Biological and Applied Environmental Research

Vol. 5(2): 281-306, 2021

https://doi.org/10.51304/baer.2021.5.2.281

ISSN: 2002-6153
Biol. Appl. Environ. Res.
www.baerj.com
editor@baerj.com

Checklist of Fish Hosts of Species of *Contracaecum* Railliet & Henry, 1912 (Nematoda: Ascaridida: Anisakidae) in Iraq

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Abstract: Surveying literature concerning the occurrence of the nematode larval forms of the genus *Contracaecum* in fishes of Iraq, showed the infection of 44 freshwater and marine fish species in Iraq with such larvae. The infection included larvae of unidentified *Contracaecum* species, *Contracaecum rudolphii* type-B and *Contracaecum septentrionale* Kreis, 1955. 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. This checklist also provided references on some histopathological and biochemical changes, some ecological aspects of the infection, life cycle and scanning electron microscopy. In addition, this checklist includes literature on six species of adult *Contracaecum* species as well some unidentified species of this genus from 17 bird species from different parts of Iraq, of which both Eurasian bittern *Botaurus stellaris* and pygmy cormorant *Microcarbo pygmaeus* were infected with a maximum number of three *Contracaecum* species as well as unidentified species of this genus.

Keywords: Nematoda, Ascaridida, Anisakidae, *Contracaecum*, Fishes, Iraq

Introduction

The genus *Contracaecum* Railliet & Henry, 1912 has 68 accepted species which belong to the family Anisakidae, order Rhabditida and class Chromodorea of the phylum Nematoda (WoRMS, 2021). Both EOL (2018) and ITIS (2021) listed 25 valid species for this genus. According to GBIF (2021), this genus is considered as a synonym of *Hysterothylacium* Ward & Magath, 1917. Members of *Contracaecum* are significant due to their number of species, wide range of host species involved in their life cycles, and their adverse health impacts on hosts (Shamsi, 2019). Some species have no specificity for fish hosts, so they are able to use a wide variety of fish species as intermediate hosts, and in addition, some nematodes have the ability to survive in "alternative" organisms, known as "paratenic" hosts. These hosts are not required for completion of the life cycle but they can contain infective nematode life stages and be a source of infection (Yanong, 2017).

Received Apr. 14, 2021, accepted July 1, 2021

Yanong (2017) summarized the general life cycle pattern for nematodes infecting fishes that act as intermediate hosts. Nematode eggs/ larvae (a) pass out in the faces of the definitive host (various species of piscivorous birds and mammals) enter a variety of invertebrate intermediate hosts (b) or a fish intermediate host (c) prior to being eaten by or entering the final host, a fish-eating mammal, bird, or fish (d). Also, Shamsi (2019) gave another summary for the general life cycles of *Contracaecum* species in which she demonstrated that nematode eggs embryonate into first-stage larvae (L1) within the egg. Then, they develop further and moult to the second larval stage (L2). Eggs or larvae can be ingested by the first intermediate hosts (variety of invertebrates) and then grow in their haemocoel. When the infected invertebrates are eaten by second intermediate hosts (variety of teleost fishes), larvae reach the third larval stage (L3). Various species of piscivorous birds and mammals become infected by predating upon infected fishes and are definitive hosts of *Contracaecum*. The definitive host may become infected even by consuming the infected first intermediate hosts or the second intermediate hosts (Fig. 1). This general life history pattern is variable and there may be differences in the types of intermediate/definitive hosts among different species of *Contracaecum* (Shamsi, 2019).

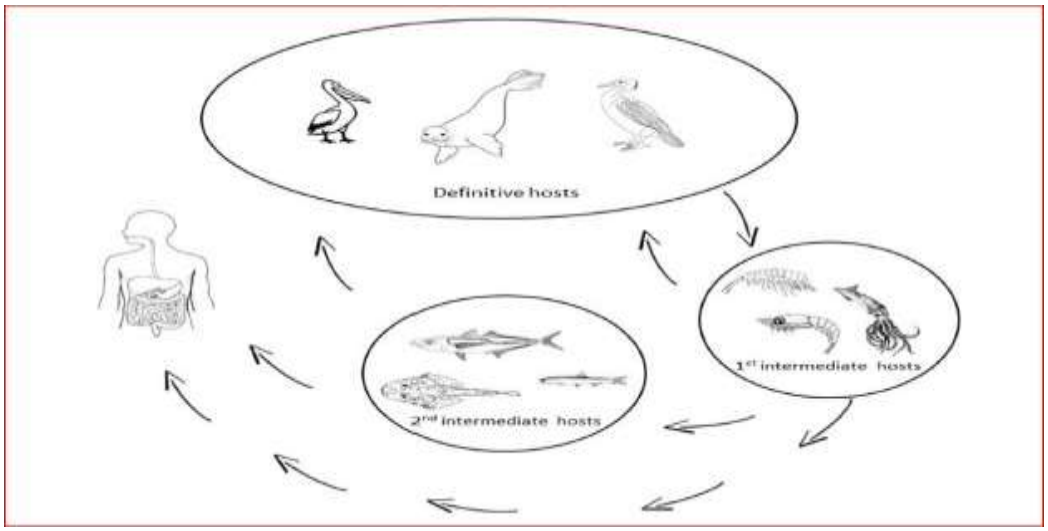

Figure 1: General life cycle of *Contracaecum* species (from Shamsi, 2019).

The morphological characteristics of the body of the third stage larvae of *Contracaecum* was demonstrated by Shamsi & Aghazadeh-Meshgi (2011) and summarized by Shamsi (2019). As the genus' name suggests, these nematodes have two oppositely-directed caecae as part of their digestive system (Figure 2). They also have an excretory pore located at their anterior (cephalic) end. These should be considered the most significant morphological characteristics when differentiating *Contracaecum* species from the rest of the anisakid nematodes because they are the most consistent at all developmental stages (Shamsi, 2019). In adult *Contracaecum*

species, other important features with taxonomic significance include the presence of interlabia and labia, the absence of labial denticulation, rounded eggs with smooth shells, the presence of two spicules, conical tails in both male and females (which are shorter in males) and the presence of post- and pre-cloacal papillae in males (Shamsi, 2019).

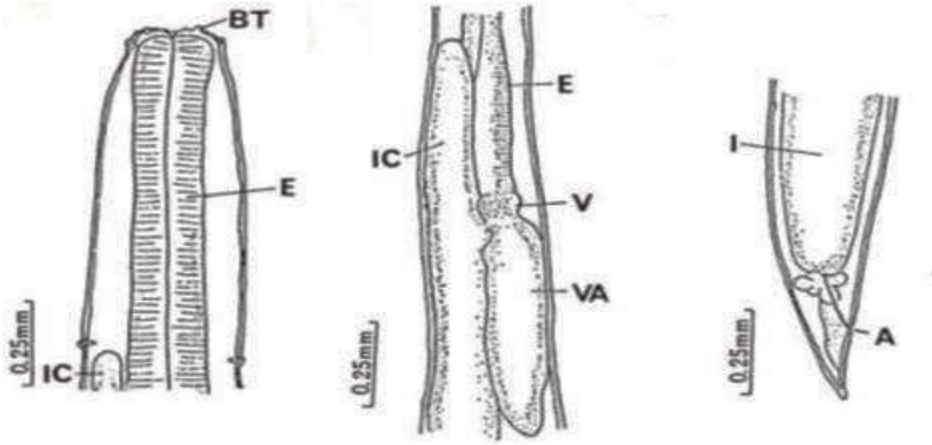

Figure 2: From left to right, anterior, middle and posterior parts of a third-stage larva of *Contracaecum* sp. A: anus, BT: boring tooth, E: oesophagus, I: intestine, IC: intestinal caecum, V: ventriculus, VA: ventricular appendix (from Nagasawa, 2012).

Contracaecum species are known to be able to have highly pathogenic impacts on both wildlife (fishes, birds, marine mammals) and humans (Shamsi, 2019). If the larvae are accidentally taken by humans by consuming raw or undercooked fish meat, they may cause a zoonotic infection characterized by stomach pains, fever, diarrhoea and vomiting (Girişgin et al., 2012).

In Iraq, Herzog (1969) was the first to detect *Contracaecum* spp. larvae in nine freshwater fishes from different Iraqi waters and fish markets. After that, many published and unpublished sources were given, most of which dealt with records of different larval forms of *Contracaecum* species from fishes of Iraq, which will be demonstrated in the results and discussion. However, some articles predicted that these larvae belonged to some adult *Contracaecum* species (Herzog, 1969; Shamsuddin et al., 1971; Al-Hadithi & Habish, 1977; Habish, 1977). Such prediction is not acceptable as identification of adult *Contracaecum* species depends on some features of the reproductive organs, which are no so well developed in the larval forms. However, only recently in Iraq, some molecular investigations were carried out which demonstrated the identification of some adult forms of *Contracaecum* (Abdullah, 2020; Al-Musaedi, 2020; Abdullah et al., 2021a, b).

In addition to the demonstration of the occurrence of larval forms of *Contracaecum* in some fishes of Iraq, other researches covered some

aspects of histopathological changes (Shamsuddin et al., 1971; Habish, 1977; Khalifa et al., 1978; Abdul-Ameer, 1989; Mohamad, 1989; Nawab Al-Deen, 1994; Al-Salim & Mohamad, 1995; Rahemo & Nawab Al-Din, 1995; Ali, 2001; Al-Jadoaa, 2002; Al-Salihi, 2002; Rahemo et al., 2005; Abbas, 2007; Abdul Fraj & Ftohe, 2008; Al-Darweesh, 2010; Al-Jubouri et al., 2017), biochemical changes (Al-Niaeem, 1999; Ali, 2001; Al-Jadoaa, 2002; Al-Niaeem & Al-Azizz, 2002; Al-Salihi, 2002; Abdul Fraj & Ftohe, 2008) and some ecological aspects of the infection (Al-Hadithi & Jawad, 1975; Habish, 1977; Al-Hadithi & Habash, 1979; Anwar & Ismail, 1979; Khamees, 1983; Al-Daraji, 1986; Khamees & Mhaisen, 1988; Mhaisen et al., 1988; Al-Alusi, 1989; Mohamad, 1989; Taher et al., 1994; Al-Awadi, 1997; Al-Nasiri, 2000; Abdullah, 2002; Al-Waaly, 2005; Abdullah & Mhaisen, 2006; Al-Zubaidy, 2009; Abubakr, 2015; Hussein, 2018; Hathal et al., 2020; Hathal, 2021) as well as life cycles (Habish, 1977) and by using scanning E.M. (Rahemo & Nawab Al-Din, 2009).

The present article is designed to revise all records on *Contracaecum* species from fishes of Iraq and provide updated list of their host species in Iraq. It is a continuation of some recent checklists on some groups of fish parasites of Iraq, which included those on *Dactylogyrus* species (Mhaisen & Abdul-Ameer, 2019a), ancylodiscoidid and ancyrocephalid species (Mhaisen & Abdul-Ameer, 2019b), *Trichodina* species (Mhaisen & Abdul-Ameer, 2020), *Myxobolus* species (Mhaisen & Al-Jawda, 2020) and *Lernaea* species (Mhaisen & Abdul-Ameer, 2021).

Sources and Methods

A total of 120 references (66 published research papers, 35 unpublished M. Sc. theses, one M. Technol. thesis, 14 unpublished Ph. D. theses, three conference abstracts, and one article abstract) dealing with records on *Contracaecum* species from fishes of Iraq were used to prepare the present article. Data from such references were gathered to provide reliable information on *Contracaecum* distribution in fishes from different water bodies and fish farms in Iraq as well as fish-*Contracaecum* 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 a well-known specialized electronic site (Fricke et al., 2021). Valid fish host species are also alphabetically arranged together with their synonyms (if any) and their chronologically arranged references. The nomenclature taxonomy of *Contracaecum* species was updating according to WoRMS (2021).

Results and Discussion

Surveys Achieved on *Contracaecum* Species from Fishes of Iraq

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

1- Tigris River at Nineveh Province (Saleem, 1991; Nawab Al-Deen, 1994; Rahemo & Nawab Al-Din, 1995; Al-Niaeemi, 1997; Rahemo & Al-Niaeemi, 2001; Al-Salihi, 2002; Mustafa, 2005; Mustafa et al., 2006; Abdul Fraj & Ftohe, 2008; Rahemo & Nawab Al-Din, 2009), Salah Al-Din Province (Abdul-Ameer, 1989; Al-Jawda et al., 2000; Hussein, 2018) and Baghdad Province (Ali et al., 1987b; Balasem et al., 1993; Al-Moussawi, 1997; Hammood, 2017; Abbas, 2019) as well as some tributaries of Tigris River which included Greater Zab River (Ali, 1989; Nawab Al-Deen, 1994; Abdullah, 2002; Abdullah & Mhaisen, 2006; Shwani, 2009; Shwani & Abdullah, 2010; Abdullah & Mhaisen, 2011; Abubakr, 2015), Lesser Zab River (Abdullah, 2002; Abdullah & Mhaisen, 2006; Shwani & Abdullah, 2010; Abdullah & Mhaisen, 2011; Abdullah, 2020; Hathal et al., 2020; Abdullah et al., 2021a, b; Hathal, 2021), Mortuka stream at Erbil Province (Abdullah, 2004), Serchinar stream at Sulaimaniya Province (Rahemo et al., 2005), Sirwan River at Sulaimaniya Province (Abdullah, 2020; Abdullah et al., 2021a, b) and Diyala River (Ali et al., 1987a; Al-Shaikh et al., 1995; Mhaisen et al., 2002).

2- Euphrates River and its branches at Al-Anbar Province (Mhaisen et al., 1997; Al-Sady, 2000; Al-Alusi, 2011; Al-Salmany, 2015), Babylon Province (Al-Sa'adi, 2007; Al-Zubaidy, 2009; Al-Sa'adi et al., 2012, Mhaisen et al., 2015), Karbala Province (Al-Saadi, 2007; Al-Saadi et al., 2010, 2011), Al-Diwaniah Province (Al-Jadoaa, 2002; Al-Waaly, 2005; Yassin, 2010; Al-Mahi, 2014; Al-Mahi & Al-Mayali, 2016, 2017), Thi Qar Province (Rahemo & Al-Abbadie, 1994; Al-Abbadie, 2006; Al-Kinanny & Al-Ubaydi, 2017) and Al-Muthanna Province (Al-Asadiy, 2018).

3- Shatt Al-Arab River (Al-Hadithi & Habish, 1977; Habish, 1977; Al-Hadithi & Habash, 1979; Anwar & Ismail, 1979; Al-Hadithi et al., 1980; Mhaisen, 1986; Ali, 2001; Eassa et al., 2014) and some of its branches at Basrah Province which included: Garmat Ali River (Jori, 1998; Abdul-Rahman, 1999; Al-Niaeem, 1999; Al-Niaeem & Al-Azizz, 2002; Kadhim, 2009; Al-Janae'e, 2010), Al-Majidiah River (Mehdi, 1989); Al-Salihiya River (Al-Janae'e, 2010) and Mehaijeran Creek (Khamees, 1983; Mhaisen et al., 1986; Khamees & Mhaisen, 1988; Mhaisen et al., 1988).

4- Some lakes, depressions and marshes: These included surveys from two lakes in Sulaimaniya province: Darbandikhan Lake (Abdullah, 2005) and Dokan Lake (Abdullah, 1990; Abdullah & Rasheed, 2004), Al-Tharthar Lake (Khalifa et al., 1978; Al-Saadi, 1986), three lakes in Al-Anbar Province: Al-Rutba Dam Lake (Al-Karboly, 2012), Al-Qadisiya Dam Lake (Al-Alusi, 1989) and Al-Habbaniyah Lake (Ali et al., 1988a; Mhaisen et al., 1999), Hemrin Dam Lake in Diyala Province (Balasem et al., 2000), man-made lakes in Salah Al-Din Province (Ali et al., 1988b; Abul-Eis et al., 1989), Al-Tharthar- Tigris Canal in Salah Al-Din Province (Ali & Shaaban, 1984; Khalifa, 1989), Bahr Al-Najaf depression in Al-Najaf Al-Ashraf Province (Al-Awadi, 1997; Al-Awadi et al., 2010a), Al-Dalmaj Marsh of Al-Diwaniyah Province (Mohammad, 2016), Huwazah Marsh at Maysan Province (Ali, 2008; Al-Musaedi, 2020), Central

marshes of Thi-Qar Province (Mohammad, 2016) and Al-Hammar Marsh in Basrah Province (Al-Daraji, 1986; Dawood, 1986; Mohamad, 1989; Al-Salim & Mohamad, 1995; Jori, 2006; Abbas, 2007) as well as in Al-Mashab Marsh in Basrah Province (Al-Tameemi, 2013; Awad & Al-Tameemi, 2013).

5- Some drainage networks at Babylon Province (Al-Zubaidy, 2009) and Al-Diwaniyah Province (Al-Waaly, 2005; Al-Jadoaa, 2008).
6- Fish ponds and farms which included some at Erbil Province (Abdullah, 2004), Baghdad Province (Al-Nasiri, 2000; Al-Nasiri et al., 2002, 2003; Wasit Province (Al-Darweesh, 2010), Babylon Province (Ali et al., 1989; Al-Zubaidy, 1998; Al-Jadoaa, 2002; Al-Zubaidy, 2009), and Basrah Province (Rasool, 2017) in addition to some floating cages at Babylon Province (Al-Jubouri et al., 2017).
7- Fish markets at Nineveh Province (Al-Mowla, 2010), Erbil Province (Abdullah, 2000), Baghdad Province (Al-Moussawi et al., 2018), fishermen at Al-Najaf Al-Ashraf Province (Taher et al., 1994), Basrah Province (Al-Hadithi & Jawad, 1975; Mhaisen, 1986) as well as from fish brought from different areas in mid and southern Iraq: Amara, Habbaniyah, Kut, Tharthar and rivers of Tigris and Euphrates (Shamsuddin et al., 1971).
8- Marine waters of Iraq, which included those from Khor Al-Zubair lagoons (Al-Daraji, 1995) and Khor Abdullah (Bannai, 2002).

It is reliable to state here that most records done by Herzog (1969) cannot be categorized to any of the above localities of collection as he mentioned no location for most of the infected fishes in his collections.

The following is a list of the scientific names and the full authority of the infected fishes with *Contracaecum* species together with their orders and families, based on Fricke et al. (2021).

Class Actinopteri
Order Clupeiformes
Family Clupeidae
Tenualosa ilisha (Hamilton 1822)
Order Cypriniformes
Family Cyprinidae
Arabibarbus grypus (Heckel, 1843)
Barbus lacerta Heckel, 1843
Capoeta damascina (Valenciennes, 1842)
Capoeta trutta (Heckel, 1843)
Carasobarbus luteus (Heckel, 1843)
Carassius auratus (Linnaeus, 1758)
Cyprinion macrostomus Heckel, 1843[1]
Cyprinus carpio Linnaeus, 1758
Garra rufa (Heckel, 1843)
Luciobarbus barbulus (Heckel, 1847)

Luciobarbus esocinus Heckel, 1843
Luciobarbus kersin (Heckel, 1843)
Luciobarbus mystaceus (Pallas, 1814)[2]
Luciobarbus subquincunciatus (Günther, 1868)
Luciobarbus xanthopterus Heckel, 1843
Mesopotamichthys sharpeyi (Günther, 1874)
Family Xenocyprididae[3]
Ctenopharyngodon idella (Valenciennes, 1844)
Family Leuciscidae
Acanthobrama centisquama Heckel, 1843
Acanthobrama marmid Heckel, 1843
Alburnus orontis Sauvage, 1882[4]
Alburnus sellal Heckel, 1843
Chondrostoma regium (Heckel, 1843)
Leuciscus vorax (Heckel, 1843)
Squalius cephalus (Linnaeus, 1758)
Squalius lepidus Heckel, 1843
Order Siluriformes
Family Bagridae
Mystus pelusius (Solander, 1794)
Family Siluridae
Silurus glanis Linnaeus, 1758
Silurus triostegus Heckel, 1843
Family Heteropneustidae
Heteropneustes fossilis (Bloch, 1794)
Order Aulopiformes
Family Synodontidae
Saurida undosquamis (Richardson, 1848)
Order Synbranchiformes
Family Mastacembelidae
Mastacembelus mastacembelus (Banks & Solander, 1794)
Order Pleuronectiformes
Family Soleidae
Brachirus orientalis (Bloch & Schneider, 1801)
Order Cichliformes
Family Cichlidae
Coptodon zillii (Gervais 1848)
Order Cyprinodontiformes
Family Poeciliidae
Gambusia holbrooki Girard, 1859
Poecilia latipinna (Lesueur, 1821)
Family Aphaniidae
Aphanius stoliczkanus (Day, 1872)[5]
Order Beloniformes

Family Belonidae Bonaparte 1835
Ablennes hians (Valenciennes, 1846)
Order Mugiliformes
Family Mugilidae
Planiliza abu (Heckel, 1843)
Planiliza subviridis (Valenciennes, 1836)
Order Perciformes
Family Sillaginidae
Sillago sihama (Fabricius, 1775)
Family Sciaenidae
Johnius belangerii (Cuvier 1830)
Otolithes ruber (Bloch & Schneider 1801)

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[1] The specific name of this fish is spelled as *macrostomus* according to Fricke et al. (2021) but as *macrostomum* in Froese & Pauly (2021), WoRMS (2021) 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] According to Freyhof et al. (2021), *Luciobarbus mystaceus* has been described by Pallas (1814) from the Kura River in Georgia and this species is a synonym of *L. capito* and some authors refer the species description of *B. mystaceus* to Heckel (1843), who only identified some barbels from Mesopotamia as *B. mystaceus*, but did not describe the species.

[3] One reference (Abdul-Rahman, 1999) so far concerning with the occurrence of *Contracaecum* species in Iraq referred to the grass carp *Ctenopharyngodon idella* as belonging to the family Cyprinidae. However, Tan & Armbruster (2018) in their phylogenetic classification, placed this species within the family Xenocyprididae. This is also followed by Fricke et al. (2021) and Froese & Pauly (2021).

[4] According to Fricke et al. (2021) and Froese & Pauly (2021), *Alburnus orontis* is distributed in Turkey and Syria.

[5] 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).

Types of *Contracaecum* Species Known from Fishes of Iraq

According to Herzog (1969), the first *Contracaecum* larvae detected from seven fish host species: *Arabibarbus grypus* (as *Barbus grypus*), *Carasobarbus luteus* (as *Barbus luteus*), *Heteropneustes fossilis*, *Leuciscus vorax* (as *Aspius vorax*), *Luciobarbus xanthopterus* (as *Barbus xanthopterus*), *Mystus pelusius* and *Silurus triostegus* belonged to *C. rudolphii* Hartwich, 1964, while four fish species: *Luciobarbus esocinus* (as *Barbus esocinus*), *L. xanthopterus* (as *B. xanthopterus*), *Mesopotamichthys sharpeyi* (as *Barbus sharpeyi*) and *Planiliza abu* (as *Mugil abu*)

were infected with unspecified *Contracaecum* species. Shamsuddin et al. (1971) demonstrated the infection of some freshwater fishes with larvae of *Contracaecum* species, which they suggested, on basis of their morphology, as belonging to *C. microcephalum* (Rudolphi, 1809), *C. multipapillatum* (Drasche, 1882) Lucker, 1941 and *C. spiculigerum* (Rudolphi, 1809). According to WoRMS (2021), *C. spiculigerum* is considered as a synonym of *C. rudolphi*. Al-Hadithi & Habish (1977) and Habish (1977) concluded that larvae of *Contracaecum* belonged to *C. microcephalum* as they found the adults of this species in the intestine of the purple heron *Ardea purpurea*. The intestine of this bird also contained *L. abu* (as *Mugil hishni*) of which some specimens, from the same collecting area (Shatt Al-Arab River and its branches), were infected with larvae of *Contracaecum* species.

Recent studies, based on the molecular analysis (Abdullah, 2020, Abdullah et al., 2021a, b) showed that the *Contracaecum* larval specimens from 10 infected fish species from northern Iraq represented *Contracaecum rudolphii* type-B. Another recent molecular study (Al-Musaedi, 2020) showed that the isolated *Contracaecum* sp. from *Carasobarbus luteu*s from Al-Huywazah Marsh, southern Iraq belonged to *Contracaecum septentrionale* Kreis, 1955.

Contracaecum-Host List

The following is a list of *Contracaecum* species so far recorded from fish species of Iraq with their concerned hosts and references.

1- *Contracaecum* species larvae: Such larvae were reported from 44 valid fish species as in the following alphabetically listed fish species.

Ablennes hians: Bannai (2002).

Acanthobrama centisquama: Ali et al. (1987b).

Acanthobrama marmid: Ali et al. (1988b), Abdul-Ameer (1989), Nawab Al-Deen (1994), Al-Nasiri (2000), Abdullah (2002, 2005), Rahemo & Nawab Al-Din (2009), Abdullah & Mhaisen (2011), Al-Salmany (2015).

Alburnus orontis: Al-Sa'adi (2007), Mhaisen et al. (2015).

Alburnus sellal (as *Alburnus capito* by Al-Nasiri, 2000 and *Chalcalburnus sellal* by Abdul-Rahman, 1999): Abdul-Rahman (1999), Al-Nasiri (2000).

Aphanius stoliczkanus (as *Aphanius dispar*): Al-Awadi (1997), Kadhim, (2009), Al-Awadi et al. (2010a).

Arabibarbus grypus (as *Barbus grypus*): Herzog (1969), Shamsuddin et al. (1971), Al-Hadithi & Habish (1977), Habish (1977), Ali & Shaaban (1984), Al-Saadi (1986), Al-Alusi (1989), Khalifa (1989), Abdullah (1990), Nawab Al-Deen (1994), Al-Awadi (1997), Al-Moussawi (1997), Abdullah (2000), Al-Jawda et al. (2000), Mhaisen et al. (2002), Abdullah & Rasheed (2004), Al-Saadi (2007), Al-Sa'adi (2007), Al-Awadi et al. (2010a), Al-Saadi et al. (2010), Al-Karboly (2012), Al-Mahi (2014), Mhaisen et al. (2015), Al-Mahi & Al-Mayali (2017).

Barbus lacerta: Nawab Al-Deen (1994), Al-Alusi (1989).

Brachirus orientalis (as *Synaptura orientalis*): Bannai (2002).

Capoeta damascina (as *Barbus belayewi*): Abdullah (2002), Abdullah & Mhaisen (2011).

Capoeta trutta (also as *Varicorhinus trutta*): Abdul-Ameer (1989), Nawab Al-Deen (1994), Rahemo & Nawab Al-Din (1995), Abubakr (2015).

Carasobarbus luteus (also as *Barbus luteus*): Herzog (1969), Shamsuddin et al. (1971), Al-Hadithi & Habish (1977), Habish (1977), Khalifa et al. (1978), Khamees (1983), Al-Daraji (1986), Al-Saadi (1986), Mhaisen (1986), Mhaisen et al. (1986), Ali et al. (1987a), Khamees & Mhaisen (1988), Ali (1989), Abdullah (1990), Nawab Al-Deen (1994), Abdul-Rahman (1999), Al-Niaeem (1999), Abdullah (2000), Al-Nasiri (2000), Abdullah (2002), Al-Jadoaa (2002), Abdullah & Rasheed (2004), Al-Waaly (2005), Al-Abbadie (2006), Al-Sa'adi (2007), Abdullah & Mhaisen (2011), Al-Karboly (2012), Mhaisen et al. (2015), Al-Asadiy (2018).

Carassius auratus: Al-Janae'e (2010).

Chondrostoma regium: Ali et al. (1988a), Abdul-Ameer (1989), Abdullah (1990), Al-Moussawi (1997), Abdullah (2002), Abdullah & Rasheed (2004), Abdullah (2005), Abdullah & Mhaisen (2011).

Coptodon zillii (also as *Tilapia zillii*): Al-Sa'adi (2007), Al-Sa'adi et al. (2012), Mhaisen et al. (2015), Mohammad (2016).

Ctenopharyngodon idella: Abdul-Rahman (1999).

Cyprinion macrostomum: Ali et al. (1987b, 1988b), Abdullah (1990), Abdullah & Rasheed (2004), Abubakr (2015).

Cyprinus carpio: Shamsuddin et al. (1971), Dawood (1986), Al-Alusi (1989), Abdullah (1990), Al-Zubaidy (1998), Abdul-Rahman (1999), Abdullah (2000), Al-Nasiri (2000), Abdullah (2002), Al-Jadoaa (2002), Al-Nasiri et al. (2002), Abdullah & Rasheed (2004), Abdullah & Mhaisen (2006), Al-Darweesh (2010), Yassin (2010), Abdullah & Mhaisen (2011), Al-Alusi (2011), Eassa et al. (2014), Al-Jubouri et al. (2017), Rasool (2017), Hussein (2018).

Gambusia holbrooki (as *Gambusia affinis*): Al-Awadi (1997), Al-Awadi et al. (2010a).

Garra rufa: Al-Moussawi (1997), Abdullah (2002), Abdullah & Mhaisen (2011).

Heteropneustes fossilis (also as *Saccobranchus fossilis*): Herzog (1969), Al-Hadithi & Habish (1977), Habish (1977), Mhaisen (1986), Ali et al. (1987a, b), Mohamad (1989), Balasem et al. (1993), Al-Salim & Mohamad (1995), Al-Shaikh et al. (1995), Abdul-Rahman (1999), Ali (2001), Abdullah (2002), Mhaisen et al. (2002), Abdullah (2005), Abdullah & Mhaisen (2011).

Johnius belangerii: Bannai (2002).

Leuciscus vorax (also as *Aspius vorax*): Herzog (1969), Al-Hadithi & Jawad (1975), Al-Hadithi & Habish (1977), Habish (1977), Khalifa et al. (1978), Khamees (1983), Ali & Shaaban (1984), Al-Daraji (1986), Al-Saadi (1986), Mhaisen (1986), Mhaisen et al. (1986), Abdul-Ameer (1989), Al-Alusi (1989), Nawab Al-Deen (1994), Al-Moussawi (1997), Mhaisen et al. (1997), Abdul-Rahman (1999), Al-Jawda et al. (2000), Al-Nasiri (2000), Al-Jadoaa (2002), Al-

Abbadie (2006), Al-Saadi (2007), Al-Sa'adi (2007), Al-Saadi et al. (2010), Al-Alusi (2011), Al-Karboly (2012), Al-Salmany (2015), Mhaisen et al. (2015).

Luciobarbus barbulus (as *Barbus barbulus*): Abdullah (1990, 2002), Abdullah & Rasheed (2004), Abdullah & Mhaisen (2011).

Luciobarbus esocinus (as *Barbus esocinus*): Herzog (1969) in page 136 but not in 135, Shamsuddin et al. (1971), Khalifa et al. (1978), Abdulllah (1990), Nawab Al-Deen (1994), Abdullah (2000), Balasem et al. (2000), Abdullah & Rasheed (2004), Abdullah (2005).

Luciobarbus kersin (as *Barbus kersin*): Abdullah (1990), Abdullah & Rasheed (2004).

Luciobarbus mystaceus (as *Barbus mystaceus*): Al-Alusi (1989).

Luciobarbus subquincunciatus (as *Barbus subquincunciatus*): Abdullah (1990), Abdullah & Rasheed (2004).

Luciobarbus xanthopterus (as *Barbus xanthopterus*): Herzog (1969), Shamsuddin et al. (1971), Al-Hadithi & Habish (1977), Habish (1977), Khalifa et al. (1978), Abdul-Ameer (1989), Al-Alusi (1989), Khalifa (1989), Abdullah (1990), Abdullah (2000), Al-Nasiri (2000), Al-Jadoaa (2002), Abdullah & Rasheed (2004), Al-Abbadie (2006), Al-Saadi (2007), Al-Sa'adi (2007), Al-Saadi et al. (2010), Al-Alusi (2011), Mhaisen et al. (2015), Hathal et al. (2020), Hathal (2021).

Mastacembelus mastacembelus (also as *M. simach*): Abdul-Rahman (1999), Abdullah (2002), Al-Salihi (2002), Abdullah (2005), Al-Sa'adi (2007), Ali (2008) as Type BA L3 larva, Al-Mowla (2010), Abdullah & Mhaisen (2011), Mhaisen et al. (2015).

Mesopotamichthys sharpeyi (also as *Barbus sharpeyi*): Herzog (1969) in page 136 but not in 135, Shamsuddin et al. (1971), Al-Hadithi & Habish (1977), Habish (1977), Khalifa et al. (1978), Al-Daraji (1986), Mhaisen (1986), Nawab Al-Deen (1994), Abdul-Rahman (1999), Al-Niaeem & Al-Azizz (2002), Al-Saadi (2007), Al-Saadi et al. (2010).

Mystus pelusius (also as *M. halepensis**): Herzog (1969) in page 136 but not in 135, Al-Hadithi & Habish (1977), Habish (1977), Ali et al. (1987b)*, Al-Moussawi (1997), Abdul-Rahman (1999), Al-Sa'adi (2007), Mhaisen et al. (2015).

Otolithes ruber (misspelled as *Otolithus ruber*): Bannai (2002).

Planiliza abu (also as *Liza abu*, *Mugil abu* & *Mugil hishni*): Herzog (1969) in page 136 but not in 135, Shamsuddin et al. (1971), Al-Hadithi & Jawad (1975), Al-Hadithi & Habish (1977), Habish (1977), Al-Hadithi & Habash (1979), Anwar & Ismail (1979), Al-Hadithi et al. (1980), Khamees (1983), Al-Saadi (1986), Mhaisen (1986), Mhaisen et al. (1986), Ali et al. (1987a), Mhaisen et al. (1988), Al-Alusi (1989), Ali et al. (1989), Mehdi (1989), Balasem et al. (1993), Rahemo & Al-Abbadie (1994), Taher et al. (1994), Al-Awadi (1997), Jori (1998), Abdul-Rahman (1999), Mhaisen et al. (1999), Al-Nasiri (2000), Al-Sady (2000) p. 36, Al-Jadoaa (2002), Al-Nasiri et al. (2003), Abdullah (2004), Mustafa (2005), Al-Abbadie (2006), Mustafa et al. (2006), Al-Saadi (2007), Al-Jadoaa (2008), Al-Zubaidy (2009), Al-Awadi et al. (2010a), Al-Janae'e (2010), Al-Saadi et al.

(2010), Yassin (2010), Al-Saadi et al. (2011), Al-Mahi (2014), Al-Mahi & Al-Mayali (2016), Al-Kinanny & Al-Ubaydi (2017), Al-Mahi & Al-Mayali (2017), Hammood (2017), Hussein (2018), Abbas (2019).

Planiliza subviridis (as *Liza subviridis* & *Mugil dussumieri*): Al-Hadithi & Habish (1977), Habish (1977), Abdul-Rahman (1999).

Poecilia latipinna: Al-Tameemi (2013), Awad & Al-Tameemi (2013).

Saurida undosquamis: Bannai (2002).

Sillago sihama: Bannai (2002).

Silurus glanis: Saleem (1991), Al-Niaeemi (1997), Rahemo & Al-Niaeemi (2001), Al-Salihi (2002), Abdul Fraj & Ftohe (2008), Al-Mowla (2010) as L3 & L4 larvae.

Silurus triostegus (also as *Parasilurus triostegus*): Herzog (1969), Shamsuddin et al. (1971), Al-Hadithi & Habish (1977), Habish (1977), Khalifa et al. (1978), Al-Daraji (1986), Ali et al. (1987a), Abdul-Ameer (1989), Abdul-Rahman (1999), Al-Abbadie (2006), Jori (2006), Abbas (2007), Al-Sa'adi (2007), Ali (2008) as Types BA and BB L3 larvae, Shwani (2009), Al-Janae'e (2010), Shwani & Abdullah (2010), Mhaisen et al. (2015), Al-Moussawi et al. (2018), Hussein (2018), Hathal et al. (2020), Hathal (2021).

Squalius cephalus (as *Leuciscus cephalus*): Ali et al. (1987b), Abdullah (2005), Rahemo et al. (2005).

Squalius lepidus (as *Leuciscus lepidus*): Abdullah (1990, 2002), Abdullah & Rasheed (2004), Abdullah & Mhaisen (2011).

Tenualosa ilisha: Al-Janae'e (2010).

Unspecified host: Abul-Eis et al. (1989).

2- *Contracaecum rudolphii* B larva: This species was recently recognized from the following ten fish species:

Acanthobrama marmid: Abdullah (2020), Abdullah et al. (2021b).

Arabibarbus grypus: Abdullah (2020), Abdullah et al. (2021b).

Capoeta trutta: Abdullah (2020), Abdullah et al. (2021b).

Carasobarbus luteus: Abdullah (2020), Abdullah et al. (2021b).

Chondrostoma regium: Abdullah (2020), Abdullah et al. (2021b).

Cyprinus carpio: Abdullah (2020), Abdullah et al. (2021a).

Luciobarbus barbulus: Abdullah (2020), Abdullah et al. (2021a).

Luciobarbus esocinus: Abdullah (2020), Abdullah et al. (2021a).

Luciobarbus xanthopterus: Abdullah (2020), Abdullah et al. (2021a).

Mastacembelus mastacembelus: Abdullah (2020), Abdullah et al. (2021a).

3- *Contracaecum septentrionale* Kreis, 1955 larva: This species was recently recognized from *Carasobarbus luteus* by Al-Musaedi (2020).

It is appropriate to mention here that Ali et al. (2014) indicated that larvae of *Contracaecum* species in Basrah Province had either a very small caecum, as it the case in those infecting *H. fossilis* (hence known as *Contracaecum* sp. 2) or a long

caecum as in the remaining 19 fish host species (hence known as *Contracaecum* sp. 1). In addition, some adult *Contracaecum* species were recorded from Khor Al-Zubair estuary. These included *J. belangerii* by Al-Daraji (1995) as well as three other fish species (*A. hians*, *S. undosquamis* and *S. sihama*) by Bannai (2002). Al-Salim & Ali (2010) transferred these *Contracaecum* species to the genus *Hysterothylacium* Ward & Magath, 1917 as adult *Contracaecum* species are known to be parasites of birds and mammals (Fagerholm, 1991).

Adult *Contracaecum* Species from Birds of Iraq

In Iraq, some adult *Contracaecum* species were recorded from some birds in different parts of Iraq such as Baghdad City (Al-Moussawi & Mohammad, 2011; Al-Moussawi, 2017; Al-Qaisi et al., 2020), Bahr Al-Najaf depression of Al-Najaf Al-Ashraf Province (Al-Awadi et al., 2010b), Al-Sanaf Marsh of Thi-Qar Province (Mohammad, 2014; Mohammad & Hbaiel, 2019a, b), Al-Hammar Marsh of Thi-Qar Province (Ali, 2008; Al-Kinanny, 2013), Al-Hammar Marsh of Basrah Province (Ali, 2008), Basrah marshes (Abdullah, 1988; Al-Hadithi & Abdullah, 1991; Awad et al., 1994; Al-Tameemi, 2013) and Shatt Al-Arab River (Al-Hadithi & Habish, 1977; Habish, 1977; Abed, 2005; Swadi, 2013; Yaseen, 2018). The bird's valid scientific names followed BirdLife International (2021).

The following is a list of *Contracaecum* species so far recorded from bird species of Iraq with their concerned hosts and references.

1- *Contracaecum microcephalum* (Rudolphi, 1809): This species was reported from the following seven bird species:

Ardea purpurea: Al-Hadithi & Habish (1977), Habish (1977), Awad et al. (1994), Mohammad & Hbaiel (2019b).
Ardeola ralloides: Ali (2008), Mohammad & Hbaiel (2019b).
Botaurus stellaris: Ali (2008).
Bubulcus ibis: Swadi (2013).
Egretta grazetta: Awad et al. (1994), Ali (2008), Mohammad & Hbaiel (2019b).
Microcarbo pygmaeus (reported as *Phalocrocorax pygmaeus*): Awad et al. (1994).
Pelecanus onocrolalus: Mohammad & Hbaiel (2019b).

2- *Contracaecum micropapillatum* (Stossich, 1890): This species was reported from the following three bird species:

Ardea cinerea: Ali (2008).
Botaurus stellaris: Ali (2008).
Nycticorax nycticorax: Mohammad & Hbaiel (2019a) as free larvae in the proventriculus.

3- *Contracaecum multipapillatum* (Drasche, 1882) Lucker, 1941: This species was reported from the following three bird species:

Ardeola ralloides: Mohammad & Hbaiel (2019b).
Egretta grazetta: Mohammad & Hbaiel (2019b).

Microcarbo pygmaeus (reported as *Phalocrocorax pygmaeus*): Awad et al. (1994).

4- *Contracaecum ovale* (Linstow, 1907): This species was reported from the following three bird species:
Ardea purpurea: Abdullah (1988), Al-Hadithi & Abdullah (1991), Al-Kinanny (2013).
Botaurus stellaris: Ali (2008).
Egretta gularis: Yaseen (2018).

5- *Contracaecum rudolphi* Hartwich, 1964 (also reported as *C. spiculigerum*): This species was reported from the following two bird species:
Microcarbo pygmaeus (reported as *Phalocrocorax pygmaeus*): Awad et al. (1994), Al-Kinanny (2013).
Phalocrocorax carbo: Al-Moussawi & Mohammad (2011), Al-Moussawi (2017), Mohammad & Hbaiel (2019b), Al-Qaisi et al. (2020).

6- *Contracaecum septentrionale* Kreis, 1955: This species was reported as free larvae from proventriculus of one bird species:
Nycticorax nycticorax: Mohammad & Hbaiel (2019a).

7- Unidentified adult and fourth larval stages of *Contracaecum* species were reported from the following 17 bird species:
Ardea alba (reported as *Egretta alba*): Awad et al. (1994), Al-Awadi et al. (2010b).
Ardea cinerea: Ali (2008) as larvae and Al-Tameemi (2013).
Ardea purpurea: Al-Awadi et al. (2010b), Al-Tameemi (2013), Mohammad (2014).
Ardeola ralloides: Ali (2008) as larvae, Al-Awadi et al. (2010b), Al-Tameemi (2013), Mohammad (2014).
Botaurus stellaris: Ali (2008) as larvae, Al-Awadi et al. (2010b).
Bubulcus ibis: Al-Tameemi (2013), Mohammad (2014).
Ceryle rudis: Al-Awadi et al. (2010b).
Egretta garzetta: Al-Awadi et al. (2010b), Al-Tameemi (2013), Mohammad (2014), Yaseen (2018).
Egretta gularis: Yaseen (2018).
Himantopus himantopus: Al-Tameemi (2013).
Larus cachinnans: Yaseen (2018).
Larus genei: Al-Tameemi (2013), Mohammad (2014).
Microcarbo pygmaeus (reported as *Phalocrocorax pygmaeus*): Al-Tameemi (2013).
Nycticorax nycticorax: Al-Tameemi (2013), Mohammad (2014), Yaseen (2018).
Pelecanus onocrotalus: Mohammad (2014).
Phalacrocorax carbo: Abed (2005), Al-Tameemi (2013), Mohammad (2014).
Platalea leucordia: Awad et al. (1994).

Acknowledgements

Sincere thanks are due to Dr. Jörg Freyhof of Leibniz Institute for Evolution and Biodiversity Science, Berlin for ascertaining the specific name of the fish *Cyprinion macrostomum* through a correspondence with Dr. Atheer H. Ali. Sincere thanks are also due to Dr. Atheer H. Ali of the College of Agriculture, University of Basrah, Iraq for forwarding some literature and for his valuable suggestions while revising the manuscript.

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