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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Composition and structure of parasite communities in white bream *Blicca bjoerkna* from Lake Büyük Akgöl, Sakarya-Turkey

Sakarya Büyük Akgöl'den tahta balığı *Blicca bjoerkna'*da parazit komünitenin kompozisyon ve yapısı

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Abstract: No data on the parasites of *Blicca bjoerkna* have been reported to date from Lake Büyük Akgöl. Therefore, the current study aimed to investigate the composition and diversity of parasite component and infra-communities in this cyprinid fish from hypereutrophic Lake Büyük Akgöl. A total of 61 *B. bjoerkna* were examined between July 2016 and June 2017. All fishes were hosts to at least one parasite species from the following taxa: *Trichodina* sp., *Epistylis* sp. (Protozoa); *Myxobolus* sp. (Myxozoa); *Dactylogyrus sphyrna, D. cornu, D. cornoides, D. distinguendus* and *Paradiplozoon homoion* (Monogenea); *Caryophyllaeus laticeps* and Cestoda gen. sp. (Cestoidea); *Diplostomum* sp., *Thylodelphys clavata* and *Posthodiplostomum cuticola* (Digenea); *Piscicola geometra* (Hirudinea); *Glochidium* sp. (Mollusca) and *Argulus foliaceus* (Crustacea). Dominant species in the component community were *Diplostomum* sp., *D. cornoides,* and *D. cornu*. Totally 2063 metazoan parasite individuals were collected. Parasite infra-communities of *B. bjoerkna* infected 1-10 species and the mean species richness found was 5.3. The mean metazoan parasite diversity (Shannon's H index) was 2.08 and the Shannon-Wiener Evenness (E) had a mean value of 0.81. Identified parasite species in *B.bjoerkna* were the first records from Lake Büyük Akgöl.

Keywords: *Parasite communities, Blicca bjoerkna, Lake Büyük Akgöl*

Öz: Bugüne kadar Büyük Akgöl'den *Blicca bjoerkna*'da bulunan parazitler hakkında herhangi bir veri bildirilmemiştir. Bu nedenle çalışmamız, hiperöytrofik karakterdeki Büyük Akgöl'de yaşayan bu cyprinid balığın parazit component ve infra-komünitesinin kompozisyon ve çeşitliliğinin araştırılmasını amaçlamış ve Temmuz 2016 ile Haziran 2017 arasında toplam 61 *B. bjoerkna* ile çalışılmıştır. Tüm balıklar aşağıda belirtilen taksonlardan en az bir parazit türüne konak olmuştur: *Trichodina* sp., *Epistylis* sp. (Protozoa); *Myxobolus* sp. (Myxozoa); *Dactylogyrus sphyrna, D. cornu, D. cornoides, D. distinguendus* ve *Paradiplozoon homoion* (Monogenea); *Caryophyllaeus laticeps* ve Cestoda gen. sp. (Cestoidea); *Diplostomum* sp., *Thylodelphys clavata* ve *Posthodiplostomum cuticola* (Digenea); *Piscicola geometra* (Hirudinea); *Glochidium* sp. (Mollusca) ve *Argulus foliaceus* (Crustacea). Komponent komünitedeki baskın türler *Diplostomum* sp., *D. cornoides* ve *D. cornu* olarak belirlenmiş ve toplam olarak 2063 adet çok hücreli parazit bireyi toplanmıştır. *B. bjoerkna*'nın parazit infra komunitesinin 1-10 tür tarafından enfekte edildiği ve ortalama tür zenginliğinin 5.3 olduğu belirlenmiştir. Çok hücreli parazit ortalama çeşitliliği (Shannon's H index) 2.08 ve Shannon-Wiener Evenness (E) ortalama değeri 0.81 olarak bulunmuştur. *B.bjoerkna*'da teşhis edilen parazit türleri Büyük Akgöl için ilk kayıtlardır.

Anahtar kelimeler: *Parazit komünite, Blicca bjoerkna, Büyük Akgöl*

INTRODUCTION

Lake Büyük Akgöl is considered hypereutrophic due to high nutrient input from domestic sources and agricultural activities (Şahin et al., 2013). During the summer months, the entire lake area is covered by sixteen species of submerged, floating and emergent macrophytes associated with excessive blooms of planktonic algae (Altınsaçlı et al., 2013). This shallow lake with a mean depth of 1.5 m is located in the north-west region of Turkey. Fish species examined in the current study *Blicca bjoerkna* is a European species of freshwater fish of the family Cyprinidae. White bream was zoogeographically introduced into Turkey from the Western Thrace region, and it spreads widely in inland waters and lagoons of Marmara and Black Sea regions in Turkey (Geldiay and Balık, 1988). *B. bjoerkna* are exclusively bottom feeders and their diet depends largely on benthic invertebrates and insect larvae. There are some papers on parasites of *B. bjoerkna* in Turkey (Akıncı,1999; Öztürk, 2001; Soylu, 2006, 2012; Selver, 2010; Akmirza and Yardımcı, 2014). The description of the composition and structure of the fish parasite communities was based on species richness and diversity. Diversity is one of the most important community attributes, and measured using both species richness and species evenness. Species richness is the simplest measure of

diversity and does not consider whether abundances are evenly distributed among species (Krebs, 1999; Stirling and Wilsey, 2001). Therefore relative abundance of each parasite species or species evenness is a key component of the structure of any parasite community (Poulin, 1996). Index of dominance is another diversity indice and use to assess the magnitude of the numerical supremacy of the top-ranked species in the parasite community (Poulin et al., 2008). In the present study we calculated species richness, Shannon-Wiener Index, Shannon-Wiener Evenness and Simpson's Diversity as some diversity indices to determine composition and structure of parasite community of *B. bjoerkna*.

This study represents the first investigation of parasite fauna of white bream from Lake Büyük Akgöl.

MATERIALS AND METHODS

Study area

Lake Büyük Akgöl is located in Western Black Sea Region of Turkey (41º02'52.97"N and 30º33'49.61"E), at an altitude of 58 m above sea level. Büyük Akgöl is a freshwater lake of a eutrophic character and with a mean depth of 1.5 m, maximum depth of 5 m and surface area of 3.5 km^2 (Altınsaçlı et al., 2013). Mean annual surface water temperature in the lake is 16.5^{0}C and varied from 0^{0}C in January to 27.1^{0}C in August during the present study. The Lake fed by underground and rain water, in spring months excess lake water is discharged by a small chanel to Sakarya River (Altınsaçlı et al., 2014).

Fish sampling and parasitological analysis

A total of 61 white bream *B. bjoerkna* specimens (20 males and 41 females) were examined between July 2016 and June 2017. They had a mean (± SD) total length of 21.0 ± 2.8 cm (range 15.9–28.3 cm) and a mean (± SD) weight of 111.1 ± 48.4 g (range 48.6–178.9 g). Fish were caught using gillnets with a knot to knot mesh size of 10, 20 and 30 mm. Nets were 50 m long with a 1.5 m hanging depth and cast net. The fish were transported to the laboratory alive, anesthetized with 100 mg/l buffered Tricaine Methane Sulfonate (MS-222), weighed and measured. The sex of each individual was determined by visual and microscopic examination of the gonads. The fish were necropsied as soon as possible; the external surfaces of the body, gills, eyes and internal organs were examined separately.

Wet smears of skin and gills were prepared and examined in order to detect the presence of protozoan parasites. Monogenean parasites were removed and placed on a slide with ammonium picrate-glycerine or lactophenol and covered with a cover-glass, and flat mounts were prepared. Trematode and cestode specimens were identified alive or fixed in 70% alcohol. Parasites were stained in acetocarmine, dehydrated through an alcohol series, cleared in dimethyl phthalate and examined as permanent mounts in Canada balsam. Most of these parasite specimens were slightly flattened before fixation. Crustacean parasites were cleared in lactophenol and mounted in Canada balsam. Slides were studied with a microscope at 40x and 100x magnification.

Statistical analysis

The prevalence, mean intensity and abundance of the parasite species were determined as defined by Bush et al., (1997). Kruskal Wallis H Test were used to compare species richness and parasite effect on fish condition factor. Mann Whitney U Test was used to compare differences in mean number of parasite species between male and female fish. The following indices were used to characterise the parasite communities: the Berger-Parker dominance index, $d=n_{max}/N$; the Shannon-Wiener species diversity index, $H'=-\Sigma(pi \times \ln pi)$; the Simpson index, $D=\Sigma ni(ni-1)/N(N-1)$; an index of evenness = H/H_{max}. Parasites recovered were fixed and preserved according to Bylund et al., (1980). Parasite species were identified according to Lom and Dykova (1992), Niewiadomska (2003), Pugachev et al., (2010) and Bykhovskaya-Pavlovskaya et al., (1962).

RESULTS

A total of 61 *Blicca bjoerkna* specimens were examined; all of the fish hosts were parasitised by at least one parasite species and a total of 2063 individuals of metazoan parasites were collected in or on the fish hosts. Totally 16 parasite species were identified from the following taxa; *Trichodina* sp., *Epistylis* sp. (Protozoa); *Myxobolus* sp. (Myxozoa); *Dactylogyrus sphyrna, D. cornu, D.cornoides, D. distinguendus* and *Paradiplozoon homoion* (Monogenea); *Caryophyllaeus laticeps* and Cestoda gen. sp. (Cestoidea); *Diplostomum* sp., *Thylodelphys clavata* and *Posthodiplostomum cuticola* (Digenea); *Piscicola geometra* (Hirudinea); *Glochidium* sp. (Mollusca) and *Argulus foliaceus* (Crustacea), (Figs. 2-7). The infra-communities consisted of 1–10 parasite species, overall, 3.3% were parasitised by one species, 6.6% by two, 26.2% by five parasite species (Figure 1).

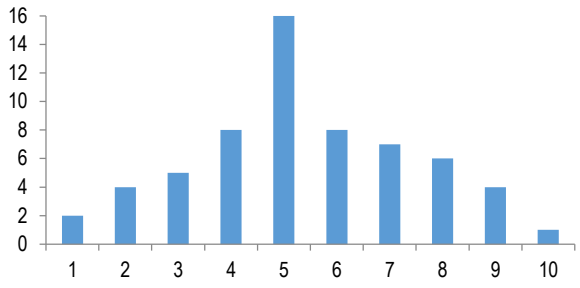

Figure 1. Frequency distribution of the number of parasite species in *Blicca bjoerkna* from Lake Büyük Akgöl

Dominant species in the component communities were *Diplostomum* sp., *D. cornoides,* and *D. cornu*. The most prevalent parasites were *Diplostomum* sp. (78.7%), *D. cornoides* (68.9%), *D. cornu* (67.2%) and *D. sphyrna* (63.9%). The epidemiological parameters of infection by parasites of *B. bjoerkna* are given in (Table 1).

Table 1. Infection parameters of *Blicca bjoerkna* from Lake Büyük Akgöl (n=61)

Parasite	IFN	Prevalence (%)	TPN	MI± SD	MA± SD	Min- max	Site of Infection
Trichodina sp.	9	14.8	-	-	-	-	Skin
Epistylis sp.	1	1.6	-	-	-	-	Skin
Myxobulus sp.	22	36.1	-	-	-	-	Gill
Dactylogyrus sphyrna	39	63.9	206	5.3 ± 3.04	3.5 ± 3,52	1-12	"
Dactylogyrus cornu	41	67.2	262	6.4 ± 4.02	4.46 ± 3.52	1-17	"
Dactylogyrus cornoides	42	68.9	479	11.4 ± 5.31	7.9 ± 6.90	1-25	"
Dactylogyrus distinguendus	12	19.7	41	3.4 ± 2.31	0.7 ± 1.69	1-7	"
Paradiplozoon homoion	21	34.4	146	7.0 ± 5.78	2.4 ± 4.72	1-24	"
Caryophyllaeus laticeps	24	39.3	226	9.4 ± 10.65	3.7 ± 8.06	1-37	Intestine
Cestoda gen. sp.	3	4.9	7	2.3 ± 1.53	0.1 ± 0.58	2-3	"
Diplostomum sp.	48	78.7	422	8.8 ± 9.50	6.9 ± 9.16	1-57	Lens of eye
Tylodelphys clavata	4	6.6	12	3.0 ± 2.16	0.2 ± 0.89	1-6	Vitreous humor
Posthodiplostomum cuticola	27	44.3	160	5.9 ± 5.33	2.6 ± 0.89	1-26	Skin
Piscicola geometra	3	4.9	6	2.0 ± 1.0	0.1 ± 0.47	1-3	"
Glochidium sp.	13	21.3	94	7.2 ± 7.43	1.5 ± 4.47	1-25	Gill-Skin
Argulus foliaceus	2	3.3	2	1.0 ± 0	0.03 ± 0.18	1	Gill

IFN: Infected Fish Number; TPN: Total Parasite Number; MI: Mean Intensity; MA: Mean Abundance

The highest dominance index of the metazoan parasites was recorded for *D. cornoides* (23.2%), and the lowest for *A. foliaceus* (0.1%); the dominance index (D) values of the parasite species are given in (Table 2).

Table 2. Dominance index of the metazoan parasites in *Blicca bjoerkna* from Lake Büyük Akgöl

Parasite Species	Dominance index D (%)
Dactylogyrus sphyrna	10.0
Dactylogyrus cornu	12.7
Dactylogyrus cornoides	23.2
Dactylogyrus distinguendus	2.0
Paradiplozoon homoion	7.1
Caryophyllaeus laticeps	11.0
Cestoda gen. sp.	0.3
Diplostomum sp.	20.5
Tylodelphys clavata	0.6
Posthodiplostomum cuticola	7.7
Piscicola geometra	0.3
Glochidium sp.	4.5
Argulus foliaceus	0.1

The mean parasite diversity (Shannon's H index) was 2.08 and the Shannon-Wiener Evenness (E) had a mean value of 0.81. Diversity indices of the parasite community of *Blicca bjoerkna* from Lake Büyük Akgöl are given in (Table 3). The mean number of parasite species richness per host individual (mean infracommunity richness) found was 5.3 and this value increased from 5 in (15.0-16.9 cm) size class to 6.2 in 23.0 cm > size class and no significant differences were found (Kruskal Wallis *H test* $p > 0.05$). Also, the mean numbers of parasite species in male and female fish hosts were found to be 4.4 and 5.8 respectively with significant differences observed (Mann-Whitney U test $p < 0.05$). The condition factor from each size group was computed to analyse the influence of the parasites on fish condition and no significant differences were found (Kruskal Wallis *H test* $p > 0.05$). Higher prevalence and mean intensity for *Dactylogyrus cornu* and *D. cornoides* were found in March and April whereas *D. sphyrna* reached high prevalence and mean intensity in February. Distribution of other most prevalent parasite *Diplostomum* sp. was highly homogenous. Monthly prevalence and mean intensity of the parasites are given in (Table 4).

Table 3. Diversity indices of the metazoan parasites of *Blicca bjoerkna* in Lake Büyük Akgöl

Diversity Indices	
Number of white bream	61
Number of metazoan taxa	13
Species richness	16
Shannon-Wiener Index	2.08
Shannon-Wiener Evenness	0.81
Simpson's Diversity	0.85
Dominant taxon	*Dactylogyrus cornoides*

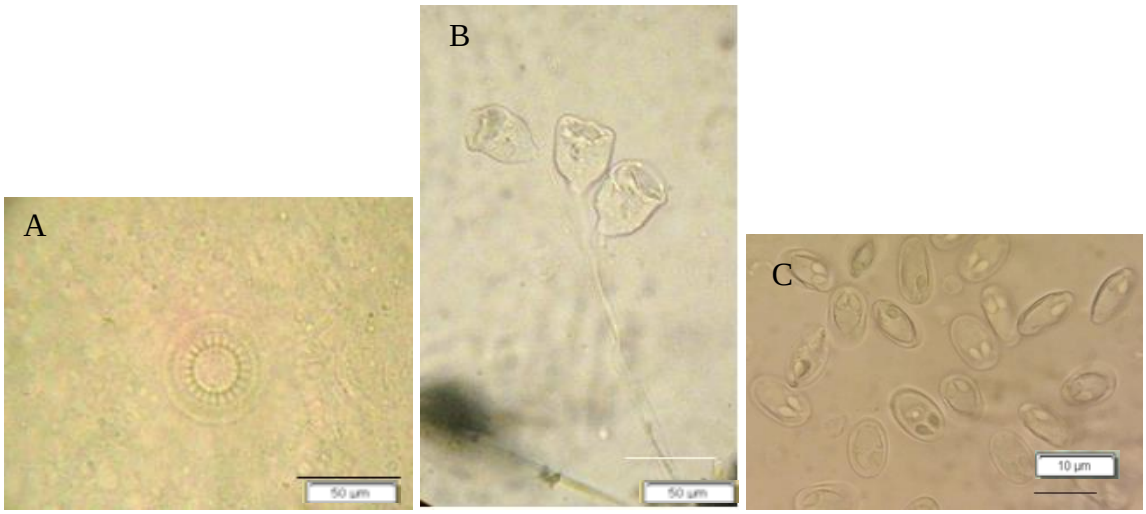

Figure 2. A. *Trichodina* sp., B. *Epistylis* sp., C. *Myxobolus* sp.

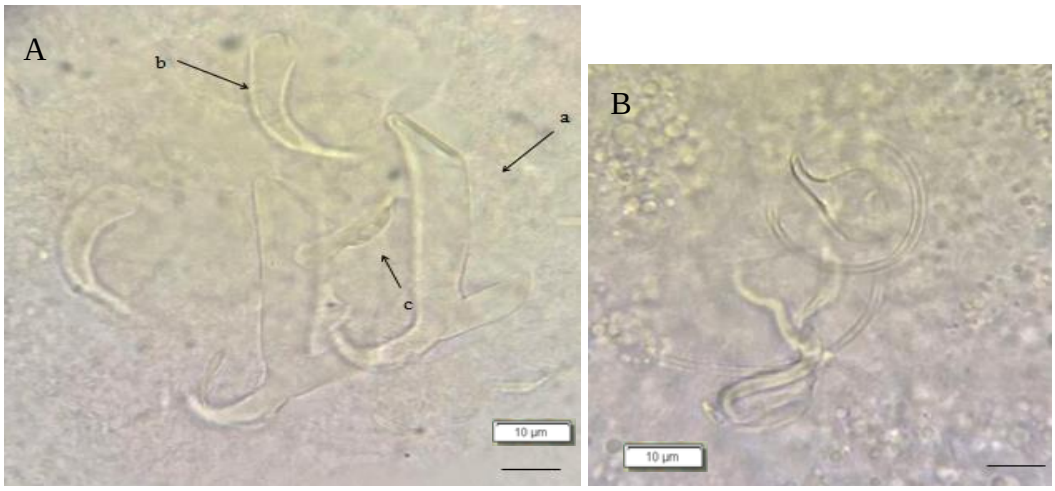

Figure 3. *Dactylogyrus sphyrna* A. haptor, a. anchor b. third pair of marginal hook c. bar, B. copulatory organ

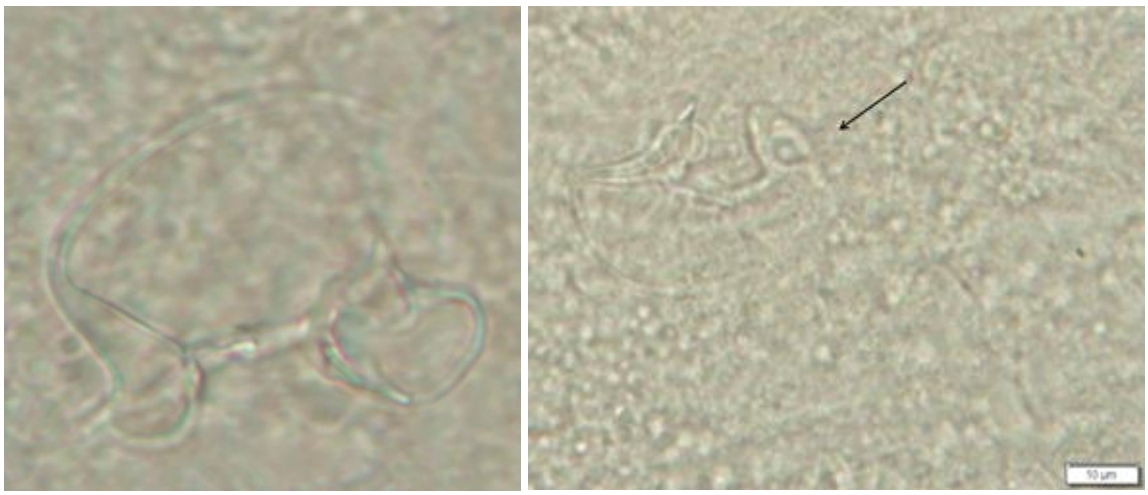

Figure 4. A. *Dactylogyrus cornu*, B. *Dactylogyrus cornoides* copulatory organs

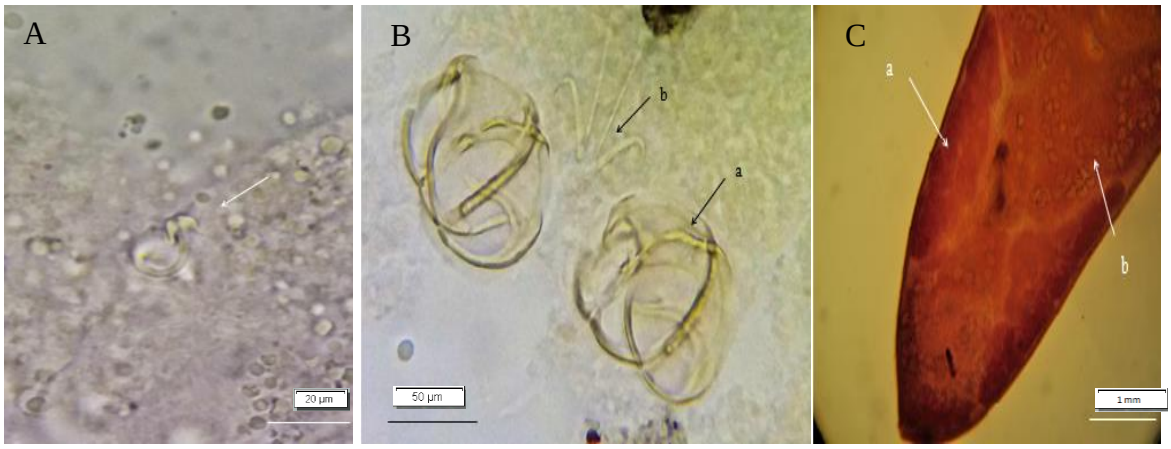

Figure 5. A. *Dactylogyrus distinguendus* vaginal tube, B. *Paradiplozoon homoion* a. clamp b. anchors. C. *Caryophyllaeus laticeps* a. ovary b. vitelline follicles.

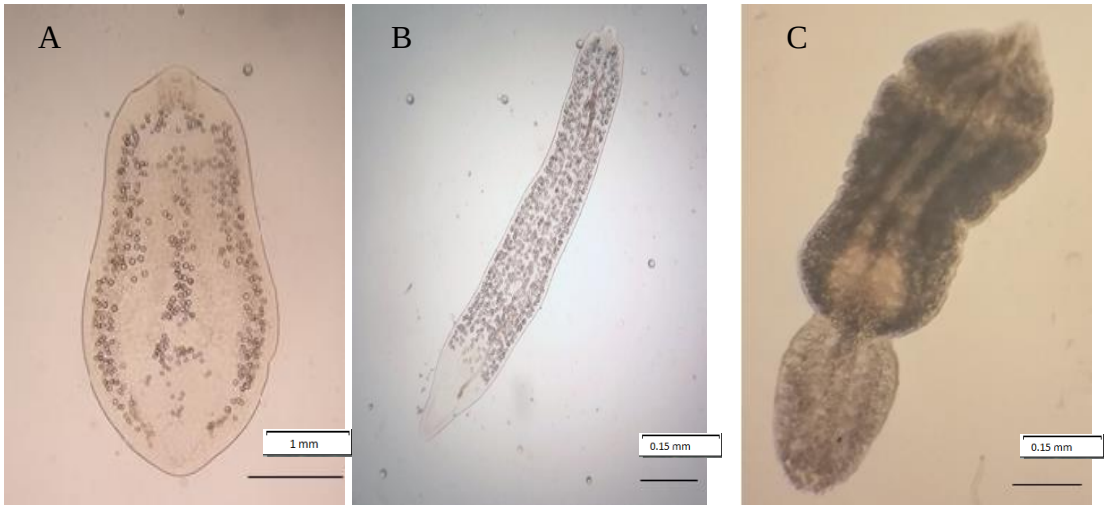

Figure 6. A. *Diplostomum* sp., B. *Thylodelphys clavata*, C. *Posthodiplostomum cuticola*

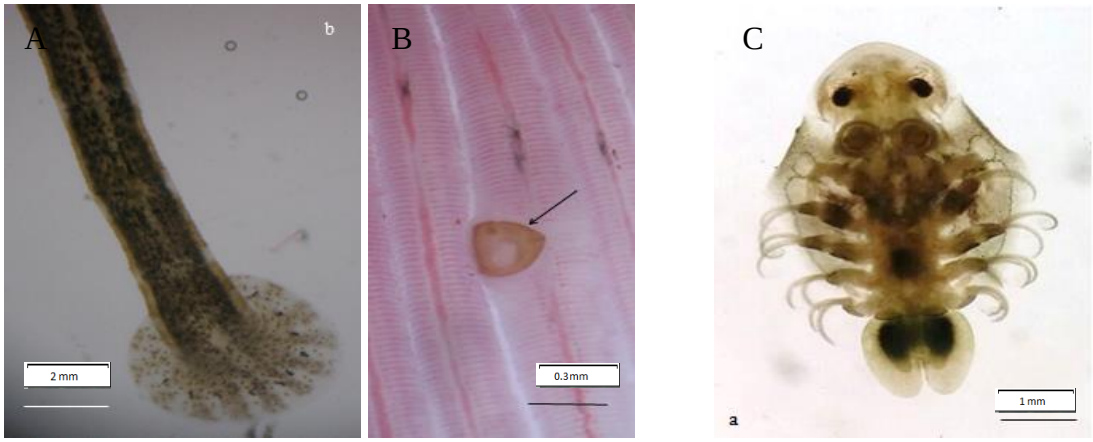

Figure 7. A. *Piscicola geometra* posterior end, B. *Glochidium* sp., C. *Argulus foliaceus*

Table 4. Monthly prevalence and mean intensity of the parasites in *Blicca bjoerkna* from Lake Büyük Akgöl

Parasite Species	December		February		March		April		May		June	
	P (%)	MI	P (%)	MI	P (%)	MI	P (%)	MI	P (%)	MI	P (%)	MI
D.sphyrna	25	2	84.7	6.8	73.9	3.4	44.4	7.5	25	8.5	100	6.5
D.cornu			53.8	7.4	73.9	5.5	88.9	10.9	62.5	4.4	100	4
D.cornoides			69.2	9.5	69.5	10.1	88.9	8.1	50	9.5	100	10
D.distinguendus			7.7	3	34.8	3	22.2	6				
Paradiplozoon homoion							44.4	5.7	100	9.9		
Caryophyllaeus laticeps			46.1	2.5	65.2	11	66.7	9.8				
Cestoda gen. sp.							11.1	2	25	2.5		
Diplostomum sp.	100	15.2	69.2	10.2	100	6.2	88.9	15	75	5.3	100	16
Tylodelpyhs clavata	100	3.3	7.7	1	4.3	1						
Posthodiplostomum cuticola			38.5	3.6	65.2	5	55.5	11.4	11.1	4.0	75	5
Pisciola geometra			7.7	1								
Glochidium sp.	50	3	7.7	5			88.9	11.3	75	6.3		
Argulus foliaceus											25	2

P: Prevalence; MI: Mean Intensity

DISCUSSION

The *present paper* is a *first-time study* of *parasites communities infecting B. bjoerkna* from Lake Büyük Akgöl. When the water level is high at the end of winter, the Lake is connected by a canal to Sakarya River. On the other hand nearby Lake Sapanca, during spring months release excess water into Sakarya River. Soylu (1991, 2006) recorded *D. cornu*, *D. cornoides*, *D. sphyrna*, *D. distinguendus*, *Bothriocephalus acheilognathi*, *Aspidogaster limacoides*, *Asymphylodora imitans*, *Tetracotyl* sp., *Diplostomum* sp., *Tylodelphys clavata*, *Posthodiplostomum cuticola* and *Glochidium* sp. in *B. bjoerkna* from oligotrophic Lake Sapanca. Akmirza and Yardımcı (2014) found *Trichodina* sp., *Paradiplozoon homoion*, *Allocreadium lobatum*, *Caryophyllaeus laticeps* and *Glochidium* sp. in *B. bjoerkna* from Sakarya River. Naturally, there are similarities between parasite communities of *B. bjoerkna* from these three related aquatic environments. But there are also some differences, in Lake Büyük Akgöl, no intestinal digeneans, acanthocephalan and nematodes were found in *B. bjoerkna*, despite this fish infected by three intestinal digeneans in Lake Sapanca. A parasitological survey conducted in Kocadere Stream, Bursa on *B. bjoerkna* by Selver et al. (2010) and five parasite species identified. The overall prevalence of parasitic infection in this lotic environment were *Dactylogyrus sphyrna* 24.2%, *D. distinguendus* 30.8%, *Diplostomum spathaceum* 95.8%, *C. laticeps* 2.5% and *Eustronglydes* sp. 8.3%. Similar parasitological investigation on *B. bjoerkna* performed in Anzali Lagoon, Caspian Sea Iran by Pazooki et al. (2011) and 11 parasite species found. Identical parasite species from Anzali with our study and their overall prevalence are *Trichodina perforate* 53.9%, *Myxobolus musayevi* 27.2%, *D. sphyrna* 5.2%, *D. spathaceum* 98.7% and *P. cuticola* 15.4%. In Anzali Lagoon only one and in Kocadere Stream two monogenean species recorded, however in the present study five monogenean species identified. *D. sphyrna* has highest prevalence in our study with 63.9%. In three studies *Diplostomum* recorded in high percentage. Differently than these two studies we could not find nematodes. According to Wisniewski (1958) character of a water body, especially its trophic status influenced and determined composition of parasite species. Toxic pollutants were effective on the free-living stage of parasites and reduced their infectivity and longevity of cercariae. Parasites with indirect life cycles are linked more tightly to the presence of intermediate hosts. The prevalence of digeneans in their intermediate and definitive hosts is inversely related to the degree of pollution and disturbance of aquatic ecosystems (Sures et al., 2017). The species composition of parasite communities is clearly impacted by environmental stress and species richness tends to decrease under degraded conditions (Marcoglies, 2005). Absence of *intestinal* digenean, acanthocephalan and nematodes in the present study is connected to heavy polluted conditions of the lake. During summer and autumn months accompanied by hypereutrophy and minimum water level, dissolved oxygen measured at bottom and surface of the lake were 0.17 and 0.93 mg/l respectively (Şengörür and Demirel, 2002). Drainage waters that flow from irrigated fields bring fertilizers and pesticides into the lake.

The most common elements of zoobenthic biomass were three dominant taxa: Gastropoda, Chironomidae, and Oligochaeta (Aras, 2011). *Viviparus viviparus*, *Lynnea stagnalis*, *Borysthenia naticina* and *Planorbarius corneus* are dominant gastropod species as intermediate host of digeneans that has a wide range of tolerance to different environmental conditions. But two pulmonats; *Gyraulus* sp., and *Radix labiata* (bioindicator species for pollution) were very scarce. *Caryophyllaeus laticeps* was one of the most prevalent parasites in *Blicca bjoerkna* and intermediate host *Potamothrix hammoniensis* is dominant oligochaet in the lake benthos.

Aquatic tubificid oligochaetes known as the intermediate host of *C. laticeps* Mackiewicz (1994) is common on benthic fauna of Lake Büyük Akgöl and is pollution tolerant. *Proclaidus* sp., *Chironomus plumosus* and *C. tentans* are also dominant chironomids Aras (2011), that are tolerant organisms to pollution (Taşdemir et al., 2010). In Lake Büyük Akgöl, *annual mean* concentration of Pb, Cu, Cr and Cd *exceeded* the alert *limit* (Aras, 2011). Monogeneans were the most abundant species in parasite component communities of *B. bjoerkna.* Dzika (2003) specified that the structure of a parasite community, where monogeneans are a dominant component, indicates a high eutrophication. Koskivaara (1992) found the highest density of *Dactylogyrus* parasites in the most eutrophied and polluted Vatia Lake. In the current study, the lowest mean abundance value of glochidium sp. (1.5 individual per fish) was associated with distorted lake conditions. Anthropogenic disturbances, including pollution are the major factors driving changes in *freshwater mussels* and listed as threatened or endangered species in some countries (Keller and Zam, 1991; Nobles and Zhang, 2015). Many mussel species are relatively intolerant of elevated nutrient and toxin concentrations, especially during their larval and juvenile life stages (Valenti et al., 2006).

In conclusion, Monogenea were the most common parasitic group encountered with 16 species found. Identified parasite species of *B.bjoerkna* and their intermediate hosts are pollution tolerant organisms. *Intestinal* digenean, acanthocephalan and nematodes were not found in *B. bjoerkna* from this heavily polluted lake.

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