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Effect of seasons and location on the carpet shell clams *Donax semistriatus* (Mollusca: Bivalvia), Mediterranean Sea coast, Egypt

Mohamed M.M. Toutou [1], Ahmed B.E. Darwish [2], Abdel Razik H. Farrag [3], Shimaa R. A. Abo Daif [2]

[1] National Institute of Oceanography and Fisheries, Egypt
[2] Zoology Department, Faculty of Science, Suez University, Egypt
[3] Pathology Department, Research, National Research Centre, Cairo, Egypt

[*] **Corresponding Author: mtoutou50@yahoo.com**

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ABSTRACT

The Bivalve carpet shell clams *Donax semistriatus* was collected seasonally from three locations on the Mediterranean coastline, Idku urban, North Egypt. The greatest dominant size of the clam *D. semistriatus* is the individuals with class intervals of 12.8-22.3 mm. The population of *D. semistriatus* exhibited two periods of recruitment each year. The results of the biochemical analyses exhibited a significant increase in moisture contents in *D. semistriatus* during the summer season. The obvious increment in protein contents was reported in *D. semistriatus* during the autumn season, while ash contents decreased during the winter season. Both aliphatic and aromatic hydrocarbon concentrations were higher in winter than in summer. The present Highest content of aliphatic hydrocarbon (48605.87) was in summer at site "2" and the lowest content of aliphatic hydrocarbon (4052.33) was in winter at the site "1". The highest content of aromatic hydrocarbon (4525.56) was in winter at site "3" and the lowest content of aromatic hydrocarbon (873.36) was in summer at the site "1". Site "2" has the highest concentration of hydrocarbon because of sea currents near the natural gas company, located in site "1".

INTRODUCTION

Visible sandy coasts are unique of the greatest dynamic and rich environments, where they were being continually moved by waves, and currents. Egyptian sandy beaches are commonly dominated by bivalves of the family Donacidae. Bivalves can acquire an important role in solving the problem of shortage and high price of animal protein in Egypt. In addition, bivalve fisheries performance an essential role in social-economic context, mainly due to amount of fishermen involved in this activity of the Rosetta to El media coastal in Mediterranean Sea. The most common and edible bivalves *D. semistriatus* and *Donax trunculus* have been reported on the Egyptian Mediterranean coasts such as Alexandria **(Frihy *et al.*, 2004)**, Port said city **(El Refaey, 2006 and Ali *et al.*, 2009)**, Damietta and El-Jamil **(El Nemr *et al.*, 2012)**. The biology and population dynamics of *D. trunculus* were also studied by **Zeichen *et al.* (2002)** along the Italian Southern Adriatic coast. **Manatrinon *et al.* (2011)** studied the morphological variation among five populations of *Donax spp*. in Prachaupkhirikhan, Thailand. **El Ghalban (2010)** stated that the population structure was unimodal with the dominance of 10.1-20 mm class sizes. Most relationships between lengths and other shell dimensions or weights showed negative allometric growth **(El Ghalban, 2010)**. Positive allometry and isometry was recorded in *Donax semistriatus* for H/L and W/L relationships respectively **(Gaspar *et al.* 2002). Mohammad (2008)** showed that the vertical zonation has a great effect on population structure and biometric relationships of the intertidal snail *Cerithium scabridum.* **Mohammad (2002)** studied the gonad and digestive indices of the bivalve *Cerastoderma glaucum* and reported that they are inversely correlated with each other. **Orban *et al.* (2006)** investigated the condition index of *Chamelea gallina* clams to show the nutritional and commercial importance for this bivalve. Also condition index of the side *clam Donax serra* was studied by **Laudien *et al.* (2001)** as indication to the reproductive cycle of this species, however **Herrmann *et al.* (2009)** mentioned that the condition index was not valuable in describing the yearly reproductive cycle of *Mesodesma mactroides*. Several studies on the growth of *Donax* have been conducted. Most of these studies based on analysis of the monthly progression of the mean size of each cohort identified in size frequency distributions and showed that there is a seasonal pattern to shell growth. **Zeichen *et al.* (2002)** recorded the growth parameters of *D. trunculus* from Italy. **El Ghalban (2010)** recorded asymptotic length for Egyptian *D. trunculus.* She also detected three age groups for *D. trunculus* inhabiting the Mediterranean sea of Port Said city (Egypt). **Neuberger-Cywiak *et al.* (1990)** found that Mediterranean *D. trunculus* showed a life span of about 3 years. **Ramón *et al.* (1995)** declared that ring formation in *Donax trunculus* occur in clams larger than 25 mm. **El Refaey (2006)** studied the age of *D. semistriatus* and *D. trunculus* inhabiting the Mediterranean Sea water at the western area of Gamasa city and the eastern area of Port Said city (Egypt) respectively.

The main objectives of this study are to study the fisheries of bivalve and to look at the distribution and dispersion of some pollutant using the bivalve (Donax) as the bio-indicator since individuals of this species accumulate pollutant from water, sediments and/or from food. So, this study aims to provide basic information for detecting the current status of pollution in area of the Egyptian coasts on Mediterranean Sea, and to determine if humans that consume the bivalve Donax from this region might be at risk for pollutant -related health issues.

MATERIALS AND METHODS

Study area

Idku city located on the Mediterranean shore in Behira governorate, North Egypt (Latitude: 31.31° N, Longitude: 30.3° E). The altitude of Idku was 6 m (figure 1). The samples were collected from three regions that exposed to different pollutions in order to see the differences in population structure, growth and maturity stages of the clams between the three sites. Site (A) is located near sources of pollution (harbor and petroleum Company) selected region site (B) located near Idku city, selected region site (C) located at waterway that discharges waste water (result from irrigation) into the sea.

Fig. 1: Location of Idku city (northern Egypt) and the sampling sites.

Sampling

A total of 3000 specimens of *D. semistriatus* of different size were examined. The samples were seasonally collected from September 2017 to March 2019. The samples were collected at approximately 1.3 m in depth using simple harvesting tool (hand dredge). Fishing gear (hand dredge) was described (Fig. 2) in this study.

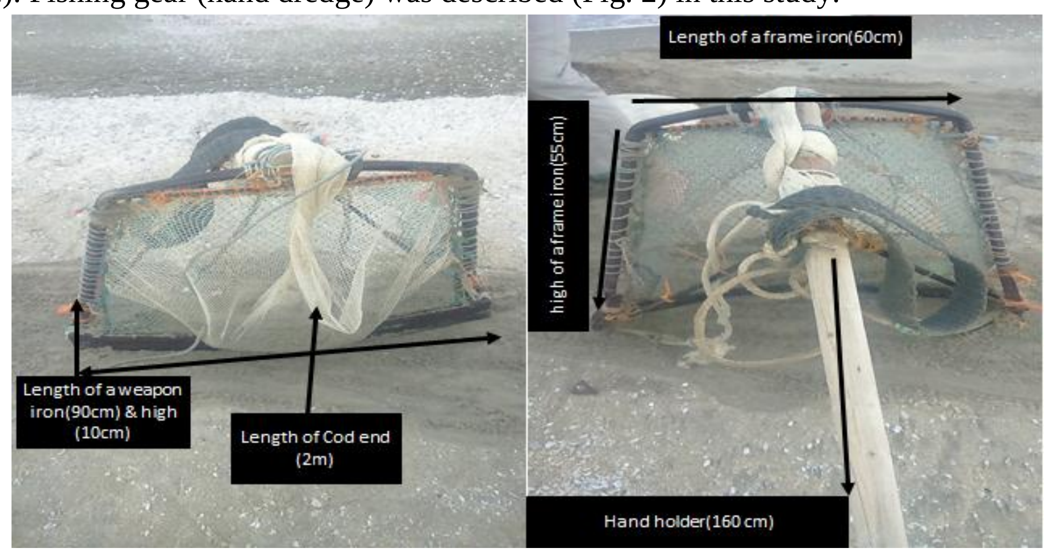

Fig. 2: Description of the fishing gear (hand dredge)

Population structure and biometric studies:

The morphometric analysis was done by measurement of the three shell axes;

1- Shell length: maximum distance on the anterior–posterior axis.

2- Shell height: maximum distance on the dorsal-ventral axis.

3- Shell width: maximum distance on the lateral axis.

All the measurements were taken to the nearest 0.01 mm with a manual Vernier caliper. Each specimen was weighed using electric balance with a precision of 0.001 g (Total weight). The soft parts were removed, dried on paper towel and weighted (soft weight), then dried at 70 °C for overnight and weighted again (dry weight). Empty shell was also weighted (dry weight).

Fig. 3: Steps of collection and grading of the bivalve *D. semistriatus*

Analytical methods:

Proximate composition analyses of samples including moisture, protein, lipid and ash contents were performed according to standard **AOAC (2000)** methodology on dry weight basis as follow:

Moisture content:

Water content was determined by drying a preweighed sample into an oven, thermostatically regulated, at 70^{o}C overnight and then weighed until constant weight (complete dryness) and the difference between the final and initial weights represent the water content of the sample. Moisture% = 100 [weight loss /weight of sample (g)].

Crude protein content (CP):

Protein content (on dry weight basis) was estimated as the total nitrogen content using the semi-automatic kjeldahl (Model VELP Scientifica, UDK 127). Protein content was then calculated by multiplying total nitrogen by 6.25. Protein%= % Nitrogen content * 6.25.

Ether extract:

Lipid content was determined on wet weight basis using a Soxhlet apparatus as described with petroleum ether as the extraction solvent. Lipids% = 100 [weight of lipid (g)/ weight of sample (g)].

Ash content:

Ash content was done by ignition a preweighed dry sample in a porcelain crucible at 600 ^{0}C, in a Muffle furnace, for about 4 hours. The difference between final and initial weights equals the ash content. Ash content% = 100 [weight of ash (g)/ weight of dry sample (g)].

Hydrocarbon concentrations:

Flesh of the shellfish samples of species in each site was scraped out of the shell and dissected. All the soft tissues of the 30–40 individual shellfish were mixed well into a composed sample and then dried in an open oven at 50^{0}C. The dried sample (5 g) was extracted in methanol (200 ml) for 8 h with Soxhlet extractor. KOH (15 ml of 0.8M) and distilled water (25 ml) were added to the extraction. Then the reflux continued for two more hours to saponify the lipids. The mixture obtained was extracted three times with n-hexane (50 ml, each) in a separator funnel. The n-hexane was then combined and sodium sulfate anhydrous was added, filtered and finally concentrated under vacuum down to about 10 ml at 40- ^{0}C, followed by a concentration using nitrogen gas streaming 1.0 ml volume. A column chromatography was prepared using silica gel (10 g), followed by aluminum oxide(10 g) and finally 1.0 g of sodium sulfate anhydrous **(Kelly *et al.*, 2000; El Nemr *et al.*, 2004, 2012)**.

The concentrated extract (1.0 ml) was sequentially eluted with 25 ml of n-hexane belonging to the fraction of n-alkaines (F1), then 50 ml of dichloromethane-n-hexane (1:9) belonging to the PAHs fraction (F2). The two fractions (F1 and F2) were concentrated to 1.0 ml each for the GC–MS analysis. The blanks of 500 ml of solvent that were used were concentrated to 1.0 ml and then analyzed by gas chromatography as previous reported by **El Nemr *et al.* (2014)**. Gas chromatography Shimadzu Class LC-10 equipped with Shimadzu Autoinjector, split/splitless injector and a fused silica capillary B-5 (30 m, 0.32 mm, 0.17 lm) 100% dimethylpolysiloxane. The temperature was programed from 60 to 300 ^{0}C with a rate of 5 ^{0}C min^{1} and was then maintained at 300 ^{0}C for 25 min. The injector and detector temperatures were set at 280 and300 ^{0}C, respectively. Helium was used as the carrier (1.5 ml min^{1}) and nitrogen as the make-up (60 ml min ^{1}) gas. 2ml volume of each sample was injected in the split mode (10:1) and the purge time was one minute. Identification and quantification of 16 PAH compounds were based on matching their retention time with a mixture of PAH standards. Compound identification was confirmed by GC coupled to mass spectrometry (Trace DSQ II Ms. with capillary column: Thermo TR-35 MS Mass Selective Detector). To validate the analytical method used in this study and the accuracy of the results, 6 analyses were made on the PAH compounds in the reference materials, IAEA – 406 (organochlorine compounds, petroleum hydrocarbons in tuna homogenate sample).

Statistical analysis

Data were presented as mean±SD. The results were subjected to one-way analysis of variance (ANOVA) to test the effect of treatment inclusion on fish performance. Data were analyzed using SPSS program, Version 22. Differences between means were compared using Duncan's (1955) multiple range test at $p < 0.05$ level.

RESULTS

Biometric studies

This study was carried out on different body parameters for shell height (SH), shell width (SW), total weight (TW), wet weight (WW), shell weight (SW), flesh dry weight (DW), and against shell length (L) as independent parameters (Table 1).

Table 1: Values of regression equations describing the relative growth between shell length (mm) and each of shell measurements and weights of *D. semistriatus* at the studied sites.

	Site 1			
	summer	**autumn**	**spring**	**Winter**
shell height (SH)	3.66	4.38	5.07	4.28
shell width (SW)	6.90	7.45	9.32	7.67
total weight (TW)	0.21	0.35	0.69	0.40
wet weight (WW)	0.07	0.12	0.41	0.24
flesh dry weight	0.02	0.04	0.12	0.07
shell length (L)	14.09	16.31	18.37	15.97
	Site2			
	summer	**autumn**	**spring**	**Winter**
shell height (SH)	4.00	4.33	5.07	4.21
shell width (SW)	7.32	7.68	9.31	7.27
total weight (TW)	0.24	0.35	0.64	0.35
wet weight (WW)	0.07	0.12	0.39	0.20
flesh dry weight	0.02	0.04	0.10	0.05
shell length (L)	15.11	16.53	18.56	15.58
	Site3			
	summer	**autumn**	**spring**	**Winter**
shell height (SH)	3.50	4.82	5.22	4.37
shell width (SW)	7.02	7.64	9.20	7.80
total weight (TW)	0.19	0.36	0.68	0.33
wet weight (WW)	0.07	0.13	0.41	0.22
flesh dry weight	0.02	0.04	0.12	0.07
shell length (L)	13.59	16.62	19.37	15.76

Biochemical composition of *D. semistriatus*:

the effects of seasons and locations on carpet shell clams on muscles composition of *D. semistriatus* in the present study are illustrated in Table "2". In generally locations didn't have a clear effect on the had no obvious effect on carpet shell clams on muscles composition, but the effect of the seasons was clearly visible and it was as follows , moisture contents of *D. semistriatus* were the best in autumn season also crude protein.

Table 2: Biochemical analyses of *D. semistriatus* during four seasons (dry matter weight basis).

	Site 1			
	summer	**autumn**	**spring**	**Winter**
Moisture	70.70±0.26[b]	69.70±0.55[b]	71.63±0.42[a]	70.50±1.17[b]
C.P.	12.80±0.36[b]	13.87±0.30[a]	13.17±0.09[ab]	12.36±0.52[b]
E.E.	13.17±0.18[b]	13.93±0.35[ab]	12.03±0.10[c]	14.3±0.59[a]
Ash	3.20±0.23[b]	3.70±0.06[a]	2.97±0.09b[c]	2.63±0.15[c]
	Site2			
	summer	**autumn**	**spring**	**Winter**
Moisture	70.83±0.32[b]	70.12±0.26[b]	71.48±0.27[a]	70.20±1.00[b]
C.P.	12.90±0.52[b]	13.64±0.49[a]	13.14±0.06[ab]	12.81 ±0.49[b]
E.E.	13.03±0.09[b]	13.80±0.26[a]	12.83±0.42[b]	14.10±0.21[a]
Ash	3.15±0.52[b]	3.65±0.26[a]	3.07±0.15[bc]	2.91±0.03[c]
	Site3			
	summer	**autumn**	**spring**	**Winter**
Moisture	70.91±0.32[b]	69.97±0.26[b]	71.40±0.27[a]	71.17±1.00[a]
C.P.	12.80±0.52[b]	13.74±0.49[a]	13.10±0.06[b]	12.57±0.49[b]
E.E.	13.12±0.09[b]	12.60±0.26[c]	12.33±0.42[c]	14.21±0.21[a]
Ash	3.07±0.52[b]	3.48±0.26[a]	3.13±0.15[b]	2.65±0.03[c]

Letters (a The highest significant, b and c lowest significant) meanings of in the table

The highest significant ($p \geq 0.05$) content of protein (13.87%) and the lowest significant ($p \geq 0.05$) content of ether extract (12.03%) of fish body composition were detected at spring season. Ash content showed significant ($p \geq 0.05$) differences among the different seasons. However, the lowest retention of crude protein at winter season and ether extract was observed at spring.

Hydrocarbon concentrations (aliphatic and aromatic) measured in the tissue of D. semistriatus during summer and winter is illustrated in Table "3". Both aliphatic and aromatic hydrocarbon concentrations were higher in winter than summer. The highest significant content of aliphatic hydrocarbon (48605.87) was in summer at site "2" and the lowest significant content of aliphatic hydrocarbon (4052.33) was in winter at site "1". The highest significant content of aromatic hydrocarbon (4525.56) was in winter at site "3" and the lowest significant content of aromatic hydrocarbon (873.36) was in summer at site "1". Site "2" has the highest concentration of hydrocarbon because of sea currents near the natural gas company, located in site "1".

Table 3: Hydrocarbon analyses of *D. semistriatus* during two seasons.

	Site 1	
	summer	**Winter**
Aliphatic (ppb)	25862.28	4052.33
Aromatic (ppm)	873.36	3061.14
Site 2		
Aliphatic (ppb)	48605.87	5860.24
Aromatic (ppm)	1393.27	4291.84
Site 3		
Aliphatic (ppb)	22648.11	4851.09
Aromatic (ppm)	2071.44	4525.56

DISCUSSION

Studying the population structure is the most effective way to recognize the ecological and biological behavior of bivalves. In the present work, population structure of *D. semistriatus* from three sites at Edku shores was investigated. We also carried out biochemical analysis and hydrocarbon concentrations in the tissue of *D. semistriatus* at the same three sites.

A total of 3000 specimens of *D. semistriatus* were measured. Shell lengths ranged from 9.88 to 24.1 mm. The most dominate length of the carpet shell calm *D. semistriatus* was individuals within class breaks of (13.59 -19.37 mm) at the three sites. The shortest length (13.59mm) was in summer and the longest (19.37mm) was in spring in site "3".

Site "3" has the longest individuals because of food availability contained in the agricultural waste dumped in this site. **Donn (1987)** declared that more abundant food source may allow for increased survivorship and hence a larger population size. **Defeo and de Alava (1995)** also mentioned that differential mortality due to differences in salinity and food availability could affect the distributional pattern of *D. hanleyanus* population. The present work revealed that the smallest individuals of *D. semistriatus* were found in summer and the largest individuals were found in spring in the three sites.

In the present study, *D. semistriatus* presented obvious overall leaning toward undesirable allometry in greatest relationships among shell length and either of the other measurements or body weight measurements. These undesirable allometries and consequent slight and lengthened shape may be an adaptive approach to recover investigating adeptness and depth inside the substrate, evading dislodgement from the bottom sediments by indigenous hydrodynamics. This assumption agreed with that of **Gaspar *et al.* (2002)** for *D. semistriatus* for L/H and L/Wi relationships respectively.
Growth and morphometric allometries could be correlated with environmental parameters and food availability.

Whilest **Tirado and Salas (1999)** recorded an important decrease in the ratio of flesh dry weight/length from June to August in *D. semistriatus* which related with peaks of spawning.

The positive allometry that appeared in record months among shell length and all of body weights, in the present investigation, may be related to many factors such as food availability, temperature and sexual maturity. **Ramesh and Ravichandran (2008)** found variations in the continuous allometry of length-weight relationship of Turbo brunneus from Tuticorin (Southeast coast of India) are attendant through development in size and sexual adulthood. **Herrmann (2008)** assumed that Sea surface temperature and nutrients obtainability are strategic features affecting development of *Mesodesma mactroides* in addition to features of population dynamics for instance transience, reproduction, recruitment and production,. **Urrutia *et al.*, (1999)** also mentioned that food availability and temperature constitutes a major determinant of growth in bivalves. Differentiations of types morphometric relations may be a significance of different hydrological and sedimentological structures among different geographical regions **Gaspar *et al.*, (2002)**. Present study showed slightly higher growth frequency at site "3" than that of site "1" and site "2". Obvious increment observed in spring may be related to the food availability.

The highest moisture (71.63%) was verified in spring at site "1" and the lowest moisture (69.70%) was recorded in autumn at site "1"

The highest significant content of protein (13.87%) was recorded in autumn at site "1" and the lowest significant content of protein (12.36%) was recorded in winter at site "1".

The highest significant content of ether extract (14.3%) was recorded in winter at site "1" and the lowest significant content of ether extract (12.03%) was recorded in spring at site "1".

The highest significant content of ash (3.70%) was recorded in autumn at site "1" and the lowest significant content of ash (2.63%) was noted in winter at site "1".
These findings disagree with **Periyasamy *et al.* (2014)** who studied the proximate composition of public coast clam, *D. incarnatus.* The findings of biochemical composition in *D. incarnatus* exhibited the proportion of protein was great 23.51%, monitored by the carbohydrate 10.23% and lipid 1.34 %.

Earlier studies on biochemical composition of bivalve molluscs defined certain characteristic features that considered of importance in understanding the economic importance of bivalves as food for human. They are: (1) protein represents major organic constituent of bivalves body, compared to the other components, lipids and glycogen **(Marcano *et al.*, 2003)**. (2) Bivalve molluscs lack the specific organs for nutrient storage of higher vertebrates and thus body constituents of bivalves represent energy reserves that are changed seasonally, showing cyclic synthesis and utilization **(Guacira and Thomé, 2004 and Lomovasky *et al.*, 2004)**.

These findings disagree with data from the present study where ether extracts being the major body component of the *D. semestraitus* tissue after moisture throughout the whole examination period. Present data also indicated that body composition indices (moisture, protein, ether extract, and ash) showed low seasonal variations through the study period and this finding disagrees with **El Wakf *et al.* (2021)** who found high seasonal variations through the study period.

The explanation is that bivalves body composition may change in response to seasonal changes in environmental conditions, especially in the food availability, where abundance of food during summer allow nutrient storage and use of energy for growth of somatic tissue and also for gonadal development **(Manduzio *et al*., 2004 and Borković *et al*., 2005)**.On the other hand, food storage during winter may to some extent be responsible for the decreased body reserves and reproductive capacity of the bivalves **(Lomovasky *et al*., 2004)**.

Bivalves are known to accumulate pollutants into their body from the surrounding medium either passively or by active absorption.

It is well known that bivalve molluscs are not inert collectors of petroleum but can passively depurate these materials. Of the factors influencing the depuration rate the first factor is that of worse molecular weight and additional aquatic soluble materials are cleared further rapidly. Following, animals temporarily visible to petroleum depurate rapidly at low residual concentrations while chronically exposed animals depurate gradually and have developed remaining levels. The relationship of these features which lead to progressive trends in accumulation is not yet understood properly. **(Shaw *et al*, 1986)**

Polycyclic aromatic hydrocarbons (PAHs) and n-alkanes remain aquatic environment chronic elements and their concentrations have significantly augmented because of anthropogenic actions. This pretentious adverse effects, specifically in seaside zones adjacent to greatly populated city areas. N-Alkanes contain saturated and conservative carbon chains of C6 to C40 which have even and odd carbon amounts that specify anthropogenic and natural sources of hydrocarbon. The United Nation Environmental Program (UNEP) provided rules to categorize the altitudes of harmless (<10 lg/g) and harmful (>10 lg/g) n-alkanes in marine residue.

PAHs view organic combinations that result from the part burning of organic material (pyrolytic), and oil and its derivative (petrogenic) sources. Pyrogenic PAHs are categorized by the occurrence of PAHs that transmit a heavy group of molecular weights, whereas petroleum hydrocarbons are dominated by PAHs of the lowermost molecular weight **(Neff, 1979).** They remain extensively dispersed in the marine environment, mainly in ports, estuaries, shipyards, marinas, and further low seaside zones with anthropogenic contributions **(El Nemr, 2005, 2008 and 2011)**. PAHs have been exposed to remediation studies and hazard valuation, owing to their mutagenic and carcinogenic properties. Consequently, PAHs tend to swiftly be immersed into the elements and fat flesh of filtrating animal's similar mussels and oysters **(Zemanek *et al.*, 1997).** PAHs stay certainly engaged by living organisms Due to their great octanol/water partition coefficient (Kow). PAHs can be absorbed into combinations that are visible in liquids and can be used as biomarkers of the coverage to the PAHs **(Nudi *et al.*, 2010)**. The assessment and contrast heights of PAHs and their activist variations in a marine coastline area are real dynamic from an environmental topic of vision **(El Sikaily *et al.*, 2003; Salem *et al.*, 2014)**.

The object of the current work is to inspect the presence of n-alkanes and PAHs in the collected shellfish from the Mediterranean Sea shore (Egypt) and likewise, to decide the greatest polluted region.

Highest significant content of aliphatic hydrocarbon (48605.87) was in summer at site "2" and the lowest significant content of aliphatic hydrocarbon (4052.33) was in winter at site "1". The highest significant content of aromatic hydrocarbon (4525.56) was in winter at site "3" and the lowest significant content of aromatic hydrocarbon (873.36) was in summer at site "1". Site "2" has the highest concentration of hydrocarbon because of sea currents near the natural gas company, located in site "1".

El Sikaily (2002) assessed the pollution of aliphatics and polycyclic aromatic hydrocarbons by collecting two altered class of bivalves (*Modiolus auriculatus* and *Donax sp*.) in April 2000 in around twenty sites alongside the Mediterranean coastline of Egypt from El-Max to Bardawel (around 500 km). The results exhibited that the absorption of total aliphatics (average 180 ng g-1 wet weight) and PAHs (average 8180 ng g-1 wet weight) was usually worse than that reported from several of the published investigation and observing studies of coastline regions from several areas of the world. PAHs in mussel illustrations from most locations were typically of pyrolytic sources similar grass fires (6 million tons per year) and expend gases from cars, whereas PAHs in other positions (El-Borg, Ras El-Bar, El-Jamil (west), Rommana) were mainly of petrogenic sources. Though, other contamination sources are complicated.

Khairy *et al.* (2009) investigated the pollution of remains and mussels tested from Abu-Qir Bay by polycyclic aromatic hydrocarbons (PAHs). Concentrations of PAHs noted in the bay sediments reached from 2660 g/kg. In overall, concentrations of PAHs in mussels were greater than their conforming sediment concentrations shiny their excessive bioavailability (242–3880 g/kg dw). The maximum concentration was experiential in the western measure of the bay, a position affected by concentrated shipping actions. The distribution arrangement of (PAHs) was comparable for mussels and sediments, mainly for sediments considered by extraordinary pollution level, and they were subjugated by the high molecular weight PAHs (4–6-rings). Smearing various PAHs parts, it was institute that PAHs created predominantly from the pyrogenic source either from the burning of grass, wood and coal (majority of the samples) or from petroleum combustion (harbour area). The output of a Screening Level Ecological Risk Valuation (SLERA) on the bay sediments exposed that adverse ecological effects to benthic organisms are predictable to occur in only one sample, and thus PAHs are not considered as contaminants of worry in Abu-Qir Bay. Moreover contrary health properties are not predictable to happen from the depletion of the examined mussels with deference to PAHs in Abu-Qir Bay.

CONCLUSION

Present study showed slightly higher growth frequency at site "3" than that of site "1" and site "2". Obvious increment observed in spring may be related to the food availability and current. The explanation is that bivalves body composition may change in response to seasonal changes in environmental conditions, especially in the food availability, where abundance of food during summer allow nutrient storage and use of energy for growth of somatic tissue and also for gonadal development. Highest significant content of aliphatic hydrocarbon (48605.87) was in summer at site "2" and the lowest significant content of aliphatic hydrocarbon (4052.33) was in winter at site "1". The highest significant content of aromatic hydrocarbon (4525.56) was in winter at site "3" and the lowest significant content of aromatic hydrocarbon (873.36) was in summer at site "1". Site "2" has the highest concentration of hydrocarbon because of sea currents near the natural gas company, located in site "1".

REFERENCES

A.O.A.C. (2000). Association of Official Analytical Chemists official methods of analysis. Arlington, VA: Author. aepam12.

Abdelwahab, O.; El Nemr, A.; El Sikaily, A. and Khaled, A. (2005). Use of rice husk for adsorption of direct dyes from aqueous solution: a case study of Direct F. Scarlet. Egyptian Journal of Aquatic Research, 31(1): 1-11.

Ali, E.M.; Mohammad, S.H.; Mohamed S.Z. and Aamer, M.A. (2009). Reproductive cycle of Donax trunculus (Mollusca: Bivalvia) in port said, Mediterranean Coast, Egypt. Mansoura J. Biol., 36: 243-259.

Borković, S.S.; Šaponjić, J.S.; Pavlović, S.Z.; Blagojević, D.P.; Milošević, S.M.; Kovačević, T. B. and Saičić, Z. S. (2005). The activity of antioxidant defence enzymes in the mussel Mytilus galloprovincialis from the Adriatic Sea. Comparative Biochemistry and Physiology Part C: Toxicology and Pharmacology, 141(4): 366-374.

Defeo, O. and de Alava, A. (1995). Effects of human activities on long-term trends in sandy beach populations: the wedge clam Donax hanleyanus in Uruguay Mar Ecol. Prog. Ser., 123: 73-82.

Donn, T. E. (1987). Longshore distribution of Donax serra in two log-spiral bays in the eastern Cape, South Africa. Mar. Ecol. Prog. Ser, 35(3): 217-222.

El Ghalban, E. M. A. (2010). Biological studies on commercial clams Donax trunculus in Port Said shores. M. Sc. thesis Marine Department, Faculty of Science, Suez Canal University.

El Nemr, A. (2005). Petroleum contamination in warm and cold marine environments. Nova Publishers.

El Nemr, A. (Ed.). (2011). Impact, monitoring and management of environmental pollution. Nova Science Publishers, Incorporated.

El Nemr, A. H. M. E. D. (2008). Organic hydrocarbons in surface sediments of the Mediterranean coast of Egypt: distribution and sources. Egyptian Journal of Aquatic Research, 34(3): 36-57.

El Nemr, A.; El-Sadaawy, M.M.; Khaled, A.and El-Sikaily, A. (2014). Distribution patterns and risks posed of polycyclic aromatic hydrocarbons contaminated in surface sediment of the Red Sea coast (Egypt). Desalination Water Treat. 52: 7964–7982.

El Nemr, A.; El-Sikaily, A.; Khaled, A. and Ragab, S. (2012). Distribution patterns and risk assessment of hydrocarbons in bivalves from Egyptian Mediterranean coast. Blue Biotechnol. J. 1 (3): 457–472.

El Nemr, A.; El-Sikaily, A.; Khaled, A.; Said, T.O. and Abd-Alla, A.M. A. (2004). Determination of hydrocarbons in mussels from the Egyptian Red Sea coast. Environ. Monit. Assess. 96, 251–261.

El Refaey, S. H. R. (2006). Biological studies on some bivalves (bivalvia: mollusca) inhabiting the Mediterranean Sea coast, north of Egypt (Doctoral dissertation, Ph. D. Thesis, Mansoura University, Faculty of science, Department of zoology).

El Sikaily, A.; Khaled, A.; El Nemr, A.; Said, T.O. and Abd-Alla, A. M. A. (2003). Polycyclic aromatic hydrocarbons and aliphatics in the coral reef skeleton of the Egyptian Red Sea coast. Bulletin of environmental contamination and toxicology, 71(6): 1252-1259.

El Sikaily, A.; Khaled, A.; El Nemr, A.; Said, T. O. and Abd-Allah, A. M. A. (2002). Determination of hydrocarbons in Bivalves from the Egyptian Mediterranean Coast. Mediterranean Marine Science, 3(2). https://doi.org/10.12681/mms.251

El Wakf, A.; Elnaggar, M.; Guirguis, A. and El-Ghany, S. (2021). Seasonal Variations In Biochemical Composition Of The Two Edible Bivalves, Donax Trunculus And Donax Semistriatus.

Frihy, O. E.; Iskander, M. M. and Badr, A. A. (2004). Effects of shoreline and bedrock irregularities on the morphodynamics of the Alexandria coast littoral cell, Egypt, Geo-Mar Lett, 24:195–211.

Gaspar, M.B.; Santos, M.N.; Vasconcelos, P. and Monteiro, C.C. (2002). Shell morphometric relationships of the most common bivalve species (Mollusca: Bivalvia) of the Algarve coast (southern Portugal). Hydrobiol., 477: 73-80.

Guacira, M.G. and Thomé, J.W. (2004). Descrição do ciclo reprodutivo de Donax hanleyanus (Bivalvia, Donacidae) no sul do Brasil. Iheringia, Sér. Zool., Porto Alegre, 94(3): 271-276.

Herrmann, M. (2008). Population dynamics of the Argentinean surf clams Donax hanleyanus and Mesodesma mactroides from open-Atlantic beaches off Argentina .Submitted for the degree Dr. rer. nat. of the Faculty 2 of Biology and Chemistry University of Bremen (Germany).

Herrmann, M.; Alfaya, J.E.F.; Lepore, M.L.; Penchaszadeh, P.E. and Laudien, J. (2009). Reproductive cycle and gonad development of the Northern Argentinean Mesodesma mactroides (Bivalvia: Mesodesmatidae). Helgol Mar Res 63:207– 218.

Kelly, C.A.; Law, R.J. and Emerson, H.S. (2000). Methods for analysis for hydrocarbons and polycyclic aromatic Hydrocarbons (PAHs) in marine samples. https://www.cefas.co.uk/publications/aquatic.

Khairy, M.A.; Kolb, M.; Mostafa, A.R.; EL-Fiky, A. and Bahadir, M. (2009). Risk assessment of polycyclic aromatic hydrocarbons in a Mediterranean semi-enclosed basin affected by human activities (Abu Qir Bay, Egypt). Journal of Hazardous Materials, (1). 170.

Laudien, J.; Brey, T. and Arntz, W. E. (2001). Reproduction and recruitment Pattern of the surf clam Donax serra (Bivalvia, Donacidae) from two Namibian sandy beaches. S. Af. J. mar. Sci., 23: 53-60.

Lomovasky, B.J.; Malanga, G.F. and Calvo, J. (2004). Seasonal changes in biochemical composition of the clam Eurhomalea exalbida (Bivalvia, Veneridae) from Ushuaia Bay (54º 50'S), Beagle Channel (Argentina). National Shellfisheries Association.

Lomovasky, B. J.; Morriconi, E.; Brey, T. and Calvo, J. (2004). Individual age and connective tissue lipofuscin in the hard clam Eurhomalea exalbida. J. Exp. Mar. Biol. Ecol., 276: 83-94.

Manatrinon, S.; Thonglor, O.U. and Boonyapakdee, A. (2011). Morphological Variation of Donax spp. from Five Beaches in Prachaupkhirikhan, Thailand. J. Agri. Sci. Technol., 1(A). 1109-1111.

Manduzio, H.; Monsinjon, T.; Galap, C.; Leboulenger, F. and Rocher, B. (2004). Seasonal variations in antioxidant defences in blue mussels Mytilus edulis collected from a polluted area: major contributions in gills of an inducible isoform of Cu/Zn-superoxide dismutase and of glutathione S-transferase. Aquatic Toxicology, 70(1): 83-93.

Marcano, J. S.; Prieto, A.; Lárez, A. and Salazar, H. (2003). Crecimiento de Donax denticulatus (Linné 1758) (Bivalvía: Donacidae) en la ensenada La Guardia, isla de Margarita, Venezuela. Zootec. Trop., 21(3): 237-259.

Mohammad, S. H. (2002). Ecological and biological studies on the bivalves Cerastoderma glaucum and Papyridea papyracea, in Lake Timsah "Suez Canal", Ph.D. thesis, Fac. Sci. Zool. Depart. Suez Canal Univ.

Mohammad, S. H. (2008). Vertical zonation and biometric parameter of the gastropod Cerithium scabridum in Suez Canal. Res. J. Environ. Sci., 2 (2):100-107.

Neff, J. M. (1980). Polycyclic aromatic hydrocarbons in the aquatic environment. Biol. Conserv.;(United Kingdom), 18(1).

Neuberger-Cywiak, L.; Achituv, Y. and Mizrahi, L. (1990). The ecology of Donax trunculus Linneus and Donax semistriatus Poli from the Mediterranean coast of Israel. J. Exp. Mar. Biol. Ecol., 134:203-220.

Nudi, A.H.; de LR Wagener, A.; Francioni, E.; Sette, C.B.; Sartori, A.V. and Scofield, A. D. L. (2010). Biomarkers of PAHs exposure in crabs Ucides cordatus: Laboratory assay and field study. Environmental Research, 110(2): 137-145.

Orban, E.; Di Lena, G.; Nevigato, T.; Casini, I.; Caproni, R.; Santaroni, G. and Giulini, G. (2006). Nutritional and commercial quality of the striped venus clam, Chamelea gallina, from the Adriatic sea. Food Chemistry, 101:1063–1070.

Periyasamy, N.; Murugan, S. and Bharadhirajan, P. (2014). Biochemical composition of marine bivalve Donax incarnatus (Gmelin, 1791) from Cuddalore Southeast coast of India. International Journal of advances in pharmacy, biology and chemistry, 3(3): 575-582.

Ramesh, R. and Ravichandran, S. (2008). A statistical approach on the length-weight relationship and allometry of Turbo brunneus. Rese. J. Environ. Sci., 2(2): 124-131.

Ramón, M.; Abelló, P. and Richardson, C. A. (1995). Population structure and growth of Donax trunculus (Bivalvia: Donacidae) in the western Mediterranean. Marine Biology 121: 665-671.

Salem, D.M.; Morsy, F.A.; El Nemr, A.; El-Sikaily, A. and Khaled, A. (2014). The monitoring and risk assessment of aliphatic and aromatic hydrocarbons in sediments of the Red Sea, Egypt. The Egyptian Journal of Aquatic Research, 40(4): 333-348.

Shaw, D.G.; Hogan, T.E. and McIntosh, D. J. (1986). Hydrocarbons in bivalve mollusks of Port Valdez, Alaska: Consequences of five years' permitted discharge. Estuarine, Coastal and Shelf Science, 23(6): 863-872.

Tirado, C. and Salas, C. (1999). Reproduction of Donax venustus Poli 1795, Donax semistriatus Poli 1795 and intermediate morphotypes (Bivalvia: Donacidae) in the littoral of Málaga (Southern Spain). Marine Ecology, 20(2): 111-130.

Urrutia, M.B.; Ibarrola, I.; Iglesias, J.I.P. and Navarro, E. (1999). Energetics of growth and reproduction in a high-tidal population of the clam Ruditapes decussatus from Urdaibai Estuary (Basque Country, N. Spain) J. Sea Res., 42:35-48.

Zeichen, M.M.; Agnesi, S.; Mariani, A.; Maccaroni, A. and Ardizzone, G.D. (2002). Biology and population dynamics of Donax trunculus L.(Bivalvia: Donacidae) in the South Adriatic coast (Italy). Estuarine, Coastal and Shelf Science, 54(6): 971-982.

Zemanek, M.G.; Pollard, S.J.; Kenefick, S.L. and Hrudey, S. E. (1997). Multi-phase partitioning and co-solvent effects for polynuclear aromatic hydrocarbons (PAH) in authentic petroleum-and creosote-contaminated soils. Environmental Pollution, 98(2): 239-252.