

Examining the Lateral Line System of Captive-Bred *Pristella maxillaris*

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Introduction

The lateral line is a mechanosensory system present in all fish species and is characterized by the ability to detect external water movement. It consists of larger canal neuromasts embedded in the bone canal and smaller superficial neuromasts found on the skin's surface. The lateral line system plays a crucial role in predator avoidance, schooling, navigation, and prey detection, making it essential for survival. The lateral line system is relatively conserved across species, yet research has shown that it remains plastic, as its reliance can change under different ecological conditions (Schwalbe et al., 2012). Furthermore, the ability to acquire sensory information is often specialized for an animal's behavioral needs (Spiller et al., 2017), suggesting that the lateral line system can evolve and adapt to specific needs and environmental pressures, or, possibly, the lack thereof. A study conducted by Fischer et al. (2013) investigated developmental plasticity in the lateral line system in response to predation. They found that guppies (*Poecilia reticulata*) from high-predation sites had more superficial neuromasts than those from low-predation sites. Additionally, a study by Vanderpham et al. published in 2013 found that fish from coastal rivers had more head canal pores than those collected upstream from rivers or lakes.

These studies highlight how increased predation and varying water flow can influence the density and distribution of neuromasts in wild fish, however, there is a gap in knowledge regarding the effect on the lateral line in long term captive-bred fish experiencing a prolonged lack of pressure. This experiment aims to investigate this gap in knowledge by examining the lateral line system of a genetically modified and long-term captive-bred species, *Pristella maxillaris*. To achieve this, a fluorescent microscopy technique will be used to visualize and identify the various components of the lateral line in *Pristella maxillaris*, enabling further investigation into the distribution of the superficial and canal neuromasts. Due to the lack of long-term environmental pressures in captivity, I hypothesize that the lateral line system will be less complex.

Methods

The experiment was conducted on Friday, February 21. A camera was mounted on a dissecting microscope, with the camera's visual feed displayed on the monitor. The camera was connected to the monitor via an HDMI cable and to the laptop via a USB cable. The software utilized for this experiment was CaptaVision+.

A fish was selected from a tank in the room LI 176. The fish selected for this experiment was the *Pristella maxillaris*. It was gently collected with a fish net and placed in a beaker of ~100-200 mL of conditioned tap water. Once the fish was isolated, it was gently transferred into a beaker containing ~100 mL of 4-di-2-ASP, using gloved hands. The fish remained in this solution for 5 minutes. After 5 minutes, the fish was then transferred with gloved hands to a beaker containing ~100mL of MS222 for 5 minutes. This solution humanely euthanized the fish. Both the 4-di-2-ASP and the MS222 solutions were not disposed of in the drain or trash; they were properly disposed of in their designated waste containers. After 5 minutes, the fish was placed onto a petri dish lined with sylgard containing 1:1 conditioned tap water and MS222. Throughout the experiment, the fish was handled with gloved hands to protect the skin from the MS222.

The fish was then placed under the microscope to obtain its total length. This was done by measuring from the mouth to the edge of the caudal fin. This length was 32 mm and was recorded in the "Lab 7 - Fish Lateral Line System spreadsheet". With gloved hands, the fish was positioned and secured with pins to expose the lateral view. This view

displayed the mouth to the left with the left side of the body pointing up. Extreme caution was taken when pinning the fish so that it was not impaled and would not potentially damage the neuromasts. The fish was then placed under the microscope and focused using the fiber-optic light. In the software, the exposure was adjusted so that the fish was well lit but not overexposed. The fish was first observed at low magnification under fluorescent light. This was done by switching off the fiber optic light, turning on the fluorescence light, and placing a yellow filter under the microscope. A lateral full body view was captured using the live stitching feature.

This displayed the fluorescently lit lateral line system of the fish along the head and body. An image of a close-up view of the head was also captured to provide better visualization of the neuromasts. The fluorescence light was then switched to the fiber optic light, and the yellow filter was removed, allowing images under bright light to be captured. The live stitching feature did not work in bright light, so three separate images of the fish's body were taken and later cropped together. These steps of image capturing were repeated for both the dorsal and ventral views of the fish. For each image taken and saved to the computer, information on the image number, the type of light, the view, the magnification, and other relevant notes was recorded in the spreadsheet. After sufficient images were obtained, they were transferred to our personal devices via email.

After the experiment, the fish was disposed of in a designated Ziplock bag, and the workstation and equipment were disinfected using 70% ethanol. Later, the images were cropped and pieced together, and the various components of the lateral line system were labelled using PowerPoint.

Results

Lateral View

Figures 1, 2, and 3 display the lateral view of the *Pristella maxillaris*. These images display the supraorbital (SO), otic (OT), mandibular (MD), infraorbital (IO), postotic (PO), and trunk (T) canals. As seen in the fluorescent images in Figures 1 and 2, the trunk canal runs roughly 5 mm along the fish's body. Additionally, a higher number of neuromasts is observed on the head compared to the side of the body.



Figure 1. Lateral full body view of *Pristella maxillaris* under fluorescent light. Labelled are various canals of the lateral line system. These include the supraorbital (SO), otic (OT), trunk (T), mandibular (MD), infraorbital (IO), and postotic (PO) canals. The image was taken with live stitching under X6 magnification.

Dorsal View

Figures 4 and 5 display a dorsal view of the *Pristella maxillaris*. The supratemporal (ST) and supraorbital (SO) canals are labelled in Figure 4.

Ventral View

Figures 6 and 7 display the ventral view of the *Pristella maxillaris*. The mandibular (MD) canal is labelled in Figure 6.

*This author wrote this paper for Biology 340: Animal Physiology taught by Dr. Margot Schwable.

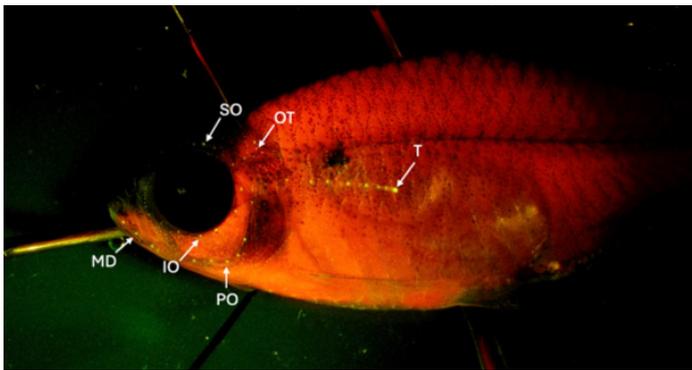


Figure 2. Close-up lateral view of the head with the labelled canals of the lateral line system. The image was taken with X6 magnification.



Figure 3. Lateral full body view image of *Pristella maxillaris* under bright light. Two images were taken separately and then stitched together. The images were taken under X6 magnification.



Figure 4. Dorsal full body view of *Pristella maxillaris* under fluorescent light. The supra-temporal (ST) and supra-orbital (SO) canals are labelled. The image was captured with live stitching under X6 magnification.

Discussion

Fluorescent images of the *Pristella maxillaris* revealed a shorter trunk canal along the body, supporting the original hypothesis that there will be a less complex lateral line. Past literature has shown that the lateral line system is adaptable, as behavioral needs and environmental factors can affect its development and specialization. However, continuous research is needed to understand the lateral line system in long-term captive species. A 2013 study by Brown et al. was among the first to investigate lateral line differences between captive bred and wild-origin fish. In this research, they found that wild steelhead trout (*Oncorhynchus mykiss*) juveniles had significantly more superficial neuromasts than hatchery-reared juveniles. This study highlights how a loss of environmental factors, such as predation and strong water currents, may cause the lateral line system to undergo evolutionary modifications due to decreased selective pressure, supporting the findings of this experiment.



Figure 5. Dorsal full body view of *Pristella maxillaris* under bright light. Two images were taken separately and then stitched together. The images were taken under X6 magnification.



Figure 6. Ventral full body view of *Pristella maxillaris* under fluorescent light. The mandibular (MD) canal is labelled. The image was captured with live stitching under X6 magnification.



Figure 7. Ventral full body view of *Pristella maxillaris* under bright light. Two images were taken separately and then stitched together. The images were taken under X6 magnification.

This experiment provided further investigation of the lateral line in a captive-bred species and highlights the importance of continued research to better understand the effects of a domesticated environment on a fish's lateral line system. The findings of this experiment are vital to creating a more holistic understanding of how the lack of environmental pressures may affect the adaptation and development of the lateral line system. Since the lateral line is species-specific, future research can investigate its effects on the lateral line system in species that have experienced prolonged pressure relief. This research can be applied to future sustainability and conservation efforts, particularly in fisheries.

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References

1. Brown, A. D., Sisneros, J. A., Jurasin, T., Nguyen, C., & Coffin, A. B. (2013). Differences in lateral line morphology between hatchery-and wild-origin steelhead. *PLoS One*, 8(3), e59162.
2. Fischer, E. K., Soares, D., Archer, K. R., Ghalambor, C. K., & Hoke, K. L. (2013). Genetically and environmentally mediated divergence in lateral line morphology in the Trinidadian guppy (*Poecilia reticulata*). *Journal of Experimental Biology*, 216(16), 3132-3142.
3. Schwalbe, M. A., Bassett, D. K., & Webb, J. F. (2012). Feeding in the dark: lateral-line-mediated prey detection in the peacock cichlid *Aulonocara Stuartgranti*. *Journal of Experimental Biology*, 215(12), 2060-2071.
4. Spiller, L., Grierson, P. F., Davies, P. M., Hemmi, J., Collin, S. P., & Kelley, J. L. (2017). Functional diversity of the lateral line system among populations of a native Australian freshwater fish. *Journal of Experimental Biology*, 220(12), 2265-2276.
5. Vanderpham, J. P., Nakagawa, S., & Closs, G. P. (2013). Habitat-related patterns in phenotypic variation in a New Zealand freshwater generalist fish, and comparisons with a closely related specialist. *Freshwater Biology*, 58(2), 396-408.