Polygordius sp. nov on the Move! What this Marine Worm and Other Macrofauna Can Tell You About Where to Live and When to Move

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ABSTRACT

Macrofaunal core samples collected from ripple crests and troughs at LEO-15, New Jersey, revealed that bivalve densities were higher in crests compared to troughs. The opposite trend was found for polychaetes, crustaceans, and nemerteans with higher densities in ripple troughs. These patterns may be a result of sediment grain size differences observed between crests and troughs with crests having a higher proportion (60%) of coarse sand (500-1000 µm) compared to troughs (40%). Percent total organic carbon did not differ between crests and troughs. *Polygordius* sp. exhibited subsurface post-settlement movement under still water and low flow conditions that was preferentially directed toward organic sediments. Very few *Polygordius* sp. moved by means of active bedload or suspended-load transport.

INTRODUCTION

Macrofaunal communities in sandy sediments on the inner continental shelf off New Jersey are often dominated by high densities of an undescribed polychaete (*Polygordius* sp. nov), formerly considered to be a member of the little-studied Archiannelida (Ramey 2005). These sediments are transported by waves, tidal currents, and storms and this study was designed to examine certain aspects of this worm's habitat preferences, and how it makes a living in these physically disturbed habitats. Spatial patterns (e.g. abundance, distribution, composition) of macrofauna in soft-sediment communities are greatly influenced by the characteristics of the sediment in which they live, such as organic content, grain size, dissolved oxygen, stability and porosity (Lenihan & Micheli, 2001; Snelgrove, 2001). Of these, we measured organic content and grain size. Although looking at where larvae of benthic organisms settle is important to gain an understanding of faunal patterns, it may be more interesting to ask where they move after settlement. This question has never been addressed for *Polygordius* sp. We tested several means of post-settlement movement using two flumes located at the Institute for Marine and Coastal Sciences, Rutgers University, NJ). In the miniflume we examined subsurface movement, whereas in the racetrack flume, we examined whether *Polygordius* sp. would actively move into the water column and be either transported as bedload or as suspended load. There is direct evidence that several organisms including polychaetes actively enter the water column to migrate (e.g. Cummings et. al. 1995; Olivier et. al. 1996; Stocks 2002). We used two sediment treatments (inorganic and organic) to determine whether they would affect the quantity of worm movement (e.g. Olivier et al. 1996; Stocks 2002).

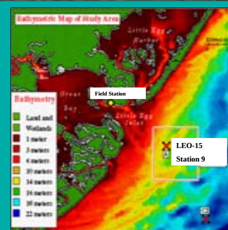
GOALS

The main goal of this study was to examine the habitat preference, capacity and mode of post-settlement movement of *Polygordius* sp. nov (Ramey 2005). We examined the distribution of *Polygordius* sp. and other macrofaunal taxa (i.e. polychaetes, crustaceans, bivalves, nemerteans) in crests compared to troughs of sand ripples on the inner continental shelf, LEO-15, New Jersey. Sediment parameters such as grain size and organic content were examined to help explain observed patterns. In addition, we experimentally tested whether *Polygordius* sp. exhibited post-settlement movement and if more movement occurred when they found themselves in an unfavorable habitat (e.g. inorganic sediments/no food). Three modes of movement were examined: subsurface movement within the sediment, active bedload transport, and active water column transport.

METHODS

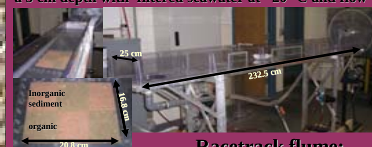
Field Collections:

Macrofaunal cores were collected at Station 9 at Rutgers Long-term Ecosystem Observatory, LEO-15 (39˚ 28' N, 74˚ 15' W). Station 9 is ~ 12 m deep, and is a coarse sand habitat with ripples 10-12.5 cm high and 35 cm apart at the time samples were collected. A total of 16 cores were collected by divers consisting of crest/ trough pair samples each taken ~ 2 m apart on May 19, 2005. Five crest/trough (n total=10) samples were used for macrofaunal analyses and 3 others were used for organic carbon analyses of the top 1 cm of sediment. Macrofaunal cores were preserved in 4% formalin and transferred to 70% ethanol with Rose Bengal. Macrofaunal taxa were sorted and enumerated. After cores were sorted, grain size was determined using stacked sieves and dry weight measures. Organic carbon analysis was preformed using a Carlo Erba elemental analyzer. A Van Veen grab (0.04 m²)was used to collect live *Polygordius* sp. for experiments.



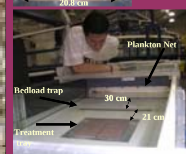
Miniflume:

Polygordius sp. was starved for ~24 h and acclimated for 30 min (20˚C). A sediment tray was divided into 6 cells, arranged in 2 rows of alternating sediment treatments with a removable plastic divider and placed in the flume. One treatment was fresh organic sediment (Station 9) and the other was Station 9 baked (375 °C for 24 h) sediment (inorganic). The same number of *Polygordius* sp. (4-7 individuals) was placed in the center of each cell, and left to burrow (1 min). The flume was filled to a 5 cm depth with filtered seawater at ~20 °C and flow was 1.04 cm^{-1}. After ~ 68-96 h the divider was replaced and the number of worms within each cell was counted. This experiment was also performed in still water conditions.



Racetrack flume:

Set up included a down-stream bedload trap to catch *Polygordius* sp. transported as bedload, and plankton net designed to catch *Polygordius* sp. transported as suspended load. Upstream of this was a 2 celled sediment tray. Cell 1: (organic sediment, 12 *Polygordius* sp.) and Cell 2: (inorganic sediment, 13 *Polygordius* sp.). Water temperature was 22 °C and velocity 18 cm^{-1}. The exp. was run for ~18 h and the trap/net were checked for worms every 2 h for the first 6 h.



RESULTS

Ripples: Crests vs troughs, LEO-15

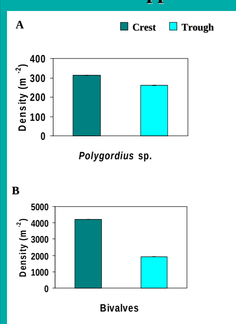


Fig. 1 Bar graph showing density of (A) *Polygordius* sp. (B) bivalves in ripple crests vs troughs with 95% confidence intervals, n=5. Note: scale on y-axes differ.

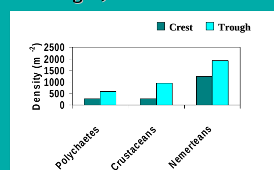


Fig. 2 Bar graph showing density of polychaetes, crustaceans and nemerteans with 95% confidence intervals, n=5.

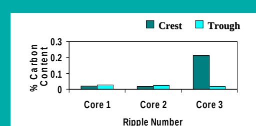


Fig. 5. Bar graph showing percent total carbon in ripple crests vs troughs.

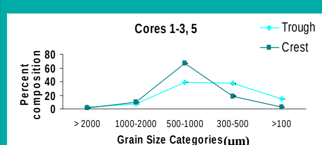


Fig. 3 Plot showing percent composition of eight grain size categories in ripple crests vs troughs with 95% confidence intervals (n=4).

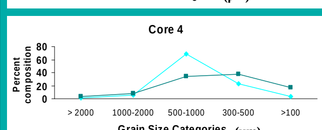


Fig. 4 Plot showing percent composition of eight grain size categories in ripple crests vs troughs of core 4.

Mini and racetrack flumes

Mini flume: flow

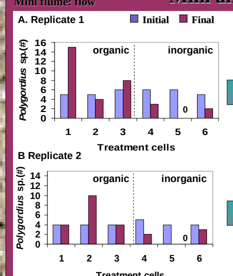


Fig. 6 Bar graph showing initial vs final numbers of *Polygordius* sp. in organic vs inorganic sediment treatment cells under flow conditions A. rep. #1 B. rep. #2

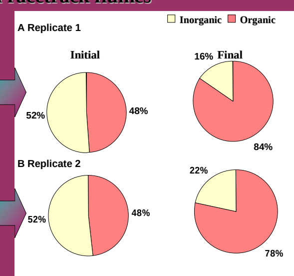


Fig. 7 Pie charts showing initial and final percentages of *Polygordius* sp. in organic vs inorganic sediment treatments under flow conditions A. rep. #1 B. replicate #2. Note: organic and inorganic treatment cells have been combined.

Mini flume: still water

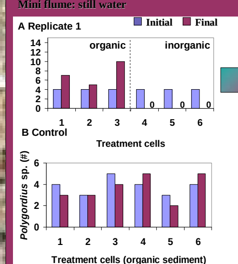


Fig. 8(A) Bar graph showing initial vs final numbers of *Polygordius* sp. in A. organic vs inorganic treatment cells B. the control (organic treatment cells only) under still water conditions.

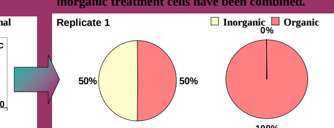


Fig. 9 Pie charts showing initial and final percentages of *Polygordius* sp. in organic vs inorganic sediment treatments under still water conditions.

Racetrack flume:

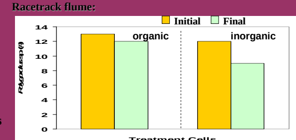


Fig. 10 Bar graph showing initial vs. final numbers of *Polygordius* sp. in organic vs. inorganic treatments.

QUESTIONS

- 1. Is there a difference in abundance of *Polygordius* sp. and other macrofaunal organisms in the troughs compared to crests of sand ripples at LEO-15 (12 m depth), and can patterns in abundance be related to sediment grain size, and/or organic content of the sediment? (Examined with field collections from LEO-15)
- 2. Does *Polygordius* sp. exhibit post-settlement movement and if it does which type is more common: subsurface movement, active bedload or active suspended load? (Examined using mini and racetrack flumes)
- 3. Is there more post-settlement movement if *Polygordius* sp. is present in unfavorable environments (e.g. inorganic sediments/no food) than if they are in favorable ones (organic sediments/with food)? (Examined using mini and racetrack flumes)

DISCUSSION OF RESULTS

Ripple crests vs. troughs, LEO-15: Macrofaunal core samples showed that *Polygordius* sp. and bivalve densities were higher in crests compared to troughs (Fig. 1 A, B). Other polychaetes, crustaceans, and nemerteans showed the opposite trend with higher densities in troughs (Fig. 2). These trends may be a result of sediment grain size differences observed in crests vs. troughs. With the exception of core 4, crests had a higher proportion (60%) of coarse sand (500-1000 µm) compared to troughs (40%), (Fig. 3). Troughs had a greater proportion (50%) of fine sand (100-500 µm) compared to crests (20%), (Fig. 3). Core 4 showed the reverse grain size and faunal patterns which suggests that the crest and trough core samples may have been switched during sample collection (Fig. 4). With the exception of one core organic carbon content was not different between crests and troughs (Fig. 5) and therefore probably did not influence faunal patterns. High amounts of carbon in core 3 may have been due to a dead macrofaunal organism in the sample.

Miniflume: In the miniflume, under still and low flow water conditions, *Polygordius* sp. exhibited subsurface movement which was preferentially directed toward organic sediments (Figs. 6-8A, 9). Pie charts show that at the beginning of the experiments there were ~ 50:50 *Polygordius* sp. in organic vs. inorganic sediments, whereas at the end at least 78% of *Polygordius* sp. were in organic sediment (Fig. 7, 9). In addition, movement between cells was much greater when *Polygordius* sp. was present in alternating inorganic/organic sediment treatments compared to a control containing only organic sediment (Fig. 8 A vs B control).

Racetrack flume: Very few *Polygordius* sp. moved by means of active bedload or suspended-load transport (Fig. 10). The few individuals that were found in the bedload trap moved within the first 2 h of the experiment and were likely those that may not have completely burrowed into the sediment and were swept away when the flow began.

ACKNOWLEDGMENTS

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