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The Influence of Passive Flow on the Feeding Current of Sea Squirts (Urochordata: Chordata)

Michelle Rabon, '03
Illinois Wesleyan University

Ebony Tillman, '02
Illinois Wesleyan University

Alison Sweeney, '01
Illinois Wesleyan University

Elizabeth Balser, Faculty Advisor
Illinois Wesleyan University

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THE INFLUENCE OF PASSIVE FLOW ON THE FEEDING CURRENT OF SEA SQUIRTS (UROCHORDATA: CHORDATA).

Michelle Rabon, Ebony Tillman, Alison Sweeney, and Elizabeth Balser*
Department of Biology, Illinois Wesleyan University

Many aquatic animals that feed on particles suspended in the water column employ a filter mechanism to capture food particles, such as algae or bacteria. This type of feeding method requires a filter and a water current to carry food particles across this filter. Animals can use energy to generate water flow through their filters; however, they can benefit greatly by taking advantage of any flow in the environment. The research presented here was designed to examine how an organism might utilize ambient current by altering its structure to promote passive (not requiring energy expenditure by the animal) water flow through feeding structures. A common marine filter feeder, a sea squirt, also called a tunicate, is thought to employ passive flow to augment its feeding current. Tunicates live with one end attached to the ocean floor and the other end pointed upward. The upper end supports an incurrent and excurrent opening. Each opening is located at the end of a tube called a siphon. Water flows into the incurrent siphon, across a filter that traps food particles, and out the excurrent siphon. A flow tank was constructed to generate laminar (non-turbulent) flow in order to examine the relationship between siphon characteristics and utilization of passive flow. A living tunicate and an artificial glass tunicate were placed in the flow and the rate of water movement, as indicated by dye movement, through the animal and the glass tunicate was measured. The particular structure of the siphons allows tunicates to take advantage of three different mechanisms involved in passive flow-- viscous entrainment, Bernoulli's Principle, and the Pitot Tube Effect. The position of siphons, length of siphons, and angle of the siphons relative to the laminar flow were manipulated to measure the potential contribution of Bernoulli's Principle and the Pitot Tube Effect to the flow through the organism. For the artificial tunicate, which has no ability to generate flow, a wide range of these structural parameters (listed above) resulted in passive flow through the tunicate. Further, an optimal position of the siphons, resulting in the greatest rate of passive flow, was determined. Similar results were observed in the living tunicate, which is capable of generating flow using tiny hair-like structures called cilia. However, the animal could also manipulate the position and diameter of the siphons presumably to achieve the optimal position to enhance passive flow through the feeding structures.