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Occurrence of Caryophyllaeid parasite species (Plathelminthes) in chub, *Squalius cephalus*, of Serban Dam Lake, Turkey: including a new host and a new locality

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Abstract: An examination was conducted on caryophyllaeid cestode fauna of *Squalius cephalus* obtained from Serban Dam Lake in Turkey between February 2009 and August 2010. At the end of the study, from the 114 *S. cephalus* examined, 14 host fish specimens were infected with 75 *Caryophyllaeus brachycollis* (prevalence 12.3% and mean parasite intensity 5.3 ± 10.0 parasites/fish) and one host fish specimen was infected with 65 *Biacetabulum appendiculatum* (prevalence 0.9%, 65 parasites). Infection data of the parasite species were evaluated for seasons, host fish size, and sex. The period of the study covered the four seasons: spring, summer, fall, and winter. The infection values of *C. brachycollis* changed according to seasonal conditions, except for fall. Prevalence of infection and mean intensity of the species were maximum in spring. Host fish specimens were divided into four groups according to their size. The occurrence of *C. brachycollis* was recorded in III, V and VI groups. The highest infection prevalence and mean intensity were seen in age group VI. *C. brachycollis* was recorded in both male and female hosts, but the occurrence of parasites was higher in females. The other species, *Biacetabulum appendiculatum*, was found in only one host fish specimen that belonged to group V according to its size in spring. According to the results of this study, among these species, *Caryophyllaeus brachycollis* is observed for the first time in Turkey, and *Biacetabulum appendiculatum* is a new parasite species record for *S. cephalus* in Turkey. Thus, a new locality and a new host fish species have been added to the geographical invasions by the two caryophyllaeid species.

Key words: *Biacetabulum appendiculatum*, Cestodes, *Caryophyllaeus brachycollis*, new host record, *Squalius cephalus*

1. Introduction

Caryophyllaeid cestodes have been examined in Turkey, and a few species have been identified through these studies. Of the caryophyllaeid species, *Caryophyllaeus laticeps* was found on *C. carpio* in Karacaören Dam Lake (Kır et al., 2004), Lake Sapanca (Uzunay and Soylu, 2006), Lake Manyas (Öztürk and Altunel, 2006), and Lake Kovada (Kır and Tekin-Özan, 2007). The same parasite was recorded on *Tinca tinca* in Lake Beyşehir (Tekin-Özan et al., 2006), Lake Sapanca (Akbeniz and Soylu, 2008), and Lake Terkos (Demirtaş, 2011). The parasite species was also found on *Blicca bjoerkna* in Lake Manyas (Öztürk and Altunel, 2001), *Abramis brama* in Lake Terkos (Karatoy and Soylu, 2006), *Vimba vimba* in Gölbaşı Dam Lake (Aydoğdu et al., 2008), and *Blicca bjoerkna* in Kocadere Stream (Selver et al. 2010). Another caryophyllaeid species, *Caryophyllaeus fennicus*, was found on *Scardinius erythrophthalmus* in Lake Manyas (Öztürk and Altunel, 2001) and *Biacetabulum appendiculatum* was recorded on *Abramis brama* in Enne Dam Lake (Koyun, 2010). The most recent evaluation was conducted by Vilizzi et al. (2015).

The aim of the present study was to determine the caryophyllaeid cestode fauna of *Squalius cephalus* in Serban Dam Lake. It was also aimed to reveal the changes in the intensity and prevalence level of the parasite species related to season, age, and sex of the fish. During the study, three parasite species of the host fish were also found. The parasite species were reported previously (Açikel and Öztürk, 2012a, 2012b, 2013).

2. Materials and methods

Serban Dam Lake is located within the geographic borders of Afyonkarahisar Province's Sinanpaşa District at 38°38'43"N and 30°22'37"E. The dam lake was constructed in 1995 on the Serban Stream for irrigational purposes and flood prevention. It is at an altitude of 1285 m above sea level and has a surface area of ca. 3.1 km² (DSİ, 2004).

In total, 114 *S. cephalus* specimens were caught with trammel nets at depths from approximately 1 to 3 m between February 2009 and August 2010. The host fish specimens were placed in plastic tanks with local lake water and transferred to the research laboratory, where they were

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kept in an aquarium. They were examined within 24 h. Fork lengths of fish specimens were recorded, and then scale samples were examined and divided into four size groups (group III: 16.8–18.5 cm, group V: 21.1–22.3 cm, group VI: 23.1–25.3 cm, group VII: 28.2–28.3 cm), using the reference data given by Şaşı (2004). After the gallbladder was dispatched, the stomach and intestine were dissected and placed in separate petri dishes with physiological water. To determine the presence of parasites, all parts were thoroughly examined under a binocular microscope. Parasites that were found on the host fish were removed using a preparation needle. The parasite specimens were fixed in formaldehyde. They were stained with Mayer's hematoxylin and identified using the reference keys given by Khalil et al. (1994). During this process a light microscope with 100× and 400× magnification was used. The obtained parasitological data were evaluated by using the Quantitative Parasitology Software 3.0 (Rózsa et al., 2000) according to seasons, and length and sex of the host fish.

3. Results

Two caryophyllaeid cestode parasite species found in the intestine of the studied host fish specimens were recorded: *Caryophyllaeus brachycollis* Janiszweska, 1953 and *Biacetabulum appendiculatum* Szidat, 1937. Reaching a total number of 75, *C. brachycollis* was recorded with a mean number of 5.3 ± 10.0 parasites per fish. Its prevalence of infection was found to be 12.3% during the study period. The other parasite species, a total of 65

B. appendiculatum, was found only in one host fish, and the prevalence of infection was found to be 0.9%. Among these species, *C. brachycollis* is a new record for Turkey. In addition, *B. appendiculatum* is a new species for *S. cephalus* in Turkey also. The paratypical samples for the two species have been registered in the London Natural History Museum (*C. brachycollis*-NHMUK 2011.3.16.1, *B. appendiculatum*-NHMUK 2011.3.16.2).

The period of the study covered the four seasons: spring, summer, fall, and winter. From twenty-six to thirty-two fish specimens were taken during each season's sampling period. The occurrence of the infection values changed according to seasonal conditions (Table 1). Among the parasites, *C. brachycollis* appeared in high numbers as a rich community on the host fish in the study. It was observed during the spring, summer, and winter. Prevalence of infection and mean intensity were maximum in spring. The prevalence decreased from summer through winter, but there was no significant difference in this respect ($P > 0.05$).

Infection with *C. brachycollis* gradually decreased relative to fish size. It was absent in the largest fish. Both infection prevalence and mean parasite number were higher in the bigger fish specimens, group VI. However, there was no significant difference ($P > 0.05$). The other parasite species, *B. appendiculatum*, was found only in host fish size specimens (group V) in spring (Tables 1 and 2).

As seen in Table 3, maximum infection prevalence and mean intensity of *C. brachycollis* were recorded in females. The difference in mean number of the parasites was more

Table 1. Infection value of the parasite species according to season. Ifn: Infected fish number, %: Infection prevalence, M: Mean parasite number, SD: Standard deviation, Min.–max: Minimum–Maximum parasite number.

Seasons	Examined fish number	Infection parameters	<i>C. brachycollis</i>	<i>B. appendiculatum</i>
Spring	28	Ifn & (%)	8 (28.5)	1 (3.6)
		M & SD.	8.3 ± 12.7	65.0 ± 0.0
		Min.–max.	1–35	65–65
Summer	32	Ifn & (%)	3 (9.3)	-
		M & SD.	1.6 ± 0.6	-
		Min.–max.	1–4	-
Autumn	26	Ifn & (%)	-	-
		M & SD.	-	-
		Min.–max.	-	-
Winter	28	Ifn & (%)	3 (10.7)	-
		M & SD.	1.0 ± 0.0	-
		Min.–max.	1–1	-

Table 2. Infection value of the parasite species according to size groups of *L. cephalus*.

Fish size (cm) and age groups	Examined fish number	Infection parameters	<i>C. brachycollis</i>	<i>B. appendiculatum</i>
16.8–18.5 (III)	49	Ifn & (%)	6 (12.2)	-
		M & SD.	1.5 ± 0.5	-
		Min.–max.	1–2	-
21.1–22.3 (V)	58	Ifn & (%)	7 (12.1)	1 (1.7)
		M & SD.	6.4 ± 12.6	65.0 ± 0.0
		Min.–max.	1–35	65–65
23.1–25.3 (VI)	3	Ifn & (%)	1 (33.3)	-
		M & SD.	21.0 ± 0.0	-
		Min.–max.	21–21	-
28.2–28.3 (VII)	4	Ifn & (%)	-	-
		M & SD.	-	-
		Min.–max.	-	-

Table 3. Infection value of the parasite species according to sex groups of *L. cephalus*.

Fish sex groups	Examined fish number	Infection parameters	<i>C. brachycollis</i>	<i>B. appendiculatum</i>
Female	75	Ifn & (%)	10 (13.3)	1 (1.3)
		M & SD.	6.9 ± 11.6	65.0
		Min.–max.	1–35	65
Male	39	Ifn & (%)	4 (10.2)	-
		M & SD.	1.5 ± 0.5	-
		Min.–max.	1–2	-

significant than the percentage of parasites between the males and females. Similarly, the most abundant parasite number seen in a fish is higher for females. The other species, *B. appendiculatum*, was seen in only one female fish in spring.

4. Discussion

As Poulin (2007) stated, changing populations and local conditions are the most important factors in determining the helminth parasite fauna composition of freshwater localities. In line with this argument, as noted in the introduction, a few caryophyllaeid cestode species (*B. appendiculatum*, *Caryophyllaeus laticeps*, and *C. fennicus*) have been recorded in different localities of Turkey so far (Öztürk and Altunel, 2001; Kır et al., 2004; Uzunay and Soylu, 2006; Akbeniz and Soylu, 2008; Selver et al., 2010;

Demirtaş, 2011). However, *C. brachycollis* had not been seen in Turkey. The caryophyllaeid cestode parasite species was recorded for the first time in the intestine of the host fish species in the present study. Therefore, *C. brachycollis* is a new record for the parasite fauna in Turkey. The other caryophyllaeid species, *B. appendiculatum*, lives in fish of the families Cyprinidae and Catostomidae (Khalil et al., 1994). It was previously recorded in *Abramis brama* in Turkey (Selver et al., 2010). Furthermore, this is the first time that *B. appendiculatum* has been found in the intestine of *S. cephalus* in Turkey. Thus, at the end of the study, a new record and a new locality were added to the distribution of the two caryophyllaeid cestode parasite species in Turkey, which is located in the southeastern region of Europe.

Bertasso and Avenant-Oldewage (2005) reported that temperature has a significant effect on cestodes with a heteroxenous life cycle. Similarly, Kennedy (1969) recorded a prevalence for *C. laticeps* in *A. brama* of 18% in June and of 5% in September. Aydoğdu and Altunel (2002) found the maximum level density of *C. laticeps* to be 25 individuals in the spring period. The parasite infection encountered above completely disappeared in summer and fall. In parallel with the data above, the seasonal variation in *C. brachycollis* reveals that it provides one generation per year in the study period. After the major infection in spring, parasite density decreases in summer and autumn. However, the other species, *B. appendiculatum*, was recorded only in spring in the present study. It can be concluded that the nutrition type, and physical and chemical ecological properties of the geographic location are the main elements affecting parasite communities, as stated by Poulin (2007).

In the present study, *B. appendiculatum* was recorded in one of the host fish specimens, in fish size group V. The other cestode species, *C. brachycollis*, was acquired by younger fish rather than older fish. In addition, a positive correlation exists between the increase in intensity and the rate of infection by *C. brachycollis*, and the size of the host fish. Based on these data, it can be suggested that facts such as the size of the fish play a significant role in the increasing, decreasing, or disappearing of the infection by the parasite species (Tieri et al., 2006). Similarly, Öztürk and Altunel (2001) recorded *C. fennicus* infection in medium age (3+) *Scardinius erythrophthalmus* at maximum level. The special diet of the host fish specimens, preferring potential parasite intermediate hosts like amphipods and aquatic insect

larvae, seems to be the main reason for the low or high diversity of their helminth parasite community (Poulin, 2007). Khalil et al. (1994) focused on the fact that when the fish eat *Tubifex* with larval cestodes, they show infection in the host fish specimens. Geldiay and Balık (1999) support the aforementioned views, stating that *S. cephalus* when it is a finger fish eats phytoplankton; when it is young it eats organisms like insects and crustacea and finally when it becomes an adult it eats small fish specimens.

Kurupınar and Öztürk (2009) detected that *Caryophyllaeus* infection prevalence in *S. cephalus* was equal between the sexes. However, in the present study, infection incidences for both of the parasite species were higher in female host fish specimens. Kennedy (1969) explained that densities of parasitic infections change according to the sex and feeding of the fish, and listed some reasons for the host fish being infected by parasites. One of them is the variation in the hormonal balance of the fish during the spawning season. The second reason is that the female stays deeper much longer than the male, and so eats much more *Tubifex* found in the benthic fauna.

In conclusion, *Caryophyllaeus brachycollis* was found for the first time in Turkey, and *Biacetabulum appendiculatum* is a new parasite species record for *S. cephalus* in Turkey. Thus, a new locality and a new host fish species have been added to the geographical invasions by the two caryophyllaeid species. The data are particularly interesting given that so little is known about the geographical invasions by the two caryophyllaeid cestodes parasite species. In addition, this study determined the existence of the two caryophyllaeid species linked to seasonal changes and both the age and sex of the host fish.

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