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# Checklist of Fish Hosts of Species of *Lernaea* Linnaeus, 1758 (Hexanauplia: Cyclopoida: Lernaeidae) in Iraq

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**Abstract:** Surveying literature concerning the occurrence of *Lernaea cyprinacea* and *L. oryzophila* as well as some unidentified *Lernaea* species infecting fishes of Iraq, showed the infection of 31 fish species with *L. cyprinacea*, one fish species with *L. oryzophila* and seven fish species with unidentified *Lernaea* species as adults or larval stages. The infections were distributed in Tigris, Euphrates and Shatt Al-Arab rivers as well as some of their tributaries, lakes, marshes, drainage networks in addition to many fish ponds and floating cages in different parts of Iraq. The study also provided information on control methods, histopathological effects, some ecological aspects of the infection, life cycle, experimental infection, fertilization of fish ponds and effect of water pollution on the infection with *L. cyprinacea*. It is concluded that fail of inspection of the common carp, *Cyprinus carpio*, while transferring to different inland waters and fish farm as well as ignoring the application of quarantine measures plaid an important role in spreading *L. cyprinacea* in new habitats as well as the infection of other freshwater fishes with this parasite.

**Keywords:** *Lernaea cyprinacea*, *L. oryzophila*, *Lernaea* spp., Fishes, Iraq

## Introduction

According to GBIF (2020), the genus *Lernaea* Linnaeus, 1758 belongs to the family Lernaeidae, order Cyclopoida, class Hexanauplia of the phylum Arthropoda. In addition to these ranks, ITIS (2020) and WoRMS (2020) add the subphylum Crustacea. However, ITIS (2020) considers the class as Maxillopoda. This genus includes 61 valid species (GBIF, 2020). However WoRMS (2020) listed 53 valid species, EOL (2020) listed 55 valid species, but ITIS (2020) listed only nine species. Lester & Hayward (2006) demonstrated that there are over 40 species of this genus and the World of Copepods database (Walter & Boxshall, 2020) listed 43 valid species.

Among the species of this genus, *Lernaea cyprinacea* Linnaeus, 1758 is known to infect 34 fish species and subspecies from Japan (Nagasawa et al., 2007), Gervasoni et al. (2018) listed 23 fish species as hosts for this parasite in Argentina.

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On the other hand, a minimum of 79 different native and exotic host fish species have been documented as hosts in North America, many of which are found in the southeast (Benson, 2020). This species is also known to infect some amphibians (Nagasawa et al., 2007) especially frog tadpoles (Roberts & Janovy, 2009; Noga, 2010). *L. cyprinacea* has been introduced to many countries by translocation of cyprinids (Piasecki et al., 2004; Hassan et al., 2008).

The adult female *L. cyprinacea* has a small semi spherical cephalothorax, which contains the mouth. Behind it, is a well-developed holdfast, normally consisting of two bifurcate dorsal processes and two simple ventral processes (Figure 1). The anterior of the parasite is embedded in its host's flesh and is anchored there by these large processes that arise from the parasite's cephalothorax and thorax, hence, the common name anchor worm (Roberts & Janovy, 2009). The elongate neck and trunk carry the four pairs of legs of the premetamorphosed female. The abdomen is short. The holdfast and part of the trunk are buried in the host while most of the trunk and the abdomen project into the water (Lester & Hayward, 2006). The genital pore is located at or near the posterior extremity and the two egg sacs project well beyond the body (Thatcher & Williams, 1998). Gervasoni et al. (2018) gave a detailed description and measurements of the post metamorphic females of *L. cyprinacea*. A single female may produce several hundred larvae about every two weeks for up to 16 weeks at optimal temperatures (> 25 °C). After several nonparasitic stages, the terminal copepodid stage attaches to a fish and mates, and the male dies. The female then penetrates under the skin of the fish and differentiates into an adult (Noga, 2010).

The anchor worm, agent of lernaeosis, can cause intense inflammation, leading to secondary bacterial (e.g., *Aeromonas hydrophila*) and fungal infections. These secondary infections sometimes worsen and kill the infected fishes. Larger numbers of parasites on the gill can interfere with respiration, causing death (Hossain et al., 2018). It causes damage to scales, skin, and underlying muscle tissue. Sever lesions including ulcers, hemorrhages and fibrous nodules were found on the body surface of parasitized fishes (Raissy et al., 2013). These parasites attach themselves to all external parts of the host body and also inside the mouth, in the gill chambers, occasionally on the gill filaments or even in the eyes of fishes (Avenant-Oldewage, 2012). Fishes that are small relative to the parasite can easily be killed by infection with several individuals (Roberts & Janovy, 2009).

*L. cyprinacea* has nine stages in the life cycle, including three free-living naupliar stages, five copepodid stages and one adult stage (Hoffman, 1999). A well line drawing of this life cycle is well demonstrated by Avenant-Oldewage (2012).

For treatment, Molnár et al. (2019) recommended Diflurobenzuron (Dimilin) against *Lernaea* spp. in a concentration of 0.5 kg/ha. Organophosphates can also be used in ponds in concentration of 1-1.5 g/m3 as well as in bath treatment in a concentration of 0.5 mg/l for a period of six hours. Quarantining fishes for at least three weeks at 25 °C (where tolerated by the fishes) will allow time for any *L. cyprinacea* present on the gills to mature and attach to the skin making them easily recognizable by the naked eye (Hoole et al, 2001).

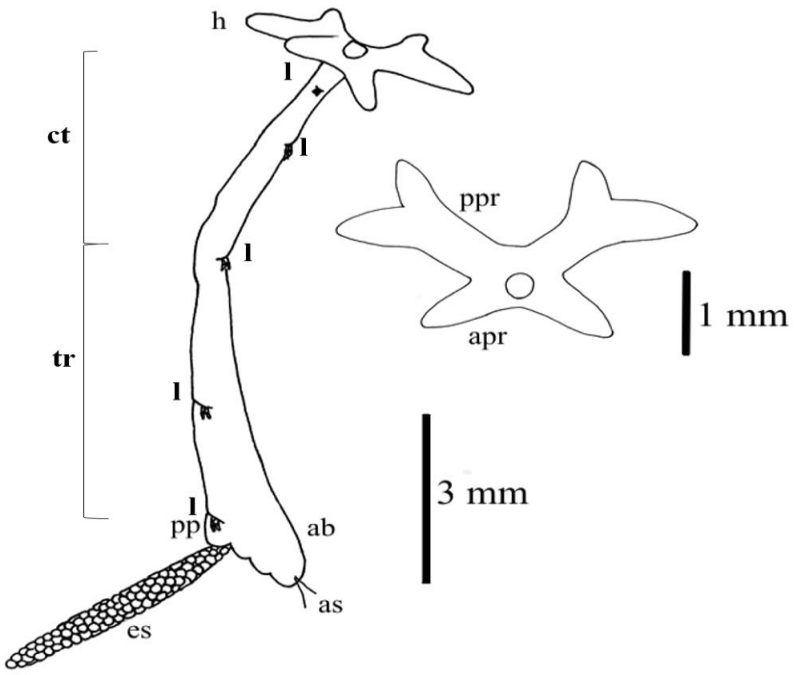


Figure 1: *Lernaea cyprinacea*, side view (left): ab=abdomen; as= anal setae; ct= cephalothorax; es= egg sac; h= head; l= legs; pp= pregenital prominence; tr= trunk. Detail of cephalic structures (right): apr= anterior protuberance; ppr= posterior protuberance (from Gervasoni et al., 2018).

In Iraq, *L. cyprinacea* was firstly observed and identified in April 1969 in Al-Zaafaraniyah fish culture station, south of Baghdad on four exotic fish species as well as on three native fish species (Al-Hamed & Hermiz, 1973). Since then, 105 references demonstrated the occurrence of *L. cyprinacea* from native as well as exotic fish species from different inland water bodies as well as from fish farms in Iraq. The forthcoming subtitle "Surveys achieved on *Lernaea* species from fishes of Iraq" within the Results and Discussion provides an account on such references. Beside the record of *L. cyprinacea* within these references, some other aspects were also covered by some researchers of these references. Such aspects included the control methods with quicklime (Al-Sardee, 1992), sumcidin (Bannai et al., 2007; Al-Ali et al., 2013), dipterex and other organophosphorus compounds (Al-Hamed & Hermiz, 1973; Ali & Shaaban, 1984; Ali, 1986; Al-Dabhawi, 1992), formalin (Al-Hamed & Hermiz, 1973), potassium permanganate (Mhaisen, 1982) and plant extracts (Al-Dulaimi, 2002; Yaseen, 2004; Yaseen et al., 2009; Naji, 2010), histopathological effects (Al, Sardee, 1992; Al-Shaikh & Al-Sardee, 1993; Al-Jadoaa, 2002; R.A. Kadim, 2003; Kadim & Al-Zubaidy, 2009), some ecological aspects of the infection (Al-Niaeem, 2006; Al-Salim et al., 2007; Jassim, 2007; Al-Jubory, 2009; Sadiq, 2017), life cycle (Al-Hamed & Hermiz, 1973; Al-Marjan,

2007; Al-Marjan & Abdullah, 2008), experimental infection (Al-Marjan, 2007; Al-Marjan & Abdullah, 2008; R.A. Kadhim, 2009), fertilization of fish ponds with ruminant faeces and then poultry faeces (Al-Jubory, 2009) and effect of water pollution on lernaeosis (Al-Saboonchi et al., 2009).

The present article is designed to revise all records on *Lernaea* species from fishes of Iraq and provide update lists on them and their host species in Iraq. Al-Nasiri et al. (2001) gave a distinguishing key to distinguish between *L. cyprinacea* and *L. oryzophila* on the basis of the formula of antennule, number of setae of the distal part of a terminal segment of antenna, number of claws which tip the terminal segment of maxilliped as well as the armature of the terminal segment of endopods of legs 1-4.

This article is a continuation of some previous checklists on some groups of fish parasites of Iraq, such as those of acanthocephalan species (Mhaisen, 2002), *Gyrodactylus* species (Mhaisen & Abdul-Ameer, 2013), diplozoid species (Mhaisen & Abdul-Ameer, 2014), *Dactylogyrus* species (Mhaisen & Abdul-Ameer, 2019a), ancylodiscoidid and ancyrocephalid species (Mhaisen & Abdul-Ameer, 2019b), *Trichodina* species (Mhaisen & Abdul-Ameer, 2020) and *Myxobolus* species (Mhaisen & Al-Jawda, 2020).

## Sources and Methods

A total of 106 references (64 published research papers, 26 unpublished M. Sc. theses, two M. Tech. theses, one higher diploma, six unpublished Ph. D. theses, five conference abstracts, one report and one book) dealing with records on *Lernaea* species from fishes of Iraq were used to prepare the present article. Data from such references were gathered to provide reliable information on the distribution of such parasites on fishes from different water bodies and fish farms in Iraq as well as fish-*Lernaea* list. For fishes, the scientific names were reported as they appeared in their original references but then they were checked with an account on freshwater fishes of Iraq (Coad, 2010). Fish valid scientific names and their authorities were corrected according to well-known specialized electronic site (Fricke et al., 2020). For each alphabetically listed *Lernaea* species, valid fish host species are also alphabetically arranged together with their synonyms (if any) and their chronologically arranged references.

## Results and Discussion

### Surveys Achieved on *Lernaea* Species from Fishes of Iraq

The available literature concerning the occurrence of *Lernaea* species from fishes of Iraq indicated that such parasites are distributed in freshwater fishes in different water bodies as well as in fish ponds, farms and hatcheries. The records of such parasites can be grouped into seven major categories according to localities of collection of the infected fishes. These are:

1- Tigris river at Nineveh province (Al-Niaeemi, 2011), Salah Al-Din province (Al-Jawda et al., 2000) and Baghdad province (Balasem et al., 1993; Al-Janabi, 2010a; Sheyaa, 2019), as well as some tributaries of Tigris river which included

Greater Zab river (Al-Marjan, 2016), Lesser Zab river (Mama, 2012; Mama & Abdullah, 2012, 2013) and Mortuka stream at Erbil province (Abdullah, 2004).

2- Euphrates river and its branches at Babylon province (Al-Zubaidy, 2007; Hussain, 2007, 2008), Al-Diwaniah province (Al-Jadoaa, 2002; Al-Waaly, 2005; Yassin, 2010), and Al-Muthanna province (Al-Helli, 2019).

3- Shatt Al-Arab river (Al-Janabi, 2010b; Eassa et al., 2014; Ahmed, 2015; Al-Niaeem et al., 2015) and its branches which included Ashar canal (Ahmed, 2015), Garmat Ali river (Khamees, 1997; Al-Saboonchi et al., 2009; A.H. Kadhim, 2009), Al-Salihiya river (Al-Janae'e, 2010) and Kuritrad river (Al-Saboonchi et al., 2009).

4- Some lakes, depressions and marshes: These included surveys from two lakes in Sulaimaniya province: Darbandikhan lake (Abdullah, 2005, 2013; Abdullah & Abdullah, 2015a, b) and Dokan lake (Abdullah, 1990, Abdullah & Ismail, 2004; Abdullah & Rasheed, 2004), Habbaniyah Lake in Al-Anbar province (Ali et al., 1988a), Hemrin dam lake in Diyala province (Balasem et al., 2000) and Al-Hammar marsh in Basrah province (Jarallah et al., 2005; Abbas, 2014).

5- Some drainage networks at Baghdad province (Mhaisen et al., 2003), Babylon province (Al-Musawi, 2016) and Al-Diwaniyah province (Al-Waaly, 2005) in addition to some pools in Basrah province (Al-Ali et al., 2013).

6- Fish ponds and farms which included some at Duhok province (Ali, 2002; Sadiq, 2017), Nineveh province (Daoud et al., 2005; Al-Hamdane & Azziz, 2006), Erbil province (Ali, 2002; Abdullah, 2004; Al-Marjan, 2007; Al-Marjan & Abdullah, 2008, 2009; Mama, 2012; Mama & Abdullah, 2012; Mustafa, 2016), Suliemaniya (Ali, 2002; Abdulrahman et al., 2020), Salah Al-Din province (Khalifa, 1989), Al-Tameem province (Mhaisen, 1983), Baghdad province (Al-Hamed & Hermiz, 1973; Khalifa et al., 1978; Khalifa, 1982; Sarsam, 1982; Ali & Shaaban, 1984; Ali, 1985, 1986; Khalifa, 1989; Al-Dabhawi, 1992; Al-Sardee, 1992; Al-Shaikh & Al-Sardee, 1993; Mhaisen et al., 1993a, b; Al-Aubaidi, 1999; Al-Aubaidi et al., 1999; Mohammad-Ali et al., 1999; Sadek, 1999; Al-Nasiri, 2000; Salih et al., 2000; Al-Nasiri et al., 2001; Al-Tamimi, 2001; Al-Dulaimi, 2002; Al-Nasiri et al., 2002; Asmar et al., 2004; Sadek et al., 2006), Babylon province (Mhaisen, 1983; Ali et al., 1988b; 1989; Mhaisen et al., 1989, 1990; Mhaisen & Abul-Eis, 1991; Al-Sardee, 1992; Al-Shaikh & Al-Sardee, 1993; Al-Zubaidy, 1998; Muhammed, 2000; Al-Jadoaa, 2002; Al-Zamily, 2002; Kadim, 2003; Yaseen, 2004; Al-Rubaie et al., 2007; Al-Jubory, 2009; R.A. Kadhim, 2009; Kadim & Al-Zubaidy, 2009; Yaseen et al., 2009; Hussain et al., 2011; Al-Musawi, 2016; Hussain, 2017; Al-Turaihi, 2018), Wasit province (Ali et al., 1988b), Al-Diwaniyah province (Abd & Abdul wahab, 2011) and Basrah province (Mhaisen, 1982, 1986; Abed, 2005; Al-Niaeem, 2006; Al-Salim et al., 2007; Bannai et al., 2007; Jassim, 2007; Hussein et al., 2011; Ahmed & Ali, 2013; Rasool, 2017) in addition to some fish aquaria in Al-Najaf Al-Ashraf province (Naji, 2010) and Basrah province (Al-Niaeem, 2006) as well as some floating cages at Euphrates river at Al-Najaf Al-Ashraf province (Al-Salami, 2019) and Basrah province (Eassa et al., 2014). Al-Tayyar et al.

(2011) gave no site for the fish pond.

7- Fish markets at Baghdad province (Al-Zamily, 2002), Al-Diwaniyah province (Abd & Abdul wahab, 2011) and Basrah province (Khamees, 1997).

Surveying literature concerning the occurrence of *Lernaea* species from fishes of Iraq showed the infection of 31 valid fish species with *L. cyprinacea* and *L. oryzophila* in addition to some unidentified species of *Lernaea*. In some cases, the copepoidal larval stage (fifth larval stage) of either *L. cyprinacea* were isolated (Jassim, 2007; Ahmed & Ali, 2011; Al-Helli, 2019) or the larval stages of *Lernaea* sp. were isolated (Al-Tayyar et al., 2011; Al-Helli, 2019) from different fish species. The scientific names as well as the full authority of the infected fish species with *L. cyprinacea*, *L. oryzophila* as well as the unidentified *Lernaea* species together with their orders and families, based on Fricke et al. (2020), are shown in the following systematic account.

Class Actinopteri
Order Cypriniformes
Family Cyprinidae
*Arabibarbus grypus* (Heckel, 1843)
*Capoeta damascina* (Valenciennes, 1842)
*Carasobarbus luteus* (Heckel, 1843)
*Carassius auratus* (Linnaeus, 1758)
*Carassius carassius* (Linnaeus, 1758)
*Cyprinion macrostomus* Heckel, 1843[1]
*Cyprinus carpio* Linnaeus, 1758
*Garra rufa* (Heckel, 1843)
*Luciobarbus barbulus* (Heckel, 1847)
*Luciobarbus esocinus* Heckel, 1843
*Luciobarbus xanthopterus* Heckel, 1843
*Mesopotamichthys sharpeyi* (Günther, 1874)
Family Xenocyprididae[2]
*Ctenopharyngodon idella* (Valenciennes, 1844)
*Hemiculter leucisculus* (Basilewsky, 1855)
*Hypophthalmichthys molitrix* (Valenciennes, 1844)
Family Leuciscidae
*Acanthobrama marmid* Heckel, 1843
*Alburnus sellal* Heckel, 1843
*Chondrostoma regium* (Heckel, 1843)
*Leuciscus vorax* (Heckel, 1843)
*Squalius lepidus* Heckel, 1843
Order Siluriformes
Family Bagridae
*Mystus pelusius* (Solander, 1794)
Family Siluridae

*Silurus triostegus* Heckel, 1843
Family Heteropneustidae
*Heteropneustes fossilis* (Bloch, 1794)
Order Gobiiformes
Family Gobiidae
*Boleophthalmus dussumieri* Valenciennes, 1837
Order Synbranchiformes
Family Mastacembelidae
*Mastacembelus mastacembelus* (Banks & Solander, 1794)
Order Anabantiformes
Family Osphronemidae
*Trichopodus trichopterus* (Pallas 1770)
Order Cyprinodontiformes
Family Poeciliidae
*Gambusia holbrooki* Girard, 1859
*Poecilia sphenops* Valenciennes, 1846
Family Aphaniidae
*Aphanius stoliczkanus* (Day, 1872)[3]
Order Mugiliformes
Family Mugilidae
*Planiliza abu* (Heckel, 1843)
*Planiliza subviridis* (Valenciennes, 1836)

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[1] The specific name of this fish is spelled as *macrostomus* according to Fricke et al. (2020) but as *macrostomum* in Froese & Pauly (2019), WoRMS (2020) as well as in all concerned Iraqi references within this article. The specific name *macrostomum* was also ascertained through a personal communication with Dr. Jörg Freyhof.

[2] All references so far concerning the occurrence of *Lernaea* species in Iraq referred to the grass carp *Ctenopharyngodon idella*, sharpbelly *Hemiculter leucisculus* and the silver carp *Hypophthalmivhthys molitrix* as belonging to the family Cyprinidae. However, Tan & Armbruster (2018) in their phylogenetic classification, placed these three species within the family Xenocyprinidae. This is also followed by Fricke et al. (2020) but not yet by Froese & Pauly (2019).

[3] According to Freyhof et al. (2017), *Aphanius dispar* in the Arabian Peninsula waters is a complex species and the species in Iraq was *Aphanius stoliczkanus* (Day, 1872).

***Lernaea*-Host List**

The following is an alphabetical listing of *Lernaea* species so far recorded from fish species of Iraq with their concerned hosts and references. Most of the records refer to the adult stage of *Lernaea* species, but some refer to both the adult as well as the larval stages (Jassim, 2007; Ahmed & Ali, 2011; Al-Tayyar et al., 2011; Al-Helli, 2019).

1- *Lernaea cyprinacea* Linnaeus, 1758: As stated by Mhaisen (1982), the identification of this crustacean was ascertained by Dr. H.E. Gruner, the curator of the Crustacean Department at Berlin Natural History Museum when the senior author of this article brought some specimens to him during his visit to Germany in December 1981. This species was reported from 30 valid fish species in addition to its report from some unidentified fish species as in the following alphabetically listed fish species.

*Acanthobrama marmid*: Al-Nasiri (2000).

*Alburnus sellal*: Al-Nasiri (2000) reported this fish by its synonymous name *Alburnus capito*.

*Aphanius stoliczkanus* (as *Aphanius dispar*): Mhaisen (1986) and A.H. Kadhim (2009).

*Arabibarbus grypus*: Al-Hamed & Hermiz (1973), Khalifa et al. (1978), Abdullah (2004), Abdullah & Ismail (2004), Hussain (2007) and Sheyaa (2019). The synonymous name of this fish (*Barbus grypus*) was used by all the mentioned references in this paragraph, except Sheyaa (2019).

*Boleophthalmus dussumieri*: Khamees (1997) and Al-Janabi (2010b). This fish was misidentified as *Pseudopocrypte dentatus* by Al-Janabi (2010b).

*Capoeta damascina*: Al-Jawda et al. (2000) reported this fish with its synonymous name *Barbus belayewi*.

*Carasobarbus luteus*: Al-Hamed & Hermiz (1973), Khalifa et al. (1978), Abdullah (1990), Khamees (1997), Al-Nasiri (2000), Al-Jadoaa (2002), Abdullah & Ismail (2004), Al-Waaly (2005), Ahmed (2015). Apart from Ahmed (2015), all the remaining references reported this fish by its synonymous name *Barbus luteus*.

*Carassius auratus*: Al-Hamed & Hermiz (1973), Khalifa et al. (1978), Mhaisen (1982), Ali (1986), Mhaisen (1986), Asmar et al. (2004), Al-Niaeem (2006), Al-Janae'e (2010), Naji (2010), Ahmed (2015).

*Carassius carassius*: Salih et al. (2000).

*Chondrostoma regium*: Balasem et al. (1993), Al-Marjan (2016).

*Ctenopharyngodon idella*: Al-Hamed & Hermiz (1973), Ali et al. (1988b), Mhaisen et al. (1990), Al-Zubaidy (1998), Al-Nasiri (2000), Muhammed (2000), Al-Dulaimi (2002), Ali (2002), Al-Jadoaa (2002), Jassim (2007).

*Cyprinion macrostomum*: Mohammad-Ali et al. (1999), Abdullah & Ismail (2004), Hussain (2007).

*Cyprinus carpio*: Al-Hamed & Hermiz (1973), Khalifa et al. (1978), Khalifa (1982), Mhaisen (1982), Sarsam (1982), Mhaisen (1983), Ali & Shaaban (1984), Ali (1985, 1986), Mhaisen (1986), Ali et al. (1988a, b), Khalifa (1989), Abdullah (1990), Mhaisen & Abul-Eis (1991), Al-Dabhawi (1992), Al-Sardee (1992), Al-Shaikh & Al-Sardee (1993), Mhaisen et al. (1993a, b), Khamees (1997), Al-Zubaidy (1998), Al-Aubaidi (1999), Al-Aubaidi et al. (1999), Mohammad-Ali et al. (1999), Sadek (1999), Al-Nasiri (2000), Muhammed (2000), Salih et al. (2000), Al-Tamimi (2001), Al-Dulaimi (2002), Ali (2002), Al-Jadoaa (2002), Al-Nasiri et al. (2002), Al-Zamily (2002), Kadim (2003), Mhaisen et al. (2003), Abdullah (2004), Abdullah & Ismail (2004), Abdullah &

Rasheed (2004), Asmar et al. (2004), Yaseen (2004), Abdullah (2005), Abed (2005), Daoud et al. (2005), Al-Hamdane & Azziz (2006), Al-Niaeem (2006), Sadek et al. (2006), Al-Marjan (2007), Al-Rubaei et al. (2007), Al-Salim et al. (2007), Al-Zubaidy (2007), Bannai et al. (2007), Jassim (2007), Al-Marjan & Abdullah (2008), Al-Jubory (2009), Al-Marjan & Abdullah (2009), Al-Saboonchi et al. (2009), R.A. Kadhim, (2009), Kadim & Al-Zubaidy (2009), Yaseen et al. (2009), Yassin (2010), Al-Niaeemi (2011), Hussain et al. (2011), Hussein et al. (2011), Mama (2012), Mama & Abdullah (2012), Abdullah (2013), Al-Ali et al. (2013), Mama & Abdullah (2013), Eassa et al. (2014), Abdullah & Abdullah (2015a, b), Ahmed (2015), Mustafa (2016), Hussain (2017), Rasool (2017), Sadiq (2017), Al-Turaihi (2018), Al-Helli (2019), Al-Salami (2019).

*Gambusia holbrooki*: Mhaisen (1986), Al-Nasiri (2000), Jarallah et al. (2005), Al-Niaeem (2006), Al-Salim et al. (2007), Bannai et al. (2007), Hussain (2008), A.H. Kadhim (2009), Al-Ali et al. (2013). Apart from A.H. Kadhim (2009), all the remaining references reported this fish by its synonymous name *Gambusia affinis*.

*Garra rufa*: Al-Helli (2019).

*Hemiculter leucisculus*: Abdullah (2013), Abdullah & Abdullah (2015a, b).

*Heteropneustes fossilis*: Salih et al. (2000).

*Hypophthalmichthys molitrix*: Al-Hamed & Hermiz (1973), Ali et al. (1989), Al-Zubaidy (1998), Muhammed (2000), Al-Dulaimi (2002), Ali (2002), Al-Jadoaa (2002), Jassim (2007).

*Leuciscus vorax* (also as *Aspius vorax*): Khalifa et al. (1978), Al-Nasiri (2000), Al-Jadoaa (2002), Al-Helli (2019).

*Luciobarbus barbulus*: Abdullah & Ismail (2004), Abdullah (2013), Abdullah & Abdullah (2015a, b). This fish was referred to by its synonymous name *Barbus barbulus* by all references in this paragraph.

*Luciobarbus esocinus*: Khalifa et al. (1978), Balasem et al. (2000), Abdullah & Ismail (2004), Abdullah (2013), Abdullah & Abdullah (2015a, b). The first three references in this paragraph referred to this fish by its synonymous name *Barbus esocinus*.

*Luciobarbus xanthopterus*: Al-Hamed & Hermiz (1973), Sarsam (1982), Khalifa (1989), Al-Nasiri (2000), Al-Jadoaa (2002), Abdullah & Ismail (2004). All these references referred to this fish by its synonymous name *Barbus xanthopterus*.

*Mastacembelus mastacembelus*: Al-Janabi (2010a).

*Mesopotamichthys sharpeyi*: Khalifa et al. (1978), Sarsam (1982), Khalifa (1989), Khamees (1997), Al-Jadoaa (2002). All these references referred to this fish by its synonymous name *Barbus sharpeyi*.

*Mystus pelusius*: Al-Jadoaa (2002).

*Planiliza abu* (also as *Liza abu*): Mhaisen et al. (1989), Mohammad-Ali et al. (1999), Al-Zubaidy (2007), Al-Musawi (2016). Apart from Al-Musawi (2016), all the remaining references reported this fish by its synonymous name *Liza abu*.

*Planiliza subviridis*: Ahmed (2015) reported this fish by its synonymous name *Chelon subviridis*.
*Poecilia sphenops*: Naji (2010), Abbas (2014).
*Silurus triostegus*: Ahmed (2015), Al-Helli (2019).
*Squalius lepidus*: Abdullah (1990), Abdullah & Ismail (2004), Abdullah & Rasheed (2004). All these references referred to this fish by its synonymous name *Leuciscus lepidus*.
Unspecified host: Khalifa (1982), Al-Niaeem et al. (2015).

2- *Lernaea oryzophila* Monod, 1932: As stated by Al-Nasiri et al. (2001), the identification of this crustacean was ascertained by Prof. Dr. Ju-Shey Ho of California State University. This species was reported from only one valid fish species.
*Cyprinus carpio*: Al-Nasiri et al. (2001).

3- Unidentified *Lernaea* species were reported from seven valid fish species as in the following list.
*Carassius auratus*: Al-Tayyar et al. (2011).
*Ctenopharyngodon idella*: Abd & Abdul wahab (2011), Abdulrahman et al. (2020).
*Cyprinus carpio*: Abd & Abdul wahab (2011), Ahmed & Ali (2013), Al-Helli (2019), Abdulrahman et al. (2020).
*Hypophthalmichthys molitrix*: Abd & Abdul wahab (2011), Abdulrahman et al. (2020).
*Poecilia sphenops*: Al-Tayyar et al. (2011).
*Silurus triostegus*: Al-Helli (2019).
*Trichopodus trichopterus*: Al-Tayyar et al. (2011). This aquarium fish was misidentified as *Trichogaster trichopterus* by Al-Tayyar et al. (2011).

Finally, to conclude on the records of *L. cyprinacea* from fishes of Iraq, it is appropriate to mention here that the common carp *C. carpio* was introduced for the first time in Iraq from Holland in 1955 and then from Indonesia in 1956 (Al-Hamed, 1960). These fishes were stocked in Al-Zaafaraniyah fish culture station, southern Baghdad. This station was used in propagation of *C. carpio* in order to provide fish fingerlings to be stocked and reared in other Iraqi fish farms. In 1967, carps and goldfishes were introduced to Basrah (Al-Robaae, 1968). The story of how *L. cyprinacea* reached Basrah University fish farm at Al-Tannuma in 1980 was well documented by Mhaisen (1982) who emphasized that no infection was found in carps and goldfishes brought to this farm from small ponds belonging to the Natural History Museum of Basrah University in September 1980. In addition, some mugilid fishes (*Planiliza abu*) brought to this farm from Shatt Al-Arab river were also non-infected. But, stocking of carps and other cyprinids, brought from Al-Zaafaraniyah fish station during September 1980 was the cause of the establishment of *L. cyprinacea*. At that time, quarantine measures could not be achieved due to some administrative difficulties and due to the frequent electricity

power cut at that time. So, the anchor worm had established itself in this farm. Mhaisen (1983) also demonstrated that the infection of *C. carpio* with *L. cyprinacea* in both Al-Riath fish farm (Al-Tameem province) and Al-Latifiyah fish farm (Babylon province) came through liberating infected *C. carpio* from Al-Zaafaraniyah fish farm to these farms. Later in his review, Mhaisen (1993), emphasized that lack of inspection and quarantine of carps transferred from Al-Zaafaraniya to other fish farms of Iraq are responsible for distribution of *L. cyprinacea* to such farms as well as to some Iraqi lakes, reservoirs, rivers and marshes.

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