Macro-invertebrates response to acute salinity changes in the Shatt Al-Arab River system, Southern Iraq

Hanaa Hussei Mohammed iD, Huda Kadhim Ahmed iD, Samer Adnan Al-Taei and Malik Hassan Ali iD

Marine Science Centre, Univ. of Basrah, Basrah, Iraq
Email: malikh.ali1954@gmail.com

Received 16/1/ 2020, Accepted 23/5/ 2020, Published 25/6/ 2020
DOI: https://doi.org/10.58629/ijaq.v18i1.121

Abstract

The stress of acute salinity increase on the life of macro-invertebrates in Shatt Al-Arab River system were investigated based on their abundance estimation acute salinity increase during the year 2018,where the salinity of the River at central, Basrah City became above 5 ppt and reached up to 25 ppt. Review work was done to determine the sizes and densities of the species during the normal conditions in past decades (1975-1995). The results of observations, photography and semi-quantitative sampling which were taken during many visits in the years 2012, 2015, 2016, 2016, 2017, 2018, 2019 and 2020 at Al-Salhia, Abo Al-Kassib, Al-Garmma and Al-Gurnah, were expressed in an ordinal six abundant scales (SACFOR), modified for species sizes and densities. All the species were have superabundance or common scale during the period 1975-1995, whereas at 2018-2020 the abundance of all species except *M. affinis*, were declined in general, 7 species were absent and 3 more were rare. The amphipods *Parhyale basrensis*, *Platorchestia monod*i, the isopod *Sphaeroma annandalei* and the annelid *Namalycastis indica* were commonly or frequently found at good state indicating their ability to resist the mesohaline conditions, the euryhaline species *M. affinis* and *B. amphitrite* weren't affected. The study concluded that, in case of long term mesohaline conditions, most of the estuarine macro-invertebrates will be unable to persist and may be shifting to the upper reaches of the River.

Key words: Abundance, macro-invertebrates, salinity, Shatt Al-Arab River.

P-ISSN: 1812-237X, E-ISSN: 2788-5720, https://ijaqua.uobasrah.edu.iq/index.pip/iaqua

Introduction

Most macro-invertebrates of Shatt Al-Arab River are benthic fauna which known as a very sensitive community to various negative environmental changes due to the reason that they are relatively sedentary and therefore, their abundance and distribution are greatly affected against this changes. Furthermore, they considered a good indicators for detecting the impacts of such environmental changes (Sarker *et al.,* 2016; Little *et al*., 2017; Izegaegbe *et al.,* 2020). On the other hand, the community of macrobenthos is an essential biological unit in any aquatic ecosystem throughout their important role in the processes of nutrients cycling and ecological energy flow (Ali, 2001; Geeth *et al*., 2010; Li and Morrison, 2011).

It is well known that the estuarine species are adapted to live in brackish waters and they are capable to tolerate the continuous fluctuations of salinity during the diurnal and semi-diurnal tidal cycles of the seawater by having a perfect osmoregulation system (Wilson, 2002; McLusky and Elliott, 2005; Solan and Nia, 2016). Although having this physiological resilience, different estuarine species may have different salinity tolerance limits and each species has it's upper limits to salinity, in other words even that estuarine species are a brackish water animals but many of them are adapted to an oligohaline (0.5-5 ‰) or mesohaline (5-18 ‰) limits (McLusky and Elliott, 2005).

Practically no detailed studies had been done on the salinity tolerances of the macrobenthic invertebrate's species at Shatt Al-Arab habitat, and therefore we find impossible to predict the impact of the marine saltwater intrusion on these animals unless the availability of sufficient experimental direct measurements database (Kefford *et al*., 2003). As an alternative, field monitoring of some ecological parameters such as species composition, abundance and distribution can be useful indicator and a measure of the effect of a medium-term salinity fluctuations on the estuarine benthic fauna (Belal *et al*., 2016; Little *et al.,* 2017).

The lifespan of macro-invertebrates in the Shatt Al-Arab are relatively short (1-3 years) compared with the cold and temperate species due to the high rates of growth caused by the high temperature range of the subtropical climate at Basrah region (Ali and Salman, 1986; Sultan, 1987; Ali *et al.,*1995; Abdullah, 1996; Salman *et al.,* 1996). As an outcome of this short lifespan, these species can be greatly affected by any salinity

increases to a condition out of their upper limits of salinity tolerance for a medium-term (one year) period as happened in Shatt Al-Arab. The goal of this article is to document field observations on the macro-invertebrates abundances before and during the period of saltwater intrusion to the Shatt Al-Arab estuary in the year 2018 and to show the responses of these species to such salinity increase.

Materials and Methods

The investigation based on qualitative and semi quantitative sampling of the intertidal benthic macro-invertebrates including the invertebrates dwelling between aquatic macrophyts. Visits and sampling of macrobenthos conducted during 2012, 2015, 2016, 2018, 2019 and 2020 at Al-Salhia mainly Abo Al-Kassib, Al-Garmma and Al-Qurna sites of the Shatt Al-Arab River system. Fauna were collected by hand net or directly by hand, washed through 0.5 mm mesh sieve and some specimens were preserved in 85% alcohol for further laboratory examination. Photography was used to documents the fauna composition and abundance in the sites, photographs were taken by the cameras Nekon 700D, Nekon 84X optical zoom and Canon Power shot D 10. Previous studies were reviewed for the sizes and abundance of the studied fauna.

Water salinity data of the year 2018 were obtained from direct digital measurement sensors type HOBO Salt Water Conductivity/Salinity Data Logger/ High range.

A semi-quantitative six abundance scale SACFOR (Superabundant, Abundant, Common, Frequent, Occasional, and Rare) method, modified for sizes and densities, was used for abundance modified for sizes and densities, for abundance comparison (Hiscok,1998; Strong and Jonson, 2020). Statistically each scale is significantly ($P < 0.001$) different from the other scales.

All Macro-invertebrates were easily identified throughout the authors experience and according published local papers (Ahmed, 1975; Ali, 1979,1989; Al-Dabbagh & Daoud, 1985; Rabie, 1986; Ali and Salman, 1986; Saoud, 1987,1997; Sultan, 1987; Salman *et al.,* 1990,1996; Abdul-Sahib *et al*., 1995; Ali *et al*., 1995, 2013; Abdullah, 1996; Salman *et al*., 1996; Idrisi and Salman, 2005).

Results and Discussion

Water salinity

Figure (1) showing the map of Shatt Al-Arab River [29 56' 59.0"N 48 34' 23.0"E] as well as all sites used for sampling and for other ecological observations of the present investigation indicated by numbers with the GPS coordination of the sites. The Shatt Al-Arab river formed by confluence of the two great rivers the Tigers and Euphrates in Gurna, it runs for nearly 196 km to the Arabian Gulf. A detailed information on the geography, environmental and sedimentary characteristics of the river are available in many published papers (Al-Ramadan and Pastour, 1987; Al-Badran, 2004; Al-Maliky, 2012; Brandimarte, 2015; Abdullah *et al.,* 2016; Al-Mahmood, 2020).

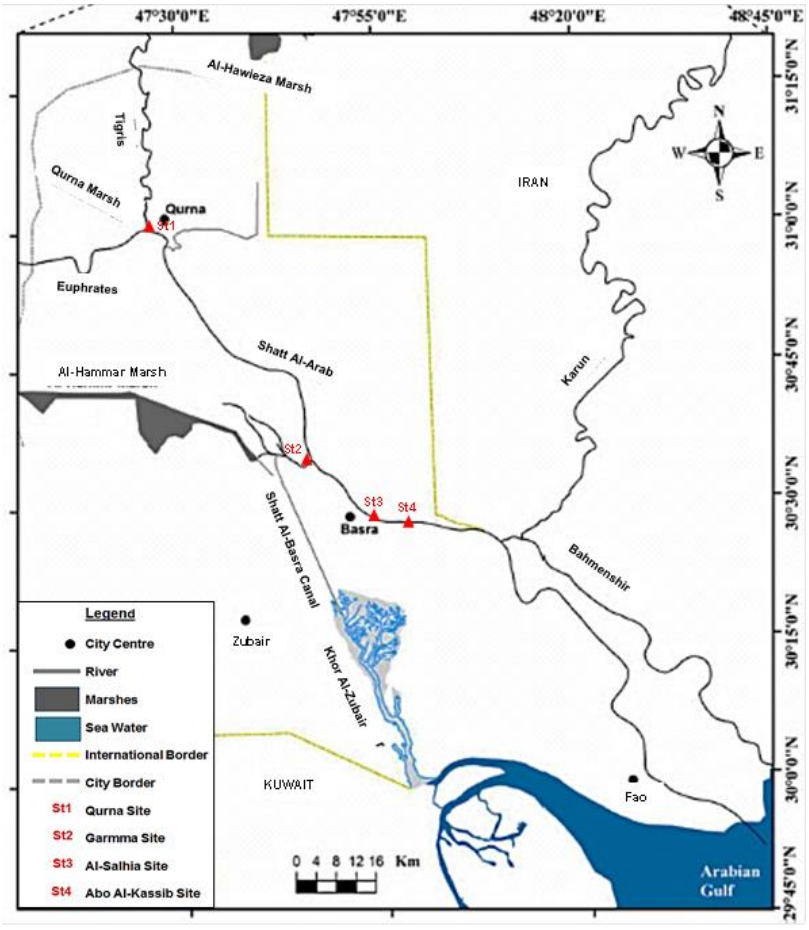

Figure 1: Map of Shatt Al-Arab River. All sites used for sampling of macrofauna and other ecological observations are indicated by red numbers.

Al-Salhia site, is located at a distance nearly 120 km North Rass Al-Besha where the River meets the sea. At this site and at the normal conditions when there is enough freshwater discharges, the River is usually an oligohaline brackish water (<5 ‰), and in fact the salinity mostly doesn't exceed 2 ‰ (the results of 16 months environmental monitoring 1983-1984, ROPME, 1986). The digital recording of salinity values of this study at Al-Salhia site during the periods anterior the acute salinity increases (2018), and during the 2018, were the seawater intrusion happened, as well as the data of the previous decades ,are given in Figure (2).

There is apparent increases of salinity in the years 1984, 2009, 2010, 2013, 2014, 2015 and 2018, but there is an acute increases in the years 2009 and 2018. However, in the event of 2009 the salinity exceeded 5 ‰ for only short period (1-2 month),while during 2018 the period was extended from April to November. Furthermore, the salinity value was as high as 25 ‰ in September.

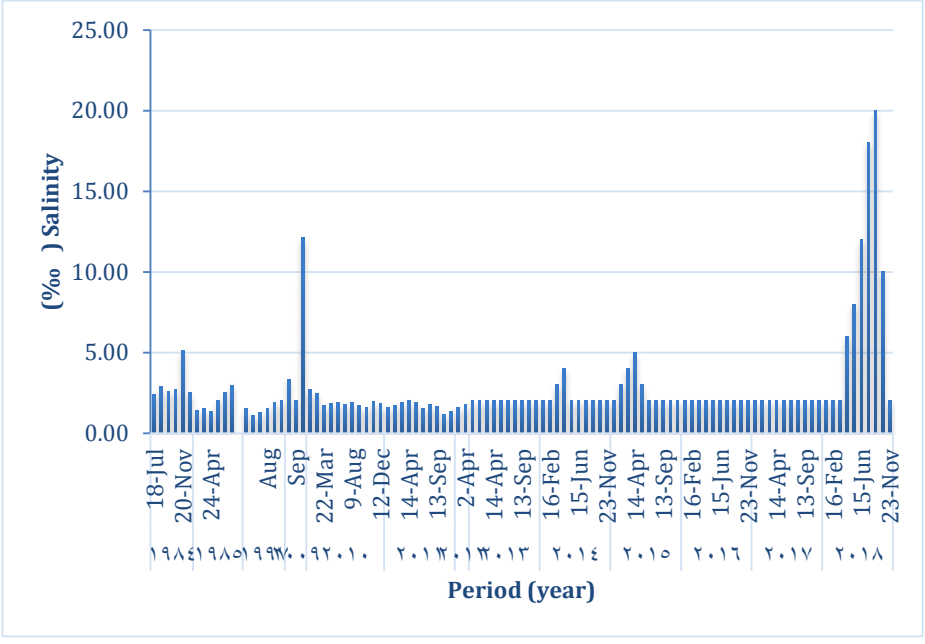

Figure 2: The salinity values in Shatt Al-Arab River (Center of Basrah City) during the periods (1984-2018), (Al-Taei *et al.,* 2020).

Macro-invertebrates
Size and abundance

The list of the most common macro-invertebrates inhabitants of Shatt Al-Arab River system comprised seventeen species belonging to three phyla, Crustacea, Mollusca and Annelida. Data of maximum sizes and abundance of these species based on reviewing the published and unpublished studies of the past decades are given in Table (1).

The sizes of the species are ranged from the smaller species, the gastropod *Theodoxus jordani* (6 mm) followed by the hymenosomatid crab *Elamenopsis kempi* (7.5mm) and the large penaeid shrimp *Metapenaeus affinis* (125 mm). The recorded densities (maximum density) of these species were ranged between very high value (18333 and 12512 ,ind/m^2) for the barnacle *Balanus amphitrite amphitrite*,the amphipod *Parhyale basrensis* respectively and the lower value(100 ind/m^2) for the gastropod *Neritina schlaeflii*.

According to the results of the species sizes and abundance, a SACFOR scale is made for the purpose of abundance standardization (Table 2). The six classes ,modified by body size, have the highest individual densities scale S (super abundant) 18000, 1800 and 180 (ind/m^2) for the sizes < 10, 10-30 and >30 (mm) respectively, whereas the rare scale (R) of these sizes are 0.18, 0.018 and 0.0018 (ind/m^2) respectively.

This semi-quantitative six abundance scale system had developed by many researchers (Hiscock, 1998; Stark, 1998; Strong and Jonson, 2020) for roving surveying techniques such as video collection, diving and rapid intertidal surveys.

According to the results of the SACFOR scale the abundance of the macro invertebrates species have been determined for four periods 1975-1995, 2012-2016, 2018 and 2020 (Table 3).

Crustaceans

The caridean shrimps, *Atyaephyra mesopotamica*, *Caridina babaulti basrensis* and the hymenosomatid crab *E. kempi* are subtidal decapods associated with macrophytes, mostly dwelling between the plant *Ceratophyllum demersum*, and the other macrophytes species which were characterized the habitat of Shatt Al- Arab River system (Al-Mayah *et al.*, 2016).

Table (1): Macro-invertebrates in Shatt Al-Arab River size and abundance and date.

species	Size (mm.)	Abundance (ind./m²)	Year of survey	Reference
Caridina babaulti basrensis	28.0	1200	1987-1989	Al-Adhub & Hamzah, 1998; personal data, this study
Atyaephyra desmaresti mesopotamica	29.0	1000	1987-1988	(Al-Adhub, 1987); Personal data, This study
Metapenaeus affinis	125	1000		(Salman *et al.*, 1990)
Chiromantes boulengeri	33	33-330		Ali, 1976; Sultan,1987
Elamenopsis kempi	7.5	150-1310	1987-1988	(Ali et al., 1995)
Parhyale basrensis	9.75	928-12512	1983-1984	(Ali &Salman, 1987; Ali & Ahmed 2006)
Platorchestia monodi	15	138-769	1993-1995	(Salman *et al.*, 2018)
Sphaeroma annandalei	12	767	1985-1986	(Saoud, 1987)
Annina mesopotamica	11	1218-5760	1984-1986	(Salman *et al.*, 1996)
Balanus amphitrite amphitrite	8.75	9250-18333	1994-1995	Abdul-Sahib *et al.*, 2019
Melanopsis preamorsa	19.0	100->2000	1970-1980	Abdullah, 1996; Personal data; this study
Melanoides tuberculata	30.0	100->2000	1970-1980	Abdullah, 1996; Personal data; this study
Theodoxus jordani	6.0	40->3000	1975-1980	(Al-Dabbagh & Daoud, 1985)
Radix auricularia	18.0	20->5000	1975-1985	Rabie, 1986
Neritina schlaeflii	23.0	20-100	1975	
Corbicula fluminalis	32.0	400	1975-1985	(Abdul-Sahib *et al.*, 1995; Personal data; this study
Namalycastis indica	13.5	120-370	1987	(Sultan *et al.*, 2017; Personal Data; this study)

The caridean shrimp species which were abundant during 1975-1995 and the crab *E. kempi* which was common, their numbers were declined gradually during the period 2012-2016 and became frequent (scale F), coincided with apparent decline of the macrophytes distribution in the site. At the year 2018 and the later period these species were absent from the site and most macrophytes were deteriorated and became rare or disappeared (Al-Mayah & Al-Asadi, 2018).

However, in 2017 samples were collected from Al-Gurna site (1), the upper reach of the Shatt Al-Arab estuary, in which large numbers (C) of the three species were found between the macrophytes. The situation was quite different and the condition was positive for the migratory penaeid shrimp species *M. affinis*, large numbers (S)were catched in the main river in all years (2012-2018). This shrimp species wasn't facing problem with salinity increases due to it is an euryhaline sea species (Salman *et al.*, 1990).

Table 2: The SACFOR abundance scale of macro-invertebrate in Shatt Al-Arab River.

SACFOR Count Scale			
Maximum Density at $1m^2$	Size of individuals (mm)		
	<10	10-30	>30
	18000 S		
	1800 A	S	
	180 C	A	S
	18 F	C	A
	1.8 O	F	C
	0.18 R	O	F
	0.018	R	O
	0.0018		R

In the same context the seawater barnacle *B. amphitrite* amphitrite was maintained its existence along Shatt Al-Arab River system (Abdul-Sahib *et al.*, 2019). Although it's abundance was declined gradually from super

abundant (S) to common scale (C). This May be attributed to many factors, mostly the declined of plankton food and change in water quality (Al-Mudaffar *et al*., 2020).

The crab *Chiromantes boulengeri* was very abundant intertidal species during the 70th and 80th decades of the previous century (Ali, 1979; Sultan, 1987). Their numbers were highly declined in the period 2012-2016 (F), and only few numbers (occasionally) observed in 2018, while they were absent during 2019-2020 surveys.

The isopod *Sphaeroma annandale*i and the amphipod *P. basrensis* were capable to maintain their existence successfully in the intertidal habitat at Al-Salhia site as well as they were observed and collected from Abo-Al-Kassib site and in Al-Garmma site during 2018-2019 .

A remarkable point should be highlighted is the absence of the other intertidal isopod species, *Annina mesopotamica* in all visited sites during 2018-2020. This species was very abundant during the previous periods 1984-1986 (Salman *et al.,* 1996).

The abundance of the supra tidal amphipod, *Platorchestia monodi* was less affected by salinity changes (although it's abundance declined from A to F scale), obviously that is due to the semi terrestrial life style of this species (Salman *et al.,* 2018).

Mollusca

The phylum Mollusca is represented by six main species at Al-Salhia site and it is the second macrobenthic inhabitant of Shatt Al-Arab (Ali *et al*., 2017). Reports indicated that the gastropods species were very abundant during the period 1970-1985 (Abdul-Sahib *et al*., 1995; Abdullah, 1996). They were widely distributed in the intertidal zone and sub tidally associated with the macrophytes. At Al-Salhia site during the period 2012-2016, most of the gastropods species (*Melanopsis praemorsa*, *Melanopsis tuberculata*, *T. jordani* and *N. schlaeflii*) were more or less maintained their abundances, but the numbers of *Radix auricularia* and the bivalve *Corbicula fluminalis* , which were very abundant during the years (1975-1995, became remarkably few or very few (F and O scales respectively) during the period (2012-2016) .

After 18 months (July 2018-January 2020) when the brackish water of the River was mesohaline (>5ppt), only three species of the gastropods

(*M. praemorsa*, M. *tuberculata* and *N. schlaeflii*) were found at Al-Salhia site, but their numbers rare (R) and they were of larger sizes, which indicate the absence of any new broods produced by the populations of these species during the previous reproductive season. The other two gastropods species, *R. auricularia*, *T. jordani* and the bivalve *C. fluminalis* were absent. However, all these molluscan species were observed in Al-Gurna site in which the salinity never exceeded the oligohaline limits (<5ppt) during the period of seawater intrusion.

Table (3): The abundance of macro-invertebrates in Shatt Al-Arab river (Al-Salhia site) during four periods based on SACFOR Count Scale, given in six codes scale Superabundant (S), Abundant (A), Common (C), Frequent (F), Occasional (O) and Rare (R), (-) is non.

Periods				
Species	1975-1995	2012-2016	2018	2019-2020
Crustacea				
Caridina babaulti basrensis	A	F	-	-
Atyaephyra desmaresti mesopotamica	A	F	-	-
Metapenaeus affinis	S	S	S	S
Chiromantes boulengeri	S	F	O	-
Elamenopsis kempi	C	F	-	-
Parhyale basrensis	A	C	F	C
Platorchestia monodi	A	C	F	F
Sphaeroma annandalei	A	C	F	F
Annina mesopotamica	S	-	C	C
Balanus amphitrite	S	A	C	C
Mollusca				
Melanopsis preamorsa	S	C	O	R
Melanoides tuberculata	S	C	R	R
Theodoxus jordani	A	C	R	-
Radix auricularia	S	F	-	-
Neritina schlaeflii	C	C	O	R
Corbicula fluminalis	S	F	-	-
Annelida				
Namalycastis indica	A	A	C	-

Annelids

Although reports mentioned many species of Annelida inhabited the area, only one polychaete species was observed and followed in the present study at Al-Salhia site, however, further extensive samples may be needed to cover other species. The numbers of the polychaete *Namalycastis indica* was abundant during the years (1975-2016) and seems to be declined (C) in 2018 due to salinity increases or may be affected by pollution and other changes of the water quality in the River (Al-Mudaffar *et al*., 2020).

In general there is significant associations between the salt-wedge intrusion and various ecological processes such as the trophic levels of the phytoplankton and the zooplankton communities, the species composition, biomass, food consumption and productions, all these components can be changed due to the salinity shifting (Falco *et al*., 2010; Weston *et al*., 2010; Antonio *et al*., 2012; Watanabe *et al*., 2014). Apparently, the macrobenthos of Shatt Al-Arab, in addition to the direct effect of salinity stress they can be also affected indirectly throughout the changes in one or more of the ecological processes. For example, the decapod species (crabs and shrimps) all have a planktonic larval stages (Idrisi and Salman, 2005), and their larval development are largely controlled by the salinity factor and also by the availability of specific kinds of phytoplankton and zooplankton assemblages, as suitable diets. Furthermore, the grazing activity gastropods species and the filter feeding of the bivalve *C. fluminalis*, are dependent on the benthic, epiphytic and the planktonic diatoms in the habitats. The diatoms of Shatt Al-Arab are a mixture of seawater, estuarine and freshwater assemblages (Al-Handal, 2009) and in any aquatic ecosystem the ratio of each component is a function of the salinity gradient (Snceijs and Weckkström, 2010; Potapore, 2011).

One of the most important results on many world's estuaries concerns the effect of seawater intrusion on the macrobenthic fauna is the shifting of their spatial distribution to further upstream (Fujii, 2012; Elliot and David, 2017). From this view point the shifting of salinity gradient that Shatt Al-Arab experienced during 2018 had noticeable effect on the distribution of the macrophytes along the main river and it's branches (Al-Mayah & Al-Asadi, 2018), as well as it changes the species

competition, distribution and abundance of the benthic community (Table 1).

However, when there's enough freshwater discharges to the Shatt Al-Arab, as the situation in the year 2020, and because there is no bearer, there is possibility, at different degrees, that the populations of these species at the upper reaches of the River can support the re-recruitments of these macro- invertebrates in the middle and some lower reaches of the River.

Conclusion

Based on the results of the present investigation concerned the medium-term of the mesohaline condition's stress on the macro-invertebrates species, we expected that at a long-term salinity stress conditions, only two estuarine species will persist, the amphipod *P. basrensis* and the isopod *S. annandale*i. Of course in addition to the euryhaline species, the shrimp *M. affini*s and the barnacle *B. amphitrite amphitrite*. The other species will be unable to persist in the lower reach and the middle distances of the River, and their distribution will be shifted to further upstream reaches (Al-Gurna site area).

However, further detailed studies, especially, the experimental works on the salinity tolerances of each benthic species are needed to predict more precisely the extent to which the salinity stressor affected the benthic community of Shatt Al-Arab River System.

References

Al-Taei, S. A.; Abdulla, S. S., Lafta, A. A. and Al-Fartosi, A. J. (2020). Physical properties review of previous studies numerical modeling. In: Shatt Al-Arab-the future of Basrah, regulatory Barrage and environmental impact. Ali, M. H. (eds.), University of Basrah, Basrah, 24-39. (in Arabic).

Abdullah, S. B. (1996). Ecological study and population dynamic of two gastropods in the intertidal zone *Melanopsis nodosa* Ferussac and *Melanoides tuberculata* (Müller), at Southern Iraq. Ph.D. Thesis, College of Science, Basrah Univ., pp 122.

Abdullah, A. D.; Karim, O.F.A.; Masih, I.; Popescu, I and Van der Zaag (2016). Anthropogenic and tidal influences on salinity levels of the

Shatt Al-Arab River, Basrah, Iraq. International journal of River Basin Management, 14(3): 357-366.

Abdullah, S. B.; Saoud, K. D. and Ageel, S. G. (2015). Population dynamics of the fresh water SHRIMP *Caridina babaulti basrensis* (Decapoda, atyidae) from Garmat-Ali River, Iraq, Hawlyat Al-Montada, 1(2): 3-11.

Abdul-Sahib, I. M., Salman, S.D. and Ali, M. H. (2019). Oxygen consumption and energy budget of the barnacle *Balanus amphitrite amphitrite* (Darwin, 1824) of an estuarine ecosystem, Basrah, Iraq. Mesopot. J. Mar. Sci., 34(2): 126-141.

Abdul-Sahib, I. M., Salman, S.D. and Jassim, A. K. (1995). Population dynamics and secondary production of the Asiatic calms *Corbicula fluminea* and *Corbicula flumenalis* (Müller), in the Shatt Al-Arab River System, Basrah, Iraq Marina Mesopotamica 10(1); 1-25.

Abdul-Sahib, I. M., Salman, S. D. and Ali, M. H. (2003). Population dynamics of the barnacle *Balanus amphitrite amphitrite* Darwin (Crustacea: Cirripedia) at Garmat Ali, Basrah, Iraq. Marina Mesopotamica,18(1): 55-76.

Ahmed M. M. (1975). Systematic study on Mollusca from Arabian Gulf and Shatt Al-Arab. Center for Arab Gulf studies, Basrah Univ. Iraq,; 75 pp.

Al-Adhub, A.H. Y. (1987). On a new sub species of freshwater shrimp (Decapoda, Atyidae) from the Shatt Al-Arab River, Iraq. Crustaceana 53(1): 1–4. DOI: https://doi.org/10.1163/

Al-Adhub, A.H. Y. and Hamzah, H. A. (1987). *Caridina babaulti basrensis* Subs nov. from Shatt Al-Arab region, Iraq (Decapoda, Atyidae), Crustaceana, 52(3): 225-228.

Al-Badran, B. (2004). Delta of River Shatt Al-Arab south of Iraq. Marina Mesopotamica, 19(2): 311-322.

Al-Dabbagh, K. Y. and Daoud, Y. T. (1985). The ecology of three gastropod mollusks from Shatt Al-Arab. Journal of Biological Sciences Research 16(2): 155-168.

Al-Handal, A. Y. (2009). Littoral diatoms from the Shatt Al-Arab estuary, North west Arabian Gulf. Cryptogamie, Algol, 30(1); 153-183.

Al-Mayah, A. A. and Al-Asadi, W. M. (2018). The impact of increase salinity on the aquatic plant assemblage in Shatt Al-Arab river. Marsh Bulletin, 13(2): 74-86.

Al-Mayah, A. A.; Al-Edani, T. Y. and Al-Asadi, W. M. (2016). Ecology and flora in Basrah. 688 pp.

Ali, M. H. (2001). The energy gains and energy losses by the intertidal amphipod *Parhyale basrensis* from the Shatt Al-Arab region. Marina Mesopotamica, 16(1): 141-159.

Ali M. H. (1979). Studies in the ecological behavior of the crab *Sesarma boulengeri* Calman, from Shatt Al-Arab. M. Sc. Thesis College of Science, Basrah Univ.,PP

Ali, M. H. (1989). Population dynamics and bioenergetics of the fresh water hyminosomatid crab *Elamenopsis kempi* (Chopra & Das), in Basrah. Ph.D. thesis, College of Science, Basrah Univ.

Ali, M. H. and Salman, S. D. (1986). The reproductive biology of *Parhyale basrensis* Salman (Crustacea: Amphipoda) in the Shatt Al-Arab River. Estuarine Coastal and Shelf Science, 23, 339-351.

Ali M. H.; Salman S. D. and Al-Adhub, A.H. Y. (1995). Population dynamics of Hyminosomatid crab *Elamenopsis kempi* in the brakish subtidal region of Basrah, Iraq. Science Marina 59, 1-13.

Ali, M. H.; Al-Mudaffar, N. A.; Mohammed, H. H. and Ahmed, H. K. (2017). Poster of Microinvertebrates of Shatt Al-Arab (II) Mollusca, DOI: 10.13140/RG.2.2.33098.67523.

Al-Mahmood, H. K. (2020). Referential analysis of discharge and salinity data in Shatt Al-Arab River. Iraqi Journal of Aquaculture 17(1): 11-26.

Al-Maliky, J. H. (2012). Analysis of water quality and the impact of the salt wedge of the Arabian Gulf on the Shatt Al-Arab River. A Thesis of MSc. Queensland, Australia.

Al-Mudaffar, N. A.; Ahmed, A. N.; Jasim, A. A.; Dawood, A. S. and Al-Mukhtar, S. A. (2018). Chemical water quality. In: Shatt Al-Arab-the future of Basra, Technical Report, Marine Science Center, University of Basrah, Iraq. (in Arabic). 229 pp.

Al-Ramadan, B. and Pastour, M. (1987). Tidal characteristic of Shatt Al-Arab River. Marina Mesopotamica, 2(1): 15-28.

Antonio, E. S.; Kasai, A.; Veno, M.; Ashihi, Y.; Yokoyama, H. and Yamashita, Y. (2012). Special and temporal feeding dynamics of benthic communities in an estuary marine gradient. Estuarine Coastal Shelf Science, 112, 86-97.

Belal, A.A. M.; El-Sawy, M. A. and Dar, M. A. (2016). The effect of water quality on the distribution of macro-benthic fauna in western Lagoon and Temsah Lake Egypt, The Egyptian Journal of Aquatic Research. Vol. 42(4): 437-448.

Brandimarte, L.; Popescu, I. and Neamah, N. K.(2015). Analysis of fresh-saline water interface at the Shatt Al-Arab estuary. International journal of River Basin Management, 13(1): 17-25.

Elliot, W. and David, K. (2017). Restore or retreat ? saltwater intrusion and water management in coastal wetlands, Ecosystem Health and Sustainability, 3: 1, Doi: 10.1002/ehs2.1258.

Falco, S.; Niencheski, L. F., Rodilla, M.; Gonzalez Del Rio, J. and Mösso C. (2010). Nutrient flux and budget in the Ebro Estuary, Estuarine Coastal Shelf Science, 87(1): 92-102.

Fujii, T. (2012). Climate change Sea-Level Rise and implications for coastal and estuarine shoreline Management with particular reference to the ecology of intertidal benthic macrofauna in north west Europe, Biology. 1, 597-616.

Geetha, P. M.; Thasneem, T. A. and Nadan, S. P. (2010). Macrobenthos and its relation to ecosystem dynamics in the Cochin estuary.

Hiscok, K. (1998). In situ survey of intertidal biotopes using abundance scales and checklists at exact locations (ACE),. Version 1 of 23 March In: Biological monitoring of Marine special areas of conservation: a hand book of methods for detecting changes. Part 2 procedual guidelines (ed. Hiscotik, K.), 3 pp. Peterborough, joint Nature conservation committee.

Idrisi, N. and Salman, S. D. (2005). Distribution, development and metabolism of larval stages of warm water shrimp, *Caridina babulti basrensis* (Decapoda, Atyidae). Mar. Fresh. Behav. Physiol, (38): 31-42.

Izegaegbe, J. I; Vevier, L. and Mzimela, H. M. M. (2020). Macrobenthic community structure of the Mhlathuze Estuary, a permanently open estuarine embayment in Kwazulu-Natal, South Africa. African Journal of Aquatic Science. 45(1-2): 95-107.

Kefford, B. J.; Papus P. J. Nugegoda, D. (2003). Relative salinity tolerance of macroivertebrates from the Barwon River, Victoria, Australia. Marine and Freshwater Research, 54(6): 755-765.

Li, B. and Morrison, R. J. (2011). Analysis of macrobenthic assemblage of Illawarra, New South Wales, Australia. Transit, Water Bull, n.2, 11-20.

Little, S.; Wood, P. and Elliot, M. (2017). Quantifying salinity-induced changes on estuarine and benthic fauna: the potential implications of climate change estuarine, Coastal and Shelf Science 198. 610-625.

Mackay, C. F. and Cyrus, D. P. (1998). A review of macrobenthic fauna of the Mhlathuze Estuary: setting the ecological reserve Southern African Journal of Aquatic Science, 24(1-2): 111-129.

McLusky, D. S. and Elliot, M. (2005). The estuarine ecosystem. Oxford University press, Oxford. (An accessible and readable guide to the estuarine ecosystem and the interactions between Science and management)

Potapora, M. (2011). Patterns of diatoms distribution in relation to salinity. In: The diatoms of world. Publisher: Springer. Editors; Seckbach, J. and J. P. Kocloiek.

Rabie, A. K. A. S. (1986). The ecology of two species of Pluminate snails *Lymnaea auricularia* (L.), *Physa acuta* Draparnaud in Shatt Al-Arab River. M. Sc. Thesis, University of Basrah, Iraq.

Salman, S. D.; Hamxah, H. A. and Ali, M. H. (2018). On the reproductive biology of the talitrid amphipod Platorchestia monodi (Mateus et al.,1986) from the Shatt Al-Arab region, Basrah, Iraq. Iraqi Journal of Aquaculture, 15(1): 78-102.

Salman, S. D.; Ali, M. H. and Al-Adhub, A.H. Y. (1990). Abundance and seasonal migration of the penaeid shrimp *Metapenaeus affinis* (H. Milen and Edwards) within Iraqi waters. Hydrobiologia, 196: 79-90.

Salman, S. D.; Oshana, V. K. and Ali, M. H. (1996). Life cycle and population dynamics of *Annina mesopotamica* (Ahmed), (Isopoda: Flabellifera), in the Shatt Al-Arab region, Basrah, Iraq. Hydrobiologia 330, 119-130.

Saoud, K. D. (1987). Population dynamics, secondary production and swimming behavior of *Sphaeroma annandalei annandalei* Stebbing 1911, M. Sc. Thesis, College of Science, Basrah Univ.

Saoud, K. D. (1997). A comparative ecological study of two isopods crustaceans *Annina mesopotamica* and *Sphaeroma annandalei annandalei* in the Shatt Al-Arab Region, Iraq. Ph. D. Thesis. College of Science, Basrah Univ.

Sarker, J.; Tanmay, M. H.; Rahman, F.; Ptwary, M. S. A. and Rima, N. N. (2016). Assessment of coastal water pollution In Greater Noakhali-Bangladesh. Journal of Coastal Zone Management, 19:427. doi:10.4172/2473-3350.1000427

Snoeijs, P. I. and Weckstrom, K. (2010). Diatoms and environmental change in large brakish-water Ecosystem. In: The diatoms: Applications for environmental and earth science. Publisher; Cambridge University Press, Cambridge. Eds: Smol, J. P. and E. F. Stoermer.

Solan, M. and Nia, M. (eds.) (2016). Stressors in the Marinr Environmental. Publisher: Oxford University Press, 384 pp.

Stark, J. D. (1998). SQMCI: A biotic index for freshwater invertebrate coded-abundance data. New Zealand Journal of Marine and Freshwater Research 32:1, 55-66.

Strong, J. A. and Johnson, M. (2020). Converting SACFORdata for statistical analysis: Validation, Demonstration and further possibilities Marine Biodiversity Records 13(2): 1-18.

Sultan, E. N. (1987). Pupulation dynamics, secondary production and burrowing behavior of *Sesarma boulengeri* Calman, in Shatt Al-Arab. M. Sc. Thesis College of Science, Basrah Univ.

Sultan, I. N.; Abed, J. M. and Ahmed, N. S. (2017). Population biology and production dynamic of *Namalycastic indica* (Southern, 1921) in two habitats in the Shatt Al-Arab. Journal of Basrah Research Science, B, 2 (43):

Watanabe, K.; Kasai, A.; Antonio, E.; Suzuki, K.; Ueno, M. and Yamashita, Y. (2014). Influence of salt-wedge intrusion on ecological processes at lower trophic level in the Yura Estuary. Japan estuarine, coastal and shelf science, vol. 139, 67-77.

Weston, N. B.; Vile, N. A.; Neubauer, S. C. and Velinsky, D. J. (2010). Accelerated microbial organic matter mineralization following salt-water intrusion into tidal freshwater marsh soils. Biogeochemistry, 102, 135-151.

Wilson, J. G. (2002). Adaptation to life in Estuaries. In: Encyclopedia of life support systems (EOLSS) Publisher: Paris, France: UNISCO, (EOLSS).

استجابة اللافقريات الكبيرة للتغيرات الحادة في الملوحة لنظام شط العرب جنوب العراق

هناء حسين محمد و هدى كاظم أحمد و سامر عدنان رحمة و مالك حسن علي

مركز علوم البحار، جامعة البصرة، البصرة، العراق

Email: malikh.ali1954@gmail.com

Received: 16/1/2020 Accepted: 23/5/2020 published: 25/6/2020
DOI: https://doi.org/10.58629/ijaq.v18i1.121

المستخلص

جرى تقدير ضغط الزيادة الحادة في الملوحة على حياة اللافقاريات الكبيرة في نظام شط العرب بناءً على تقييم وفرة الاحياء مع الزيادة الحادة في الملوحة خلال عام 2018، حيث زادت ملوحة النهر في وسط مدينة البصرة على 5 جزء من الألف ووصلت إلى 25 جزء من الألف. اجريت مراجعة لتحديد أحجام وكثافة الأنواع خلال الظروف العادية في فترة العقود الماضية (1975-1995). نتائج المشاهدات والصور والمعاينة شبه الكمية التي تم أخذها خلال زيارات عديدة نفذت في الأعوام 2012 و 2015 و 2016 و 2016 و 2017 و 2018 و 2019 و 2020 في محطات الدراسة الصالحية وأبو الخصيب والكرمة والقرنة، وعبر عنها في ستة مقاييس للوفرة (SACFOR) ، معدلة لأحجام الأنواع وكثافتها. جميع الأنواع كانت تحتوي على وفرة أو مقياس شائع خلال الفترة 1975-1995، بينما في 2018-2020 انخفضت وفرة جميع الأنواع باستثناء *M. affinis* بشكل عام، وغابت 7 أنواع و 3 أخرى كانت نادرة. تم العثور على amphipods *Parhyale basrensis* و *Platorchestia monodi*و isopod *Sphaeroma annandalei* و *Namalycastis indica* بشكل شائع أو متكرر في حالة جيدة مما يشير إلى قدرتها على مقاومة الظروف المتوسطة الملحية، ولم تتأثر الأنواع *M. affinis* euryhaline و *Balanus amphitrite*. خلصت الدراسة إلى أنه في حالة الظروف المتوسطة الملحية طويلة المدى، فإن معظم اللافقاريات الكبيرة في مصبات الأنهار لن تكون قادرة على البقاء وقد تتحول إلى الروافد العليا للنهر.

كلمات مفتاحية: الوفرة، اللافقريات الكبيرة، الملوحة، شط العرب.

P-ISSN: 1812-237X, E-ISSN: 2788-5720, https://ijaqua.uobasrah.edu.iq/index.pip/iaqua