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Marine Adaptations
Exploratory 2

Hood Orientation of the *Pista pacifica*

Introduction:

Pista pacifica, having no common name, are deposit feeding terebellids. When the tide comes in, the worm spreads it tentacles over the substrate and collects edible particles. The *pacifica* can be found from British Columbia to southern California (Kozloff, 1993). They prefer a sandy mud substrate, and are known for making burrows in the sediment and having practically vertical tubes made from mucus and sand. At the surface of the tube, is a signature characteristic to the *Pista pacifica*, a triangular shaped hood. The worm itself can reach up to 30cm long and the tube can be up to 1 meter long (Winnick, 1981).

The purpose of the hood for the *Pista pacific* is still not quite known. In other terrebellids, similar appendages are used to harness the energy of water to assist in feeding behaviors. *Lanice conchilega,* a commonly studied terebellid, also builds a tube ornament described as a "fringed crown" (Seilacher, 1951). After much research, the fan-shaped crown of the *conchilega* was shown to orient its hood against the direction of the current. The tentacle-like projections from the hood help catch the current, forcing edible particles to drop to the substrate (Winnick, 1981). This benefits the corresponding worm, by having it exert less energy to collect food from the water column like filter feeders. Another example, *Diopatra cuprea,* a tube building polychaete, also was shown to orient it's tube caps against the direction of the current. When sediment begins to collect over the tube, both worms respond by elongating the tube upwardly (Schafer, 1912).

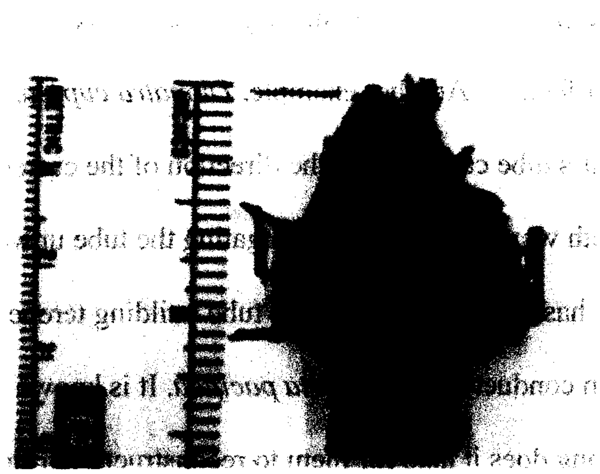
Research has been done on similar tube building terebellids and polycheates, but little research has been conducted on the *Pista pacifica.* It is known that terebellids continue to build their tubes, but how long does it take for them to reconstruct their tube hood? What is the particular evolutionary purpose of the hood for the *Pista pacifica?* Does the *Pista pacifica* also exhibit the similar tendency to orient its hood against the direction of the current to take advantage of the environment's energy? I would hypothesize that it would take the *pacifica* less time to rebuild its tube hood when cut below the surface, because it known for other teribellids to start reconstructing their tubes when sediment collects over the entrance to their tube. Cutting the tube below the surface can simulate the sediment gathering over the top of the tube. My second hypothesis is that the *Pista pacifica* would orient its hood ornament against the direction of the current like other teribellids, because of the potential benefits the worm would receive in food gathering.

Methods and Materials:

This experiment was designed to test whether *Pista pacifica* utilize their tube hoods as a tool to suppliment their feeding behaviors, and also to determine the growth rate at which they fully re-grow their hoods. All test subjects were located in the South Slough mudflat under the south end of the bridge leading into Charleston, Oregon. At low tide, 12 *Pista pacifica* were found and marked with a survey flag, each flag being numbered 1- 12 (Fig 1). Initial observation of general characteristics of the tube and hoods were taken. The length (from the opening of the tube to the tip of the hood), width (the widest point of the hoods) and orientation of each subject were measured. All measurements were taken with a common ruler and marked in centimeters (Fig 2).

(Fig 1)

(Fig 2)



After initial observations were made, the hoods were cut off at different points on the tube stalk. Subjects 1-6 had their hoods cut 2cm below the substrate surface, while subjects 7-12 were cut 2cm above the substrate. This process was done by using a standard ruler and a pair of scissors. For subjects 1-6, the ruler was inserted into the substrate until 2cm of the ruler was submersed. The scissors were then inserted to a level equal to the lowest point of the ruler and the tube stalk was then cut. For subjects 7-12, the ruler rested upon the top of the substrate surface and the tube column was then cut at the 2cm mark.

After the *pista* tubes were cut, they were left undisturbed for 4 consecutive days. After this waiting period the subjects were located again; observations and measurements were then taken.

Initial Observations: The Hoods are grainy in texture and the material mostly consists of sand held together by clear mucus secreted by the polycheate. The organic material is flexible and some are more flaccid than others. Coloration ranges from fairly clear, with mucus dominating the hood material to dark gray/brown/greenish color, which consists of more sand than mucus. The general consistency of the of the material consists of clumps of sand or sparsely dispersed grains.

Hood shapes ranged from a triangular shape (Fig 3), which tended to be the larger of the hoods, to rounded tear drop shape (Fig 4) for the smaller hoods. Regardless the size, each hood was lined with tentacle like structures made from the same material as the hoods. On average each tube ornament had 17 +/- 5 tentacles.

Fig 3

Fig 4

Results:

Table 1 Before and After Hood Removal: Orientation/Length/Width measurements

#	**Before Hood Removal Orientation/Length(cm)/Width(cm)**	**After Hood Removal Orientation/Length(cm)/Width(cm)**
	(Subjects 1-6 cut 2 cm below substrate)	
1	Hood opens **towards** the water current 3 cm/ 3.5 cm	Hood opens **towards** the water current 2 cm/ 1.5 cm
2	Hood opens **Parallel** to the water current 2.5 cm/ 2.5 cm	Hood opens **Parallel** to the water current 2.5 cm/ 2 cm
3	Hood opens **towards** the water current 2 cm/ 2 cm	Hood opens **towards** the water current 2 cm/ 2 cm
4	Hood opens **towards** the water current 1.5 cm/ 1.5 cm	Hood opens **towards** the water current 1cm/ 1.75 cm
5	Hood opens **towards** the water current 4 cm/ 3 cm	Hood opens **Parallel** to the water current 3 cm/ 3 cm
6	Hood opens **towards** the water current 3 cm/ 2 cm	Hood opens **towards** the water current 1.5 cm/ 1.5 cm
	(Subjects 7-12 cut 2 cm above substrate)	
7	Hood opens **towards** the water current 2 cm/ 2cm	Hood opens **towards** the water current 1.5 cm/ 1.75 cm
8	Hood opens **opposite** to water current 2 cm/ 2.5 cm	Hood opens **opposite** to water current 2 cm/ 1.75 cm
9	Hood opens **towards** the water current 2 cm/ 3cm	Hood opens **towards** the water current 2.5 cm/ 2.5 cm
10	Hood opens **towards** the water current 3 cm/ 2 cm	Hood opens **towards** the water current 2 cm/ 2 cm
11	Hood opens **towards** the water current 2 cm/ 3 cm	Hood opens **towards** the water current 2.5 cm/ 2.5 cm
12	Hood opens **towards** the water current 2 cm/ 2 cm	Hood opens **towards** the water current 1.75 cm/ 2 cm

Table 2 Before and After Hood Removal Area and Total difference (cm^2)

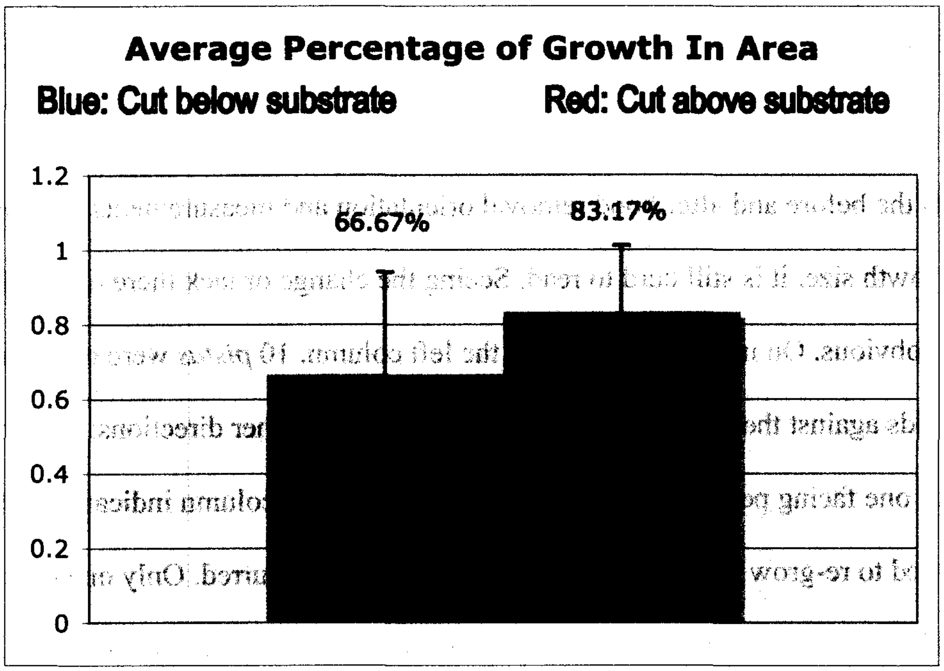
	1	**2**	**3**	**4**	**5**	**6**		**7**	**8**	**9**	**10**	**11**	**12**
Before	10.5	6.25	4	2.25	12	6		4	5	6	6	6	4
After	3	5	4	1.75	9	2.25		2.63	3.5	6.25	4	6.25	3.5
Total	7.5	1.25	0	.5	3	3.75		1.37	1.5	-.25	2	-.25	.5
% Total growth	29%	80%	100%	78%	75%	38%		66%	70%	104%	67%	104%	88%

Table 1 lists the before and after hood removal orientation and measurements. Although the results measured growth size, it is still hard to read. Seeing the change or lack there of, of the hood orientation is fairly obvious. On initial observations, the left column, 10 *pistas* were orienting the opening of their hoods against the water current. Only 2 were facing other directions; one being with the current and one facing perpendicular to the current. The right column indicates the results after time was allotted to re-grow the hood ornament. Little change occurred. Only one *pista*, number 5, had a different orientation than it did before the hood removal. Number 5 was originally facing against the water current and changed to be perpendicular to water flow.

Because the results in table 1 were unclear, table 2 was constructed. Table 2 shows the area of each test subject before and after the hood removal (rows 1&2). Each average was calculated by multiplying the length by the width and recorded in cm^2. Row 3 indicates the total growth by subtracting the area after hood removal from the original areas of the hood.

Showing the total growth, does not however accurately represent the comparative amount of growth that occurred, because each *Pista* started out with a different size hood. Larger hoods may be harder to rebuild or it may take a longer period in comparison to smaller hoods. Showing the percentage of growth will help to compare the growth rate of the six test subjects that were cut 2cm below the substrate (#1-6) to the six that were cut 2 cm above the substrate (#7-12). The percentage of growth is calculated by dividing the area after the hood removal and regrowth by the area before hood removal. The result is then multiplied by 100 to give the percentage of growth that occurred for each test subject. Seeing the percentage of growth per tube, allows analysis of growth to represent the results more accurately.

Graph 1



Graph 1 clearly shows the difference in growth rates between the *Pista pacificas* that were cut above the substrate (Red) and below (Blue). On average the test subjects that were cut above the substrate exhibited a faster growth rate than the test subjects that were cut below the substrate.

Discussion:

There was no significant difference in the subjects' hood orientation before and after hood removal. Due to the high percentage of hoods before the hood removal and the resulting number facing against the current of the water, the results do support the earlier stated hypothesis. The *Pista pacifica* orients its hood ornament against the direction of the current like other teribellids, most likely because of the potential benefits the worm would receive in food gathering.

Pista pacificas grew faster when their hoods were cut above the substrate rather then below it, thus refuting my hypothesis. The average growth rate in area of the test subjects 7-12, the *Pistas* cut above ground had a percentage of 83.17% while the *Pistas* that were cut below the substrate only 66.67%.

This experiment was not a closed test, meaning there were a lot of variables that were not, and could not have been, controlled. One possible source of error could be due to the positioning of the flags. There was no pattern or linear fashion to which the *Pistas* were found and marked. Perhaps the hood orientation and the area growth rate could be influenced by factors depending on how high they are located on shore. Their locations could have experienced differences in the sun exposure, wind vulnerability and most importantly the current direction and velocity since this directly affects their feeding habits.

If this experiment was to be conducted again, changes should be made. When marking *Pista pacifica*, there should be an equal amount of subjects from different distances from the shoreline when performing the area growth rate test. Another option could be to have an equal number of different sized hoods for each group of subjects (those cut above the surface and those cut below). This way the beginning sizes might be varied but each test group would be varying the same amount. Another change that could be made would be to obtain the test subjects and house them in a laboratory. One way to do this would be to contain the *Pistas* in a glass box with water and their natural substrate and measure the growth rates and hood orientation. One could experiment with different current directions and velocity with and without food particles. These changes can help reduce the excess variables that were not controlled in this experiment.

References:

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