Kinematic variations of the aquatic-terrestrial transition in *Polypterus senegalus*.

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Introduction

- *Polypterus senegalus* is an amphibious fish capable of surviving and locomoting on terrestrial environments for a certain period of time.
- Many research studies have addressed the amphibious locomotor behavior for one habitat at a time. However, little has been done to understand the aquatic-terrestrial transition.
- From an evolutionary perspective, this project examines how environmental restrictions affect the water to land locomotory transitions.
- Here, we investigated the kinematic parameters of locomotion by manipulating the water depths from a fully terrestrial to a fully aquatic environment.

Methods

Fish were filmed at 500 frames/second using two Photron high-speed cameras placed on different angles above the tank capturing the dorsal view and one Fastec camera on the side for the lateral view.

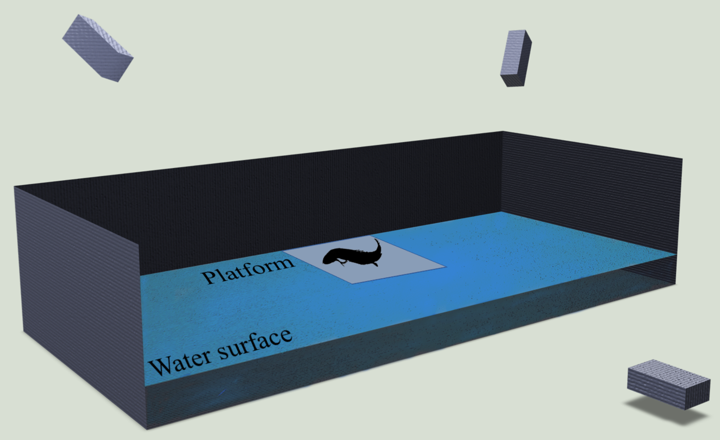

Fig.1. Filming setup schematic. The front wall has been omitted for clarity.

We filmed the fish in six different transitional environments: terrestrial, 25% body depth, 75% body depth, one, two, and three body depths.

Head and tail points were digitized from each video using DLTdv5[1], fish outline between digitized points was defined using ImageJ contrast binarization. 100 points along each fish midline were calculated using custom Matlab code.

We calculated body curvature, tail frequency, wave amplitude and the distance overground of five (head, 25%, 50%, 75% and tail) points along the body of the fish.

Results

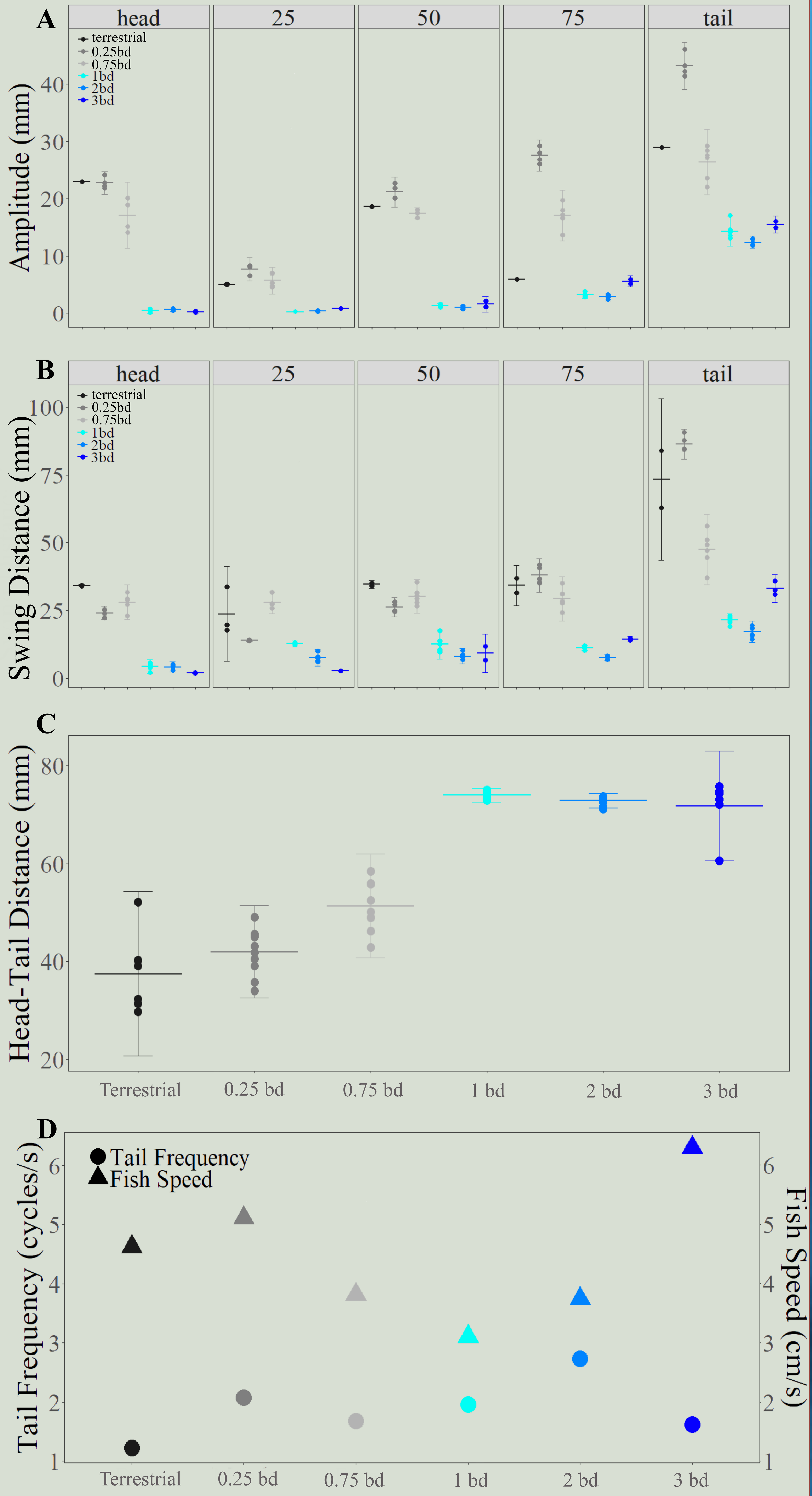

Fig.2. Kinetic parameters at six different transitional environments, by body depth (bd). **(A)** wave amplitude (mm) for five points along the body, **(B)** swing distance (mm) for five points along the body, **(C)** body curvature represented as the linear head to tail distance (mm), **(D)** tail frequency (cycles/s) and fish speed (cm/s). The mean values and the error bars are representative of different trials for one fish.

Discussion

- In *P.senegalus,* aquatic and terrestrial locomotion are distinct from one another and kinematic variables differ during the transition from the fully aquatic to the fully terrestrial environment. (fig.2)
- In all six treatments, the wave amplitude and swing distance increased going from the head to tail direction and was consistently greatest at the tail. When the fish is moving on land until the 0.75 bd environment, wave amplitude showed higher values on all points along the body with a transition at 1 bd. (fig.2.B)
- The head-tail distance in the terrestrial-like movement before 1 bd emphasize a walking behaviour. The body oscillates with a high wave amplitude and corresponding swing distance. A swimming behaviour with greater head-tail distance occurs at 1 bd and remains mostly stable, correlating with smaller wave amplitudes and swing distance. (fig.2.C)
- Tail frequency varies proportionally with the fish speed meaning that the fish is mostly using the tail to propel itself. This is not the case for the 3bd where the fish is likely mostly using its fins. In terrestrial environments, *P.senegalus* had a lower tail frequency than the aquatic environments. That is because at lower water level, the body friction overground makes the locomotion harder. (fig.2.D).
- The fish swims with higher velocities in comparison to walking. (fig.2.D).
- In the future, further research is needed to evaluate the kinematic variations and muscles activity pattern in the 1 bd transitional environment.

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References

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