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Investigation of Endohelminths in Some Fish Species Caught in the Dicle River and Keban Dam Lake

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Abstract: In this study, a total of 94 fish were used, including 10 *Acanthobrama marmid*, 17 *Capoeta trutta*, and 20 *Capoeta umbla* specimens, obtained from fishermen in the Dicle River and Keban Dam Lake in October 2021. It was found that 85 of the fish examined were infected. *Diplostomum spathaceum* was identified in the eye fluid, and *Neoechynorhynchus rutili* was identified in the intestines of the fish. A total of 2.846 parasites were found in the Dicle River, with 2109 *D. spathaceum* and 737 *N. rutili*, and the density, abundance, and prevalence of parasites were determined to be 66.18, 60.55, and 91.48, respectively. In Keban Dam Lake, a total of 2.846 parasites were detected, including 1.817 *D. spathaceum* and 737 *N. rutili*, and the density, abundance, and prevalence of the parasites were determined to be 54.80, 48.97, and 89.36, respectively.

Keywords: Dicle River, Keban Dam Lake, parasite, endohelminth, *Diplostomum spathaceum, Neoechynorhynchus rutili*

Dicle Nehri ve Keban Baraj Gölü'nden Avlanan Bazı Balıklarda Endohelmintlerin Araştırılması

Özet: Bu çalışmada, Ekim 2021 yılında Dicle Nehri'nden ve Keban Baraj Gölü'nden balıkçılardan alınan 10'ar adet *Acanthobrama marmid*, 17'şer adet *Capoeta trutta*, 20'şer adet *Capoeta umbla* olmak üzere toplam 94 adet balık kullanıldı. İncelenen balıkların 85 tanesinin enfekte olduğu belirlendi. Balıkların göz sıvısında *Diplostomum spathaceum* ve bağırsaklarında *Neoechynorhynchus rutili* teşhis edildi. Dicle Nehri'nde 2109 adet *D. spathaceum*, 737 adet *N. rutili* olmak üzere toplam 2846 adet parazit bulunmuş olup parazitlerin yoğunluk, bolluk ve yaygınlıkları sırasıyla 66,18, 60,55 ve 91,48 olarak saptandı. Keban Baraj Gölü'nde ise 1817 adet *D. spathaceum*, 737 adet *N. rutili* olmak üzere toplam 2846 adet parazit teşhis edilmiş olup parazitlerin yoğunluk, bolluk ve yaygınlıkları sırasıyla 54,80, 48,97 ve 89,36 olarak belirlendi.

Anahtar kelimeler: Dicle Nehri, Keban Baraj Gölü, parazit, endohelmint, *Diplostomum spathaceum, Neoechynorhynchus rutili*

INTRODUCTION

Industrial and agricultural activities produce a range of chemical and physical agents that are constantly damaging the natural environment (Barim et al., 2009; Barim and Karatepe, 2010). One of the most significant challenges in aquaculture is reported to be parasitic diseases, which are often difficult to

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detect or recognize in natural environments, together with the direct effects of parasites exert on host organisms (Öztürk, 2000).

It is well known that parasitism in host organisms can lead to reduced productivity, reduced resistance, and even mortality. Therefore, studies aimed at identifying the parasite fauna of fish in natural environments are of great importance for the implementation of effective control and conservation measures. (Oğuz et al., 1996).

Like all living organisms, fish are subject to various harmful effects from their parasites. These effects can be categorized as depletive and exploitative effects, mechanical and functional effects, toxic effects, influences on host nutrition, and the impairment due to parasites attachment to fish gill lamellae (Ekingen, 1983; Doğan Barata and Önalan, 2022a).

Through these various effects, parasites can sometimes lead to fish mortality; in cases where hosts survive, the pathological effects caused by parasites result in significant economic losses. Parasitic infections in fish also increase susceptibility to bacterial, viral, and fungal diseases, and facilitate the spread of these infections among fish populations (Öge, 1999, 2005).

As fish occupy the upper levels of the aquatic food pyramid, they are constantly exposed to parasite infestations. While a small number of parasites in fish may be negligible, high parasite loads can lead to significant problems. The larval stages of Diplostomid parasites are important pathogens that can severely impact both wild and aquacultured fish populations (Chibwana et al., 2013; Lebedeva et al., 2021; Doğan Barata and Önalan, 2022b).

Diplostomum species induce cataracts in fish in natural environments, which significantly affect fish welfare. Studies have shown that cataracts caused by Diplostomum species result in reduced nutrient intake, reduced growth rates (Bjerkas et al., 1996; Crowden and Broom, 1980; Ersdal et al., 2001; Savino et al., 1993), and increased mortality rates (Lester, 1977; Menzies et al., 2002) (Doğan Barata et al., 2022). Fish affected by cataracts show weakened escape responses and are more easily captured than those with healthy vision (Brassard et al., 1982; Seppälä et al., 2011). Consequently, cataracts have been associated with increased economic losses in the fishing industry (Menzies et al., 2002; Doğan Barata et al., 2023).

Acanthocephalans, commonly referred to as 'spiny' or 'thorny-headed' worms, have long been recognized as parasites of both freshwater and marine fish, in natural ecosystems and in aquaculture settings (Nickol, 2009). However, these parasites are primarily documented as incidental findings during routine necropsies, with morphological identification by fish pathologists typically not extending to the species level. In ecologically stable and well-balanced environments, the impact of these parasites on fish populations is generally minimal. Conversely, in environments where fish are stressed by various factors, or where non-native species (including fish, parasites, or intermediate hosts) have been introduced, the delicate balance between parasites and fish populations may be significantly disturbed (Emde et al., 2012; Lewisch et al., 2020**).** Mature *N. rutili* parasites inhabit the intestines of fish species such as carp, trout, mullet, and black fish (Barata and Dörücü, 2014).

The aim of this study is to identify the parasites found in *A. marmid*, *C. trutta*, and *C. umbla* fish in the Dicle River and Keban Dam Lake, and to determine their prevalence, intensity, and abundance. In addition, the study aims to analyze the relationship between parasite infestation and fish weight and length through correlation analysis.

MATERIALS and METHODS

The study was conducted in October 2021 on *A. marmid*, *C. trutta*, and *C. umbla* fish, collected dead from fishermen in the Dicle River and Keban Dam Lake. A total of 94 fish were used, including 17 *Capoeta trutta*, 20 *Capoeta umbla*, and 10 *Acanthobrama marmid* from each region. Total length and weight of the fish were measured and recorded. Necropsy was performed according to Arda et al. (2005).

The eyes of the fish were removed using forceps and a scalpel and placed into petri dishes containing 0.9% saline solution. The lenses of the eyes were examined under a stereomicroscope, counted with a pipette, and transferred to another petri dish containing saline solution. The body cavity and internal organs were first examined macroscopically. The sex of each fish was determined during the autopsy, and internal organs were placed into petri dishes for parasite examination under a stereomicroscope. The heart, swim bladder, and gall bladder were crushed with a dissecting needle, while the liver was examined by pressing small pieces between microscope slides and coverslips.

The intestines were opened with dissecting scissors to release their contents to be released. Parasites identified in the intestines were placed into separate petri dishes containing 0.9% saline solution. The parasites were cleaned with a brush and counted, then transferred to separate petri dishes containing 0.9% saline solution. Finally, the parasites were preserved in Eppendorf tubes containing 70% ethanol.

Parasite identification was carried out according to Bykhovskaya-Pavlovskaya (1964), Hoffman (1967), Kennedy (1974), Ekingen (1983), and Williams and Jones (1994). The formulae provided by Bush et al. (1997) were used to calculate the mean intensity, prevalence, and mean abundance values of the parasites:

- Mean intensity = Total number of parasites / Number of infected fish
- Prevalence = (Number of infected fish / Total number of fish) x 100
- Mean abundance = Total number of parasites / Total number of fish

The relationship between number of parasites and the length and weight of the fish was analyzed using simple correlation analysis.

RESULTS and DISCUSSION

The study conducted in October 2021, examined a total of 94 fishincluding 10 *A. marmid*, 17 *C. trutta*, and 20 *C. umbla* collected dead from fishermen in the Dicle River and Keban Dam Lake, were examined, and two parasite species, *D. spathaceum* and *N. rutili*, were identified.

The research revealed that 43 out of 47 fish examined from the Dicle River were infected, with a total parasite count of 2.846; in the Keban Dam Lake, 42 out of 47 fish were infected, with a total parasite count of 2,302. The intensity, abundance, and prevalence of parasites in the Dicle River were determined to be 66.18, 60.55, and 91.48, respectively, while in the Keban Dam Lake, these values were 54.80, 48.97, and 89.36, respectively. In addition, the total number of parasites was recorded as 2.846 in the Dicle River and 2.302 in the Keban Dam Lake (Table 1).

Table 1. Total number of fish examined and ınfection levels by region.

Regions	Total Fish Count	Non-infected	Infected	Parasite Count	Intensity	Abundance	Prevalence (%)
Dicle River	47	4	43	2846	66.18	60.55	91.48
Keban Dam Lake	47	5	42	2302	54.80	48.97	89.36

In all three fish species examined from the Dicle River and Keban Dam Lake, *D. spathaceum* was identified in the ocular fluid. Among the three species, *D. spathaceum* was most abundant in *C. trutta* from the Dicle River, with the highest number of 881 parasites. In the Keban Dam Lake, *C. trutta* also had the highest number of parasites with 813 parasites identified. Thus, *D. spathaceum* was determined to be the dominant parasite species in both regions. The *N. rutili* parasite species was most frequently observed in *C. umbla* from the Dicle River, with a maximum number of 534 parasites. However, *N. rutili* was not found in *A. marmid* in either region. In addition, a comparison between the two regions revealed a higher number of parasites in the Dicle River (Table 2).

Table 2. Distribution of parasite species in fish by region.

		Fish species			
Regions	**Parasite Species**	***A. marmid***	***C. trutta***	***C. umbla***	**Total**
Dicle River	*D. spathaceum.*	449	881	779	2109
	N. rutili	0	203	534	737
Keban Dam Lake	*D. spathaceum.*	361	813	643	1817
	N. rutili	0	208	277	485

The average weights and lengths of the fish were calculated as follows: *A. marmid* had an average weight of 169.8 g and an average length of 25.6 cm; *C. trutta* had an average weight of 195.7 g and an average length of 26.3 cm; and *C. umbla* had an average weight of 230.5 g and an average length of 28.4 cm (Table 3).

Table 3. Average weight and length of the examined fish.

Fis species	**Average weight (g)**	**Average length (cm)**
A. marmid	169.8	25.6
C. trutta	195.7	26.3
C. umbla	230.5	28.4

The correlation coefficients based on fish weight were calculated as follows: In the Dicle River, *A. marmid* had a coefficient of 0.46; *C. trutta* had 0.63, and *C. umbla* had 0.82. In the Keban Dam Lake, *A. marmid* had a coefficient of 0.76, *C. trutta* had 0.74, and *C. umbla* had 0.52 (Table 4).

Table 4. The relationship between fish weight and parasitism.

Regions	**Fish species**	**Correlation coefficient (r)**
Dicle River	*A. marmid*	0.46
	C. trutta	0.91
	C. umbla	0.82
Keban Dam Lake	*A. marmid*	0.76
	C. trutta	0.74
	C. umbla	0.52

The correlation coefficients based on fish length were calculated as follows: In the Dicle River, *A. marmid* had a coefficient of 0.63, *C. trutta* had 0.72, and *C. umbla* had 0.82. In the Keban Dam Lake *A. marmid* had a coefficient of 0.70, *C. trutta* had 0.72, and *C. umbla* had 0.55 (Table 5). When these data were examined, it was found that as the fish weight and length of the fish increased, so did number of parasites. In other words, we can say that the fish size was directly proportional to the level of parasitism.

Table 5. The relationship between fish length and parasitism.

Regions	Fish species	Correlation coefficient (r)
Dicle River	*A. marmid*	0.63
	C. trutta	0.72
	C. umbla	0.82
Keban Dam Lake	*A. marmid*	0.70
	C. trutta	0.72
	C. umbla	0.55

In our study, it was observed that more than 50% of the male fish were infected, whereas this rate was found to be around 30% in female fish. In other words, male fish were found to be more infected than female fish (Figure 1).

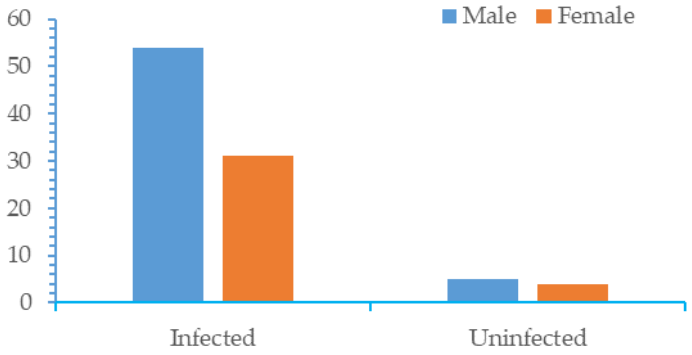

Figure 1. Infection status of the examined fish according to gender.

The results of this study indicate that *D. spathaceum* is a common and dominant parasite species in the three fish species studied. Similarly, in a study conducted by Karatoy and Soylu (2006) on carp species in Lake Terkos, the infestation rate of *Diplostomum* sp. was found to be 92.5%, and they identified *Diplostomum* sp. as the dominant parasite. In a study by Uzunay and Soylu (2006), *Diplostomum* sp was found in 12.5% of *Cyprinus carpio* and 46.6% of *Carassius carassius*. Selver (2008), in his study on the helminth fauna of various fish species caught in Kocadere Stream, reported that the most dominant parasite among the identified species was *D. spathaceum* metacercaria, with a prevalence of 69%. Soylu (1989), in his study on different fish species in Lake Sapanca, found *D. spathaceum* in *Barbus plebejus* with an infestation rate of 58%. In a study by Dörücü et al. (2002) on the occurrence and effects of *D. spathaceum* in the eyes of *Barbus barbus* in Keban Reservoir, an infestation rate of 78% was found in 100 fish examined. In addition, Dörücü and İspir (2005) reported that *Diplostomum* sp was widespread, with a total of 209 cases found in fish species from Keban Reservoir.

In a study conducted by Barata and Dörücü (2014) on four fish species from Karakaya Reservoir, *Diplostomum* sp was identified as the dominant parasite species. Kavak and Şeker (2017), in their study on five fish species from the Pertek region of Keban Reservoir, reported *Diplostomum* sp as the dominant species with a prevalence of 74.97%. Similarly, Aktürk et al. (2020), in their study on Çemişgezek region of Keban Reservoir, found *Diplostomum* sp as the most dominant parasite species with a prevalence of 73.33% and a density of 8.97 in four fish species.

In our study, *N. rutili* was diagnosed in the intestines of the fish species *C. trutta* and *C. umbla*. In their study on *C. trutta*, Sağlam and Sarıeyyüpoğlu (2002) reported that 14 out of 37 fish from the Koçkale

region of the Keban Reservoir, where Elazığ wastewater is discharged, were infected with *N. rutili*. They found that the prevalence to be 2.70%, with a density of 14 and a mean abundance of 38%. In a study by Dörücü et al. (2008) on internal parasites of fish species from Keban Reservoir, they found that 5 out of 7 *Capoeta trutta* were infected with *N. rutili*, with a prevalence of 71.43%, a mean intensity of 36.8, and an abundance of 26.3. İspir and Özcan (2023) reported that the mean weight and length of *C. trutta* specimens collected from Keban Dam were 213 ± 25 g and 24.4 ± 3.2 cm, respectively. Of the 24 *C. trutta* specimens examined, 13 (54.16%) were found to be infected with *N. rutilii*, with a total of 371 parasites recovered from the infected fish. In a larger sample of 44 *C. trutta*, 13 were identified as infected, with a total of 371 parasite. The mean intensity was recorded as 28.54, the prevalence as 54.16%, and the mean abundance as 15.46.

In a study by Aslan (2009) on the endohelminths of certain fish species caught from the Murat River in Ağrı Province and the Aras River in Erzurum Province *N.rutili* was found in *Capoeta capoeta* caught from the Aras River, with a prevalence of 58%, an mean intensity of 2.2, and a mean abundance of 1.3. In Tepe's (2011) study on the endohelminth fauna of economically important teleost fish species caught from the coasts of Trabzon, Rize, and Artvin, 5 out of 50 *Mugil auratus* were infected with *N.agilis* with a total of 23 parasites observed.

In their study on the ecology of endoparasitic helminth infections in Salmo trutta and *Oncorhynchus mykiss* in Scotland, Dörücü et al. (1995) examined 245 *Salmo trutta* and reported the presence of 118 *N.rutili.* Dörücü and İspir (2005), in their study on internal parasitic diseases in fish species from Keban Reservoir, examined 170 fish from 9 species and found a total of 218 *N.rutili*. In a study conducted by Kavak and Şeker (2017) conducted in Keban Reservoir, the overall prevalence of *N.rutili* was reported to be 17.30%, with a prevalence of 69.44% in *C.trutta.* Furthermore, in a study by Aktürk et al. (2020) in the Çemişgezek region of Keban Reservoir, the prevalence of *N.rutili* was reported as 40.95%, with a density of 7.11. Özcan et al. (2019) conducted a study on 1113 samples collected from Menzelet Dam Lake, including 36 *Cyprinus carpio*, 449 *Barbus rajanorum*, 60 *Alburnus* sp., 78 *Capoeta angorae*, 332 *Capoeta barroisi*, 150 *Luciobarbus pectoralis*, and 8 *Leuciscus cephalus*. Among the parasitic species identified, *Neoechinorhynchus rutili* was the most abundant, with a total of 14575 individuals recorded. Özcan and Bozdoğan (2020) examined 267 *Capoeta barroisi*, 1 *Cyprinus carpio*, and 2 *Barbus rajanorum* specimens collected from Menzelet Dam Lake and reported a total of 12533 *Neoechinorhynchus rutili* parasites in their intestines.

N. rutili parasites weren't found in *A. marmid* fish. This may be due to the small size of the fish and their inability to feed on *Asellus aquaticus*, the intermediate host of *N. rutili.* The higher parasite density observed in fish from the Dicle River compared to those from the Keban Reservoir may be due to the higher pollution levels and the mixing of sewage effluents in the river.

Ethical Statement

Since the fish used in the study were obtained dead from fishermen, an Ethics Committee approval is not required.

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