

## REVIEW OF PARASITIC COPEPODS RECORDED IN FISH FROM TURKEY

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### ABSTRACT

This review presents the occurrence of 62 parasitic copepod species from 72 different fish species (64 wild, two cultured, seven from aquarium) from Turkey.

The parasite species list is arranged by providing parasite species name, host fish, location of host fish capture and author, date of published record.

All parasites and their hosts are confirmed with the recent systematic accounts and full taxonomic account according to literature and internet database. Siphonostomatoida with 47 species and Caligidae with 12 species are the dominant order and family among parasitic copepoda with regard to species diversity, host distribution and location.

### ZUSAMMENFASSUNG: Übersicht parasitärer in Fischen festgestellter Copepoden.

Vorliegende Übersicht bezieht sich auf das Vorkommen von 62 als Parasiten in 72 verschiedenen Fischarten lebender Copepoden Arten (64 wildlebende, zwei in Fischzuchtanlagen, sieben in Aquarien) in der Türkei.

Die Liste der Parasiten umfasst den Namen der parasitierenden Art, den Wirtsfisch, Fangort des Fisches, Name des Sammlers und Veröffentlichung des Belegs.

Alle Parasiten und deren Wirte werden nach den rezenten systematischen und taxonomischen Beschreibungen angegeben. Die Siphonostomatoida sind mit 47 Arten und die Caligidae mit 12 Arten die dominanten Ordnungen und Familien unter den parasitischen Copepoden im Hinblick auf die Artendiversität, Verteilung der Wirte und der Fundorte.

Die wissenschaftlichen Namen aller Parasiten, der Wirtsfische und deren Synonyme wurden anhand von Fachliteratur und Internet Datenbanken überprüft.

### REZUMAT: Recenzia copepodelor parazite pe pești înregistrate în Turcia.

Această recenzie prezintă apariția a 62 de specii parazite copepode pe un număr de 72 de specii diferite de pești din Turcia (64 sălbatice, două de cultură, șapte de acvariu).

Lista de specii parazite cuprinde numele speciilor parazite, a peștilor gazdă, locația din care au fost colectați peștii, autorul, datele publicate în care a fost semnalată apariția lor.

Toți paraziții împreună cu gazdele lor sunt confirmați și actualizați cu cele mai recente elemente de sistematică și taxonomie în vigoare. Ordinul și familia ce domină sunt: Siphonostomatoida cu 47 de specii și Caligidae cu 12 specii (Copepoda) cu privire la diversitatea speciilor, distribuție și areal.

Denumirile științifice ale paraziților, peștii gazdă și sinonimele lor au fost verificate după literatura de specialitate și bazele de date de pe internet.

## INTRODUCTION

Parasitic crustaceans are common on fish hosts in coastal marine and also brackish waters. Three major groups of Crustacea contain fish parasites; Isopoda, Branchiura and Copepoda (Öktener and Sezgin, 2000).

Parasitic copepods belong to the suborder Siphonostomatoida (75%), some 20% to Poecilostomatoida, and only about 5% to Cyclopoida according to Kabata (1988). Parasitic copepods occur on several hosts such as the sponges, cnidarians, chitoderms chordates, sea squirts, fishes and mammals (Boxshall, 2005). Parasitic copepods damage their hosts directly by their attachment mechanisms and by their feeding activities. Infestation by any parasitic copepod may result in loss of condition of the host (Boxshall, 2005). Lester and Hayward (2006) explained effect on host, morphology and life cycle, infection of different parasitic copepods on freshwater and marine habitats.

In Turkey, the total length of the sea coast is 8,333 km, having the Black Sea, the Mediterranean Sea, the Aegean Sea and the Marmara Sea. Among these, the Black and Mediterranean shores have no recessed-protruding structures, instead the Aegean Sea has indented coastline, including bays, gulfs, deltas and islands. The Marmara Sea connects the Mediterranean Sea to the Black Sea (Kılıç, 1999).

The examination of literature on marine and inland water habitats (lake, river) of Turkey by Bilecenoğlu et al. (2014), Çiçek et al. (2015) has revealed the report of 512 marine fish species and 368 freshwater fish species.

This review plans to show the parasitic copepods reported from marine, freshwater, and aquarium fish of Turkey.

## MATERIAL AND METHODS

Information from all available references on parasitic copepod of fishes in Turkey (journal publications, reports of research projects, thesis, proceedings of congress, symposium proceedings) from 1931 to 2015 was gathered to provide parasite-host lists.

The scientific names of all parasites, host fishes and their synonyms were checked according to Bilecenoğlu et al. (2014), Çiçek et al. (2015) and the electronic sites; Eschmeyer (2015); Froese and Pauly (2015), ITIS (2015); WoRMS Editorial Board (2015), concerning with the classification (Tabs. 1 and 2).

Table 1: Change of synonymies and incorrect spellings of parasitic copepod species to current valid names.

Synonyms and incorrect spellings	Valid Names
<i>Lernanthropus mugilis</i> Brian, 1898	<i>Lernanthropsis mugilis</i> (Brian, 1898)
<i>Lernanthropus trachuri</i> Brian, 1903	<i>Lernanthropinus trachuri</i> (Brian, 1903)
<i>Neobrachiella impudica</i> Nordmann, 1832	<i>Thysanote impudica</i> (Nordmann, 1832)
<i>Neobrachiella bispinosa</i> Nordmann, 1832	<i>Parabrachiella bispinosa</i> (Nordmann, 1832)
<i>Eubrachiella exigua</i> Brian, 1906	<i>Parabrachiella exigua</i> (Brian, 1906)
<i>Hatschekia pagellibogneravi</i> Hesse, 1879	<i>Hatschekia pagellibogneravei</i> (Hesse, 1878)
<i>Ergasilus nanus</i> van Beneden, 1870	<i>Ergasilus lizae</i> Krøyer, 1863
<i>Tracheliastes stellifer</i> Nordmann, 1832	<i>Pseudotracheliastes stellifer</i> (Kollar, 1835)
<i>Clavellopsis fallax</i> Heller, 1868	<i>Clavellothis fallax</i> (Heller, 1865)
<i>Caligus fugu</i> Yamaguti and Yamasu, 1959	<i>Caligus lagocephali</i> Pillai, 1961
<i>Hatschekia mulli</i> van Beneden, 1851	<i>Hatschekia mulli</i> (Van Beneden, 1851)

Table 2: Change of synonymies and incorrect spellings of fish to current valid names.

Synonyms and incorrect spellings	Valid Names
<i>Carassius auratus auratus</i>	<i>Carassius auratus</i>
<i>Chondostroma regium</i>	<i>Chondrostoma regium</i>
<i>Leuciscus cephalus</i>	<i>Squalius cephalus</i>
<i>Leuciscus cephalus orientalis</i>	<i>Squalius cephalus</i>
<i>Vimba vimba tenella</i>	<i>Vimba vimba</i>
<i>Chalcalburnus chalcoides</i>	<i>Alburnus chalcoides</i>
<i>Rhodeus sericeus amarus</i>	<i>Rhodeus amarus</i>
<i>Rhodeus sericeus</i>	<i>Rhodeus amarus</i>
<i>Pomatomus saltator</i>	<i>Pomatomus saltatrix</i>
<i>Sparus auratus</i>	<i>Sparus aurata</i>
<i>Spondylisoma cantharus</i>	<i>Spondylisoma cantharus</i>
<i>Trigla lucerna</i>	<i>Chelidonichthys lucerna</i>
<i>Platichthys flesus</i>	<i>Platichthys flesus</i>
<i>Pleuronectes flesus luscus</i>	<i>Platichthys flesus</i>

## RESULTS

Review list on parasitic copepod of fish from Turkey is arranged by providing parasite species name, host fish, location of host fish capture, infestation site and author, date of published record (Tab. 3). Although parasitic copepods at species and genera level were reported from marine fish, only species level will be considered here.

This review presents the occurrence of 62 parasitic copepod species from 72 different fish species (64 wild, two cultured, seven from aquarium) of Turkey.

Diversity of parasitic copepods according to order are as follows: Cyclopoida with two species; Poecilostomatoida with 14 species; Siphonostomatoida with 46 species (Fig. 1).

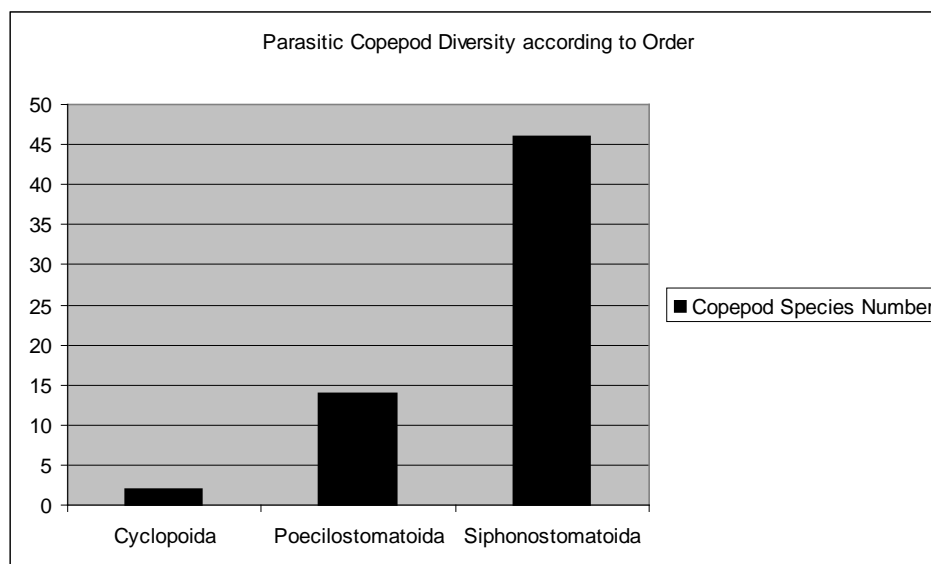


Figure 1: Parasitic copepod species diversity according to order.

Five families are dominant in terms of diversity of parasitic copepods according to family such as: Lernaepodidae with 15 species, Caligidae with 12 species, Lernanthropidae with 10 species, Ergasilidae with nine species, Pennellidae with six species (Fig. 2).

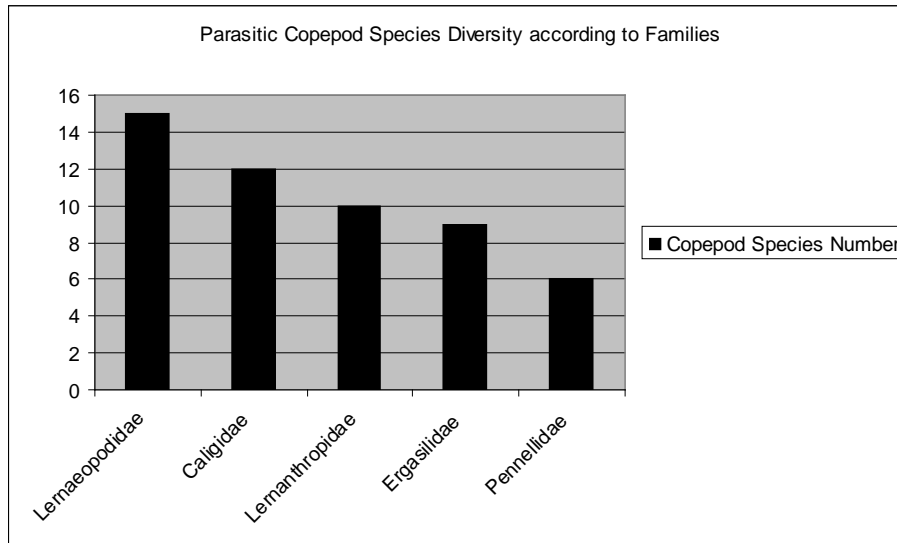


Figure 2: Parasitic copepod species diversity according to dominant families.

Reports of parasitic copepods from Turkey are compatible according to literature in terms of infestation site on host fishes such as caligids from gill filaments, body surface, lernanthropids from gill filaments.

Ergasilidae species were reported from 25 different host fish species; Lernaepodidae from 16 different host fish species; Caligidae from 15 different host fish species; Lernanthropidae from eight different host fish species and Pennellidae from six different host fish species (Fig. 3).

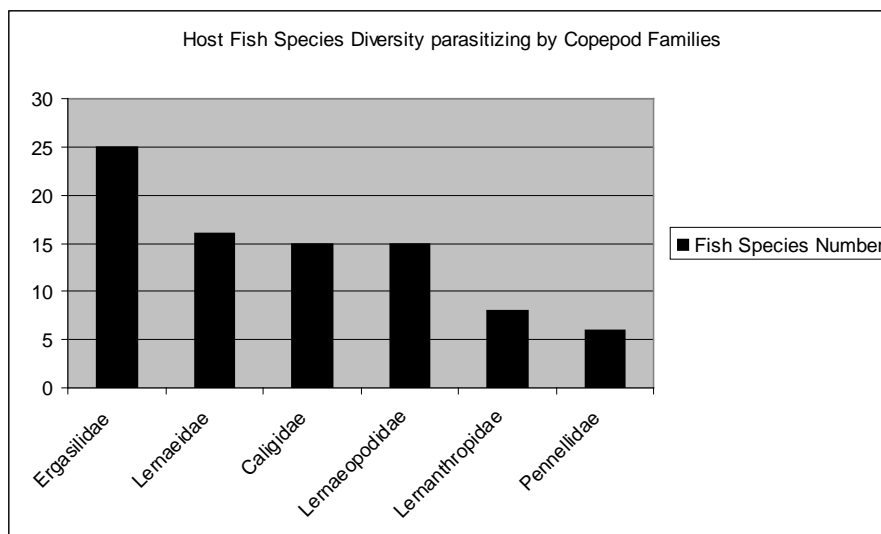


Figure 3: Host fish species diversity parasitizing by copepod families.

Parasitic copepods were reported 40 marine fish species; 20 freshwater host species; seven aquarium fish; three transitional species; two culture fish species. Only two copepod species (*Lernaeopoda galei*, *Pandarus bicolor*) were recorded as parasitic on the two chondrichthyans species (Fig. 4).

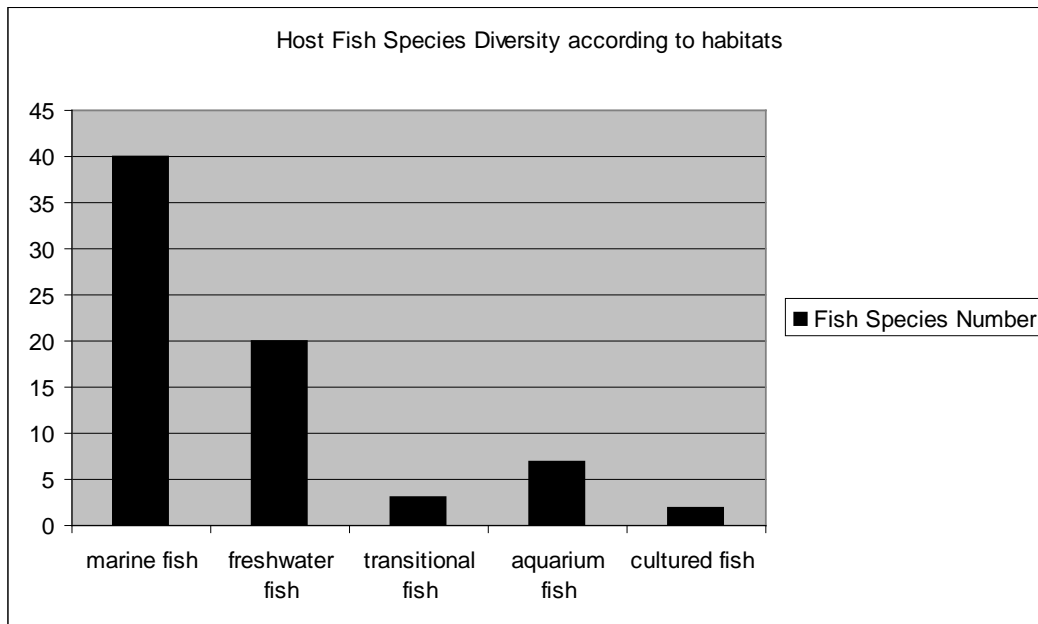


Figure 4: Host fish species diversity examined according to habitats.

Host species belonged to the following functional group categories: one benthopelagic, 21 demersal, 11 pelagic species (Fig. 5).

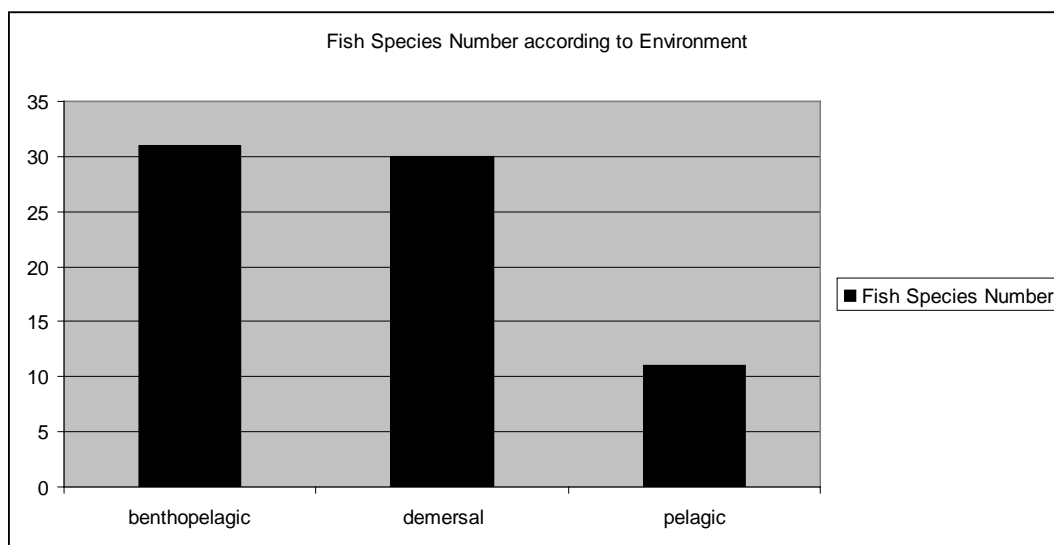


Figure 5: Host fish species diversity examined according to functional group.

Table 3: Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b>Class Copepoda</b>			
<b>Order Cyclopoida</b>			
<b>Family Lernaeidae</b>			
<b><i>Lernaea cyprinacea</i> Linnaeus, 1758</b>			
<i>Carassius carassius</i>			Geldiay and Balık (1974)
<i>Esox lucius</i>	gill	Sapanca Lake	Soylu (1990)
<i>Silurus glanis</i>	gill	Sapanca Lake	Soylu (1990)
<i>Rhodeus sericeus</i>	body surface	aquarium fish producers (Ankara)	Murat (2000)
<i>Pterrophyllum scalare</i>	body surface	aquarium fish producers (Ankara)	Murat (2000)
<i>Poecilia reticulata</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu (2002)
<i>Poecilia latipinna</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu (2002)
<i>Xiphophorus hellerii</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu (2002)
<i>Xiphophorus maculatus</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu (2002)
<i>Carassius auratus</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu (2002)
<i>Ctenopharynodon idella</i>	body surface	Adana DSI	Tabakoğlu (2004)
<i>Cyprinus carpio</i>	body surface	Adana DSI	Tabakoğlu (2004)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<i>Poecilia reticulata</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu and Dönmez (2006)
<i>Poecilia latipinna</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu and Dönmez (2006)
<i>Xiphophorus hellerii</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu and Dönmez (2006)
<i>Xiphophorus maculatus</i>	body surface, muscle	aquarium fish producers (Mersin)	Koyuncu and Dönmez (2006)
<i>Cyprinus carpio</i>		Fish Research Unit, University of Cukurova	Şahan and Duman (2010)
<i>Cyprinus carpio</i>		Karacaören II, Dam Lake	Samancı (2011)
<i>Carassius carassius</i>		Karacaören II, Dam Lake	Samancı (2011)
<i>Cyprinus carpio</i>	skin, fin	Tahtalı Dam Lake	Karakişi and Demir (2012)
<i>Oncorhynchus mykiss</i>	skin	Sücüllü Dam Lake	Akçimen et al. (2012)
<i>Oncorhynchus mykiss</i>	skin	Sücüllü Dam Lake	Tokşen et al. (2015)
<b><i>Lamproglena pulchella</i> Nordmann, 1832</b>			
<i>Scardinius erythrophthalmus</i>	gill	Sapanca Lake	Soylu (1990)
<i>Capoeta trutta</i>	gill	Keban Lake	Sağlam (1992)
<i>Chondrostoma regium</i>	gill	Keban Lake	Sağlam (1992)
<i>Cyprinus carpio</i>	gill	Halil-ür Lake	Öktener et al. (2008a)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<i>Capoeta trutta</i>	gill	Halil-ür Lake	Öktener et al. (2008a)
<b>Order Poecilostomatoida</b>			
<b>Family Chondracanthidae</b>			
<b><i>Chondracanthus lophii</i> Johnston, 1836</b>			
<i>Lophius piscatorius</i>	gill	Marmara Sea	Öktener and Trilles (2004a)
<b>Family Ergasilidae</b>			
<b><i>Ergasilus briani</i> Markevich, 1932</b>			
<i>Alburnus mossulensis</i>	gill	Keban Dam Lake	Sağlam (1992)
<b><i>Ergasilus fryeri</i> Paperna, 1964</b>			
<i>Anguilla anguilla</i>	gill	Bafa Lake	Altunel (1979)
<b><i>Ergasilus gibbus</i> Nordmann, 1832</b>			
<i>Anguilla anguilla</i>	gill	Aegean Sea	Altunel (1980)
<i>Anguilla anguilla</i>	gill	Karacabey Lagoon Lake	Altunel (1990)
<i>Anguilla anguilla</i>	gill	Köyceğiz Lake	Soylu et al. (2013)
<b><i>Ergasilus lizae</i> Krøyer, 1863</b>			
<i>Mugil cephalus</i>	gill	Aegean Sea	Tareen (1982)
<i>Mugil cephalus</i>	gill	Aegean Sea	Altunel (1983)
<i>Liza saliens</i>	gill	Aegean Sea	Altunel (1983)
<i>Liza ramada</i>	gill	Aegean Sea	Altunel (1983)



Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<i>Chelon labrosus</i>	gill	Aegean Sea	Altunel (1983)
<i>Oedalechilus labeo</i>	gill	Aegean Sea	Altunel (1983)
<i>Mugil soiuy</i>	gill	Black Sea	Öktener and Trilles (2004a)
<i>Anguilla anguilla</i>	gill	Köyceğiz Lake	Soylu et al. (2013)
<b><i>Ergasilus mosulensis</i> Rahemo, 1982</b>			
<i>Liza abu</i>	gill	Atatürk Dam Lake	Öktener et al. (2007)
<i>Alburnus mossulensis</i>	gill	Atatürk Dam Lake	Öktener et al. (2008c)
<b><i>Ergasilus sieboldi</i> Nordmann, 1832</b>			
<i>Cyprinus carpio</i>	gill		Geldiay and Balık (1974)
<i>Abramis brama</i>	gill		Geldiay and Balık (1974)
<i>Squalius cephalus</i>	gill		Geldiay and Balık (1974)
<i>Alburnus mossulensis</i>	gill		Geldiay and Balık (1974)
<i>Scardinius erythrophthalmus</i>	gill		Geldiay and Balık (1974)
<i>Esox lucius</i>	fins		Geldiay and Balık (1974)
<i>Capoeta trutta</i>	dorsal, caudal fins	Keban Dam Lake	Sarıyüboğlu and Sağlam (1991)
<i>Chondrostoma regium</i>	gill	Keban Dam Lake	Sağlam (1992)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<i>Capoeta trutta</i>	gill	Keban Dam Lake	Sağlam (1992)
<i>Alburnus orontis</i>	gill	Balıkliag Stream	Cengizler and Goksu (1994)
<i>Capoeta capoeta</i>	gill	Balıkliag Stream	Cengizler and Goksu (1994)
<i>Cyprinus carpio</i>	gill	Karacabey Lagoon Lake	Aydoğdu et al. (2001)
<i>Tinca tinca</i>	gill	Uluabat Lake	Öztürk (2002)
<i>Esox lucius</i>	gill	Karacabey Lagoon Lake	Öztürk et al. (2002)
<i>Mugil cephalus</i>	gill	Karacabey Lagoon Lake	Öztürk and Aydoğdu (2003)
<i>Aphanius chantrei</i>	gill	Sarikum Lagoon Lake	Öztürk (2005)
<i>Platichthys flesus</i>	gill	Sarikum Lagoon Lake	Öztürk (2005)
<i>Tinca tinca</i>	gill	Sapanca Lake	Akbeniz (2006)
<i>Cyprinus carpio</i>	gill	Sapanca Lake	Uzunay (2006)
<i>Vimba vimba</i>	gill	Sapanca Lake	Uzunay (2006)
<i>Neogobius melanostomus</i>	gill	Sırakaraağaçlar Stream	Özer (2007)
<i>Aphanius danfordii</i>	gill	Sarikum Lagoon	Öztürk and Özer (2008)
<b><i>Paraergasilus longidigitus</i> Yin, 1954</b>			
<i>Alburnus alburnus</i>	gill	Enne Dam Lake	Koyun et al. (2007)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Nipergasilus bora</i> Yamaguti, 1939</b>			
<i>Mugil cephalus</i>		Aegean Sea	Ben Hassine (1983)
<i>Chelon labrosus</i>		Aegean Sea	Ben Hassine (1983)
<b><i>Neoergasilus japonicus</i> (Harada, 1930)</b>			
<i>Scardinius erythrophthalmus</i>	fins, gill	Sapanca Lake	Soylu and Soylu (2012)
<b>Family Taeniacanthidae</b>			
<b><i>Taeniacanthus lagocephali</i> Pearse, 1952</b>			
<i>Lagocephalus spadiceus</i>	gill, operculum	Mediterranean Sea	Özak et al. (2012)
<b><i>Anchistrotos laqueus</i> (Leigh-Sharpe, 1935)</b>			
<i>Serranus hepatus</i>	gill	Marmara Sea	Öktener and Trilles (2009)
<b>Family Bomolochidae</b>			
<b><i>Bomolochus bellones</i> Burmeister, 1833</b>			
<i>Belone belone</i>	gill	Aegean Sea	Alaş et al. (2015b)
<b><i>Bomolochus unicirrus</i> (Brian, 1906)</b>			
<i>Sphyraena sphyraena</i>	gill	Mediterranean Sea	Demirkale et al. (2015b)
<b>Order Siphonostomatoida</b>			
<b>Family Caligidae</b>			
<b><i>Caligus apodus</i> (Brian, 1924)</b>			
<i>Mugil cephalus</i>	gill	Aegean Sea	Altunel (1983)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<i>Liza saliens</i>	gill	Aegean Sea	Altunel (1983)
<i>Liza ramada</i>	gill	Aegean Sea	Altunel (1983)
<i>Chelon labrosus</i>	gill	Aegean Sea	Altunel (1983)
<i>Solea solea</i>	body surface	Mediterranean Sea	Özak et al. (2013)
<b><i>Caligus bonito</i> Wilson C. B., 1905</b>			
<i>Coryphaena hippurus</i>	gill, inner surface of operculum	Aegean Sea	Öktener and Trilles (2009)
<b><i>Caligus brevicaudatus</i> Scott, 1901</b>			
<i>Solea solea</i>	body surface	Mediterranean Sea	Özak et al. (2013)
<b><i>Caligus diaphanus</i> Nordmann, 1832</b>			
<i>Chelidonichthys lucerna</i>	gill, inner face of operculum	Aegean Sea	Alaş et al. (2015b)
<b><i>Caligus lagocephali</i> Pillai, 1961</b>			
<i>Lagocephalus suezensis</i>	mouth cavity	Mediterranean Sea	Özak et al. (2012)
<i>Lagocephalus spadiceus</i>	mouth cavity	Mediterranean Sea	Özak et al. (2012)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Caligus ligusticus</i> Brian, 1906</b>			
<i>Lithognathus mormyrus</i>	inner opercular surface	Mediterranean Sea	Demirkale et al. (2015a)
<b><i>Caligus minimus</i> Otto, 1821</b>			
<i>Dicentrarchus labrax</i>		Aegean Sea	Tareen (1982)
<i>Dicentrarchus labrax</i>	mouth, operculum, gill	Farm – Aegean Sea	Tokşen (1999)
<i>Dicentrarchus labrax</i>	mouth, gill	Farm – Aegean Sea	Uluköy and Kubilay (2007)
<i>Dicentrarchus labrax</i>	mouth, operculum, gill	Çamlık Lagoon Lake, Çukurova University Station	Özak (2007)
<i>Dicentrarchus labrax</i>	body surface, fins	Hurmaboğazı Lagoon Lake	Canlı (2010)
<i>Dicentrarchus labrax</i>		Farm – Black Sea	Özer and Öztürk (2011)
<i>Labrus merula</i>	gill, external surfaces	Aegean Sea	Tanrikul and Perçin (2012)
<b><i>Caligus pageti</i> Russel, 1925</b>			
<i>Mugil cephalus</i>	gill	Aegean Sea	Altunel (1983)
<i>Liza saliens</i>	gill	Aegean Sea	Altunel (1983)
<i>Liza ramada</i>	gill	Aegean Sea	Altunel (1983)
<i>Chelon labrosus</i>	gill	Aegean Sea	Altunel (1983)
<b><i>Caligus solea</i> Demirkale, Özak, Yanar and Boxshall, 2014</b>			
<i>Solea solea</i>		Mediterranean Sea	Demirkale et al. (2014)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Caligus pelamydis</i> Krøyer, 1863</b>			
<i>Scomber scombrus</i>		Aegean Sea	Tareen (1982)
<b><i>Caligus temnodontis</i> Brian, 1924</b>			
<i>Pomatomus saltatrix</i>	operculum inner surface, buccal cavity	Mediterranean Sea	Özak et al. (2010)
<b><i>Lepeophtheirus europaensis</i> Zeddäm, Berrebi, Renaud, Raibaut, Gabrion, 1988</b>			
<i>Platichthys flesus</i>	gill	Ekinli Lagoon	Oğuz and Öktener (2007)
<b>Family Hatschekiidae</b>			
<b><i>Hatschekia mulli</i> (Van Beneden, 1851)</b>			
<i>Mullus surmuletus</i>	gill	Aegean Sea	Akmirza (2000a)
<b><i>Hatschekia pagellibogneravei</i> (Hesse, 1878)</b>			
<i>Diplodus annularis</i>		Aegean Sea	Akmirza (2000b)
<b>Family Lernaeopodidae</b>			
<b><i>Clavellotis fallax</i> (Heller, 1865)</b>			
<i>Diplodus sargus</i>	gill	Aegean Sea	Akmirza (2000b)
<i>Spondylisoma cantharus</i>	gill	Aegean Sea	Akmirza (2000b)
<i>Pagellus erythrinus</i>	gill	Aegean Sea	Akmirza (2000b)
<i>Sarpa salpa</i>	gill	Aegean Sea	Akmirza (2000b)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Clavellotis briani</i> Benmansour, Hassine, Diebakate, Raibaut, 2001</b>			
<i>Lithognathus mormyrus</i>	gill	Mediterranean Sea	Koyuncu et al. (2015)
<b><i>Clavellotis strumosa</i> (Brian, 1906)</b>			
<i>Pagellus erythrinus</i>	gill	Marmara Sea	Öktener et al. (2008b)
<b><i>Clavella alata</i> Brian, 1909</b>			
<i>Phycis phycis</i>	gill	Aegean Sea	Öktener et al. (2010)
<b><i>Clavellisa scombri</i> (Kurz, 1877)</b>			
<i>Scomber scombrus</i>	gill	Marmara Sea	Öktener and Trilles (2009)
<b><i>Lernaeopoda galei</i> Kroyer, 1837</b>			
<i>Mustelus mustelus</i>	cloacal region	Aegean Sea	Karaytuğ et al. (2004)
<b><i>Thysanote impudica</i> (Nordmann, 1832)</b>			
<i>Chelidonichthys lucerna</i>	gill	Marmara Sea	Öktener and Trilles (2004a)
<b><i>Parabrachiella bispinosa</i> (Nordmann, 1832)</b>			
<i>Chelidonichthys lucerna</i>	gill	Mediterranean Sea	Öktener and Trilles (2004b)
<b><i>Parabrachiella exigua</i> (Brian, 1906)</b>			
<i>Pagellus erythrinus</i>	gill	Mediterranean Sea	Öktener and Trilles (2004b)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Parabrachiella merlucii</i> (Bassett-Smith, 1896)</b>			
<i>Merluccius merluccius</i>	gill	Aegean Sea	Alaş et al. (2015d)
<b><i>Parabrachiella insidiosa</i> (Heller, 1865)</b>			
<i>Merluccius merluccius</i>	gill	Aegean Sea	Alaş et al. (2015d)
<b><i>Parabrachiella hostilis</i> (Heller, 1868)</b>			
<i>Umbrina cirrosa</i>	gill	Aegean Sea	Alaş et al. (2015a)
<b><i>Tracheliastes polycolpus</i> Nordmann, 1832</b>			
<i>Capoeta trutta</i>	fins	Keban Dam Lake	Sağlam (1992)
<i>Capoeta umbla</i>	fins	Murat River	Koyun (2011)
<b><i>Naobranchia cygniformis</i> Hesse, 1863</b>			
<i>Spicara maena</i>	gill	Aegean Sea	Alaş et al. (2015c)
<b><i>Pseudotracheliastes stellifer</i> (Kollar, 1835)</b>	gill	Uluabat Lake, Kocadere Lake	Geldiay and Balık (1974)
<i>Silurus glanis</i>	gill	Uluabat Lake, Kocadere Lake	Geldiay and Balık (1974)
<b>Family Lernanthropidae</b>			
<b><i>Lernanthropus brevis</i> Richiardi, 1879</b>			
<i>Dicentrarchus labrax</i>	gill	Aegean Sea	Akmirza (2003)
<b><i>Lernanthropus callionymicola</i> El-Rashidy and Boxshall, 2012</b>			
<i>Callionymus filamentosus</i>		Mediterranean Sea	Özak et al. (2014)
<b><i>Lernanthropus gisleri</i> Van Beneden, 1852</b>			
<i>Umbrina cirrosa</i>	gill	Mediterranean Sea	Özak et al. (2014)



Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b><i>Lernanthropus kroyeri</i> Van Beneden, 1851</b>			
<i>Dicentrarchus labrax</i>	gill	Farm – Aegean Sea	Tokşen (1999)
<i>Dicentrarchus labrax</i>	gill	Farm – Aegean Sea	Özel et al. (2004)
<i>Dicentrarchus labrax</i>	gill	Farm – Black Sea	Öktener et al. (2010b)
<b><i>Lernanthropus nordmanni</i> Wilson C. B., 1922</b>			
<i>Dicentrarchus labrax</i>	gill	Aegean Sea	Tareen (1982)
<b><i>Lernanthropsis mugilis</i> (Brian, 1898)</b>			
<i>Liza aurata</i>	gill	Aegean Sea	Altunel (1983)
<b><i>Lernanthropinus trachuri</i> (Brian, 1903)</b>			
<i>Trachurus mediterraneus</i>	gill	Sea of Marmara	Öktener and Trilles (2004a)
<b><i>Lernanthropus indefinitus</i> Koyuncu, Romero, Karaytuğ, 2012</b>			
<i>Argyrosomus regius</i>	gill	Mediterranean Sea	Koyuncu et al. (2012)
<b><i>Mitrapus oblongus</i> (Pillai, 1964)</b>			
<i>Sardinella aurita</i>	gills	Mediterranean Sea	Romero and Öktener (2010)
<b><i>Sagum posteli</i> Delamare – Deboutteville and Nunes-Ruivo, 1954</b>			
<i>Epinephelus aeneus</i>	gill	Aegean Sea	Tokşen et al. (2012)
<b>Family Pandaridae</b>			
<b><i>Pandarus bicolor</i> Leach, 1816</b>			
<i>Mustelus mustelus</i>	ventral surface, fins	Aegean Sea	Öktener and Trilles (2009)

Table 3 (continued): Parasitic Copepods – Host species list.

Parasites and hosts	Sampled from	Location of the host fish capture	Authors
<b>Family Pennellidae</b>			
<b><i>Pennella instructa</i> Wilson, 1917</b>			
<i>Xiphias gladius</i>	base of anal, pectoral fins, abdominal tissue	Aegean Sea	Öktener et al. (2007)
<i>Seriola dumerili</i>	skin	Farm – Mediterranean Sea	Öktener (2009)
<i>Xiphias gladius</i>	eye	Aegean Sea	Öktener et al. (2010c)
<b><i>Pennella filosa</i> (Linnaeus, 1758)</b>			
<i>Xiphias gladius</i>	fins, body, operculum	Aegean Sea	Tuncer et al. (2010)
<i>Xiphias gladius</i>	operculum	Aegean Sea	Tanrikul and Akyol (2011)
<b><i>Lernaeenicus neglectus</i> Richiardi, 1877</b>			
<i>Mugil cephalus</i>		Aegean Sea	Tareen (1982)
<b><i>Lernaeolophus sultanus</i> Nordmann, 1839</b>			
<i>Diplodus vulgaris</i>	Mouth base	Mediterranean Sea	Öktener and Trilles (2004b)
<b><i>Peniculus fistula</i> von Nordmann, 1832</b>			
<i>Coryphaena hippurus</i>	ventral fin	Aegean Sea	Öktener (2008)
<b><i>Lernaeocera branchialis</i> (Linnaeus, 1767)</b>			
<i>Trisopterus minutus</i>	upper and base of mouth	Aegean Sea	Alaş et al. (2015c)

### CONCLUSIONS

The parasitic copepods are one of the most important enemies of fish. There were done several studies about parasitic copepods in Turkey. This review is aimed to update the species list of the parasitic copepods reported from host fish in aquarium and farm conditions, marine and freshwater habitats of Turkey. It includes new parasitic copepod species records with host according to changes in classification.

Several studies on diversity of parasitic copepods in fish from freshwater and marine water habitats have been studied in the world (Dippenaar, 2005; Benmansour and Ben Hassine, 1997; Avenant-Oldewage and Oldewage, 1993; Barzegar and Jalali, 2009; Holland and Kennedy, 1997; Radujkovic and Raibaut, 1989; Ramdane and Trilles, 2010; Bakır et al., 2014; Khamees et al., 2015; Luque et al., 2013; Morales-Serena et al., 2012; Raibaut et al., 1998).

Fish-parasite checklist studies are important taxonomic documents obtaining the fish-parasite relationships, host selectivity and geographic distribution of fish parasites. They may contribute as baseline data in the disciplines of parasitology, zoology, medicine, environmental science in terms of determining biological diversity, treatment and control of parasites, identification of parasite, determining host selectivity and geographic distribution of fish zoonoses, compare of fish parasite fauna of local, regional and worldwide (Alaş and Öktener, 2015).

Online databases about flora and fauna were created by both civil society organizations and international science centres in a virtual environment developing with the information age. Online database such as ITIS; Fishbase, WoRMS, shark-references.com, etc., can contribute to the demonstration of biodiversity, taxonomy of the species of the existing flora and fauna and their geographic, the provision of bio-ecological characteristics, also fulfils a really important task by revising and updating the addition of new species presented to the scientific world (Alaş and Öktener, 2015).

Checklist studies about fish parasites can give information of host specificity, geographic distribution, bio-ecological characteristics between parasite and host. They may constitute a source for scientists as zoologists, parasitologists, ecologists, etc., working about fish parasites and also useful in minimizing of doubtful, error reports and notifications of both the parasite-host. Checklists are important in achieving all of data about parasite and hosts among the countries at a glance. But, you know that valid names and synonymies of parasite and host species may be changed. Reports of parasite findings may be published at different/same dates and regions by different researchers. Some information can not be reached. Although checklist studies are important, they need to revise and update and it must be delivered to many readers. In this sense, checklist studies may contain little restrictive and not current information, hence these constitute disadvantages. Therefore, we want to specify the examples that the opinion that the more efficient the database (Alaş and Öktener, 2015).

Ecological conditions, habitat properties and fish diversity can be different in each country. For these reasons, data obtained from various countries cannot be compared with each other. Our aim is to reveal the parasitic copepod diversity for fishes in Turkey.

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