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A checklist of Cladocera (Crustacea: Branchiopoda) of the Shatt Al-Arab River, Basrah, Iraq

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Abstract: About 51 species belonging to 2 Orders, 7 Families, and 20 Genera were recognized. The present review is based on ten systematic studies recording the species found in the region. The largest number of species recorded was 23 species at the Al-Qurnah station and 14 species in each of the Al-Hartha and Al-'Ashar stations. It was found that the most common species in the Shatt Al-Arab River were *Chydorus sphaericus* and *Simocephalus* (*Simocephalus*)*vetuloides*.

Keywords: Shatt Al-Arab, Cladocera, number of species .

1 Introduction

The Basrah province is located between 29°48'N–31°18'N and 46°39'E–48°10'E, it is located on the west bank of the Shatt Al-Arab River. The Shatt Al-Arab River is 200 km in length formed by the confluence of the Euphrates and the Tigris Rivers at Al-Gurnah town, eventually flowing into the Arabian Gulf. It varies in width from about 232 meters at Basrah to 800 meters at its mouth (Al-Faw). Basrah city is 110 km away from the Estuary of Shatt Al-Arab opens at the Arabian Gulf and receives most of its freshwater input from three major Rivers Tigris,Euphrates, and Qurnah (a tributary that joins the waterway from the Iranian side)in addition to the number of smaller streams connecting with the main Rivers, and the area a round Shatt Al-Arab River was estimated as one million square kilometers and include agricultural land on both sides of an area configured so downstream (Hassan, 2007).

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The cladocerans (common names: water fleas) are freshwater small-sized (0.2–6 mm, few representatives rich up to 18 mm) belong to the subphylum Crustacea, class Branchiopoda which forms (together with the Copepoda, andRotifera), most of the freshwater plankton, and that are a common component of many freshwater ecosystems, inhabiting pelagic, littoral,and benthic zones which in turn forms a basic and medium link in the fish food chains (Fryer, 1987; Batal et al., 2004). The cladocerans have been the object of microscopic study dating back to the 18^{th} century, they are minute forms, prefer to live in deep water and constitute a major itemchain and energy transformation (Uttangi, 2001). Four cladocerans orders are recognized, although two ctenopods and several onychopods from the family Podonidae are truly marine, and a few more ctenopod, anomopod and onychopod species occur in brackish waters. Seven known speciesmay be regarded as true inhabitants of the subterranean environments, and a fewothers (of the family Chydoridae) live in semi-terrestrial conditions (Forro´et al., 2008).

Cladocera is an important component of the microscopic crustacean zooplankton, they have limited horizontal migration and they are an important food link in the food chain. They are food for many fish, especially fish larvae, and they are important freshwater zooplankton and are used in many studies, laboratory experiments and biotechniques as in genetics research and evolution (Havel, 2009). Their numbers are large in different environments and have short life cycles, and easy access to and deal with. They inhabit most types of continental fresh and saline water habitats, occurring more abundantly in both temporary and permanent stagnant waters. Cladocera is an ancient group of Palaeozoic origin (Zawisza et al., 2016). Over 700 extant species, in $>$ 100 genera have been recognized so far, with many more undescribed (Damme and Kotov, 2016). They first appeared in the Oligocene period, and have since invaded most freshwater habitats (John, 2014). They are frequently considered key organisms in both pelagic environments (Daphniidae and Bosminidae families) as well as littoral habitats (Chydoridae family) (Frey, 1980). Cladocerans have long been recognized as important ecological and paleolimnological indicators (Korhola and Rautio, 2001; Jeppesen et al., 2001; Bennike et al., 2004). Because they hold an intermediate trophic position within the food web, they can be impacted by changes at the base of the food web such as nutrient loading (Lotter et al., 1998; Bos and Cumming, 2003; Hann et al., 1994), as well as by shifts in predator densities, such as fish or other invertebrates (Amsinck et al., 2005; Kerfoot and Weider, 2004).

Cladocerans(water fleas) are freshwater small-sized (0.2–6 mm, few representatives rich upto 18 mm) branchiopod crustaceans, that are a common component of manyfreshwater ecosystems, inhabiting pelagic, littoral, and benthic zones. Four cladocerans orders are recognized (Fryer, 1987). Although two ctenopods and several onychopods from thefamily Podonidae are truly marine, a few more ctenopod, anomopod andonychopod species occur in brackish waters. Seven known species may be regardedas true inhabitants of the subterranean environments, and a few others (of thefamily Chydoridae) live in semi-terrestrial conditions (Forró et al., 2008).

2 Materials and Methods

Data were obtained from a literature search on Cladocera in the Shatt Al-Arab River. The studies on Cladocera began about 100 years ago, the first of which was that of Gurney (1921), the second study was the Mohammad (1965) followed by Ajeel et al. (2001), Ajeel and Abbas (2012, 2016), Abbas et al.(2014), Ajeel and Abbas (2019), Maytham et al. (2019) and Al-Amery (2021). While there, are several studies indicating the presence of Cladocera in the region without classifying them as that of Salman et al. (2012), Al-Zubaidi and Salman (2001), Ajeel (2004), Morad

(2011) and Jebir (2013). Bledzki and Rybak (2016) were consulted in the present identification of Cladocera.

3 Results and Discussions

Historical Cladocera study in the Shatt Al-Arab River:

In the Shatt Al-Arab River there are a number of conducted studies on the group of Cladocera, but only nine of them are concerned with the identification of the species that occurred in the region. The interest in the group here goes more than 100 years back. The first study covered the area between the Shatt Al-Arab estuary and Amara city, and recorded 18 species of Cladocera, including eight species in the Shatt Al-Arab River (Gurney, 1921). Followed by Mohammad (1965) who studied the central and southern parts of Iraq including the Shatt Al-Arab from the estuary to Al-Qurnah, where he found 23 species of Cladocera including 15 species recorded for the first time in Iraq, he recorded 11 species from the Shatt Al-Arab River. Ajeel et al. (2001) recorded 23 species in Basrah city, including 17 species registered in the Shatt Al-Arab River of which 3 species were new records, and 14 species were recorded in Al-Hartha and Al-Ashar stations. Al-Jizani (2005) studied the effect of organic pollution on the diversity and abundance of the zooplankton in the Shatt Al-Arab River and Al-Ashar and Al-Rebat creeks and noted that the rotifers were dominant followed by Copepoda and Cladocera. Abbas et al. (2014) have found 23 species of Cladocera in the northern part of the Shatt Al-Arab River, 12 species were at Al-Gurna station, 11 species at Al-Hartha station close to a paper mill, 6 species near Al-Sindbad Isle and 6 at Al-Ashar station. Ajeel and Abbas (2016) reported 5 species at Al-Ashar station, 2 species at Abul-Khaseeb and one at Al-Faw station. Ajeel and Abbas (2019) recorded 15 species of Cladocera at the confluence of the Euphrates and Tigris Rivers in the Al-Qurnah region. Lughaiwi (2019) found only two species of Cladocera at the Al-Majideia and Al-'Ashar stations. Finally, Al-Amery (2021) reported 16 species, 15 of which were near Al-Sindbad Isle and 5 near Al-Sader Teaching Hospital.

Fifty-one species of Cladocera have been recorded from the Shatt Al-Arab River, Table (1) shows the Cladocera species recorded in the Shatt Al-Arab River and the sources from which the information was obtained. Other studies have documented the presence of the Cladocera in the Shatt Al-Arab River as that of Salman et al. (1986), which reported that the Cladocera was dominant (68%) in the Shatt Al-Arab River. In the south of the Shatt Al-Arab River, Al-Zubaidi (1998) studied the distribution of zooplankton and mentioned that the Cladocera at Al-Saybah station was dominant (58%). While Ajeel (2004) who studied the distribution of zooplankton in the Shatt Al-Arab River from the Dear region to Garmat Ali and suggested that the Cladocera was the second most important group after the Cirripede larvae and formed about 5.4-35.4% of the total zooplankton.

Shatt Al-Arab River is affected by many influences represented by the drainage of nutrients coming from rivers and marshes, and food materials that drift with waters rivers in addition to the effect of marine waters coming from the Arabian Gulf and concomitant changes in salinity concentrations, in addition to fluctuations in water temperature between summer and winter (Al-Mutar et al., 2003), this certainly affects the composition of the cladocerans species. Due to its geographic position and to its climate, the Shatt Al-Arab River is generally very rich in species of zooplankton.

Table 1. List of Cladocera species and figures obtained from previous sources in different regions of the Shatt Al-Arab River.

No	Species	Sources
Phylum: Arthropoda		
Infrakimgdom: Protostomia		
Superphylum: Ecdysozoa		
Phylum: Arthropoda		
Subphylum: Crustacea (Brünnich, 1772)		
Class: Branchiopoda (Latreille, 1817)		
Subclass: Diplostraca (Latreille, 1829)		
Superorder: Cladocera (Milne-Edwards, 1840)		
Order: Anomopoda, (Sars, 1865)		
Suborder: Radopoda (Dumont and Silva-Briano 1998)		
Superfamily: Eurycercoidea (Dumont and Silva-Briano 1998)		
Family : Chydoridae (Dybowski and Grochowski 1894)		
Subfamily : Aloninae (Frey, 1966)		
Genus: *Alona* (Baird, 1843)		
1	*Alona cambouei* (Guerne & Richard, 1893)	3,4
2	*A. costata* (Sars, 1862) 5,7	
3	*A. guttata* (Sars, 1862) 1	
4	*A. karua* (King, 1853) 3,4	
5	*A. rectangula* (Sars, 1862) 1	
6	*A. rustica rustica* (Scott, 1895) 5,7	
Genus: *Camptocercus* (Baird, 1843)		
7	*Camptocercus rectirostris* (Schödler, 1862)	5,7
8	*C. uncinatus* (Smirnov, 1971)	3,4
Subfamily : Chydorinae (Stebbing, 1902)		
Genus: *Chydorus* (Leach, 1816)		
9	*Chydorus sphaericus* (O.F. Müller, 1776)	2,3,4,5,6,7
Genus: *Dunhevedia* (King, 1853)		
10	*Dunhevedia crassa* (King, 1853)	3,4,5.7
Genus: *Alonella* (Sars, 1862)		
11	*Alonella diaphana* (King, 1853)	5
12	*A. excise* (Fischer, 1854)	1
13	*A. nana* (Baird, 1843)	10
Genus: *Leydigia* (Kurz, 1875)		

14	*Leydigia acanthocercoides* (Fischer, 1854)	5
15	*L. macrodonta macrodonta* (Sars, 1916)	5

Genus: *Eurycercus* (Baird, 1843)

16	*Eurycercus* (*Eurycercus*) *lamellatus* (Müller, 1776)	2

Genus: *Pleuroxus* (Baird, 1843)

17	*Pleuroxus paraplesius* (Frey, 1993)	5,7

Order: Anomopoda, (Sars, 1865)
Family : Bosminidae (Baird, 1845)
Genus: *Bosminopsis* (Richard, 1895)

18	*Bosminopsis deitersi* (Richard, 1895)	10

Genus: *Bosmina* (Baird, 1845)
Subgenus: *Eubosmina* (Seligo, 1900)

19	*Bosmina* (*Eubosmina*) *coregoni* (Baird, 1857)	2

Subgenus: *Bosmina* (Baird, 1845)

20	*Bosmina* (*Bosmina*) *longirostris* (Müller, 1785)	3,4

Subgenus: *Liederobosmina* (Kotov et al., 2013)

21	*Bosmina* (*Liederobosmina*) *meridionalis* (Sars, 1904)	5,7

Genus: *Ceriodaphnia* (Dana, 1853)

22	*Ceriodaphnia rigaudi* (Richard, 1894)	3,4,5
23	*C. reticulata* (Jurine, 1820)	2

Order: Anomopoda, (Sars, 1865)
Suborder: Aradopoda (Kotov, 2013)
Family : Daphniidae (Straus, 1820)
Subfamily: Daphniinae (Dumont and Pensaert, 1983)
Genus: *Daphnia* (Mueller, 1785)
Subgenus: *Ctenodaphnia* (Dybowski and Grochowski, 1894)

24	*Daphnia* (*Ctenodaphnia*) *exilis* (Herrick, 1895)	5,7
25	*D.* (*C.*) *magna* (Straus, 1820)	1,2,3,4,10
26	*D.* (*C.*) *cephalata* (King, 1853)	8,10

Subgenus: *Daphnia* (Muller, 1785)

27	*Daphnia* (*Daphnia*) *hyalina* (Leydig, 1860)	4,5,6,7
28	*D.* (*D.*) *longispina* (Müller, 1776) 1,2	
29	*D.* (*D.*) *lumholtzi* (Sars, 1885)	5,7,10
30	*D.* (*D.*) *pulex* (Leydig, 1860)	1,2,3,4,10

Genus: *Simocephalus* (Schoedler, 1858)

31	*Simocephalus serrulatus* (Koch, 1841)	10

Subgenus: *Simocephalus* (Schoedler, 1858)

32	*Simocephalus* (*Simocephalus*) *vetuloides* (Muller, 1776)	1,3,4,5,6,7,10

Subgenus: *Echinocaudus* (Orlova-Bienkevskaja, 1995)

33	*Simocephalus* (*Echinocaudus*) *exspinosus* (De Geer, 1778)	2,5,7

Genus: *Scapholeberis* (Schoedler, 1858)

34	*Scapholeberis kingii* (Sars, 1888)	2,5
35	*S. aurita* (Fischer, 1849)	1

Suborder: Radopoda (Dumont and Silva-Briano, 1998)
Superfamily: Macrothricoidea (Dumont and Silva-Briano, 1998)
Family: Macrothricidae (Norman Brady, 1867)
Genus: *Macrothrix* (Baird, 1843)Macrothrix

36	*Macrothrix rosea* (Jurine, 1820)	2
37	*M. spinosa* (King, 1853)	3,4,5
38	*M. laticornis* (Jurine, 1820)	10

Family : Ilyocryptidae (Smirnov, 1992)
Genus: *Ilyocryptus* (Sars, 1862)

39	*Ilyocryptus agilis* (Kurz, 1878)	3,4,5,7
40	*I. spinifer* (Herrick, 1882)	3,4

Family Moinidae (Goulden, 1968)
Genus: *Moina* (Baird, 1850)

41	*Moina affinis* (Birge, 1893)	5,6,7
42	*M. brachiata* (Jurine, 1820)	3,4
43	*M. micrura* (Kurz, 1875) 3,4	
44	*M. macropa* (Straus, 1820)	10
45	*M. belli* (Gurney, 1904)	9

Order: Ctenopoda (Sars, 1865)

Family : Sididae (Baird, 1850)
Genus: *Diaphanosoma* (Fischer, 1850)

46	*Diaphanosoma brachyurum* (Liévin, 1848)	5,6,7,10
47	*D. orghidani* (Negrea, 1982)	3,4
48	*D. sarsi* (Richard, 1894)	10
49	*D. dubium* (Manuilova, 1964)	10

Genus: *Sida* (Straus, 1820)

50	*Sida crystallina* (Müller, 1776)	2,10

Genus: *Latonopsis* (Sars, 1888)

51	*Latonopsis fasciculata* (Daday, 1905)	5

Sources: 1, Gurney, (1921); 2, Mohammad, (1965); 3, Ajeel et al., (2001); 4, Ajeel & Abbas (2012); 5, Abbas et al., (2014); 6, Ajeel & Abbas, (2016); 7, Ajeel & Abbas, (2019); 8, Maytham et al., (2019); 9, Lughaiwi (2019) 10, Al-Amery, (2021).

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Conflict of interests

The authors declare that there are no competing interests.

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