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A review of the Cladocera in Basrah, Iraq

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Abstract

Sixty five species of freshwater Cladocera belong to twenty-two Genera are reported from Basrah city, based on 15 studies mentioned the species of Cladocera in addition to seven other studies reported only density of Cladocera group. The maximum density of Cladocera was 91225 (ind./m^3) recording at Shatt Al-Arab- Al-Hartha region.

Keywords: Basrah, Cladocera, Freshwater

Introduction

Geographic and climatic position of Basrah

Basrah province is located between 29°48' N–31°18' N and 46°39' E–48°10' E, and its located on the west bank of the Shatt Al-Arab River, which consists of the Tigris and Euphrates Rivers confluence and flows into the Arabian Gulf after 195 km (Hussein and Attee, 2000). Basra City center is 110 km from the estuary and has a hot desert climate, characterized by a large thermal range (Hassan, 2007).

Literature review

The cladocerans has been the object of microscopic study dating back to the 18th century are minute forms have an average length being 0.2 mm to 3.5 mm. About 600 species of freshwater cladocerans occur throughout the world (Korovchinky, 1996). Cladocerans commonly called water flea prefer to live in deep water and constitute a major item chain and energy transformation (Uttangi 2001). Müller (1785), Daday (1898), Sars (1901) and Swammerdam (1969) the first to reveal valuable information about Cladocerans.

The Cladocera or Water fleas are freshwater zooplankton inhabiting all the niches of freshwater bodies; they are small floating or drifting crustaceans, commonly found in most freshwater habitats, including lakes, ponds, streams and rivers (Kaestner, 1970). While there have been a few marine species, freshwater that lack an abundance of fish that act as predators provide the most suitable habitats (Schram, 1986). Many species of cladocerans can be found residing in the open water of lakes, as do plankton. In most species, the body is not segmented, but it is covered by a secreted shell (Litchman, *et al*. 2013). The shell has an appearance

that looks like a bivalve; however, the shell is one continuous piece, folded in half (Fryer 1993; Uttangi 2001). The Cladocera have limited horizontal migration and they are an important food link in the food chain (Carpenter and Kitchell 1988). They are considered food for many fish, especially fish larvae, and they are important freshwater zooplankton and used in many studies, laboratory experiments and biotechniques as in genetics research and evolution (Monaghan and Milner, 2010). Their numbers are large in different environments, have short life cycles, easy to access and deal with (Vandekerkhove, *et al.* 2005).

The cladocerans found in the freshwater ponds and lakes around the world and could be considered a good replacement for Artemia and rotifer (Sharma & Chakrabarti, 2000).

The cladocerans are an extremely interesting invertebrate; they have a specialized feeding mechanism (Ye, *et al.* 2013). They are very sensitive to their habitats, and they will continue to thrive in great numbers due to their high reproduction rates. The cladocerans life is very complex and there are known to be four distinct life stages: the egg, juvenile, adolescent and adult (Lovrich and Thiel 2020). Their life expectancy has been documented at anywhere between 25 and 100 days (MacArthur and Baillie 1929).

Materials and methods

The data was based on following published studies on Cladocera at Basrah regions included the Shatt Al-Arab and its subsidiary Rivers, Basrah marshes, Shatt Al-Basrah Canal, marine waters, ponds and water bodies. Gurney, (1921); Mohammad, (1965); Khalaf and Smirnov, (1976); Salman *et al.* (1986); Salman *et al.* (1990); Ajeel *et al.*, (2001); Al-Zubaidi and Salman (2001); Ajeel (2004); Ajeel *et al.*, (2004); Ajeel *et al.* (2006); Abbas, (2010); Morad, (2011); Ajeel, (2012); Ajeel and Abbas (2012); Salman *et al.* (2012); Ajeel and Abbas, (2013); Jebir, (2013); Ajeel and Abbas, (2016); Ajeel and Abbas, (2019); Maytham *et al.* (2019); Lughaiwi (2019); Al-Amery (2021).

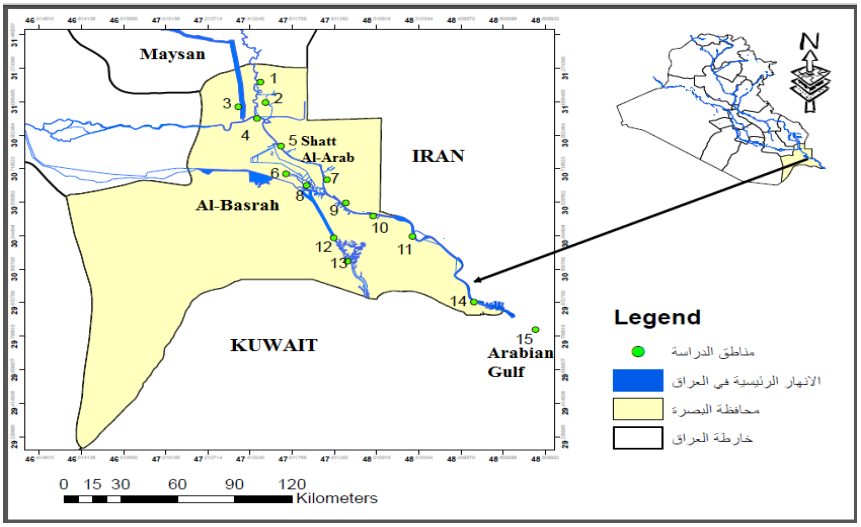

Figure 1: Map of Basra, Southern Iraq, showing sample collection locations.

Station locations: 1. Tigris River/ North of Basrah near Al-Jewaber Bridge 2, Tigris River/ North of Basrah near Hamayon Bridge; 3, Al-Izze River 4, Al-Qurna/ at the confluence of Euphrates and Tigris; 5, Shatt Al-Arab/ near paper mill; 6, South Al-Hammar Marshes; 7, Shatt Al-Arab/ Al-Hartha; 8, Garmat Ali River; 9, Shatt Al-Arab/ near Sinbad Island; 10, Shatt Al-Arab/ Al-Ashar; 11, Shatt Al-Arab/ Abu Al-Khasib; 12, Shatt Al-Basrah /north the Dam; 13, Khour Al-Zubair/ near the port; 14, Shatt Al-Arab/ Al-Fao; 15, Iraqi marine waters.

Results and Discussion

Historical Cladocera study in Basrah waters

Cladocera plays an important role in the freshwater ecosystem, it is a major component in aquatic food webs and their ecology has been extensively studied in larger water bodies (Forro *et al.* 2008).

In the Shatt Al-Arab there are many studies on the group of Cladocera, which researchers more than 100 years ago. Table (1) shows a list of Cladocera species recorded in previous studies in different areas of Basrah.

Table 1: List of Cladocera species recorded in previous studies at different regions of Basrah.

	Species		**References**
1	*Alona affinis* (Leydig, 1860)	R	6, 8
2	*A. cambouei* (Guerne & Richard, 1893)	D	4, 5, 9
3	*A. costata* (Sars, 1862)	R	3, 6, 7, 10, 12
4	*A. guttata* (Sars, 1862)	R	1,
5	*A. karua* (King, 1853)	R	4, 9
6	*A. rectangula* (Sars, 1862)	D	1, 4, 6, 10
7	*A. rustica rustica* (Scott, 1895)	R	7, 12
8	*Alonella diaphana* (King, 1853)	R	7, 10
9	*A. excist* (Fischer, 1854)	R	1,
10	*A. Nana* (Baird, 1843)	R	15
11	*Bosmina coregoni* (Baird, 1857)	R	2, 6
12	*B. longirostris* (Müller, 1785)	D	4, 5, 6, 9
13	*B. meridionalis* (Sars, 1904)	A	7, 12
14	*Bosminopsis deitersi* (Richard, 1895)	A	15
15	*Camptocercus rectirostris* (Schödler, 1862)	D	6, 7, 10, 12
16	*C. uncinatus* (Smirnov, 1971)	R	4, 5, 6, 8, 9
17	*Ceriodaphnia carnuta* (Sars, 1885)	D	3. 8
18	*C. regaudi* (Richard, 1894)	R	4, 7, 9, 10
19	*C. reticulata* (Jurine, 1820)	R	1, 2
20	*Chydorus barroissi* (Margalef, 1955)	R	3, 6, 8
21	*C. sphaericus* (Muller, 1776)	D	1, 2, 4, 5, 6, 9
22	*C. sphaericus sphaericus* (Müller, 1776)	D	7, 10, 11, 12
23	*Daphnia exilis* (Herrick, 1895)	R	7, 12

24	*D. hyalina* (Leydig, 1860)	R	4, 7, 9, 11, 12
25	*D. longispina* (Müller, 1776)	R	1, 2
26	*D. lumholtzi* (Sars, 1885)	R	7, 12, 15
27	*D. magna* (Straus, 1820)	D	1, 2, 4, 5, 9, 15
28	*D. pulex* (Leydig, 1860)	A	1, 2, 4, 8, 9, 15
29	*D. cephalata* (King, 1853)	R	13, 15
30	*Diaphanosoma brachyuurm* (Liévin, 1848)	D	4, 5, 6, 7, 9, 10, 11, 12, 15
31	*D. dubium* (Manuilova, 1964)	R	15
32	*D. orghidani* (Negrea, 1982)	D	4, 5, 9
33	*D. sarsi* (Richard, 1894)	R	15
34	*Dunhevedia crassa* (King, 1853)	R	4, 5, 6, 7, 8, 9, 10, 12
35	*Eurycercus lamellatus* (Müller, 1776)	R	2,
36	*Ilyocryptus agilis* (Kurz, 1878)	R	4, 5, 7, 9, 12
37	*I. spinifer* (Herrick, 1882)	R	4. 9
38	*I. sordidus* (Liévin, 1848)	R	6
39	*Kurzia longirostris* (Daday, 1898)	R	4, 9
40	*Latonopsis fasciulata* (Daday 1905)	R	7
41	*Leydigia acanthocercodes* (Fischer, 1854)	R	4, 7
42	*L. macrodonta macrodonta* (Sars, 1916)	R	7
43	*Leydigia* sp.	R	7
44	*Lynceus* sp.	R	4, 9
45	*Macrothrix laticornis* (Jurine, 1820)	R	15
46	*M. rosea* (Jurine, 1820)	R	2, 6
47	*M. spinosa* (King, 1853)	L	3, 4, 5, 7, 9, 10
48	*Moina affinis* (Birge, 1893)	L	7, 10, 11, 12
49	*M. belli* (Gurney, 1904)	R	14
50	*M. brachiate* (Jurine, 1820)	D	4, 5, 6, 8, 9
51	*M. hutchinsoni* (Brehm, 1937)	R	4
52	*M. macrocopa* (Straus, 1820)	R	15
53	*M. micrura* (Kurz, 1875)	L	4, 9
54	*Pleuroxus* sp.	R	6
55	Pleuroxus aduncus (Jurine, 1820)	R	3
56	*P. paraplesius* (Frey, 1993)	R	7, 12
57	*Podon polyphemoides* (Leuckart, 1859)	R	2,
58	*Scapholeberis kingi* (Sars, 1888)	R	2, 7, 12
59	*S. aurita* (Fischer, 1849)	R	1,
60	*Sida* sp.	R	10
61	*S. crystalline* (Müller, 1776)	R	2, 15
62	*Simocephalus (Echinocaudus) exspinosus* (De Geer, 1778)	L	2, 6, 7, 8, 10, 12
63	*S. (Simocephalus) vetuloides* (Muller, 1776)	D	1, 7, 10, 11, 12, 15
64	*S. serrulatus* (Koch, 1841)	R	15
65	*S. vetulus* (Müller, 1776)	D	4, 5, 6, 9, 15

Sources: 1. Gurney (1921) 2. Mohammad (1965) 3. Khalaf and Smirnov (1976) 4. Ajeel *et al.* (2001) 5. Ajeel *et al.* (2004) 6. Ajeel *et al.* (2006) 7. Abbas (2010) 8. Ajeel (2012) 9. Ajeel and Abbas (2012) 10. Ajeel and Abbas (2013) 11. Ajeel and Abbas (2016) 12. Ajeel and Abbas (2019) 13. Maytham *et al.* (2019) 14. Lughaiwi (2019) 15. Al-Amery (2021).

The abundance of the species in most studies are expressed as follow:

70 > %: Dominant species (D)
40 - 70 %: Abundant species (A)
10 - 40 %: Less abundant species (L)
10 < %: Rare species (R)

First research was published by Gurney (1921) between the mouth of the Shatt Al-Arab and Amara City, as taxonomic study did not mention the densities; samples were collected by Dr. P.A. Buxton between 1917 and 1918. Eighteen species of Cladocera, including 10 species were recorded in the Shatt Al-Arab. Mohammad (1965) 23 species of Cladocera including 15 species recorded for the first time in Iraq; in Shatt Al-Arab he recorded only 6 species. Ajeel (1998) recorded 23 species in the Basra City, including 17 species registered in the Shatt Al-Arab 6 species were new records. Al-Jizani (2005) studied the effect of organic pollution on the diversity and abundance of zooplankton in the Shatt Al-Arab, Al-Ashar and Rebat channels, and noted that rotifers more dominant then Copepoda and Cladocera. Finally, Abbas (2010) has recorded 23 species of Cladocera in the northern part of the Shatt Al-Arab (Table 2).

Other studies documented the presence of the Cladocera in the Shatt Al-Arab without being categorized as a study Salman *et al.* (1986), which reported that the Cladocera was dominant 68% in the Shatt Al-Arab, then Copepoda. In the south of the Shatt Al-Arab, Al-Zubaidi (1998) studied the distribution of zooplankton. It was mentioned that the Cladocera at Al-Seba station was dominant by 58% then Copepoda 27%. While Ajeel (2004) studied the distribution of zooplankton in the Shatt Al-Arab from the Dear region to Garmat Ali and mentioned that the Cladocera comes in the second important group after the Cirripede larvae and its formed proportion ranged between 5.4-35.4% of the total zooplankton.

Morad (2011) recorded he presence very few of Cladocera (not classified) during the spring and autumn at station 4 (Shatt Al-Arab / Al-Faw) (4 ind./m^3 in the spring and 24 ind./m^3 in the autumn), while recorded at station 3 (Khour Al-Zubair) 46 ind./m^3 during the summer, and the percentage in the study area was 15%, On the other side, did not record any presence in the Shatt Al-Basra before and after the dam.

In Shatt Al-Basrah channel, the abundance and diversity of Cladocera are few. Where Morad (2011) mentioned not recording any presence in the stations before and after the dam. Whereas, (Ajeel, 2012) reported that Cladocera, comprised 3.1 % of the total zooplankton, and its highest density was 5267 ind./m^3 *P* which occurred in March 2009. While Jebir (2013) recorded the presence of Cladocera, 17% in the three stations Shatt Al-Basrah before the dam, Al-Siba and Al-Faw, while a lower proportion (8%) at the Shatt Al-Basrah after the dam.

In rivers, a high number of Cladocera were recorded in Garmat Ali River, which reached 7207 Ind./m^3 during April 1997, which is higher than the number recorded by Salman *et al.* (1986) in the Shatt Al-Arab River, which amounted to 520 Ind./m^3 during January 1983. While Al-Zubaidi (1998) recorded the highest, number of Cladocera in the Shatt Al-Arab region and was 10,854 ind./m^3 and 8781 ind./m^3 in August 1994 in Al-Saybah and Al-Faw regions respectively. These differences in the density of Cladocera in different regions may be due to the different environmental conditions and the availability of food. In Garmat Ali River, there was a bloom of phytoplankton during the spring season, which led to an increasing number of Cladocera.

Table (2): Density, average density (ind./m^3), number of species and percentage of Cladocera in some areas of Basrah

Study area	mesh-sized (μm)	Density of Cladocera (ind./m^3)	Average density of Cladocera (ind./m^3)	Number of species	Percentage of Cladocera	References
Shatt Al-Arab	No. 49	-	-	10	-	Gurney (1921)
Shatt Al-Arab-Al-Qurna	158	-	-	4	-	Mohammad (1965)
Shatt Al-Arab-Al-Basrah	158	-	-	7	-	Mohammad (1965)
Shatt Al-Arab-Wasilia	158	-	-	4	-	Mohammad (1965)
Shatt Al-Arab-Faw	158	-	-	2	-	Mohammad (1965)
Khour Al-Amaya	158	-	-	1	-	Mohammad (1965)
Marshes of Qurna				5		Khalaf and Smirnov (1976)
Shatt Al-Arab River					68 %	Salman *et al.* (1986)
Khour Abdullah	200	0-1				Salman *et al.* (1990)
Shatt Al-Arab River Al-Seba	90	4-10854	1388		57.8 %	Al-Zubaidi and Salman (2001)
Shatt Al-Arab River Al-Faw	90	4-8781	1329	-	36.2	Al-Zubaidi and Salman (2001)
Shatt Al-Arab River – Al-Hartha	90	5-229	82	14	16.6	Ajeel *et al.* (2001)
Shatt Al-Arab River – Al-Ashar	90	0.3-145	24	14	3.8	Ajeel *et al.* (2001)
Garmat Ali River	90	17- 7207	1045	15		Ajeel, *et al.* (2001)
Shatt Al-Arab River – Al-Dear	120	0-621	178	-	5.4	Ajeel (2004)
Shatt Al-Arab- Sindbad Island	120	0.3-2118	510	-	23.3	Ajeel (2004)
Shatt Al-Arab- Sindbad Island	120	0.7-1423	547	-	35.4	Ajeel (2004)
Khour Al-Zubair	120	0-5	1		0.035 %	Ajeel (2004)
Shatt Al-Basrah channel	120	0 - 5	1.2		0.1 %	Ajeel (2004)
Garmat Ali River	250	3-98	22.6	12	17.8 %	Ajeel *et al.* 2004

Al-Huwaiza Marshes	120	0.4-72	33.7	4	6 %	Ajeel *et al.* (2006)
Al-Izze River	120	10-290	97.2	7	23.9 %	Ajeel *et al.* (2006)
Basrah Marshes	120	0.4-235	61.5	14	10.3%	Ajeel *et al.* (2006)
Shatt Al-Arab–Al- Qurna	120	1.3-2435	275	16	28.7%	Abbas (2010)
Shatt Al-Arab-Al-Hartha	120	1.2-91225	8992	12	70.4%	Abbas (2010)
Shatt Al-Arab-Sindbad Island	120	2-19800	3116	9	42.8%	Abbas (2010)
Shatt Al-Arab-Al-Ashar	120	0.08-20721	3605	7	52.3%	Abbas (2010)
Khour Al-Zubair	120	0 - 46	11.5	-	0.5%	Morad, (2011)
Shatt Al-Arab-Al-Faw	120	0 -24	7	-	0.1%	Morad, (2011)
Shatt Al-Basrah channel	120	0 - 5267	698	8	3.1 %	Ajeel (2012)
Shatt Al-Arab-Al-Hartha	120	5 - 229	151	14		Ajeel and Abbas (2012)
Garmat Ali River	120	18 - 7207	1051	15		Ajeel and Abbas (2012)
Shatt Al-Arab- Al-Ashar	120	0.3 - 145	25	14		Ajeel and Abbas (2012)
Shatt Al-Arab-Aboflos	120	11216	-	-	92.7	Salman *et al.* (2012)
Al-Hammar Marshes	90	79-41971	12158	13	10.6%	Ajeel and Abbas (2013)
Shatt Al-Arab-Al-Seba	85	0-1640	148.3	-	3.1%	Jebir (2013)
Shatt Al-Arab-Al-Faw	85	0.425	69.3	-	0.35	Jebir (2013)
Shatt Al-Arab-Al-Ashar	85	0.01-18922	5500	5	39.6%	Ajeel and Abbas (2016)
Shatt Al-Arab-Abu Al-Khasib	85	4.9-818	332.8	2	4.7%	Ajeel and Abbas (2016)
Shatt Al-Arab-Al-Faw	85	0-149	37.3	1	1%	Ajeel and Abbas (2016)
Tigris River	100	1 - 211	41.2	16	35.2%	Ajeel and Abbas (2019)
Shatt Al-Arab-Sindbad Island	50	0-1005	227	1	2%	Maytham *et al.* (2019)
Shatt Al-Arab-Al-Ashar	50	0-1450	352	1	1%	Maytham *et al.* (2019)
Shatt Al-Arab-Al-Majdiyah	50	-	-	2	2%	Lughaiwi (2019)
Shatt Al-Arab-Al-Ashar	50	-	-	2	2%	Lughaiwi (2019)
Shatt Al-Arab-Sindbad Island	50	0-2380	842	15	0.28%	Al-Amery (2021)
Shatt Al-Arab-Al-Ashar	50	0-4530	759	5	0.59%	Al-Amery (2021)

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دراسة مرجعية لمتفرعة اللوامس (Cladocera) في البصرة، العراق

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المستخلص

تم تسجيل خمسة وستون نوعاً من متفرعة اللوامس في المياه العذبة في البصرة تنتمي إلى 22 جنساً، اعتمادا على 15 دراسة تصنيفية بالإضافة إلى سبع دراسات أخرى ذكرت فقط كثافة مجموعة متفرعة اللوامس. لوحظ ان اعلى كثافة سجلت لمتفرعة اللوامس كانت في شط العرب قرب منطقة الهارثة وبلغت 91225 (فرد/م^3).

الكلمات المفتاحية: بصرة، متفرعة اللوامس، دراسة مرجعية