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Original Article

A comparative study of parasite communities of some endemic fish species in the Alborz Dam and the Babol River in the Southern Caspian Sea basin, Mazandaran Province

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Abstract: The Babol River is one of the main rivers in the Southern Caspian Sea basin in Mazandaran Province. The Alborz Dam has been built along the river to provide annual irrigation and flood protection. This study aimed to identify and describe the prevalence and parasite intensity of some endemic fish species in Babol River and Alborz Dam and to compare their parasite communities. The field investigations were carried out from June 2016 to March 2017 and approximately, 546 fish specimens, including *Alburnoides tabarestanensis, Capoeta razii* and *Squalius turcicus,* were examined. A total of 13 parasite species, including *Ichthyophthirius multifiliis*, *Trichodina gracilis*, *Myxobulus minutus*, *Dactylogyrus chalcalburni*, *D. vistulae*, *D. lenkorani*, *Gyrodactylus gobioninum*, *G. prostate*, *Paradiplozoon* homoion, *Allocreadium isoproum*, *Rhabdochona denudatai, Ligula intestinalis* and *Bothriocephalus acheilognathi,* were isolated from the examined fishes. The results showed that host-parasite system in Alborz Dam is mainly influenced by the parasite's fauna of Babol River. The only exception in this regard is the plerocercoids of *L. intestinalis*, one of the most common parasites in Alborz Dam and found in the abdominal cavity of all fish species. The prevalence rate and the mean intensity of parasitic infection in this reservoir are far more than those in Babol River. In addition this is the first report of *Trichodina gracilis* from the gills and skin of *C. razii* in Iran.

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Introduction

The Babol River is one of main rivers in the Southern Caspian Sea basin in Mazandaran Province. The river originates from the northern slopes of the Alborz Mountains and flows toward the Caspian Sea after passing through the cities of Babol and Babolsar. The river flows in the mountainous part as a valley river with a notably slope. But as the river enters the Caspian coastal zone, the slope decreases rapidly and the river continues as a stream. The width of the Babol River in the Caspian coastal zone is about 40 kilometers (Ramin, 2001). The Alborz dam, with a height of 78 meters and volume of 150 million cubic meters, was built on the Babol River in 2010 to provide annual irrigation; it also is beneficial for flood protection and fisheries activities (Ghaffari et al., 2006).

The Babol River provides a suitable habitat for numerous species of migratory and non-migratory fishes belonging to the families of Petromyzonidae, Cobitidae, Nemacheilidae, Esocidae, Cyprinidae, Mugilidae and Gobiidae, but the largest number of fish species belongs to cyprinid family. *Alburnoides tabarestanensis* Mousavi-Sabet, AnvariFar & Azizi 2015; *Capoeta razii* Jouladeh-Roudbar, Eagderi, Ghanavi & Doadrio 2017 and *Squalius turcicus* De Filippi, 1865 are the most abundant fish species in the Babol River (Ramin, 2001; Esmaeili et al. 2017; Jouladeh-Roudbar et al., 2017) found in the Alborz Dam.

Several parasitological studies have been conducted on the fishes inhabiting in rivers of the Southern Caspian Sea basin in Mazandaran Province. Molnár and Jalali (1992) have recorded the monogeneans *Dactylogyrus lenkorani* in the Tonekabon and Tajan rivers of the Caspian Sea basin

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and *D. pulcher* in the Tajan, Tonekabon, and Ghasemlu rivers of the Caspian Sea basin as parasites of *C. capoeta*. Malek and Mobedi (2001) have reported *Clinostomum complanatum* from this species in the Shiroud River. Rohei Aminjan and Malek (2004) have found nine parasite species in fish from the Shiroud, namely trematodes *C. complanatum*, *Diplostomum spathaceum*, *Posthodiplostomum cuticola* and *Allocreadium* sp., the monogeneans *D. pulcher*, *D. lenkorani* and *Gyrodactylus mutabilitas,* and nematodes *Rhabdochona fortunatowi* and *Capillaria* sp. Miar et al. (2008) have reported *Myxobolus saidovi* in the fish from the Valasht Lake and the Chalus River, Mazandaran. Maleki and Malek (2007) have reported infection of fish from the Shirud River in the Caspian Sea basin with the digeneans *P. cuticola*, *D. spathaceum*, *C. complanatum,* and *Allocreadium* sp. Jalali et al. (2005) have summarized the occurrence of *Gyrodactylus* species in Iran and recorded these species from fish in Sefid River. Barzegar and Jalali (2008) have reviewed crustacean parasites in Iran and found *Ergasilus peregrinus*, *Ergasilus* sp., *Lamproglena compacta*, *Lernaea* sp., *Tracheliastes longicollis,* and *Tracheliastes polycolpus*. Barzegar et al. (2008) have recorded the digenean eye parasite *D. spathaceum* from *A. bipunctatus*. The only research study on the fish parasites in the Babol River has been carried out by Hassanpour et al. (2004), who have recoded three metazoan parasite species, including *Hepaticola petruschewskii* from the intestine of *A. bipunctatus* (*tabarestanensis*), *S. cephalus* (*turcicus*) and *C. gracilis* (*razii*), and *Capillaria* sp., and *Corynosoma villosum* from the intestine of *Rutilus kutum*. So far, there is no report on fish parasites from the Alborz Dam.

Communities of fauna and flora and the related parasites differ among the rivers and other water body; thus, different parasites are found in single hosts from two different ecosystems (Miar et al., 2008). These two water bodies, the Babol River and the Alborz Dam, belong to a single region, biogeographically, but with different ecosystems: one is a lotic, but the other is a lentic ecosystem. This study aimed to identify protozoan and metazoan parasites in some endemic fish species in the Babol River and the Alborz Dam in Mazandaran Province. It also aimed to compare parasite communities in the case of species diversity and the prevalence and intensity of parasite species among the infected members between the two different ecosystems.

Materials and Methods

Parasitological study: Field investigations were carried out in the Babol River and the Alborz Dam from June 2016 to March 2017. The fishes were caught by hook or electrofishing and immediately transported alive in oxygen-filled plastic bags to laboratory to be kept in aquaria. Identification of the fish was carried out according to Berg (1965), Coad (2017), and Keivany et al. (2017). Only fresh or immediately killed fish samples were examined for parasites. First, the fish were sedated using clove oil and then necropsied for parasitological analysis. The fish internal and external organs were examined. Methods used for collecting, fixing, staining, and mounting of the parasite specimens were carried out in accordance with Fernando et al. (1972), Gussev (1983), and Roberts (2001). The identification of parasites was carried following Gussev (1985), Lom and Dykova (1992), Yamaguti (1961), Woo (2000), and Jalali (1998).

Data collection and management: To describe the parasite populations, some indices of infection, such as parasite prevalence and mean intensity were determined. Prevalence was defined as the number of individuals of a host species infected with one or more particular parasite species, divided by the total number of hosts examined for that parasite species (expressed as a percentage). The mean intensity was defined as the average intensity of a particular species of parasite among the infected members of a particular host species (Bush et al., 1997).

Statistical analysis: To analyze of data, Excel and SPSS version 19 software were used. In this regard, Mann-Whitney U was used to compare the mean intensity of parasitic infection between the Babol River and the Alborz Dam. The values of $P<0.05$

Table 1. Examined fish species from the Babol River and Alborz Dam in the southern part of the Caspian Sea basin, Iran.

Examined fishes	Length (cm)	Weight (g)	Number of specimens	Number of infected fish
A. tabarestanensis	6.9±0.2	7.20±0.6	114	94
C. razii	16.0±0.3	29.0±1.5	224	157.5
S. turcicus	12.3±0.4	14.8±0.6	208	187.5

Table 2. The parasite communities of some endemic fish species in the Babol River and Alborz Dam, in the southern Caspian Sea basin in Mazandaran Province.

	Parasite	Host (S)	Infected organs	
Ciliophora	*Ichthyophthirius multifiliis* Fouquet, 1876	*A. tabarestanensis*	Gills	Alborz Dam, Babol River
	Trichodina gracilis Polyanski, 1995	*C. razii*	Gills	Babol River
Myxozoa	*Myxobulus minutus* Nemeczek, 1911	*S. turcicus*	Gills	Alborz Dam, Babol River
Monogenea	*Dactylogyrus chalcalburni* Dogiel & Bychowsky, 1934	*A. tabarestanensis*	Gills	Babol River
	Dactylogyrus vistulae Prost, 1957	*S. turcicus*	Gills	Alborz Dam, Babol River
	Dactylogyrus lenkorani Mikhailov, 1967	*C. razii*	Gills	Alborz Dam, Babol River
	Gyrodactylus gobioninum Gussev, 1955	*C. razii*	Gills & skin	Babol River
	Gyrodactylus prostae Ergens, 1963	*C. razii* *A. tabarestanensis*	Gills & skin	Babol River
	Paradiplozoon homoion Byckowsky et Nagibina, 1959 (Diporpa & adult stage)	*A. tabarestanensis* *S. turcicus*	Gills	Alborz Dam, Babol River
Digenea	*Allocreadium isoproum* Looss, 1900	*S. turcicus*	Intestine	Babol River
Cestoda	*Ligula intestinalis* Linnaeus, 1758	*A. tabarestanensis* *S. turcicus* *C. razii*	Abdominal cavity	Alborz Dam
	Bothriocephalus opsariichthydis Yamaguti, 1934	*A. tabarestanensis* *S. turcicus*	Intestine	Alborz Dam, Babol River
Nematode	*Rhabdochona denudata* Dujardin, 1845	*S. turcicus*	Intestine	Babol River

were considered as significant.

Results

Approximately 546 fish specimens belonging to the cyprinid family, include *A. tabarestanensis, C. razii,* and *S. turcicus,* were examined (Table 1). A total of 13 protozoan and metazoan parasites were isolated from the examined fish of the Babol River and Alborz Dam. The species identified in the host fish include *Ichthyophthirius multifiliis*, *Trichodina gracilis*, *Myxobulus minutus*, *Dactylogyrus chalcalburni*, *D. vistulae*, *D. lenkorani*, *Gyrodactylus gobioninum*, *G. prostate*, *Paradiplozoon homoion*, *Allocreadium isoproum*, *Rhabdochona denudatai, Ligula intestinalis* and *Bothriocephalus acheilognathi* (Table 2). Monogenean parasites were the most abundant parasitic group in both river fish and dam fish (Fig. 1).

The prevalence of the parasites among the examined fish in the Babol River and Alborz Dam are compared in Figure 2. Different fish species showed

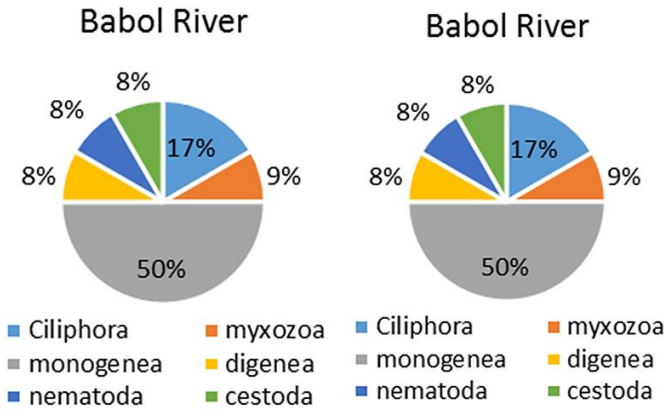

Figure 1. Frequency of different parasitic groups in the fish from the Babol River and Alborz Dam, in southern Caspian Sea basin in Mazandaran Province.

different prevalence; also prevalence of the Alborz Dam and Babol River is different. Mean intensity of the parasite species collected from the examined fish from the Babol River and Alborz Dam is also presented in Figure 3. There were significant difference in mean intensity of different parasites

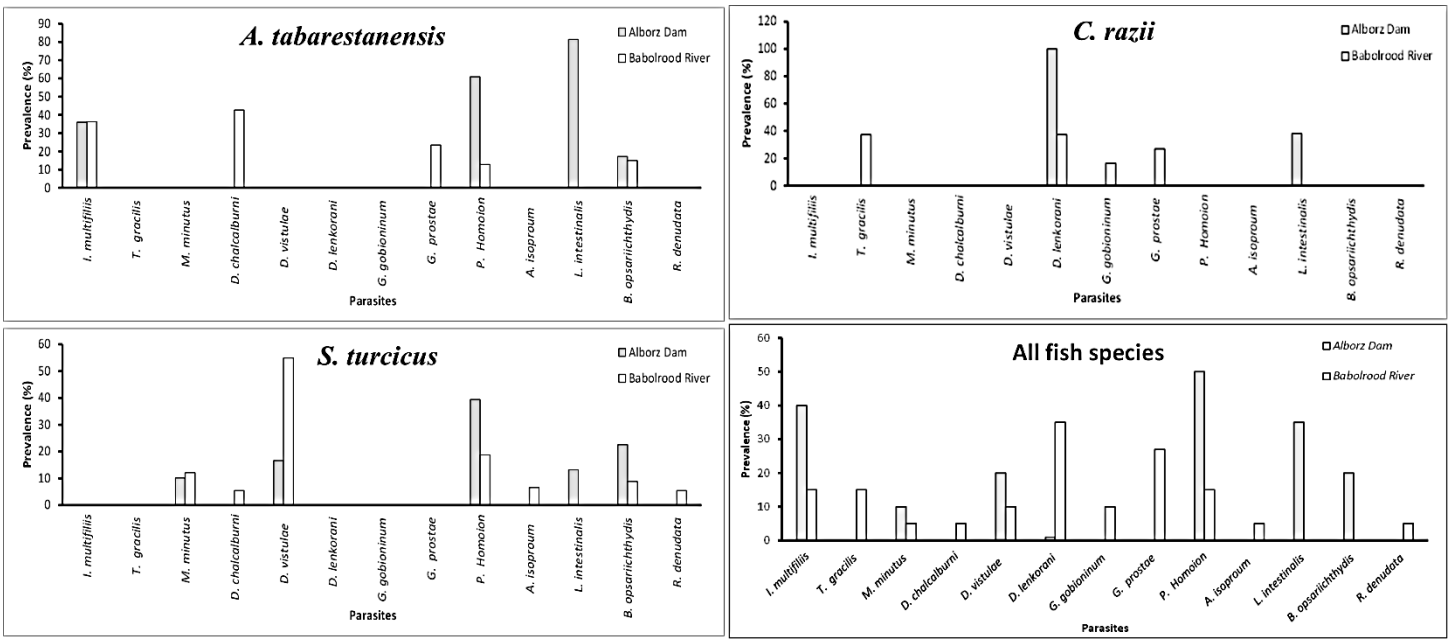

Figure 2. Prevalence of different fish parasites in different fish species from the Babol River and the Alborz Dam in the southern Caspian Sea basin in Mazandaran Province.

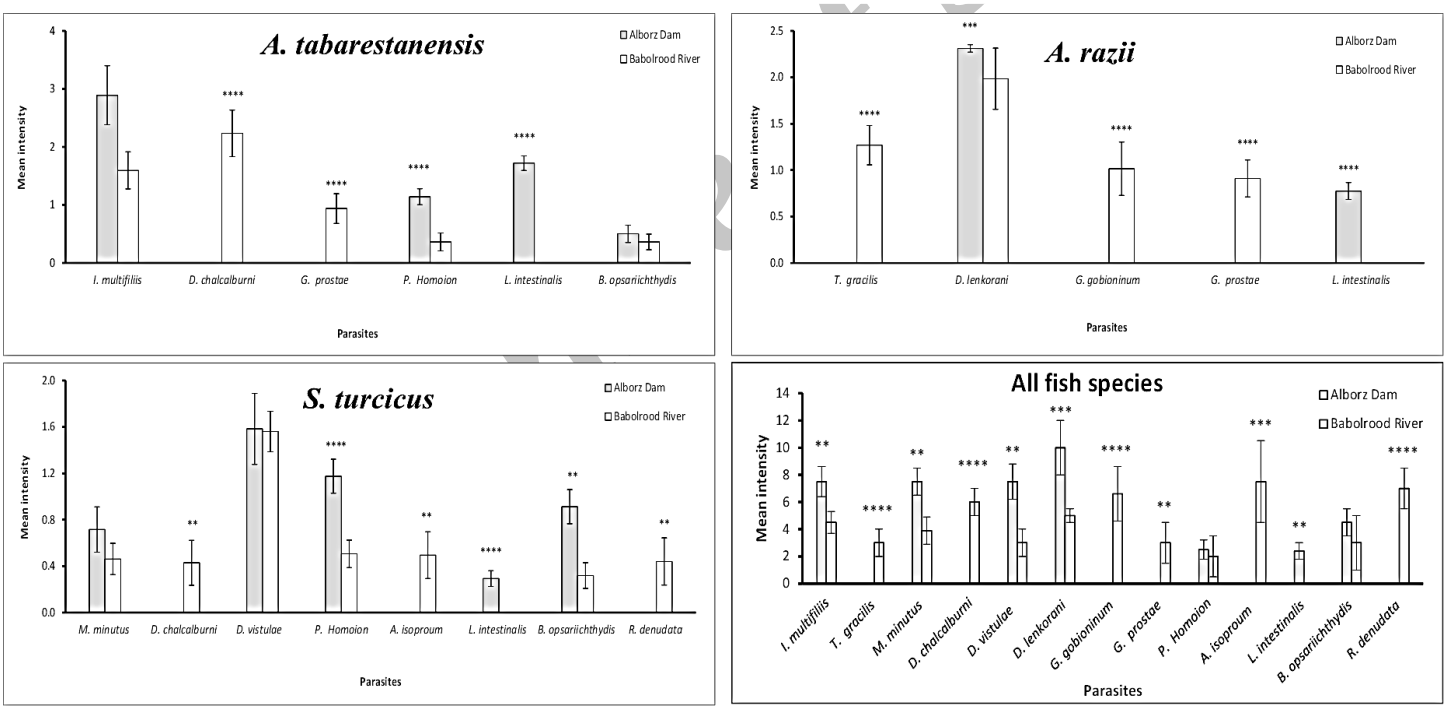

Figure 3. Mean intensity of fish parasite in different fish species from the Babol River and Alborz dam in the southern Caspian Sea basin in Mazandaran Province. Asterisks show significant difference between the Alborz Dam and Babol River. ** P<0.01; *** P<0.001; **** P<0.0001.

among the fish species and between the Babol River and Alborz Dam. Overall, mean intensity of *I. multifiliis*, *M. minutus*, *D. vistulae*, *D. lenkorani* and *L. intestinalis* in the tested fish from the Alborz Dam was significantly higher than those of Babol River. However, *T. gracilis*, *D. chalcalburni*, *G. gobioninum*, *G. prostate*, *A. isoproum* and *R. denudate* in the tested fish from the Alborz Dam was significantly lower than those of Babol River.

Discussion

Only eight parasite species were isolated from the fishes in the Alborz Dam, of which seven species, including *I. multifiliis*, *M. minutus*, *D. chalcalburni*,

D. vistulae, *D, lenkorani*, *P. homoion* and *B. opsariichthydis*, are similar to those of Babol River. Miar et al. (2008) found similar results during their investigation on parasitic fauna of fish in the Valasht Lake and the Chaloos River. Based on their result, of 12 parasite species only three were isolated from the fish of the Valasht Lake. The Alborz Dam is a newly constructed and therefore the fish-parasite system in this reservoir is not completely formed and mainly influenced by the parasitic fauna of the River (Iziumova, 1987).

The plerocercoids of *L. intestinalis* are of the most common parasites among examined fish which found only in the Alborz Dam. All the conditions for the incidence of Ligulose, including the high density of cyclops as the first intermediate host, the extensive presence of host fish species that feed on the cyclops as their preferred diet, and the fish-eating birds as definitive host are available in standing water of lakes and reservoir of dams (Jalali, 1998). In Iran, *L. intestinalis* has been reported from almost all dam reservoirs and lakes (Rouhani, 1998; Yousefi et al., 2005; Barzegar and Jalali, 2005; Jalali and Barzegar, 2006; Mohammadi Hefzabad and Ghare-Daghi, 2012). In the present study the prevalence rate of infection in *C. capoeta* and *S. cephalus* were 33% and 10% respectively, while the highest infection was observed in *A. tabarestanensis* (81%). An important aspect of the damage of *l. intestinalis* infestation is its effect on fish reproduction. The size of gonads even slightly infested fish is always smaller and participation in reproduction always ceases, which ultimately leads to a decrease in fish host populations (Parsa Khanghah et al., 2011). Besides direct losses caused by mortality, their presence may also reduce marketability of fish (Sac et al., 2016). This issue is important in commercially valuable fish and may cause great economic losses. Yousefi et al. (2005) recorded the occurrence of *L. intestinalis* in abdominal cavity of *R. kutum* with the prevalence rate of 100% in the Aras Dam.

Bothriocephalus acheilognathi was isolated from *A. tabarestanensis* and *S. turcicus* from both Babol River and Alborz Dam. This parasite has spread throughout the world and grass carp and common carp are the hosts of this parasite (Xi et al., 2016). This parasite commonly infects native and endemic fish species in Iran. *Bothriocephalus acheilognathi* can cause massive fish kills in cultivated fish. However, it is a pathogen in the fish from natural environments (Salgado-Maldonado and Pineda-Lopez, 2003). This is the first report of *B. acheilognathi* in the intestine of *A. tabarestanensis* in Iran.

The protozoan *I. multifiliis* was found on the skin of *A. tabarestanensis* in the Babol River and the Alborz Dam. Ichthyophthiriasis is recognized as one of the most pathogenic protozoan of fish resulting in significant economic losses in the affected fish (Jalali, 1998) and has been reported from many Iranian fish species (Pazooki et al., 2006; Jalali, 1998; Raissy et al., 2010). High infection rate with this parasite will have negative effect on fish population, a phenomenon that may occur in the Alborz Dam. Wurtsbaugh and Tapia (1988) reported a mass mortality of fish in the Lake Titicaca associated with an epizootic of the protozoan parasite, *I. multifiliis.*

During the present study, adult stage of *A. isoporum* was found in the intestine of *S. turcicus*. Digeneans are heteroxenous, which means that they require more than one host to complete their life cycle and fish may also be infected by the metacercarial larval or adult stages (Paperna, 1964). Of course adult intestinal trematodes are normally considered unable to cause disease unless at high number (Paperna, 1964).

Among the groups of parasites found in this study, monogeneans presented the highest number of species. Six species of monogeneans were found in the fish with *D. lenkorani* as the most abundant one. It is likely that fish protozoan and metazoan parasites, which are not dependent on an intermediate host, will be presented in their hosts. Their intensity may suddenly increase particularly when the hosts are under high stocking density (Lom and Hoffman, 1964). In the present study *C. razii* and *A. tabarestanensis* were introduced as a new host for *P. homoion* in Iran.

Despite low number of the parasite species, the

prevalence and mean intensity parasite infection in the Alborz Dam is far more than Babol River. In most cases, the construction of a dam results in changes in fish biodiversity and stock abundance. Usually, the number of migrating fish species and fast flowing water species decline while stocks of pelagic species and species that prefer slow moving water such as *A. tabarestanensis C. razii* and *S. turcicus* (i.e. pre-adapted to lacustrine conditions) increase. The impounded waters have often been managed by introducing species better adapted to lacustrine environments to develop fishery activities. The high fish density in lakes and reservoirs along with other conditions including fairly constant environmental conditions, increase the chance of meeting the free living stages of parasites with their hosts and develop the outbreak of protozoan and metazoan parasites.

In conclusion, both rapid and gradual changes of the environment can modify host immune responses, parasite communities and the specificity of their interactions so continuing such studies are powerful tools to understanding of how biotic and abiotic factors affect fish species and their parasite communities.

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چکیده فارسی

بررسی مقایسه‌ای جمعیت انگلی برخی ماهیان بومی رودخانه بابلرود و سد البرز در جنوب شرقی حوضه آبریز دریای خزر در استان مازندران

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چکیده:
بابلرود یکی از پر آب‌ترین رودخانه‌های جنوب‌شرقی حوضه آبریز دریای خزر در استان مازندران بوده و سد البرز در امتداد این رودخانه به‌منظور فراهم آوردن آب مورد نیاز جهت آبیاری و حفاظت مناطق در برابر خطر سیل احداث شده است. هدف اصلی این تحقیق شناسایی و تشریح میزان شیوع و شدت آلودگی به انگل‌های تک یاخته و پریاخته برخی ماهیان بومی بابلرود و سد البرز و مقایسه انگل‌های ماهیان مذکور است. تحقیقات میدانی در طی سال ۱۳۹۶ انجام شده و تقریباً ۵۴۶ نمونه ماهی متعلق به خانواده کپورماهیان شامل ماهی خیاطه طبرستانی، سیاه‌ماهی رازی و سفید رودخانه‌ای مورد بررسی انگل‌شناسی قرار گرفتند. در مجموع ۱۳ گونه انگل شامل *Ichthyophthirius multifili*، *Trichodina gracilis*، *Myxobulus minutus*، *Dactylogyrus chalcalburni*، *D. vistulae*، *D.* lenkorani، Gyrodactylus gobioninum، *G. prostate*، *Paradiplozoon homoion*، *Allocreadium isoproum*، *Rhabdochona denudatai*، *Ligula intestinalis* و *Bothriocephalus opsariichthydis* از اندام‌های مختلف ماهیان مورد بررسی جدا شدند. نتایج نشان می‌دهد که سیستم انگل-میزبان در دریاچه سد البرز اساساً متأثر از فون انگلی رودخانه بابلرود است. تنها استثناء در این زمینه پلروسرکوئید لیگولا اینتستینالیس است که یکی از فراوانترین گونه‌های انگلی در دریاچه سد البرز بوده و در محوطه شکمی تمامی ماهیان مورد بررسی یافت شد. این در حالی است که درصد شیوع و شدت آلودگی به گونه‌های مختلف انگلی در دریاچه سد البرز به مراتب بیشتر از بابلرود است. علاوه بر این، بررسی حاضر اولین گزارش حضور تریکودینا گراسیلیس از آبشش و پوست سیاه ماهی در ایران است.

کلمات کلیدی: دریای خزر، انگل ماهی، بابلرود، سد البرز.