SETTLEMENT AND GROWTH OF *SPIRORBIS CORRUGATUS* (MONTAGU) IN THE EASTERN HARBOUR OF ALEXANDRIA

By

A.F.A. Ghobashy and S.A. Selim

Institute of Oceanography and Fisheries, Alexandria, Egypt.

ABSTRACT

In the Eastern Harbour of Alexandira, *Spirorbis corrugatus* was found predominantly on the green algae *Caulerpa prolifera* from April to November. Experimentally it was found that settlement on rough, balck and concave is greater than on smooth, white and flat surfaces respectively. On panels placed at different depths greatest settlement occurred at 1.0 m and 1.5 m below the surface and on shaded panels at all depths. It is gregarious during settlement; presence of worms on panels induced others to settle neighbour to them. Maximum length of tubes (1.4 mm in diameter) was attained after 25 days after settlement. Growth rate on rough and smooth panels was found about 0.04 mm/day.

INTRODUCTION

Fauvel (1927) and De Silva and Knight-Jones (1962) classifed the Spirorbinae (Polychaeta) into dextral (anticlock wise tube coiling and sinistral forms (clock •ise tube Coiling). Other writers found that members of this subfamily behave in a distinguishable way, particularly, in their specific choice of certain algae as substrates for settlement. For instance, *Spirorbis spirorbis* L. (previously *S. borealis* Daudin) selects to settle on *Fucus* species (Williams, 1964 and Knight-Jones 1971). *S. corallinae* De Silva and Knight-Jones select *Coralina officinalis* (De Silva and Knight-Jones, 1962) and *S. rupestris* Gee and Knight-Jones select *Lithophyllum* species (Gee and Knight-Jones, 1962). Other studies, which are often dealing with behaviour during settlement indicated that larvae of these tube worms are affected by various enviromental conditions; including substrate conditions, before settling(Knight-Jones, 1951 and 1953 and Wisely, 1959 and 1060).

Previous studies on fouling organisms in the Eastern of Alexandria harbour (Banoub, 1960 and Megally, 1970) and did not mention presence of *Spirorbis* species among the polychaetes in this harbour. On the contrary, *Spirorbis corrugatus* Montagu, enlisted by Fauvel (1934) to be in Alexandria was observed by us on test panels and on fronds of *Caulerpa prolifera* Forssk. Through this account on this serpulid we attempt to add more informations about Spirolinae. It includes 3 parts the first is a morphological description of the species to compare it with that shown by Fauvel (1927), the second is a study on settlement behaviour and the third is on growth rate of this species on rough and smooth surfaces.

MATERIALS AND METHODS

Panels made of impact-resistant polystyrene, 0.3 cm. thick were immersed under a raft in the eastern harbour throughout the year 1973. They were fixed periodically to a wooden frame 100 × 50 × 5.0 cm as attachment sites to find out settlement rate and its reacion to surface texture, surface contour, surface background and to previous presence of worms of the same species on the panel.

Intensity of settlement at different depths was investigated by placing panels, size of each 12.15 × 12.5 cm, similarly roughened on both sides at equal distance from each other and from the sea surface into a vertically suspended rack, 2.5 m. long. Panels were either placed vertically or horizontally in a way that panels of the same orientation were 0.5 meter from each other. While one side of the vertically suspnded panels was facing the sun and hence daylighted the other was darkened by placing a screen over the corresponding side of the mounting rock. Each exposure period was for one week but sometimes it was for two weeks.

RESULTS

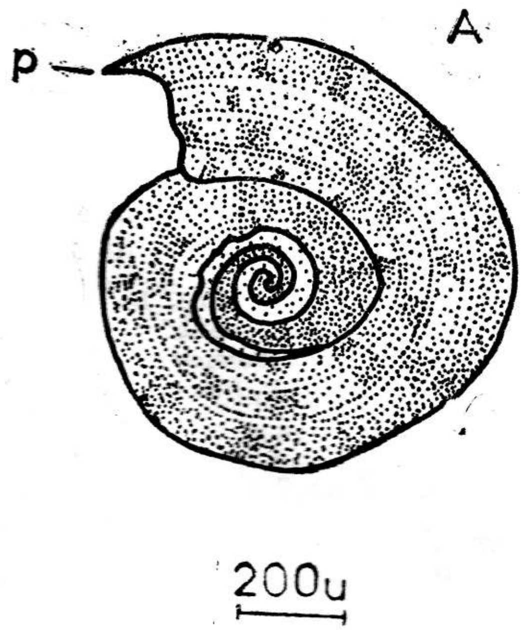
I. Taxonomic characters of Spirorbis corrugatus :

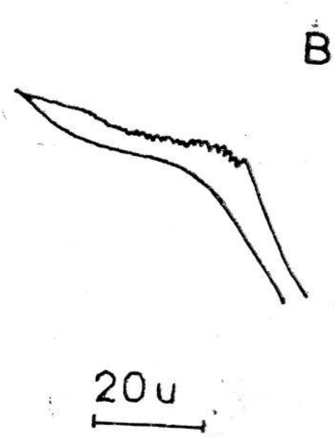
The algal community of the eastern harbour of Alexandria comprises large number of green, brown and red forms. Nevertheless, fronds of the green alga *Caulĕrpa prolifera* (Plate 1) were always the only favourable plant for settlement of this tube worm. The plant either was dredged at depths not more than 3 m. or collected with other fouling organisms at depths from 1.0 to 1.5 meters.

Different strucures for this serpulid were drawn by a camera lucida from unstained specimens.

Structures shown in Fig. (1) indicate that they, with slight difference, belong to *Spirorbis corrugatus* as described by Fouvel (1927) than to any other spirorbid species. The tube Fig. (1 a) is white, dextral, with 3 whorls. Its coil never exceeded 1.4 mm. in diametre while the maximum diameter of its aperture was no more than 0.4 mm. At the outer side of this aperture a process always projects, this may be the part from which the formation of new regions proceeds. The tube is rigid longetudinally and it is yellowish in colour. In cross section, we found the tube is arch shaped because, as in the other serpulids *Pomatoceros striqueter* L. (Faouzi, 1931) and *Hydroides norvegica* Gunnerus (Ghobashy & Selim, unpubished) at the setting side the calcareous tubing is absent. When the tube was removed, the colour of the worm was found pale yellow at the first and second segments, chocolate brown at the third and orange at the rest of the body. The thorax possesses 3 setigers, in the first the setae are long with blade cone shaped, coarsely serrated and no gap separates the blade from the fin (Fig. 1 b). In the second and third thoracic setigers the setae are either simple (Fig. 1 c) or serrated. In each abdominal segment there are 3 setae each is delicate, curved and with coarsely serrated side (Fig. 1 d). The uncini (Fig. 1 e) in the thoracic are greater in number than in the abdominal tori, both uncini are serrated. The hepatic pigments are red.

Eggs were found inside the operculum which indicates that incubation of the youngs occurs in this structure. The operculum is (Fig. 1 f) funnel shaped, transparent and consists of a calcified circular plate, a short stalk and a foot.





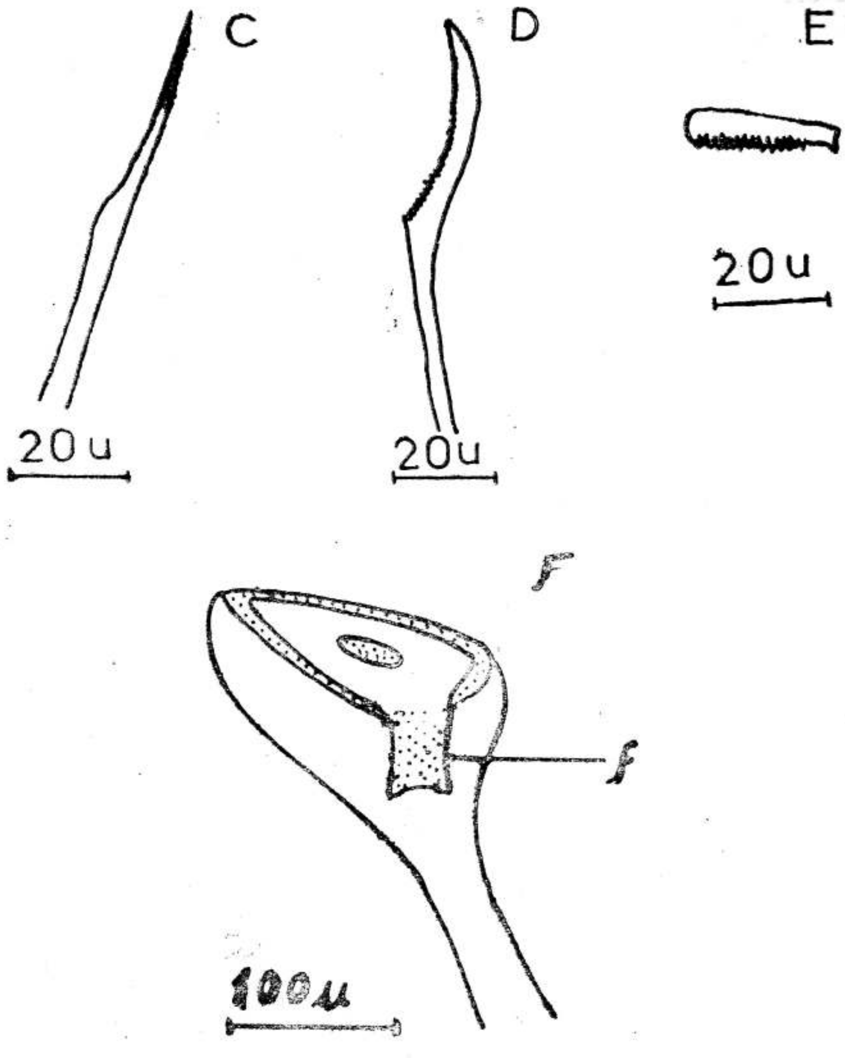


Fig. 1. Taxonomic charactors of *S. corrugatus;* A) the tude, B) serrated seta of the first thoracic setiger, C) simple seta of the second thoracic setiger, D) an abdominal seta, E) a thoracic uncini, and F) a lateral view of the operculum. f. foot, P. frocess.

In addition to the operculum there are 7 filaments constituting the branchiae.

II. Settlement behaviour of S. corrugatus.

a. *Rate of settlement on rough and smooth panels :*

Panel (10 $\times$ 12.5 cm) were weekly replaced throughout the year 1973 to determine settlement season of this serpulid. Half number of these panels were smooth while the others were roughened by fine sand paper . The latter panels were always preferred by *S. corrugatus.* In the second half of April, the time at which settlement of this species started to appear on test panels, 199 worms settled on 5 rough panels, while 60 worms settled on the same number of smooth panels. During May rate of settlement was nearly similar, but in the first half of June the settlement reached the maximum. On 5 pairs of rough and smooth panels settlement of 1542 and 429 worms respectively occurred. Subsequently, settlement decreased from 69 and 18 worms during the second half of June, 39 and 12 in he first half of July to 3.5 and 2 worms in the second half of July per each rough and smooth respectively. No further settlement was observed on test panels during the subsequent months. Mean temperature of the sea surface in the four months, from April to July were 21, 23, 25 and 28°C respectively.

Cease of settlement on the test panel was not accompanied by disappearance of the species from sea. Collected fronds of the green alga (*Caulerpa prolifera*) were found carrying attached worms of *S. corrugatus* during the whole period from April to November but in decreasing numbers after June.

b. *Settlement on irregular surfaces :*

On one side of a panel, 15 $\times$ 15 cm in size, 24 pits arranged in 4 rows and 3 grooves in between these rows were drilled. Méan radius of th pits as well as the grooves was 0.15 cm and length of each groove was 10 cm. This panel was immersed 3 times from 22 April to 24 June 1973 to find out the effect of surface contour on settlement. Fig. (2) shows intesity of settlement per 1.0 cm of each of the three types of surface, pits, grooves and the flat surface of the panel. Pits were the most attractive sites for settlement while the flat surface was the least attractive. While the total surface area of the pits, the grooves and the flat surface were 3.4, 14.1 and 206.72 cm^2, respective total settlement, on these sites were 71, 103 and 291 worms.

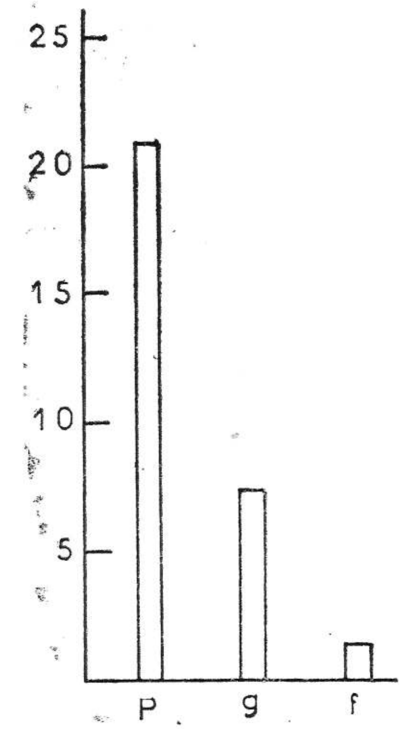


Fig. 2. Comparison between the number of settled worms in pits (P), grooves (g) and flat surface (f).

c. *Settlement on white and black backgrounds :*

Equal black and white areas were drawn by nontoxic paint on 3 panels. Two of them, 12.5 × 10 cm in size, were halved ; 10 × 6.5 cm of the panel for each colour. On the third panel (15 × 15 cm) chequeur background was drawn containing for each colour, 9 squares each 2×2 cm, 12 of 1X1 cm and 24 of ½×½ cm. The first 2 panels were exposed fos 3 periods betweên 10.6 and 17.7.1973 and the third panel was exposed for 4 periods between 22.4 and 30—6—1973. While the first 2 panels were used to find out the effect of light reflection on settlement, the latter panel was exposed for testing effect of smallness of areas on the ability of worms to descriminate between the two alternatives. Table (1) shows that the black background, where light reflection is minimum, was always highly preferred. However, as the size of the squares decreasd the ratio of settlement on black and white bacgrounds also decreased ranging from 13.7 for 10 X 6.25 cm to 2.98 for ½ X ½ cm.

d. *Gregariousness during settlement* :

Four panels size of each 6×7 cm were immersed in the sea for 3 days, afterwards they were brought to a laboratory where all settled organisms other than *S. corrugatus* were thoroughly removed. These panels, referred to as experimentals, beside othérs of the same size (controls) but immersed, simultaneously, in sea weter in the laboratory were then exposed in the sea for one week. These steps were repeated 6 times during May and June 1973. A comparison btween settlement of *S. corrugatus* on experimental panels which were having worms of this species previously attaching and on the controls is shown in Table (2). Evidently, settlement of this form was promoted on the experimental panels, they attracted, in average more than 3 times of settled worms on control panels.

E. *Settlement at different depths* :

Three exposures were carried out from 1.5 to 13/6/1973 in each of which 5 panels wre placed horizontally at depths 0.5, 1.0, 1.5. 2.0. and 2.5 in addition to other 4 panels vertically at only for the first 4 depths. Fig. (3) shows percentage of settlement on each of the two sides of the similarly directed panels and at dfferent depths. The histograms in column A represent comparative settlement on the two sides, dark and light, of vertically suspended panels while in column B the histograms represent comparative settlement on the horizontally suspended panels. In column A one can find that settlement was always, and at all investigated depths, very much higher on dark than on lighted sides. Cumuilatively 426 °orms settled on the lighted and 3454 worms settled on the dark sides. On the other hand undersides of the horizontal panels (Column B) attracted 4995 worms compared with 450 worms atached to the uppersides. Generally speaking, maximum settlement occurred at depths 1 and 1.5 n and in particular at 1.0 meter. Table (3) notifies that the undersides of horizontal panels were the most favoured settlement sites.

TABLE 1.—**Choice of** *Spirorbis corrugatus* **between black and white backgrounds.**

Area of each background	Experiment number	Settlement of worms on		black/white
		black	white	
(10 x 6.5 cm)	1	2000	100	18.2
	2	1030	115	9.0
	3	270	5	54.0
	4	340	38	9.0
	5	130	4	32.5
	6	168	15	11.2
	Total	3938	287	13.7
(20 x 20 cm)	1	42	1	42.0
	2	71	7	10.1
	3	95	28	3.4
	4	120	20	6.0
	Total	328	56	5.9
(1.0 x 1.0 cm)	1	66	1	66.0
	2	43	7	6.1
	3	77	32	2.4
	4	110	30	3.7
	Total	296	70	4.23
(-0.5 x 0.5 cm)	1	43	1	43.0
	2	43	7	6.1
	3	20	11	1.8
	4	25	25	1.0
	Total	131	44	2.98

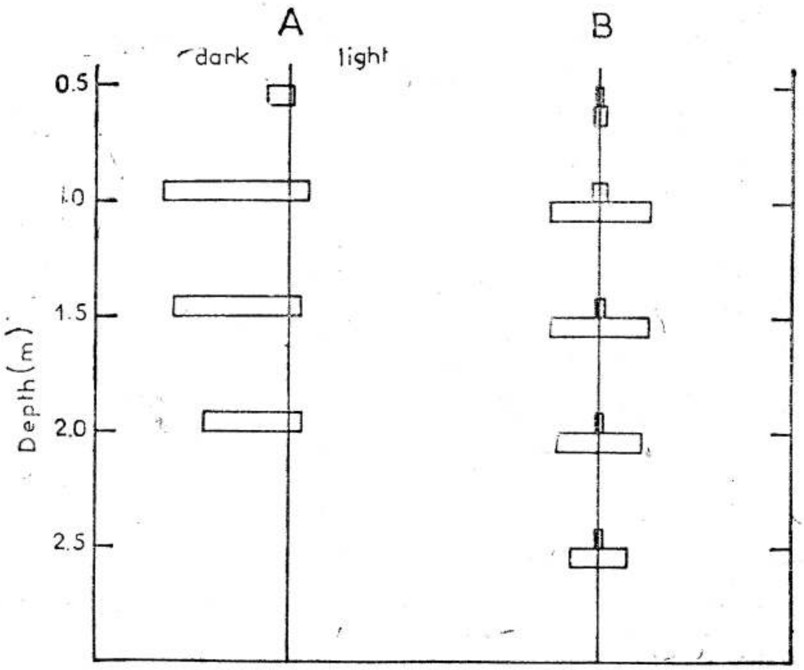


Fig. 3. Percentage settlement on both sides of panels placed at different depths : A) vertically suspended panels, and B) horizontally suspended panels.

TABLE 2.—Comparison between settlement of *S. corrugatus* on panels attaching to it Worms of this species and on panels free from it.

Number of exposure	Number of the settled worms		Ratio
	Experimental panels**	Control panels	
1	95	35	2.7
2	140	35	4.0
3	90	18	5.0
4	130	61	2.1
5	33	2	16.5
6	28	4	7.0
Total . . .	516	155	3.31

** Number of worms were previously seftling on the experimenta panels in the sixexperiments was, 81, 60, 25, 90, 15 and 15 respectively.

TABLE 3.—Settlement of *S. corrugatus* on panels placed at different depths and With different origentations.

Fanel position	Depth meters						
	0.5	1.0	1.5	2.0	2.5	Total	Ratio
Horizontal, upper side .	6	222	51	60	111	450	11.1
Horizontal, lower side. .	160	1412	1385	1200	838	4995	
Vertical, daylighted . . .	27	175	103	121	—	426	8.1
Vertical, shaded	225	1260	1134	835	—	3454	

III. Growth rate of the tube and its operature in *S. corrugatus*

Two panels 10 × 12.5 cm one rough and the other smooth were immersed in 13.6.1973 in the sea to collect worms of *S. corrugatus*. In the fifth day both panels were taken to the laboratory for few hours where the biggest 7 worms on each pannel were selected to study their growth rate. Periodical measurements were made to obtain means of the diameter of tube spiral from the furthest two points to find out the tube length increase, a method adopted by both Gee (1967) and De Silva (1967) with other *Spirorbis* species, and of their tube diameter opertures. The second immersion continued for one week but subsequently the immersions were were twice week. A calibrated ocular lens was used to measure the diameter of both spiral and aperture of each tube. The growth of the tube and its aperture on both rough and smooth panels obviously was continuous throughout this work. (Fig. 4). At age 25 days all worms on both panels apparently ceased to grow ; no increase in diameter of the tubes spirals and their aperture was observed. The largest mean spiral diameter was 1.1 mm and the widest tube aperture reached 0.4 mm on these panels as well as in the field where no tube spiral was found larger than

1.4 mm. Although on the rough panels increase in tube lengh was slightly greater than on the smooth panel for the first 17 days and for 22 days in the case of opening width, at the end of the experiment on both panels the mean spiral diameter as well as the mean aperture diameter were nearly equal. The growth rate of the tube spiral on the rough panel was 0.0436 mm/day and on the smooth panel was 0.0551 mm/day. For tube aperture it was 0.016 mm/day on both panels. It is worthmentioning that during this work it was noticed that the exposed surfaces of both panels become green due to the formation of a thick film of the green alga *Enteromorpha lenza*. On the other exposed panels, where *S. corrugatus* was not continuously attaching, settlement of the green alga was very slight.

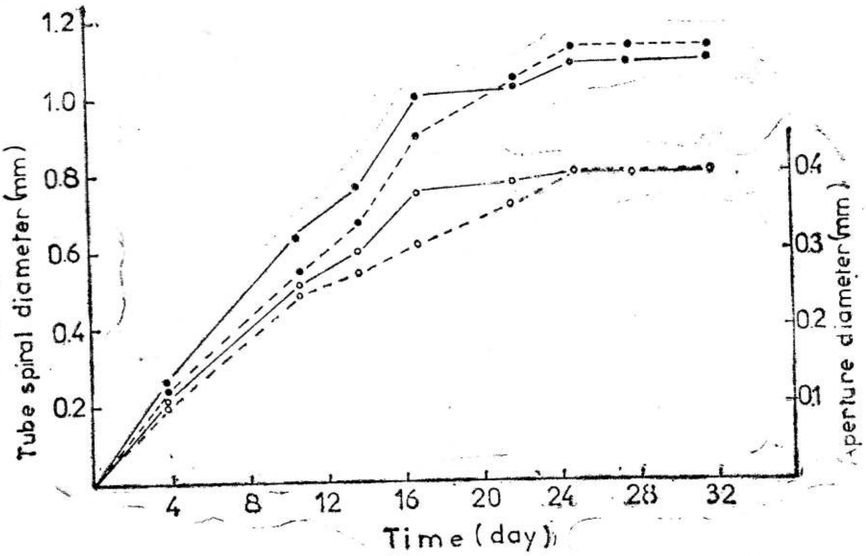


Fig. 4. The growth of the tube of *S. corrugatus* (•) and its opening (o) on rough (continuous lines) and on smooth (broken lines) panels against time.

DISCUSSION

Fauvel (1934) listed *Spirorbis corrugatus* as the only *Spirobis* form he found in Alexandria waters. However the structure of the present worms varies slightly from that described by Fauvel (1927); while we found the abdominal seta narrow and sickel shaped, he showed it broad and the blade nearly at right angle with the fin. Moreover, Fauvel mentioned that it is dominant on brown algae but we found it mostly available on the green alga *Caulerpa prolifera than* on the other algae. This is despite of the occurrance of several algal forms in E. harbour composed of green algae; *Cladophora* sp., *Codmium* sp., *Ulva* sp., ets., brown; *Colpenia sinuosa*, etc., and red; *Bangia* sp., *Ceramium* sp., *Corallina* sp., *Pterocladia* sp., etc. (Megally, 1970). The last beharioure emphasizes the tendency of *Spirorbis* species to be specific in their choic of algae for settlement (Knight-Jones, 1971). This helped authers to differentiate between *S. spirorbis, S. corrallinae* and *S. tridentatus* (De Silva, 1967). On the other hand settlement of *S. corrugatus* preferentially on black surtace and in dimly lit places indicates that larvae of this worm are photonegative during settlement. In this respect they are similar to larvae of *S. tridentatus* (De Silva, 1962) but dissimilar to larvae of *S. rupestris* (Gee and Knight-Jones, 1967). Both *S. tridentatus* and *S. rupestris* as well as *S. spirobis* are sinistrally coiled (De Silva and Knight-Jones, 1962). On the other hand *S. corrugatus,* like *spirorbis* (Knight-Jones 1951 and 1953, and wisely, 1960), is gregarious during settlement. But because gregarious tendency in *S. corrugatus* is apparently not as strong as in the other serpulid *Hydroides norvegica* (Ghobashy and Selim,un-published study), in addition to other considerations, the former did not appear on test panels at the time it was appearing on fronds of *Caluerpa prolifera*. On the other hand similarity in the behaviour of dissimilarity coiled spirorbid forms points to a fact that coiling direction although of primary importance in the tax-onomy of *Spirorbinae* it has a limited influence on the behaviour of the species.

It is a matter of interest to find that maximum growth in *S. corrugatus* was attained within 25 days after the birth of the adult. The maximum size attained by the tube of *S. corrugatus* was 1.4 mm in diameter. This is smaller than that attained by *S. spirorbis* (3.5 mm) (De Silva, 1967) and *S. rupestris* (4.5 mm) (Gee, 1967). Nevertheless, growth rate of *S. corrugatus* in the *Eastern* Harbour of Alexandria (0.04 mm/day) is much greater in *S. spirorbis* and *S. rupestris* (0.022 and 0.020 mm/day respectively), as cited by the forementioned writers.

Surface texture influenced rate of settlement of *S. corrugatus;* rough panels were preferred, but the growth rate of this species nearly equal on rough and smooth parels. This result differs from that obtained by the authers (unpublished results) on *H. norvegica* where both settlement and growth rate were promoted on rough panels. This is possibly because the latter serpulid reached its maximum size (96.4 mm in lenght) in a relatively long period, about 6 months, during which the surface texture was involved as an important factor but in the case of *S. corrugatus* the total growth accomplished in a limited period and the total attachment area is relatively minute.

SUMMARY

Structure of the only spirorbid tube worm occurring in the eastern harbour of Alexandria shows that it is the dextral form *Spirorbis ocrrugatus* Montagu. In the sea it appears, from April to November, on fronds of the green algae *Caulerpa prolifera* but on test panels it was found only frpm April to July and maximally during the first half of June. It disappeorance from the panel after July is due to the dominance of the other serpulid *Hydroides norvegica* Gunnerus. This spirorbid (S. corrugatus) prefers to settle on rough, concave and black rather than smooth, flat and white surfaces. It is gregarious during settle ment and prefer to settle at depths 1.0, - 1.5 meters below the sea surface. The under sides of horizontally suspended panels is the attractive on gle for settlement of this tube worm. The larvae are photonegative at the settlement stage. No worm forms a tube larger than 1.4 mm in diameter and the total length growth occurs with 25 days after settlement with a rate about 0.04 mm/day.

REFERENCES

Banoub, M.W. 1960. Notes on the fouling of glass plates submerged in the eastern harbour, Alexandria, 1958. Alex. Insitute of Hydrobiol. Notes and Memoires 64, 1-17.

De Silva, P.H.D.H. 1962. Experiments on choice of substrates by spirobis larvae. J. Exp. Biol., 39 : 483-490.

——— 1967. Studies on the biology of Spirorbinae (Polychaeta). J. Zool. London, 152 : 269-279.

De Silva, P.H.D.H. and Knight-Jones, E.W. 1962. *Spirorbis coarallinae* n. sp. and some other spirobinae (Sperpulidae) common on British shores. J. mar. biol. Ass., U.K., **42** : 601-608.

Fauvel, P., 1927. Faune de France 16. Polychaetes sedentaires. Paris, pp. 412.

Fauvel, P., 1937. Les Fonds de pêche près d'Alexandria. Alexandria Inst. Oceanogr. Fish., Notes and Memoires 19.

Gee, J.M. 1967. Growth and breeding of *Spirorbis* rubestris (Polychaeta, Serpulidae). J. Tool. London, 152, 235-244.

Gee, J.M. and Knight-Jones, E.W., 1962. The morphology and larval behaviour of a new species of *Spirorbis* (Serpulidae). J. Mar. Biol. Ass., UK., 42 : 641-654.

Ghobashy, A.F.A. and Selim, S.A. 1977. Settlement behaviour of the tube worm *Hydroides norvegica* in the eastern harbour of Alexandria. (unpublished).

——— (1977). Growth of the tube worm *Hydroides norvegica* in the eastern harbour of Alexandria. (unpublished).

Knight-Jones, E.W., 1951. Gregariousness and some other aspects of the setting behaviour of *Spirorbis*. J. mar. biol. Ass., U.K., 30 : 201-222.

Knight-Jones, E.W., 1953. Decreased descrimination during settlement after prolonged planktonic life in larvae of *Spirorbis borealis* (Serpruli dae). J. mar. biol. Ass., U.K., 32 : 337-345.

——— 1971. Choice of algae be larvae of *Spirorbis*, particularly of *Spirorbis spirobis*. Fourth European Mar. Biol. Symp., Cambridge University Press, 89-104.

Megally, A.H., 1970. Ecological study on marine fouling organisms in eastern harbour, Alexandria, U.A.R., Ph. D. Thesis, Alexandria University, 250 pp.

Williams, G.B., 1964. The effect of extracts of *Fucus serratus* in promoting the settlement of larvae of *Spirorbis borealis* (Polychaeta). J. mar. biol. Ass., U.K., 44 : 397-414.

Wisely, B., 1959. Factors influencing the setting of the principal marine fouling organisms in Sidney Harbour. Austr. J. Mar. Freshw. Res., 10 (1) 30-44.

——— 1960. Observations on the setting behaviour of larvae of the tube worm *Spirorbis borealis*. Dauden (Polychaeta). Austr. J. Mar. Freshw. Res., 11 (1) : 55-73.