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Marine fouling community in the Eastern harbour of Alexandria, Egypt compared with four decades of previous studies

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Abstract

The aim of the present study is to compare the fouling communities between the years 1960 and 1999 in the Eastern harbour of Alexandria, Egypt and to study the main factors that may be controlling these communities. This comparison is based on monthly durations of panel immersion.

By using roughened white polystyrene test panels (12.5x12.5 cm), monthly samples of marine fouling were collected from the harbour from October 1998 through September 1999.

It is clear that a remarkable variation in number and diversity of fouling communities throughout the last four decades is evident. The minimum diversities were recorded during the studies of 1960 and 1970 (19 and 20 species respectively), while the maximum diversity (35 species) was achieved during the 1991 study. Moreover, a small shift among the four dominant groups (Polychaeta, Cirripedia, Bryozoa and Amphipoda) was noted during the four decades of the studies.

The present comparison indicated that many factors may contribute to this variation, of which nutrient enrichment is the most important and the nature of the applied test panel is lees so.

Keywords: Ecology; Community; Marine fouling; Eastern harbour of Alexandria; Comparison.

Introduction

Fouling results from the growth of marine animals and plants on the surfaces of submerged structures (ANON, 1952). Attaching of marine fouling organisms in a remarkable numbers to submerged objects has been demonstrated by several authors as a usual phenomenon in different world harbours (e.g. WISELY, 1959; LEPORE & GHERARDI, 1977; HUANG *et al.*, 1982; NAIR & NAIR, 1987; CAI & LI, 1990; GORDON & MAWARATI, 1992; LI *et al.*, 1996) and in the Mediterranean harbours (e.g. RIGGIO & MAZZOLA, 1976; GALLUZZO, 1980; RAMADAN, 1986)

Pollution creates major differences in benthic community structure (MORAN & GRANT, 1991). Nutrient enrichment significantly affects the composition of marine fouling communities (RASTETTER & COOKE, 1979).

The Eastern harbour of Alexandria, Egypt is a relatively shallow semicircular bay, situated from longitudes 29º 53´ to 29º 54´ 40” E and latitudes 31º 12´ to 31º 13´ N (Fig.1). The harbour is surrounded by the city except on its northern side, where it communicates with the sea through two outlets. The area of the harbour is about $2.53X10^6$ m^2, with a maximum depth of 11m (SELIM, 1997). The average water depth of the bay is about 6.0 m

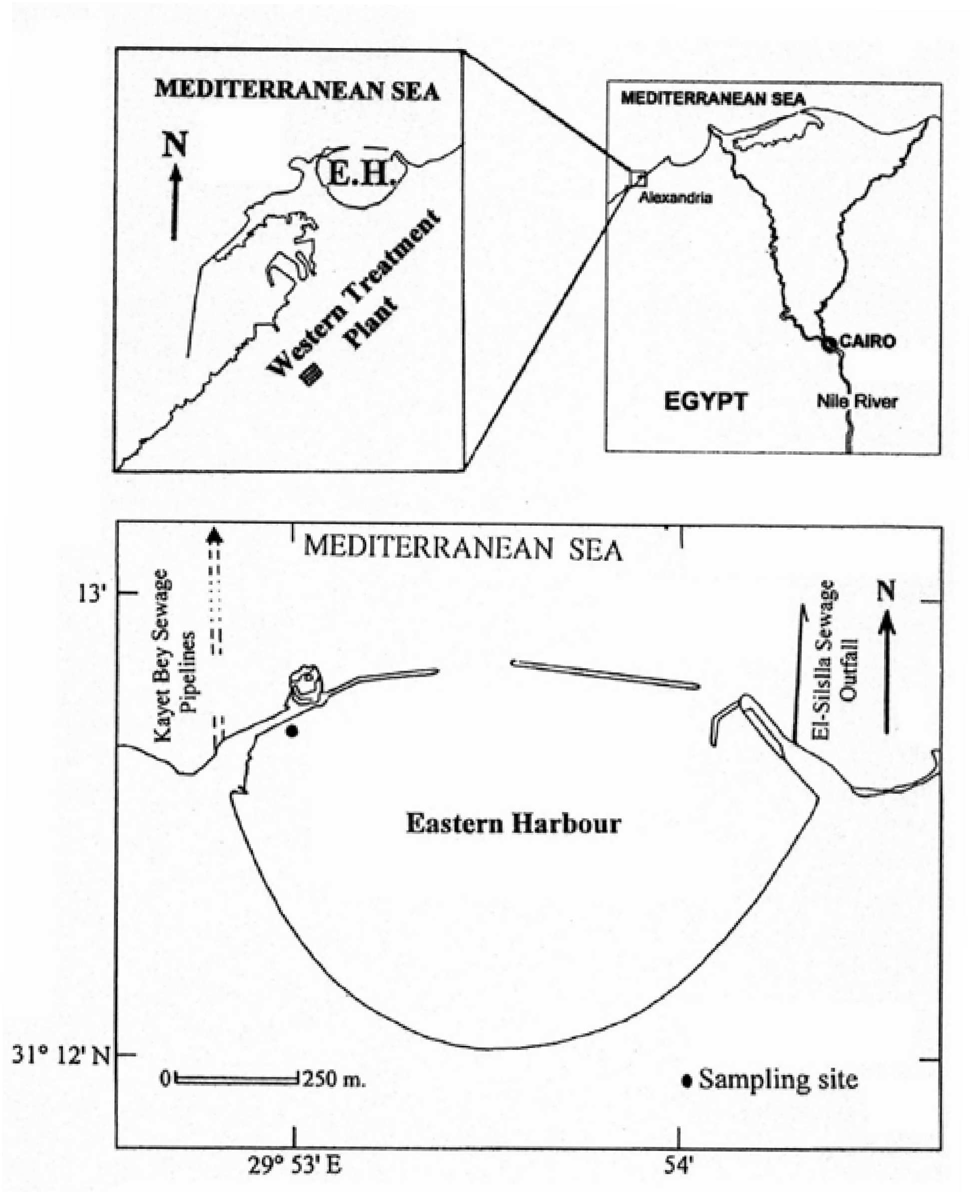

Fig. 1: Location of the Eastern Harbour (E.H.) of Alexandria and sampling site.

and it receives many kinds of vessels, especially fishing boats (AL SAYES & SHAKWEER, 1997). Since 1977, the diversion of municipal wastewater into the harbour has rendered its water eutrophic (HALIM *et al*., 1980). Although it is supposed that since 1999 the discharge of domestic sewage into the harbour has totally ceased, LABIB (2002) mentioned that due to water circulation the harbour is subjected to an additional amount of municipal wastewater from the main sewer of Alexandria (Kayet Bey), located in its western vicinity (Fig.1).

Studies of fouling organisms in the Egyptian waters go back to BANOUB (1960), who investigated the succession of fouling organisms settled on glass plates in the Eastern harbour of Alexandria, Egypt. He recorded 19 fouling species. The Eastern harbour of Alexandria has also been studied by MEGALLY (1970); GHOBASHY (1976); EL-KOMI (1991; 1992; 1998).

The present work aims to compare the fouling communities between the years 1960 and 1999 in the Eastern harbour of Alexandria, Egypt and to discuss the factors responsible for controlling these communities.

Material and Methods

This work was carried out in the Eastern harbour of Alexandria, Egypt. Three replicate test panels fixed to a wooden rack suspended vertically 0.5 m under water level were used to collect monthly fouling samples from the harbour from October 1998 through September 1999.

The surface of the test panels facing seawater was roughened by using sand paper. These panels were regularly replaced every month.

A preliminary study was performed to compare two substrata (the smooth glass and the roughened polystyrene panels). Three smooth glass panels and 3 roughened polystyrene panels (each 12.5x12.5 cm) were immersed in seawater for one month during August (summer) 1998, before the survey was started. The fouling communities on these panels were weighed and identified to species level under (20X) zoom stereo- microscope.

It is worth mentioning that this work and all the previous studies in the Eastern harbour of Alexandria were carried out at the same place (panels were suspended vertically under the jetty of the National Institute of Oceanography and Fisheries, Alexandria, Egypt). The present comparison is based on monthly durations of panel immersion.

Results

It is clear that there has been a variation in the number and diversity of fouling species throughout the last four decades (Table 1).

BANOUB (1960) investigated the fouling organisms settled on glass plates for a period of 7 months from February to September 1958. He recorded 19 species of fouling organisms which represent the minimum diversity of fouling organisms in the Eastern harbour as compared with the other studies that followed. He mentioned that competition was very evident between the encrusted bryozoa and any other organisms. The most dominant species were the polychaete *Hydroides norvegica*, the barnacle *Balanus amphitrite* and the erect bryozoan *Bugula neritina*. As well, MEGALLY (1970) investigated the marine fouling organisms settled on glass plates for a period of 15 months from October 1968 to December 1969 and recorded 20 fouling species. The most dominant species were the polychaete *Hydroides norvegica*, the barnacle *Balanus amphitrite* and the erect bryozoan *Bugula neritina*. He found that all fouling organisms in the harbour showed marked seasonal variations in abundance.

GHOBASHY (1976) studied the monthly variation and settlement behaviour of the principal fouling organisms that settled on roughened panels made of impact-resistant polystyrene for a period of 12 months from March 1973 to February 1974. He recorded 23 species of fouling organisms and indicated that fouling occurred throughout the year but, the community might have been developing, flourishing and vanishing in a definite period of time. The most dominant species were the polychaete *Hydroides norvegica*, the barnacle *Balanus perforatus* and the erect bryozoan *Bugula neritina*. EL-KOMI (1991; 1992) studied the fouling organisms settled on roughened test panels made of polystyrene for periods of 12 and 14 months from March 1983 to February 1984 and October 1990 to November 1991, respectively. In 1991 he recorded 35 species of fouling organisms which represent the maximum diversity of fouling organisms recorded at the Eastern harbour, while in 1992 he recorded 29 fouling species. In the study of 1991, the most dominant species were the polychaete

Table 1
Fouling communities recorded on test panels between the years 1960 and 1999 at the Eastern Harbour of Alexandria.
Data from Banoub (1960), Megally (1970), Ghobashy (1976), El-Komi (1991; 1992; 1998) and the present study.

Author	*Banoub (1960)*	*Megally (1970)*	*Ghobashy (1976)*	*El-Komi (1991)*	*El-Komi (1992)*	*El-Komi (1998)*	*present study*
	Algae	**Algae**	**Algae**	**Algae**	**Algae**	**Algae**	**Algae**
	Ectocarpus sp.	*Enteromorpha compressa*	*Enteromorpha compressa*	*Ulva intestinalis*	*Ulva lactuca*	*Ulva lactuca*	*Ulva lactuca*
	Enteromorpha sp.	*Enteromorpha linza*	*Enteromorpha linza*	*Cladophora* sp.	*Enteromorpha* sp.	*Enteromorpha linza*	*Corallina officinalis*
	Ulva sp.	*Ulva lactuca*	*Ulva* sp.	*Chaetomorpha* sp.	*Cladophora* sp.	*Chaetomorpha aera*	**Hydrozoa**
	Porifera	*Ectocarpus irregularis*	*Ectocarpus* sp.	*Enteromorpha* sp.	*Chaetomorpha* sp.	*Cladophora prolifera*	*Obelia geniculata*
	small unidentified specimen	**Erect Bryozoa**	**Hydrozoa**	*Ectocarpus* sp.	*Ectocarpus irregularis*	*Ectocarpus* sp.	**Erect Bryozoa**
	Hydrozoa	*Bugula neritina*	*Obelia geniculata*	*Ceramium* sp.	**Hydrozoa**	*Ceramium rubrum*	*Bugula neritina*
	Sertularia sp.	*Bugula avicularia*	*Tubularia* larynx	**Hydrozoa**	*Obelia geniculata*	**Hydrozoa**	**Encrusting Bryozoa**
	Tubularia sp.	*Zoobotryon pellucidus*	**Erect Bryozoa**	*Obelia geniculata*	**Platyhelminthes**	*Obelia geniculata*	*Cryptosula pallasiana*
	Platyhelminthes	**Encrusting Bryozoa**	*Bugula neritina*	*Tubularia* larynx	*Stylochus* sp.	**Nematoda**	**Polychaeta (Sed.)**
	unidentified specimen	*Schizoporella unicornis*	*Bugula avicularia*	**Platyhelminthes**	**Erect Bryozoa**	*Epsilonema* sp.	*Hydroides elegans*
	Erect Bryozoa	*Watersipora cucullata*	**Encrusting Bryozoa**	unidentified specimen	*Bugula neritina*	**Erect Bryozoa**	**Bivalvia**
	Bugula neritina	**Polychaeta (Sed.)**	*Schizoporella unicornis*	**Erect Bryozoa**	*Bugula turbinata*	*Bugula neritina*	*Modiolus barbatus*
	Bugula sp.	*Hydroides norvegica*	*Watersipora cucullata*	*Bugula neritina*	*Zoobotryon verticillatum*	*Bugula turbinata*	**Cirripedia**
	Encrusting Bryozoa	*Spirorbis* sp.	**Polychaeta (Sed.)**	*Bugula turbinata*	**Polychaeta (Erra.)**	*Zoobotryon verticillatum*	*Balanus amphitrite*
Fouling	unidentified specimen	*Sabella pavonina*	*Hydroides norvegica*	*Zoobotryon* sp.	*Nereis diversicolor*	**Polychaeta (Erra.)**	*Balanus eburneus*
communities	**Polychaeta (Erra.)**	**Cirripedia**	*Spirorbis corrugatus*	*Bowerbankia* sp.	**Polychaeta (Sed.)**	*Nereis diversicolor*	*Balanus perforatus*
	Nereis sp.	*Balanus amphitrite*	*Dasychone* sp.	**Encrusting Bryozoa**	*Hydroides elegans*	*Syllis* sp.	*Balanus* sp.
	Polychaeta (Sed.)	*Balanus eburneus*	**Cirripedia**	*Watersipora* sp.	*Spirorbis* sp.	**Polychaeta (Sed.)**	**Tanaidacea**
	Hydroides norvegica	*Balanus perforatus*	*Balanus amphitrite*	**Polychaeta (Erra.)**	*Pomatocerus triqueter*	*Hydroides elegans*	*Tanais dulongii*
	Bivalvia	**Solitary Ascidian**	*Balanus eburneus*	*Nereis diversicolor*	*Polydora ciliata*	*Serpula vermicularis*	**Isopoda**
	a single specimen	*Ciona intestinalis*	*Balanus perforatus*	*Syllis* sp.	*Sabella* sp.	*Polydora ciliata*	*Cirolana bovina*
	Cirripedia	*Styela plicata*	*Balanus trigonus*	**Polychaeta (Sed.)**	**Cirripedia**	*Sabella pavonina*	*Sphaeroma walkeri*
	Balanus amphitrite	**Colonial Ascidian**	**Amphipoda**	*Hydroides elegans*	*Balanus amphitrite*	**Cirripedia**	*Sphaeroma serratum*
	Balanus eburneus	*Didemnum gelatinosum*	*Jassa falcata*	*Spirorbis* sp.	*Balanus eburneus*	*Balanus amphitrite*	*Paradella dianae*
	Balanus perforatus	*Didemnum maculosum*	*Ericthonius brasiliensis*	*Serpula vermicularis*	*Balanus perforatus*	*Balanus eburneus*	*Cymodoce truncata*
	Solitary Ascidian	*Botrylloides leachii*	**Solitary Ascidian**	**Cirripedia**	*Balanus trigonus*	*Balanus perforatus*	**Amphipoda**
	Ciona sp.		*Ciona intestinalis*	*Balanus amphitrite*	**Tanaidacea**	**Tanaidacea**	*Corophium acutum*
	Styela sp.		*Styela plicata*	*Balanus eburneus*	*Tanais cavolinii*	*Tanais cavolinii*	*Corophium sextonae*
	Colonial Ascidian		**Colonial Ascidian**	*Balanus perforatus*	**Isopoda**	**Amphipoda**	*Elasmopus pectenicrus*

(continued)

Table 1. (Continued)

Author	**Banoub (1960)**	**Megally (1970)**	**Ghobashy (1976)**	**El-Komi (1991)**	**El-Komi (1992)**	**El-Komi (1998)**	**present study**
	unidentified specimen		*Diplosoma listerianum*	*Balanus trigonus*	*Cirolana aegyptiaca*	*Corophium sextoni*	*Podocerus variegatus*
			Botryllus schlosseri	**Tanaidacea**	*Sphaeroma walkeri*	*Elasmopus pectenicrus*	*Stenothoe gallensis*
				Tanais cavolinii	**Amphipoda**	*Ericthonius brasiliensis*	*Ericthonius brasiliensis*
				Isopoda	*Corophium sextoni*	*Jassa falcata*	**Decapoda**
				Cymodoce truncata	*Elasmopus pectenicrus*	*Halesoma* sp.	*Liocarcinus depurator*
				Idotea baltica	*Stenothoe gallensis*	**Solitary Ascidian**	
				Dynamene bidentata	*Ericthonius brasiliensis*	*Ciona intestinalis*	
				Amphipoda	**Pycnogonida**		
Fouling				*Corophium sextoni*	*Pycogonum* sp.		
communities				*Elasmopus pectenicrus*	**Solitary Ascidian**		
				Stenothoe sp.	*Ciona intestinalis*		
				Ericthonius brasiliensis			
				Jassa falcata			
				Caprella equilibra			
				Colonial Ascidian			
				Diplosoma listerianum			
				Botryllus schlosseri			
No. of fouling species	19 species	20 species	23 species	35 species	29 species	27 species	24 species
Nature of test panels	Smooth glass	Smooth glass	Roughened polystyrene	Roughened polystyrene	Roughened polystyrene	Iron slides	Roughened polystyrene
Dimensions of test panel	19 X 17 cm	12.5 X 20 cm	10 X 12.5 cm	15 X 15 cm	17.5 X 17.5 cm	7 X 2.5 cm	12.5 X 12.5 cm
Date of the experiment	Feb. to Sept. 1958	Oct.1968 to Dec. 1969	March 1973 to Feb. 1974	Mar. 1983 to Feb. 1984	Oct.1990 to Nov. 1991	Feb. 1992 to May 1993	Oct. 1998 to Sep. 1999

Sed. = Sedentaria, Erra. = Errantia

Table 2
(a). List of fouling species recorded on roughened polystyrene and smooth glass panels experimented at the Eastern Harbour of Alexandria during the same period of immersion during summer 1998.

Type of panel	Roughened Polystyrene panels	Smooth Glass panels
Recorded species	Cyanophycophyta layer	Cyanophycophyta layer
	Ulva lactuca	*Ulva lactuca*
	Corallina officinalis	*Bugula neritina*
	Obelia geniculata	*Hydroides elegans*
	Bugula neritina	*Balanus amphitrite*
	Hydroides elegans	*Tanais dulongii*
	Balanus amphitrite	*Corophium acutum*
	Balanus perforatus	*Stenothoe gallensis*
	Tanais dulongii	*Ericthonius brasiliensis*
	Corophium acutum	
	Stenothoe gallensis	
	Ericthonius brasiliensis	
	Elasmopus pectenicrus	

(b). Average number of species and total biomass ± S.E. of fouling assembled on roughened polystyrene and smooth glass panels experimented at the Eastern Harbour of Alexandria during the same period of immersion during summer 1998.

Type of panel	Roughened Polystyrene panel	Smooth Glass panel
Number of species/panel	10.3±0.9	7±0.6
Total biomass (gm)/panel	53±3.4	38±3.2

Hydroides elegans, the amphipods *Ericthonius brasiliensis*, *Corophium sextoni* and the erect bryozoan *Bugula neritina,* while in the study of 1992 the most dominant species were the polychaete *Hydroides elegans*, the barnacle *Balanus amphitrite*, the polychaete *Polydora ciliata* and the erect bryozoan *Bugula neritina*.

EL-KOMI (1998) studied the monthly fouling organisms settled on iron slides from February 1992 to May 1993. He recorded 27 species of fouling organisms in the harbour.

The most dominant species were the polychaete *Hydroides elegans*, the amphipod *Corophium sextoni* and the barnacles *Balanus eburneus* and *B. amphitrite*.

The present work refers to the biota settled on roughened polystyrene test panels for a period of 12 months from October 1998 to September 1999 and records 24 species of fouling organisms. The most dominant species were the polychaete *Hydroides elegans*, the barnacle *Balanus amphitrite*, the amphipods *Corophium acutum* and *Elasmopus pectenicrus*. As well as the experiment for the settlement of fouling on the roughened polystyrene and smooth glass, test panels revealed that the roughened ones collected more weight and fouling species than the smooth panels (Table 2).

Concerning the dominant groups, the results indicated that there is a shift from Polychaeta, Cirripedia and Bryozoa during the studies of 1960, 1970and1976 to Polychaeta, Amphipoda and Bryozoa during the study of 1991, and a return to the previous dominant groups in the study of 1992. The study of 1998 indicated that there was another shift from Polychaeta, Cirripedia and Bryozoa to Polychaeta, Amphipoda and Cirripedia. Meanwhile, in the present study, the dominant groups are Polychaeta, Cirripedia and Amphipoda.

Discussion

Recruitment of many sessile invertebrates is influenced by a variety of biological, chemical and physical factors (CRISP, 1984; PAWLIK, 1992; WALTERS *et al*., 1997). The present results indicate that the maximum diversity of fouling organisms was recorded during the work of EL-KOMI (1991), while the minimum diversity was recorded during the work of BANOUB (1960).

Generally speaking, the fouling communities in the harbour consisted mainly of Algae, Hydrozoa, Bryozoa, Polychaeta, Cirripedia, Amphipoda and Ascidiacea (GHOBASHY, 1976).

BANOUB (1960) indicated the appearance of detrital tubes during the period (May-September, 1958) and he thought that the builder of these tubes was either an amphipod or a worm, since neither of these had been found inside the tubes. GHOBASHY (1976) mentioned the occurrence of Amphipoda tubes and he recorded two species *Jassa falcata* and *Ericthonius brasilensis*. Moreover, he added that Megally (1970) did not refer to Amphipoda tubes although their attachment constitutes one of the characteristics of this harbour fouling. From these, it could be concluded that during the studies of (1960 and 1970), the Amphipoda group was represented but the authors did not mention the appearance of any species of this group.

The present comparison revealed the appearance of 15 fouling groups in the Eastern harbour of Alexandria. These groups are Algae, Porifera, Hydrozoa, Nematoda, Platyhelminthes, Bryozoa, Polychaeta, Bivalvia, Cirripedia, Tanaidacea, Isopoda, Amphipoda, Decapoda, Pycnogonida and Ascidiacea.

The distribution of fouling groups varies from one study to another, but there are groups which appeared in all studies (Algae, Bryozoa, Polychaeta and Cirripedia). The groups Hydrozoa and Ascidiacea appear in all studies except one. On the other hand, there are animal groups like Porifera, Nematoda, Decapoda, Pycnogonida which were recorded only in one study. Bivalvia appear in the studies of BANOUB (1960) and the present work. Platyhelminthes were recorded during the studies of BANOUB (1960) and El-KOMI (1991, 1992). Tanaidacea appear in the studies of EL-KOMI (1991, 1992, and 1998) and in the present work. The Isopoda group appear in the present study and the studies of EL-KOMI (1991 and 1992).

It is clear that, the appearance or disappearance of animal groups may be related to some environmental changes in the Eastern harbour. BANOUB (1960) mentioned that the Alexandria sewage pumping station discharged very near to the harbour, which was occasionally slightly affected. MEGALLY (1970) indicated that the harbour was moderately polluted due to both sewage disposal and waste material dumped from fishing boats.

Pollution creates major differences in community structure (MORAN & GRANT, 1991). It is worth mentioning that the discharge of domestic sewage into the harbour started in 1977 (HALIM, 1980). During 1983, a total of 230,137 m^3/day of this waste was discharged in the Eastern harbour. At Kayet Bey pumping station, 200,000 m^3 of wastes were discharged daily into the open sea and the remainder was discharged into the Eastern harbour of Alexandria. This means that the daily amount of discharge of domestic sewage inside the harbour was 30,137 m^3 / day in 1983. This amount varied with time. It gradually increased to reach 63,014 m^3 / day in 1986 (SAID & MAIYZA, 1987) and 95,134 m^3 /day in 1987 (FARAGALLAH, 1995). Recently during 1999-2000, after the construction of the western treatment plant (which primarily treats the sewage and industrial wastes from the central and western parts of Alexandria), the discharge of domestic sewage inside the harbour totally ceased and the daily discharge into the open sea decreased to reach 140,000 m^3 /day and 50,000 m^3 /day from the main Kayet Bey pipeline and El-Silslla outfall respectively (JAMMO, 2001). The waste discharged from the Kayet Bey pipeline may enrich the environment inside the harbour with nutrients, depending on the direction of both water current and wave action.

Nutrient enrichment significantly affects the composition of marine fouling communities (RASTETTER & COOKE, 1979). The discharge of sewage can stimulate autotrophic production in planktonic food sources and in the fouling community itself, or depress the abundance of species sensitive to toxins in the effluent and low oxygen levels associated with eutrophication. Biotic diversity in terms of species number usually increases when pollution is moderate (MOR *et al*., 1970), but drops again in heavily disturbed areas. This was the case in 1983 when the daily amount of discharge of domestic sewage inside the harbour was moderate, reaching 30,137 m^3 / day. This amount may support the maximum diversity of fouling organisms (35 species) in the Eastern harbour during the study of EL-KOMI (1991), meanwhile the increased or the decreased amounts of domestic sewage inside the harbour may not support the settlement of larger numbers of fouling organisms. That is to say that the daily amount of about 30,000 m^3 /day of sewage may be the optimum amount for fouling diversity in the Eastern harbour.

It is well established that most of the sedentary animals settle preferably on rough rather than on smooth surfaces (RAMADAN, 1986; MCGUINNESS & UNDERWOOD, 1986; MCGUINNESS, 1989; ANDERSON & UNDERWOOD, 1994). Indeed, a preliminary study in the Eastern harbour of Alexandria indicated this. The roughened polystyrene panel hosted more species with higher biomass (10.3±0.9 species and 53±3.4 gm respectively) than the smooth glass panel with the same area (7±0.6 species and 38±3.2 gm) during the same period of immersion (Table 2). This may be an explanation of the low diversities of fouling organisms during the studies of (1960 & 1970) which used smooth glass surfaces.

The present comparison revealed that the polychaete *Hydroides elegans* was the most dominant species in all the studies. It is worth noting that the previous studies in the Eastern harbour (1960, 1970 and 1976), mentioned *Hydroides elegans* as *H. norvegica*. ZIBROWIUS (1971) discriminated between the two similar species in the shape of byonet setae and in the operculum, as well as in the habitats. *H. elegans* is an introduced species commonly found in Mediterranean harbours and polluted waters while *H. norvegica* inhabits deeper, unpolluted waters. SCHELTEMA (1975) reported that the calcareous tube worm *Hydroides* is an important fouling organism in warm temperate and tropical seas. Moreover, it has already been shown that the development of an epibenthic community is influenced by interspecific or intraspecific epigrowth competitions. Despite the fact that epigrowth competitions should be far more frequent on smaller panels than on larger ones, LEVIN & PAINE (1974) observed that on a larger surface where many species compete for the available space, the chances of survival in the presence of spatial competition are relatively small. KARANDE & SWAMI (1988) indicated that the polychaete *Hydroides* showed no preference for any particular area. This may favor the dominance of this species in any panel area.

The comparison indicated that there is a small shift between the four dominant groups (Polychaeta, Cirripedia, Bryozoa and Amphipoda) during the four decades of studies.

Regarding the results of dominant species, there are few alien species occurring in the harbour. Alien species are those occurring outside their historically known range as a result of direct or indirect introduction or care by humans (ZENOTOS *et al*., 2005). In the Mediterranean Sea the polychaete *Hydroides elegans* is considered as a cryptogenic invasive species and the amphipod *Elasmopus pectenicrus* is an established alien species (ZENOTOS *et al*., 2005). The cryptogenic species are those whose probable introduction has occurred in early times (ZENOTOS *et al*., 2005). This may explain the early records of *Hydroides elegans* in many parts of the Mediterranean Sea. In spite of the fact that the barnacle *Balanus amphitrite* is a tropical species, it exists in the Mediterranean and Black Sea areas, as well as in harbours on the Atlantic coast (SOUTHWARD & CRISP, 1963). It may migrate to the Mediterranean through the Suez Canal or it may transfer to the northern areas with fouling on ship's hulls. The barnacle *Balanus perforatus* is a southern species, occurring in the Mediterranean and along the eastern Atlantic seaboard from south-west Wales to West Africa (CRISP &SOUTHWARD, 1953). Of the other dominant species, the erect bryozoan *Bugula neritina* is found in numerous temperate and subtropical regions worldwide (RUSSELL *et al*., 1999); *Ericthonius brasilensis, Corophium sextoni* and *C. acutum* are the best known amphipod fauna of the north-east Atlantic and the Mediterranean region (RUFFO, 1982; 1989 and 1993). The abundance of *Ericthonius brasilensis* and *Corophium sextoni* during the study of EL-KOMI (1991) may be related to available food content (total phytoplankton and/or total zooplankton) which depends on the nutrient enrichment of the harbour. RUFFO (1998) reported that the littoral amphipods seem to be greatly impacted by variations in food sources and temperatures.

Results of non-dominant species in the harbour during the four decades of study indicated that the barnacles *Balanus eburneus* and *B. trigonus* are cryptogenic established species, while the amphipod *Stenothoe gallensis* and the isopods *Sphaeroma walkeri* and *Paradella dianae* are regarded as established alien species (ZENETOS *et al*., 2005).

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