**Totally Tube-ular! The Retraction Response of Fan Worms**

Maya Mylott, College of Charleston

Jiang, W., Sun Y., Wu, Z., Pan, Z., Bok, M. J., Wu, J. (2023). Rapid Manoeuvre of Fan Worms (Annelida: Sabellidae) Through Tubes. *Journal of Experimental Biology*, 226 (9).

Escape response strategies depend on the body plan of an organism to be able to flee from potential predators. Invertebrates tend to lack the support of a solid skeleton and cannont move like vertebrates but are still able to escape predation. One such invertebrate, fan worms in the annelid family Sabellidae*,* have an escape response that has been difficult to study due to their enclosed tubing and quick response to stimuli. These worms create tubes around themselves by secreting a protective mucus that attaches to a substrate. In order to feed and respire, they extend their bodies 2-3x their original length above their tubes and use over 40 tentacles to carry out bodily functions. Arranged in a radiolar crown, these tentacles contain a number of small structures called pinnules, which could become damaged from the quick movement and could cause increased drag on the worm when it moves quickly underwater. With the enclosed space and large appendages, how are fan worms able to respond so quickly to predators when provoked?

To answer this question, Jiang et al. (2023) examined the mechanisms behind how these worms retract their bodies and tentacles. They used a high-speed camera to record the movements of 6 different fan worm species (*S. japonica, S. australiensis, S. magnifica, S. sanctijosephi, S. indica, S. spectabilis*) along with 3 other annelid species, including earthworms (*Lumbricus rubellus*), leeches (*Hirudo medicinalis*), and nereidids (*Alitta succinea*). Each species was individually transferred into a glass tube in order to record the contractions of the muscles and obtain the retraction speed. Once they were acclimated to the new tubing, each of the species were stimulated by shooting a jet of water at the anterior end. After recording each of the annelids' responses, tissue samples were taken from the middle region of the body of each species, and an extra sample of the tentacles were also taken from the fan worms. To see how the fan worms were able to retract their pinnules without damaging them, the lab created computer-simulated mathematical models to test the fluid drag force around each of the fan worm species.

The camera recordings showed that in order to retract, fan worms contract their muscles longitudinally and relax their circumferential muscles. The speed of retraction for the fan worm species ranged from 130 to 490 millimeters per second, with the other annelids performing slower at 30 to 90 millimeters per second (Figure 1). When compared to other marine organisms, fan worms are able to retract at around 8 body lengths per second, which is double the swimming speed of the sailfish *Istiophorus platypterus,* one of the fastest swimmers, which can only travel 4 body lengths per second. This quick retraction in the fan worms may be due to the fact that in the muscle samples, fan worms had 1.7 times the amount of longitudinal muscle mass of the other annelid groups. It was also found that this muscle mass allows the fan worms to generate a contractive force up to 36 times their own body weight, aiding the fast movement. The glass tubes also allowed researchers to examine the symmetrical ridges on the sides of the fan worm's segmented body that condensed during retraction. When condensing, the ridges no longer hold the worm in the body wall, creating bilateral normal forces. This allows the worm body to never come into contact with the tube wall when retracting and orienting the body to reduce friction by 89%. As for the tentacles, the video showed that the worm will flatten the pinnules using small longitudinal muscles within each tentacle before the worm contracts back into its tube. With the help of the simulated models, the authors discovered that flattening the pinnules allowed the worms to protect their appendages, reduce drag, and decrease the water mass brought into the tube, which helped increase retraction speed.

This research not only answers the question of how fan worms are able to retract quickly but also provides evidence as to how the worm is able to have such large appendages and elicit a quick response at the same time. By utilizing the strong longitudinal muscles in both the body and tentacle region, segmented ridges, and the flattening of their pinnules, fan worms are able to effectively retract into their tubes. This research may have implications in the engineering field by providing ideas on how to create underwater machinery that is fast and drag-efficient, especially when moving through pipes and small enclosed spaces. While this research looks at the motor response in fan worms, the pinnules that have very unique sensory receptors to elicit the flattening response were not examined. Furthermore, the radiolar crown contains eye structures that aid in the detection of predators (Bok et al. 2019). Research looking into the neural pathway connecting the muscular and nervous system in these organisms would further the knowledge about their movement and response behavior.

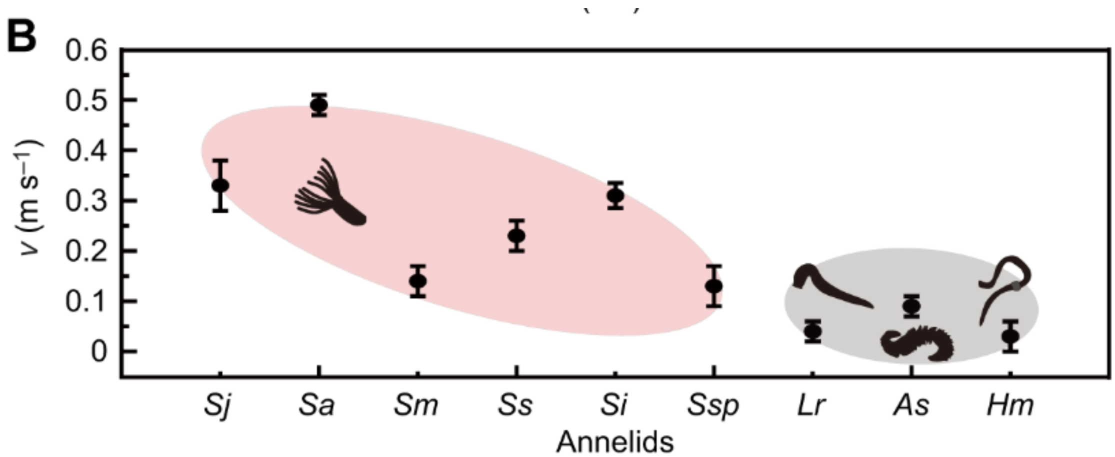


Figure 1: Comparison of the average retraction speed (v) between the 6 Sabellidae species (*S. japonica, S. australiensis, S. magnifica, S. sanctijosephi, S. indica, S. spectabilis)* and the three other annelid species (*Lumbricus rubellus*, *Hirudo medicinalis*, *Alitta succinea*) demonstrating that the order Sabellidae has a faster retraction speed.

**Literature Cited:**


Bok, M. J., Nilsson, D., & Garm, A. (2019). Photoresponses in the radiolar eyes of the fan worm, *Acromegalomma vesiculosum. Journal of Experimental Biology,* 222 (23). https://doi.org/10.1242/jeb.212779.

Jiang, W., Sun Y., Wu, Z., Pan, Z., Bok, M. J., Wu, J. (2023). Rapid Manoeuvre of Fan Worms (Annelida: Sabellidae) Through Tubes. *Journal of Experimental Biology*, 226 (9). https://doi.org/10.1242/jeb.245731.