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Abundance and diversity of amphipod species associated with macro-algae at Ras-Mohamed, Aqaba Gulf, Red Sea, Egypt

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ABSTRACT

Amphipod community is considered one of the main and important invertebrate communities associated with macro-algae in intertidal zone. So, the present work aimed to study the seasonal abundance and diversity of amphipod species inhabited macro-algal hosts in Ras Mohamed protectorate. Samples and data of the present study were collected seasonally from three sites inside this protectorate.

Results showed that twenty-three amphipod species associated with 15 macro-algal species (red, brown, and green algae) were recorded. The algal species fluctuated during different seasons. The highest abundance and diversity of amphipod species were recorded with species that associated with the red algae. Some amphipod species were found to have a high selection for their hosts. Also, the present study showed that some physical factors (such as type and shape of the place of living habitat, size of host plants patches, seasonality} and chemical factors (secondary metabolic chemicals) playing the main role in the evolution of the amphipod community by effecting on the abundance and diversity of amphipod species.

INTRODUCTION

The major focus of evolutionary, ecological and applied research is the plant selection by herbivores into plant-herbivore interactions **(Futuyma & Moreno 1988**; **Jaenike, 1990)**. Amphipods commonly associated with marine macro-algae; many species are herbivores and potentially consume their host plant **(Duffy & Hay, 1990)**. The forests of macroalgae and some of the filamentous algae support a very dense assemblage of amphipods in the Antarctic **(Amsler *et al*., 2012)**.

Warm months showed a high density of amphipods against cold months **(Aikins & Kikuchi, 2002)**. Density, size and isolation of host plants patches can vary the abundance and diversity of herbivores invertebrates **(Bach, 1988; Matter, 1996; Kunin, 1999; Doak, 2000)**. Also tidal range, seasonality, exposure, predation, some chemicals and biological factors effect on the abundance and diversity of such fauna **(Zeina, 2012),** and the proximity of unsuitable plants or habitats and the plants surrounding composition, as hosts or as non-host plants **(Coll & Bottrell 1994; Rand, 1999; Jonsen *et al.*, 2001)**. The choice of host and development of the amphipod community depending on the type and shape of the place of living habitat, and they play a main role in the evolution of the amphipod community **(Aikins & Kikuchi, 2001)**.

Amphipods considered algae as an important environment used for protection from predators and waves and sometimes for feeding on macro-algae and different types of epiphytes that associated with their hosts **(D'Antonio, 1985; Wahl, 1989)**. The diversity of species and their numbers vary with each algal species according to its composition and increase the surface of the algae. For example, algae which are composed of overlapping feathers have higher densities of small amphipods than the filamentous algae which have very few densities and most of them are *Caprilla,* but these densities are increased by increasing the depth **(Eilertsen *et al.*, 2011)**. Branched algal habitats can give higher protection than leaf-shaped one against visual predators **(Jacobi & Langevin 1996; Borg *et al.*, 1997)**. So, the physical structure of the habitat and amphipod size controlled at rates of predation "large animals usually more susceptible" **(Nelson, 1979; Holmlund *et al.*, 1990)**. The color of algae and size-selective may be the reasons for selection of amphipods toward its own algal habitats as a protection **(Main, 1987; Hacker & Steneck, 1990)**.

On the other hand, many bio-chemical products are effect on the number of species and individuals of amphipods. The evidence for chemical defenses against native herbivores has so far only been provided for a few non-native species **(Enge *et al.* 2013, Sagerman *et al.* 2014; Hawkins *et al.* 2017)**. Red and brown algae have been described as having the highest number of induced chemical defenses, making them less palatable, while green algae have deterrents secondary metabolites, but has not been reported to the induced defenses **(Rothausler *et al.*, 2005; Nylund *et al.* 2011; Hammann *et al.* 2016).**

Red Sea has very little knowledge about the associated fauna with different habitats in particular the Red Sea amphipod fauna **(Zeina, 2012)**. So, the aim of the work dealt with increasing our information about seasonal abundance and diversity of amphipod species inhabited macro-algal hosts in the Ras Mohamed protectorate, Red Sea.

MATERIALS AND METHODS

Study area:

Ras Mohamed protectorate is located in South Sinai. Samples were collected seasonally from three sites inside the protectorate **(Table 1** and **Figure 1)**.

***Samples collection*:**

The algal samples were collected with its associated fauna seasonally starting from November 2017 to August 2018. The collection of samples was done at each site during low tide at inter-tidal zone from shore line to reef edge. For each sample, the algal samples collected at nylon net bags (25 x 25 cm capture opening) with mesh size (500 µm). All collected samples immediately fixed in 70 % ethyl alcohol.

Table (1). Geographical limits and biotopes of sampling sites at Ras Mohamed Protectorate, Egypt

No.	Site	Latitude limits	Remarks
1	**Yollanda**	27° 43′ 56″ N and 27° 43′ 59″ N 34° 14′ 31.5″ E and 34° 14′ 33.5″E	Opened area; depth 30 to 250 cm; mixed substrate mostly sand; many algal patches and seagrass bed with variable size associated epiphytes.
2	**Aqaba beach**	27° 44′ 10″ N and 27° 44′ 22.8″ N 34° 15′ 22″ E and 34° 15′ 28.5″ E	Short intertidal zone with sharp reef edge; depth 30 to 100 cm; hard substrate mostly dead coral, contained small numbers of algal patches and seagrass beds; reef slope dominated with live coral.
3	**Old Quay**	27° 43′ 23″ N and 27° 43′ 28.5″ N 34° 15′ 04″ E and 34° 15′ 10.7″ E	Short intertidal zone with sharp reef edge; depth 30 to 200 cm; hard substrate mostly dead coral contained small numbers of algal patches; reef slope dominated with live coral.

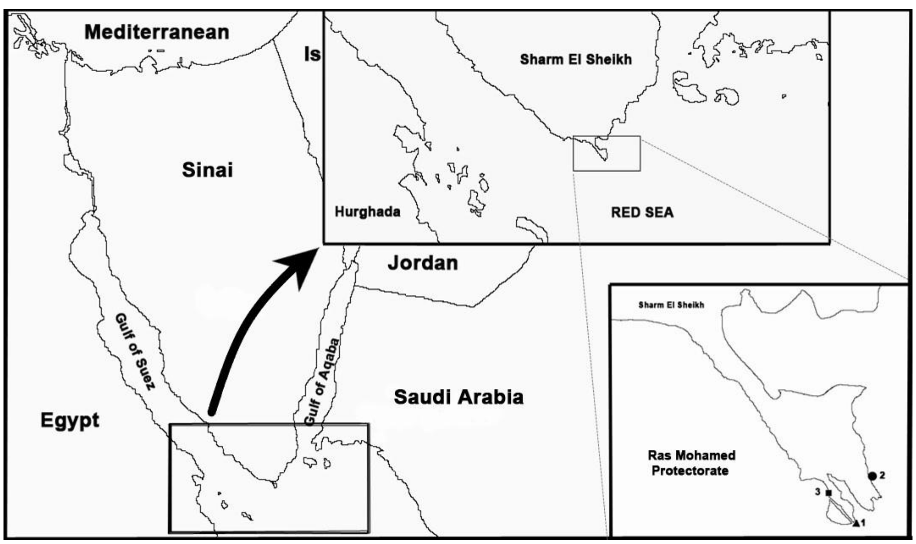

Figure (1). Map showing sampling sites at Ras-Mohamed protectorate.

***Laboratory studies*:**

At the Marine Biology Laboratory of Faculty of Science, Al-Azhar University, the collected samples reopened, and the algal specimen poured into one liter glass backer, nylon net bags washed three times for to retain all associated amphipod on sieve with mish size 0.5 µm for filtering. On the other hand, the associated amphipod on the branched algae removed by using forceps or fine dissecting needle. Finally the retained amphipod fauna on the sieve moved to another plastic container and preserved in 70 % ethyl alcohol.

Using dissecting stereo microscope all amphipod fauna were sorted and counted on petri dish. After that all amphipod fauna identified at species level by using traditional taxonomic methods and keys **(Barnard & Karaman, 1991** and **Lowry & Myers, 2013)**. According to **Lincolin (1998),** abundance may be defined as the total number of individuals of a taxon or taxa in an area, volume, population or community. Relative abundance is a useful measure knowing the changes in population condition and density. Diversity is considered as one of the major characteristics of a community. It may be defined as the number of species present and their numerical composition **(Sanders, 1968)**. All collected data in the present study were tabulated and appropriate graphs and statistically analyzed by using computer software Excel 2010.

RESULTS

Faunal composition

Ras Mohammad protectorate has less variety of algal diversity compared to other adjacent localities. Data presented in **Table (2)** revealed that the total number of algal species recorded during the study period, were 15 algal species. Algal species classified to red algae (9 species), brown algae (5 species) and green algae which represented by one species. Red algae comprised more than 95.6 % of total recorded amphipod species. This group of algae inhabited by variable number of amphipod species ranged between one species (*Ampithoi ramondi)* associated with the algal species *Digenea simplex* and 17 species associated with algal species *Galaxaura sp1*. On the other hand, brown algae constituted 19 species (82.6 %) of recorded amphipods. However, *Dictyota dichotoma* inhabited by only one amphipod species (*Ampithoi kava),* while *Cystoseira crinite* inhabited by 14 amphipod species. Finally, there are four amphipods species associated with green algae, *Halimeda macroloba* **(Table 2)**. There were some amphipods species associated with some specific hosts, for example *Cerapus maculanigra*, only recorded on *Galaxaura rugosa*, *Galaxaura sp1*, while *Quadrimaera massavensis* only associated with *Jania rubens* of red algae. Another species like *Parelasmopus suensis* was only found on *Cystosera crinita* from brown algae. In contrast, members of family Ampithoidae distributed throughout all the collected algal patches, in particular the amphipod, *Ampithoi ramondi,* which associated with 80 % of the inter-tidal recorded macroalgae in the study area.

Seasonal diversity and abundance of amphipods associated with algal species:

Data presented in **Table (3)** and **Figs (2 & 3)** showing the annual and seasonal diversity and abundance of amphipods associated with different algal species. Data showed that the highest total diversity of amphipods associated with the algal species, *Galaxaura sp.*1, being 17 species, while *Cystoseira crinita* came in the second rank, and inhabited by 14 amphipod species. The lowest value of amphipod diversity was one species and recorded with *Dictyota dichotoma* and *Digenea simplex*. The amphipod diversity associated with other algal species ranged between 4 species with each of *Gelidium sp.* and *Halimeda macroloba* and 12 species with *Padina pavonica* **(Table 3** and **Fig. 2)**. On the other hand, the algal species, *Dichotomaria obtusata*, had the highest amphipod abundance, being 257 individuals. While *Galaxaura sp.1* came in the second rank and includes 157 individuals. But in the last place *Dictyota dichotoma* and *Digenea* *simplex* comes with only one amphipod individual. The other algal species comprising variable number of amphipod abundance ranged between 12 and 102 individuals with *Gelidium sp.* and *Palisada perforate* **(Table 2 and Fig. 3)**.

Table (2): List of recorded amphipod species associated with different algal species.

Famiy	Species	Alage types and species															Frequency
		Brown					Red									Green	
		Di.d.	Pa.p.	S.l.	C.c.	T.t.	D.s.	P.p.	J.r.	D.o.	Ga.r.	Ga.1	Ga.2	L.	G.	H.m.	
Ampithoidae	*Ampithoi ramondi*		+	+	+	+	+	+		+	+	+	+	+	+		12
	Ampithoi kava	+	+			+		+		+		+	+				7
	Cymadusa filosa							+		+	+	+	+			+	6
	Paragrubia vorax		+					+	+	+		+	+				6
Amphillochidae	*Gitanopsis sp*		+		+			+	+	+		+					6
Aoridae	*Bemlos sp*		+		+							+					3
	Lembos sp		+	+	+	+		+				+		+	+	+	9
Caprellidae	*Hemiaegina minuta*					+			+				+				3
	Metaprotella africana			+	+	+		+		+		+	+			+	8
	Paradeutalla multispinosa				+				+			+					3
	Pseudocaprellina							+	+		+	+					4
Cyroideidae	*Cyproidea ornata*		+		+			+			+	+		+			6
Ischyroceridae	*Cerapus maculanigra*										+	+					2
Leucothoidae	*Leucothoi acanthopus*					+				+			+	+			4
	Leucothoi bannwarthi				+					+				+			3
Maeridae	*Ceradocus sp*		+		+	+		+	+					+			6
	Elasmopus pectenicrus		+		+	+		+				+		+			6
	Elasmopus rapax		+	+	+				+		+	+			+	+	8
	Parelasmopus suensis				+												1
	Quadrimaera massavensis								+								1
	quadrimaera schallenbergi					+		+	+		+	+					5
Phliantidae	*Pereionotus yongensis*		+	+	+				+			+					5
Photidae	*Photis sp*		+	+	+			+	+		+	+		+	+		9
Total number of species		1	12	6	14	9	1	13	11	8	8	17	7	8	4	4	

Di.d.= *Dictyota dichotoma,* **Pa.p.**= *Padina pavonica,* **S.l.**= *Sargassum latifolium,* **C.c.**= *Cystoseira crinite,* **T.t.**= *Turbinaria triquetra,* **D.s.**= *Digenea simplex,* **P.p.**= *Palisada perforate,* **J.r.**= *Jania rubens,* **D.o.**= *Dichotomaria obtusata,* **Ga.r**.= *Galaxaura rugosa,* **Ga1**= *Galaxaura sp1,* **Ga2**= *Galaxaura sp2,* **L.**= *Laurencia sp.,* **G.**= *Gelidium sp.,* **H.m.**= *Halimeda macroloba.*

Seasonal diversity and abundance of amphipods associated with algal species:

Data presented in **Table (3)** and **Figures (2 & 3)** showing the annual and seasonal diversity and abundance of amphipods associated with different algal species. Data showed that the highest total diversity of amphipods associated with the algal species, *Galaxaura sp.*1, being 17 species, while *Cystoseira crinita* came in the second rank, and inhabited by 14 amphipod species. The lowest value of amphipod diversity was one species and recorded with *Dictyota dichotoma* and *Digenea simplex*. The amphipod diversity associated with other algal species ranged between 4 species with each of *Gelidium sp.* and *Halimeda macroloba* and 12 species with *Padina pavonica* **(Table 3** and **Fig.2)**. On the other hand, the algal species, *Dichotomaria obtusata*, had the highest amphipod abundance, being 257 individuals. While *Galaxaura sp.1* came in the second rank and includes 157 individuals. But in the last place *Dictyota dichotoma* and *Digenea simplex* comes with only one amphipod individual. The other algal species comprising variable number of amphipod abundance ranged between 12 and 102 individuals with *Gelidium sp.* and *Palisada perforate* **(Table 2 and Fig.3)**.

Table (3): Seasonal diversity and abundance of amphipod species in relation to algal species.

Algal species		Seasonal diversity				Seasonal abundance				Total number	
		Autumn	Wintr	Spring	Summer	Autumn	Wintr	Spring	Summer	Species	Individ.
Brown	*Sargassum latifolium*	3			4	17			35	6	52
	Cystoseira crinita	14			1	91			5	14	96
	Turbinaria triquetra	7	2	2	2	46	4	3	16	9	69
	Dictyota dichotoma			1				1		1	1
	Padina pavonica	12		5		65		18		12	83
Red	*Digenea simplex*				1				1	1	1
	Palisada perforata	8	4	9	1	26	17	58	1	8	102
	Jania rubens		7	4	5		16	17	11	10	44
	Dichotomaria obtusata		4	3	6		98	45	114	8	257
	Galaxaura sp2		1	2	6		2	10	36	7	48
	Galaxaura rugosa		5	5			9	28		8	37
	Galaxaura sp1	12	7	9		59	78	20		17	157
	Laurencia sp	7		4		25		56		8	81
	Gelidium sp		4					12		4	12
Green	*Halimeda macroloba*			3	2			9	6	4	15

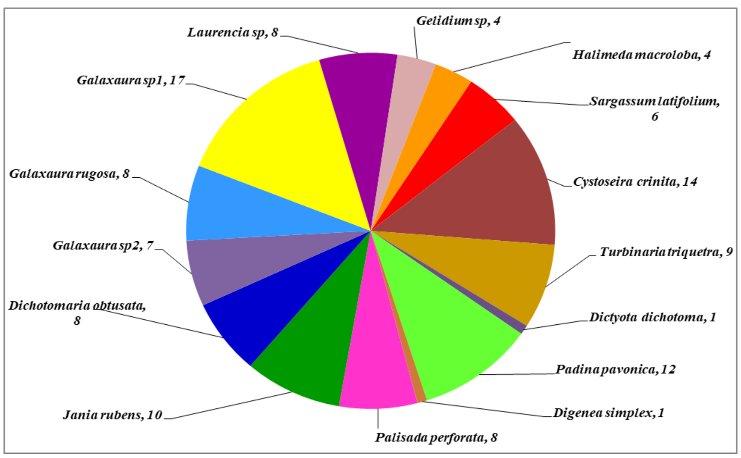

Figure (2): Showing total diversity of amphipod species associated with different algal species.

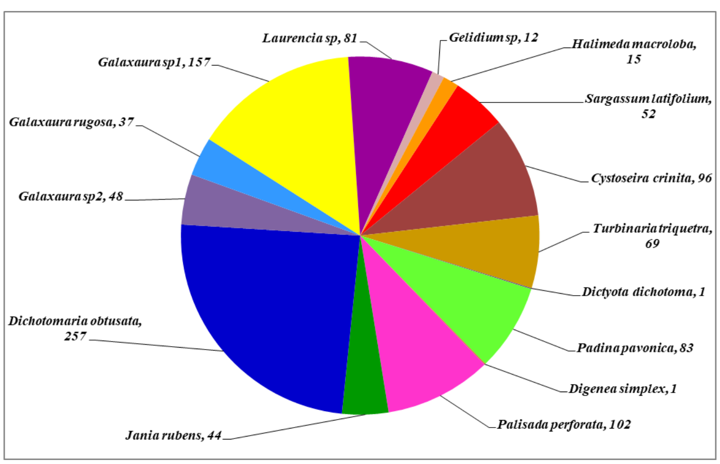

Figure (3): Showing total abundance of amphipod species associated with different algal species.

Spatial and temporal relative abundance of amphipods in relation to types of algae:

Concerning with seasons red algae had the highest relative abundance of amphipods, it recorded 98.21 % during winter, followed by 88.81 % during spring, and however the lowest one was 33.43 % during autumn. Brown algae came in the second rank after red algae and had 66.56 % relative amphipods abundance during autumn. Then it decreased to 24.88 % during summer and sharply decreased to 7.94 % and 1.78 % during spring and winter respectively. On the other hand, green algae were detected during two seasons only and accommodate 3.25 % and 2.66 % during spring and summer respectively **(Fig. 4)**.

Regarding to sites, red algae had the highest relative abundance of amphipods, being 80.0 % and 79.06 % at Old Quay and Aqaba beach respectively, then it is slightly decreases to 55.5 % at Yollanda site. Brown algae came in the second rank after red algae and had 43.12 % relative amphipods abundance at Yollanda site. Then it sharply decreased to 20.94 % and 17.66% at Aqaba beach and Old Quay sites respectively. On the other hand, again green algae were detected at two sites only and had very low relative amphipod abundance, being 2.34 % and 1.38 % at Old Quay and Yollanda sites respectively **(Fig. 5)**.

Seasonal distribution of recorded algae and their relative diversity

Figures of seasonal diversity or abundance presented in **Table (3)** indicated the presence of algal species in the same season. Results showing that there are two algal species were recorded during all seasons, these are *Turbinaria triquetra* (brown algae) and *Palisada perforate* (red algae). On the other hand, there are three algal species were recorded only during one season, these are the brown algae, *Dictyota dichotoma* (during spring) and the red algae, *Digenea simples* (during summer) and *Gelidium sp* (during winter). The remaining ten algal species were recorded during two or three seasons **(Table 3)**.

Generally, out of 15 recorded algal species, spring season had the highest species diversity being, 11 species (73.3 % of all recorded species), followed by summer season and had 9 species (60.0 %). While autumn and winter seasons had slightly algal diversity, being 46.7 % and 53.3 % respectively. Regarding to algal types, the results showed that there are great fluctuation in their relative diversity. Red algae had the highest relative diversity and recorded 87.5 % during winter, followed by 63.6 % during spring, while the lowest relative diversity was 42.9 % and recorded during autumn season. Brown algae showed high seasonal fluctuation in their relative abundance, where the highest one was 57.1 % recorded during autumn and the lowest relative diversity was 12.5 % recorded during winter. Finally, green algae were recorded only during spring and summer seasons with very low relative diversity being, 9.1 % and 11.1 % respectively **(Fig. 6)**.

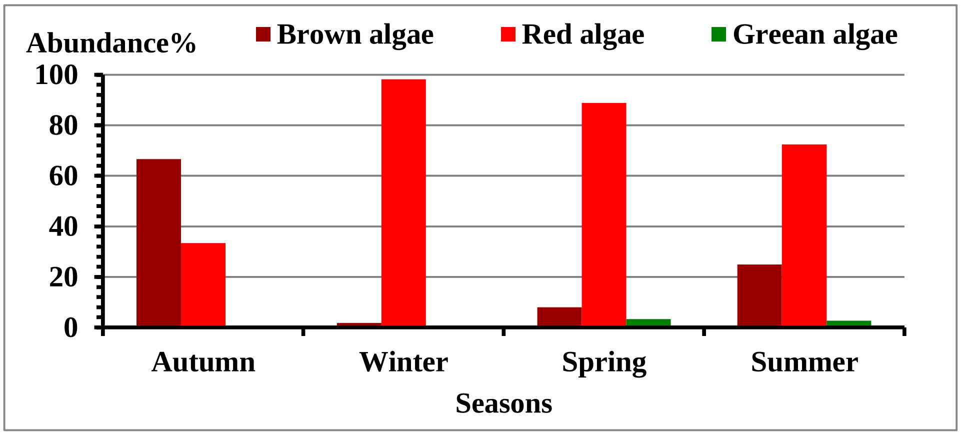

Figure (4): Showing temporal relative abundance of amphipods in relation to types of algae.

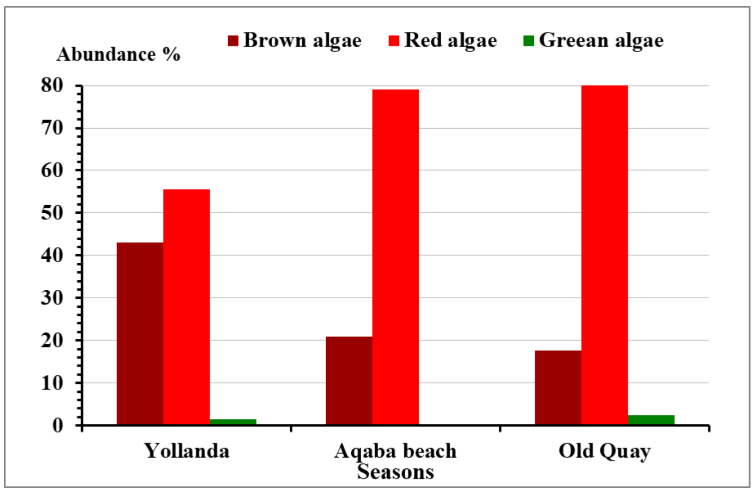

Figure (5): Showing spatial relative abundance of amphipods in relation to types of algae.

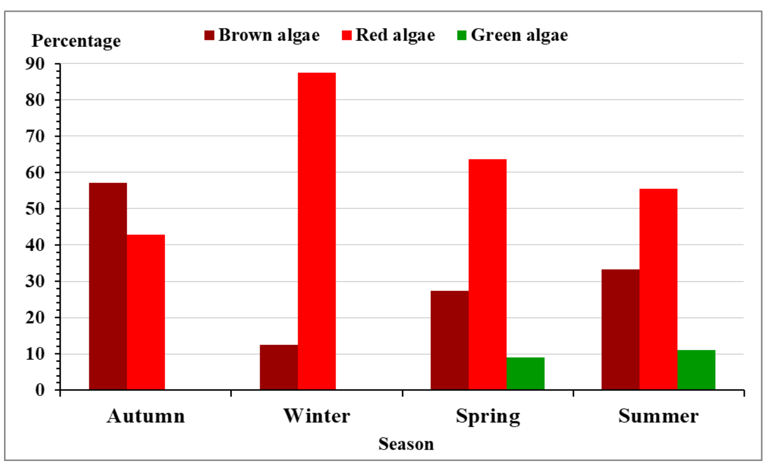

Figure (6): Showing seasonal relative diversity of recorded algal types.

Statistical analysis:

Based on the seasonal abundance of amphipod species inhabited different algal types, the statistical analysis performed using the analysis of variance test (ANOVA). As shown in **Table (4)**, one way analysis proved that, there was a high significant difference between the abundance of amphipod species and highly significant differences between the different types of algae and the abundance of amphipods. Also the data showed that the tow way analysis (interaction) between species and season were non-significant and the same for the interaction between species and algae, finally between seasons and sites were significant.

Table (4): Results of analysis of variance performed on the number of individuals of amphipod species during different seasons inhabited different types of algae.

Sourece of variation	D.F	SS	MS	F-value
Species $_{ss}$	**22**	**158.888**	**7.222**	**4.094****
Season $_{ss}$	**3**	**12.985**	**4.328**	**2.454**
Algae $_{ss}$	**2**	**90.090**	**45.045**	**25.535****
Species X Season $_{ss}$	**66**	**61.849**	**0.937**	**0.531**
Species x Algae $_{ss}$	**44**	**9.810**	**0.223**	**0.126**
Algae x Season $_{ss}$	**6**	**46.534**	**7.756**	**4.396****
Error	**132**	**232.889**	**1.764**	
Total	**275**	**613.045**		

**= high Significant at significance level 0.01 %

DISCUSSION

Studies of amphipod community that associated with macro algae are very little at Red Sea especially in Egyptian coasts, although the flexibility that Red Sea gives to associated fauna because its tide is limited with narrow range **(Zeina, 2012)**, so the associated fauna select their target algae without the risk of tidal barrier. Amphipods and gastropods were the dominant groups in the studied macroalgae habitats as proposed by **Tanaka & Pereira-leite (2003)** and **Huang *et al.* (2006)**.

In this research we studied the relation between some amphipod species and their macroalgae hosts. Algal biomass in the present study increased in spring and summer (warm months) which is disagreement with **Mohamed *et al.* (2006)**, but the salinity and water temperature in intertidal area controlling the fluctuated of macroalgae during year not only for the substrate distribution **(Guerra-García *et al.*, 2010)**, so with the global warming and the nature of our study area, the peaks of algal biomass are reached earlier from marsh to June.

The present results showed that the density and abundance of amphipods increases with the increasing of macroalgae in the same months. The study carried out by **Aikins & Kikuchi (2002)** confirmed our results and showed a high density of amphipods during the warmer months and vice versa in the cold months. **Duarte *et al.* (2009)** explain that amphipods are also found in the macroalgae strips that are found on the sandy beaches and found that algal density plays a large role in the abundance of some amphipod females, fertile females, males and young, as well as their body size.

The present study showed that there are a high fluctuation and sequencing of appear and disappear of different types of macroalgae was followed and parallels with increases and decreases in density of amphipod species. This interconnection can be optional if this species can live on different types of hosts at the same time, and the shape of host does not effect on its life requirements, or non-optional if it does. **Hacker & Steneck (1990)** found both morphology and surface area of different algae are effecting on amphipods cling ability on them. The large amphipod can wrap the algal blades to be used as a nest and this cannot be possible on the more finely branched algae **(Poore, 2004)**. The losing of habitat forming may be makes an imbalance in the main job (shelter and protection) which leads to occurrence of drastic consequences for the number of individuals and species number of its associated fauna **(Machado *et al*., 2019)**. For example, algae which are composed of overlapping feathers have higher densities of small amphipods than the filamentous algae which have very few densities and most of them are *Caprilla,* but these densities are increased by increasing the depth **(Eilertsen *et al.*, 2011)**. So the appear and disappear of different types of algae during seasons especially that are different in architecture between massive, complicated, branched profile or non-branched effect on amphipod density.

The present study clearly showed that there are some amphipod species like *Pseudocaprellina pambanensis, Cerapus maculanigra* and *Quadrimaera massavensis* have a highly selection for red algae as a host. Another species like *Parelasmopus suensis* has a highly selection for brown algae. This is contradicting with **Zeina (2012)**, who recorded *Quadrimaera massavensis* and *Cerapus maculanigra* as a limit selective species (lived on red and brown algae) and *Pseudocaprellina pambanensis* as a non-selective one.

In the present work the results indicate that the red algae recorded the highest number of amphipod species and individuals and this results disagreement with **Paul *et al.*(2001)** because the red algae have the many variety of secondary metabolites (prostaglandins, hydroxylated fatty acids and arachidonic acid-derived lactones) this chemicals factor doing as a chemical defenses and deter grazers of amphipods on macro-algae **(Targett & Arnold 2001; Van-Alstyne *et al.*, 2001; Taylor *et al.*, 2002; Nylund & Pavia, 2003; Brock *et al.*, 2007; Nylund *et al*. 2011**; **Hammann *et al*. 2016)**.

The brown algae come at second place, although brown algae according to **Rothausler *et al.* (2005)** having chemical defenses, that chemical making red and brown less palatable for amphipod fauna. So we can say that both red and brown algae have chemical defense against fauna but amphipod fauna adapted to live in this algae and amphipod species looking for shelter more than feeding and nutrition functions, this opinion agreement with finding by **Gutow *et al.* (2012)**.

Form and function of the host (macroalgae) is more important for the distribution of amphipods because the most important functions provided by the algae to the amphipods it is a place they can escape from predators in it **(Norderhaug, 2004)**. Another reason we give the red algae present during the year but brown and green algae present in season and absent in another. The amphipods community replaced his type of host according to what available.

Distribution of amphipods depending on the form and function of the host (macroalgae) more than its food value. The present study cleared that some amphipod species inhabited leaf-shaped algae and another branched, this is because one of the most important functions provided by the algae to the amphipods is protection from predators. These findings agree well with **Norderhaug (2004)**. On the other hand food value, form and architecture of the hosts making a difference in densities of amphipods. Also, different predation pressure or different reproductive rates effect on amphipod density, because many amphipods species moving frequently and highly mobile between hosts **(Norderhaug *et al*., 2002; Jorgensen & Christie 2003)** and this agreement with the present results.

The small living areas provided by the algae give a great serve and benefit for the small amphipods which live in it **(Gutow *et al.*, 2012)**. So in present work the types of algae that inhabited by highest number of species and individuals like *Dichotomaria obtusat*, *Galaxaura sp.1*, *Cystosira crinite*, *Palisade perforate* and *Padina pavonica* have branched leafs, overlapping feathers and complicated structure or associated with epiphytes that is very important for protection and that agreement with the studies by many authors **(Nelson, 1979; Holmlund *et al.*, 1990**; **Eilertsen *et al.*, 2011)**. So complication and overlapping of branches algae may give a higher protection from dangerous and visual predator **(Martin- Smith, 1993; Jacobi & Langevin 1996; Borg *et al.*, 1997)**. On another hand, coloration of different types of algae may be the reason for selection of amphipods to their own algae as a more defense against their eater **(Main, 1987)**.

CONCLUSION

According to the present results it became clear that, several factors interfere with the selection of amphipod communities for their macroalgae. Some of the main factors are the structure of macroalgae and its type; chemical factors such as secondary metabolic chemicals are effect on amphipod choice. The most important function that amphipod species looking for macroalgae is the protection from dangerous such as predation.

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ARABIC SUMMARY

الوفرة والتنوع لأنواع الامفيبودا المصاحبة للطحالب كبيرة الحجم فى رأس محمد، خليج العقبه، مصر

مصطفى خالد جبر - عمرو فرج زينه – احمد متولى هلال

شعبه علوم بحار واسماك ، قسم علم الحيوان ، كليه العلوم ، جامعه الازهر ، القاهرة ، مصر.

تعتبر مجتمع ألأمفيبودا واحدة من مجتمعات اللافقاريات الرئيسية والهامة المرتبطة بالطحالب كبيرة الحجم في منطقة المد والجزر. لذا، استهدف العمل الحالي دراسة الوفرة الموسمية وتنوع أنواع الأمفيبودا القاطنة للطحالب كبيرة الحجم في محمية رأس محمد. وقد تم تجميع عينات ومعلومات هذه الدراسة بصورة موسمية من ثلاثة مواقع داخل هذه المحمية.

أظهرت النتائج تسجيل ٢٣ نوعًا من الأمفيبودا مرتبطًا بـ ١٥ نوعًا من الطحالب الكبيرة (الطحالب الحمراء والبنية والخضراء) من المواقع الثلاثة محل الدراسة. اظهرت أنواع الطحالب تباينًا خلال المواسم. تم تسجيل أعلى وفرة وتنوع لأنواع ألأمفيبودا مع الأنواع المرتبطة بالطحالب الحمراء. وقد وجد ان بعض انواع الامفيبودا لديها اختيارية عالية لمضيفها. كما أوضحت الدراسة أن بعض العوامل الفزيائية (مثل نوع وشكل مكان المعيشة، وحجم رقعة النباتات المضيفة والموسمية) وكذلك العوامل الكيميائية (كيماويات الايض الثانوية) تلعب دورًا رئيسيًا فى تطور مجتمعات الامفيبودا عن طريق التأثير فى كثافة وتنوع انواع الامفيبودا.