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Temporal variations and edge effects on polychaetes in continuous and fragmented seagrass beds in northern Red Sea, Egypt.

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ABSTRACT

The present study describes the structure and seasonal distribution of polychaete assemblages inhabiting seagrass beds of *Halphila stipulacea* species in Abo Monkar Island coast, Red Sea, near Hurghada city, during the period from mid-April 2016 to mid-January 2017. Seasonal samples of seagrass canopies and roots from the edge and center of 3 different sized seagrass patches were examined for their polychaetes content to figure out the effect of different habitat variables on the abundance and diversity of polychaetes. Such variables comprise habitat fragmentation, edge effects and microhabitat nature beside the effect temporal variation.

Overall, 35 polychaete species belong to 18 families were recorded, from all different seagrass patches with a comparable temporal distribution in 2 main marked seagrass habitat categories involving the canopy and root. Results indicated that large seagrass patches harbor higher polychaete's abundance than medium and small seagrass patches in seagrass canopies microhabitat especially in warm seasons, which promote the assumption of the negative effect of seagrass fragmentation, which become positively correlated with the increasing of water temperature and become more noticeable in the summer season. Reduction of habitat size led to reducing the polychaetes species richness in both seagrass canopies and roots. Total polychaetes abundance is relatively increased toward the patch's edge with the increasing of temperature whereas such animals tend to colonize patch's center in the winter season (in seagrass canopy microhabitat) as well as root microhabitats. However, polychaetes species richness was markedly increased in the patch-edge habitat only in seagrass canopies in only large continuous patch summer and spring seasons recording 19 and 20 species respectively. Our findings suggested that polychaete species tend to migrate toward the patch center or seagrass roots microhabitats whenever temperature and vegetation cover is reduced.

INTRODUCTION

Seagrasses are clonal, sessile, submerged angiosperms with a relatively simple, modular morphology. Seagrass meadows are increasingly subject to both natural and anthropogenic disturbance and fragmentation (Tanner, 2005). Natural disturbances include major storms such as cyclones and hurricanes (Hemminga and Duarte, 2000), as well as smaller scale grazing by animals such as dugongs (Nakaoka and Aioi, 1999). Anthropogenic causes range from propeller scars to dredging as well as nutrients supply (Uhrin and Holmquist, 2003; Honig *et al.*, 2017; Román *et al.*, 2019).

Seagrass community response to disturbance, fragmentation, and increased edge has an interest as these plants provide several ecosystem functions and services. Several studies have been conducted on seagrasses, at both the level of the patch and the individual organism, to determine whether seagrass growth changes in response to resource patchiness and/or disturbance. For example, at the patch level, Fonseca and Bell (1998) recorded evidence of correlations between the landscape-level spatial patterns of seagrass beds and local hydrodynamic exposure, disturbance, and water depth. At the individual level, Jensen and Bell (2001) found that *Halodule wrightii* morphology varied according to spatial position (edge vs. center) in a patch and they investigated the relationship between such variation and sediment nutrient availability. Changes in seagrass morphology have also been used to trace sediment disturbances such as the movement of subaqueous dunes (Marbá *et al.,* 1994) and erosional scarps (Patriquin, 1975). Duarte *et al.* (1994) affirm that seagrass density can provide useful evidence for reconstructing seagrass patch dynamics, tracing accretion and erosion indicating changes in sediment chemistry.

An ecological "edge" is generally understood as the abrupt transition between two adjacent ecosystems (Murcia, 1995). Both terrestrial and marine edge studies often focus on visually distinct habitat transitions and the effect of such boundaries on associated floral and faunal communities. "Edge effects" are defined as either marked increases or decreases in species density or richness, concentrated within a given distance from a habitat patch boundary (Odum, 1971). Center-to-edge transects, as well as comparisons of differently-sized patches with varying amounts of edge, are commonly used to identify edge responses (Bell *et al.,* 2001; Dorenbosch *et al.,* 2005; Smith *et al.,* 2008; Arponen and Boström, 2012; Shaban *et al.,* 2016).

Studies of seagrass edge responses may potentially provide insights into broader effects of ecosystem disturbance (Jensen and Bell, 2001). Seagrasses have demonstrated consistent edge responses in numerous studies, with predictable differences in densities, growth rates, biomass, rhizome morphology, and productivity observed between patch's centers and edges, regardless of species or climatic region (Nakaoka and Aioi, 1999; Bowden *et al*., 2001; Jensen and Bell 2001; Bologna and Heck, 2002). Hypothesized mechanisms for recorded edge responses often claim that differences in resources such as light (Nakaoka and Aioi, 1999) or nutrients (Jensen and Bell, 2001; Honig *et al.*, 2017; Román *et al.*, 2019) may be responsible. However, a general mechanism has not been determined.

Despite the increase in anthropogenic and natural disturbance that affect seagrass habitat along the Egyptian Red Sea coast only few classic studies that described some classic ecological aspects of seagrass-associated epifauna in different Red Sea waters (for example Hellal *et al.*, 2016). Shaban *et al.* (2016) described the response of crustacean assemblages to seagrass habitat fragmentation using the annual crustacean data, with neglecting the seasonal variation and the infaunal data interfere. They described the extent of active seagrass habitat edges on species richness and abundance of selected epiphytic group in two sites in the Red Sea.

The present study is aimed to evaluate the response of actively mobile seagrass-associated fauna (represented here by polychaetes) to edge effects in two different seagrass beds of *Halophila stipulacea*: 1- healthy continuous seagrass bed and 2- fragmented seagrass patches different in size. Such effects evaluated under temporal variation stress and in two main seagrass microhabitat that include canopy and root ecosystems involved in the same seagrass patch/bed.

MATERIALS AND METHODS

Study area

The present study was carried out during the period from mid-April 2016 to mid-January 2017 in only one site in the vicinity of Hurghada city on the Egyptian Red Sea coast. Study area (Fig. 1) is located on the coast of Abo Monkar Island (527.221284 N, °33.896852 E). Several surveys were achieved for many different locations before selecting the current which meet study requirements whereas it is containing many scattered seagrass patches variable in size and easy to find in appropriate depth. Seagrass bed and patches were found at this site at 0.5 - 7.0 m depth beside different Red Sea habitats including coral reefs and algae. Study site was selected containing many fragmented seagrass patches, and a large continues seagrass bed. Different physical and chemical water parameters were seasonally measured according to standard methods and their seasonal averages with its standard deviation were determined for study area and presented in Table (1).

Table 1: Seasonal variations of the physical and chemical parameters at studied site during the study period (Data expressed as Mean ±S.D).

Parameter	Spring	Summer	Autumn	Winter
Temp. (°C)	23.13 ± 0.11	31.29 ± 0.04	25.22 ± 0.12	19.69 ± 0.14
pH	7.97 ± 0.02	8.15 ± 0.01	8.1 ± 0.03	7.96 ± 0.02
Salinity ‰	41.35 ± 0.1	41.9 ± 0.03	40.1 ± 0.05	41.22 ± 0.1
DO (mgL^{-1})	7.17 ± 0.09	6.93 ± 0.22	7.12 ± 0.22	7.7 ± 0.12
BOD (mgL^{-1})	0.77 ± 0.12	2.72 ± 0.13	0.93 ± 0.1	0.71 ± 0.3
Ammonia (μML^{-1})	2.65 ± 0.22	2.72 ± 0.17	2.48 ± 0.18	3.02 ± 0.4
Nitrate (μML^{-1})	0.35 ± 0.08	0.73 ± 0.13	0.2 ± 0.09	1.32 ± 0.19
Nitrite (μML^{-1})	0.05 ± 0.01	0.09 ± 0.01	0.07 ± 0.01	0.08 ± 0.01
Phosphate (μML^{-1})	0.12 ± 0.01	0.11 ± 0.02	0.15 ± 0.03	0.19 ± 0.08
Silicate (μML^{-1})	1.42 ± 0.03	1.67 ± 0.11	0.85 ± 0.05	0.72 ± 0.14
T. Organic Matter (%)	2.53 ± 0.43	2.6 ± 0.57	1.5 ± 0.62	1.9 ± 0.34

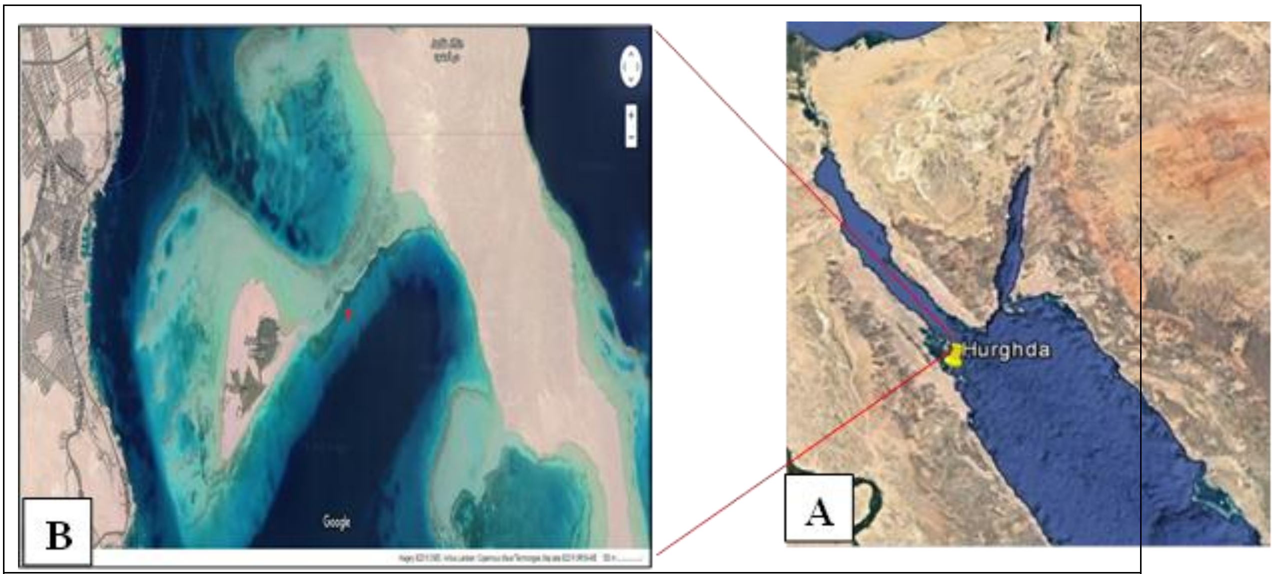

Fig. 1: A map of the study area site (Google map); showing (A): location of study area on the Red Sea coast near Hurghada city, Egypt; (B): enlarged part of map (A) showing Abo Monkar Island (study site) details.

Field work Design:

Seagrass patches were restricted to beds of the dominant seagrass, *Halophila stipulacea*, which occur in shallow waters of 2- 7 m depth. Three representative beds in relation to their patch size were chosen at the study site, the most suitable patches based upon preliminary observations and measurements. The three different bed sizes are designated here as large continuous seagrass bed (size I), medium fragmented seagrass patch (size II) and small fragmented seagrass patch (size III). For each, the patch area and morphology were determined using modern satellite photos, using Google earth application, with field updating for accurate determining to the circumference points of the patch. Several longitudinal line-transects will placed throughout the different regions, these transects will incorporate both center and edge locations to examine center-to-edge polychaete fauna dynamic throughout the different patch size.

Sampling and examination

Seagrass canopy and root samples with their polychaete fauna were collected seasonally from the edge and center of each seagrass patch selected in the study site using SCUPA diving. Three replicates from each were taken in the same time during the mid-season. Canopy fauna were collected using a propylene quadrate frame (25 x 25 cm). Seagrass shoots were cut using a scissor and quickly putted inside a polyethylene bags along with associated fauna. Root sample were taken immediately after shoot cutting using cores with different diameters which penetrates 10 cm sediment depth. Several core samples were taken until the appropriate size of sediment and their root content, which should be equal the canopy coverage area that sampled from the same collection point. All samples were preserved in 10 % seawater formalin.

In the Laboratory, the seagrass canopy and root samples were washed, and their fauna were extracted through 0.5 mm mesh sieves. Pohychaetes from different species extracted, sorted and preserved in 70 % ethyl alcohol. Critical identification for each specimen and species was carried out using extensive literatures available (e.g. Fauchald, 1977; Vine, 1986; Wehe and Fiege, 2002). Each polychete species was separated, counted and photographed with a digital camera. Species density (number of individuals per square meter), was calculated for each single seagrass microhabitat. Correlation between seasonal environmental variables and polychaetes abundance were also reported.

RESULTS

Polychaetes occurrence and seasonality:

Polychaetes distribution among different two seagrass microhabitats (canopies and roots) were given in Table (2) which figured out that about 35 polychete species were totally recorded within all the seagrass patches in the study area. Out of them 23 species were occured in both microhabitats and 12 species prefer only one type of microhabitats (of which 5 species were prefer canopy habitats and 7 species prefre root habitat).

Out of 5 species were prefer canopy habitats, 2 species belonging to family Glyceridae (*Glycera Africana* and *Glycera capitata*) and 3 species belonging to family Nereididae (*Nereis vexillosa*, *Perinereis nuntia* and *Heteronereis* sp.). Meanwhile, 7 species prefre root habitat, of which one species belonging to family Onuphidae (*Onuphis eremita*), one species belonging to family Nephtyidae (*Nephtys* sp.), two species belonging to family Capitellidae (*Decamastus gracilis* and *cossura* *longocirrata*) and 3 species belonging to family Opheliidae (*Ophelia borealis*, *Ophelia* sp. and *Armandia* sp.).

Table 2: Occurrence and abundance of polychaete species (Individuals/m^2) inhabiting both seagrass canopies and roots microhabitats in different seasons.

Systematic taxa		**Canopy**				**Root**			
		Seasons				**Seasons**			
Family	**Species**	**Spring**	**Summer**	**Autumn**	**Winter**	**Spring**	**Summer**	**Autumn**	**Winter**
Amphinomidae	*Archinome rosacea*	-	49	5	-	-	3	1	11
Dorvilleidae	*Dorvillea angolana*	-	5	-	-	-	17	6	12
Eunicidae	*Leodice antennata*	12	32	-	-	-	2	3	-
Lumbrineridae	*Lumbrineris* sp.	6	15	-	-	-	2	4	-
	Lumbrineris latreilli	5	-	16	-	-	5	1	3
Onuphidae	*Onuphis eremita*	-	-	-	-	2	10	5	-
Glyceridae	*Glycera africana*	57	100	5	16	-	-	-	-
	Glycera capitata	12	76	5	-	-	-	-	-
	Glycera sp.	26	26	10	10	9	-	-	-
Hesionidae	*Hesionides gohari*	148	392	77	92	4	8	4	16
	Oxydromus sp.	32	-	-	5		-	1	-
Nephtyidae	*Nephtys* sp.	-	-	-	-	10	13	4	3
Nereididae	*Ceratonereis mirabilis*	10	32	-	16	4	-	1	5
	Heteronereis sp.	29	80	-	16	-	-	-	-
	Nereis vexillosa	61	140	28	-	-	-	-	-
	Perinereis nuntia	25	69	-	-	-	-	-	-
Phyllodocidae	*Phyllodoce maculata*	5	21	-	-	7	2	1	1
Syllidae	*Syllides* sp.	17	300	16	28	10	2	1	10
Capitellidae	*Capitella capitata*	-	24	5	12		5		-
	Heteromastus filiformis	24	12	-	-			15	-
	Decamastus gracilis	-	-	-	-	8	23	15	8
Cossuridae	*cossura longocirrata*	-	-	-	-	30	7	11	9
Maldanidae	*Clymenura* sp.	10	76	-	-		-	-	21
	Axiothella obockensis		77	20	-		-	-	5
	Praxillella gracilis	65	85	5	-	10	-	-	10
Opheliidae	*Ammotrypane polycheles*	21	-	-	-	2	-	-	1
	Ophelia borealis	-	-	-	-	9	12	20	24
	Ophelia sp.	-	-	-	-	27	10	1	11
	Armandia sp.	-	-	-	-	12	2	1	10
	Scoloplos (Leodamas) chevalieri	5	16	-	-	-	-	-	-
Paraonidae	*Aricidea sp.*		16	-	-	16	6	26	4
	Paradoneis harpagonea	15	12	-	-	13	-	-	10
Cirratulidae	*Cirratulus cirratus*	5	5	-	-	5	-	-	-
Terebellidae	*Morgana bisetosa*	-	12	-	-	2	-	-	-
	Terebella sp.	-	5	-	-	10	-	-	-
Total abundance (Individuals)		**590**	**1677**	**192**	**195**	**190**	**131**	**121**	**174**
Total number of species		**21**	**25**	**11**	**8**	**19**	**18**	**19**	**19**

Seasonal variations of polychaetes abundance is markedly fluctuated among different species. At canopies microhabitat, the highest total polychaetes abundance is recorded during summer season, being 1677 individuals which decreased in spring season to 590 indfividuals. While the lowest abundance was 192 individuals during autumn season. Meanwhile, at root microhabitat the highest abundance of all species counted during spring season being 190 individuals. While the lowest abundance was 121 individuals during autumn season (Table 2).

Also the maximum polychaete species richness (number of species) that occurred in a single microhabitat and single season was 25 species recorded in summer season in canopy habitat which gradually decease with temperature deceasing to record only 8 species in winter season, which reflect the effect of temperature/seasons on caonpy-associated polychaetes.

Statistical analysis (ANOVA) for polychaetes abundance variability in roots habitat (Table 3) is also cleared the seasonal impact on total polychaete abundance that ranged from 121 in Autumn to 194 in summer with narrow species richness range from 18 to 19 (Table 2).

Table 3: Results of three-way ANOVA performed on abundance of associated polychaetes in seagrass canopy and root microhabitats

Variables	Canopy				Root			
	D.F	**SS**	**MS**	**F-value**	**D.F**	**SS**	**MS**	**F-value**
Patch Size (PSz)	2	6327.083	3163.542	0.508	2	916.333	458.167	19.589**
Edge/center (E/C)	1	9087.042	9087.042	1.459	1	2204.167	2204.167	94.240*
Seasons (S)	3	244953.792	81651.264	13.106*	3	552.333	184.111	7.872*
PSz x S	6	19984.583	3330.764	0.535	6	541.667	90.278	3.860*
PSz x E/C	2	26101.583	13050.792	2.095	2	382.333	191.167	8.173
E/C x S	3	15700.458	5233.486	0.840	3	362.167	120.722	5.162
Error	6	37381.417	6230.236		6	140.333	23.389	
Total	23	359535.958			23	5099.333		

Effect of edge and habitat fragmentation:

A total of 144 seagrass samples represented 48 different habitat variables were examined to figure out the role of some habitat characteristics on abundance and diversity of seagrass-associated polychetes including habitat fragmentation (patch size), habitat edge and in turn the correlation between the previous two factors with seasonal variability (Table 4).

Table 4: Seasonasl variations in polychaetes species richness (number of species) and abundance (number of individuals/m^2) in seagrass canopy and root microhabitats, fragmentation (different sizes), edge and center

	Microhabitats	Size	Position	Spring	Summer	Autumn	Winter
Species richness	**Canopy**	**Size I**	**Edge**	19	20	3	2
			center	8	7	3	3
		Size II	**Edge**	9	5	5	3
			Center	6	10	2	3
		Size III	**Edge**	2	6	1	2
			Center	3	10	2	3
	Root	**Size I**	**Edge**	5	3	5	9
			center	10	5	9	7
		Size II	**Edge**	7	6	5	5
			Center	8	8	4	9
		Size III	**Edge**	2	4	1	2
			Center	6	4	4	6
Abundance	**Canopy**	**Size I**	**Edge**	**220**	**459**	**49**	**15**
			center	**87**	**83**	**26**	**49**
		Size II	**Edge**	**125**	**220**	**36**	**27**
			Center	**30**	**219**	**17**	**29**
		Size III	**Edge**	**32**	**332**	**16**	**32**
			Center	**96**	**364**	**48**	**48**
	Root	**Size I**	**Edge**	**18**	**10**	**11**	**26**
			center	**46**	**20**	**17**	**48**
		Size II	**Edge**	**18**	**17**	**7**	**11**
			Center	**33**	**24**	**16**	**24**
		Size III	**Edge**	**15**	**25**	**20**	**15**
			Center	**60**	**35**	**50**	**50**

In canopies habitat, results in Figure (2) indicated that large seagrass patches promote higher total polychaetes abundance and a higher species richness, than medium and small seagrass patches during warm seasons (spring, summer); unlike the cold season (autumn and winter) wherein close abundance species richness value is recorded which reduced F-value number in patch size statistical analysis of abundance variance (Table 3). In roots microhabitat, however, statistical analysis (Table 3) showed that a highly significance effect of patch size factor along with a significant effect of their patch-size season interaction on polychaetes abundance. On the other hand only small patch size that being reduced in their polychaetes diversities in different seasons (Table 4 and Fig. 3).

Regarding to the actively response of polychaetes to the seagrass patch-edge (Table 4 and Figs. 2 &3), we can figure out 3 different variation sets in relation to the changing patterns in polychaetes composition and abundance in different seagrass ecosystems : 1- Warm seasons (summer, spring and autumn) versus cold season (winter). 2- Canopy versus Root microhabitats. 3- Large and medium seagrass patch size versus small one. Polychaetes abundance in canopies showed the same pattern during the different seasons, which increased markedly toward the edge, only in large seagrass patches and relatively in medium patches; during spring, summer and autumn seasons, which promote the assumption of the positive effect of edge but that pattern activity, is conditionally appeared and that restriction reduced F-value number in the statistical analysis of edge effect on abundance variance (Table 3). However, in roots microhabitats, statistical analysis (Table 3) showed the significance effect of edge/center factor along with a significant effect of their season interaction on polychaetes abundance. Such effect is markedly clear here due to the uniform increasing pattern in different sample variability toward the centers of all seagrass patches, which promotes the assumption of negative effect of edge in seagrass roots habitat.

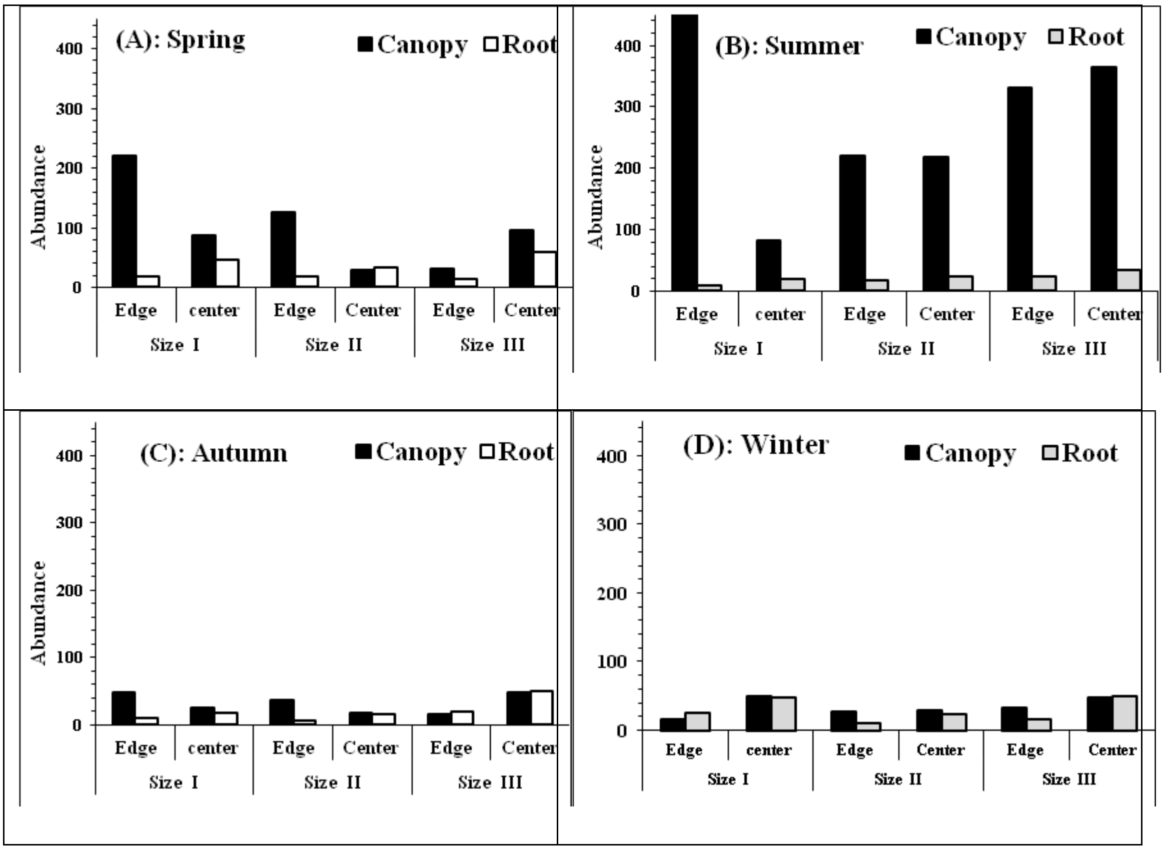

Fig. 2: Total polychaetes abundance at different habitat variables (Patch size and patch edge/center for canopy and root microhabitats) in different seasons.

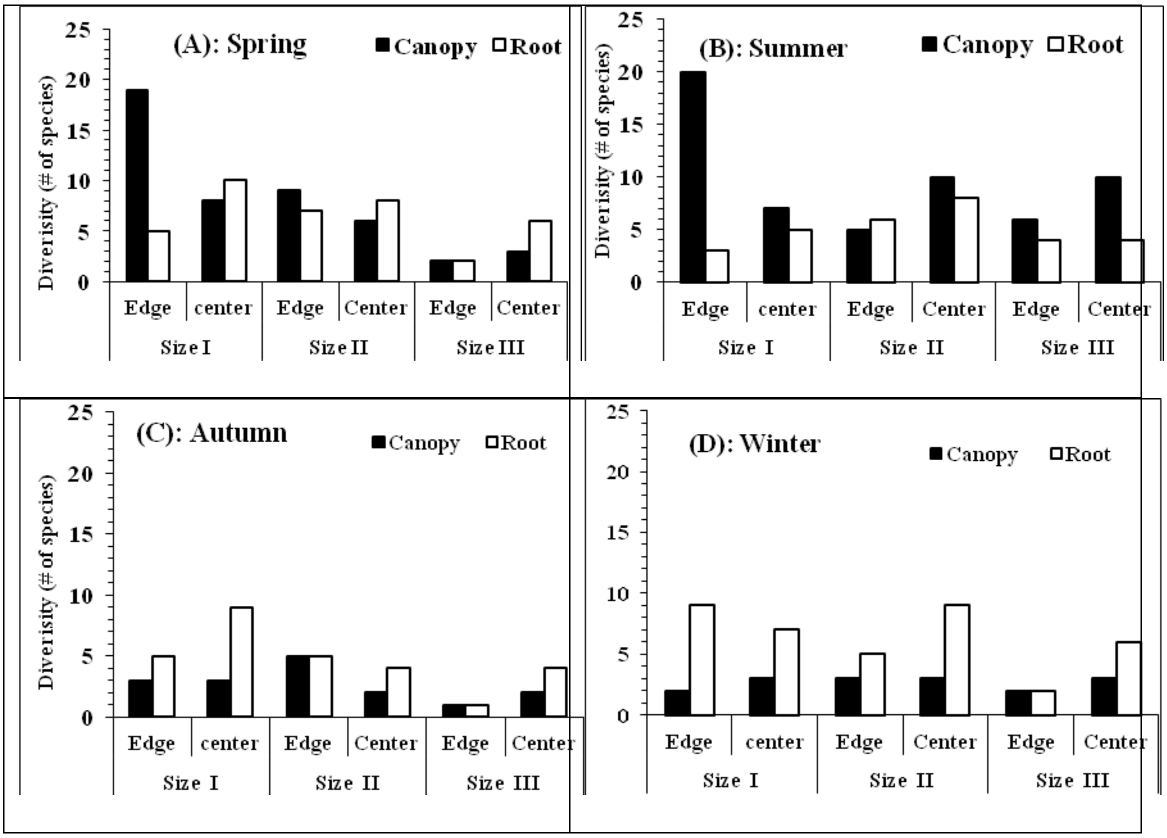

Fig. 3: Effect of seagrass habitat variables (Patch size and patch edge/center for canopy and root microhabitats) on species richness of polychaetes in different seasons.

In canopies microhabitat, maximum polychaetes diversity values were recorded in the edges of large patches in summer and spring seasons, recording 19 and 20 species, respectively. However, in roots habitats, maximum polychaetes diversity values were recorded in the center of large patch in spring season (10 species) and the center of medium patch in summer season (8 species).

Statistical analysis showed the extent of seasonal effect on the abundance of polychaetes in different habitat conditions (Table 3) and consequently some water quality parameters that exhibit temporal variation is positively correlated with polychaetes abundance in both canopy and root habitats including temperature, pH, dissolved oxygen, biological oxygen demands, in addition to a little effect of different nutrient seasonal fluctuations.

DISCUSSION

Seagrass beds are highly productive ecosystem; they fulfill a key role in the coastal zone with important ecological and economic functions, notably their importance to fisheries (Jackson *et al*., 2001) and their role in preventing coastal erosion and siltation of coral reefs (Duarte, 2002). Despite its value and importance, they are very sensitive, and its health is affected by a wide range of natural and human disturbances that occur at a range of spatial and temporal scales. Many previous works were studying the effect of seagrass habitat fragmentation, and in turn the edge effect resulting from this fragmentation using, as in current work, the center and edge fauna variability, as well as comparisons of differently-sized patches with varying amounts of edge to identify edge responses (Bell *et al.,* 2001; Dorenbosch *et al.*, 2005; Smith *et al.,* 2008; Arponen & Bostrőm, 2012; Shaban *et al.,* 2016).

Results indicated that large seagrass patches harbor higher polychaete's abundance than medium and small seagrass patches in seagrass canopies microhabitat especially in warm seasons (spring, summer and autumn), which promote the assumption of the negative effect of seagrass fragmentation, which become positively correlated with the increasing of water temperature and become more noticeable in the summer season. However, in the cold temperature season as it clear in winter or even in autumn seasons the nearly neutral effect of patch size is observed especially in the epiphytic faunal conditions. According the fragmentation studies on terrestrial habitats it is feasible to predict that density and diversity of related fauna is decreased in the smaller habitat patches when compared with larger and continuous ones (Saunders *et al*., 1991). Such prediction is not consistent in marine habitat in which neutral or even positive effects of habitat fragmentation on faunal abundance and diversity were reported in many studies (Bell *et al.*, 1987; Sogard, 1989; McNeill & Fairweather, 1993; Eggleston *et al.,* 1998; Loneragan *et al.,* 1998; Hovel & Lipcius, 2001; Healey& Hovel, 2004; Macreadie *et al.,* 2009; Arponen and Boström, 2012). However, the conditional effect of fragmentation as it shown in the current results is also recorded (Gustafsson and Salo, 2012; Shaban *et al.*, 2016). Furthermore, there are unexpected opposite colonization pattern of associated fauna especially crustaceans such as amphipods in the seagrass in north Gulf of Mexico and Baltic Sea in Gustafsson and Salo (2012) whom suggested that associated fauna are not equally sensitive to patch fragmentation in different regions. Changing of the pattern of fragmentation effect is also noticeable in polychaetes where in current study the temporal variations stress playing important role in the distribution of polychaetes which seems to need more vegetation cover in spring and summer season and this findings are also clear in the polychaetes in seagrass beds in Tyrrhenian Sea, Italy (Gambi *et al.,* 1998) wherein in less vegetation stations and summer season the lower polychaetes diversity and patchiness is recorded.

Habitat fragmentation have different impacts on biodiversity that can be both positive and negative (Fahrig, 2003; Healey and Hovel, 2004; Laurance, 2008; Macreadie *et al.,* 2009). In the present study, reduction of habitat size led to reducing the number of crustacean species in both canopy and root habitats. This is consistent with the similar findings related to effect of seagrass fragmentation on fish assemblage by Macreadie *et al.* (2009) and crustacean assemblage by Shaban *et al.* (2016) whom suggested that positive edge effects compensated for area loss.

Faunal responses to increased habitat patchiness and edge effects are largely determined by individual dispersal abilities, which are higher in marine than in terrestrial environments (Robbins and Bell, 1994). Many animals move across edges in their search for food, mating opportunities or avoidance of predators (Schooley and Wiens, 2003). Alternatively, organism preferences or active habitat choice for edges or interior parts of patches can be an important factor in their colonization of fragmented habitats (Bender *et al*., 1998; Arponen and Boström, 2012). In this study, polychaetes composition and abundance impacted conditionally by edge effect where such animal group seems to prefer edges in large/continuous seagrass bed and relatively in medium- size patches in seagrass canopy micohabitat, where the vegetation dense cover is available, and this assumption is conditionally appeared in worm seasons.

Edges caused by fragmentation are dynamic regions characterized by variable microclimates with temperatures, oxygen supply by strong currents, and habitat characteristics that being variable from habitat interiors and also the temporal variation could be lead the reverse distribution (Turner *et al.,* 2001; Bologna and Heck

2002; Sweatman *et al.,* 2017). Thus, roots habitats in current study, showed significance edge to center polychaetes movement, reflected in their abundance and relatively in their diversity, which increased toward the patches interior, or occasionally in the other more correct sense movement from up toward the root microhabitat. Such dynamic mobility of polychaete species was also reported by Virnstein and Howard (1987) where they provided evidence that the mobility of the fauna between seagrass canopy and root systems is governed by activity in certain groups while it is also affected by interspecies competition from other groups like Mollusca. Negative edge effect also noticed in crustacean amphipods in the seagrass of north Gulf of Mexico and Baltic Sea (Gustafsson and Salo, 2012)

In the present study, polychaetes species richness was alternatively dynamic across patch edge and center in both microhabitats suggesting that species richness is insensitive to differences in patch edge-center microhabitat and seems to be more governed by seasonal variations (Frost *et al.,* 1999; Bowden *et al.*, 2001; Reed and Hovel, 2006). Although edges may be advantageous to some mobile polychaete species, they are also sites of increased predation risk (Tanner, 2005).

CONCLUSION

Polychaete species in seagrass beds in the present study have affected markedly by temporal variations. Moreover, epiphytic polychaete species Shows response to the active seagrass edge, but it is not automaized movement/colonization at/toward seagrass edges/centers and it seems as a conditionally movements. Temporal variation stress, represented by temperature, oxygen/nutrients supply in addition to habitat gragmentation and predation avoiding (and in turn vegetation density), are the main abiotic and biotic factors that push polychaete species to move toward seagrass patch's edges/center and even to other seagrass microhabitat (canopy and root). Finally, we concluded from current results that polychaetes shows important prefference to edges and epiphytic life style in preffered worm seasons and such species become more abundant and diverse in healthy seagrass patches with large and dense vegetation cover.

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ARABIC SUMMARY

التباين الزمني وتأثيرات الحافة على عديدات الأشواك داخل بيئة مروج الحشائش البحرية المستمرة والمجزأة في شمال البحر الأحمر ، مصر

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تصف هذه الدراسة تركيب الأنواع والتوزيع الموسمي لتجمعات الديدان الحلقية عديدة الأشواك داخل موائل مروج الحشائش البحرية في المياه الساحلية التي تلى منطقة المد والجزر لجزيرة أبو منقار (قرب مدينة الغردقة) البحر الأحمر، خلال الفترة من منتصف أبريل ٢٠١٦ إلى منتصف يناير ٢٠١٧. بعد اختيار موقع الدراسة تم اختيار ثلاث مناطق من الحشائش البحرية مختلفة في حجمها: المنطقه الاولى تميزت بحجمها الكبير وانتشار النباتات بها والاثنين الأصغر تم اختيارهم من بقعة قد تجزأت واختير من اجزاءها بقعة متوسطة الحجم واخري صغيرة. تم تجميع الفونة المصاحبة للحشائش البحرية التى تقطن بيئة المجموع الخضرى (جزء الحشائش القائم فوق التربة) وبيئة الجذور من على حواف بقع الحشائش ومركزها لمعرفة تأثير المتغيرات البيئيه المختلفة على وفرة وتنوع الديدان الحلقية عديدة الأشواك ، وتشمل هذه المتغيرات: تجزئة الموائل ، آثار الحافة بجانب تأثير الاختلاف الزمني ونوعية الموائل الفرعية (الجذور والجزء الخضري).

إجمالاً ، تم تسجيل ٣٥ نوعًا من أنواع من عديدات الأشواك تنتمي إلى ١٨ عائلة وبينت النتائج إلى أن موائل الجزء الخضري لبقع الأعشاب البحرية الكبيرة المتواصلة تحتوي على ديدان اعلى في الوفرة والتنوع من بقع الأعشاب البحرية الأصغر في الحجم والتي تكون بنسبة أوضح في المواسم الدافئة (الربيع والصيف) مما يعزز فرضية التأثير السلبي لتفتيت الأعشاب البحرية ، والذي يرتبط إيجابياً بزيادة درجة حرارة الماء ويكون في ذروته خلال موسم الصيف. كما يؤدي تقلص مساحة وحجم بقع الحشائش إلى الحد من ثراءها بانواع عديدات الأشواك في كلا من موائل الجزء القائم و موائل الجذور. هذا ووضحت نتائج الدراسة ازدياد الوفرة الكلية لهذه الديدان البحرية باتجاه حافة رقعة الحشائش مع زيادة درجة الحرارة والتي تميل بدورها الى التجمع نحو مركز الرقعة في فصل الشتاء (في موائل جزء الحشائش)، هذا ويكون مركز الحافة مفضلا بشكل نسبي في موائل الجذور. كما بينت نتائج دراسة تنوع عديدات الأشواك تحت تأثير عامل الحافة-المركز على أنه كان هناك زيادة ملحوظة في عدد الأنواع في الحافة فقط داخل موائل الجزء القائم من الحشائش في المروج المتواصلة (البقع الكبيرة) فقط في موسمي الصيف والربيع حيث سجلت ١٩ و ٢٠ نوعًا على التوالي. هذا وقد توصلت نتائجنا إلى أن أنواع عديدات الأشواك تميل إلى الهجرة نحو مركز البقع أو جذور الأعشاب البحرية كلما انخفضت درجة الحرارة وكلما قلت الغطاء الخضري النباتي.