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The Role of Alien Polychaetes along the Alexandria Coast, Egypt

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ABSTRACT: The alien polychaetes are widely distributed in the whole Mediterranean Sea as well as in the Egyptian waters. The objective of this study is to highlight the distribution and abundance of the alien polychaetes along the Alexandria coast, their contribution to the total polychaete community and the changes they caused in the community structure. Through monthly sampling polychaetes were collected at four sites of different ecological characteristics During June 2005 - May 2006 from hard substrates at 0.5-1m depth and from soft bottom of the intertidal zone. Ten alien species were recorded from the study area, five of them (*Linopherus canariensis* Langerhans, 1881, *Loimia medusa* Savigny in Lamarck 1818, *Syllis schulzi* Hartmann-Schröder 1960, *Phyllodoce longifrons* Ben-Eliahu 1972 and *Leodice antennata* Savigny in Lamarck, 1818) were found for the first time in the Egyptian waters. Six species were widely distributed in the study area demonstrating considerable different count on both the spatial and temporal scales, with total count fluctuating between 10 - 18810 ind/m^2 (individual/m^2), constituting 14.3% - 45.5% of the total polychaetes and peaks occurring in different times at the sampling sites. *Syllis schulzi* and *Pseudoneries anomala* were the major components, accounting for 53.4 and 41.5% of the alien polychaetes, and of pronouncedly less contribution was *Linopherus canariensis* (3.8%), in addition to occasional active contribution of *Hydroides elegans* and *Loimia medusa*, which displayed at times up to 22% and 19% respectively at some sampling sites.

Key words: Mediterranean taxa, exotic species, invasive polychaetes, *Pseudonereis anomala, Syllis schulzi*

INTRODUCTION

The intrusion of alien polychaetes to the Mediterranean Sea through the Suez Canal and/or through other vectors like ballast waters and ships' hulls have been documented firstly by Fauvel (1927) and later on by several authors (e.g. Cinar *et al.*, 2006, 2008; Musco *et al.*, 2009; Zenetos *et al.*, 2010, 2011, 2012; Martýn & Gil, 2010; Faulwetter, 2010; Coll *et al.*, 2010; Cigliano *et al.*, 2010; Occhipinti-Ambrogi *et al.*, 2011; Cinar & Daglý, 2012; Nunes *et al.*, 2014). The alien polychaetes in the Egyptian Mediterranean waters have drawn the attention of several authors (Selim, 1996, 1997a,b, 2009; Abd-Elnaby, 2005, 2009a, 2009 b; Selim *et al.*, 2006a, 2006b; Abd-Elnaby & San Martin, 2010, 2011; Dorgham *et al.*, 2013, 2014). The majority of these studies considered the geographical distribution of the alien polychaetes in the Mediterranean, but they drive little attention to their abundance cycle and distribution, particularly in the Egyptian Mediterranean waters. The present study focuses on the monthly count of the alien polychaetes and their temporal and spatial distribution along the Alexandria coast throughout a complete year.

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MATERIALS & METHODS

Polychaete samples were collected monthly from June 2005 to May 2006 at four distant from each other sites along about 35 km of the Alexandria coast on the southeastern Mediterranean, representing different ecological entities, namely Abu Qir (AQ), El-Mandara (MN), Stanly (ST) and El-Mex (MX) (Fig. 1).

Abu Qir lies at 31°20'N - 30°04'E east of Alexandria City with sandy bottom, including large natural exposed rocky area covered with rich algal flora and is found under the effect of continuous wave action. El Mandara lies at 31°16'N - 29°59'E, west to AQ with a sandy bottom and patches of calcareous shell fragments. This site is protected by rows of concrete blocks extending about 100 m inside the sea and covered by different species of macro-algae. Stanly lying at 31°14'N - 29°56'E is a semi-circular embayment west to MN with sandy bottom surrounded by cement wall covered with macro-algal mats. El Mex found at 31°09'N - 29°50'E west to the Alexandria City and composed of exposed rocky area covered by macro-algae and surrounded by a beach of hard debris of different benthic animals and receives directly polluted

Fig. 1. The sampling sites along the Alexandria coast

Table 1. The frequency (in months) of the alien polychaetes at the sampling sites on the Alexandria coast. (AQ-Abu Qir, MN-El Mandara, ST- Stanly, MX- El Mex).

Species	AQ	MN	ST	MX
Eurythoe complanata (Pallas, 1766)	0	1	0	0
Hydroides dianthus (Verrill, 1873)	0	2	1	1
Hydroides elegans (Haswell, 1883)	0	2	4	8
Leodice antennata Savigny in Lamarck, 1818	1	0	0	0
Linopherus canariensis Langerhans, 1881	5	11	5	2
Loimia medusa (Savigny in Lamarck, 1818)	10	10	9	2
Phyllodoce cf. *longifrons* Ben-Eliahu, 1972	0	1	0	0
Pseudonereis anomala Gravier, 1900	12	11	9	12
Spirobranchus tetraceros (Schmarda, 1861)	0	0	1	0
Syllis schulzi	11	11	11	12

waters of industrial, agricultural and domestic origins from adjacent drain.

Benthic invertebrates including Polychaetes were collected from the hard bottom in three random replicates at each site from the shallow subtidal zone within the depth range of 0.5 – 1 m by careful scraping of the biota inside 0.1 m² quadrate. The benthic organisms were placed in plastic bags, preserved in 7% neutralized formalin, and polychaetes were isolated in the laboratory in plastic jars.

From the soft bottom polychaetes were collected through three random cores of 20 cm length and 38.485 cm² surface area at the same sites mentioned above, and the sediment samples were placed in plastic bags and preserved in 7% formalin solution. Both hard and soft bottom samples were gently rinsed with large quantities of filtered sea water on a piece of zooplankton net (100 ì mesh) and the polychaetes were separated and kept in plastic jars. The worms were examined under stereo- and compound microscopes, identified according to several references, counted and the total count was expressed as ind/m^2.

RESULTS & DISCUSSION

A total of 10 alien polychaete species were recorded from the Alexandria coast, displaying different distributional patterns as regard to their count and frequency. Four species were found throughout the study area with variable frequency over the year, two species occurred at three sites and four species appeared once at one site only (Table 1). The alien species demonstrated active contribution to the total polychaetes throughout the whole study area, with greater contribution at AQ and MN than at ST and MX (Fig. 2), forming 51.4 – 100% during seven months at AQ, 35.5% - 50.7% during five months at MX, 53 - 85% in autumn and early winter at MN, against 22.1% – 32.9% at ST in autumn only (Fig. 3). The monthly average count of the abundant alien species at the sampling sites is illustrated in table 2, with pronouncedly greater annual mean of total alien

Table 2. Monthly average count (ind/m^2) of the alien polychaetes at the sampling sites on the Alexandria coast. (*Leodice miurai, Phyllodoce cf. longifrons, Spirobranchus tetraceros and Eurythoe coplanata* were recorded once only in a few specimens) (AQ- Abu Qir, MN-El Mandara, ST- Stanly, MX- El Mex).

Species		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Hydroides	AQ	0	0	0	0	0	0	0	0	0	0	0	0
dianthus	MN	0	0	0	0	0	0	0	0	20	0	0	40
	ST	0	0	0	0	0	0	0	0	0	0	0	10
	MX	0	0	0	0	0	0	0	0	0	0	0	3
Hydroides	AQ	0	0	0	0	0	0	0	0	0	0	0	0
elegans	MN	0	0	0	3.3	0	0	0	57	0	0	0	0
	ST	0	0	73	3	0	7	7	0	0	0	0	0
	MX	0	37	67	70	47	7	3	87	0	0	7	0
Linopherus	AQ	0	0	3	10	0	0	10	0	0	0	3	200
canariensis	MN	3	253	47	77	60	540	900	380	103	0	103	557
	ST	0	3	0	0	0	3	0	7	0	0	7	10
	MX	0	0	0	0	0	0	0	0	0	0	3	3
Loimia medusa	AQ	7	0	13	20	30	3	3	13	3	0	10	13
	MN	10	13	0	40	3	0	7	3	20	3	60	33
	ST	0	10	113	3	3	40	3	7	13	0	0	17
	MX	0	0	0	0	0	0	0	0	0	0	7	3
Pseudonereis	AQ	907	630	107	460	327	400	130	403	197	3	267	690
anomala	MN	63	207	307	1957	4270	7163	5990	2373	2210	0	293	2603
	ST	0	7	107	337	657	373	227	33	20	0	0	147
	MX	180	120	47	280	473	383	170	267	153	30	150	33
Syllis	AQ	120	223	460	1067	500	580	400	787	103	0	343	550
schulzi	MN	50	2127	3420	2970	6250	5263	8350	1473	450	0	297	307
	ST	0	73	1357	1643	1547	620	673	163	37	20	23	113
	MX	33	10	283	253	467	793	800	1100	103	187	70	20

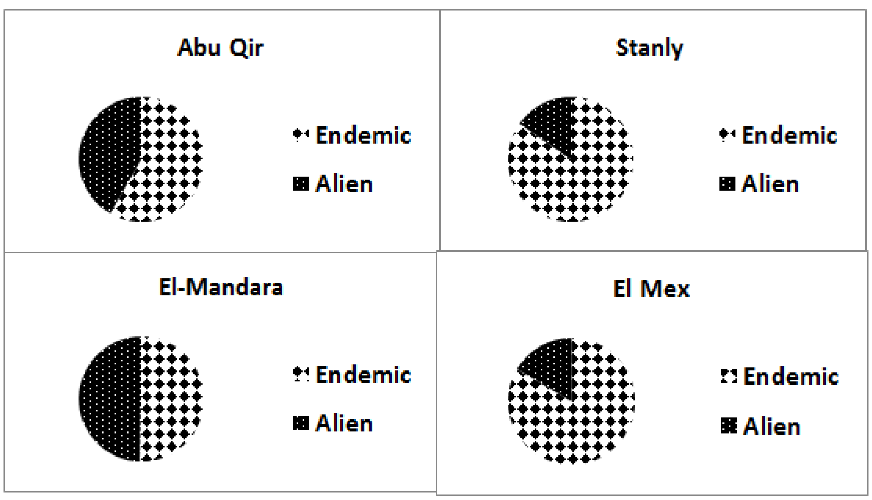

Fig. 2. Contribution of the alien and endemic species to the total polychaetes at the sampling sites

polychaetes (5144.7 ± 5053.3 ind/m^2) at MN than the other sites: 833.3± 454.6 ind/m^2 at AQ, 710 ± 828.8 ind/m^2 at ST and 563.3 ± 469.2 ind/m^2 at MX. On the temporal scale, the high count was recorded during late autumn and early winter at MN, in autumn at both AQ and ST and in November and January at MX (Fig. 4). *Syllis schulzi* was the most dominant alien species over the whole study area, followed by *Pseudoneries anomala*, displaying variable contributions at the sampling sites (Fig. 5), whereas *S. schulzi* formed 51.3, 50.1, 73.6 and 61.1% of the total alien polychaetes at AQ, MN, ST and MX respectively, against 45.2, 44.4, 22.4 and 33.8% for *P. anomala* at the four sites respectively. *Syllis schulzi* displayed high count from September to January with distinct peak in December at MN, small peaks in September and January at AQ,

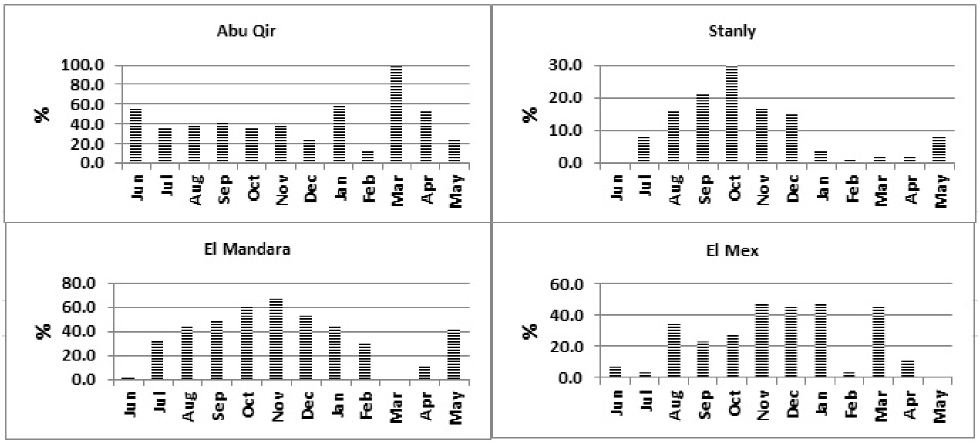

Fig. 3. Monthly contribution of the alien species to the total polychaetes at the sampling sites

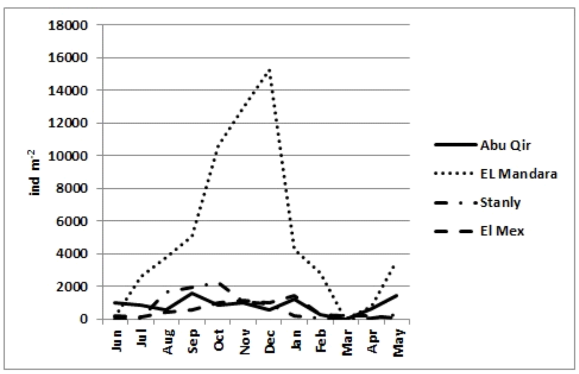

Fig. 4. Monthly abundance of total alien polychaetes at the sampling sites

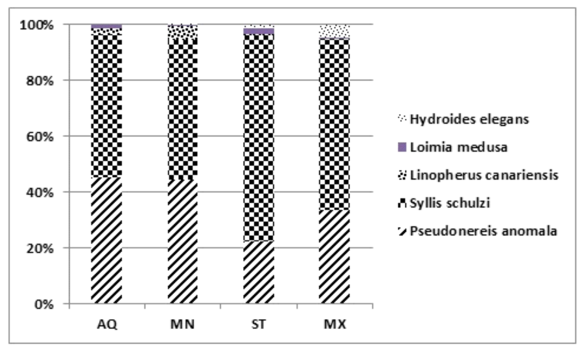

Fig. 5. Contribution of the dominant species to the total alien polychaetes at the sampling sites (AQ: Abu Qir, MN: El Mandara, ST: Stanly, MX: El Mex)

high count during August – October at ST and high count during November – January at MX (Fig. 6). For *P. anomala* the highest count was recorded from October to December at MN, during May -July at AQ, in October at ST and during October – November at MX (Fig. 7).

Other species showed flash appearance, *Linopherus canariensis* appeared in high count all the year round (47 - 900 ind/m^2), particularly at MN, but it was less frequent at AQ with a maximum of 200 ind/m^2 in May and rarely found (3 - 10 ind/m^2) at ST and MX, constituting 2.3 and 4.9% of the total alien polychaetes at AQ and MN respectively (Fig. 5). *Loimia medusa* persisted at three sites, attaining the highest average count (113 ind/m^2) at ST in August, 60 ind/m^2 at MN in April, 30 ind/m^2 at AQ in October and occasionally found (up to 7 ind/m^2) at El Mex. In contrast, *Hydroides elegans* occurred at El Mex from June to January and in August, attaining a maximum of 87 ind/m^2 in January, less frequent at ST (maximum: 73 ind/m^2 in August), occasional at MN (maximum: 57 ind/m^2 in January) and completely missed at AQ. *Hydroides dianthus* was recorded twice at MN (maximum: 40 ind/m^2) and once only at ST and MX in few specimens, while *Eurythoe complanata* and *Phyllodoce cf. longifrons* occurred once at MN only represented by three specimens each, *Leodice antennata* at AQ and *Spirobranchus tetraceros* at ST, with three worms for each.

The polychaete community along the Alexandria coast comprised 73 species, including 63 autochthonous species dominated by *Spirobranchus triqueter*, *Syllis pulvinata*, *S. hyalina*, *Nianereis laevigata* and *Cirratulus cirratus* (Dorgham *et al.*, 2014). Regardless of the low number of the alien polychaetes in the study area some of them have adapted to the environmental conditions on the Alexandria coast and became established species, encountering for great bulk of the total polychaete count and displaying pronouncedly variable patterns of temporal and spatial distribution. The highest count of alien polychaetes during the present study was recorded at MN which was characterised by the

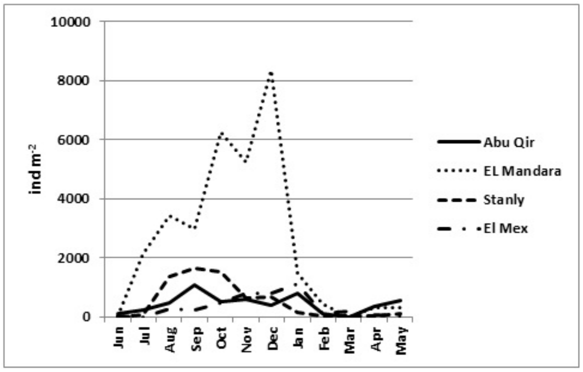

Fig. 6. Monthly abundance of *Syllis schulzi* at the sampling sites

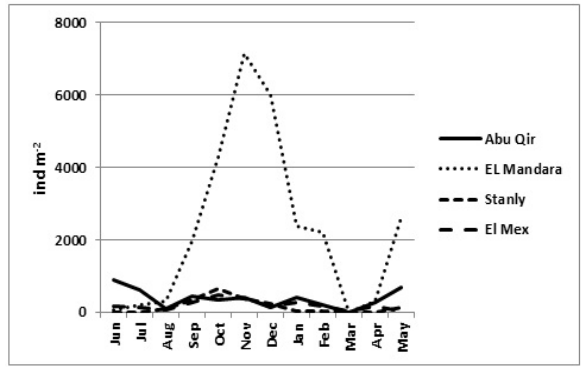

Fig. 7. Monthly abundance of *Pseudonereis anomala* at the sampling sites

abundance of the brown alga *Colpomenia sinuosa*. This alga is considered as indicator of sheltered area (Fletcher, 1987), and consequently provides suitable habitat for abundant polychaetes (Dorgham *et al*., 2014). Despite the spatial differences that are usually observed for shallow water polychaetes (e.g. Giangrande *et al*., 2003; Musco, 2012), human activities must be considered in such context (Musco *et al*., 2009; Del-Pilar-Ruso *et al*., 2014), whereas at the stressed site (MX) on the Alexandria coast the total polychaetes as well as the alien species sustained mostly the lowest count, except *H. elegans* which attained the highest count at this site reflecting its tolerance to the unfavourable environmental conditions.

This species was referred to as opportunistic species (Simboura & Zenetos, 2002) and a problem fouling organism in warm water marine harbors around the world, often the first significant animal biofouler on newly submerged surfaces and its calcareous tubes can accumulate rapidly and create serious problems for ships (Nedved & Hadfield, 2009). It was considered to be an alien species in different parts of the Mediterranean Sea that travelled on ship hulls (Zibrowius, 1992; Koçak *et al*. 1999; Cinar, 2006; Cosentino *et al*., 2009**),** in the Egyptian waters **(**Selim, 1996, 1997a,b; Abdel Naby 2005, 2009a) and from the Suez Canal (Selim, 2009 & Abdel Naby, 2009b; Ben-Eliahu & Ten Hove, 2011). Each of the alien species displayed its own pattern of distribution in the study area relative to its abundance. *Pseudoneries anomala* is one of the widely distributed alien polychaetes in the Mediterranean and has become an important invasive component of shallow-water benthic communities of the eastern Mediterranean (Cinar & Altun, 2007) displaying greatly variable count (Table 3). The high abundance of this species along the Alexandria coast (up to 9390 ind/m^2 at MN) confirm its invasive behavior and support the findings of the last authors, and its occurrence in undisturbed as well as in polluted habitats (Cinar & Ergen, 2005; Kambouroglou & Nicolaidou, 2006; present study) may regarded this species as an ecological generalist (Ben-Eliahu, 1991) and it has a wide ecological valance that enables it to gradually extend its distributional range from the eastern to the western Mediterranean (Cinar & Altun, 2007). On the other hand, the structure of the benthic algal community may affect the abundance of P. anomala, whereas the thallus structure and availability of nourishment on the host plant were reported to be major factors affecting species diversity and density (Fishelson and Haran, 1986/87; Cinar, 2003). *P. anomala* showed a preference for C*orallina elongata* on which it may feed (Kambouroglou & Nicolaidou 2006), the brown alga *Padina pavonica* contained only a few worms, and the more structurally complex brown alga, Cystoseira sp., seem to have more complex structures for species settlement than others like Jania rubens, Ulva sp., and *P. pavonica* (Cinar and Altun, 2007). Although *Corallina* and *Jania* were the dominant macro algae at all the sampling sites it seems that the algal cover had no clear effect on the pronounced spatial differences in the abundance of P. anomala, as the highest count of the worm occurred at MN, which was characterized by poor algal cover as compared to its low count at the site rich in algae (AQ).

Syllis schulzi is little known in the Mediterranean or worldwide , recorded earlier in the Suez Canal (Ben-Eliahu, 1972), Red Sea-Egypt (Wehe & Fiege, 2002), in Chafarinas lslands, Alborán Sea, W Mediterranean (López *et al*., 1996), listed among the alien in Italy waters (Zenetos *et al*., 2010) and was newly recorded in the Egyptian Mediterranean waters (Dorgham *et al*., 2013). In our observations, *S. schulzi* could establish healthy population along the Alexandria coast and demonstrated variable abundance on the spatial and temporal scales, in accordance with the variability of the environmental conditions at the sampling sites. This species showed different patterns of abundance

Table 3. Maximum count of *Pseudonereis anomala* at different areas of the Mediterranean Sea

Area	Indiv/m^2	Reference
Mediterranean coast of Israel	47	Ben-Eliahu, 1989
Izmir Bay, Turkey	100	Cinar and Ergen (1995)
Antalya, Levant coast of Turkey	17	Cinar and Ergen, 2005
Saronikos Bay, Aegean Sea	382.5	Kambouroglou and Nicolaidu, 2006
Iskenderun Bay, Turkey	2475	Cinar and Altun, 2007
Alexandria Coast	9390	Present study

distribution among the sampling sites, with the highest count at MN, and pronouncedly less so at ST, followed by AQ and then MX, where it attained a maximum of 1750 ind/m^2 in January. The abundant occurrence of *S. schulzi* in undisturbed (AQ, ST& MN) and in polluted habitats (MX) during the present study indicates its adaptability to wide ecological differences and it could be considered as ecological generalist. On the other hand, the algal cover play no clear effect on the abundance of this in the study area, whereas its highest count occurred at MN with pronouncedly poor algal cover and the low count was associated with the dense algal cover at AQ.

Generally, spatial variation of polychaetes along the Alexandria coast was more significant than temporal variation on shallow hard substrates, suggesting that spatial variation of hard bottom polychaete assemblages might depend on the scale of observation, being high at small spatial scales but lower at the scale of kilometres (Musco, 2012). Algal coverage is well known structuring factor enhancing small scale habitat variation (Giangrande, 1988), and *J. rubens* coverage on the Alexandria coast ranked first among the predictor variables of hard bottom assemblage distribution and it might represent a suitable habitat for polychaetes, but other algae with less complex thalli (i.e. *Enteromorpha* sp., *Petalonia* sp., *U. rigida*, *C. sinuosa*) contributed significantly to explaining the variation of Alexandria hard bottom polychaete assemblages (Dorgham *et al*., 2014).

Linopherus canariensis and *Loimia medusa* seem to prefer the more sheltered conditions at MN, attaining higher count than the exposed sites (AQ) and stressed one (MX). *Linopherus canariensis* is a species not too much known all over the world (Núñez *et al*., 1991**),** and it was found to be a new potential invader of stressed environments that is probably tied to the import of oysters in the Lake of Faro, NE Sicily (Cosentino *et al*., 2009) with an average density of 41.86 ind L^{-1} in the sandy bottom assemblage and 205.29 ind L^{-1} in the artificial substratum (Cosentino & Giacobbe, 2011). During the present study *L. canariensis* recorded the highest count (up to 900 ind/m^2) at El Mandara, which characterized by the highest amount of organic matter (annual average: 5.1%) and the highest organic carbon (annual average: 2.8%) and showed flash appearance (200 ind/m^2) at AQ in May at 7.07% and 3.93% for the two components respectively. This species was found as new record to the eastern coast of Turkey, Levantine Sea, Eastern Mediterranean (Cinar, 2009).

Loimia medusa is a common species at summer hypoxia in estuarine habitats, but subtle changes in oxygen concentrations may be important in the control of its populations in habitats affected by low oxygen disturbances (Llanso & Diaz, 1994). Although no hypoxia was observed at the stressed site (MX) *L. medusa* was missed over the year except a few specimens in April and May, while it was persistent at the other sites mostly in low counts at oxygen level of 6 – 10.7 mg/l, with a maximum of 113 ind/m^2 in August at ST at a temperature of 29.5 ^{o}C, salinity of 36.2%o and DO of 7.4 mg/l, in addition to high count (60 ind.m^2) at MN in April at 22 ^{o}C, 38 %o and 7.1 mg/l. This agrees with Seitz & Schaffner (1995) who observed the maximum count of *L. medusa* (60 ind m^2) in a shallow sand habitat of the York River, Chesapeake Bay, Virginia, in August and September, but lower count (20 ind m^2) was found in Kuwaiti waters, the ROPME Sea Area, at temperature of 16.9 ^{o}C and 40.5 %o (Al-Yamani *et al*., 2009).

Despite of being native at the east coast of North America, Europe and western Africa and is widely distributed in a variety of 'natural' habitats including open coasts as well as in partly brackish waters of bays, lagoons, and/or ports (Link *et al*., 2008) *H. dianthus* has been recorded as alien species in the faro coastal lake (Cosentino *et al*., 2009), on the Alexandria coast (Selim, 1997b; Abdel Naby, 2005; Hamdy, 2008) and in the Suez Canal (Selim 1997a, 2009; Ben-Eliahu & Ten Hove, 2011). This species was found twice a year at MN (20 & 40 ind m^2) and once at ST and MX (10 & 3.3 ind m^2 respectively), indicating its inability to adapt to the surrounding conditions. This species has been found at different salinities, ranging from 20–30 psu (Hill, 1967), 25‰ – 35 psu (Leone, 1970), 28–50 psu (Zibrowis, 1971), not more than 30 psu (Otani and Yamanishi, 2010) and 20.8 - 38.2 psu (Present study). However, the highest count of *H. dianthus* on the Alexandria coast was found inside relatively poor algal cover on the concrete blocks at MN and the complete absence of this worm occurred in the dense algal growth on the exposed natural rocky patches at AQ. This supports the findings of Otani and Yamanishi (2010), who stated that water temperature, salinity and dissolved oxygen at Akashi and Tannowa, Japan, did not have any significant correlation with the density of *H. dianthus* but macroalgae are likely to be the limiting factor for its distribution, because they may form a barrier for the settlement of the larvae of this worm through inhibition of water-borne movement or whiplash action (Russell *et al*., 2008) or due to the competition for substrata between the macroalgae and the worm (Otani and Yamanishi, 2010).

Phyllodoce longifrons was firstly described in the Suez Canal (Ben-Eliahu, 1972) appeared later as new record to the Mediterranean coast of Israel (Ben-Eliahu, 1976), and then for the first time from the Egyptian Mediterranean Coast off Alexandria (Dorgham *et al.*, 2013) and recently it formed relatively dense populations along the southern coast of Turkey, and was classified as an established Lessepsian migrant (Çinar & Dagli, 2012). No more information is known about the abundance and distribution of this species and its rare occurrence along the Alexandria coast reflects its inability to adapt to the environmental conditions.

Eurythoe complanata was recorded from Alexandria Coast for the first time by Fauvel (1937) and have never been observed later until the record of Dorgham *et al*. (2013), indicating that this species could not adapt to the Alexandria coast, may be due to the effect of the long term sewage discharge to the coast during the second half of the last century, but was recently transferred to the area by ballast waters or ship hulls, and was not observed elsewhere in the Egyptian waters. Although *Spirobranchus tetraceros* was found in the Suez Canal (Abdel Naby, 2009b; Selim 2009; Ben-Eliahu & Ten Hove, 2011), in Alexandria (Selim 1997a,b; Abdel Naby 2005; Hamdy, 2008) and in Abu Kir Bay, Egypt (Selim *et al.*, 2005) it sustained mostly low count and could not establish healthy population.

Although a total of 130 alien polychaete species were found in the Mediterranean Sea including 43 species in the Egyptian Coast (Dorgham *et al.*, 2013), 10 species only were recorded along the Alexandria coast, which lies about 250 km west to the Suez Canal, the passage of the Indo-Pacific species to the Mediterranean Sea. This indicates from one hand that not all the Red Sea immigrants to the Mediterranean Sea can reach the Alexandria coast due to the inhibiting effect of the eastward current prevailing on the Egyptian Mediterranean Coast and from the other hand that the alien polychaetes in the Mediterranean are not totally of Indo-Pacific origin and number of them were introduced from other areas rather than the Red sea through other vectors like ballast waters or ship hulls. Such statement is clearly supported by the world geographical distribution of the alien species on the Alexandria coast given by Zenetos *et al*. (2010) which illustrated that *L. antennata, P. anomala, S. schulzi, P. longifrons* and *E. complanata* are Indo-Pacific, *H. dianthus* and *L. canariensis* are Atlantic, *H. elegans* and *S. tetraceros* are circumtropical and *L. medusa* is cosmopolitan. It is worth to mention that, introduction of the alien species into the Alexandria coast not only affected the species diversity but also caused changes in the pattern of species dominance, whereas *S. schulzi* caused the disappearance of *Syllis prolifera* and *S. variegate* which were recorded previously among the dominant species in the study area (Hamdy, 2008). In contrast, the Red Sea migrant, *Spirobranchus tetraceros*, which was predominant along the Alexandria coast during 1999-2001 (Abd El-Naby, 2005) has been substituted by the Mediterranean cosmopolitan *Spirobrancus triqueter* during the present study. Furthermore, the high abundance of *P. anomala* (3.2 – 20.2% of the total polychaetes) along the Alexandria coast compared to the Nereididae species, *Perinereis cultifera* (0.0- 1.6%) supports Ben-Eliahu (1991) who stated that *P. anomala* is supposed to exclude *Perinereis cultifera* from Mediterranean habitats.

CONCLUSIONS

The present study revealed that the alien polychaetes are the main component of the total polychaetes along the Alexandria coast, forming at times up to 33 – 84.6% at the sampling sites. They showed pronounced different abundance and distribution patterns throughout the study area and two species only were persistent and responsible for the bulk of their abundance (*Syllis schulzi* and *Pseudonereis anomala*). Other species were less frequent either with temporal abundance or rarely occurrence. The entrance of alien polychaetes caused the replacement of some dominant endemic species.

REFERENCES

Abd-El-Naby, F. A. (2005). Systematic and environmental studies on polychaetes from Alexandria marine waters. Ph. D. Thesis, Faculty of Science, Alex. Univ., 330 pp.

Abd-Elnaby, F.A. (2009a). New records of Polychaetes from the South Part of Suez Canal, Egypt. World J. Fish Mar. Sci., **1 (1)**, 7–19.

Abd-Elnaby, F.A. (2009b). Polychaete study in Northeastern Mediterranean Coast of Egypt. World J. Fish Mar. Sci., **1 (2)**, 85–93.

Abd-Elnaby, F.A. and San Martin, G. (2010). Eusyllinae, Anoplosyllinae, and Exogoninae (Polychaeta: Syllidae) for the Mediterranean Coasts of Egypt,together with the description of one new species. Life Sci. J., **7 (4),** 131–139.

Abd-Elnaby, F.A. and San Martin, G. (2011). Syllinae (Syllidae: Polychaeta) from the Mediterranean coast of Egypt with the description of two new species. Med. Mar. Sci., **12 (1)**, 43–52.

Al-Yamani, F., Boltachova, N., Revkov, N., Makarov, M., Grintsov, V., Kolesnikova, E. and Galyna-Vantsetti, M. (2009). Winter species composition, diversity and abundance of macrozoobenthos in Kuwait's waters, Arabian Gulf. Zoo Keys, **31**, 17–38.

Ben-Eliahu, M. N. (1972). Polychaeta Erantia of the Suez Canal, Isr. J. Zool., **24**, 54-70.

Ben-Eliahu, M. N. (1976). Errant Polychaete cryptofauna (excluding Syllidae and Nereidae) from rims of similar intertidal vermetid reefs on the Mediterranean Coast of Israel and in the Gulf of Elat. Israel Journal of Zoology, **25 (4),** 156 – 177.

Ben-Eliahu, M.N. (1989). Lessepsian migration in Nereididae (Annelida: Polychaeta). Some case histories. p. 125-134. In: Spainer, E. et al. (Eds). Environmental quality and ecosystem stability, vol. IV-B. ISEEQS Publish-ers, Jerusalem.

Ben-Eliahu, M.N. (1991). Nereididae of the Suez Canal-Potential lessepsian migrants? Bull. Mar. Sci. **48**, 318-329.

Ben-Eliahu, M.N. and ten Hove, H.A. (2011). Serpulidae (Annelida: Polychaeta) from the Suez Canal-From a Lessepsian Migration Perspective (a Monograph). Zootaxa, **2848,** 1-147.

Cigliano, M., Gambi, M.C., Rodolfo-Metalpa, R., Patti, F.P. and Hall-Spencer, J.M. (2010). Eûects of ocean acidiûcation on invertebrate settlement at volcanic vents. Mar. Biol., **157 (11)**, 2489–2502.

Çýnar, M.E. (2006). Serpulid species (Polychaeta: Serpulidae) from the Levantine coast of Turkey (eastern Mediterranean), with special emphasis on alien species. Aquatic Invasions, **1 (4),** 223-240.

Çýnar, M.E. (2009) Alien polychaete species (Annelida: Polychaeta) on the southern coast of Turkey (Levantine Sea, eastern Mediterranean), with 13 new records to the Mediterranean Sea. Journal of Natural History, **43 (37-38),** 2283-2328.

Çinar, M.E. and Altun, C.A. (2007). A preliminary study on population char-acteristics of the Lessepsian species, Pseudonereis anomala (Polychaeta: Nereididae), in Iskenderun Bay (Levantine Sea, eastern Mediter-ranean). Turkish Journal of Zoology, **31,** 403-410.

Çýnar, M.E. and Daglý, E. (2012). New records of alien polychaete species for the coasts of Turkey. Med. Mar. Sci., **13(1)**, 103–107.

Çinar, M.E. and Ergen, Z. (1995). Lessepsian migrants expanding their distributional ranges; Pseudonereis anomala (Polychaeta: Nereididae) in Izmir Bay (Aegean Sea). J. Mar. Biol. Ass. U.K. **85**, 313-321.

Çinar, M.E. and Ergen, Z. (2005). Lessepsian migrants expanding their distributional ranges; Pseudonereis anomala (Polychaeta: Nereididae) in Izmir Bay (Aegean Sea). Journal of the Marine Biological Associations of the U.K., **85**, 313-321.

Çýnar, M. E., Katagan, T., Öztürk, B., Egemen, Ö., Ergen, Z., Kocatas, A., Önen, M., Kirkim, F., Bakir, K., Kurt, G., Dagli, E., Kaymakçi, A., Açik, S., Dogan, A. and Özcan, T. (2006). Temporal changes of soft bottom zoobenthic communities - in and around Alsancak Harbor (Izmir Bay, Aegean Sea), with special attention to the autoecology of exotic species, *Marine Ecology*, **27**, 229- 246.

Çýnar, M. E., Katagan, T., Kocak, F. Öztürk, B., Ergen, Z., Kocatas, A., Önen, M., Kirkim, F., Bakir, K., Kurt, G., Dagli, E., Açik, S., Dogan, A. and Özcan, T. (2008). Faunal assemblages of the mussel ***Mytilus galloprovincialis*** in and around Alsancak Harbour (Izmir Bay, eastern Mediterranean) with special emphasis on alien species, Journal of Marine System, 71, 1 – 17.

Coll, M., Pirrodi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., Aguzzi, J., Ballesteros, E., Bianchi, C. N., Corbera, J., Dailianis, T., Danovaro, R., Estrada, M., Froglia, C., Galil, B.S., Gaso, J. M., Gertwagen, R., Gil, J., Guilhaumon, F., Kesner-Reyes, K., Kitsos, M., Koukouras, A., Lampadariou, N., Laxamana, E., Lopez-F´e de la Cuadra, C. M., Lotze, H., Martin, D., Mouillot, D., Oro, D., Raicevich, S., Rius-Barile, J., Saiz-Salinas, J. I., San Vicente, C., Somot S., Templado, J., Turon, X., Vaûdis, D., Villanueva, R. and Voultsiadou, E. (2010). The biodiversity of the Mediterranean Sea, estimates, patterns and threats. PloS ONE, **5 (8),** e11842, http://dx.doi.org/10.1371/journal.pone.0011842.

Cosentino, A. and Giacobbe, S. (2011). The new potential invader Linopherus canariensis (Polychaeta: Amphinomidae) in a Mediterranean coastal lake: colonization dynamics and morphological remarks. Mar. Pollut. Bull., **62 (2),** 236-245.

Cosentino, A. Giacobbe, S. and Potoschi, A. Jr (2009). The CSI of the faro coastal lake (messina): a natural observatory for the incoming of marine alien species. Biol. Mar. Mediterr., **16 (1),** 132-133.

Del-Pilar-Ruso, Y., de-la-Ossa-Carretero, J.A., Giménez-Casalduero, F., Sánchez-Lizaso, J.L. and San Martín, G. (2014). Checking the concurrence among macrobenthic organism distribution patterns at different taxonomic scales in relation to environmental factors. *Journal of Sea Research*, **86**, 49-57.

Dorgham, M.M., Hamdy, R., Al-Rashidy, H. H. and Atta, M.M. (2013). First records of polychaetes new to Egyptian Mediterranean waters. OCEANOLOGIA, **55 (1)**, 235-267.

Dorgham, M.M., Hamdy, R., Al-Rashidy, H.H., Atta, M.M. and Musco, L. (2014). Distribution patterns of shallow water polychaetes (Annelida) along the Alexandria coast, Egypt (eastern Mediterranean). Marine Mediterranean science (In Press).

Faulwetter, S. (2010). Check-list of marine Polychaeta from Greece. Arist University of Thessaloniki, Assembled within the framework of the EU F PESI project.

Fauvel, P. (1927). Repport sur les polychaetes Errantes. Zool. Res. of the Cambridge expedition to the Suez Canal, 1924. J. Zool. (Lond.), **22,** 411-439.

Fauvel, P. (1937). Les fonds de pèche pres d'Alexandria. XI. Annèlides Polychaètes. Notes Mèm. Fish. Res. Dir., Cairo., **19**, 1-60.

Fishelson, L. and Haran, T. (1986/87). Epifauna of algae on a rocky platform near Mihmoret (Mediterranean Sea, Israel): composition and dynamics. Isr. J. Zool., **34**, 105-123.

Fletcher, R.L. (1987). Seaweeds of the British Isles. Volume 3 Fucophyceae (Phaeophyceae) Part 1. British Museum (Natural History), London. 359 pp.

Giangrande, A. (1988). Polychaete zonation and its relation to algal distribution down a vertical cliff in the western Mediterranean (Italy): a structural analysis. Journal of Experimental Marine Biology and Ecology, **120**, 263-276.

Giangrande, A., Delos, A.L., Fraschetti, S., Musco, L., Licciano, M. and Terlizzi, A. (2003). Polychaete assemblages along a rocky shore on the South Adriatic coast (Mediterranean Sea): patterns of spatial distribution. Marine Biology, **143**, 1110—1116.

Hamdy, R. (2008). Ecological studies on benthic polychaetes along Alexandria coast, M. Sc. thesis, Alexandria University, 214 pp.

Hill, M.B. (1967). The life cycles and salinity tolerance of the serpulids Mercierella enigmatica Fauvel and Hydroides uncinata (Philippi) at Lagos, Nigeria. J Anim Ecol **36,** 303–321.

Kambouroglou, V. and Nicolaidou, A. (2006). A new alien species in Hellenic waters, Pseudonereis anomala (Polychaeta, Nereididae) invades harbors in the Eastern Mediterranean. Aquat. Inv., **1(2)**, 97–98.

Koçak, F., Ergen, Z. and Çinar, M. E. (1999). Fouling organisms and their developments in a polluted and an unpolluted marina in the Aegean Sea (Turkey). Ophelia, **50,** 1–20

Leone, D.E. (1970). The maturation of Hydroides dianthus. Biological Bulletin, Marine Biological Laboratory, Woods Hole, **138**, 306–315.

Llanso, R.J. and Diaz, R.J. (1994). Tolerance to low dissolved oxygen by the tubicolous polychaete ***Loimia medusa*,** Journal of the Biological association of UK, **74(1),** 143- 148.

Link, H., Nishi, E., Tanaka, K., Bastida-Zavala, R., Kupriyanova, E.K. and Yamakita, T. (2008). Hydroides dianthus (Polychaeta: Serpulidae), an alien species introduced into Tokyo Bay, Japan, JMBA2 - Biodiversity Records, Published on-line

López, E., San Martin, G. and Jiménez, M. (1996). Syllinae Syllidae, Annelida, Polychaeta. from Chafarinas lslands (Alborán Sea; Western Mediterranean). Misc. Zool., **19 (1)**, 105-1 18.

Martýn, D. and Gil, J. (2010). Checklist of class Polychaeta (Phylum Annelida), 199–236, in: The biodiversity of the Mediterranean Sea: estimates, patterns, and threats. M. Coll et al., PLoS ONE, **5 (8)**, 36 pp.

Musco, L. (2012). Ecology and diversity of Mediterranean hard-bottom Syllidae (Annelida): a community-level approach. Marine Ecology Progress Series, **461**, 107-119.

Musco, L., Terlizzi, A., Licciano, M. and Giangrande, A. (2009). Taxonomic structure and the eûectiveness of surrogates in environmental monitoring: a lesson from polychaetes. Mar. Ecol. Prog. Ser., **383,** 199–210.

Nedved, B.T. and Hadfield, M.G. (2009). Hydroides elegans (Annelida: Polychaeta): A Model for Biofouling Research. Marine and Industrial biofouling, Springer Series of Biofouling, **4**, 203–217.

Núñez, J., Brito, M.C. and Ocaña, O. (1991). Anelidos poliquetos de Canarias: familia Amphinomidae = Annelida, Polychaeta from Canary Islands: Amphinomidae. Cah. Biol. Mar., **32(4),** 469-476.

Nunes, A.L., Katsanevakis, S., Zenetos, A. and Cardoso, A.C. (2014). Gateways to alien invasions in the European seas. Aquatic Invasions, **9 (2)**, 133–144.

Occhipinti-Ambrogi, A., Marchini, A., Cantone, G., Castelli, A., Chimenz, C., Cormaci, M., Froglia, C., Furnari, G., Gambi, M.C., Giaccone, G., Giangrande, A., Gravili, C., Mastrototaro, F., Mazziotti, C., Orsi-Relini, L. and Piraino, S. (2011). Alien species along the Italian coasts: an overview. Biol. Invasions, **13(1)**, 215–237.

Otani, M. and Yamanishi, R. (2010). Distribution of the alien species Hydroides dianthus (Verrill, 1873) (Polychaeta: Serpulidae) in Osaka Bay, Japan, with comments on the factors limiting its invasion. Plankton Benthos Res., **5 (2)**, 62–68.

Russell, L.K., Hepburn, C.D., Hurd, C.L. and Stuart, M.D. (2008). The expanding range of Undaria pinnatifida in southern New Zealand: distribution, dispersal mechanisms and the invasion of wave-exposed environments. Biol. Invas., **10**, 103–115.

Sagarin, R.D. and Gaines, S.D. (2002). Geographical abundant distribution of coastal invertebrates: using one-dimensional ranges to test biogeographic hypothesis. Journal of Biogeography, **29**, 985- 997.

Seitz, R.D. and Schaffner, L.C. (1995). Population ecology and secondary production of the polychaete ***Loimia medusa*** (Terebellidae). Marine Biology, **121 (4)**, 701-711.

Selim S.A. (1996). Notes on the distribution of polychaetes along Alexandria coast, Egypt, Bull. High Inst. Public Health, **26 (2)**, 341–350.

Selim S.A. (1997a). Assessment of Polychaete fauna in the Eastern Harbour of Alexandria, Egypt, Bull. High Inst. Public Health, **27 (1)**, 131–146.

Selim S.A. (1997b). Description and remarks on Suez Canal serpulids (Polychaeta*)*, J. Egypt. Ger. Soc. Zool., **22 (D)**, 87–110.

Selim, S.A. (2009). Polychaete fauna of the northern part of the Suez Canal (PortSaid-Toussoum). Egypt. J. Aquat. Res., **35(1)**, 69–88.

Selim, S.A., Abdel Naby, F.A., Gab-Alla, A. and Ghobashy, A. (2005). Gametogenesis and spawning Ôf Spirobranchus tetraceros (Polychaeta, Serpulidae) in Abu Kir Bay, Egypt. Medit. Mar. Sci., **6 (1)**, 89-97.

Selim, S.A., Abd-Elnaby, F.A., Gab-Alla, A. and Ghobashy, A.A. (2006a). New records of errant polychaetes from coastal waters of Alexandria, Egypt. Egypt. J. Aquac. Res., **32,** 210–227.

Selim, S.A., Abd-Elnaby, F.A., Gab-Alla, A. and Ghobashy, A.A. (2006b). New records of sedentary polychaetes from coastal waters of Alexandria, Egypt. Egypt. J. Aquac. Res., **32**, 228–241.

Simboura, N. and Zenetos, A. (2002). Benthic indicators to use in Ecological Quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index. Mediterranean Marine Science, **3(2)**, 77-111.

Wehe, T. and Fiege, D. (2002). Annotated checklist of the polychaete species of the seas surrounding the Arabian Peninsula: Red Sea, Gulf of Aden, Arabian Sea, Gulf of Oman, Arabian Gulf. Fauna of Arabia, **19**, 7-238.

Zenetos, A., Gofas, S., Verlaque, M., Cinar, M.E., Garcýa Raso, J.E., Bianchi, C.N., Morri, C., Azzurro, E., Bilecenoglu, M., Froglia, C., Siokou, I., Violanti, D., Sfriso, A., San Martýn, G., Giangrande , A., Katagan, T., Ballesteros, E., Ramos Espla, A., Mastrototaro, F., Ocana, O., Zingone, A., Gambi, M.C. and Streftaris, N. (2010). Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution, Med. Mar. Sci., **11 (2)**, 381–493.

Zenetos, A., Katsanevakis, S., Poursanidis, D., Crocetta, F., Damalas, D., Apostolopoulos, G., Gravili, C., Vardala-Theodorou, E. and Malaquias, M. (2011). Marine alien species in Greek Seas: additions and amendments by 2010. Med. Mar. Sci., **12 (1)**, 95–120.

Zenetos, Á. Gofas, S., Morri, C., Rosso, A., Violanti, D., García Raso, J.E., Çinar, M.E., AlmogI-Labin, A., Ates, A.S., Azzurro, E., Ballesteros, E., Bianchi, C.N., Bilecenoglu, M., Gambi, M.C., Giangrande, A., Gravili, C., Hyams-kaphzan, O., Karachle, P.K., Katsanevakis, S., Lipej, L., Mastrototaro, F., Mineur, F., Pancucci-Papadopoulou, M.A., Ramos Esplá, A., Salas, C., San Martín, G., Sfriso, A., Streftaris, N. and Verlaque, M. (2012). Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. Medit. Mar. Sci., 13 (2), 328-352.

Zibrowius, H. (1971). Les especes méditerranéennes du genre Hydroides (Polychaeta Serpulidae). Remarque sur le pretend polymorphisme de Hydroides uncinata. TéthyS, 2 (3), 691-745.

Zibrowius, H. (1992). Ongoing modification of the Mediterranean marine fauna and flora by the establishment of exotic species. Mesogee, **51**, 83–107.