Swimming Mechanics of Gossamer Worms

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Introduction:
Gossamer worms are a group of polychaetes that are unique among marine segmented worms. They range in size from a few mm to nearly a meter in length. Unlike most polychaetes, they lack mesenteries that isolate their body segments. They also lack the many bristles at the tips of each of their appendages that polychaetes are named for. These differences make the mechanics behind how they swim particularly interesting because both features typically play a role in polychaete swimming. Tomopterids show remarkable flexibility, maneuverability, and speed in their swimming, contradicting previous hypotheses of the mechanisms of swimming in polychaetes. The purpose of this project is to begin to describe the kinematics of tomopterid swimming.

Methods:
- Tomopterids collected via remotely operated vehicle Doc Ricketts
- High speed videos taken on board the R/V Western Flyer with a Photron FASTCAM MiniAX50 high-speed video camera.
- 52 landmarks tracked using MATLAB R2017a and DLT software.
- Counted # wavelengths, # parapodia per wavelength in power and recovery strokes, and # segments per wavelength for 9 animals.
- Regressions calculated for each in relation to body length.

Conclusions:
- Tomopteris swimming mechanics are not significantly affected by animal size.
- Tomopteris changes the length of its appendages to create a difference in drag.
- The body wave further aids in this by displacing the parapodia further in or out.

Figure 1. Tomopteris swim using a combination of their paddle-like parapodia (appendages) and a metachronal wave that is generated from the tail. Parapodia stroke from front to back during the power stroke, and are pulled forward during recovery stroke.

Figure 2. Landmarks tracked using MATLAB.

Figure 3. Traces of selected landmarks. Head (blue), tail (orange), tips of parapodia (red & purple), front bases of parapodia (yellow & light blue), back bases of parapodia (green and blue).

Figure 4. Ten animals, ranging in size from 1.36 to 9.09 cm, were examined. This figure shows four different swimming metrics by body length. None of the trends seen are significant suggesting the basic mechanism used for swimming is not different between different sized animals.

Figure 5. The above figure shows that there is a significant change in parapodia length between power and recovery strokes. This difference in length increases the drag experienced during power stroke and reduces the drag experienced during the recovery stroke.

Figure 6. The above figure shows the displacement of the bases of the parapodia created by the body wave. This displacement pushes the parapodia out into water during the power stroke and displaces them in the opposite direction – inward – during the recovery stroke. This further increases the difference in drag between power and recovery stroke.

Figure 8. Green line illustrates displacement of parapodia during power vs. recovery.