



An Investigation on *Argulus foliaceus* (Crustacea) Infestation of Fishes in the Kunduzlar Dam Lake

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ABSTRACT

In this study, crustacean parasite species, *Argulus foliaceus* was investigated on the seven fish species (*Alburnus escherichii*, *Barbus plebejus*, *Capoeta tinca*, *Carassius gibelio*, *Chondrostoma nasus*, *Cyprinus carpio*, *Squalius cephalus*) from the Kunduzlar Dam Lake in Kırka-Eskişehir, Türkiye. The parasite was found on the gills, fins, and skin of all of the host fish species except *Chondrostoma nasus*. Its prevalence and mean intensity of the parasitic infection value for the infected six fish species are as follows: 3 out of 38 *Alburnus escherichii* (prevalence 7.9%, mean intensity 4.3±3.1), 9 out of 16 *Barbus plebejus* (56.2%, 47.9±28.5), 12 out of 47 *Capoeta tinca* (25.5%, 27.5±18.9), 7 out of 17 *Carassius gibelio* (41.1%, 6.9±5.3), 4 out of 4 *Cyprinus carpio* (100%, 4.3±4.2) and 6 out of 14 *Squalius cephalus* (42.8%, 2.3±1.8). *Argulus foliaceus* was recorded for *A. escherichii* among the six host fish species for the first time within the study area from Türkiye. Thus, a new host fish species and a new locality have been added to the geographical infestation zone of the *A. foliaceus* species from Türkiye, which is located in the southeast region of Eurasia. Parasitological findings were evaluated concerning seasonal, age, and gender groups of the host fishes. In conclusion, *A. foliaceus* infestation was observed higher in summer due to the increased in water temperature, which is significantly different from winter, spring, and autumn. The infestation of *A. foliaceus* was more common in larger fish than in smaller fish. Moreover, the similar rates of infestation were recorded between the male and female fish.

Keywords: *Argulus*, crustacea, freshwater fish species, Kunduzlar Dam Lake, Türkiye

ARTICLE INFO

RESEARCH ARTICLE

Received : 14.07.2022

Revised : 31.08.2022

Accepted : 29.09.2022

Published : 30.12.2022



DOI:10.17216/LimnoFish.1143984

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Kunduzlar Baraj Gölü Balıklarında *Argulus foliaceus* (Crustacea) Enfestasyonu Üzerine Bir Araştırma

Öz: Bu çalışmada, crustacean parazit türü olan *Argulus foliaceus* Türkiye'de Kunduzlar Baraj Gölü'nden (Kırka-Eskişehir) yedi balık türü (*Alburnus escherichii*, *Barbus plebejus*, *Capoeta tinca*, *Carassius gibelio*, *Chondrostoma nasus*, *Cyprinus carpio*, *Squalius cephalus*) üzerinde araştırılmıştır. Parazit *Chondrostoma nasus* hariç tüm konakçı balık türlerinin solungaçlarında, yüzgeçlerinde ve derisinde bulunmuştur. Enfekte altı balık türü için parazitin enfeksiyon oranı, ve ortalama yoğunluğu şu şekildedir: 38 *Alburnus escherichii*'den 3'ü (enfeksiyon oranı %7.9, ortalama yoğunluk 4.3±3.1), 16 *Barbus plebejus*'dan 9'u (%56.2, 47.9±28.5), 47 *Capoeta tinca*'dan 12'si (%25.5, 27.5±18.9), 17 *Carassius gibelio*'dan 7'si (%41.1, 6.9±5.3), 4 *Cyprinus carpio*'dan 4'ü (%100, 4.3±4.2) ve 14 *Squalius cephalus*'tan 6'sı (%42.8, 2.3±1.8). *Argulus foliaceus*, Türkiye'den çalışma alanında altı konak balık türü arasındaki *A. escherichii*'den ilk kez kaydedilmiştir. Böylece Avrasya'nın güneydoğu bölgesinde yer alan Türkiye'den, *A. foliaceus* türünün coğrafi dağılımına yeni bir konak balık türü ve yeni bir yerleşim yeri eklenmiştir. Parazitolojik bulgular mevsimler ile konak balıkların yaş ve cinsiyet grupları açısından değerlendirilmiştir. Sonuç olarak *A. foliaceus* türü kış, ilkbahar ve sonbahar dönemlerine göre su sıcaklığındaki artış nedeniyle yaz aylarında daha fazla gözlenmiştir. *Argulus foliaceus* enfestasyonu büyük balıklarda küçük olanlara göre daha yaygındı. Ayrıca, erkek ve dişi balık örnekleri arasında benzer oranlarda enfeksiyon kaydedilmiştir.

Anahtar kelimeler: *Argulus*, krustacea, tatlısu balık türleri, Kunduz Baraj Gölü, Türkiye

How to Cite

Öztürk MO. 2022. An Investigation on *Argulus foliaceus* (Crustacea) Infestation of Fishes in the Kunduzlar Dam Lake 8(3): 282-288. doi: 10.17216/LimnoFish.1143984

Introduction

As a crustacean parasite species, *Argulus foliaceus* is a common invasive ectoparasite species for freshwater fishes. It's a low host specificity that lives on the gills, mouth cavity, skin, and fins of host fishes. The parasite species is causing infestations of host fish species in natural environments and culture fishing ponds. Moreover, it can cause bacterial, fungal, and viral secondary parasitic diseases in relevant tissues and organs and thus can cause economic losses (Walker et al. 2008).

The aim of this present study is to reveal the occurrence of *Argulus foliaceus* in fish species living in the Kunduzlar Lake Dam from Türkiye, and to compare the infection of prevalence and the mean intensity of *A. foliaceus* between fish species living in the same locality. Moreover, the aim is to determine between *A. foliaceus* infestation and the each fish species for size and gender groups, and seasonal changes.

Materials and Methods

Study Area

The Kunduzlar Dam Lake Kırka-Eskişehir-Türkiye, is located at 39°20'30" Parallel North and 30°32'25" Meridian East. The minimum water elevation of the Dam Lake is 1011.50 m, and the maximum water elevation is 1027.10 m. The lake area at maximum water level is 4.40 km² (Özbek and Öztürk 2010).

Sampling Methods And Laboratory Examination

Argulus foliaceus specimens were examined at the skin, fin, gill, and mouth cavity of the fish via with Olympus x30 stereo microscope. Parasites found on these organs were taken to a physiological water environment with the help of a scalpel, were washed with tap water, and their mucus was cleaned. They were placed in warm AFA (Alcohol-Formaldehyde-Acetic acid) fixative, and they were left for 12-24 hours. Then, the dehydration process was applied to parasites with the help of the ethyl alcohol series (35%, 50%, 70%). Following this, some of the parasites were preserved in 70% ethyl alcohol. Another part of them was made into preparation in glycerine gel.

Statistics

For the species definition of the parasite, Bykhovskaya-Pavlovskaya et al. (1962) were used. Infestation prevalence, parasite intensity, and minimum-maximum numbers of parasites were calculated according to Bush et al. (1997). Parasitological data obtained were analyzed using SPSS 11.5 software package. Accordingly, relations between infection data of the parasite species, size and older groups of host fish, and seasonal changes were evaluated through the chi-square test.

Results

Argulus foliaceus infestation on the fish species

Within the study, a total number of 175 fish specimens were examined for *A. foliaceus* infestation on the fish species in the Kunduzlar Dam Lake from Türkiye. Seven fish species were examined, and all of the six fish species, *Alburnus escherichii*, *Barbus plebejus*, *Capoeta tinca*, *Carassius gibelio*, *Cyprinus carpio*, and *Squalius cephalus*, were infected with *A. foliaceus*, but it was not found on *Chondrostoma nasus*. *Argulus foliaceus* was recorded on gills, fins and skin of the infected host fish species: 3 out of 38 *A. escherichii* (prevalence 7.9%, mean intensity 4.3±3.1), 9 out of 16 *B. plebejus* (56.2%, 47.9±28.5), 12 out of 47 *C. tinca* (25.5%, 27.5±18.9), 7 out of 17 *C. gibelio* (41.1%, 6.9±5.3), 4 out of 4 *C. carpio* (100%, 4.3±4.2), and 6 out of 14 *S. cephalus* (42.8%, 2.3±1.8). Among these fish species, the highest prevalence of infestation was found in *C. carpio* and the highest parasite intensity was observed in *B. plebejus*. The lowest prevalence of infestation was found in *A. esherihii* (Table 1).

Argulus foliaceus infestation on the fish species with related to seasonal changes

Argulus foliaceus infestation on fish species was evaluated over four seasons, i.e., spring, summer, autumn, and winter. Accordingly, *A. foliaceus* infestation was encountered on *A. esherishii* in winter and *B. plebejus* in spring. However, in summer, the infestation was generally at high values, and these values are significantly different from the values in other seasons (P<0.05). The highest prevalence of infestation in summer was found in *B. plabejus*, *C. carpio*, and *C. tinca*. The highest mean intensity of parasite was recorded on *B. plebejus* and *C. tinca* (Table 2).

Table 1. Occurrence of *Argulus foliaceus* infestation of the host fish species from Lake Dam Kunduzlar.

Infection Parameters	Fish species						
	<i>Alburnus escherichii</i>	<i>Barbus lebejus</i>	<i>Capoeta tinca</i>	<i>Carassius gibelio</i>	<i>Cyprinus carpio</i>	<i>Squalius cephalus</i>	
Exm/Inf	38/ 3	16/ 9	47/ 12	17/ 7	4/ 4	14/ 6	
(%)	(7.9)	(56.2)	(25.5)	(41.1)	(100)	(42.8)	
M&SD	4.3±3.1	47.9±28.5	27.5±18.9	6.9±5.3	4.3±4.2	2.3±1.8	
M-MPN	1-7	1-86	1-62	1-14	1-12	1-8	
TPN	13	431	330	48	17	14	

Exm/Inf: Examined/Infected fish number, (%) Prevalence, M&SD: Mean parasite number and standard deviation, M-MPN: Minimum-Maximum parasite number, TPN: Totalparasite number

Table 2. Distribution of *Argulus foliaceus* infestation from Lake Dam Kunduzlar according to the seasons

Seasons	Infection Parameters	Fish species						
		<i>Alburnus escherichii</i>	<i>Barbus plebejus</i>	<i>Capoeta tinca</i>	<i>Carassius gibelio</i>	<i>Cyprinus carpio</i>	<i>Squalius cephalus</i>	
Spring	Exm/Inf		4/ 0					
	(%)		(0.0)					
	M&SD	-	0±0	-	-	-	-	
	M-MPN		0					
	TPN		0					
Summer	Exm/Inf	8/ 3	8/ 8	12/11	10/ 7	4/ 4	4/ 3	
	(%)	(37.5)	(100)	(91.6)	(70.0)	(100)	(75.0)	
	M&SD	4.3±3.1	53.7±24.0	29.8±18.1	6.9±5.3	4.3±4.2	3.7±3.4	
	M-MPN	1-7	19-86	1-62	1-14	1-12	1-8	
	TPN	13	430	328	48	17	11	
Autumn	Exm/Inf	19/ 0	4/ 1	13/ 1	7/ 0		6/ 3	
	(%)	(0.0)	(25.0)	(7.7)	(0.0)		(50.0)	
	M&SD	0±0	1.0±0.0	2.0±0.0	0±0	-	1.0±0.0	
	M-MPN	0	1	2	0		1	
	TPN	0	1	2	0		3	
Winter	Exm/Inf	11/ 0						
	(%)	(0.0)						
	M&SD	0±0	-	-	-	-	-	
	M-MPN	0						
	TPN	0						

Argulus foliaceus infestation with related to size groups of the fish species

The distribution of *A. foliaceus* infestation for size groups of fish species is shown in detail in Table 3. The first and second size groups of *B. plebejus* were higher values of both infection prevalence and mean intensity than

C. tinca. Even though it is statistically insignificant ($P>0.05$), as a noteworthy difference, the value of infestation vanished within the third size group of *B. plebejus* and *C. tinca*. It was a remarkable finding that *A. foliaceus* infestation was seen only in the largest third-size group of the other four fish species.

Table 3. Distribution of *Argulus foliaceus* infestation from Lake Dam Kunduzlar according to the host fish size and groups

Infection Parameters	Fish species, length size and groups												
	Size groups	<i>Alburnus escherichii</i> and size		<i>Barbus plebejus</i> and size		<i>Capoeta tinca</i> and size		<i>Carassius gibelio</i> and size		<i>Cyprinus carpio</i> and size		<i>Squalius cephalus</i> and size	
Exm/Inf													
(%)	I. group	-	-	15.8-16.2 cm	4/ 2	(50.0)	14.0-15.6 cm	7/ 1					
M&SD					78.5±10		10±0		-	-	-	-	-
M-MPN					71-86		10						
TPN					157		10						
Exm/Inf													
(%)	II. group	-	-	18.0-23.8 cm	10/ 7	(70)	16.2-24.3 cm	37/ 11					
M&SD					39.1±25		28.9±19		-	-	-	-	-
M-MPN					1-74		1-62						
TPN					274		320						
Exm/Inf													
(%)	III. group	11.3-14.5 cm	38/ 3 (7.9)	33.0-34.5 cm	2/ 0	(0)	27.8-31.6 cm	2/ 0	18.0-23.2 cm	17/ 7	20.4-29.5 cm	4/ 4	12.0-15.7 cm
M&SD		4.3±3.1		0±0	2/ 0		0±0		6.9±5.3	(41.1)	4.3±4.2	(100)	2.3±1.8
M-MPN		1-7		0	0±0		0		1-14		1-12		1-8
TPN		13		0	0		0		48		17		14

Argulus foliaceus infestation with related to gender groups of the fish species

The distribution of *A. foliaceus* infestation concerning gender groups of fish species is shown in Table 4. Both male and female groups of fish species were examined, except for *C. carpio*. Infestation prevalence of the parasite was higher in female than male groups of *B. plebejus*, *C. gibelio*, and *S.*

cephalus. On the other hand, mean infestation intensity was higher in male than female groups of the same host fish species; *B. plebejus*, *C. gibelio*, and *S. cephalus*. Moreover in *C. tinca* specimens, both infestation prevalence and mean intensity were higher in male than female fish specimens. However, the difference in infection between the groups of fish is not statistically significant ($P>0.05$).

Table 4. Distribution of *Argulus foliaceus* infestation from Lake Dam Kunduzlar according to host fish gender groups

Infection Parameters	Gender	Fish species					
		<i>Alburnus escherichii</i>	<i>Barbus plebejus</i>	<i>Capoeta tinca</i>	<i>Carassius gibelio</i>	<i>Cyprinus carpio</i>	<i>Squalius cephalus</i>
Exm/Inf	Male	20/ 2	8/ 4	26/ 10	8/ 3	4/ 4	12/ 5
(%)		(10)	(50.0)	(38.4)	(37.5)	(100)	(41.6)
M&SD		3.0±2.8	57.5±28.8	31.8±17.5	8.0±5.6	4.3±4.2	2.6±2.1
M-MPN		1-5	19-86	2-62	3-14	1-12	1-8
TPN		6	230	319	24	17	13
Exm/Inf	Female	18/ 1	8/ 5	21/ 2	9/ 4	-	2/ 1
(%)		(5.5)	(62.5)	(9.5)	(44.4)	-	(50.0)
M&SD		7.0±0.0	40.2±28.9	5.5±6.3	6.0±5.8	-	1.0±0
M-MPN		7	1-74	1-10	1-12	-	1
TPN		7	201	11	48	-	1

Discussion

Argulus foliaceus is a crustacean ectoparasite species that live in different habitats and is common on various fish species (Lamarre and Cochran 1992; Székely and Molnár 1997; Yıldız and Kumantaş 2002; Ökten 2003; Kır et al. 2004; Tekin-Özan and Kır 2005; Poulin 2007; Walker et al. 2008; Öztürk 2010; Açikel and Öztürk 2013). It is emphasized that this parasite does not make an evident host preference amongst fish species that are living in the same environment (Lamarre and Cochran 1992; Mikheev et al. 1998; Taylor et al. 2009). In parallel with this view, *A. foliaceus* infestation was found in 6 fish species in the study. This result supports the view that *A. foliaceus* lives in many various fish species as a parasite.

Argulus foliaceus mostly prefers to invade fish species such as *Cyprinus carpio*, *Abramis brama*, *Tinca tinca*, *Carassius auratus* and *Scardinius erythrophthalmus* (Pojmanska 1993; Kır et al. 2004; Walker et al. 2008; Pekmezci et al. 2011). The parasite was a higher value of infestation in *C. tinca* and *B. plebejus* species in comparison with other host fish species in this study. This may indicate that the parasite prefers certain fish species. In this respect, an interesting result was that *A. foliaceus* infestation was not found in *Chondrostoma nasus*. Thus, it can be said that *A. foliaceus* may adapt to live in many fish species, yet it prefers physiologically more appropriate fish species (Taylor et al. 2009).

It is a known fact that one of the abiotic factors that are most effective in the prevalence and intensity

of *A. foliaceus* infection in fish is water temperature (Harrison 2006). Öztürk et al. (2000) indicate that the infestation prevalence of *A. foliaceus* reaches its highest value in summer. In another study, this parasite was encountered in the summer and autumn (Öztürk 2002). Açikel and Öztürk (2013) observed *A. foliaceus* on *Squalius cephalus* only in the summer months. Similar results were recorded in this study as well. The parasite infestation generally reached high values in the host fish specimens examined in summer, and there was a significant difference between the values of the summer and other seasons. These results are in parallel with the view that *A. foliaceus* is a species that is prone to hot weathers (Molnar and Szekely 1995; Özer and Erdem 1999; Yıldız and Kumantaş 2002; Kır et al. 2004; Tekin-Özan and Kır 2005; Açikel and Öztürk 2013).

Grutter (1994) indicates a relationship between *A. foliaceus* infestation and the size or age groups of fish. According to Poulin (2007), the prevalence and intensity of *A. foliaceus* infection change in direct proportion to the size of the host fish. In another study, it is stated that larger fish have more parasites as they are exposed to longer periods of the parasite (Lamarre and Cochran 1992). In parallel with these data, Walker et al. (2008) did not encounter any *A. foliaceus* infestation in young host fish specimens. Öztürk (2002) indicates that the prevalence and intensity of *A. foliaceus* infestation found in second and third-size groups of fish are more dominant than in the first group. The data in the present study support the data obtained by the above-mentioned

researchers, and the value of infestation of *A. foliaceus* was more common in larger host fish than in smaller ones.

It is a known fact that there is not an evident interaction between gender groups of fish and *A. foliaceus* infection (Açıkel and Öztürk 2013; Öztürk 2002). In the present study, the value of infestation of *A. foliaceus* was not significantly different between male and female older groups of the host fish.

It is a known fact that *A. foliaceus*, which is nourished by the mucus and blood of its host, is effective, especially on gills and skin (Székely and Molnár 1997). It is also known that the parasite species causes a toxic effect on the parts, and through the wounds emanated, it causes secondary bacterial and fungal infections (Walker et al. 2008). Accordingly, the present research field is a natural environment, and the parasitic occurrence was found at a low intensity, the above-mentioned pathological symptoms were not encountered in the host fish. However, in the case of preference of Lake Dam Kunduzlar, which is an appropriate ecological environment for cyprinid species, to become a culture fish area in the future, then one should keep in mind that *A. foliaceus* is a potential pathogenic parasitic species for the host fish, especially in the summer period.

In conclusion, the infestation of *A. foliaceus* on the six fish species from Kunduzlar Dam Lake were evaluated for the first time, related to some environmental factors, such as seasonal change, size, and gender groups of the fishes. Moreover, *A. foliaceus* is a new parasite record for *A. escherichii* from Türkiye. So, *A. escherichii* is a new host record for *A. foliaceus* from Türkiye. Thus, a new host fish species and a new locality has been added to the geographical spread zone of the parasite species from Asia Minor, Türkiye, which is located in the southeast region of Eurasia.

References

- Açıkel M, Öztürk MO. 2013. Investigations on *Argulus foliaceus* (Crustacea, Branchiura) Infestation Fauna of Chub (*Squalius cephalus*, L. 1758) From Lake Dam Serban, Afyonkarahisar. *Journal of FisheriesSciences.com* 7(4): 344-1350. doi: 10.3153/jfsc.com.2013038.
- Bush AO, Lafferty KD, Lotz JM, Shostak AW. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *J. Parasitol.* 83: 575-583. doi: 10.2307/3284227
- Bykhovskaya-Pavlovskaya IE, Gussev AV, Dubinina MN, Izyumova NA, Smirnova TS, Sokolovskaya I, Shtein GA, Shulman SS, Epshtein VM. 1962. *Key to parasites of freshwater fish of the USSR*. Izdatel'svi Akademi Nauk SSSR. Leningrad, 919 p.
- Grutter AS. 1994. Spatial and temporal variations of the ectoparasites of seven reef fish species from Lizard Island and Heron Island, Australia. *Marine Ecology Progress Series* 115: 21-30.
- Harrison AJ, Gault NFS, Dick JTA. 2006. Seasonal and vertical patterns of egg-laying by the freshwater fish louse *Argulus foliaceus* (Crustacea: Branchiura). *Dis Aquat Org.* 68: 167-173. doi:10.3354/dao068167
- Kır İ, Ayvaz Y, Barlas M, Tekin-Özan S. 2004. Karacaören I Baraj Gölü'nde yaşayan sazan (*Cyprinus carpio* L., 1758)'lardaki parazitlerin mevsimsel dağılımları ve etkileri. *Türkiye Parazitoloji Dergisi* 28(1): 45-49.
- Lamarre E, Cochran PA. 1992. Lack of host species selection by the exotic parasitic crustacean, *A. japonicus*. *J. Freshwater Ecol.* 7(1): 77-80. doi: 10.1080/02705060.1992.9664672
- Mikheev VM, Valtonen ET, Rintamäki-Kinnunen P. 1998. Host searching in *Argulus foliaceus* L. (Crustacea: Branchiura): The role of vision and selectivity. *Parasitology* 116: 425-430. doi: 10.1017/S0031182098002455
- Molnar K, Székely C. 1995. Parasitological survey of some important fish species of Lake Balaton. *Parasitologica Hungarica* 28: 63-82.
- Öktener A. 2003. A checklist of metazoan parasites recorded in freshwater fish from Türkiye. *Zootaxa* 394: 1-28.
- Özbek M, Öztürk MO. 2010. Investigations on *Ligula intestinalis* plerocercoid L., 1758 infection of some fishes from dam lake Kunduzlar (Kırka, Eskişehir). *Türkiye Parazitol Derg.* 34(2): 112-117.
- Özer A, Erdem O. 1999. The relationship between occurrences of ectoparasites, temperature and culture conditions: a comparison of farmed and wild common carp (*Cyprinus carpio* L., 1758) in the Sinop region of northern Türkiye. *Natural History* 33: 483-491. doi: 10.1080/002229399300209
- Öztürk MO, Oğuz MC, Altunel FN. 2000. Metazoan parasites of pike (*Esox lucius* L.) from Lake Uluabat. *Türkiye. Isr J Zool.* 46: 119-130. doi: 10.1560/1PCU-4T5V-CA77-X3TJ
- Öztürk MO. 2002. Metazoan parasites of the tench (*Tinca tinca* L.) from Lake Uluabat, Türkiye. *Isr J Zool.* 48(4): 285-293. doi: 10.1560/7MA6-KFGP-VQHG-02KN
- Öztürk MO. 2010. An investigation on *Argulus foliaceus* infection of rudd, *Scardinius erythrophthalmus* in Lake Manyas, Türkiye. *Scientific Research and Essays* 5(23): 3756-3759.
- Pekmezci GZ, Yardımcı B, Bolukbas CS, Beyhan YE, Umur S. 2011. Mortality due to heavy infestation of *Argulus foliaceus* (Linnaeus, 1758) (Branchiura) in pond-reared carp, *Cyprinus carpio* L., 1758 (Pisces). *Crustaceana*, doi: 10.1163/001121611X574317
- Pojmanska T, Chabros M. 1993. Parasites of common carp and three introduced cyprinid fish in pond culture. *Acta Parasitol.* 38: 101-118.
- Poulin R. 2007. The structure of parasite communities in fish hosts: ecology meets geography and climate. *Parassitologia* 49: 169-172.

- Székely C, Molnár K. 1997. Preliminary survey of the parasite fauna of some important fish species in the Upper-Reservoir of the Kis-Balaton System. *Parasitologica Hungarica* 29-30: 45-54.
- Taylor NGH, Wootten R, Sommerville C. 2009. Using length-frequency data to elucidate the population dynamics of *Argulus foliaceus* (Crustacea: Branchiura). *Parasitology* 136: 1023-1032.
doi: [10.1017/S0031182009006520](https://doi.org/10.1017/S0031182009006520)
- Tekin-Özan S, Kır İ. 2005. An investigation of parasites of goldfish (*Carassius carassius* L.,1758) in Kovada Lake. *Türkiye Parazitoloji Dergisi* 29(3): 200-203.
- Walker PD, Haris JE, Velda GV, Sjoerd E, Bonga W.2008. Effect of host weight on the distribution of *Argulus foliaceus* (L.) (Crustacea, Branchiura) within a fish community. *Acta Parasitol.* 53(2): 165–172.
doi: [10.2478/s11686-008-0020-0](https://doi.org/10.2478/s11686-008-0020-0)
- Yıldız K, Kumantaş A.2002. *Argulus foliaceus* infection in a goldfish (*Carassius auratus*). *Isr J Vet Med.* 57(2):118–120.