Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 24(6): 59 – 72 (2020)
www.ejabf.journals.ekb.eg

Influence of algal architecture and shore exposure on population dynamics of marine amphipods at Ras Mohamed Protectorate, Egypt.

Mostafa Kh. Gabr[*]; Amr F. Zeina and Ahmed M. Hellal

Marine Biology and Ichthyology Section, Zool. Dept., Fac. Sci., Al-Azhar University, Cairo, Egypt
***Corresponding author**: mostafa.gabr.mg@gmail.com

ARTICLE INFO

Article History:
Received: Aug. 6, 2020
Accepted: Aug. 25, 2020
Online: Aug. 28, 2020

Keywords:
Macroalgae;
Ras-Mohamed;
Algal architecture;
Wave action

ABSTRACT

Amphipods are one of the major invertebrate groups and spreading among marine macro-algae in the intertidal zone at Ras Mohamed Protectorate. But, very scarce information is available about amphipod species presence, their abundance and the factors affecting their distribution. So the present work aimed to study the effect of some physical factors on the abundance and diversity of amphipod species inhabited macro-algal hosts. Through the present work samples were collected seasonally from three sites inside this protectorate.

Results indicated that 2 macro-algal species of red algae were collected from these three sites. The algal species fluctuated in different sites. 16 of amphipod species were recorded inhabiting them. The highest abundance and diversity of amphipod species were recorded at Yollanda beach. Some amphipod species were found at site and not recorded at other site. The diversity and abundance of these amphipod species were fluctuated between sites depending on many physical factors such as wave exposure, shape of algal hosts, surrounding habitats and environments.

INTRODUCTION

Association of amphipods with macro-algae was extensively studied in various marine regions **(Norderhaug, 2004; Espinosa & Guerra-Garcia, 2005; Izquierdo & Guerra-Garcia, 2010)**. For sheltering and feeding purposes, fauna had been attracted to macro-algae especially amphipods. Amphipod species are using the algal host as a valuable nest used for their protection against waves and larger predators as well as sometimes for herbivores feeding type **(Jones, 1988)**. Also, **Bray & Ebeling (1975)** mentioned that macro-algae have been considered as an importantsource for food to marine fauna both (adult and juveniles).

Many physical and chemical factors affecting on abundance and diversity of herbivores invertebrates especially amphipod species **(Bach, 1988; Doak, 2000; Enge *et al.*, 2013; Hammann *et al.*, 2016; Hawkins *et al.* 2017)**. The physical properties of the surface and the environment are controlling of amphipods diversity according to the living requirements for each species **(Barnard, 1969)**. **Espinosa & Guerra-Garcia (2005)** used assemblages of algal macro-fauna and temperature as a quantitative approach to intertidal ecosystems assessment in Iceland. On the other hand, two Japanese authors clarified that the amphipod individuals selected their algal host based on the morphological architecture of the substrates and its physical structure **(Aikins & Kikuchi 2001)**, this selection depend only on the algal habitat varying with depth and not on other factors **(Eilertsen *et al.*, 2011)**.

The locations of the algal host in water column as well as the degree of exposure to the wave action are influencing on type and life style of its associated amphipod fauna **(Krapp-Schickel, 1993)**. The wave exposure has positive effect on the habitat community by improving the habitat with high oxygen concentration levels and renewing food resources **(Bueno *et al*., 2016)**. It has a negative effect on amphipod abundance and distribution by the continuous exposure to wave action which causing unstable agitated mobile macro-algal host **(Fincham, 1974; Fenwick, 1976)**. **Ayala (2002)** found amphipod genera that have morphological adaptations for living at exposed places, where wave action is very high, always frequent than not adapted genera.

The Red Sea amphipods were recorded a century ago, but the Egyptian amphipod list published based on materials collected from Hurghada and Safaga **(Zeina, 2012; Zeina & Guerra-Garcia, 2016; Zeina & Asakura, 2017)** and Ras Mohammed **(Gabr *et al*., 2020)**. The present work aimed to evaluate the influence of the algal architecture and shore exposure on biodiversity indices of amphipod fauna and their hosting habitat selection.

MATERIALS AND METHODS

A. Study areas:

Ras Mohamed Protectorate is located at Southern part of Sinai Peninsula between 27˚43′ and 27˚48′ N. Ras Mohamed Protectorate has 480 km^2 surface area; less than one third of them are land scape and the rest representing the Red Sea water coverage. The land scape part representing the southern part of Sinai and surrounded completely by sea water bodies except from the northern part. The collecting 3sites **(Fig. 1)** considered to represent the water bodies from different directions. This variation of sites location gives alternation of the wind direction and algal wave exposure level. Sampling of the dominant algal species in the protectorate was conducted during subsequent seasons.

The first site (**Yollanda beach**) is located between 27˚43′23″ and 27˚43′28.5″ N and 34˚15′04″ and 34˚15′10.7″ E. The surface area of this site is approximately 19250 m^2. This site was characterized by shallow water depth ranged between 0.3 m to 2.5 m at the time of the low tide. The shore line towards to the southern direction and is highly exposure to wave action, on the shore constructions, it considered mixed substrate consists of sand, calcareous rocks, dead coral and shells of many molluscan species. This substrates composition gave the chance to flourishing many algal patches with variable size to anchor such as *Palisada perforata* and *Galaxura rugosa*, in addition to seagrass mat scattered everywhere. On the other hand, some scattered and small colonies of hard corals were present; also faunal composition was very poor at this site.

The second site (**Aqaba beach**) is located between 27˚44′10″ and 27˚44′22.8″ N and 34˚15′22″ and 34˚15′28.5″ E. The surface area of this site is approximately 19450 m^2. This site characterized by shallow water depth ranged between 0.3 to 1.0 m at the time of the low tide. Beach substrate gradually changed from sand at the shore line to rocks, gravels, dead corals and live corals on back reef. Most of the macro algal patches in this site tend to live on the dead corals and rocky substrates with low densities, such as *Dichatomaria obtusata*. This site opened, calm and somewhat sheltered due to the surf of wave action at the reef edge, but sometimes it exposed to a high wave action particularly at the beginning of high tide. On the other hand, the faunal composition is richer than those at site one due to the different structure of the bottom also, the fauna concentrated in subtidal area especially small coral reef fishes.

The third site (**Old Quay**) is located between 27˚43′56″ and 27˚43′59″ N and 34˚14′31.5″ and 34˚14′33.5″ E. The surface area of this site is approximately 3805 m^2. This site is characterized by shallow water depth ranged from 0.3 to 2.0 m at the time of the low tide. This site exposed to a high wave action all over the year but sometime calm. This site beginning with gravels and rocky beach from the shore line then gradually followed by dead coral covered with huge amount of hydroids as well as live corals continuous to the reef edge. Most of the macro algal patches in this site tend to live on the dead corals or rocks in low densities, such as *Palisada perforata* **(PLATE, I)**. On the other hand, the faunal composition much like that at the site two, in addition, other fishes such as Moray eel, sting rays, small and large coral fishes were present.

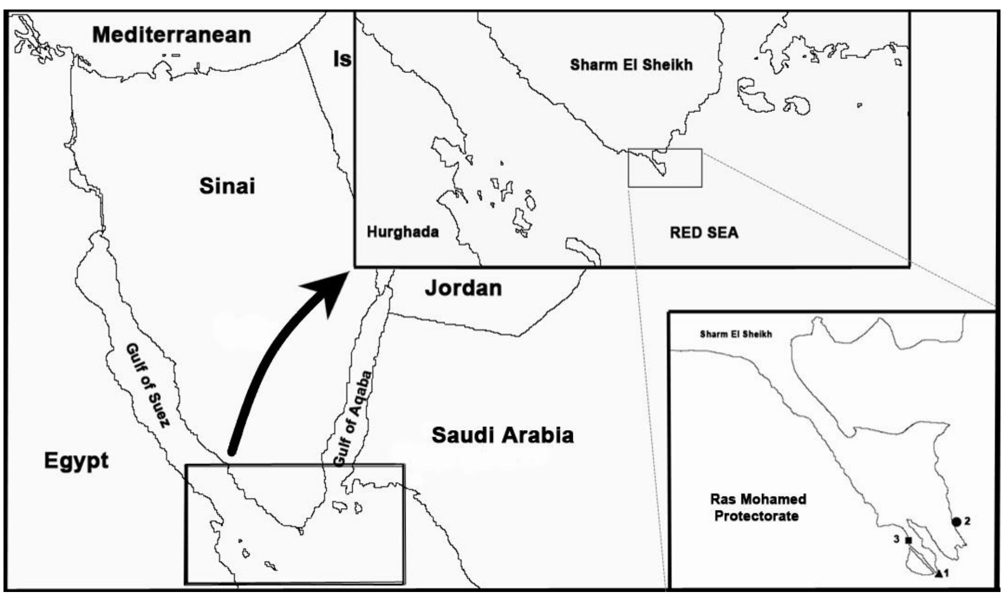

Fig. (1): Showing the three sampling sites at Ras Mohamed Protectorate.

B. Sampling Technique (on situ):

The algal samples were collected via seasons including its associated fauna starting from Nov. 2017 to Aug. 2018. At the inter-tidal and shallow sub-tidal zones, the collection of samples was done starting from shore line to reef edge through back reef plate by free snorkeling diurnally. Each algal sample was collected with nylon bags (225 cm^2 capture opening and 30: 35 for width: length) with mesh size net (0.5 mm). On shore, the collected samples immediately were fixed by immersing the algal samples completely in ethanol 70%.

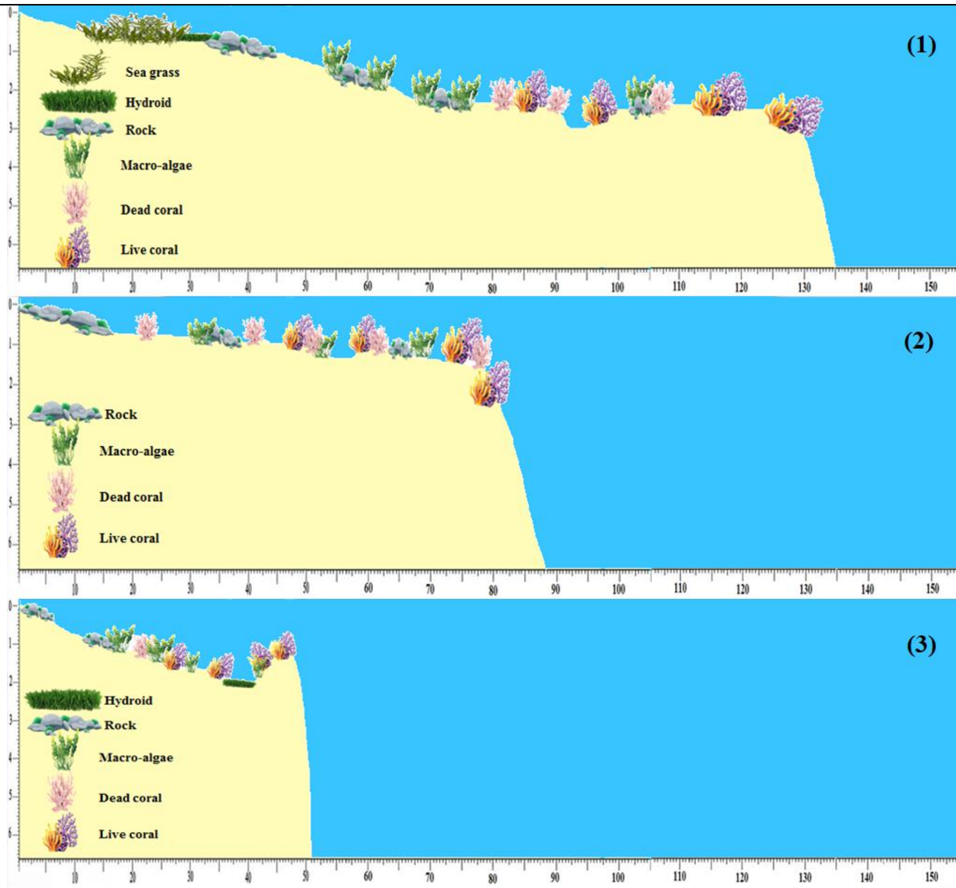

PLATE I: Diagrammatic shore's profile for three sampling sites; (1) The first site (Yollanda beach), (2) The second site (Aqaba beach), (3) The third site (Old Quay).

C- Laboratory work:

At laboratory of Marine Biology (LMB), Faculty of Science, Al-Azhar University; the collected samples bags were re-opened, and algal specimen was transferred to large container and the embedded associated amphipods on the algae were removed by using fine needle or tweezers. Wet weight of algal samples had been recorded with digital balance after 15 min of washing.

In addition, the nylon bags were washed at least five times to remove and isolate the attached amphipods. The washed material had been retained on 0.5 mm sieve. Finally the isolated amphipods fixed in another preservation plastic container using 70% Ethyl alcohol. Using stereo dissecting microscope all sampled amphipods were sorted and counted. Some nominated individuals were used for identification by morphological taxonomical keys to the species level based on **(Barnard and Karaman, 1991** and **Lowry and Myers, 2013).**

According to **Lincolin (1998)**, abundance may be defined as the total number of individuals of a taxon in an area, volume, population or community and in current study it is defined as the total number of individuals per 200g of captured algae. Relative abundance is a useful measure knowing changes in population condition and density. Diversity is considered as one of the major characteristics of a community. It may be defined as number of species present and their numerical composition **(Sanders, 1968)**. All collected data in the present study were tabulated and graphs and statistically analyzed by using computer software Excel 2010.

RESULTS

1- Total abundance and diversity of amphipod species at different sites:

The variation of the study sites location affects the amphipod species diversity among the two algal species, *Galaxura* sp. and *Palisada perforat*a **(Table 1)**. The total recorded species of amphipods during autumn and spring was 16 species on both algae. Out of them 14 species are recorded on *Galaxura* sp., and dominated by *Elasmopus pectenicrus* and *Ampithoi ramondi* **(Figure 2),** while 11 species was recorded on *P. perforata* and dominated by the same species **(Figure 3)**. On the other hand, the total abundance in both algal species is nearly similar (479 and 496 ind./200g of algae for *Galaxura* sp. and *Palisada perforata* respectively). Based on the influence of site on the faunal distribution, more than 50% (514 ind./200g of algae) of the total abundance was recorded from Aqaba beach representing 13 amphipod species, while, Yollanda beach was the lowest abundant site (217 ind./200g of algae) representing 11 amphipod species followed by nine species of amphipods were reported at Old Quey.

The algal architecture is affecting the amphipod faunal distribution. Both high profile algae (*P. perforata*) and low profile algae (*Galaxura* sp.) working as sheltering and cache off predators and this sheltering attracts different amphipod species. The sixteen amphipod species are belonging to 9 families. Families Ampithoidae and Maeridae occupied more than two third of the total faunal abundance with 397 and 271 individuals, respectively. Some amphipod species like *Bemlos* sp., *Cerapus maculanigra, Elasmopus rapax* and *Pereionotus* sp. were found on *Galaxura* sp., while *Metaprotella africana* and *Ceradocus cf rubromaculatus* were found only on *Palisada perforata* **(Table 1)**.

Table (1): The total diversity and abundance of amphipod species on *Galaxura* sp. and *Palisada perforata* at different study sites in Ras Mohamed Protectorate during the period of study

Amphipods		Algal species						Total
		Galaxaura sp.			*Palisada perforata*			
		Sites			Sites			
Families	**Species**	**Yo.**	**Aq.**	**O.Q.**	**Yo.**	**Aq.**	**O.Q.**	
Ampithoidae	***Ampithoi ramondi***	27	50			106	52	**235**
	Ampithoi kava	5	19					**24**
	Paragrubia vorax	11	44		17		30	**102**
	Cymadusa filosa	5	19			12		**36**
Amphillochidae	***Gitanopsis* sp.**	5	19				15	**39**
Aoridae	***Lembos* sp.**		13				22	**35**
	***Bemlos* sp.**		38					**38**
Caprellidae	***Metaprotella africana***					24	15	**39**
Cyproideidae	***Cyproidea ornata***	16			26			**42**
Ischyroceridae	***Cerapus maculanigra***	22						**22**
Maeridae	***Ceradocus cf rubomaculatus***				29		7	**36**
	Elasmopus pectenicrus	5	94		29		59	**187**
	Elasmopus rapax		13					**13**
	Quadrimaera schallenbergi		19		9		7	**35**
Phliantidae	***Pereionotus* sp.**		6					**6**
Photidae	***Photis* sp.**	11	38				37	**86**
Total abundance (ind./200g algae)		**107**	**372**	**0**	**110**	**142**	**244**	**975**
Total Diversity (No. of species)		**9**	**12**	**0**	**5**	**3**	**9**	**16**

Yo.: Yollanda beach; Aq.: Aqaba beach and **O.Q.: Old Quey**

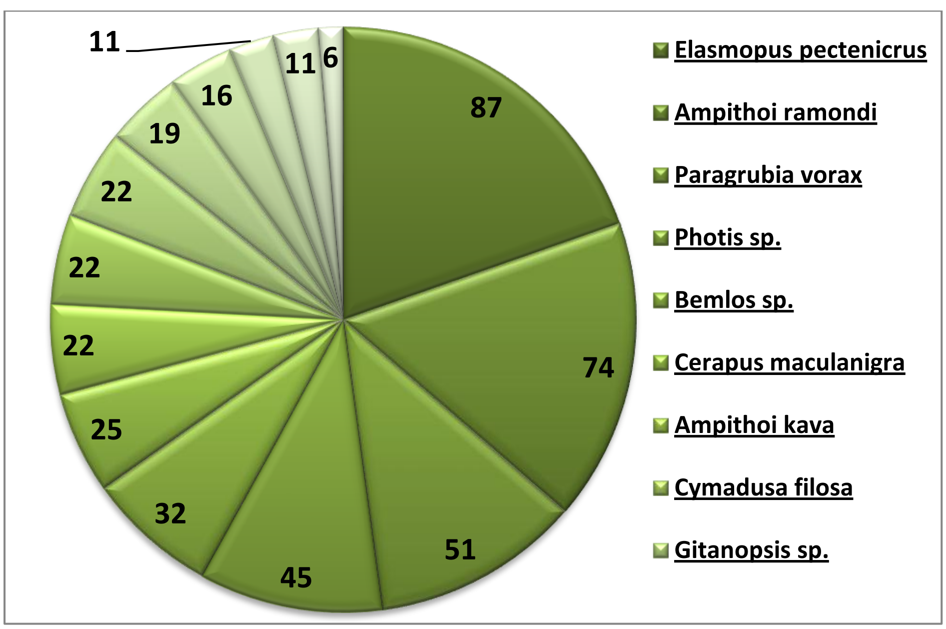

Fig. (2): Total amphipod abundance and occurrence on *Galaxura* sp. at different sites.

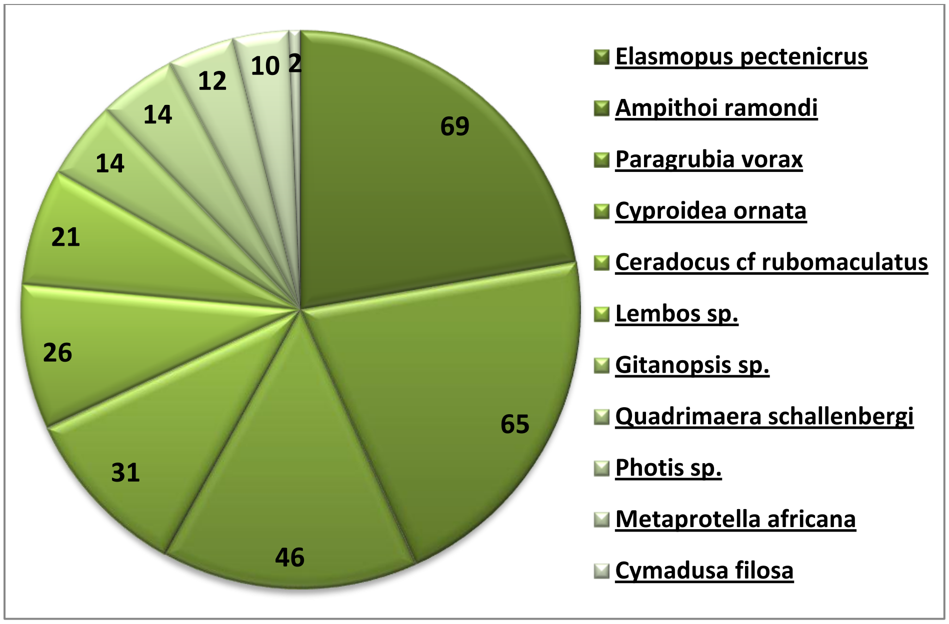

Fig. (3): Total amphipod abundance and occurrence on *Palisada perforata* at different sites.

2- Similarity index between different sites based on the number of individuals:

Based on the number of individuals of associated amphipods with *Galaxura* sp. and *Palisada perforata*, the analysis of similarity achieved as shown in **Fig. (4)**. The analysis of similarity presented one cluster. The cluster includes Aqaba beach and Old Quay with 72.73% similarity value. And both similar to Yollanda beach with 66.67% similarity. The data separate Yollanda beach from the other two sites.

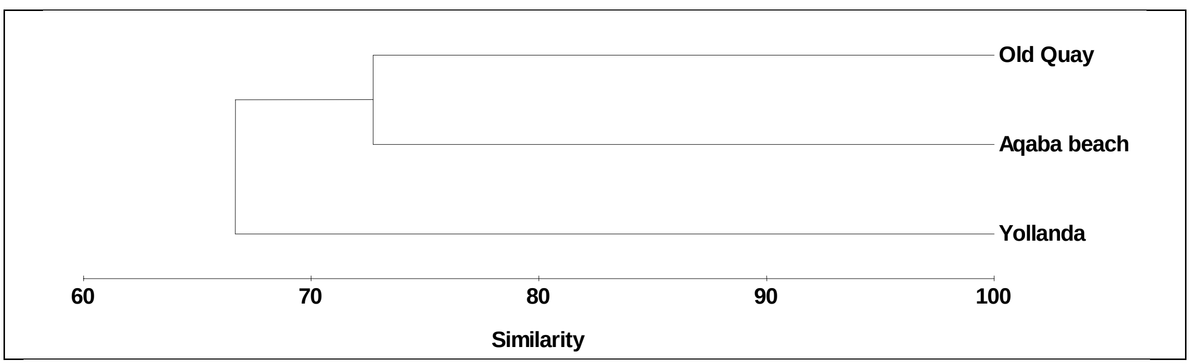

Fig. (4): Dendrogram of the similarity matrix between different sites based on the total number of individuals.

3- Diversity indices:

The results of Shannon Winner index indicated that there was little difference in diversity between collecting sites throughout the current study. The highest value of Shannon Winner index was 2.18 at Yollanda Beach as well as Aqaba beach. On the other side, the lowest Shannon Winner value was 1.98 at Old Quay. Concerning the species richness, the Aqaba beach site had the highest value being 1.92, while Old Quay site had the lowest richness index value being 1.46 **(Fig. 5)**. Finally, the highest Evenness value was 0.91 which recorded at Yollanda beach site and the lowest value (0.85) was recorded at Aqaba beach **(Fig. 5)**.

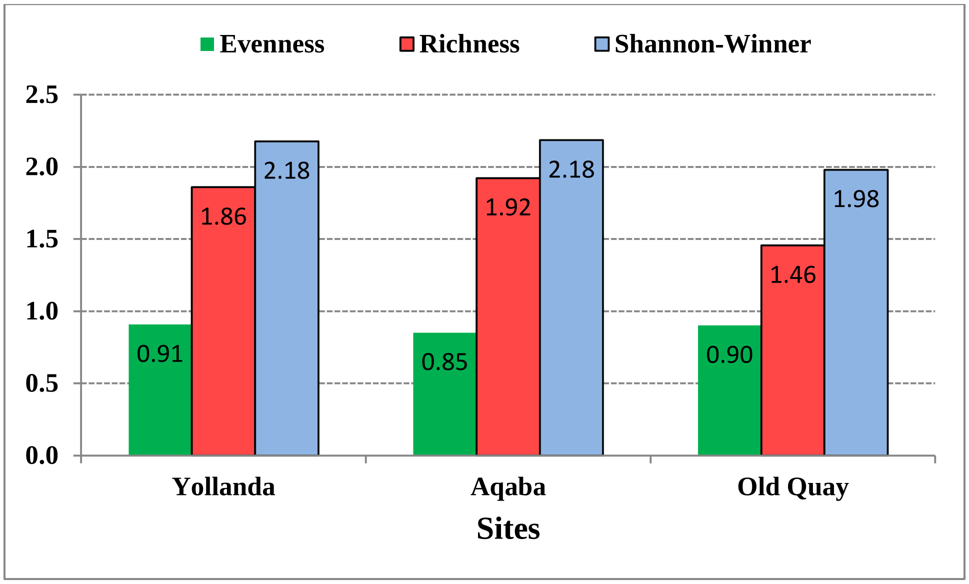

Fig (5): Showing the species diversity (Shannon-Winner), species richness and Evenness indices at different sites.

4- Bi-seasonal diversity and abundance of amphipods G. sp. and P. perforata:

Results showed that, there are some amphipod species were found associated with *Galaxura* sp. and *Palisada perforata* such as *Ampithoi ramondi* and *Elasmopus pectenirus* during autumn and spring. On the other hand, the amphipod diversity associated with the two algae are similar (9 species), which increased during autumn season with the low profile algae (*Galaxura* sp.) to be 12 species and reduced with the high profile algae (*Palisada perforata*) at the same season to be 7 species **(Table 2)**.

In contrast, the amphipod density increased during autumn season in both branching alga but the low profile algae involved two folds of amphipods against the high profile algae. At the same time, the low profile algae had three folds of density amphipod during autumn more than spring, while the high profile algae had 1.2 folds of amphipod density during autumn more than spring **(Fig. 6).** The total annual indices of both algal associated amphipods also represented.

Table (2): Frequency of occurrence of different amphipod species in algal species at different sites in Ras Mohamed Protectorate during the period of study

Amphiopds		Algal species				Total No.
Families	Species	*Galaxaura* sp.		*Palisada perforata*		
		Season		Season		
		Autumn	Spring	Autumn	Spring	
Ampithoidae	*Ampithoi ramondi*	+++	++	++	+++	235
	Ampithoi kava	++	+	-	-	24
	Paragrubia vorax	++	+	++	++	102
	Cymadusa filosa	++	+	-	+	36
Amphillochidae	*Gitanopsis* sp.	++	+	++	-	39
Aoridae	*Lembos* sp.	++	-	++	-	35
	Bemlos sp.	++	-	-	-	38
Caprellidae	*Metaprotella africana*	-	-	-	++	39
Cyproideidae	*Cyproidea ornata*	-	++	+	++	42
Ischyroceridae	*Cerapus maculanigra*	-	++	-	-	22
Maeridae	*Ceradocus cf rubromaculatus*	-	-	-	++	36
	Elasmopus pectenicrus	+++	+	++	+++	187
	Elasmopus rapax	++	-	-	-	13
	Quadrimaera schallenbergi	++	-	+	++	35
Phliantidae	*Pereionotus* sp.	+	-	-	-	6
Photidae	*Photis* sp.	++	++	-	++	86
Total density (ind./200g algae)		368	122	158	327	975
Total Diversity (No. of species)		12	9	7	9	16

Palisada perforate (Branched high profile); ***Galaxaura* sp.** (Branched low profile); Scale: **(+++)**: Abundant (51-100)**;** (++): Common (11-50); (+): Present (1-10), (--): Not recorded.

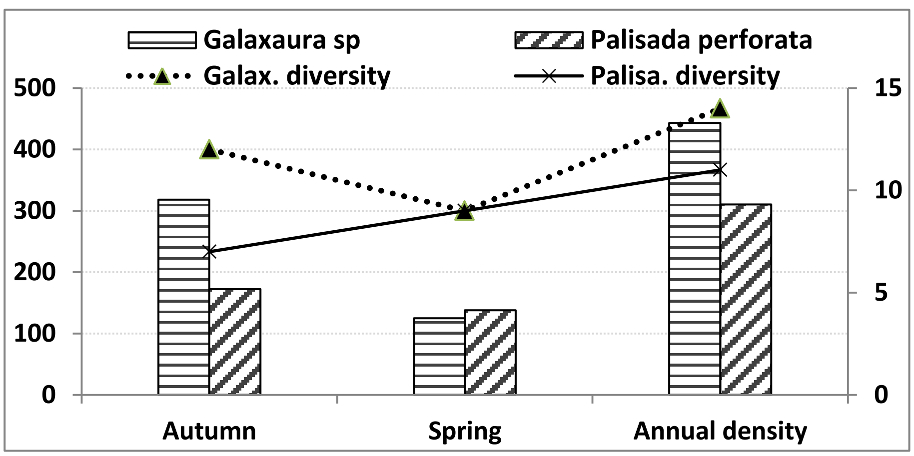

Fig. (6): Showing the amphipod diversity and abundance of *Galaxura* sp. and *Palisada perforata* during autumn and spring as well as annual indices.

DISCUSSION

Recorded amphipod species of the Red Sea from literatures and current works exceeds more than 100 amphipod species. About half of them associated with marine macro-algae. Often, amphipods tend to live on macro-algae for sheltering, feeding and camouflage **(Izquierdo & Guerra-Garcia, 2010)**, but actually those reasons sometime have priorities in application. Based on some secondary metabolites, space availability, prey and predation, food source as well as some different factors, amphipods could select their host algae or could not.

In the present work, the associated amphipod faunal abundance and diversity were compared based on two similar branched red algae. These two algal species varied in their architecture; which is identifying the algae based on the long stalked algae (high profile algae) and the short stocked algae (low profile algae). This physical character was studied to check if the algal profile could influence the faunal distribution or not **(Barnard, 1969; Hawkins *et al.* 2017)**.

During seasons, the atmospheric condition like sun light, temperature and pH have similar effect on high or low profile alga those live in the same area of study. While, the effect of the wind and wave action are alternatively changing based on shore exposure status (unpublished data). Through autumn season, the wind speed and the effect of wave action on the different habitat are strong. This wind activity is moving the sea water surface and is making a very high disturbance layer more than the lower sub-merged layers, as well as the lowest layer is more stable than other layers **(Neumann, 1956)**. In contrast, during spring season, the amphipod fauna lived in water column homogeneously and were moving between branched algae either it was low or high profiles. So, some species attend to live on the two branched algae in high densities like *Ampithoi ramondi* and *Elasmopus pectenirus*.

The fluctuation in abundance and diversity of amphipod species between the three sites in their similarity indices (Yollanda beach, Aqaba beach and Old Quay) via our study referred to few reasons. The first is shape of the red algae as a host of marine amphipods, either low or high branched profile algae. Because most of the dominant species which tend to live on the branched algae have the ability to climbing and grasping on the algal branches under unfavorable conditions. So some species like *Metaprotella africana* and *Ceradocus cf rubromaculatus* found only during spring on *Palisada perforata* (high profile algae). **Aikins & Kikuchi (2001)** studied the choice of host effect on the development of the amphipod diversity depending on the shape and type of the living place (habitat), and they found that, they playing a main role in the abundance and diversity of the amphipod community.

On the same side, the present results are in agreement with **Eilertsen *et al.* (2011)**, who found that the abundance and diversity of amphipod vary in each algal species according to shape, depth and its exposed surface area. So, losing of habitat forming may be makes an imbalance in the main job (shelter and protection) which leads to occurrence drastic consequences for the number of individuals and species of its associated fauna **(Machado *et al.,* 2019)**.

Second reason may be shore exposure, and the presence of algal patches play a role for amphipod sheltering during high wave action. Hence, our results presented many species of amphipods tend to move to low profile branched algae during bad weather and high wave action by increasing their densities, because most of amphipod species haven't ability to make nests or inhabiting tubes protecting them from wave exposure **(Fenwick, 1976)**.

Because of amphipods are living on the algal patches (Hosting), which present in places exposed to the current and wave action, they have strong claws that can cling to the algae and the resist the current **(Hagerman, 1966)**. Species are living in exposed places have special characteristics such as short pereopods, elongate body somites and a short basis of gnathopod 2. These structural characteristics give them the ability to stick and resist wave action compared with that living at protected one **(Takeuchi *et al.*, 1990; Guerra-Garcia 2001)**. The short reef flat with sharp reef edge at Old Quay and Aqaba beach making a wave breaker, these sites exposed to strong wave action. So the most amphipod fauna in these sites selected red algae as hosts because there are a low profile branched algae. But Yollanda beach hasn't wave barker topography, so amphipod fauna had different selection chances.

The last one is the habitat availability enrichment, Yollanda beach has multi variation habitat this habitat involving algae, seagrass with epiphytes, corals and hydroids, so many types of hosts are available for amphipod species at the same time, and this agreement with the study conducted by **Scipione & Zupo (2010)**.

CONCLUSION

Many physical factors are affecting on the distribution of amphipod species. Amphipods are selecting their hosts may be according to shape and type with what suite their living needs. And also the surround habitats are playing an important role in diversity and abundance as well as the population dynamics of amphipod species. These factors may be the main reasons for the differences between the abundance and diversity of amphipod species within the study sites.

REFERENCES

Aikins, S. and **Kikuchi, E. (2001).** Studies on habitat selection by amphipods using artificial substrates within an estuarine environment. Hydrobiologia, **457**(1–3): 77–86.

Ayala, Y. (2002). Relaciones entre la comunidad de anfípodos y las macroalgas asociadas a una plataforma rocosa del Litoral Central. Tesis de Licenciatura. Universidad Simón Bolívar, 71.

Bach, C.E. (1988). Effects of host plant patch size on herbivore density: underlying mechanisms. Ecology, **69**: 1103-1117.

Barnard, J. L. (1969). The Families and Genera of Marine Gammaridean Amphipoda. United States, National Museum Bulletin, 271.

Barnard, J. L. and **Karaman, G.S. (1991)**. The Families and Genera of Marine Gammaridean Amphipoda (Except Marine Gammaroids) (Part 1). Records of the Australian Museum, Supplement **13**, ISBN 0 7305 8743 6.

Bray, R.N. and **Ebeling, A.W. (1975).** Food, activity, and habitat of three ‘‘picker-type’’ microcarnivorous fishes in the kelp forests off Santa Barbara, California. Fisheries Bulletin (U.S.), **73**: 815–829.

Bueno, M.; Dena-Silva, S.A.; Flores, A.A.V. and **Leite, F.P.P. (2016).** Effects of wave exposure on the abundance and composition of amphipod and tanaidacean assemblages inhabiting intertidal coralline algae. Journal of the Marine Biological Association of the United Kingdom, **96**(3):761–767.

Doak, P. (2000). Habitat patchiness and the distribution, abundance, and population dynamics of an insect herbivore. Ecology, **81**: 1842-1857.

Eilertsen, M.; Norderhaug, M.I. and **Sjotun, I. (2011).** Does the amphipod fauna associated with epiphytes on kelp (*Larninaria hyperborea*) change with depth?. Marine Biology Research, **7**: 224-234.

Enge, S.; Nylund, G.M. and **Pavia, H. (2013).** Native generalist herbivores promote invasion of a chemically defended seaweed via refuge-mediated apparent competition. Ecology Letters, **16**: 487–492.

Espinosa, F. and **Guerra-Garcıa, H.M. (2005).** Algae, macrofaunal assemblages and temperature: a quantitative approach to intertidal ecosystems of Iceland. Helgoland Marine Research, **59:** 273–285.

Fenwick, G.D. (1976). The effect of wave exposure on the amphipod fauna of the alga *Caulerpa brownie*. Journal of Experimental Marine Biology and Ecology, **25:** 1-18.

Fincham, A.A. (1974). Periodic swimming behavior of amphipods in Wellington Harbour. NZ Journal of Marine and Freshwater Research, **8**: 505-521.

Gabr, M.Kh.; Zeina, A. and **Helal, A.M. (2020).** Abundance and diversity of amphipod species associated with macro-algae at Ras-Mohamed, Aqaba Gulf, Red Sea, Egypt. Egyptian Journal of Aquatic Biology & Fisheries, **24**(3): 1 – 15.

Guerra-García, J.M. (2001). New species of Caprellinoides (Crustacea: Hagerman, L., 1966. "The macro- and microfauna associated with *Fucus serratus* L., with some ecological remarks" Ophelia, **3**: 1-43.

Hagerman, L. (1966): The macro- and micro-fauna associated with *Fucus serratus* with some ecological remarks. Ophelia, Vol. **3**: 1-43.

Hammann, M.; Rempt, M.; Pohnert, G.; Wang, G.; Boo, S.M. and **Weinberger, F. (2016).** Increased potential for wound activated production of Prostaglandin E2 and related toxic compounds in non-native populations of *Gracilaria vermiculophylla*. Harmful Algae. **51**: 81–88.

Hawkins, S. J.; Hughes, D.J.; Smith, I.P.; Dale, A.C.; Firth, L.B. and **Evan, A.J. (2017).** A review of herbivore effects on seaweed invasions. Oceanography and Marine Biology, **55**: 421-440.

Izquierdo, D. and **Guerra-Garcıa, J.M. (2010).** Distribution patterns of the peracarid crustaceans associated with the alga *Corallina elongata* along the intertidal rocky shores of the Iberian Peninsula. Helgoland Marine Research, **65**:233–243.

Jones, G.P. (1988). Ecology of rocky reef fish of north-eastern New Zealand: a review. N.Z. J. Mar. Freshwat., Res. **22**: 445-462.

Krapp-Schickel, G. (1993). Do algal-dwelling amphipods react to the 'critical zones' of a coastal slope? Journal of Natural History, **27**: 883-900.

Lincoln, R.J. (1998). A Dictionary of Ecology, Evolution and Systematics. Cambridge University Press, Cambridge, UK, 361.

Lowry, J.K. and **Myers, A.A. (2013).** A Phylogeny and Classification of the Senticaudata subord. nov. (Crustacea: Amphipoda). Zootaxa. **3610** (1): 001–080.

Machado, G.B.O.; Ferreira, A.P.; Bueno, M.; Siqueira, S.G.L. and **Leite, F.P.P. (2019).** Effects of macroalgal host identity and predation on an amphipod assemblage from a subtropical rocky shore. Hydrobiologia, **836**(1): 65-81.

Neumann, (1956). Wind stress on water surface. Bulletin American Meteorological Society, **37**(5): 211-217.

Norderhaug, K.M. (2004). Use of red algae as hosts by kelp-associated amphipods. Marine Biology,**144**: 225–230.

Sanders, H.L. (1968). Benthic marine diversity: a comparative study. Am. Nat., **102:** 243-282.

Scipione, M. B. and **Zupo, V. (2010).** Crustacean amphipods from the seagrasses Zostera marina, *Cymodocea nodosa* and *Posidonia oceanica* in the Adriatic Sea (Italy): a first comparison.- Zoologica baetica, **21**: 15-32.

Takeuchi, I.; Yamakawa, H. and **Fujiwara, M. (1990).** The Caprellidea (Crustacea: Amphipoda) inhabiting the green alga *Cladophora wrightiana*: The influence of wave exposure on the species composition. La mer., **28**: 139-145.

Zeina, A.F. (2012). Studies on the intertidal epibenthic fauna at the Red Sea coast (Hurghada) with special emphasis on order "Amphipoda". Ph.D. thesis. Al-Azhar University. 311.

Zeina, A.F. and **Asakura A. (2017).** A new species of *Cerapus* Say, 1817 (Amphipoda: Ischyroceridae) from the Red Sea, with a key to the worldwide species of the genus. Journal of Crustacean Biology, 1-7.

Zeina, A.F. and **Guerra-García J.M. (2016).** Caprellidae (Crustacea: Peracarida: Amphipoda) from the Red Sea and Suez Canal, with the redescription of *Metaprotella africana* and *Paradeutella multispinosa*. Zootaxa, **4098** (2): 227–253.

الملخص العربي

تأثير الشكل البنائي للطحالب والتعرض الشاطئى على ديناميكية المجتمعات لمزدوجات الأرجل (Amphipods) البحرية بمحمية رأس محمد، مصر.

مصطفى خالد جبر - عمرو فرج زينه – احمد متولى هلال

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

تعد مزدوجات ألأرجل (Amphipods) واحدة من أهم مجموعات اللافقاريات المنتشرة بين الطحالب البحرية الكبيرة في منطقة المد والجزر بمحمية رأس محمد. ولكن حتى مع معرفة ذلك ، تتوافر معلومات نادرة جدًا عن وجود الأنواع ووفرتها والعوامل التي تؤثر على توزيعها. لذا فإن الهدف من هذا العمل هو دراسة تأثير بعض العوامل الفيزيائية على وفرة وتنوع أنواع مزدوجات الأرجل (Amphipods) التي تعيش في الطحالب الكبيرة. خلال هذا العمل تم جمع العينات موسمياً من ثلاثة مواقع داخل هذه المحمية. قام الباحث بتجميع نوعين من الطحالب الحمراء الكبيرة من ثلاثة مواقع.

أظهرت النتائج تباين أنواع الطحالب خلال مواقع الدراسة المختلفة. تم تسجيل ١٦ نوعا من مزدوجات ألأرجل (Amphipods) تسكن هذه الطحالب. كما تم تسجيل أعلى وفرة وتنوع لأنواع مزدوجات ألأرجل (Amphipods) على شاطئ اليولاندا. وقد تم العثور على بعض أنواع مزدوجات ألأرجل (Amphipods) في أحد الموقع والتى لم يتم تسجيلها في موقع آخر، حيث يعتمد تنوع ووفرة هذه الأنواع من مزدوجات ألأرجل (Amphipods) بين المواقع المختلفة اعتمادًا كبيراً على العديد من العوامل الفيزيائية مثل التعرض للأمواج، الشكل البنائي للطحلب العائل والبيئات المحيطة.