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**Morphology of Digestive Tract and Feeding of the Invasive Chinese Mitten Crab, *Eriocheir sinensis* (H. Milne Edwards, 1853) (Decapoda: Brachyura: Varunidae), Southern Iraq**

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**Abstract:**The digestive tract in *Eriocheir sinensis* consists of the alimentary canal which includes a foregut consisting of the mouth, esophagus, and stomach. The mouth is surrounded by several pairs of appendages which are specialized for chemoreception and prey capture while esophagus is short and straight moves food from mouth to the stomach, which look like an oval sac divided in to two parts called the cardiac chamber and the pyloric chamber. The composition of digestive tract were investigated and the diet analysis was assessed using two methods: points and frequency of occurrence. The main food items included eight types, the highest percentage of 43.6% shrimp, 42.8 % detritus and 14.5% sand, while the lowest were (0.39 %, 0.69% and 0.97% for eggs, plants and filament algae respectively. Feeding intensity and activity values arranged between 12 -15.9 and 76 - 86%, respectively, while the Vacuity index were 14 - 31.6%, and Feeding index values were 59.9 - 79.7%.

**Keywords:** *Eriocheir sinensis*, digestive tract, food composition, invasive crab.

## Introduction

The Chinese mitten crab *Eriocheir sinensis* (Milne-Edwards, 1853), commonly called the river crab, Shanghai crab and Chinese freshwater edible crab (Gollasch, 2011). This is the largest crustacean species inhabiting Polish waters. The first record of *E. sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) from the Basrah Area of Southern Iraq (Clark *et al*, 2006). It is a catadromous species that spends most of its life in freshwaters and only migrates to the sea for mating,

spawning and larval growth. The migration is happnd during the autumnal months and the adults will die after mating. The migration of *E. sinensis* occur when the larvae migrate from marine to the river, and reflected to be an domestic species in Asia, with indigenous deal along the China and Korean (Gu & Zhao, 2001).

Lowe *et al*. (2004) showed that the mitten crab *E. sinensis* is one of two of the worse crabs species on the world. It has been recorded in list of 100 most aliens

aquatic invertebrates. It has been become as an invasive species in Europe and northern America, maybe received to the coasts by ballast water of ships (Rudnick *et al.*, 2003; Herborg *et al.*, 2003; 2007;). This migrating species occurs in rivers, estuaries and marine habitats of cold temperate to tropical climate areas from lower shorelines to about 10 m in depth. These species are tolerant to highly polluted water.

In China *E. sinensis* have a high economic value and it's a most delicious sea food for Chinese consumers. (Chen & Zhang, 2006), its diet composition from algae, vascular plants, detritus, inorganic matter, animal remains, eggs and fish, it's also feed on fishes caught in traps and nets. Nets will be damaged (Cohen & Carlton, 1998; Rudnick *et al.*, 2003), Copepods, eggs of Chronomids and macroinvertebrates (Czerniejewski & Wawrzyniak, 2006). Ding *et al.* (2017) investigated the changes in composition and structure of the crab gut microbiome during various WSSV infection stages of 6 h post-infection (hpi) and 48 hpi, using a 16S rRNA approach on the MiSeq Illumina sequencing platform.

The main objective of this research was to describe the digestive system and

identify the food items of the *E. sinensis* in the southern Iraq.

## Material & Methods

In this study 200 individuals of *E. sinensis* arranged between (5.6-13.1) cm, were collected during four seasons (autumn 2016 – summer 2017), caught with Trawler nets. The body of the crab cut and opened from the dorsal side. The foregut was removed carefully and the gut was preserved in 10% formalin. Fixed crabs were dissected to collect the foregut and each stomach (gizzard) contents were transfer on a slide and examined under both a dissecting and compound microscopes. foregut used to determine dietary composition. Points were given for each food item according to (Hynes,1950). The gut contents were identified and separated into different food groups under a binocular microscope. Based on the gut content, the stomach of the crabs studied was grouped under any one of the following categories: actively fed (gorged, full, 3/4 full); moderately fed (1/2 full); poorly fed (1/4 full, trace) and empty northwest Arabian Gulf .

The percentage of feeding activity was calculated by Gordan (1977) according to the following expression:

$$\text{The percentage of feeding activity} = (\text{Diet individuals} / \text{Investigated individuals}) \times 100$$

Vacuity index calculated according to the following expression (Maia, 2006):

$$\text{Vacuity index} = (\text{Number of Vacuity} / \text{Investigated individuals}) \times 100$$

The Intensity feeding was measured according to Dipper *et al.* (1977):

$$\text{Intensity of feeding} = (\text{Total number of foregut fullness} / \text{Diet individuals}).$$

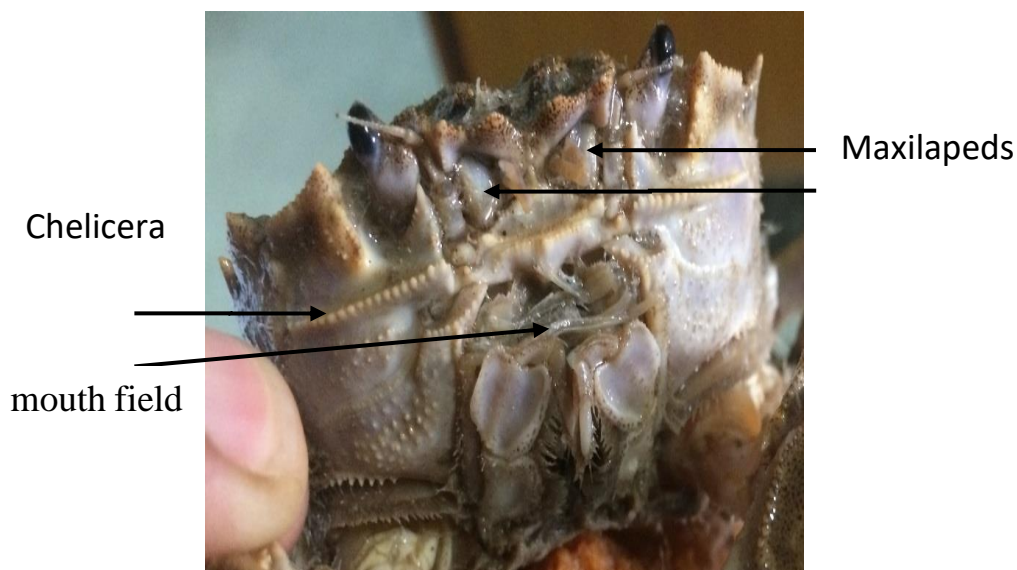
Feeding index was determined according to Mohanty (2002), by using the following equation:

$$\text{Feeding index} = (\text{Total degrees of foregut fullness} \times 100) / (\text{Diet individuals} \times \text{foregut fullness})$$

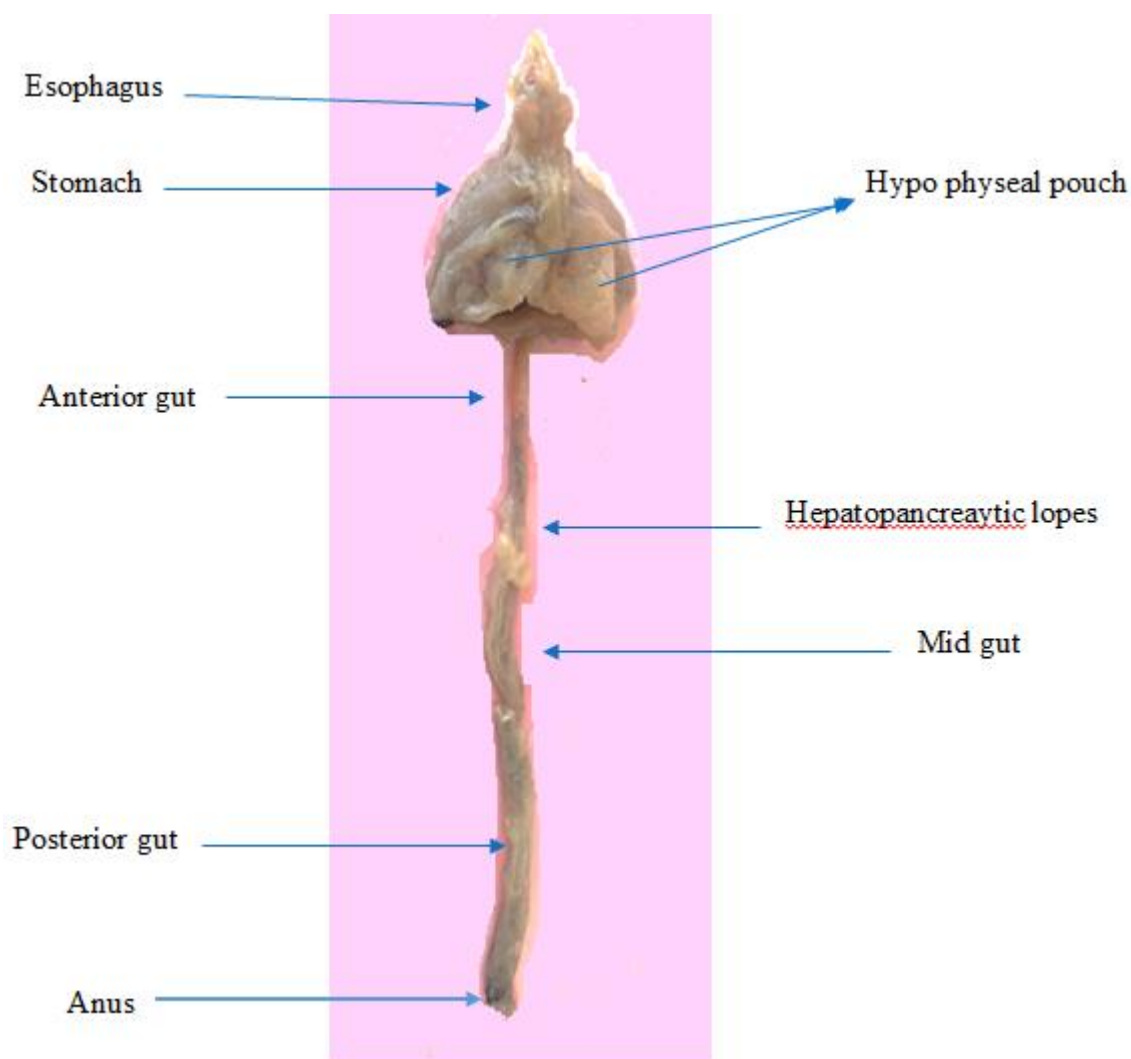
## Results

The digestive tract of crab is classically divided into five parts: mouth, oesophagus, stomach, hepatopancreas, midgut and hindgut. The position of the mouth is on the abdominal side of the vertical area surrounded by several pairs of appendages and jaws which are specialized for chemoreception and prey capture (Pic. 1).

The oesophagus is a short vertical structure its generally moves food from mouth to the stomach. While, The stomach is midday in the vertical chest and having elliptic form. The hepatopancreatic are tergally and framing the midgut completely. The midgut which is the longest part in digestive tract of the crab, and the hindgut passage to the anus (Pic. 2).



**Pic. (1): Jaws and mouth of *E. sinensis*.**



**Pic. (2):** The digestive tract of *E. sinensis* comprises the five parts: Mouth, oesophagus, stomach, hepatopancreas, midgut, and hindgut was taken by digital camera.

**Table (1):** The percentage of the composition of food items calculated by points method of *E. sinensis* sampled from 200 crab's foregut content from southern Iraq.

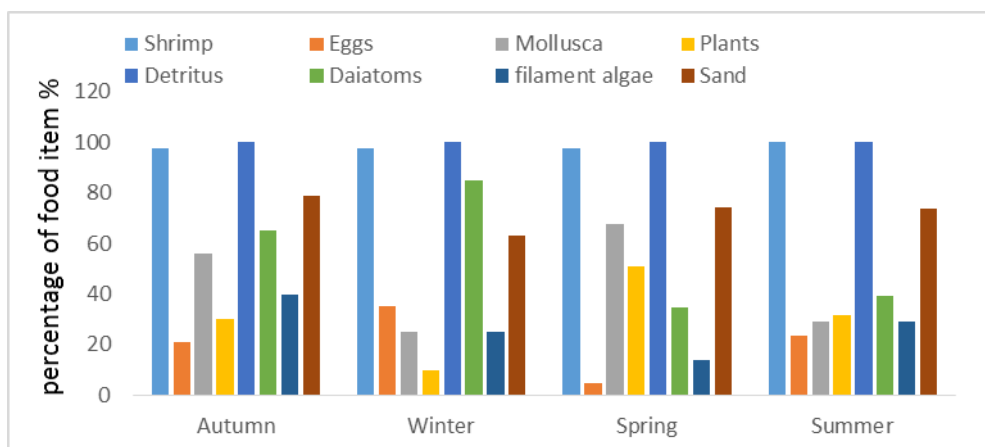
dietary categories	Autumn		Winter		Spring		Summer	
	points	%	points	%	points	%	Points	%
Shrimp	180	31.3	145	28.57	299	43.6	190	37.25
Eggs	14.5	2.52	2	0.39	8	1.16	7	1.37
Mollusca	10.5	1.82	26	5.04	26	3.82	9.5	1.26
Plants	4	0.69	20	3.88	12.5	1.82	10.5	2.06
Diatoms	33.5	5.82	12	2.23	24.5	3.57	12.5	2.45
Filament algae	11.5	2	5	0.97	16.5	2.4	12	2.3
Detritus	246	42.8	138	26.8	199	29.05	197.5	38.7
Sand	75	13	67	13	99.5	14.5	71	13.9

The number of specimens of *E. sinensis* collected for study were 200 individuals. The results showed there were eight types of diets through four seasons.

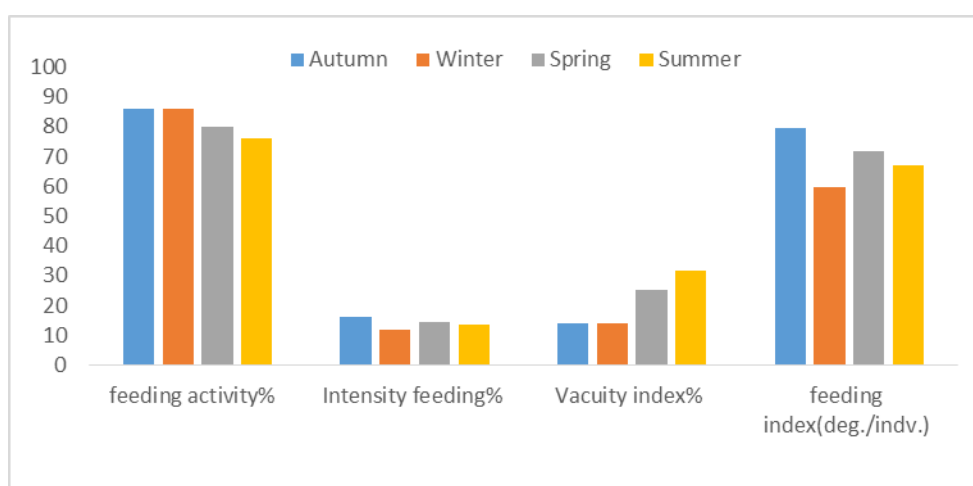
Overall, The percentage of composition of food items calculated by points method and frequency method were presented in (Table 1, fig. 1), The identifiable food items was included the shrimp remains occurred at a highest and more frequency of 43.6%, then detritus at 42.8%, Sand at 14.5%, and Mollusca remains at 5.04 %,

diatoms at 5.82 %. while the lowest percentage of food items and less frequency were eggs at 0.39 %, plant at 0.69 % and filament algae 0.97 % (table 1, fig. 1).

Feeding activity, intensity feeding and vacuity index were recorded the highest percentages were 86 %, 15.9 %, 31.6 %, while the lowest were 76%, 12%, 14% were showed in fig. (2), and the results showed that the highest values of feeding index between 79.7-59.9 (deg./ind.).



**Fig. (1): The percentage of the composition of food items of *E. sinensis* calculated by frequency method.**



**Fig. (2): The percentage of feeding activity, vacuity, intensity feeding, and feeding index of *E. sinensis*.**

## Discussion

The crustacean digestive system are similar to other species, in its complex structure. The oesophagus is a simple muscular tube which allow the food pass to the stomach. The wall of the stomach are changing. The distension degree depends on the size and amount of food confront with that found in big decapod (De Jong & Casanova, 1997). The stomach is a simple pouch without calcified structures in the interior, So, the cardiac chamber of the decapoda is cardiac or like a ball has calcified elements in the anterior wall, also crustaceans giving expression a set of highly active digestive enzymes that analysis the food (Boschi, 1981; Veroonica & Gimenez, 2013).

The muscular gut were development that has for completed mix and digestive food by enzymes that hepatopancreas which excreted than become absorbable soft mass (Saborowski *et al.*, 2012). Without doubt that, the activity of digestive are impacted via numerous factors, such as food, molting process, and growth. According to Rudnick & Resh (2005), this species was showed the ingredients of the diet, that the most frequent food of the crabs found in the Odra estuary 40% detritus, with 28.1 % plants and 25.4% animals of the crabs respectively being less frequent, copepods and chironomid larvae dominated the animal fraction of the food.

In most decapods, food is rushing to the midgut from stomach, and by polystictus the digestive is completely (Pillai, 1960).

The hindgut of this crab similar in characteristics, composition and internal anatomy with other crustacean species, but differ in size, they are bigger and its walls

stretch according the discussing diet, the walls is viscous, having cells forming a cycle around the anus. (Johnston & Alexander, 1999). As for the molecules are uncluttered it has been driven from hindgut and going out the body (Lin, 2000; Daz *et al.*, 2006).

Crabs are omnivorous, opportunism, and predacious species, its consume different foods and some them classified as herbivorous, for there were diatoms, filament algae and aquatic plants In their gut (Tina & Darumas, 2014).

The results showed that the highest percentage of food in gut were shrimp 43.5 %, then detritus 40.15 %, while the lowest was eggs. These results agree with a lot of studies in the world about Brachyurans, that because of their high digestive efficiency (De-Lestany, 2000). So, in some Portunodae species, Ikhwanudein *et al.* (2009) found about 25% decapod and crustaceans in their gut while, Josileen (2011) has been found about 73.43% from remains, which belong to shrimps' legs, diatoms, Mollusca and fish in *Portunus pelagicus* gut (Al-Mamunt *et al.*, 2008) found 44.4% crustacean, 26% molluscan, 15% fish, 10% and plants in the gut of the mud crab *Scylla serrata*.

During winter and autumn, the annual catch estimated and intensity feeding increased and being higher than the other seasons maybe because of the transparent water that increases crabs ability to see the pray or because of the slowly moving of the pray, these results agree with Mohanty (1996) and AlMamunt *et al.* (2008).

The Chinese mitten crabs in coastal water feed mainly on remains, macroinvertebrates, and plants, some studies showed a similar



results such as Rudnick & Resh (2005), who studied the Chinese mitten crab, *E. sinensis* in San Francisco Bay, showed that the large ingredients of the crabs food were algae and remains, the favourite food for crabs is macroinvertebrates, So when crabs given four types of food (algae, detritus, macro invertebrates, and shrimps), they choice the macroinvertebrates (Czerniejewski *et al.*, 2010).

## Conclusion

The basal food of the Chinese mitten crab, *E. sinensis*, in the coastal water body southern Iraq was regarded to consist in remains and animals this indicates that the Chinese mitten crab also fed on macroinvertebrates such as shrimps and Mollusca, eggs and diatoms. It is noticeable that the intensity and activity of this crab increase in winter and season.

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