INFESTATION OF FISH LOUSE, *ARGULUS FOLIACEUS* (LINNAEUS, 1758) (CRUSTACEA: BRANCHIURA) ON RAINBOW TROUT FARM IN MANYAS DAM LAKE, TURKEY

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Abstract: The study presents the occurrence of fish louse, *Argulus foliaceus* (Linnaeus, 1758) on the rainbow trout, *Onchorhynchus mykiss* caged in Manyas Dam Lake, Turkey, on 2019. This argulid species is found on the gill filaments of hosts. Morphological characters of fish louse are given with photos. This finding is the first report of *Argulus foliaceus* from rainbow trout and Manyas Dam Lake. In addition to, host preferences and updated-checklist of *Argulus* species reported from Turkey are provided. Moreover, *Ichthyophthirius* sp. that caused the death of approximately 100,000 rainbow trout fry has been identified at another trout farm that farms fish in concrete pools.

Keywords: *Argulus*, fish louse, *Ichthyophthirius*, Manyas Dam Lake, Turkey

Introduction:

Members of Branchiura are known as fish lice of fish louse. Argulidae family (Crustacea; Branchiura) contains four genera, *Argulus*, *Chonopeltis*, *Dipteropeltis* and *Dolops*. This group is especially ectoparasitic crustaceans of freshwater fishes, occasionally live marine fishes, rarely on amphibians such as tadpoles, salamanders and alligators. *Argulus* genus is cosmopolitan and very often reported in the World (Poly 2008; Møller 2009). Three species of *Argulus* are known from Europe. *Argulus coregoni* Thorell, 1865, *Argulus foliaceus* (Linnaeus, 1758) are native to Europe, while *Argulus japonicus* Thiele, 1900 as a non-native has recently been introduced (Rushton-Mellor 1992; Taylor et al. 2006; Soes et al. 2010).

Argulus is a serious pathogen capable of serious pathological effects on both wild and cultured fishes. Fish infested with *Argulus* are lethargic, cease feeding and lose condition. They are initially trying to remove the

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parasite by rubbing against the substrate. In heavier infections these changes may be accompanied by excessive production of mucus, small hemorrhages at the sites of parasite attachment, and fin erosion (Stammer 1959; Kabata 1970; Walker et al. 2004; Lester and Hayward 2006). The wounds caused by parasites facilitate the entry of secondary infections such as fungi, parasite, bacteria and viruses to fish (Bower-Shore 1940; Stammer 1959; Shimura and Inoue 1984; Rahman 1996; Molnar and Szekely 1998). There are serious argulid outbreaks resulting in fish mass mortalities in the World (Lahav et al. 1962; Menezes et al. 1990; Northcott et al. 1997; Gault et al. 2002; Pekmezci et al. 2011). Two species of *Argulus* genus are reported from Turkey: *Argulus foliaceus* and *Argulus japonicus*.

This study aims is to determine parasites in farmed trout in Manyas Dam Lake, to present host preferences and *Argulus* reported from Turkey, to obtain scientific information about cultured fish for prevent and control of possible diseases in the future.

Materials and methods:

Forty-three specimens of rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792) were obtained from a trout farm in Manyas Dam Lake (39°58'42.6"N 27°46'42.5"E) (Balıkesir, Turkey) during 2019. Fish samples were examined for ecto and endoparasites using a stereomicroscope. Specimens of argulids recovered from the hosts were fixed in 4% formaldehyde. They were cleared in lactic acid, and their appendages were dissected out by using Wild M5, Leica M140 stereo microscope. Dissected parts were mounted on slides in glycerin-gelatine mounting medium. The photos were taken with the aid of Canon camera (EOS 1100D) connected to a microscope. All measurements are in millimeters. Scientific names, synonyms of the host were checked through Froese and Pauly (2019). Identifications were done according to Bykhovskaya-Pavlovskaya et al. (1962), Yamaguti (1963), Fryer (1982), Kabata (1985), Rushton-Mellor and Boxshall (1994) for *Argulus foliaceus*.

Results and discussion:

In this parasitological study, *Argulus foliaceus* (Linnaeus, 1758) was identified as ectoparasite on the rainbow trout, but endoparasite was not found in the internal organs of fish. Prevalence value of *Argulus foliaceus* was found as 13%.

Crustacea Brünnich, 1772
Branchiura Thorell, 1864
Argulidae Leach, 1819
Argulus Müller O.F., 1785
Argulus foliaceus (Linnaeus, 1758) (Fig. 1 and Fig. 2, Annexes)

Description of male: General body shape elliptical; cephalic region oval, with symmetrical sides. Dorsal shield suborbicular. Total length 0.84 - 2.95 mm; carapace length 0.57 - 2.1 mm, carapace width 0.4-1.55 mm; abdomen length 0.13 - 0.65 mm, abdomen width 0.11 - 0.5 mm. Anterior respiratory areas much smaller than, and in front of, posterior respiratory areas. First antenna includes proximal section and distal section. Every section with two segmented. First segment with a large posterior spine, second segment bears blunt anterior spine, claw-like terminal spine and medial spine. Third segment bears a long and a short seta and terminal segment with six apical spines.

Second antenna with five segmented. First segment bears a large posterior spine and covered five setae; second, third and fourth segments with four setae; fifth segment with five small setae.

Basal plate of coxa, slightly triangular with three long spines, pad with three long setae and numerous scales. Basis and segments of endopod bear pectinate scales and short setae densely. Terminal segment of endopod bear two curved spines and a blunt spine. Abdominal lobes very broadly

rounded. Carapace not covering fourth pair legs.

In this parasitological study only male individuals of parasites were found in the gills of rainbow trout. The reason for determining only male on host may be a parasitic behavior mentioned by several researchers. Male individuals tend to detach host in order to find a mate in mating, while female individuals remain more stable in the host (Pasternak et al. 2000; Bandilla et al. 2008; Mikheev et al. 2015).

This study contributes the information of new host and new locality for *Argulus foliaceus* in Turkey. When the argulid species reported in fishes belonging to Salmoniformes are examined, *Argulus coregoni* Thorell, 1864 are known to be typical, especially for trout. *Argulus coregoni* was reported on the rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) by Pasternak et al. (2004), Hakalahti et al. (2004). Although *Argulus coregoni* has been reported from the rainbow trout, *Argulus foliaceus* also have records from rainbow trout (Menezes et al. 1990; Buchmann et al. 1995; Gault et al. 2002; Harrison et al. 2006; Taylor et al. 2009).

The information concerning *Argulus* reported in Turkey such as host, prevalence value, infestation site on host, locality of host fish, author and date of published record is presented as follows (Tab. 1 and Fig. 3, Annexes). The host parasitism was examined for the order diversity according to reports on *Argulus foliaceus* reported from fish of Turkey; 20 (71%) of 28 host species belong to Cypriniformes; the remaining 7 host species (26%) belong to Siluriformes, Perciformes, Mugiliformes, Synbranchiformes, Esociformes, Salmoniformes (Fig. 4).

The preferred habitat type of host species concerning *Argulus foliaceus* is generally benthopelagic with 16 host species (57%), demersal with 9 host species (32%), rarely pelagic with 3 species (11%) (Fig. 5).

The hosts parasitism with *Argulus foliaceus* was examined according to the climatic distribution; 14 (50%) of 28 host species in temperate zones; 13 host species (13%) in subtropical zones; 1 host species (4%) in tropical zones (Fig. 6).

The host parasitism with *Argulus foliaceus* according to feeding habits are 21 (75%) of 28 host species are omnivorous; 6 species (21%) carnivorous; 1 species (4%) herbivorous (Fig. 7).

Figure no. 4 The host distribution of *Argulus foliaceus* according to order diversity

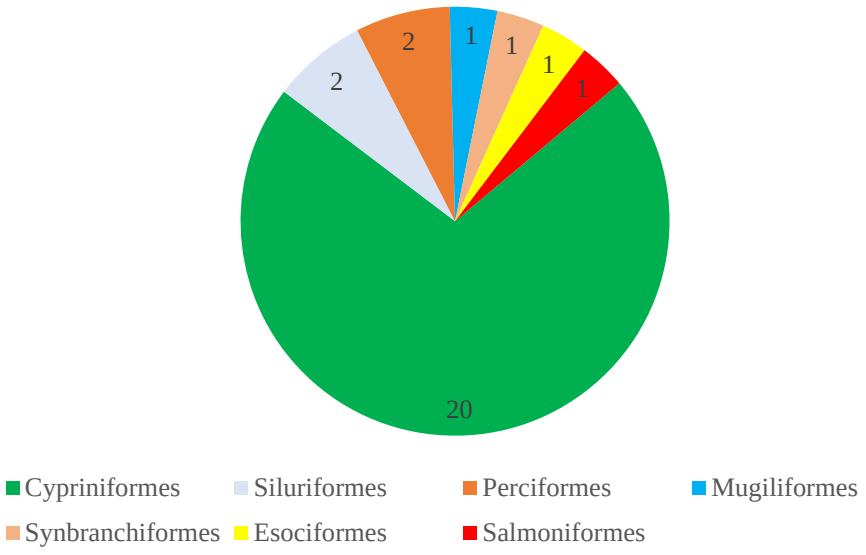


Figure no. 5 The host of *Argulus foliaceus* according to the prefered habitat type

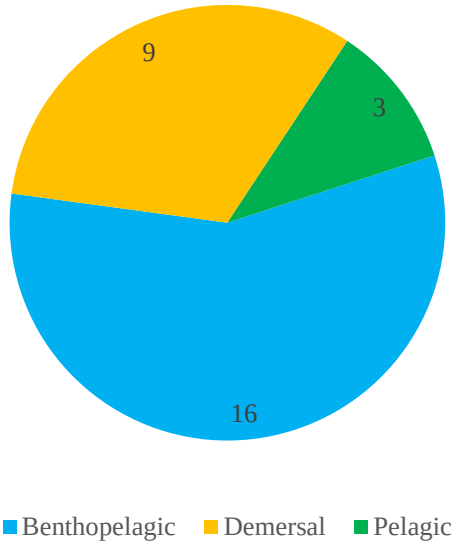


Figure no. 6 The host of *Argulus foliaceus* according to the climatic distribution

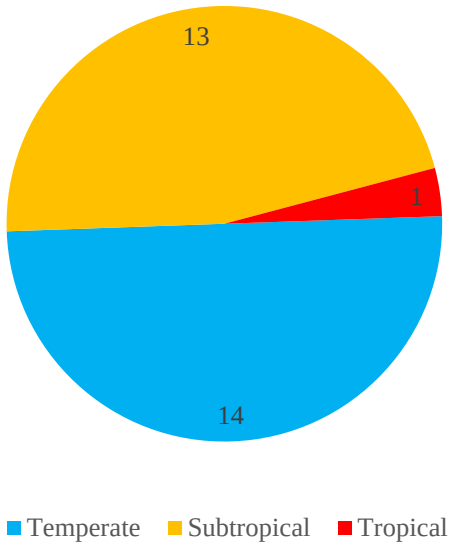
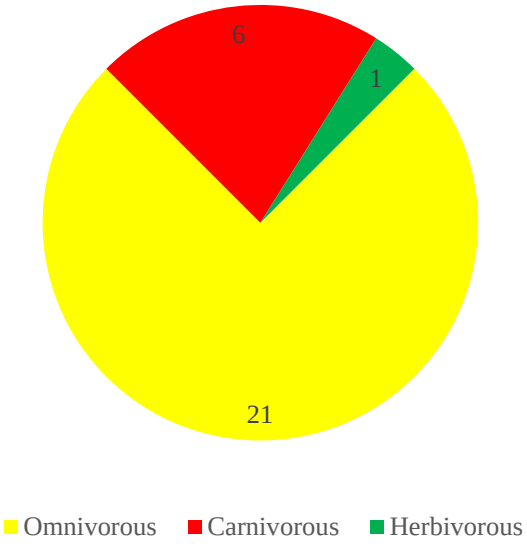


Figure no. 7 The host preference of *Argulus foliaceus* according to feeding habits



The Manyas Lake and its surroundings are under intense pressure of pollutants such as waste water including pesticides, fertilizer, paddy waters, waste from animal farms. Due to the effect of this pollution, the serious fish mortalities are observed in the lake and neighbouring places such as brook and ponds in recent years (Özaydın 2014; NTV Haber 2014; İHA 2019).

Therefore, poor water quality associated with pollution may cause possible serious fish mortalities in fish farms economically. By the way of example, it was observed that massive fish mortalities (about one hundred and fifty thousand) occurred in the concrete ponds of a rainbow trout farm that I went to upon a notice in 2019. During the parasitological examinations in the laboratory, Ichthyophthiriasis or white spot disease was identified in wet preparations from rainbow trout fry. *Ichthyophthirius* sp. was determined with 100% infection value on gill filaments of rainbow trout fry (Fig. 8, Annexes). The dense mucus and organic particle density were observed with the parasite in the gill of rainbow trout.

As is known, it is more advantageous to diagnose parasite fauna of fish and to take the necessary precautions than to treat possible diseases that may occur in the future. Therefore, it is very important to investigate the parasite faunas of fish in cultural environments and to monitor their seasonal infection percentages. This study was carried out to contribute to studies aimed at determining parasite faunas of the fish that have been farmed.

Rezumat:

INFESTAREA PĂSTRĂVULUI CURCUBEU DE CRESCĂTORIE CU PĂDUCHELE DE PEȘTE *ARGULUS FOLIACEUS* (LINNAEUS 1758) ÎN LACUL DE BARAJ MANYAS, TURCIA

Studiul prezintă apariția păduchilor de pește, *Argulus foliaceus* (Linnaeus, 1758) pe păstrăvul curcubeu, *Onchorhynchus mykiss* crescut în lacul de baraj Manyas, Turcia, în 2019. Această specie argulidă se găsește pe filamentele branhiale ale gazdelor. Caracterele morfologice ale păduchilor de pește sunt redate în fotografii. Această constatare este prima semnalare a lui *Argulus foliaceus* la păstrăvul curcubeu din lacul de baraj Manyas. În plus, a fost completată lista cu gazdele preferate ale speciilor de *Argulus* raportate in Turcia. Mai mult,

Ichthyophthirius sp., care a cauzat moartea a aproximativ 100.000 de pui de păstrăv curcubeu, a fost identificat la o altă fermă de păstrăv care exploatează pești în bazine de beton.

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Annexes:

Figure no. 1 *Argulus foliaceus* (Linnaeus, 1758)

Figure no. 2 *Argulus foliaceus* (Linnaeus, 1758) a. Antennule (0.12 mm), b. Antenna (0.12 mm), c. maxilla (0.17 mm), d. e. Maxillule (0.19 mm), f. Sclerites in supporting rods of maxillule (0.03 mm), g. Abdomen (0.25 mm), h. second leg (0.18 mm), i. Third leg (0.21 mm), j. Fourth leg (0.2 mm)

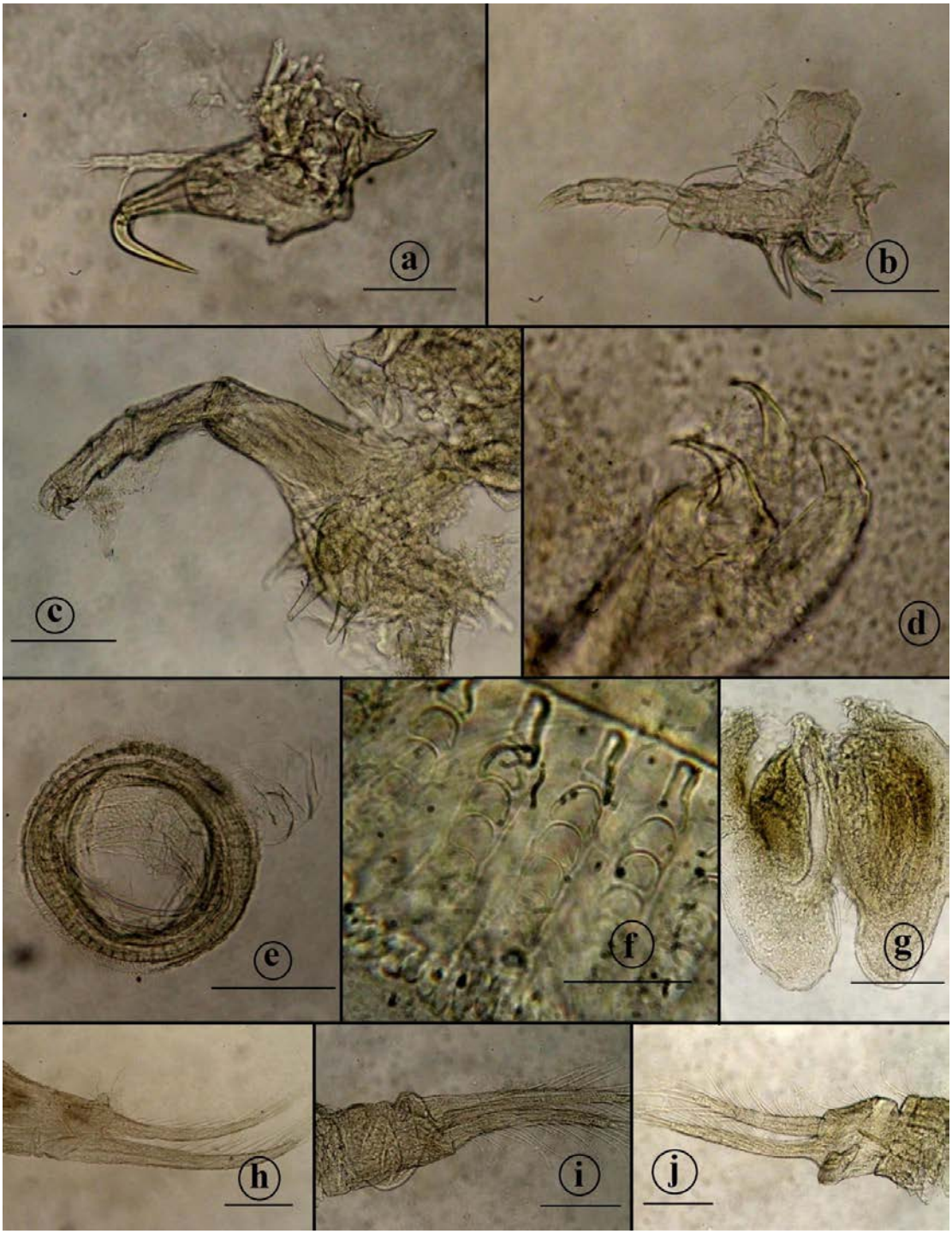


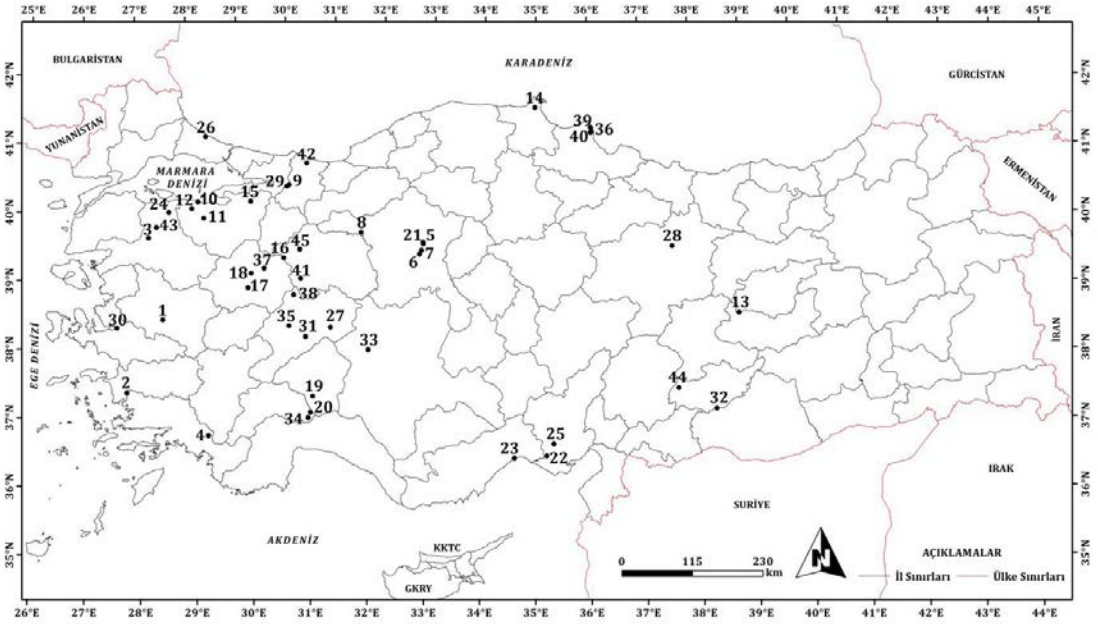
Table no. 1 *Argulus foliaceus* host fish species recorded from Turkey

Host Fish Species	Prevalence value (%)	Infestation site	Locality	References
Cyprinus carpio		Skin	Marmara Lake, Balık Lake	Geldiay and Balık (1974)
Squalius cephalus		Skin	Kocaçay Brook, Dalaman Brok	Geldiay and Balık (1974)
Carassius sp.	100	Skin	Pond of Ankara Museum	Burgu and Oğuz (1984)
Alburnus sp.	5	Skin	Gölbaşı Lake, Eymir Lake	Burgu et al. (1988)
Tinca tinca	5	Skin	Gölbaşı Lake, Eymir Lake	Burgu et al. (1988)
Silurus glanis	6	Skin	Gölbaşı Lake, Eymir Lake, Sarıyar Dam Lake	Burgu et al. (1988)
Tinca tinca	2.1	Skin, fins	Sapanca Lake	Soylu (1990)
Silurus glanis	6.3	Skin, fins	Sapanca Lake	Soylu (1990)
Cyprinus carpio	21	Gills	Ekinli Lagoon, Uluabat Lake, Kocadere	Oğuz (1991)
Capoeta trutta	6.6	Dorsal fin	Keban Dam Lake	Sarıeyyüpoğlu and Sağlam (1991)
Cyprinus carpio	14.9	Skin, gills	Bekteşağa Pond	Özer (1995)
Esox lucius	0.75	Skin	Uluabat Lake	Öztürk (1995)
Cyprinus carpio	0.6	Skin	İznik Lake	Aydoğdu (1996)
Cyprinus carpio	0.6	Skin	İznik Lake	Aydoğdu et al. (1997)
Cyprinus carpio		Skin	Porsuk Dam Lake, Çavdarhisar Dam Lake, Kayaboğazı Dam Lake	Koyun et al. (1997)
Alburnus alburnus		Skin	Porsuk Dam Lake, Çavdarhisar Dam Lake, Kayaboğazı Dam Lake	Koyun et al. (1997)
Carassius carassius		Skin	Porsuk Dam Lake, Çavdarhisar Dam Lake, Kayaboğazı Dam Lake	Koyun et al. (1997)
Tinca tinca		Skin	Porsuk Dam Lake, Çavdarhisar Dam Lake, Kayaboğazı Dam Lake	Koyun et al. (1997)
Cyprinus carpio	25.8	Fins	Kovada Lake	Becer and Kara (1998)
Cyprinus carpio	39	Skin	Karacaören I Dam Lake	Kır (1998)
Carassius auratus	18	Skin	Karacaören I Dam Lake	Kır (1998)
Esox lucius	0.16	Skin	Uluabat Lake	Öztürk et al. (2000)
Carassius auratus		Skin	Petshop - Ankara	Murat (2000)

Cyprinus carpio	7.69	Skin	Seyhan River	Cengizler et al. (2001)
Carassius auratus	62.5	Skin, fins	Petshop - Mersin	Koyuncu (2002)
Tinca tinca	4.2	Gills	Uluabat Lake	Öztürk (2002)
Carassius auratus			Pet shop - Ankara	Yıldız and Kumantaş (2002)
Cyprinus carpio	40.6	Skin, fins, gills	Manyas Lake	Öztürk and Altunel (2003)
Scardinius erythrophthalmus	15	Gills	Manyas Lake	Öztürk and Altunel (2003)
Cyprinus carpio			Seyhan River	Şahan and Cengizler (2003)
Barbus rajanorum			Seyhan River	Şahan and Cengizler (2003)
Cyprinus carpio	31.6	Skin	Karacaören I Dam Lake	Kır et al. (2004)
Cyprinus carpio	30.93	Skin	DSİ 6. Bölge Müdürlüğü	Tabakoğlu (2004)
Ctenopharyngodon idella	30.93	Skin	DSİ 6. Bölge Müdürlüğü	Tabakoğlu (2004)
Scardinius erythrophthalmus	2.6	Skin	Durusu (Terkos) Lake	Kahveci (2004)
Cyprinus carpio	6.5	Skin, fins, gills	Eber Lake	Öztürk (2005)
Vimba vimba	6.6	Gills	Sapanca Lake	Uzunay (2005)
Carassius carassius	10,7	Skin	Kovada Lake	Tekin Özan and Kır (2005)
Silurus glanis	6	Fins, gills	Durusu (Terkos) Lake	Soylu (2005)
Vimba vimba	6.6	Gills	Sapanca Lake	Uzunay and Soylu (2006)
Alburnus chalcoides	0.94	Gills	Tödürge Lake	Yıldırım (2006)
Cyprinus carpio			İst. Üniv. Sapanca Fish Unit.	Tepecik (2006)
Astronotus ocellatus		Gills, skin, fins	Petshop- İzmir	Tokşen (2006)
Abramis brama	5.9	Gills, skin	Durusu (Terkos) Lake	Karatoy and Soylu (2006)
Cyprinus carpio	64.7	Gills, skin, fins	Selevir Dam Lake	Öztürk and Bulut (2006)
Silurus triostegus	100	Gills, fins, skin	Atatürk Dam Lake	Öktener et al. (2006)
Planiliza abu	1.3	Gills, fins, skin	Atatürk Dam Lake	Öktener et al. (2006)
Mastacembelus mastacembelus	14.3	Gills, fins, skin	Atatürk Dam Lake	Öktener et al. (2006)
Cyprinus carpio	45.8	Skin, fins	Çavuşçu Lake	Öktener et al. (2007)
Carassius auratus	0.7	Skin, fins	Petshop - Mersin	Koyuncu (2009)
Scardinius erythrophthalmus	23.7	Oral cavity, gills, fins, skin	Manyas Lake	Öztürk (2010)
Cyprinus carpio	6.25	Skin	Karacaören II Dam Lake	Samancı (2011)
Squalius cephalus	17.5	Gills, fins, skin	Serban Dam Lake	Açıkel (2011)

Cyprinus carpio	100	Fins, skin	Fish Pond - Samsun	Pekmezci et al. (2011)
Cyprinus carpio	28	Fins	Emre Dam Lake	Öztürk (2012a)
Carassius gibelio	24	Fins, skin	Emre Dam Lake	Öztürk (2012a)
Carassius auratus	25	Fins	Emre Dam Lake	Öztürk (2012a)
Scardinius erythrophthalmus	8.7	Skin, gills	Sapanca Lake	Kuş (2012)
Esox lucius	12	Fins, gills	Eber Lake	Öztürk (2012b)
Sander lucioperca	10	Skin, fins	Cernek Lake	Özer and Öztürk (2012)
Cyprinus carpio	33.33	Skin, fins	Tatlı Lake	Özer and Öztürk (2012)
Squalius cephalus	17.5	Gills, fins, skin	Serban Dam Lake	Açıkel and Öztürk (2013)
Alburnus escherichii	7.9	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Barbus plebejus	56.2	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Capoeta tinca	25.5	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Carassius gibelio	41.1	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Cyprinus carpio	100	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Squalius cephalus	42.8	Fins, skin	Kunduzlar Dam Lake	Öztürk (2016)
Blicca bjoerkna	0.1	Fins, skin	Büyük Akgöl Lake	Altan (2017)
Oncorhynchus mykiss		gills	Manyas Dam Lake	Present study
Argulus sp.				
Siluris glanis		Skin	Gölbaşı Lake	Ekingen (1976)
Cyprinus carpio		Skin	İst. Üniv. Sapanca Fish Unit.	Soylu (1985)
Cyprinus carpio	15.3	Gills, skin	Ekinli Lagoon, Uluabat Lake, Kocadere	Altın (1989)
Carassius auratus		Skin	Petshop-Eskşehir	Emeksiz (1996)
Carassius auratus	5		Petshop - Ankara	Şahin (2004)
Cyprinus carpio	20		State Hydraulic Works, 6th Regional Directorate	Küçükgül Güleç and Şahan (2010)
Argulus japonicus Thiele, 1900				
Carassius auratus	0.8		Petshop- Mersin	Koyuncu (2009)
Cyprinus carpio	33	Gills, skin, fins	Petshop- Mersin	Koyuncu (2020)

Figure no. 3 Localities showing geographical distribution of *Argulus foliaceus* in Turkey Marmara Lake (1), Bafa Lake (2), Kocacay Brook (3), Dalaman Brook (4), Pond of Ankara Museum (5), Gölbaşı Lake (6), Eymir Lake (7), Sarıyar Dam Lake (8), Sapanca Lake (9), Ekinli Lagoon (10), Uluabat Lake (11), Kocadere (12), Keban Dam Lake (13), Bekteşağa Pond (14), İznik Lake (15), Porsuk Dam Lake (16), Çavdarhisar Dam Lake (17), Kayaboğazı Dam Lake (18), Kovada Lake (19), Karacaören I Dam Lake (20), Petshop – Ankara (21), Seyhan River (22), Petshop – Mersin (23), Manyas Lake (24), DSİ 6. Bölge Müdürlüğü (25), Durusu (Terkos) Lake (26), Eber Lake (27), Tödürge Lake (28), İst. Üniv. Sapanca Fish Unit (29), Petshop- İzmir (30), Selevir Dam Lake (31), Atatürk Dam Lake (32), Çavuşçu Lake (33), Karacaören II Dam Lake (34), Serban Dam Lake (35), Fish Pond – Samsun (36), Enne Dam Lake (37), Emre Dam Lake (38), Cernek Lake (39), Tatlı Lake (40), Kunduzlar Dam Lake (41), Büyük Akgöl Lake (42), Manyasa Dam Lake (43), Gölbaşı Lake (44), Petshop-Eskşehir (45)



Istros – Museum of Braila "Carol I"

Figure no. 8 *Ichthyophthirius* sp. (0.25 mm)