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# Settlement patterns of two Spirorbidae (Annelida, Polychaeta) species in the harbour of Ischia (Gulf of Naples, Mediterranean Sea)

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## ABSTRACT

Studies on settlement rate of *Neodexiospira pseudocorrugata* and *Simplaria pseudomilitaris* (Polychaeta, Spirorbidae) in the Port of Ischia (Naples) are reported. Observations were carried out monthly, during a one-year cycle (April 1995-April 1996) at two different depths (0.5 and 1.5 m) using unglazed ceramic tiles as substrate. Both species reproduced throughout the year with maximum settlement in June and July at 1.5 m depth. On tiles exposed during June, 40% of individuals of *N. pseudocorrugata*, ranging between 0.8 and 1.6 mm coil diameter, were brooding, with broods smaller (6-14 eggs, egg diameter 75 µm) than in most spirorbid species. *Simplaria pseudomilitaris* did not reach brooding size within any of the monthly exposure periods. In and after August, an algal bloom of attached brown filaments (Ectocarpaceae) covered the tiles and was accompanied by decreased settlement and heavy mortality of spirorbids.

**KEY WORDS:** *Neodexiospira pseudocorrugata* - *Simplaria pseudomilitaris* - Polychaeta - Spirorbidae - Settlement - Fouling - Mediterranean Sea.

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## INTRODUCTION

Spirorbids are small polychaetes that live in coiled calcareous tubes permanently attached to the substrate (Fauchald, 1977), where they brood their embryos to a three-setiger larval stage (Nott, 1973). Development within each brood is synchronous and lasts from two weeks to over a month (Daly, 1978). Larval period in the plankton is short, the larvae creeping or swimming for a few minutes to a day before settlement (Gee & Knight-Jones, 1962; Gee, 1963). Spirorbids exhibit several types of species-specific brooding modes, the most common being to keep the embryos within a chamber inside the operculum (Knight-Jones *et al.*, 1972).

Settlement and gregariousness of spirorbids were studied by Knight-Jones (1951, 1953), who demonstrated that larvae have a short positive phototactic period, but negative reactions to light appear soon after liberation, leading them to settle on rocky or algal surfaces before they are carried far from the parent stocks. Moreover, larvae are able to distinguish their own species from allied ones, and isolated individuals are able to delay metamorphosis. After prolonged swimming, however, they settle more indiscriminately. This life-cycle strategy enables them to build up a population quickly and rapidly colonise ephemeral substrates, both natural and artificial. Most spirorbids are typical of fouling communities and often show a cosmopolitan distribution. Probably, large-scale dispersal in these organisms is related to the adult phase rather than the larval stage, as occurs for instance in colonial organisms and in some peracarid crustacea which disperse by rafting (Highsmith, 1985).

In order to acquire more information about spirorbid life cycles, monthly settlement studies were performed during one year of observations in a confined marine environment. The study focused on *Neodexiospira pseudocorrugata* (Bush, 1904) and *Simplaria pseudomilitaris* (Thiriot-Quévieux, 1965), the only two species settling on experimental tiles. Both species are known as cosmopolitan and are commonly found throughout Mediterranean harbours, where they are among the most widespread fouling forms (Bianchi, 1981). They seem to have a continuous reproduction like the majority of spirorbids in warm latitudes (Giangrande, 1997). Despite the large amount of studies relative to Mediterranean macrofouling, data concerning these two species are scanty, and very little information on their biological features is available (Bianchi, 1981). Settlement in both species seems to occur throughout the year, with an increase during autumn in *N. pseudocorrugata*.

## MATERIALS AND METHODS

Observations started at the beginning of April 1995 and ended in March 1996. Unglazed and reddish ceramic tiles (15×15 cm) were placed at the entrance to the port of Ischia (Gulf of Naples; Fig. 1), at 0.5 and 1.5 m depth. A total of twenty-four tiles was used (one per month for each depth). Dark tile colour was chosen following James & Underwood (1994) who noted heavier

spirorbid settlement on dark surfaces. Tiles were fixed to a larger plastic support, removed after a month of exposure, and replaced with new ones. After removal, tiles were fixed in buffered 4% formalin and examined. On massively colonised tiles, taxonomic and quantitative analyses were performed by randomly selecting five replicates of 1 cm<sup>2</sup>. During periods of low settlement rate, the entire tile was analysed. Abundance was always reported as number of individuals per cm<sup>2</sup>. Data on algal coverage were obtained on a digital image of the whole tile by an image analysis computer system (Image Pro-Plus 2.0).

For each individual, the maximum diameter was measured across the spiral formed by the coiled tube. In ripe specimens, the length of brood chamber and the diameter of each egg were measured and the numbers of eggs within each brood chamber were counted. All measurements were performed using a binocular microscope with a lens micrometer. The relationship between brood chamber size and number of eggs contained, brood chamber size and diameter of coiled tube, and number of eggs and diameter of coiled tube were tested and described by linear correlation.

## RESULTS

In Fig. 2, the settler number per month of *N. pseudocorrugata* and *S. pseudomilitaris* at the two depths is shown. Except for the first month (April 1995), in both species settlement abundance was higher at 1.5 m depth. Settlement intensity was higher during summer in both species at both depths, with more pronounced peaks in *N. pseudocorrugata*. Settlement was always recorded at the deeper station, while the shallow station was characterised by the absence of *N. pseudocorrugata* settlement in November and of *S. pseudomilitaris* in May, September, and December.

During the period of maximum settlement intensity (June-July), brooding individuals were found within *N. pseudocorrugata* populations (Fig. 3), even though a few brooding individuals were also present in September. Like most of the warm latitude spirorbids, *N. pseudocorrugata* brood their embryos within a chamber inside the operculum. In the observed population, individual size ranged between 0.2 and 1.6 mm, but the minimum

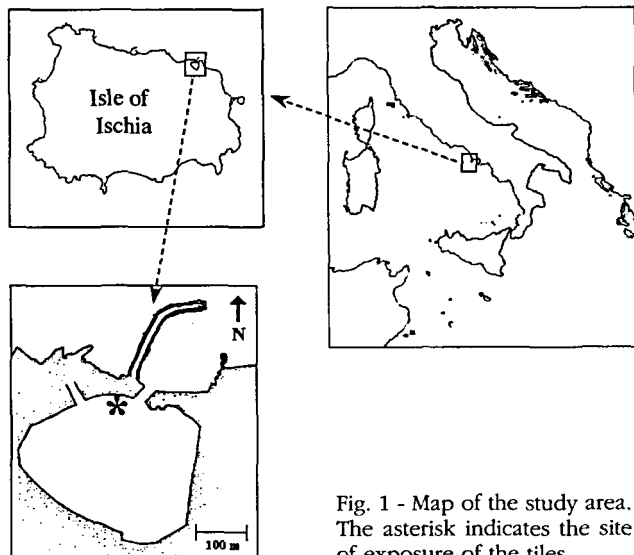


Fig. 1 - Map of the study area. The asterisk indicates the site of exposure of the tiles.

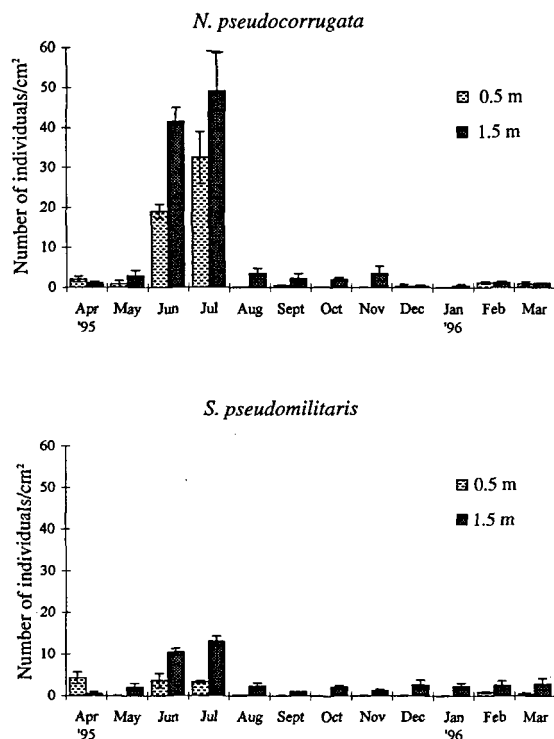


Fig. 2 - Settlement densities per month ( $\pm$  SD) of the two species at the two depths.

brooding size was 0.8 mm. The percentage of brooding specimens within the range of brooding size (0.8-1.6 mm) was higher at 1.5 m in July (27.5% vs 10%). In June, no brooding individuals were present at 0.5 m, although 40% of the larger individuals were brooding at 1.5 m.

In August, a dramatic decrease in settlement rate was observed, especially for *N. pseudocorrugata*, and most of the settled spirorbids were found dead (74% of tubes empty). This was coincident with a massive increase of brown filamentous algae (*Ectocarpaceae* gen. sp.), lasting to the end of the following January (Fig. 4).

The size of brood chamber, ranging from 0.2 to 0.5 mm, was directly related to the number of eggs contained ( $r = 0.88$ ,  $n = 62$ ,  $P < 0.01$ ; Fig. 5a). Although a relationship was also discovered between brood chamber size and the diameter of the coiled tube ( $r = 0.54$ ,  $n = 62$ ,  $P < 0.01$ ), as well as between the number of eggs contained in the chamber and the size of the specimens ( $r = 0.52$ ,  $n = 62$ ,  $P < 0.01$ , Fig. 5b, c), a wide range of brood chamber lengths containing a different number of eggs was recorded at each size. The mean egg-diameter was 75  $\mu$ m ( $\pm$  0.006 SD). *Simplaria pseudomilitaris* sizes ranged between 0.2 and 1.4 mm coil diameter. Brooding individuals were never found in this species.

## DISCUSSION

Greater settlement of both species at 1.5 m depth rather than 0.5 m may be probably explained by larval

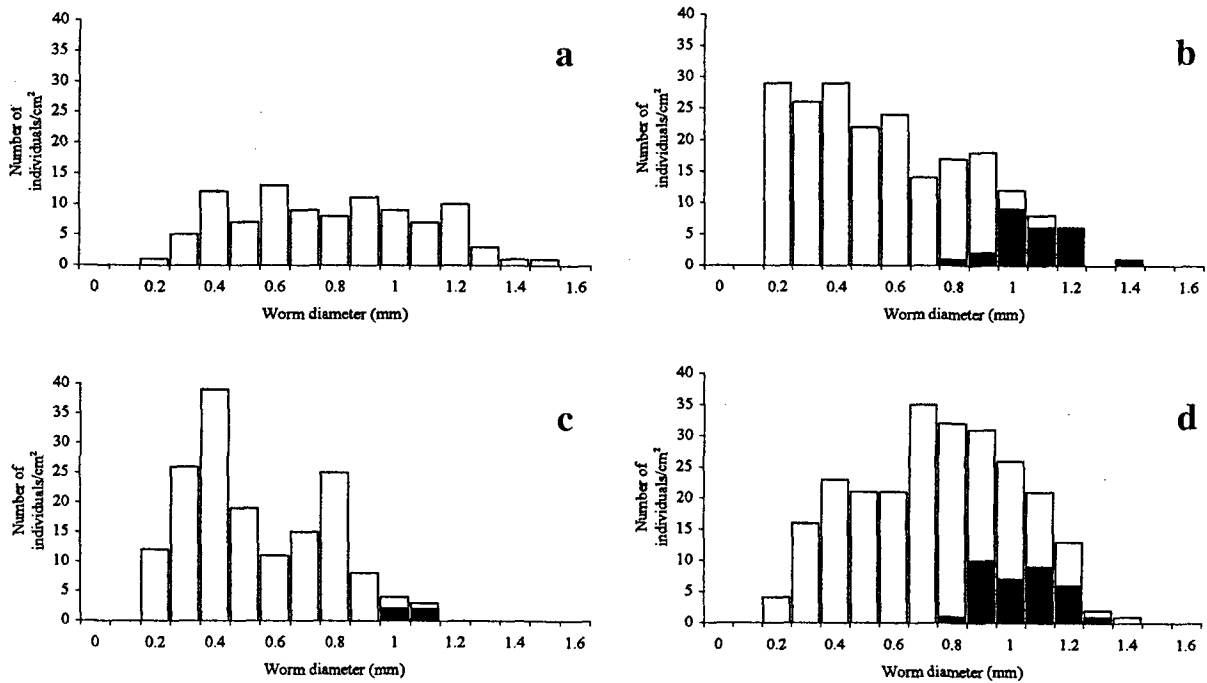


Fig. 3 - Size frequency histograms of *Neodexiospira pseudocorrugata* settling at the two depths. Black areas represent brooding individuals. a, June, 0.5 m depth; b, June, 1.5 m depth; c, July, 0.5 m depth; d, July, 1.5 m depth.

negative reaction to the light, as described by Knight-Jones (1951) for other spirorbids. Settlement was always higher in *N. pseudocorrugata*, which proved to be the dominant spirorbid on the tiles. In both species, settlement occurred throughout the whole year, but at a very low rate during winter, whilst the maximum was observed during summer. This is in contrast with Bianchi (1981), who reported an autumn peak of settlement for *N. pseudocorrugata*.

The trend of algal colonisation on the tiles, together with the dramatic decrease in settlement rate observed in August, suggests that in the studied biotope, algae played an important role in controlling spirorbid densi-

ty. Filamentous algae could have a negative effect, perhaps by inhibiting settlement and certainly by smothering settled individuals, as shown by the large percentage of empty tubes found in August. Algal massive abundance was recorded in autumn, and this could explain the lack of settlers during this period, which in other places is the most favourable reproductive period for *N. pseudocorrugata*. Clearly, this hypothesis still has to be tested by an *ad hoc* designed experiment.

Continuous reproduction is generally the rule in this family (Bianchi, 1981; Giangrande, 1997) and is confirmed by a constant presence of individuals during the whole year. Nevertheless, brooding specimens were observed only in *N. pseudocorrugata* and only during summer. Likely, in cold seasons, one month is not enough for *N. pseudocorrugata* to reach brooding size and this period is never enough for *S. pseudomilitaris*. However, the absence of brooding individuals in *S. pseudomilitaris* could also be due to its lower abundance. From the present data, it is only possible to hypothesise a life cycle of about one month for *N. pseudocorrugata*, at least during summer. However, no information concerning the life span, or number of reproductive events during life, can be obtained from the present data.

The percentage of brooding specimens within the *N. pseudocorrugata* population seemed to be quite low at both depths, also considering that spirorbids are simultaneous hermaphrodites. The mean egg size found for this species (75  $\mu\text{m}$ ) is smaller than that observed for other spirorbid species (about 140  $\mu\text{m}$ ; Giangrande, 1997). Also, the number of eggs contained in the brood chamber (a maximum of 14) is lower than that reported

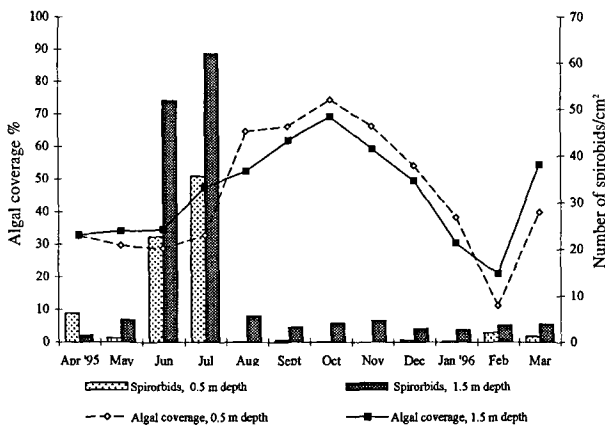


Fig. 4 - Annual trend of algal coverage on the tiles at the two depths, with the cumulated annual trend of settlement rate for the investigated species.

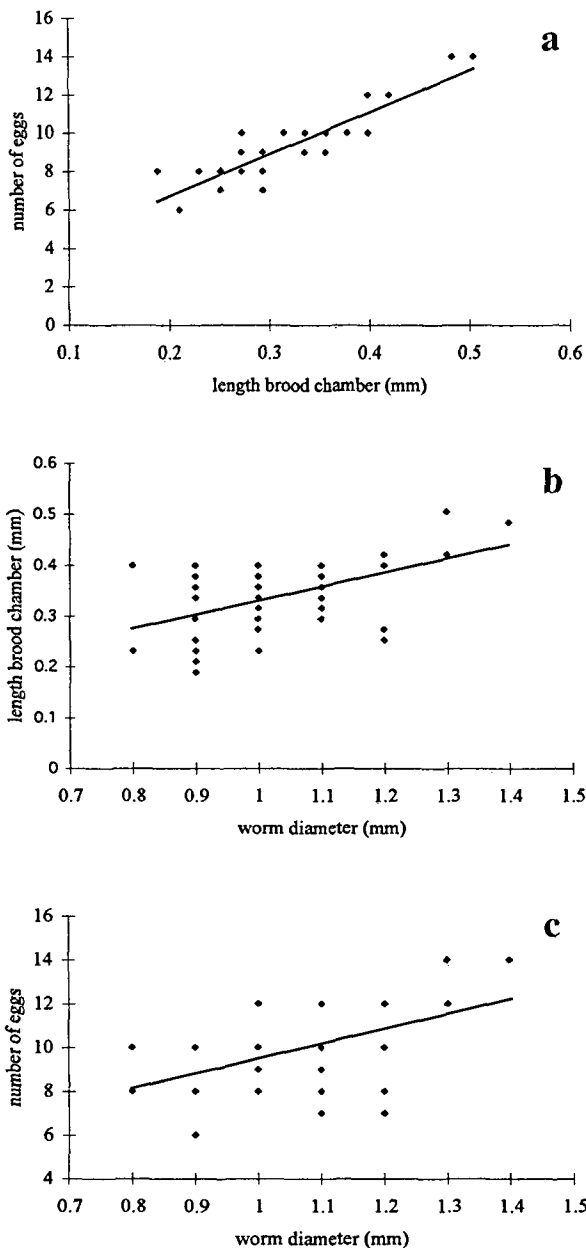


Fig. 5 - *Neodexiospira pseudocorrugata*: linear regression between length of brood chamber and number of eggs contained (a), coil diameter and length of brood chamber (b), eggs number and coil diameter (c).

for other spirorbids, e.g. 60 egg broods in *N. brasiliensis* (Fauchald, 1983) and *Bushiella armoricana* (Hess, 1993). The number of eggs produced by a single individual is probably related to its size, and it is likely that our species is smaller than what is reported in literature (Fauchald, 1983; Giangrande, 1997). However, Hess (1993), demonstrated that none of the brooding modes in this family (e.g., brooding of embryos within the chamber inside the operculum, and brooding inside the tube) appears

to be associated with constraints on brood size, and he concluded that different modes of brooding within Spirorbidae have probably not evolved in response to selective pressure associated with scaling constraints on brood size.

A relationship between size of the worm and size of the opercular chamber, was evidenced. The size of the opercular chamber was, in turn, highly correlated with the number of eggs contained in it. However, this correlation showed the presence of a wide range of brood chamber length for each size. It should be stressed that previously this kind of correlation was often computed by comparing different species, in order to evaluate the relationship between size of the animal and brood size (Strathmann & Strathmann, 1982). In the light of the present data, the need for knowledge of intraspecific variability, before interspecific differences can be compared, is emphasised.

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