SETTLEMENT BEHAVIOUR OF THE TUBE WORM HYDROIDES NORVEGICA GUNNERUS IN THE EASTERN HARBOUR OF ALEXANDRIA

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ABSTRACT

Rate of settlement of *Hydroides norvegica* in Eastern harbour of Alexandria was estimated for successive 15 months in 1972 and 1973 and found only significant from April to November, reacing maximum in September. Settlement was higher on rough sand black surfaces This serpulid is gregarious during ettlement and surfaces filmed with brown algae promoted its settlement. It preferred to settle on concavities, on the lower sides of the horizontal surfaces and at depths 1 and 1.5 m from the surfaces.

INTRODUCTION

Both Banoub (1960) and Megally (1970) reported the presence of the serpuild *Hydroides norvegica* (Gumerus) as one of the main fouling organisms in the eastern harbour of Alexandria. The former author observed that its peak settlement takes place in May whereby occupying on test panels about 60,000/square foot/month and the latter author found it settling throughout the year but predominiately between May and October.

This serpuild is world wide present; occurring from the arctic (Beherens, 1968) to Australia (Wisely, 1959) but notably in tropical and subrropical regions. In the isles of Scilly it is very common at all sublittoral localities (Harris, 1972), frequent in Hawaii (Straughan, 1969), forms serpulid reefs at the harbour of Corpus Christi, Texas (Beherens, 1968) and dominant in Cochin harbour, India (Nair, 1967). Although another serpulid *Pomatoceros triquetor* L. was recorded by Meadows (1969) in the northern coast of Britain, *H. norvegica* constitutes one of the main shipfouling organisms in this region (Pyefinch, 1950).

Despite the wide occurrance of *H. norvegica,* apart from the work of wisely (1958) on its development and metamorphsis, no study was made on its settement behaviour. In this work we attempt to determine rate of this serpulid throughout a year in the Eastern harbour of Alexandria. Heavy settlement of this fouler during summer months made it possible to investigate the effect of different factors on its rate as well.

MATERIALS AND METHODS

White panels, made of impact-resistant polystyrene 3 mm thick were used as settlement sites. In experiments where settlement sites had to be nearly at the same depth, panels were bolted into a rectangular wooden frame 100 x 50 x 5 cm and hence only one side of each panel was exposed for settlement. During this work which continued for 15 months from September 1972 to November 1973 equal numbers of smooth and roughened by fine sand paper panels of size 12.5 x 10 cm were always in use in order to find out rate of settlement. Panels of size 7 x 6 cm served in testing gregariousness of this species at settlement. This was performed by comparing amount of settlement on panels either bearing previously attached worms or already soaked with their tissue extract with settlement on panels soaked simultaneously in sea water (controls). Similarly, exposures were made to find out rate of settlement of this serpulid on panels bearing a film of brown algae.

To study the effect of surface contour on settlement four rows of pits and 3 grooves were drilled into a panel (15 x 15 cm) and settlement on these concavities was compared with settlement on the flat surface. There were two sizes of pits, narrow (radius 1.5 mm) and wide pits (radius 2.5 mm) each size was composed of 12 pits and alternatively arranged; 3 of each size in each row. Between the pits rows the grooves were drilled, each 10 cm, the inner groove with radius 2.0 mm and the outers with radius 1.2 mm. Settlement in response to background illumination was investigated by immersing 2 panels one half of each surface area, (10 x 6.25 cm) painted black and the other half painted white by the same kind of a nontoxic paints, both surfaces were smooth in texture. The investigation of this response was expanded on a panel 15 x 15 cm painted on its surface chequeur background formed of replicates of black and white squares of decreasing areas; 9 replicates of 2.0 x 2.0 cm, 12 replicates of 1.0 x 1.0 cm and 24 replicates of 0.5 x 0.5 cm.

Settlement at different depths was investigated by placing panels roughened on both sides into a vertically suspended wooden rack, 2.5 m, long. Panels were placed vertically and horizontally at half meters from the surface and from each other.

Because of heavy settlement of *H. norvegica* during this work any exposure rarely lasted for more than one week.

RESULTS

Monthly rate of settlement on rough and smooth panels :

In each exposure equal number, not less than 3, of rough and smooth panels were immersed. During winter months replacement of these panels occured every 2 weeks. Resulted settlement per 1 cm^2/day in 15 months is represented by histograms shown in Fig. (1). Settlement was observed to occur throughout the year but remarkable settlement, entered in Fig. (1), started in April (.03 worm/cm^2/ day on rough panels), reaching maximum in septmber (2.43 worm/cm^o/day on rough panels) and elapsed just after November. Average month temperature as shown in the figure reveals that during the months of start and lapse of remarkable settlement always greater than on smooth panels, the ratio was at least 2 : 1. on rough panels settement often accurred in clusters, some clusters was formed of more than 20 worms but on smooth panels this less frequently occurred and cluster size was usually smaller. Always in clusters anterior opening of the tubes were directed towards the outside of the cluster centre, which minimized the worm entangling during their growth.

Discrepancy in settlement rate in October and November of 1972 and 1973 was, possibly, due the changeable sea conditions in these two months. Usually in these months, the relative sea clamness, in summer months, come to its end.

Surface contour :

A panel designed to test effect of surface contour on settlement was immersed in 4 exposures during the period between 24.6 and 12—8—1973. Considering the total surface area of each of the five types of surfaces (narrow pits, wide pits, narrow grooves, wide groove and flat surface), intensity of settlement per 1.0 cm^2 of each surface, derived from the quantity of worms attached, after the exposures was calculated. Fig. (2) explains that narrow pits were the most favourable sites for sttlement of *Hydroides norvegica* (110 worms/cm^2) while the flat surface was the least attractive site (17,25 worms/cm^2).

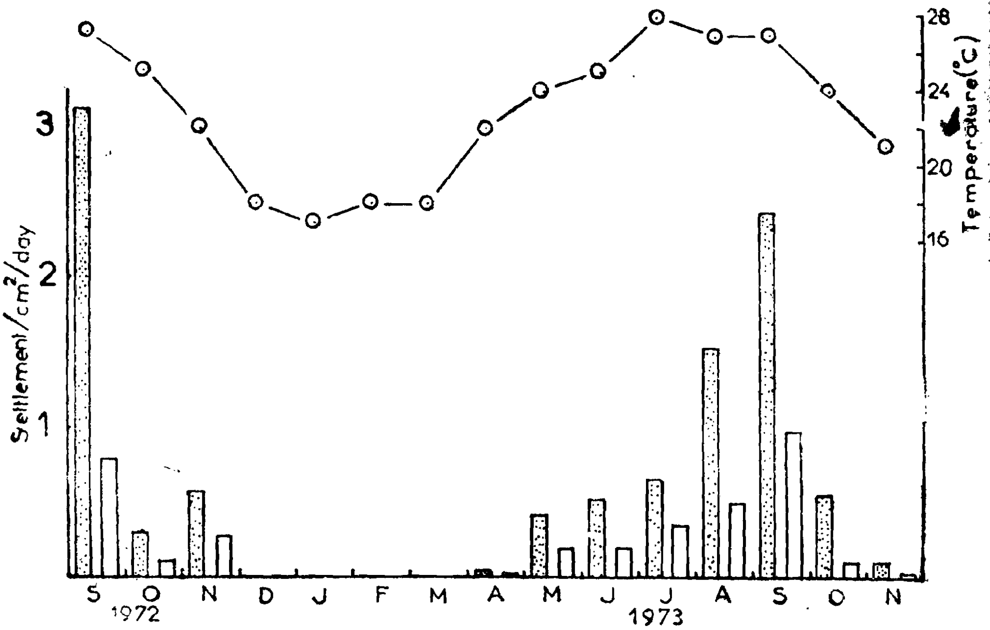

Fig. 1. Rate of settlement of *H. norvegice* for 15 months on rough (dotted histograms) and on smooth (white histograms). The circles represent mean temperature in the months.

Illumination of the background :

Results of 7 exposures, illustrated in Table (1 A), indicates preference of *H. norvegica* to settle on black (11.2 worm/cm^2) rather than on white background (1.0 worm/cm^2), For the smaller areas Table (1 B) shows that although black squares were still preferred ratio of settlement on the two backgrounds decreased by the decrease of square area, they became 6.4, 3.1 and 1.98 for 2.0 cm^2, 1.0 cm^2 and 0.5 cm^2 respectively.

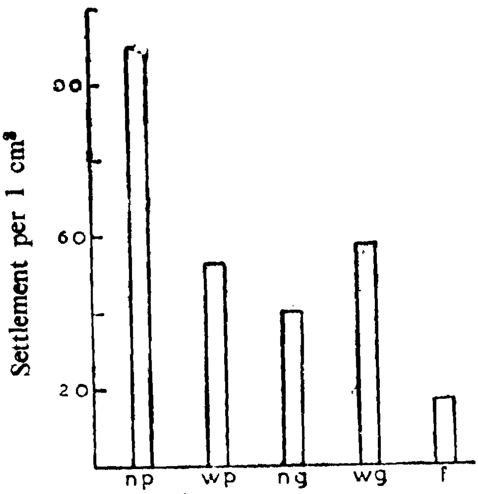

Fig. 2. Comparison between settlement intensity on narrow grooves (n.g), wide grooves (w.g.) and flat surface (f.).

Gregariousness :

Panels (6 × 7 cm) were firstly immersed in the sea for two days, all settlers on these panels other than *H. norvegica* were thoroughly removed. Subsequent settlement of this species was compared with that happened on other similar panels ; not previously inhabited (control). This comparison was repeated 8 times and the results obtained in Table (2). Obviously presence of previously attached worms stimulated further settlement. The greater the number and less dispersed the attaching worms the greater the number of the new worms. Ratio of settlement on experimental panels to that on controls ranged from 1.5 : 1 in eighth experiment when 15 worms were previously sparsely attached to 28.7 : 1 when 125 worms attached in clusters on a panel 12.5 × 10 cm in the case of third experiment.

In another series of experiments settlement on 3 panels of the same size soaked overnight at a 2°C in a solution made of tissue extract of *H. norvegica* was compared with settlement on other 3 controls soaked in sea water. Results of 5 of such exposures are shown in Table (3). Panels soaked in the tissue extract induced greater settlement than controls but to a lesser extent than panels previously inhabited with worms. The mean ratio of settlement on experimentals to that on controls was in the former case 2.74 : 1 while in the letter case was 11.5 : 1.

Effect of brown algae on settlement :

On 3 panels (12.5 × 10 cm), free from faunal attachements, film of brown algae belonging to family *Ceramiaceae* was promoted. Settlement of these panels and on other 3 panels free from any previous attachment (controls) is shown in Table (4). It reveals that presence of this brown algae induced settlement of worms which reached in average 6.3 times greater than on control panels.

TABLE 1. **Choice of *H. norvegica* between black and white backgrounds.**

	Black	White	Black/White
A. *Settlement on* 10 × 2.25 *cm² panels*:			
1*st* experiment	1270	144	8.8 : 1
2*nd* experiment	1800	186	9.7 : 1
3*rd* experiment	337	76	4.9 : 1
4*th* experiment	420	104	4.0 : 1
5*th* experiment	1675	127	13.3 : 1
6*th* experiment	3530	136	25.4 : 1
7*th* experiment	830	90	9.2 : 1
Total	9782	875	11.2
B. *Settlement on chequeur background* :			
2.0 × 2 0 1*st* experiment (total surface area 36 cm²)	288	29	10 0 : 1
2*nd* experiment	428	83	5.15 :
Total	716	112	6.4 : 1
1.0 × 1 0 cm 1*st* experiment (total surface area 12 cm)	182	63	3.0 : 1
2*nd* experiment	1005	313	3.2 : 1
Total	1187	376	3.1 : 1
0.5 × 0.5 cm Its experiment (total surface area 12 cm²)	92	63	1.46:1
2*nd* experiment	549	260	2.11:1
Total	641	322	1.98:1

Table (2) — Settlement of *H. Norvegica* in Panels (6 × 7 cm) Previously Inhabited by, Worms of this Species.

	number of settling worms on			
	Previously Settling	Newly Settled	Controls *	Ratio
1*st* experiment	100	527	210	2.5 : 1
2*nd* experiment	206**	7936	344	23.0 : 1
3*rd* experiment	125**	2300	080	28.0 : 1
4*th* experiment	130**	1500	180	8.4 : 1
5*th* experiment	015	0155	070	2.2 : 1
6*th* experiment	016	0130	060	2.2 : 1
7*th* experiment	020	0115	050	2.3 : 1
8*th* experiment	015	0185	120	1.5 : 1
Total . .	527	12828	1114	11.5 : 1

* soaked in sea water and free from any settlement.

** These worms were concentrating in a limited area on a panel 10 × 12.5 cm.

TABLE 3. **Pettlement of *H. norvegica* on panels (6 × 7 cm) previously treated with its tissue extract.**

	Number of worms settled on panels		
	Previously settling	Control*	Ratio
1*st* experiment	430	200	2.15 : 1
2*nd* experiment	190	080	2.4 : 1
3*nd* experiment	230	040	5.8 : 1
4*th* experiment	205	081	2.5 : 1
5*th* experiment	302	095	3.1 : 1
Total	1357	496	2.74 : 1

* Panels soaked with sea water only.

TABLE 4. **Settlement of *H. norvegica* on panels (10 × 12.5 cm) previously inhabited by film of brown algae.**

	Number of worms settled on panels		
	Inhabited by algae	Control*	Ratio
1*st* experiment	840	80	10.5 : 1
2*nd* experiment	2800	345	8.1 : 1
3*rd* experiment	2500	560	4.4 : 1
Total	6140	1385	6.3 : 1

* Panels soaked with sea water but no brown algae was previously formed.

Depth :

In five exposures carried out between 13.5 and 8.8.1973 a panel was placed horizontally at depths 0.5, 1.0, 1.5, 2.0 and 2.5 meters and vertically at the first 4 depths only. In the latter positions while one side of each panel was daylighted the other side was shaded by placing a screen on the corresponding side of the rack. Percentage settlement on panels of the same orientation expressed in histograms are shown in Fig. (3). Table (5) compares between numbers of settled worms in all positions during the five exposures. Highest settlement occurred at 1.0 and 1.5 m on both vertical and horizontal panels and horizontal panels and least settlement. Worms on this side approximately represented 5/3 of the number of worms settled on the upper side of panels at all depths. On the other hand, shaded sides of the vertical panels were nearly doubly attractive than lighted sides.

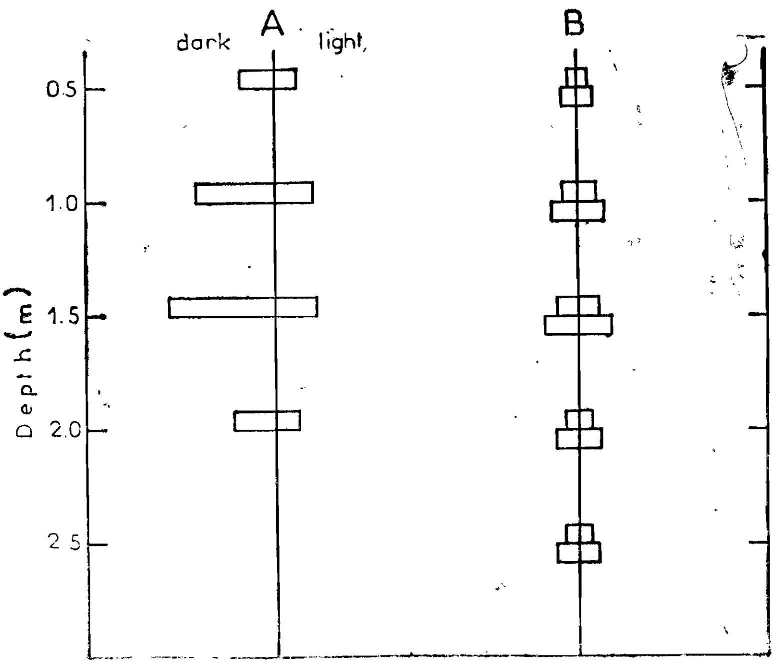

Fig. 3. Settlement of *H. norvegica* in the harbour at different depths on both sides of ; A) vertically suspended panels, and B) horizontally suspended panels.

TABLE 5. **Settlement of** H. *norvegica* **at different depths on panels (12.5 x 12.4 cm) of different orientations**

	Depth (meters)					
Panel position	½	1.0	1½	2.0	2½	Total
Horizontal, upper side	2970	5787	6987	4458	4693	24881
Horizontal, lower side.	5122	8768	11812	8130	7171	41003
Vertical, daylighted	1643	2989	3250	1858	—	9740
Vertical shaded	2616	6400	8300	3360	—	20676
	12351	23944	30335	17806	11864	

CONCLUSIONS

Peak settlement of *Hydroides norvegica* occurred in the Eastern harbour of Alexandria in may 1975 (Banoub, 1960), in july and continued to September in 1969 (Megally, 1970) and took place during this work in September. This indicates that a fluctuation of rate of settlement of this serpulid takes place during the successive years. Fluctuation of its settlement also occurs in successive months. In September 1972 rate of the settlement on rough panels during the second week was about 6.5 worms/cm^2/day but in the fourth week it was 0.20. On the contrary in September 1973 it was in second third week about 1.3 worm/cm^2/day and in the fourth weeks it was 3.7 worm/cm/day

The results of the three studies, however, emphasise the severe settlement of this tube worm in this harbour during the summer months. During his work Banoub found that about 60,000 worms attached to a square foot of test panels and in this work a layer about 5 cm thick (about 200 worms /cm) fromed on the whole surface area of two panels (15 x 15 cm) left submerged from the first to the end of July 1973. This work also suggests that settlement of this form almost disappears at temperature below 21°C, this may explain its disappearance in cold seas.

Choice of larvae of *H. norvegica* to settle in concave rather than flat surfaces is a behaviour demonstrated by various fouling organisms from diffenent groups, Barnacles (Barnes *et al.*, 1961 ; Crisp and Barnes, 1954 and Moyse, 1971), the serpulid, *Spirorbis borealis* (Wisely, 1960), the ascidian *Diplosoma listerianum* (Ghobashy, 1967) and the hydroid *Clava squamata* (Williams, 1965). It is likely that these surfaces give a shelter for these animals to withstand water currents during and just after attachment. Narrow pits apparently offer the growing *H. norvegica* the *best* opportunity to cement itself on the substrate and to grow comparatively free from being dislodged by the action of water currents.

Similar to findings of Wisely (1959) in Asstralan waters these worms select rough and black surfaces as substrates for their settlement rather than smooth and white surfaces. The other serpulid

Spirorbis borealis (Crisp and Ryland, 1960) and *Pomatoceros triqueter* (Barnes and Powell, 1950) prefer to settle on smooth surfaces.

Settlement on shaded is a behaviour parallel to settlement on dark background. Both suggest that, during settlement stage, larvae of *H. norvegica* avoid illuminated places. Wisely (1958) reported that larvae of this serpulid were firstly indifferent to light but after 4 or 5 days showed slight tendency to be photopositive. This work proved, that at settlement they are photonegative.

Conforming with the other serpulid *Spirobis borealis* (knight-Jones, 1951) *H. norvegica* is gregarious during settlment. Thus previous presence of worms on a substrate attracts other worms to be attached too and hence in a limited period a thick layer of this fouler would result. It is evident that this phenomenon is responsible of the formation of serpulid reefs in the harbour of Corpus Christi in Texas (Beherens, 1968) and heavy settlement everywhere it occurs.

Members of genus *Spirorbis* select to settle on algal filming substrates (Williams, 1964 and Knight-Jones et al, 1971). Choice of *H. norvegica* of panels inhabited by brown algae indicates that this behaviour may be common in family Serpulidae.

Settling preferentially on the undersides of horizontal panels seems to accord with seeking of larvae to settle in dimly lit places. Response to gravity may have an effect on larval behaviour in this respect. Wisely (1958) recorded settlement of this species at the bottom of a container but this claimed geopositivity in larvae be weaker than the photonegative response because the undersides were always favoured if compared with the upper sides and both sides of vertical panels. On the other hand selection of panels at depths 1.0 and 1.5 mm may be attributed to the stimuli of light intensity and pressure which need further study in the laboratory. Wisely (1960) also found that this serpulid settle mainly at a depth about 1.10 m below the surface.

SUMMARY

1— Settlement of the tube worm *Hydroides norvegica* (Gunnerus) is continuous in the eastern horbour of Alexandria throughout the year but be heavy during summer especially in September (2.43 worms/cm-day).

2.—It prefers to settle on rough, concave and black rather than smooth, flat and white surface respecively.

3.—Its larvae are photonegative at settlement.

4.—Gregariousness is well shown during settlement.

5.—Highest settlement, in the eastern harbour of Alexandria, occur at depths from 1.0 to 1.5 m. from the surface of the sea.

6.—The undersides of the horizontal panels is the most attractive orientation for its settlement.

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