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Dietary competition between the local shrimp Metapenaeus affinis and the invasive Macrobrachium nipponense shrimp Southern Iraq

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Abstract
There is no information about the natural diets and competition of Iraqi native shrimp *Metapenaeus affinis* and the invasive shrimp *Macrobrachium nipponense*, However, the aim of this study is to identify the diet items of *M. affinis* and *M. nipponense* based on the analysis of stomach contents in order to identify the existence of a dietary overlap the two species. A total of 630 Stomachs of *M. affinis* and 780 stomachs of *M. nipponense* were investigated. The result that the diets composition of *M. affinis* consisted mainly of eleven items belonging to twenty one types of food. While in the stomach contents of *M. nipponense* were categorized into thirteen types belonging to thirty items. These main groups were Phytoplankton, aquatic plant, Zooplankton, Crustacean, Fish larvae, Mollusca, sediments, Insects, unidentified matter, unidentified Invertebrate, unidentified Algae, Amphipods and Annelid. The diets of *M. affinis*, were consisting of aquatic plant (25 %), followed by Phytoplankton (16%) and fish larvae consisting the lowest percentage (1.5 %). The Phytoplankton was dominating the stomachs of *M. nipponense* (21 %) then comes the insects 12%, and fish the larvae consist of the lowest percentage (2 %). High feeding intensity of *M. affinis* was observed during March, April and May, whereas low feeding intensity was observed during July, August, September, October, November and December (maximum during April 41% and minimum in December (3%). While the high feeding intensity of *M. nipponense* was achieved during May, June and July whereas, the low intensity was observed during September, October, November and December (maximum in June 40 % and minimum during October 10%).

Keywords: dietary competition, *Metapenaeus affinis, Macrobrachium nipponense*, Southern Iraq

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INTRODUCTION

The species, *Metapenaeus afiinis* and *Macrobrachium nipponense* are belonging to decapods, but they are different in families, the first belongs to Penaeidae and second to Palaemonidae (Hothuis, 1980). In Iraqi land fresh water (except marine water), the penaeidae have only one endemic species that *M. afiinis* (Miquel, 1983). While Palaemonidae have many species and *M. nipponense* one is of these, which was recorded in Iraq as an invasive species (Salman et al. 2006). *M. nipponense*, originated in China and is distributed over East Asian (Japan, Korea, Vietnam, Myanmar, and Taiwan) (Chen et al. 2015). It was also recorded from Anzali, Iran (Grave and Ghane, 2006). Shrimp are known to feed on a wide variety, and adapt very well to changes in diet composition by the induction of digestive enzymes synthesized and secreted in the hepatopancreas (Le Moullac et al. 1997). Analysis of stomach contents provide good information about the feeding habits of the species; also it gives idea of the most preferred foods (Vengopal et al. 2014).

Studies on analysis of stomach contents of Penaeidae and Palaemonidae are supported by a number of studies, including the works by Murthy and Rajagopal (1990) on Food and feeding of *Macrobrachium equidens* ; Collins and Paggi (1998) on *Macrobrachium borelli* ; Albertoni et al. (2003) on *Macrobrachium acanthurus* ; Abayomi et al. (2011) and Jimoh et al (2011) on *Macrobrachium vollenhovenii*; Sethi and Venkatesan, (2013) on *Macrobrachium lar* ; Joseph et al. (2013) on *Macrobrachium macrobrachion*; Lavajoo, et al. (2019) on *Macrobrachium nipponense*; While the works about Penaeidae that was achieved by Condrey et al. (1972) on *Penaeus setiferus* and *P. aztecus* ; Marte (1980) on *Penaeus monodon ;* Chong and Sazekumar (2003) on *Penaeus merguiensis;* Kumlu and Kir (2005) on Food consumption of *Penaeus semisulcatus*; Deshmukh et al. (2006) on Penaeids;

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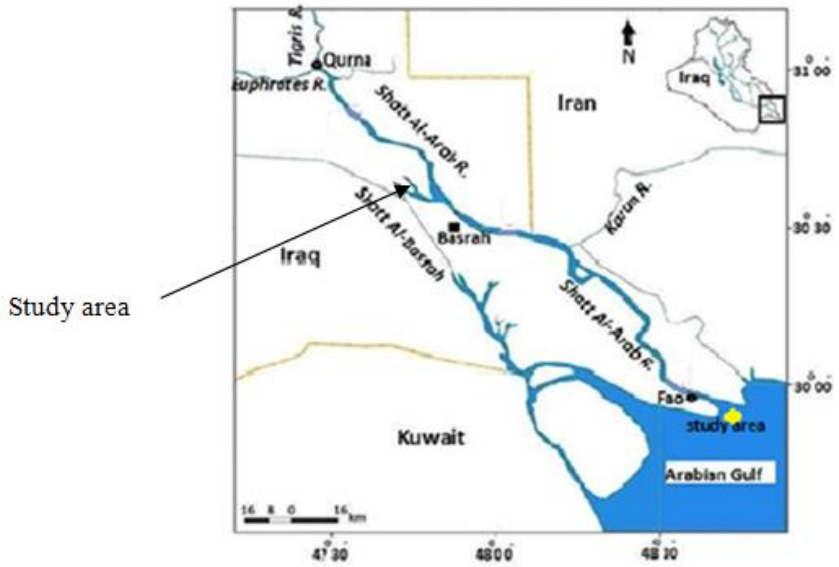

Fig. 1. Geographical location of the sampling site in Al-Hammar marsh, Southern Iraq

Varadharajan and Pushparajan (2013) on feeding of *Litopenaeus vannamei* ; Parra-Flores et al. (2019) on the feeding behavior of the genus *Penaeus*.

No local investigations on the food and feeding competition between the endemic species *M. affinis* and the invasive *M. nipponense*, and this study is considered the first attempt in this aspect to diagnose the types of food consumed in their stomachs and thus know the intensity of food competition and the extent of its impact on other species.

MATERIAL AND METHODS

This study focused on two species of shrimp *M. affinis* and *M. nipponense*, the samples were collected monthly from Al- Hammar marsh by trawl net from January to December 2016, this is located within an area that lies between 30º 39´ 34.27˝ N; 47º 39´ 13.81˝ E., (**Fig. 1**). Specimens collected were, 630 individual of *M. affinis* ranging from 40 to 87 mm TL and 780 individual of *M. nipponense* ranging from 47 to 82 mm TL. The sampled shrimps were immediately preserved in ice and transfer to the laboratory at the Marine Science Collage, University of Basrah. The stomachs were preserved in 5% formalin for further analysis. Prey items in the stomachs were emptied in a clean petri-dish containing fresh water and cut opened for the recording degree of fullness, food fullness percentage (FFP) was used to determine the type of food by using the ormula: FFP = NFI /TNF× 100. Where: NFI = Number of food item in stomach, TNF = Total number of all food ingredients in stomach. Stomach condition was classified based on quantity of food materials present as full, (more than 75 %), half full (50-75 %), a quarter full (25-50 %) and trace to empty (less than 25 %). items were examined using a microscope to the lowest possible taxonomic level by using available keys (Algae: Vuuren et al., 2006; Rotifera: Edmonson,1959; Kutikova, 2002).

RESULTS

A total of 630 stomachs of *M. affinis* and 780 stomachs of *M. nipponense* were analysed, a wide range of food items were identified in dissected stomachs, diets composition of *M. affinis* consisted mainly of eleven dietary items were categorized to twenty one types of food. While food items identified in the stomachs of *M. nipponense* were categorized into thirteen main groups belonging to thirty items. These main groups were Phytoplankton, aquatic plant, Zooplankton, Crustacean, fish larvae, Mollusca, sediments, Insects, unidentified matter, unidentified Invertebrate, unidentified Algae, Amphipods and Annelid (**Table 1**). In dominant food items of *M. affinis*, were aquatic plant ranked first (25 %), followed by phytoplankton (16%) consisting of diatoms, especially *Pleurosigma*, *Nitzschia* and the flagellate *Synedra* sp., then comes the Zooplankton (12 %) represented by Rotifers (*Brachionus calyciflorus* and *Monostyla* sp.) and Cladocera consisted by one specie *Daphina magna*. Followed by Crustacean (10%) larvae of *Elamenopsis kempi* crab and maxillipoda *Balanus amphitrite*. Insects 8 % including, Dipteran *Chironomus* sp. and Odonata *Ischnura evansi* and unidentified insects. Followed by unidentified invertebrate and unidentified algae 9 %, unidentified matter 7 %, sediments 4 %, Annelid 2 % (*Tubifex* sp., *Pristina longiseta* and *P. macrochaeta*) and Fish larvae 1.5 % (**Fig. 2**).

Table 1. List of the food items of stomachs of *Metapenaeus affinis* and *Macrobrachium nipponense* (- absent + present) in Al- Al-Hammar marsh, Southern Iraq

No.	Food items	Types		Shrimp type	abundance
1	Phytoplankton	Diatoms	*Pleurosigma*	*M. nipponense*	+
				M. affinis	+
			Nitzschia sp.	*M. nipponense*	+
				M. affinis	+
		Flagellate	Synedra sp.	*M. nipponense*	-
				M. affinis	+
2	Macro vegetable	Macro vegetable	Remains	*M. nipponense*	+
				M. affinis	+
3	Zooplankton	Rotifer	*Brachionus calyciflorus*	*M. nipponense*	+
				M. affinis	+
			Brachionus plicatilis	*M. nipponense*	+
				M. affinis	-
			*Keratell*a sp.	*M. nipponense*	+
				M. affinis	-
			Polyarthra	*M. nipponense*	+
				M. affinis	+
			Filina sp.	*M. nipponense*	+
				M. affinis	-
			Monostyla bulla	*M. nipponense*	-
				M. affinis	+
		Cladocera	*Daphina magna*	*M. nipponense*	+
				M. affinis	+
			Moina sp.	*M. nipponense*	+
				M. affinis	-
		Copepod	*Cyclops* sp.	*M. nipponense*	+
				M. affinis	-
4	Crustacean	Shrimp larvae	*Metapenaeus affinis*	*M. nipponense*	+
				M. affinis	
			Shrimp remains	*M. nipponense*	+
				M. affinis	-
		Crab larvae	*Elamenopsis kempi*	*M. nipponense*	+
				M. affinis	+
		Maxillipoda	*Balanus amphitrite*	*M. nipponense*	+
				M. affinis	+
5	Insects	Diptera	*Chironomus* sp.	*M. nipponense*	+
				M. affinis	+
		Odonata	*Ischnura evansi*	*M. nipponense*	-
				M. affinis	+
			Anax prathenope	*M. nipponense*	+
				M. affinis	-
			Other insects	*M. nipponense*	+
				M. affinis	+
6	Fish larvae	Fish larvae	Fish larvae remain	*M. nipponense*	+
				M. affinis	+
7	Amphipods	Amphipods	*Parhyale basrensis*	*M. nipponense*	+
				M. affinis	-
8	Mollusca	Gastropoda	*Lymnea sp.*	*M. nipponense*	+
				M. affinis	-
			Gyralus sp.	*M. nipponense*	+
				M. affinis	-
			Remains	*M. nipponense*	+
				M. affinis	-
9	Annelid	Annelid	*Tubifex sp.*	*M. nipponense*	+
				M. affinis	+
			Dero cooperi	*M. nipponense*	+
				M. affinis	-
			Pristina longiseta	*M. nipponense*	+
				M. affinis	+
			Pristina macrochaeta	*M. nipponense*	-
				M. affinis	+
10	Sediments	mud and sand detritus	Remains	*M. nipponense*	+
				M. affinis	+
11	Unidentified matter	unidentified matter	Remains	*M. nipponense*	
				M. affinis	+
12	Unidentified invertebrate	unidentified invertebrate	Remains	*M. nipponense*	+
				M. affinis	+
13	Unidentified algae	unidentified Algae	Remains	*M. nipponense*	+
				M. affinis	+

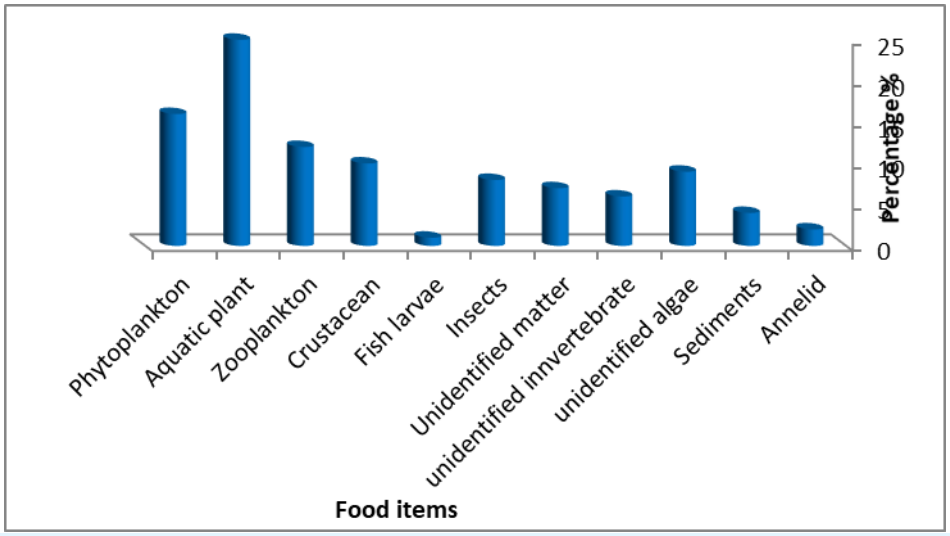

Fig. 2. Percentage of food items in the stomach of *Metapenaeus affinis* from Al Hammar Marsh, Southern Iraqi from January to December 2016

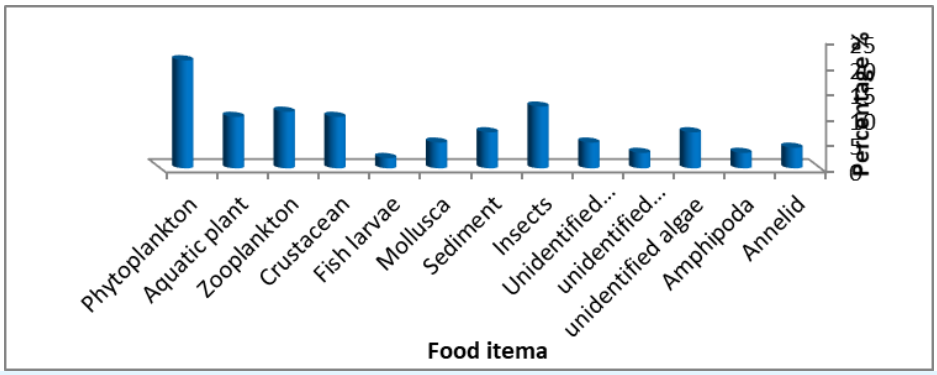

Fig. 3. Percentage of food items in the stomach of *Macrobrachium nipponense* from Al Hammar Marsh, Southern Iraqi from January to December 2016

The percentage of the food types in the stomachs of *M. nipponense* consisted of Phytoplankton 21 % comprised of diatoms, especially *Pleurosigma*, *Nitzschia*, followed by Insects 12 % including Diptera *Chironomus* sp., Odonata *Anax prathenope* and other insects, then comes the Zooplankton 11% represented by Rotifer (*Brachionus calyciflorus*, *Brachionus plicatilis*, *Keratell*a sp., *Polyarthra* sp. and *Filina* sp.), Cladocera consisted by two specie (*Daphina magna* and *Moina* sp.) and Copepods (*Cyclops* sp.), Followed by 10 % for both aquatic plants and Crustaceans (*Metapenaus affinis* shrimp, *Elamenopsis kempi* crab larvae and maxillipoda *Balanus amphitrite)*, then followed by 7 % sediments, unidentified algae, Mollusca 5% involving gastropods (*Lymnea* sp*. and Gyralus* sp.) and other unidentified. Also there are very clear other diets such as unidentified matter, Annelid that including (*Tubifex* sp., *Dero cooperi* and *Prstina longiseta)*, unidentified invertebrate, Amphipod (*Parhyale basrensis)* and fish larvae scoring 5%, 4%, 3%, 3% and 2 % respectively (**Fig. 3**). As for local shrimp *M. affinis*, high feeding intensity was observed during March, April and May, with maximum during April (41%), whereas lower feeding intensity was observed during July, August, September, October, November and December with minimum in December (3%) (**Fig. 4**). While the high feeding intensity of *M. nipponense* was achieved during May, June and July with maximum in June 40 %, whereas, the low intensity was observed during September, October, November and December with minimum 10% in October (**Fig. 5**).

DISCUSSION

Most macro-invertebrates of Shatt Al-Arab and the Marsh are known as a very sensitive community to various environmental changes, their abundance and distribution are greatly affected against this changes (Abdullah et al. 2016). In recent years, there has been a noticeable increase in salinity due to the lack of discharges coming from the Tigris and Euphrates rivers, which has affected on the composition of the biological community and the ecosystem (Al-Mahmood et al. 2015). These changes led to the introduction of a number of invasive species such as the short-nosed tripod fish *Triacanthus biaculeatus* (Ghazi et al. 2018) and *M. nipponense* shrimp (Salman et al. 2006). These

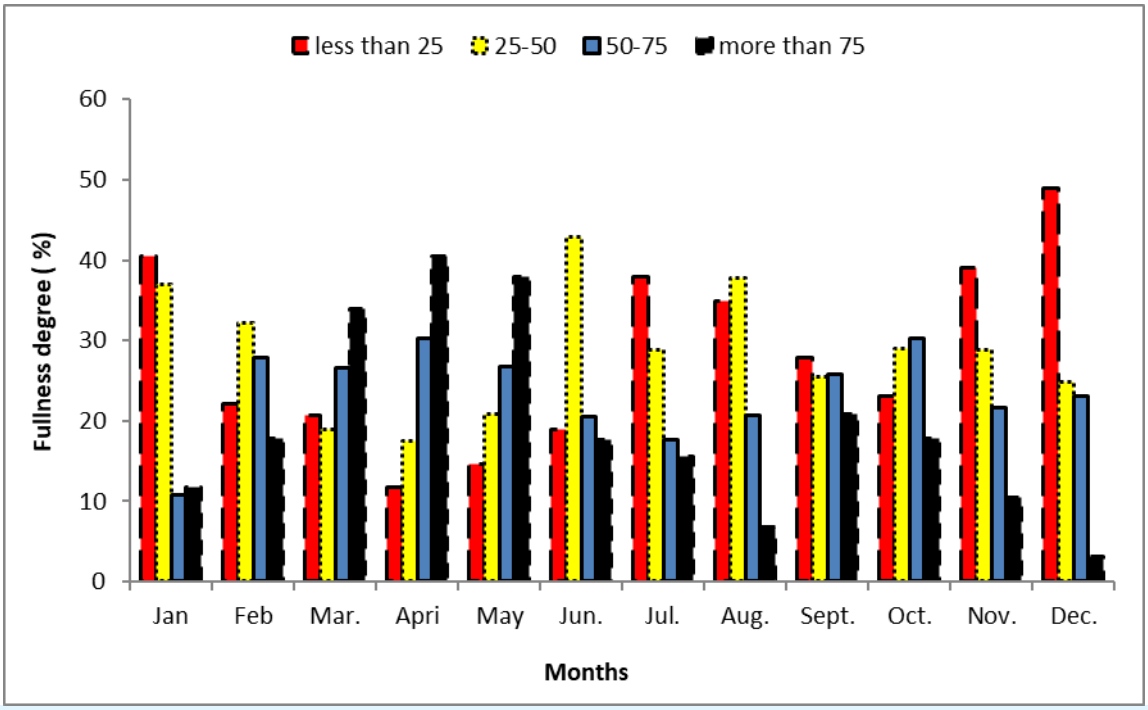

Fig. 4. Stomach monthly variation in the degree of fullness (%) for *Metapenaeus affinis* in the Al-Hammar Marsh, Southern Iraq from January to December 2016

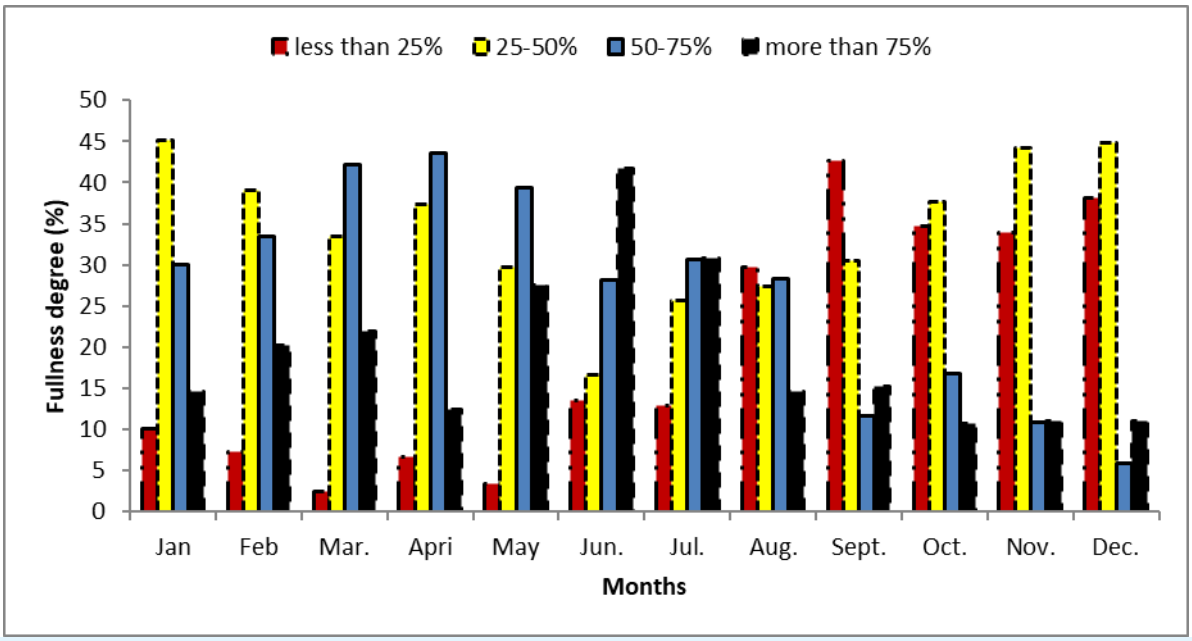

Fig. 5. Stomach monthly variation in the degree of fullness (%) for *Macrobrachium nipponense* in the Al-Hammar Marsh, Southern Iraq from January to December 2016

invasive organisms are expected to cause food, habitat and nursery ground competition with the endemic species.

In previous decades, studies showed, our local environment, especially the marshes includes many species of shrimp belong to two families, the first Atyidae which include *Caridina babulti basrensis* (Al-Ahdub and Hamza, 1987), *Atyphaera desmarestii mosopotamica* (Al-Adhub 1987), *Exopalaemon styliferus* (Salman and Bishop, 1990). The second family is Penaeid that contains one species (expect marine euryhaline) it was *M. affinis* (Miquel, 1983).

Shrimp feeding in the early stages of life on the plant and animals organism, when metamorphosis to adults, shifting to different diets such as algae, plants, larvae, insect, worm and crustacean (Parra-Flores et al. 2019). Endemic species *M. affinis* is considered as one of the important species in commercial fishing and the amount

of fishing are increasing toward southern Iraq like Shatt Al- Arab and the Marshes (Salman et al. 1990). While *M. nipponense* is of no value non-common in commercial fishing activities is which ultimately lead to an increase in numbers (Shalmani et al. 2017). This increase in densities caused competition with other local species especially those that belong to the same family. It is also expected to compete with and with other species belonging to different families, such as *M. affinis*.

Al- Hammar marshes were characterized by high densities of Caridean shrimp, Abdullah (1989) recorded density for *A. desmarestii mesopotamica* between 740–1488. Ind./ m3 during 1987 – 1989. Decreasing to 11 – 128 ind /m3 during the period between 1997 – 1998 (Saoud, 2005). Al- Adhub and Hamzah (1998) recorded a density of the caridean: species which was abundant during 1987-1989, was as 1200 ind. / m2. In other study, *A. desmaresti mesopotamica* was reported to have density during same the period as 1000 ind. / m^2 (Al-Adhub, 1987). Today, these species become very rare in the local environment, and one reason for this is may be because the competition between them and the exotic species. *M. nipponense*, so that we expect that, there is a competition with local species on habitat, food and breeding grounds, this rivalry may lead to the removal or reduced in number of endemic species such as *A. desmarestii mosopotamica* and *C. babaulti basrensis***,** and with the time, of the endemic species domination of invasive species, one of the most reason is that this invasive species had a wide ranges in food chain extend from algae and micro phytoplankton to the larger animals such as zooplankton to the benthic like worm and small molluscs, as well as, being active in eating and competing with other species (Paira-Flores et al. 2019), This is agree with the current study. On the other hand*, M. nipponense* had long periods for reproduce that extended to several months that would promote the environment at different stages of larvae, which have high ranges of tolerance to the present (Nguyen et al. 2003).

Moreover, the situation was quite different for the migratory penaeidae shrimp species *M. affinis*, this species wasn't facing a problem with salinity increases due to its euryhaline species habit, also the life cycle of *M. affinis* involves an offshore migration in which low salinity estuaries serve as nursery grounds for the juvenile stage (Mathews and Al-Hossaini, 1983). Salman et al. (1990) suggested that the Shatt Al- Arab and adjacent Tigris – Euphrates marsh system serves as a nursery ground for *M. affinis*, with total length from 50 to 125 mm. Therefore, the local species is a migratory species so the competition will be less intense, this makes it less harmful to the collective composition of this ecosystem. However, we expect the presence of the two species in the same place, which will lead in the future to more competition for food resources, especially after the amount of food decreases.

The highest rate of fullness for *M. affinis* was recorded in April, and this is seems related to the spring period and blooming of phytoplankton and zooplankton together with moderate temperature, while the lowest rate of fullness was recorded in December due to decreasing of temperature and this makes the shrimp bury at the bottom (New et al. 2010). But in the *M. nipponense* the highest degree of fullness was recorded in June, and perhaps that is due to the high activity of the organism, which increases the activities of the metabolism (Habashy and Hassan (2011). The lowest rate was recorded in October, and this may be due to the seasonal moderation, which contributes to the activity of other organisms with the same food sources (Le-Moullac et al. 1997).

CONCLUSION

The results shows, that *M. affinis* and *M. nipponense* are omnivorous, and these species have a wide range of food items attests to the fact that these species are benthic feeder, and there are clear competition on the same diets. The invasive species has contributed to the disappearance of the local shrimp. So that we recommended more research on food and feeding habit of prawn especially among the juveniles.

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