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MARINE FOULING STUDIES IN EGYPT
A- SERPULIDS

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ABSTRACT

The study reviews the researches done in the field of the serpulid fouling in the Egyptian waters from 1960 to 2005. The taxonomy of the Superfamily Serpuloidae and the habitat of each family and subfamily are explained. These polychaetes form the principal fouling organisms in nearly all localities were under investigation: Eastern and Western harbors of Alexandria, Damietta Estuary, Suez Canal, Red Sea and Suez Gulf. *Hydroides elegans* was the dominant on the test panels in all localities except in Damietta Estuary where *Mercierella enigmatica* dominated. Both *Spirobrancus tetraceros* and *Pomatoleios kraussi* compete *Hydriodes elegans* at Alexandria and at the Suez Canal and Suez Gulf respectively. Unlike the latter species *Spirobrancus tetraceros* and *Pomatoleios kraussi* were abundant on all surfaces except on the test panels. The methods of the tube formation in various tubeworms are revealed. The differences in the serpulid habitat may be a result of their gregarious behavior, which enhances their spreading. The reasons behind the paucity of fouling in the Red Sea are discussed.

INTRODUCTION

Marine fouling is concerned with the biota that attaches to artificial sites submerged in the sea, particularly in the harbors such as vessels, buoys, piers, etc. It raises economic problems not only by increasing the fuel, consumption but also by hindering the cooling system in ships as well as in power stations (Relini and Dabini, 1972 and Relini, *et al.,* 1972). The biological studies of fou1ing in Egypt started by works made by Banoub (1960) and Megally (1970) in the Eastern Harbor (EH) of Alexandria. Later several studies have been carried out on the problem by the first author of this paper and his colleagues, starting from the EH of Alexandria and extended to tile Western Harbor (WH) of Alexandria, Damietta, the whole Suez Canal from Port Said to Suez, Suez Gulf and the Red sea. Test panels of different materials and sizes were suspended in water to estimate the fouling settlements quantitatively as well as qualitatively.

The principal fouling organisms in the Egyptian waters are serpulids (tubeworms), barnacles, bryozoans, ascidians, cnidarians and bivalves. The present review is the first in series by the authors to discuss the fouling made by these groups in all Egyptian localities studied so far. This is to give an integrated picture for the fouling conditions including the constituents, settlement rate and season in every place, growth rate and reproduction potentialities of the main settlers.

In this article the authors' plan to clarify the fouling formed by the leading settling animals in nearly all Egyptian sites, i.e. the serpulids.

Serpulids

They are sedentary worms, derived from Phylum Annelida, Class Polychaeta and Order Sedentaria. Immediately after settlement, the emerging worm form

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calcareous tube for dwelling in, the tube prolongs as long as the worm growth is going on. This is why they are called the tubeworms. The body is divided into the so-called branchial crown (the head), thorax of limited number segments and the abdomen; the largest part of the body. The branchial crown carries ciliated pinnuled tentacles; among them is the operculum, which closes the tube when it withdraws inside.

Pillai (1970) and Bianchi (1979) classified the Superfamily Serpuloidae into two separate families; Family Serpulidae has an extended tube, while family Spirorbidae forms a coiled tube either dextrally or sinistrally. Ghobashy *et al.,* (1986) adopted that classification and accepted the division of the family Serpulidae into Subfamily Serpulinae with operculum carrying two funnels and the example is the genus *Hydroides.* The other subfamily is Spirobranchinae in which the operculum carries a solid calcareous plate and its stem extends laterally to a pair of wings or fins. The examples are the genus *Spirobranchus* in which the operculum is smooth conical and flattened with ramified spines and the genus *Pomatoleios,* where the operculum with calcareous part (talon) continued inside and more or less concave. The family Spirorbidae, on the other hand, is divided into Subfamily Januinae, its tube is coiled dextrally (e.g. *Janua)* and the Subfamily Pileolariinae which have sinistrally coiled tube. Ramadan (1986) put the Superfamily Serpuloidae under the suborder Serpulomorpha.

Habitat:

The Spirorbids are usually found on marine plant fronds (Knight- Jones and Knight- Jones 1974 and Knight- Jones *et al.,* 1975). These authors observed *Janua (Dexiospira) brasiliensis* on *Sargassum* at Portsmouth and on *Zostera* at Knysna (South Africa). *Spirorbis corallinae* was also found on *Corallina officinalis* (De Silva and Knight-Jones, 1962). *Spirorbis corrugatus* was collected by Ghobashy (1978) and Ghobashy and Selim 1976c) from the blades of *Caulerpa prolifera* at Eastern Harbor of Alexandria. Knight-Jones *et al.,* (1975) claimed that the new name of *Spirorbis corrugatus* is *Janua (Dexiospira) pseudocorrugata* (Bush, 1904). On the other hand, Spirolinae mostly settles in harbors and *Hydroides* worms can be collected by test panels immersed therein (Ghobashy, 1984). *Spirobranchus* and *Pomatolieos* do not prefer settlement on plants or on test panels and Belal (2001) and Abdel Nabi (2005) found them in overwhelming quantities settling on rocks, concrete and on metal surfaces at Suez Bay and Eastern Harbor of Alexandria respectively.

Status of Marine Fouling in Egypt

A- Eastern Harbor of Alexandria

This harbor represents the starting area to study marine fouling in Egypt. Starting from Banoub (1960) down to the work of Abdel Nabi (2005) about 15 studies have been carried out on marine fouling of this harbor. It receives mostly the fishermen vessels.

The results of all studies done revealed that the *Hydroides elegans* has been always the principal fouling serpulid as well as the main fouling organisms in the harbor. Ghobashy (1976) found it throughout the year and particularly from June to November when thousands of tubeworms occupied the exposed panels. *Spirorbis corrugatus* was also detected on the panels, but it was mainly on the green alga *Caulerpa prolifera* at the harbor sea bottom. Only 126 tubeworms / panel (10X12.5cm) were found mainly in June. *Spirorbis* larvae were largely obtained from April to June and much less in cold months. Very few worms of *H. uncinata (H. dianthus)* and *H. lunulifera (H. dirampha)* were settling during May and June. Similar results were obtained by Selim (1978) and Ghobashy and Selim (1976 a,b&c), who found in addition *H. elegans,* which formed about 99% of the settled worms and *H. dianthus, H. dirampha, Vermiliopsis infundibulum,* as well as *S. corrugatus* and settlement was promoted at 1.5 m depth. Mona (1982) and El Komi (1991, 1992 a&b

and 1998} showed that the settlement of *H. elegans* was still leading all fouling assemblages during most of the year. El Komi (1991 and 1992a) mentioned that *Hydroides* tubes measured more that 2 cm in the length. He (1998) studied the fouling of buoys and *Hydroides* settlement was not so great as on the test panels. Likewise, Selim (1996) observed the dominance of *H. elegans* in the harbor, but she (1997) recorded few worms of *Spirobranchus tetraceros* on solid surfaces in the harbor. Abdel Nabi (2005) reported that settlement of the latter species has become very highly promoted and overran the other serpulids in the whole harbor, despite the dominance of *H. elegans* on the test panels.

B- Western Harbor of Alexandria

This is the main harbor of Alexandria and it receives all types of ships. Ramadan (1986) in his Ph.D. thesis observed the severe settlement of the tubeworms especially *H. elegans* during the warm months particularly in August 1979 when the thickness of this serpulid aggregations on the test panels reached about 8 cm and many were erecting perpendicular to the panel. He also found that settlement increased by the depth until 1.5 meter under the sea surface and decreased gradually down to 7.5 meter below. At all depths, the worms were significantly greater in number on the undersides of the panels and on the black surface more than on the white one. A positive correlation was noticed between the maximum settlement rate and the maximum size of the tubeworms. The length of tubeworms reached 70 mm in August 1979 when the settlement was the greatest; over than 5000 tubeworms *I* panel (12.5X12.5 cm). More or less the two Alexandria Harbors are not different in their fouling, including serpulids formations.

Along the seashore of Alexandria Abdel Nabi (2005) made a study on the polychaetes distribution in five stations from Abu air to El Kashafa (in the Eastern Harbor). She recorded few species of serpulids and *Spirobranchus* was the principal polychaetes in most stations, except at the El Kashafa station where it was shared by *H. elegans.*

C- Damietta Estuary

The work on the marine fouling in this estuary was done by Hamada (1980) and Ghobashy and Hamada (1984). This was before the built up of Damietta Harbor. The estuarine serpulid *Mercierella enigmatica* was exclusively the major fouling organisms in the area. Its settlement occurred severely from March 1978 to July 1979 and reached the peak in March-April 1979, about 10,000 tubeworms per panel (12.5 x 12.5 cm) / month. There the salinity ranged between 12.6 and 36.1%o and pH from 7.25 to 8.47. Its larvae were abundant in the plankton and were obtained in the laboratory in the warm months. Worm sizes were the highest during April-July period and the longest tube attained 2 cm and the growth rate was about 0.5 mm/ day.

Mercierella which is an estuarine species (Kochi, 1973) has never found as the major fouling organisms at any Egyptian locality except Damietta Estuary. El Komi (1997) and Abdel Nabi (2005) reported its presence at Lake Manzalah and at an area of Abu Qir Bay (Eastern Alexandria) respectively, both are brackish water areas.

D- Suez Canal Waterway

The study of the fouling in the Suez Canal started by a comprehensive work done by Ghobashy *et al.* (1980) on the whole waterway, from Port Said in the North to the Suez Harbor in the south (Figure 1). The study included the lakes in between (Lake Timsah and Bitter Lakes) as well as the eleven guiding stations along the waterway. Briefly speaking, 14 locations on the Suez Canal were studied by these authors. The fouling of the Lake Timsah, the most severely fouled location was further studied by Ghobashy and El Komi (1980a). The serpulids of this lake were identified by Ghobashy *et al*., (1986). Barbary (1992) carried out his Ph.D. work on the fouling, including the serpulids of the Lake Timsah. While the fouling of the region south to the Lake Timsah was explained in a M.Sc. thesis by El Komi (1980) and by Ghobashy and El Komi (1980b). The fouling of the region northern to the Lake Timsah was studied by Ramadan (1986). Recently, Shalla and Holt (1999) and Emara and Belal (2004) studied fouling organisms at some parts of the Suez Canal.

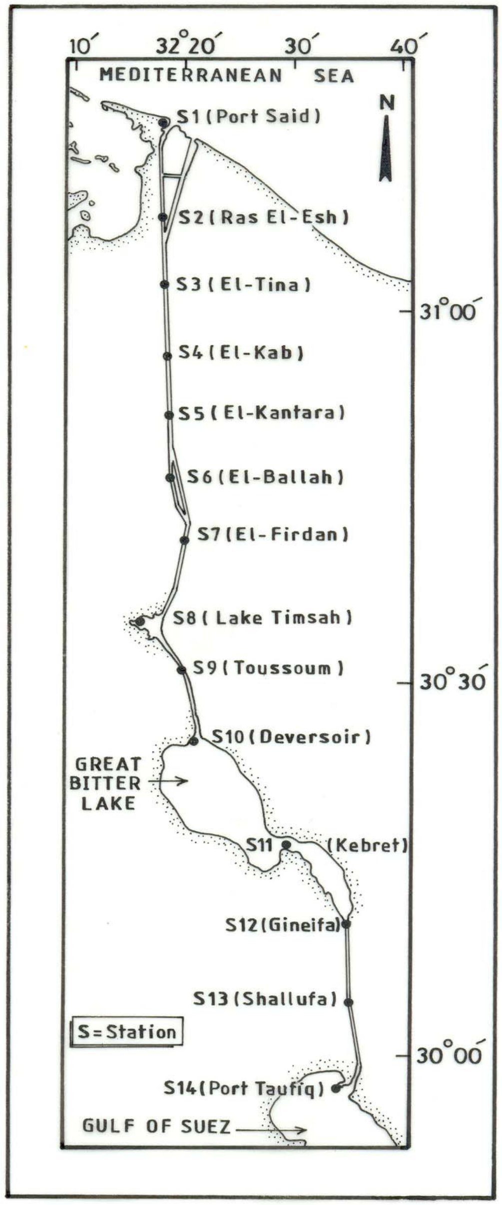

Figure (1): Map to show fouling collection locations along Suez Canal (after Ghobashy *et al.,* 1980).

These studies showed that the communities of fouling in the investigated 14 stations were not the same and its density changed but was most severe at the middle of the Suez Canal at Lake Timsah. Moreover, although some changes happened in the constitution of the serpulids of the Suez Canal in the last 24 years, the worm *H. elegans* was always leading on the test panels.

Settlement of *Hydroides* on the panels suspended in the Lake Timsah was so severe that every panel (12.5x12.5 cm) received more than 10,000 tubeworms in May 1977, and not less than 2000 tubeworms/ panel took place in most of the year months. At Port Said, this species settled continuously from May to December, reaching maximally 2000 tubeworms/ panel in May-June period. Southward, the rate of settlement decreased gradually from Ras El Esh to El Tina to El Cap to be about 300 tubeworms/ panel in the latter station. Nearer to the Lake Timsah the worms increased from El Ballah to El Ferdan and become huge in the lake. Southern to the lake, i.e. from Tossum to Suez fouling was generally weak (Ghobashy and El Komi,1980b), but *H. elegans* was abundant at Kebret on the Bitter Lakes where salinity was 43%o; reaching in July -September about 3000 tube worms/ panel. At the south, from Shalloufa to Suez fouling was poor and maximally reached 800 tubeworms/ panel during October- November. At Suez, due to the swift current there silt was always accumulated on the panels, suppressing the settlement and growth of all fouling organisms. The standing crop of the fouling reached 0.029 g /cm^2, which was the lowest in the whole Suez Canal then. The other tubeworms found by Ghobashy *et al*., (1980) but in few quantities were *Pomatoceros triqueter, Serpula vermicularis, Vermiliopsis infundibulum* and *Spirorbis* sp. It is worthy to mention that Emara and Belal (2004) found the same species in different parts of the Suez Canal and mentioned that *H. elegans* was still leading them on the test panels.

However, *Spirobranchus tetraceros* was found, for the first time, in small quantities by Ghobashy *et al*., (1986). Moreover, *Pomatoleios kraussi,* as a Red Sea form (Day, 1967) was only found at the southern region of the Lake Timsah. Both serpulid species were considered as new records to the Egyptian waters. Similarly *Pileolaria (Simplicaria*) *pseudomilitaris* and *Janua (Neodexiospira) psudocorrugatus* (or *Spirorbis corrugatus),* which are Mediterranean forms were also few and both failed to appear in the south of the lake (south of the canal). Barbary (1992) recorded that although *H. elagans* settlement was still promoting, *H. dirampha, Spirobranchus* and *Pomatoleios* appeared in increasing numbers. The latter two species as well as *Pileolaria* and *Janua* were mostly found on surfaces other than the test panels. El Komi (1980) observed the increase of serpulids on panels mounted at 1.5 m deep (Figure 2), and the least growth rate was parallel to the least settlement rate, in January-Mach 1978.

Recently Shalla and Holt (1999) observed the overwhelming aggregation of the Lessepsian migrant *P. kraussi* in the whole Lake Timsah, not only at its south as was noticed by Ghobashy (1984). The results of Emara and Belal (2004) confirmed the wide spreading of this tubeworm in the lake.

E- Red Sea and Suez Gulf

Ghobashy (1984) observed that the Gulf of Aqaba, namely Sharm El Shaikh, Dahab and Nweeba are very poor in fouling assemblages and practically fouling is absent at these areas.

Test panels (17.5 x 17.5 cm) suspended by El Komi (1992b) at El Ghardaqa Marine Station for 3 and 6 months exposure periods also showed that fouling biomass there was low and the serpulids were represented by weak settlement of *Hydroides* sp*., Spirorbis* sp. and *Serpula concharum.* The same author (1996) studied the benthos along the Eastern Coast of the Suez Gulf, and noticed the paucity of the serpulids, which were only represented by *Hydroides.* However, in the Suez Bay El Komi *et al.*, (1998) revealed that seven species of serpulids settled on the test panels; they are *H. elegans, H. heteroceros, Serpula concharum,* S. *vermicularis, Spirorbis borealis, Spirobranchus tetraceros* and *Pomatoceros triqueter. H. elegans* was more common than the others on the panels were. At the time of high settlement rate, (autumn) the growth rate of this tubeworm was also high, reaching 15 mm in length per one month of settlement, but in cold months (winter) the settlement was poor and the growth rate reached 3 mm/ month. Generally, the serpulids were leading the fouling in the Bay and more common in summer and autumn.

The findings of Belal (2001) in the Suez Bay indicated that *Pomatoleios kraussii* became the dominant fouler and formed about 95% of the polychaetes fauna in the Bay throughout the year. This worm reached 2000-4000 tubeworms *l* 2 liters of fouling. Nevertheless, this worm was abundant on all surfaces in the Bay except on the test panels, which were mainly occupied by *H. elegans,* reaching 1227 tubeworms/ 100 cm^2 in October 1997 in Attaka Harbor at the bay. The growth rate of *Hydroides* was 0.87 mm/ day and in the laboratory was 0.6 mm/day (Ghobashy *et al.,* 2000a). These authors considered the fouling in Suez Bay is comparatively weak.

Accordingly, we can summarize the prevalence of the surpulids in different Egyptian localities in the following table:

Species	**Alex. Harbors**	**Damietta Estuary**	**Suez Canal**	**Red Sea & Suez Gulf**
Spirobranchus tetraceros	+++		+++	+
Hydroides elegans	+++		+++	+
H. dianthus,	++		+	
H. dirampha	++		+	
H. nigra	+			
Pomatoceros triqueter	++		++	+
Spirorbis corrugatus	+++		++	+
S. *borealis*				+
Pomatoleios kraussii	+++		+++	++
Vermiiliopsis infundibulum	+		+	+
Serpula vermicularis			+	+
S. conchurum				+
Pileolaria (S.) pseudomilitaris			+	
Mercierella enigmatica		+++		

(+++ abundant, ++ common, + present):

Biological Studies

Ghobashy (1978) published a paper on the behavior of *Spirorbis corrugatus* larva, which is 0.2 mm long on its release. This larva is marked by the presence of two whitish globular sacs situated, anteriorly at both sides of the larva representing the two calcareous attachment glands. As soon as the larva liberates it swims towards the mostly lighted regions in the container and remains there from 30 minutes to about 10 hours before fixation and metamorphosis. Before the final attachment, the larva passes through stages the last one of them is considered the exploratory stage, which lasted from two minutes to an hour. The attachment was manifested by the formation an arc-shaped transparent calcareous tubule secreted around the two glands. By the expansion of the tube backwardly, the glands began to vanish and disappeared by the complete formation of the adult tubeworm. Certain preferences are demonstrated by this larva at settlement; it becomes photonegative, geonegative, and chooses rough surfaces as well as the undersides of the horizontal surfaces. *H. elegans* larva performed similarly at settlement (Ghobashy and Selim, 1976b).

In the Eastern Harbor of Alexandria, Ghobashy and Selim (1976c) observed that *Spirorbis corrugatus* were mostly found settling on the fronds of the green alga *Caulerpa prolifera*, always present on the seabed. By laboratory choice experiments, Ghobashy (1978) showed that *Spirorbis* behaved indifferent at the settlement on introduced fronds of both *Caulerpa* and *Ulva.* The latter was also prevailing in the harbor. The author concluded that preference of the larvae to settle on *Caulerpa* in the field is probably for physical reasons because this alga is at the bottom, a dim-lit surfaces, while *Ulva* is present on the sea surface. This conclusion contrasts with the claim that a response to a chemical stimulus makes it possible for the spirorbid larvae to exercise a highly specific choice of substrata (Crisp, 1965). This response is well demonstrated in the selection of the larvae of surfaces associated with the organism's own species, the so-called gregariousness. Nevertheless, Crisp (1965) mentioned that a larva to exert this chemical stimulus should first come in contact to the surface.

Reproduction potential of *H. elegans* was investigated by Ghobashy *et al*., (1981). The males rarely exceeded the third of the population, and they could be distinguished by the whitish abdomen, while the female abdomen was pale orange in color. Newly attached worms reached 1.5 mm in length, maturation began in few days after settlement and gametes production continued until the tube attained 15.6 mm in length. Freshly collected worms were occasionally observed squirting their gametes, like milky clouds, in water, which suggests external fertilization. This behavior was more common in September the peak settlement month in that harbor. An abdomen, about 7.0 mm long, was estimated to contain about 20,000 ova .Hence the vigorous reproduction of *H. elegans* was attributed to these high potentialities. Ghobashy and Selim (1976a) found that the growth rate of this species was 0.59 mm/ day on rough surfaces, higher than on the smooth surfaces (0.36 mm/ day).

The development of *Spirobranchus teracero* in the Eastern Harbor of Alexandria was studied by Abdel Nabi (2005); the sex ratio is 1: 1.1 because the females were slightly higher in number and gametes development took about 8 months before spawning. Hence, she suggested this worm breeds once a year, from May to September.

The morphology, histology and histochemistry of serpulid worms have been studied by Egyptian researchers. Detailed structures of *H. elegans, S. corrugatus* and *Mercierella* sp. have been explained by Mona (1978), Reda (1978), and Hamada (1980) respectively. There are two opercula in *H. elegans,* one of them is functioning and exceeds the tentacles in length. The other operculum is rudimentary, appearing as a bud-like hollow structure, extending opposite to the other. It is likely that the two opercula exchange functioning during the worm life.

In all examined serpulids, the external as well as the internal features are more or less similar. The branchial crown is loaded with the polysaccharides especially in the tentacle pinnules. The calcium secreting glands are located in the thorax of both *Hydroides* and *Mercierella* but *Spirorbis* is devoid of such large gland. The former two worms reach more than 20 mm in length, and their glands possibly contribute in the prolongation while in *Spirorbis,* which is about 8 mm in diameter apparently depends mainly on the larval attachment or other sources in the tube formation.

Toxicity of Cu and Zn to *H. elegans* has been demonstrated by Ghobashy *et al*., (2000b). The results showed that the concentration of Zn is about 21 times that Cu and the latter is 12 times more toxic than Zn. The levels of both elements were higher in the tissues of the worm than in the seawater of the Suez Bay. Moreover, the concentration of the heavy metals: Cu, Pb, Cd, Mn, Zn and Fe in the two worms *Hydroides elegans* and *Spirobranchus tetraceros*, were recorded by Abdel Nabi (2005) from both E.H. Alexandria and Abu Qir. She concluded that the concentrations of these elements except Ni and Zn, in the two localities fall within the permissible levels. In comparison with the Suez Bay Belal (2001) revealed that the concentration of Zn and Pb are higher in Alexandria waters.

Ghobashy and El Komi (1980a) reported that *Hydroides elegans* was thriving in highly polluted waters in the Lake Timsah. Belal (2001) mentioned that this species can be used as bioindicator for oil pollution because it resists it (Ignatiades and Becacos- Kontos, 1970) and the accumulation of heavy metals in the body of many polychaetes is well known (Gibbs and Bryan, 1980).

DISCUSSION

Crisp (1974) reviewed the larval settlement behavior of most of the marine invertebrates. He cited that the order of events is predictable; temporary attachment on making contact with the substratum followed by exploration and finally the metamorphosis and fixation. He showed that the tracks taken by barnacles, tubeworms, and oyster's larvae are more or less similar. *Spirorbis spirorbis* was his example of the tubeworms.

Although the serpulid larvae behave like those of *Spirorbis* until the final attachment, they behave differently in some respects afterwards. While *Hydroides elegans* chooses the test panels preferentially to settle on and form thick layers thereon, both *Spirobranchus tetraceos* and *Pomatoleios kraussi,* their major settlement occur on all available sites in the harbors except on the test panels. Spirorbids on the other hand, select the plants in the sea to live on and few worms of them, which could be found on hard substrates such as rocks and test panels (Ghobashy, 1978). The output of these independent choices of the settlement substrata may be the avoidance of the competition between the serpulids for the space and the opportunity to grow in huge quantities becomes high and each species can form its own aggregations independently. The gregarious behavior of these invertebrates at settlement (Crisp, 1965) may be one of the reasons behind that substrate segregation.

Settlement principally on the test panels enhances the strong attachment of *H. elegans* and formation of thick layers reaching 8 cm in some cases (Ramadan, 1986). The pattern of formation of piles of this worm on panels was investigated by the first author in different Egyptian harbors. On fixing themselves to a panel, the larvae were always close to each other's, and the newly grown adults direct their heads outward the center of attachment as if they tend to avoid competing with each other for maintenance. When a panel surface becomes completely covered with worms, another layer is formed upon the one below and so on. The worms underneath do not become suffocated, although there may be thousands of worms lying above them. It was interesting that many holes penetrating vertically the worm layers down to the first layer formed on the panel (Figure 3). This condition helps passage of oxygen and nourishment to all worms on the panel. However, fouling of the tubeworms is too soft and most of its upper layers can be removed by a finger push.

Dramatic changes in the serpulid map in Egypt are taking place. *S. tetraceros* was entirely absent when Ghobashy (1976) and El Komi (1992a) were working on the fouling of the Eastern Harbor of Alexandria. Nevertheless, Selim (1997) recorded this species in the harbor, but in few numbers. Now this serpulid has become abundant therein (Abdel Nabi, 2005). Similarly, *P. kraussi* was not found by Ghobashy and El Komi (1980a) in Lake Timsah. According to Ghobashy *et al*., (1986), it started to appear later in the lake. Subsequently, this tubeworm has become the dominant one not only in the lake (Barbary, 1992 and Emara and Belal, 2004) but also in the Suez Bay (Belal, 2001) and perhaps along the southern of the Suez Canal as well.

It is apparent that there are different methods for tube formation in different serpulids. Ghobashy (1978) followed the process of tube formation in *S. corrugatus,* which started by the secretion of the lime from the two thoracic calcareous glands immediately after the larval settlement. These larval glands diminished and disappeared after having the coiled tube complete. Nott and Perkes (1975) suggested that precipitation of lime absorbed from seawater, which lead to the formation of the tube. Seemingly, this happens after the degeneration of larval glands in *Spirorbis*. For *Mercierella,* Swan (1950) claimed that the seawater passes to the glands under the worm collar and when the glands were amputated the tube stopped forming. In *H. elegans,* Ghobashy *et al*., (1979) found that the calcareous glands are located on both sides of the worm thorax and they are surrounded by circular muscles, which help squeeze the calcium during the tube formation. Secretion of lime in the longer lifetime in *Hydroides* supports the formation a long tube in this form, but having the tube formation depending mainly on the larval glands in *Spirorbis* restricts the length of the worm and its diameter rarely exceed 8 mm (Ghobashy, 1978).

It might be surprising that fouling formations, including serpulids, are poor in the Red sea, although these groups of animals which constitute the fouling are present along the sea but in the form of the coral reefs. Both coral reefs and fouling assemblages are similarly formed of sedentary, filter feeding invertebrates such as sponges, cnidarians, polychaetes, bryozoans, barnacles, ascidians and bivalves. Although both systems need the same requirements such as the warmth and shallowness, they do not appear in the same area together. High salinity of the Red Sea is not an obstacle because fouling is common in the Bitter Lakes where the salinity is also high. However, one may imagine the richness of the Red Sea in the corals is probably on the expense of the fouling aggregations. This might not be true because the corals flourish along the seashores, while the fouling is mostly confined to the harbors such as Attaka (at Suez Bay) and Al Ghardaqa Harbor. In other words while the coral reefs dominate in the open waters the shores, fouling dominates in areas which are comparatively closed such as the harbors. It may be anticipated that when the Red Sea becomes more urbanized, and more harbors are built, the Red Sea would be rich in fouling assemblages.

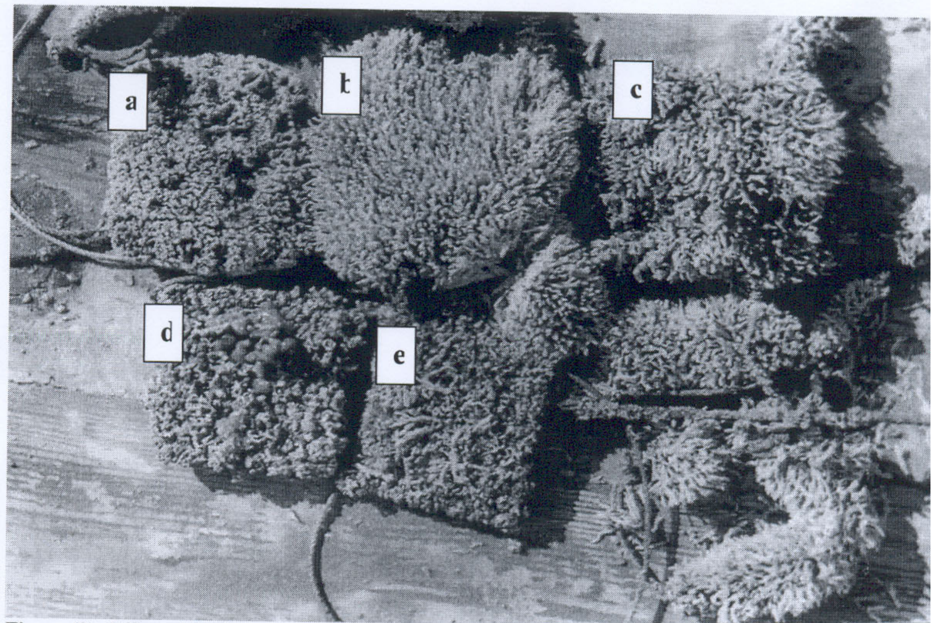

Figure (2): Effect of depth on the density of settlement of *H. elegans* at Lake Timsah (after El Komi, 1980).
a= 0.5 meter; b= 1.5 meter; c= 2.5 meter; d= 3.5 meter; e= 4.5 meter.

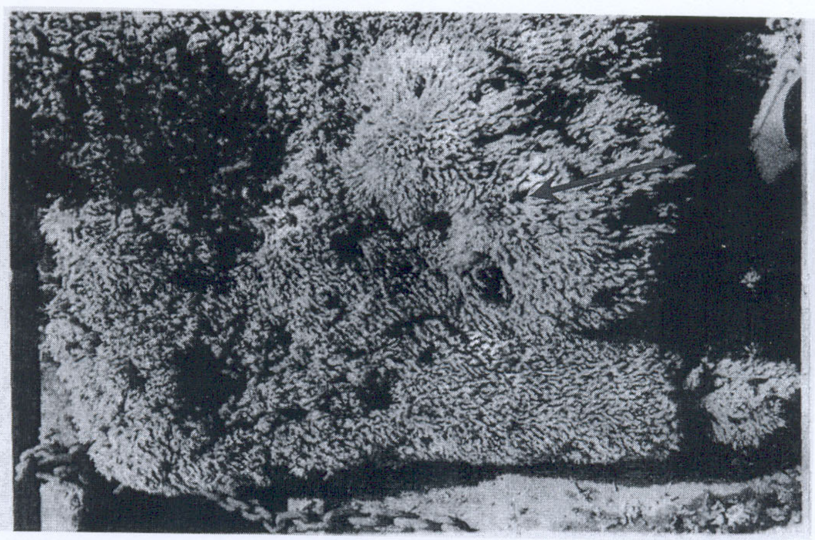

Figure (3): Severe settlement of *H. elegans* at Eastern Harbour of Alexandria, the arrow points to one of the holes made by the worms to allow the passage of oxygen and nourishment to the underlining *H. elegans* worms (after Ghobashy, 1984).

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