Biological flexibility: sensory feedback, motor control and power under different environmental regimes

Emily M. Standen*
*Comparative Physiology Group, Biology Department, University of Ottawa, Ottawa, Canada
estanden@uottawa.ca

Animals that are flexible in their locomotive performance can take advantage of new habitats avoiding competition and predation and exposing themselves to adaptive selection. This flexibility may drive the evolution of new forms. My research team is particularly interested in the flexibility of the vertebrate musculo-skeletal system and how it adapts when navigating novel environmental conditions. Amphibious fishes provide an excellent example of a vertebrate system that adapts to drastically different mechanical forces when moving from water to land. In this talk I will discuss our current research on the predominantly aquatic fish, *Polypterus senegalus* (Fig. 1) and how its kinematics, sensory feedback, neuromuscular control and muscle fiber type change during locomotion between various aquatic and terrestrial environments.

Body and fin kinematics change dramatically depending on the substrate *Polypterus* is navigating [1]. How this diversity of body motion is controlled is not entirely known. Fish have a variety of sensory systems including a lateral line system that is sensitive to changes in water flow patterns. Lateral line ablation techniques on more derived fish suggest that vision and the lateral line system work together to provide sensory feedback and influence body kinematics during swimming [2]. One goal of our research is to understand how the lateral line system influences behaviour or muscle control when amphibious fish move into a terrestrial environment.

In water, sensory feedback can also be altered by changing the viscosity of the water and thus the mechanical feedback experienced by the swimming fish. By measuring muscle activity levels and changes in kinematic performance as animals move through different media we gain information about how neuromuscular control is compensating in novel environments.

Finally, we are interested in the longer term effects environment has on the muscle fibers powering locomotion. Muscle tissue is remarkably plastic and responds to the forces it experiences by changing muscle fiber type. Using experiments that modify sensory feedback, measure muscle activation patterns and quantify muscle fiber type in biological organisms provides insight into the functional performance of biological systems in novel environments. Understanding how biological organisms use multiple systems to traverse diverse or complex environments may provide insight for biorobotic design.

Figure 1. *Polypterus senegalus* Photo credit: Antoine Morin.

References

[1] Standen, E.M., et al., "Locomotor flexibility of Polypterus senegalus across various aquatic and terrestrial substrates". *Zoology*, 2016. **119**(5): p. 447-454.
[2] Liao, J.C., "The role of the lateral line and vision on body kinematics and hydrodynamic preference of rainbow trout in turbulent flow, 10.1242/jeb.02487". *J Exp Biol*, 2006. **209**(20): p. 4077-4090.