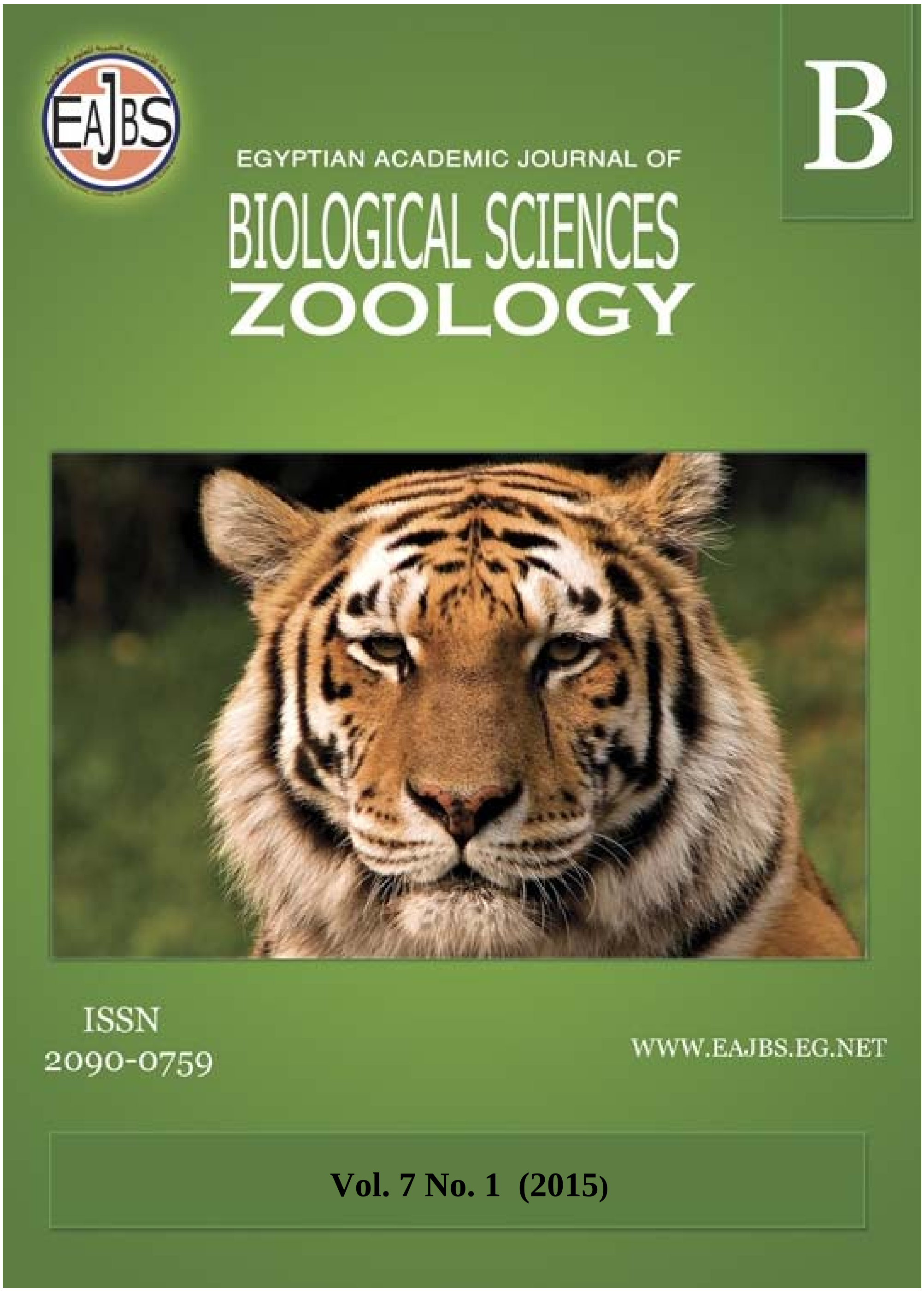

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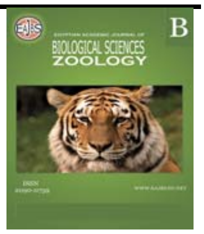

Partitioning of food resources at the intertidal zones between the marble rocky crab, *Pachygrapsus maromratus* (Grapsidae) and warty crab, *Eriphia verrucosa* (Eriphiidae) along the Mediterranean Sea coasts, Alexandria, Egypt

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ABSTRACT

The food habits of the warty crab, *Eriphia verrucosa* and the marbled rocky crab *Pachygrapsus marmoratus* are examined during this study using the frequency occurrence (% F) and point assessment (% P) methods. The overall annual stomach contents exhibited that *E. verrucosa* tends to be carnivore; whereas *P. marmoratus* is herbivorous. The two species consume a wide variety of benthic organisms comprised benthic animals as well as macro and micro algae. The stomach contents of *E. verrucosa* contained 57.40 % of animal origins, 23.26 % from algae and 19.34% of bottom sediments. In *P. marmoratus*, the stomach contents comprised 53.85 %, 27.30 % and 18.85 % of the benthic animals, benthic algae and bottom sediments, respectively. The benthic animals in the stomachs of the two species belong to different phyla, dominated by Mollusca representing 24.95 % in *E. verrucosa* and 21.68 % in *P. marmoratus*, followed by Crustacea, which have 14.04 % and 11.68 % in the two species, respectively. Results have also shown remarkable seasonal fluctuations in the diet composition and stomach fullness (feeding intensity) of the two species. The highest ratios of algae was 32.58 % and 27.32 % recorded during winter in *P. marmoratus* and *E. verrucosa*, respectively, declined sharply to the minimum values (21.49% and 19.12 %) during autumn, associated with the lowest values of sediments during winter. Animal ratios reached the maximum (60.11 % and 63.42%) in autumn and winter, but declined to the minimum (46.36% and 53.26 %) during summer in *P. marmoratus* and *E. verrucosa*, respectively. These results indicated that, both of *E. verrucosa* and *P. marmoratus* had succeeded in sharing their food resources and escape or decrease competition between them by changing types of food items either temporally or spatially according available foods.

INTRODUCTION

The brachyuran crabs, *Eriphia verrucosa* (Foråskal, 1775), Family Eriphiidae and *Pachygrapsus marmoratus* (Fabricious, 1787), Family Grapsidae, are

Mediterranean species, commonly occurring at the intertidal and shallow subtidal rocky zones (Campbell, 1982; Holthuis, 1987; European Virtual Aquarium, 2009). *E. verrucosa*, sometimes is called the warty crab or yellow crab (Campbell, 1982)and is the only species of Family Eriphiidae has wide distribution in the eastern and western Mediterranean, in addition to the Adriatic and Black Seas, as well as eastern coasts of Atlantic Ocean from south Brittany (France) to Morocco and Mauritania and Azores (Campbell, 1982; Holthuis, 1956, 1987; European Virtual Aquarium, 2009). Individuals of this species have been caught as far north as Cornwall and were frequent in the Black Sea, but decreased in numbers since the 1980s and became now listed in the Ukrainian Red Data Book of endangered species (Dumitrache, 2009; Dan, 2013). Individuals of this species were previously recorded from the Egyptian Mediterranean waters around Alexandria (Balss, 1936), at the entrance of Suez Canal (Monod, 1938) and mentioned among Suez Canal's list of true crabs by Holthuis (1956).

On the other hand, the marbled rocky crab, *Pachygrapsus marmoratus* is the most common species belonging to Family Grapsidae in the Mediterranean Sea (Campbell, 1982). It is semi-terrestrial crab (Cannicci *et al*., 1999, 2002, 2007; Warburg, *et al*., 2007, 2008) and lives in the shallow water habitats along the intertidal and shallow subtidal rocky shores of the Mediterranean Sea.

Pervious literature showed that, several studies were carried out on both of *E. verrucosa* and *P. marmoratus* along the European and Turkish coasts of Mediterranean, Adriatic and Black Seas, and comprised occurrence, habitats and general morphology (European Virtual Aquarium, 2009), food and feeding (Rossi and Parisi, 1973), reproduction (Dumitrache and Konsulova 2009; Dan,2013) and seasonal histological changes in gonads (Erkan, *et al*., 2008, 2010) of *E. verrucosa*. On *P. marmoratus*, these studies were restricted on reproductive biology of this species along European Mediterranean coasts (Vernet-Cornubert, 1958), activity, food and feeding (Cannicci, *et al*., 1999, 2002; 2007; Flores and Paula, 2001, 2002), predation and aggressive behavior (Silva *et al*., 2004; Hernadez-Benitez, 2007; Sciberras and Schemberi, 2007) as well as that done on the population structure and biology on Lebanese coasts by Arab (2010).

Along the Egyptian coasts, in spite of the frequency occurrence of these two species, there exit few studies. During the last half of the twentieth century, only two studies were undertaken, the first was done by Ramadan and Dowidar (1972) along the Mediterranean waters from Alexandria to Port Said, and the second one was carried out along the rocky coast of Alexandria by Atta (1991). These studies provided short notes on origin, habitats, and status of these species and no information are available or even work done on their biology.

Therefore, this study aims to through light on the feeding biology and feeding intensity of the common marbled crab, *P. marmoartus* and warty crab, *E. verrucosa* along Alexandria rocky coasts, Egypt.

MATERIAL AND METHODS

I- Sampling of specimens:

Specimens of *Eriphia verrucosa* and *Pachygrapsus marmoratus* were collected monthly from the rocky supralittoral, intertidal and uppermost borders of the subtidal zones that varied from 1 to 5 meters in breadth at the chosen study sites (Fig. 1) along Alexandria coast during the period from June 2011 to May 2012. Intensive sampling sites comprised:

Site # 1: It lies at 29°58'30.58" N and 31°15'18.61" E. It consists of concrete man-made rock wall, on sand bottom covered with sand, cobbles, pebbles, rocks and a vermetid reef platform. This site is exposed to direct wave action.

Site# 2: It lies at 29°59'13.45" N and 31°15'13.22" E. Its bottom includes vermetid reefs, rocks, pebbles, and gravels. This site is weakly exposed to wave action due to a natural barrier situated offshore and good formed vermetid reef platforms.

Site# 3: It lies at 29°53'03.67" N and 31°12'48.28" E. It was selected on the other side of the National Institute of Marine and Fisheries. It extends 50 m in length and 5 m in breadth, and characterizes by a long rock bed covered with pebbles and small rocks. It surrounds the edge of a large pool rich with vermetids.

Fig.1: An aerial view of Alexandria City showing three sites of the study area (upper) and shore profile of the intertidal zone at site one (left), two (middle) and three (right) at the lower photos.

Additional specimens were collected from other six sites during the same period but at irregular intervals. Collection of most specimens was carried out during days of calm weather and good sea conditions mostly before sunset when the crabs were active and easier to collect. During cold months and when seawater temperature was low, specimens were collected early from the mid-day till before sunset. For feeding activity, several specimens were collected seasonally at 2 hours intervals, starting from 2 hr after sunrise to sunset. Underneath rock and stone inhabiting crabs were caught by hand during low tides. Baiting traps, hook and lines and hand nets were also used for collection of *E. verrucosa*. Upon capture, large crabs were injected with pure formalin, then stored immediately with other smaller individuals in containers filled with 10% seawater formalin solution, provided with labels on dates and site of collection, then transported to the laboratory for sorting and identification. All observations on topography, bottom texture, tidal cycle, and vegetation cover were recorded at each field trip.

II- Laboratory studies:

At the laboratory, collected specimens were identified according keys of Crosnier (1965) for grapsids and Koh and Ng (2008) for eriphiids, then sorted, sexed and investigated. Stomachs of *E. verrucosa* and *P. marmoratus* were dissected, and the gastric mills or stomachs were separated from esophagus and hind gut. They were cut opened longitudinally and the food contents of each stomach were discharged into divided Petri dish and diluted by water.

Food items were sorted out under binocular microscope (Cambridge Model Galen TM III). Light compound microscope was also used with higher magnifications for small organisms. Food items were identified to species or generic level as possible according to available keys of identifications. Small fragments were identified to the nearest major groups as possible. The identifies food items were grouped into taxonomic categories such as gastropods, bivalves, polychaetes, crustaceans, red, green algae.. ect. The point assessment method (%P) and the percentage occurrence method or the frequencies of occurrence method (%F) were used in food analysis according to those used in the true crabs (Hyslop, 1980; Williams, 1981; Cannicci *et al*., 2002). The stomach cases were classified into empty, traces, 1/4 full, 1/2 full, ¾ full and extended and content of gastric mills were awarded points scores from 0 -15 based on their estimated volume or degree of fullness. These points were then divided among the different food categories according to their relative bulk. The very small amounts of items allocated ½ point. Frequency of occurrence was recorded by the percentage of specimens in which a given prey item was frequent from the total specimens examined.

Obtained results were tabulated and treated graphically. Statistical analyses were carried out using ANOVA and T-test to evaluate seasonal and specific differences.

RESULTS

A- Diet composition and food items:

Results of stomach contents for *E. verrucosa* and *P. marmoratus* species are given in Tables (1&2) and presented in Figure (2). These results revealed that, these crabs consume wide varieties of the benthic sedentary and movable intertidal and shallow subtidal organisms comprised animals and filamentous macro algae, associated with high percentages of sediments (sand grain and tiny rock fragments) and considerable amounts of organic debris, in addition to unicellular algal elements of blue green algae and diatoms.

I- Diet composition of *E. verrucosa*:

The overall annual results of food items of *Eriphia verrucosa* revealed that, this species is a generalized animal feeder or tends to be carnivorous. Its food comprises large quantities of benthic faunal and floral elements. Animal elements of different phyla were the dominant, and represented by the highest values, varying from 53.26 to 63.42 % and averaged 57.40 % (Table, 1 and Fig. 2). They are being more than two or three folds of the algal items, which varied from 19.12% to 27.32% and averaged 23.26 % of all contents (Table, 1 and Fig., 2).

Mollusks constituted 24.95 % of all contents and 43.47 % of the animal categories in stomach contents of *E. verrucosa* and were represented by gastropods (13.96%) comprised large individuals of *Fasciolaria* spp., *Gibulla spp.*, *Diodora gibberula* and bivalves (10.99 %), mostly large individuals of *Mytillus* g*alloprovincialis* and *Lithophaga* spp. Crustaceans came in the second order and were represented by 14.04 % of all contents and 24.56 % of all animal contents, most of them were amphipods, decapod shrimps, true and hermit crabs, then 12.23 % of the other phyla, and 6.17 % of fish remains and decayed organic matters (Table, 1).

Table (1): Diet composition of *Eriphia verrucosa* from the study area.

Food taxi \ Methods and Seasons			Point assessment %					Frequency %
			Sum.	**Aut.**	**Win.**	**Sp.**	**Mean**	
Plants (Algae)		Green Algae	0.38	2.94	3.66	5.89	3.21	27.6
		Red Algae	13.41	7.78	11.22	6.84	9.81	54.0
		Brown Algae	2.30	1.47	0	1.20	1.24	20.7
		Blue green	1.53	4.20	7.07	8.03	5.21	41.4
		Diatoms	3.45	2.73	5.37	3.60	3.79	40.2
		Subtotal P%	**21.07**	**19.12**	**27.32**	**25.56**	**23.26**	**-**
Animals	**Fish remains**	Fish scales	0.77	1.05	0.98	1.54	1.01	21.8
		Soft rays	0	0.63	0.73	1.54	0.73	6.9
		Eggs	4.60	2.31	0.73	1.20	2.21	26.4
	Crustacea	Tissues remains	1.53	2.52	2.93	1.88	2.22	34.5
		Amphipods	5.75	6.30	4.63	4.11	5.21	50.6
		Decapods	6.90	5.89	5.85	3.94	5.65	59.8
		Shrimps	1.15	1.26	2.68	0.51	1.4	13.8
		Balanus sp.	1.92	1.05	1.22	2.91	1.78	35.6
	Mollusca	Gastropoda	7.66	15.97	16.58	15.57	13.96	55.2
		Bivalvia	11.49	9.45	13.90	9.07	10.99	70.1
	Annelida (Polychaetes)	Sand worms	1.15	1.26	2.20	1.37	1.50	32.2
		Tube worms	1.15	1.68	2.20	1.88	1.73	40.2
	Others	Nematoda	1.53	0.42	0.49	0.86	0.83	12.6
		Foraminifera	1.15	2.73	2.20	2.22	2.08	42.5
		Hydrozoa	2.68	1.68	3.89	2.40	2.66	32.2
		Echinodermata	3.83	4.62	2.20	3.08	3.43	49.4
		Subtotal P %	**53.26**	**58.82**	**63.42**	**54.08**	**57.40**	**-**
Sediments		Sand grain	21.07	17.23	8.29	14.71	15.32	80.5
		Rocks	4.60	4.83	0.98	5.65	4.02	42.5
		Subtotal P %	**25.67**	**22.06**	**9.27**	**20.36**	**19.34**	**-**

Notice that: Sum= summer, Aut= autumn, Win= winter, and Sp= spring.

On the other hand, fragments of filamentous red algae (*Gelidium*, *Digenia*, *Jania rubens*, *Hypnea* and *Pterocladia capillacea*) brown algae (*Stypocaulons*and *Sargassum*) green algae (*Cladophora*, *Codium*, *Ulva* and *Enteromorpha*) in addition to diatoms and unicellular colonies of blue green algae (*Rivularia* and *Lyngbya*) were encountered in stomach contents of this species (Table, 1). The red algae have the highest ratio by both point assessment (9.81%) and frequency of occurrence method (54.0 %) in stomach contents of this species and were dominated by *Pterocladilla capillacea*, followed by blue green algae (5.21 %) and diatoms (3.79 %); while brown algae were represented by the lowest percentage (1.24 %).

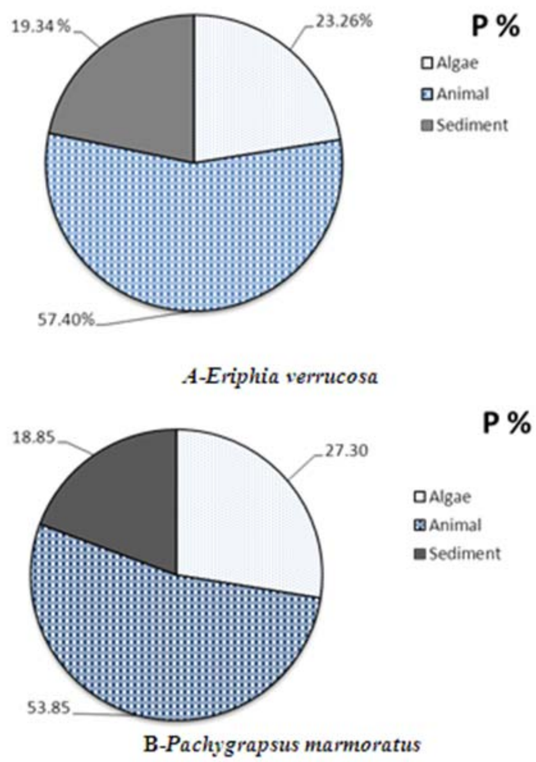

Fig. 2: General diet composition of (A)*E. verrucosa* and (B) *P. marmoratus* (Data are treated by the point assessment method P%).

Sediments were also high among food items of this species, and varied from 9.27 % to 25.67% and averaged 19.34 % of all contents, with high remarkable high ratio of sand than rock fragments (Table, 1 and Fig. 2).

II- Food composition of *P. marmoratus*:

The general diet composition of *P. marmoratus* is very similar to that of the warty crab, *E. verrucosa*, but it differs distinctly in its percentages and types of species of each item based on their natural habitats. Data in Table (2) and Figure (2) revealed that this species seems to be omnivorous, consumes considerable quantities of the benthic animals varying from 46.36 % to 60.11 % and averaged 53.85 %; while the algal ratios ranged between 21.49 % and 32.58 % and averaged 27.30 % and being remarkably higher than algal ratios in *E. verrucosa*.

Similar to that recorded in *E. verrucosa*, mollusks amounted 21.68 % of all contents, and 40.26 % of all animals, with 12.80 % of gastropods and 8.88 % of bivalves (Table, 2). Crustaceans also came next with 11.63 % of all and 21.60 % of animal categories, and then followed by other phyla (11.67 %), fish remains and decayed matters (8.53%). Bivalves comprised small and juveniles of *Mytilus galloprovincialis* and *Modiolus* spp., while gastropods included *Patella* spp. and other parts of crushed unidentified species. Crustaceans were represented by the whole crustacean's bodies and fragments of small-sized amphipods, shrimps, juveniles of true and porcelain crabs (*Porcellana platycheles*) and *Balanus* sp. Polychaetes comprised sand (*Nereis* spp.) and tube worms. But nematodes (which may be free-living), and fish remains comprised fish scales, soft rays, and decayed matters, as well as animal eggs which were taken among sediments.

Table 2: Diet composition of *P. marmoratus* from the study area.

Food taxi			Methods and seasons: Point assessment % Sum.	Aut.	Win.	Sp.	Mean	Frequency %
Plants (Algae)		Green Algae	8.68	7.47	7.28	8.93	8.09	54.0
		Red Algae	3.56	1.82	10.40	7.59	5.85	32.7
		Brown Algae	1.55	1.09	1.04	1.96	1.41	23.9
		Blue green	4.81	5.83	9.88	7.59	7.03	44.2
		Diatoms	7.13	5.28	3.98	3.30	4.92	35.4
		Subtotal P%	**25.74**	**21.49**	**32.58**	**29.38**	**27.30**	-
Animals	**Fish remains**	Fish scales	2.17	1.82	1.56	0.73	1.57	29.2
		Soft rays	1.86	1.09	1.04	0.86	1.21	13.3
		Eggs	3.25	2.00	3.81	1.96	2.76	30.1
	Crustacea	Tissues remains	0.46	4.55	3.99	2.94	2.99	31.0
		Amphipods	4.81	3.64	3.12	4.41	4.00	40.7
		Decapods	5.11	4.92	3.47	4.53	4.15	43.4
		Shrimps	1.09	1.28	1.04	0.61	1.01	16.8
		Balanus sp.	1.40	2.00	3.99	2.49	2.47	38.1
	Mollusca	Gastropoda	7.44	16.03	15.42	12.29	12.80	66.4
		Bivalvia	9.30	8.57	8.84	8.81	8.88	56.6
	Annelida (Polychaetes)	Sand worms	1.24	1.09	1.21	0.86	1.10	22.1
		Tube worms	0.78	1.28	2.77	2.20	1.76	39.8
	Others	Nematoda	0.16	1.09	1.39	0.85	0.87	13.3
		Foraminifera	2.02	2.19	1.56	1.84	1.90	42.5
		Hydrozoa	3.25	4.01	4.16	1.37	3.20	39.8
		Echinodermata	2.02	4.55	2.25	2.57	2.84	46.0
		Subtotal P %	**46.36**	**60.11**	**59.62**	**49.32**	**53.85**	-
Sediments		Sand grain	17.82	12.94	7.11	15.67	13.39	73.5
		Rocks	10.08	5.46	0.69	5.63	5.47	43.4
		Subtotal P %	**27.90**	**18.40**	**7.80**	**21.30**	**18.85**	-

Notice that: Sum= summer, Aut= autumn, Win= winter, and Sp= spring.

The algal fragments were encountered in considerable high ratio, varied from 21.49 % to 32.58 % and averaged 27.30% by point assessment (Tables, 1& 2 and Fig. 2). This ratio tends to be essential component for feeding of this species. In contrast to *E. verrucosa*, green algae dominated other algal groups, and constituted 8.09 % of all contents. The dominant species of green algae belong to genera *Ulva* and *Enteromorpha*. Their occurrence gave remarkable green color for most of the examined stomachs of *P. marmoratus*. However, the ratio of other algae were 7.03 %, 5.85 %, 1.41 % and 4.92 % for the blue green, red, brown algae and diatoms, respectively.

Sediments were also frequent in stomach contents of this species. They varied from 7.80 % to 27.90 %, averaged 18.85 % of all contents (Tables, 1&2 and Fig. 2). Sand ratio averaged 13.39 %, and was higher than rocks (5.47%).

The statistical analysis (T-test) showed no significant differences between food items of the two species (P =0.263 and df=44).

B- Seasonal variations in food items:

The seasonal fluctuations in diet composition by point assessment method for *E. verrucosa* and *P. marmoratus*are are given in Tables (1&2). For *E. verrucosa*, the ratio of algae declined gradually from 21.07 % during summer to the minimum ratio (19.12 %) in autumn, but increased remarkably again to the maximum (27.32%) in the following winter, then declined into 25.56 % in spring. There were also remarkable changes in ratios of different algal groups during different seasons (Table, 1).

The animal categories exhibited the same pattern of algal fluctuations, and increased gradually from the minimum ratio, 53.26%, in summer to 58.82% in autumn, and reached the maximum, 63.42 % during winter but declined again to 54.08 in spring (Table, 1).

For *P. marmoratus*, data in Table (2) indicated that, the percentage of each food item taken by this species has changed greatly from season to another. The overall percentage of algal items declined gradually from 25.74 % in summer to the minimum (21.49%) during autumn. It increased to the maximum ratio (32.58 %) in winter, but declined again to 29.38 % in spring. The same pattern was also noticed for animal elements. The minimum ratio was 46.36 % recorded in summer, increased sharply into the maximum ratio (60.11%) during the following autumn, but declined gradually during the following winter and spring (Table, 2).

Also, sediments were seasonally fluctuated. The ratios of sediments declined to the minimum, being 9.27 % and 7.80% during winter in *E. verrucosa* and *P. marmoartus*, respectively, but the maximum ratios were 25.67% and 27.90%, recorded during summer in the two species, respectively (Tables 1& 2).

The statistical analyses showed significant differences between different food groups at one way (df=2, F= 3.600, $P < 0.01$) and have highly significant differences between food taxa at two way interaction (df= 2, f= 27.671, $P <0.001$) for *P. marmoratus*. However, the difference was not significant between food groups at one way (df= 2, f= 2.179, $P >0.05$) in *E. verrucosa*, but was highly significant at two way interaction (df= 2, F= 68.592, $P <0.001$) between food taxa.

The Pairwise Multiple Comparison Procedures (Holm-Sidak method) gave significant differences between different animals and algae, as well as between animals and sediments in both species ($P< 0.05$), but no significant was found between algae and sediments in the two species.

C- Food preference:

Data in Tables (1&2) showed that, every species of these crabs prefers certain species of its food items. *P. marmoratus* prefers small amphipods, *Balanus,* decapods, fragile bivalves, and green algae; while *E. verrucosa* appeared more tendencies towards larger gastropods, amphipods, and decapods as well as echinoderms and fewer tendencies for algal fragments particularly the red algae. However there are seasonal variations in food preference where algal and animal items were higher in winter and autumn for *P. marmoratus*, respectively, but in *E. verrucosa* high percentages of red algae and some animal items particularly bivalves, amphipods and decapods were high in winter (Tables, 1& 2).

These results demonstrated that, in spite of these species are occurring in the same or very neighboring habitats, but they had succeeded in sharing the food resources and to some extent escape or decreasing competition by changing food items either temporally or spatially according available foods.

D- Feeding intensity:

Results in Tables (3) show the frequencies of stomachs with ½ and ¾ full cases in *P. Marmoratus* all the year around. However, the maximum percentage of extended and full stomachs was 66.67% recorded during summer 2011, but decreased gradually to reach the minimum value (23.33%) in winter. On contrast, the feeding intensity of *E. verrucosa* reached the maximum percentage (50%) in spring 2012,declined sharply to 25 % and 16.67 % in summer and autumn, respectively, and reached the minimum, 3.85 % in winter (Table,4).

Table 3: Seasonal fluctuations in stomach fullnesss of *P. marmoratus*.

Stomach case Seasons		No.	Extended	Full	¾ full	½ Full	¼ full	Trace & remains
Summer	June2011	7	3	3		1		
	July	10	3	4		3		
	August	10	2	3	1	3	1	
	Total number	27	8	10	1	7	1	
	%		29.63	37.04	3.70	25.93	3.70	0.00
Autumn	September	10	2	3	2	1		
	October	6		2	2	2		
	November	10		2	6	2		
	Total number	26	2	7	10	5	2	
	%		7.69	26.92	38.46	19.23	7.67	0.00
Winter	December	10			2	4	3	1
	January2012	10		2	4	2	1	1
	February	10	3	2	4		1	
	Total number	30	3	4	10	11	5	2
	%		10.00	13.33	33.33	36.67	16.67	6.67
Spring	March	10	1	3	3	2	1	
	April	10	1	4	1	3	1	
	May	10	2	4	3	1		
	Total number	30	4	11	7	6	2	
	%		13.33	36.76	23.33	20.00	6.67	0.00

Table 4: Seasonal fluctuations in stomach fullness of *Eriphiaverrucosa*.

Stomach cases Seasons		No.	Extended	Full	¾ full	½ full	1/4 full	Trace & remains
	July	7	1	2	3	1		
	August	5			1	2	2	
	Total number	12	1	2	4	3	2	
	%		8.33	16.67	33.33	25.00	16.67	0.00
Autumn	September	8	1	2	1	4		
	October	8		1	2	4	1	
	November	8				2	5	1
	Total number	24	1	3	3	10	6	1
	%		4.17	12.50	12.50	41.67	25.00	4.17
Winter	December	10			1	3	3	3
	January2012	9			4	1	1	3
	February	7	1			5	1	
	Total number	26	1		5	9	5	6
	%		3.85	0.00	19.23	34.62	19.23	23.08
Spring	March	7	2	1	1	2	1	
	April	9	2	2		4	1	
	May	10	2	4	2	1	1	
	Total number	26	6	7	3	7	3	
	%		23.08	26.92	11.54	26.92	11.54	0.00

DISCUSSION

Results of stomach contents of *Eriphia verrucosa*and *Pachygrapsus marmoratus* exhibited the general food habits of these species. The diet composition of these species composes of a wide variety of benthic animals and plant origins with considerable amount of bottom sediments. The frequency occurrence method demonstrates the general food habit for the examined species, but it overestimates the small-sized items over other larger sized ones. On the other hand, the point assessment method was more convenient and its values were used for statically analyses and calculations.

The present results showed that *P. marmoratus* tends to be omnivorous, with food items composed of 53.2 % animal origins, 27.5% algal fragments and 19.3 % of bottom sediments associated with bottom flora of blue green algae. These results agreed with that mentioned by *Cannicci et al.* (2002; 2007). Their results exhibited that, *Pachygrapsus marmoratus* is an omnivore that combines anatomical features of both herbivorous and carnivorous animals. The spoon-tipped claws of this species are adapted for scraping algae as in herbivorous decapods, and its gastric mill teeth (teeth-like structures found in the stomach of crabs) are specifically efficient in tearing animal tissue. Its omnivorous nature is further verified by the analysis of stomach contents, which shows a clear preference for limpets, mussels and filamentous algae as well obtained during the present study. It seems, however, a selective omnivore rather than an opportunistic browser, as Mediterranean and Atlantic populations display similar feeding preferences, regardless of the different community structure at each site. This suggests a significant role in shaping intertidal community structure by selectively choosing food items instead of randomly browsing on the most frequent ones (Cannicci *et al.*, 2002).

On contrast, food items of *E. verrucosa* contained relative high ratios of animal origin averaged 56.8 % of all contents and form twice to three folds of the algal ratio averaged 23.36%,in addition to 19.86 % of sediments. The previous findings demonstrated that, the food items of super family Xanthoedia including species of family Eriphiidae are greatly variables (Warner, 1977). Some members of this group are symbiotic (deposit feeders) such as Trapezidae (Barnard, 1950), others are carnivores such as *Carpillius sp.*, *Eriphia spp.* and *Daldorfia sp*. (Warner, 1977) and other members are herbivorous (Barnard, 1950; Warner, 1977; Turoboyski, 1973).

Eriphia verrucosa has powerful claws and can crush large snailsof gastropods and bivalves, and other larger benthic organismsas described by Rossi and Parisi (1973) andSilva *et al.* (2004), or by probing the sediments and feed on infaunal animals (e.g. polychaetes, crustaceans and fish remains), or using the sharp tips of chelipeds for scraping algal fronds from the hard objects(Barnard, 1950; Warner, 1977; Kennish, 1997).Therefore, the results of present study are in agreement with that mentioned by Rossi and Parisi (1973), and Flores and Paula (2001, 2002) on *E. verrucosa* from the European coasts and on the other xanthid species studied such as *Leptoidus exaratus*the Red Sea (El-Sayed, 2004) andon *Panopeus herbstii* (Turoboyski, 1973).However, slight changes in the food habits of *E. verrucosa* had been detected during different seasons showing tendency towards opportunistic carnivores, and at certain season it can ingest considerable amounts of benthic algae particularly during winter.

The presence of sediments among stomach contents of the examined species, *E. verrucosa* and *P. marmoratus* was evident, but they are not considered true food items. Sediments may be either entered accidentally with food items particularly polychaetes, or may be taken for associated organic debris and unicellular blue green algae and diatoms as mentioned by Warner (1977) and were greatly seasonally fluctuated. The occurrence of sediments among food items of brachyurans is common, and was reported by several authors (Warner, 1977;El-Sayed, 2004).

When the diet of a species has been studied for a year or more, it is a common that feeding intensity and diet composition change annually and seasonally. Certain food item disappears or fluctuates in its occurrence in crab's stomachs. In the present study, the ratios of different algal items in the stomachs of *E. verrucosa* and *P. marmoratus* were seasonally fluctuated and showed remarkable increase during winter and spring, but declined in summer and autumn. On the other hand, gastropods increased in spring and declined in summer, and were moderate in autumn and winter. Also, the ratios of different animals were fluctuated during different seasons, and showed slight increasing during summer and spring which agree well with those reported by Kennish (1996, 1997), Kennish *et al.* (1996) and Cannicci, *et al*. (2002, 2007).

The changes in stomach contents of marine organisms are greatly influenced by the changes in environmental factors, particularly temperature, where food intake being lower during colder months (Choy, 1986; El-Sayed, 2004) or due to fluctuation in salinity (Sumpton and Greenwood, 1990). Therefore, the changes in food composition of both species reflect changes in the availability of food type and selectivity of feeding of each species as reported by El-Sayed, (2004).

The present results showed that, both of *E. verrucosa* and *P. marmoratus*have succeeded in exploitation of all four trophic sources at the intertidal and shallow subtidal rocky habitats in the Mediterranean Sea as demonstrated by Cannicci *et al*. (2007) on the same species at the Mediterranean coasts. It was found that, the individuals of *P. marmoratus* take the advantages of being carnivores that can shifts between bivalves, more abundant in spring and summer and the periwinkle, *Melaraphe neritoides* during winter as mentioned by Cannicci *et al*. (2002, 2007). It is obvious that, both of *E. verrucosa* and *P. marmoratus* can feed on the first trophic source represented by biofilm that covers the intertidal rock surface, formed by cyanobacteria, diatoms, settling stage of invertebrates and protozoans as Cannicci*et al*. (2002, 2007). They also feed on the second trophic resource represented by macroalgae which provide also food sources for *Grapsus albolineatus* and other decapods (Kennish, 1996, 1997; Kennish *et al.*, 1996; Kennish, and Williams, 1997; Cannicci, *et al*., 2002). Also, they feed on the third trophic sources represented by stranded algal detritus propagules and associated larvae as mentioned by Cannicci, *et al*. (2002) and also feed on other invertebrates including different groups of crustaceans, mollusks which represent the fourth trophic sources (Cannicci, *et al*., 2002, 2007 and Silva *et al*., 2004).

In spite of the occurrence of the two examined species at the very close or very neighbor habitats, they have succeeded in sharing their foods resources and there is degree of competition that may be at the very low level, due the usual occurrence of *P. marmoratus* at the upper and mid-intertidal zones, and restriction of most *E. verrucosa* at the lower intertidal or shallow subtidal zones and more extension downwards to deeper portions up to 15 m (Campbell, 1982). Therefore, the food items of the first species comprise most crustaceans particularly B*alanus* spp., amphipods and other true and porcelain crabs, mollusks such as *Patella* spp. and bivalves (*Mytillus* spp.) inhabiting the upper interidal zones, in addition to green algae and blue green algae which grow in the upper shore zones as demonstrated by Cannicci *et al*. (2002, 2007). However, more studies are required to cover other biological aspects of these common species along the Egyptian Mediterranean coasts.

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