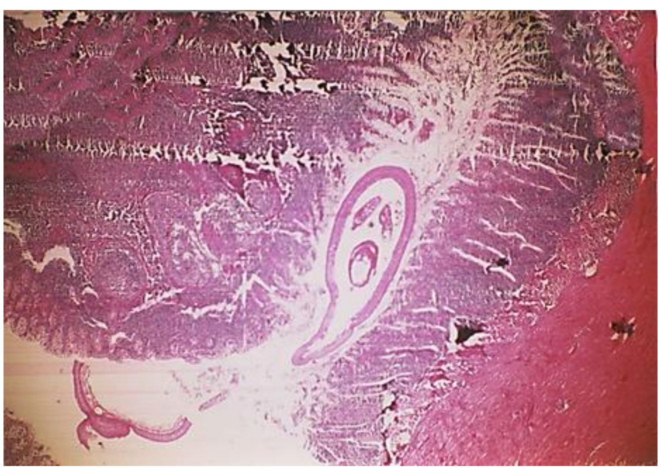

Figure 3. Histopathologic section of the infested tissues by *L. plagicephalus* in the gut of *A. nudiventris* (H&E, 40X).

dominance (56.25%). *Skrjabinopsolus semiarmatus* had the second highest prevalence (22.2), abundance (1.56) and dominance (29.17%). The mean intensity of the infection of *S. semiarmatus* (7) was higher than *C. sphaerocephalus* (5.4). These two parasites

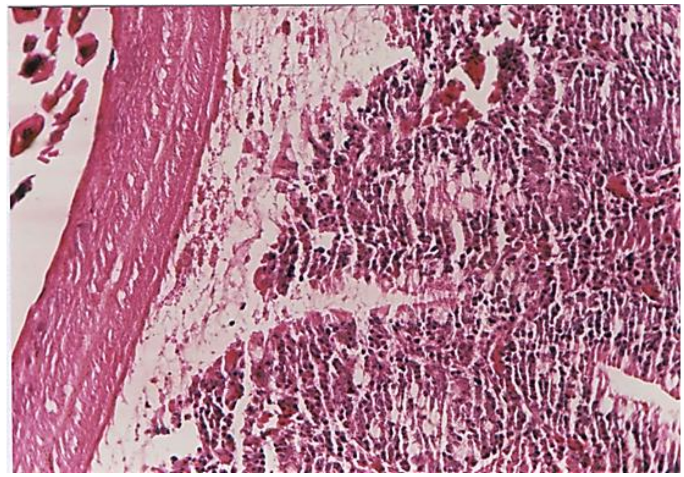

Figure 4. Histopathologic section of the infested tissues by *L. plagicephalus* in the gut of *A. nudiventris* (H&E, 400X).

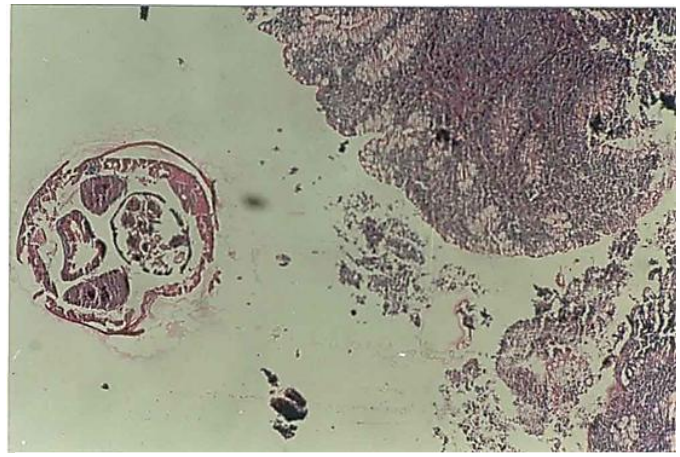

Figure 5. Histopathologic section of the infested tissues by *C. sphaerocephalus* in the gut of *A. gueldenstaedtii* (H&E, 40X).

constituted up to 85.42% of the parasite communities in *A. nudiventris*.

A total of 40 worms belonging to three species were found in the samples of *H. huso* (Table 7). *Cucullanus sphaerocephalus* had the highest prevalence (41.67%), mean intensity of infection (7) abundance (2.92) and dominance (87.5%). *Skrjabinopsolus semiarmatus* had the second prevalence (8.33), mean intensity of infection (4), abundance (0.33) and dominance (10%). These two parasites constituted up to 97.5% of parasite communities in *H. huso*.

The histopathological effects of some parasites on the gut of the sturgeons are as follows:

Eustrongylides excisus larvae: The parasites were encapsulated in the wall of the intestinal mucosa. There was chronic inflammation around the parasites

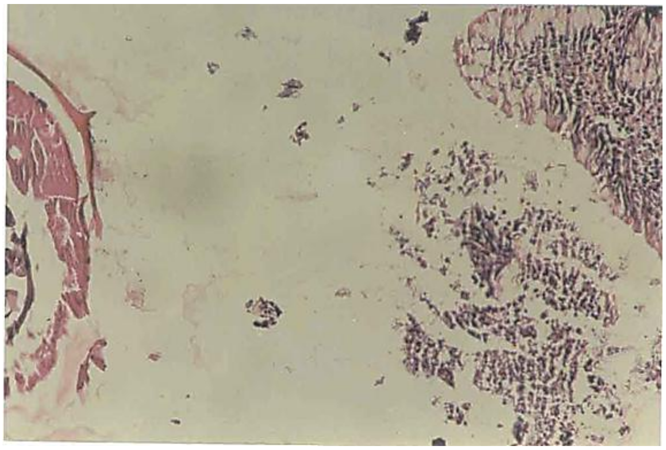

Figure 6. Histopathologic section of the infested tissues by *C. sphaerocephalus* in the gut of *A. gueldenstaedtii* (H&E, 400X).

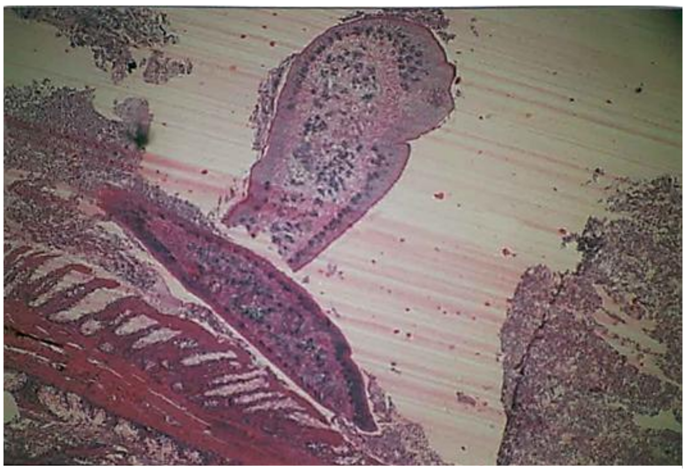

Figure 7. Histopathologic section of the infested tissues by *B. fallax* in the gut of *A. stellatus* (H&E, 40X).

with infiltration of the macrophages, lymphocytes, fibroblasts, and multiple eosinophils (Figs. 1, 2).

Leptorhynchoides plagicephalus: The head of the parasite with horny proboscis was attached in a pitted zone of intestinal wall of the sturgeon. The spines of proboscis formed severe necrosis in the epithelium with chronic inflammation. The mononuclear cells with multiple lymphocytes were infiltrated and also some lymphoid follicles were present (Figs. 3, 4)

Cucullanus sphaerocephalus: This parasite is caused the focal necrosis and acute to sub-acute inflammation with multiple lymphocytes (Figs. 5, 6).

Bothrimonus fallax: Necrosis and destruction of the mucosa were observed in the site of attachment this parasite. Mononuclear cells such as lymphocytes and a few number of eosinophils were also observed

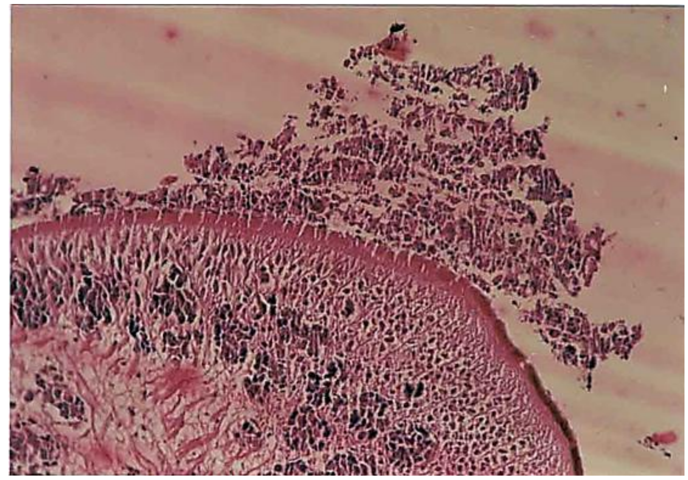

Figure 8. Histopathologic section of the infested tissues by *B. fallax* in the gut of *A. stellatus* (H&E, 400X).

(Figs. 7, 8).

Discussion

There are few reports about the parasites of sturgeons in Iran. Mokhayer (1972) studied the parasites of three sturgeon species, namely *A. stellatus*, *A. gueldenstaedtii* and *H. huso*, and reported 17 parasite species. Gorogi (1996a, b) also studied the parasites of two sturgeon species, including *A. persicus* and *H. huso* with reporting 3 and 5 parasite species, respectively. Sattari and Mokhayer (2006) studied the parasites of 206 individuals of *A. persicus* and reported nine parasite species. However, in the present study, *Trichodina reticulata*, *Polypodium hydriforme*, *Ascarophis ovotrichuri*a, *Cyclozone acipenserina*, *Contracaecum squalii* and *Pomphorhynchus laevis* were not recovered from the samples.

Skryabina (1974) found that *A. stellatus* is parasitized by more worm species than *A. gueldenstaedtii*, particularly in the Caspian Sea basin. Skryabina (1974) also found that in the Azov and Caspian Seas, the prevalence of *C. sphaerocephalus* in *A. stellatus* is less than other sturgeon species from the same localities. Similarly, in the present study, it was found that the diversity of helminth fauna in *A. stellatus* was more than other examined sturgeons. It was also found that the prevalence and mean intensity of *C. sphaerocephalus* in *A. stellatus* were less than in the other examined sturgeons.

Markov et al. (1967) found that the most important parasites of *A. stellatus* from the lower course of the Volga River are cestodes and acanthocephalans. They also found that along the coast of Dagestan, the most important species are *E. acipenserinum*, *B. fallax*, *L. plagicephalus* and *S. semiarmatus*. Similarly, in the present study, the prevalence and mean intensity of *L. plagicephalus* in *A. stellatus* were higher than other examined sturgeons. *Bothrimonus fallax* was only found in *A. stellatus*.

Of all acipenserid species, the Russian sturgeon has the best-known parasite fauna (Holcik, 1989). The complete list of the parasites found in *A. gueldenstaedtii* includes 46 species; of these, parasitic worms are the largest group (Dogiel and Bykhovskii, 1939; Shulman, 1954; Nechaeva, 1964; Skryabina, 1974). Skryabina (1974) reported that the parasite fauna of *A. gueldenstaedtii* is similar to that of *A. stellatus*, while in this study and also in Sattari and Mokhayer (2006), the parasite fauna of *A. gueldenstaedtii* was similar to that of *A. nudiventris* and *H. huso* than *A. stellatus*.

The main parasites of *A. nudiventris* includes 32 parasites species and most of them are specific to acipenserids (Dogiel and Bykhovskii, 1939; Shulman, 1954; Skryabina, 1974). Shulman (1954) pointed out that the adult ship sturgeons are infested primarily in the sea by helminthes such as *S. semiarmatus*, *E. acipenserinum* and *C. sphaerocephalus*. In juveniles, the predominant parasites are freshwater species such as *T. acipenseri, Amphilina foliacea, Hysterothylacium bidentatum, Piscicapillaria tuberculata, Chilodonella cyprini, Trichodina domerguei* and *Argulus foliaceus*. Along the Iranian shore of the Caspian Sea, however, the catching of juvenile sturgeons is forbidden by government. Therefore, there is no report about their parasite fauna in this region. Although some researchers have reported *Anisakis* sp. larvae and *Cystoopsis acipenseris* from dead juvenile sturgeons (A. Hajimoradloo, personal communications).

The parasite fauna of *H. huso* has been studied by many authors (Dogiel and Bykhovskii, 1939; Shulman, 1954; Nechaeva, 1964; Skryabina, 1974; Bauer et al., 1977) and 33 parasite species have been reported (Holcik, 1989). With great probability, the local populations of the great sturgeon are infested by different aggregations of parasitic worms (Dogiel and Bykhovskii, 1939). Dogiel and Bykhovskii (1939) stated that the stocks inhabiting the northern Caspian region are mostly infested to typical freshwater parasitic worms than those of the southern part of the Caspian Sea. Similarly, in the present study and also in the previous studies (Mokhayer, 1972; Gorogi, 1996b; Sattari and Mokhayer, 2006), more marine typical worms such as *E. acipenserinum*, *Anisakis* sp. (L.), *E. excisus* larvae, *C. strumosum* and *C. sphaerocephalus* were found in the great sturgeon.

The sample of the sturgeons, particularly *A. nudiventris* and *H. huso*, were small in the present study due to decreasing numbers of these species in catching yields. However, with respect to the works of Gorogi (1996a, b) and Sattari and Mokhayer (2006), it seems that expected helminthofauna in the sturgeons of the southern part of the Caspian Sea does not exceed 13-15 species.

In this study, *C. sphaerocephalus* and *S. semiarmatus* were the most prevalent worms and their mean intensity, abundance and dominance were higher than the others parasites. In addition, *E. excisus* larvae were mostly found in more carnivorous sturgeons such as *H. huso*, *A. gueldenstaedtii* and *A. nudiventris*. This is likely because *E. excisus* larvae needs some benthophagous fishes (e.g., *Rutilus caspius* and *Neogobius* spp.) as obligatory second intermediate hosts.

In the present study, *Amphilina foliacea* and *D. armatum* (belonging to freshwater parasite fauna) were not found in the examined sturgeons that have already been reported by Sattari and Mokhayer (2006). This may be because of decreasing spawning migrations of the sturgeons into freshwater, which can be as result of unfavorable conditions of freshwater ecosystems caused by pollution, dam construction, etc.

According to the results of this study and the results of Mokhayer (1972), Gorogi (1996a, b), and Sattari and Mokhayer (2006), the diversity of the sturgeons' parasites in the southern part of the Caspian Sea is lower than that of the northern part. It should be noted that the maximum depth of the Caspian Sea in the northern part is about 12 m, while in the southern part it is about 980 m. Furthermore, the salinity in the northern part of the Caspian Sea is about 5 ppt, while in the southern part, it is about 13 ppt and may reach to 20 ppt in the southeast region. In addition, the productivity and carbonate ions between the southern and northern parts are different. These factors may have some impacts on the parasite communities of the sturgeons.

Based on the results, the diversity of parasites (including freshwater ones) in the southern part of the Caspian Sea have decreased since the time of the first study by Mokhayer (1972). This may be related to unfavorable conditions in freshwater ecosystems, such as pollution and dam construction. In these conditions, it is impossible for the sturgeons to migrate into the rivers for spawning.

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چکیده فارسی

انگل‌های کرمی و اثرات آسیب‌شناسی آن‌ها بر روی چهارگونه از ماهیان خاویاری در سواحل جنوب‌غربی دریای خزر

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چکیده:
این مطالعه برای تعیین وضعیت جمعیت‌های انگلی چهار گونه از تاسماهیان شامل ازون‌برون، چالباش، شیپ و فیل‌ماهی و اثرات آسیب‌شناسی آن‌ها در سواحل جنوب‌غربی دریای خزر صورت گرفت. برای این منظور، تعداد ۹۳ عدد ماهی از این چهار گونه در دو ناحیه شیلاتی جنوب‌غربی دریای خزر (استان گیلان، ایران) از ماه مارس ۲۰۱۰ تا ماه می ۲۰۱۱ صید شدند. لام‌های بافت شناسی بافت‌های آلوده ماهیان مورد آزمایش برای مطالعه اثرات آسیب‌شناسی انگل‌ها مورد استفاده قرار گرفتند. متغیرهای همه‌گیری شناختی کلاسیک شامل میانگین شدت آلودگی، شیوع، فراوانی و شاخص غالبیت برای تمام نمونه‌ها و همچنین بر اساس فصل، ناحیه جغرافیایی و جنسیت محاسبه شدند. پنج گونه انگل شامل دو نماتود (کوکولانوس اسفروسفالوس و نوزاد یواسترونژیلیدس اکسیسوس)، یک سستود (بوتریمونوس فالاکس)، یک آکانتوسفال (لپتورینکوئیدس پلاژی‌سفالوس) و یک ترماتود دیژن (اسکریابینوپسولوس سمی‌آرماتوس) در نمونه‌های مورد آزمایش یافت شدند و اثرات آسیب‌شناسی آنها بر روی بافت‌های ماهیان مورد ارزیابی قرار گرفت. بر اساس نتایج، تنوع انگل‌ها (شامل گونه‌های آب شیرین) در جنوب‌غربی دریای خزر از زمان اولین مطالعه در سال ۱۹۷۲ کاهش یافته است. این امر ممکن است با شرایط نامطلوب در اکوسیستم‌های آب شیرین در ارتباط باشد.
کلمات کلیدی: ترماتود، سستود، آکانتوسفال، فیل‌ماهی، ازون‌برون، شیپ، چالباش.