The Lateral Line System of *Tanichthys albonubes*

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Introduction

The lateral line system is a mechanosensory system in fish that detects physical and hydrodynamic changes in the environment, allowing the organism to process this information and use it to guide its behavior (Kasumyan, 2003; Webb, 2011). The body is covered with a spatial array of neuromasts, the functional units of the lateral line system. Consisting of hair cells covered by a cupula, these mechanosensors are stimulated as the cupula is displaced relative to these hair cells (Webb, 2011). Many experiments inhibiting this function have shown that integral behaviors depend heavily on the lateral line system (Wunder 1927, Pitcher *et al.* 1976; Schwartz and Hasler 1966), including detecting water movement to sense prey and predators, navigating the physical environment without sight, and schooling properly (Montgomery and Pankhurst 1997; Campenhausen *et al.* 1981). Fish taxa display great diversity in the lateral line system, including differences in complexity, neuromast distribution, and quantity. For example, neuromasts are only observed on the trunk of certain groups of fish, but groups that do may display varying distributions of these neuromasts along this region (Kasumyan, 2003; Webb, 2011). Numerous studies have described the lateral line morphology of various fish taxa, using robust fluorescent staining techniques to visualize neuromasts. This study aims to describe the morphology of the neuromasts in *Tanichthys albonubes*, a minnow species commonly found in the aquarium trade but with limited research on its lateral line system. It is hypothesized that neuromasts will be distributed along both the head and the trunk, but also that distribution may resemble that of *Carassius auratus,* a well-studied fish in the same order: Cypriniformes.

Methods

This experiment was conducted on February 28th, 2025, within Lillard Hall on the campus of Lake Forest College. One live adult *Tanichthys albonubes* was chosen as the specimen of interest for this study due to its small size and its availability. The selected specimen was removed from its housing tank and gently transferred into a beaker containing conditioned tap water. A beaker containing approximately 100 ml of 63 μM 4-di-2-ASP was prepared to stain the neuromasts of the specimen, making them appear a bright fluorescent yellow under fluorescent light. After preparation, the specimen was transferred to this beaker for approximately 5 minutes. The specimen was then transferred into a separate beaker containing approximately 100 ml of 0.1% MS222, a solution used for humane euthanasia of fish. After five minutes, the specimen was placed onto a petri dish lined with a sylgard liner once proper euthanasia was confirmed. Insect pins were placed into the dorsal and ventral fins to stabilize.The specimen was placed in the petri dish. This was done to straighten the lateral side of the specimen and make it fully visible. A small amount of MS222 solution was poured into the petri dish to fully cover the specimen.

Once the body length was measured from the mouth to the caudal fin, the specimen was placed under a dissecting microscope with a camera attached. Using the program CaptaVision+ allowed for high definition observation and photography of the freshly euthanized specimen under a fiber optic light source and under a fluorescent light source (NightSea) to locate superficial and canal neuromasts. Using this technology, the distribution of neuromasts (dependent variable) was assessed as a function of fish species (*Tanichthys albonubes*) and of fluorescent staining/ imaging technique (independent variables). Photographs of the specimen in the lateral position were first taken under fiber optic light, followed by fluorescent light. Once this was completed, the specimen was re-pinned so that its dorsal side could be seen directly under the microscope. Photography under fiber-optic light, followed by fluorescent light, was repeated. For the last set of photographs, the specimen was re-pinned so that the ventral side was directly under the microscope camera. Photography under both light sources was again repeated for this view.

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

Figures and Tables

IO	Infraorbital
PO	Preoperculum
SO	Supraorbital
MD	Mandibular
ST	Supratemporal
RO	Anterior strip of neuromasts on the head
VO	Posterior strip of neuromasts on the head
T	Trunk

Table 1.1. ***Abbreviations for neuromast locations on the lateral line system.***

Results

The following images were taken under the dissecting microscope with a camera attached. Images include lateral, dorsal, and ventral views of the *Tanichthys albonubes* specimen under fiber-optic and fluorescent light. Neuromasts are visible under the fluorescent light and appear in the images as bright yellow spots.

Figure 1.1. ***Lateral Imaging of Tanichthys albonubes.*** A lateral view of the front half of Tanichthys albonubes (White Cloud Mountain Minnow) under bright light at 8x magnification, freshly euthanized with MS222.

All images depict only clear superficial neuromasts. Canal neuromasts cannot be seen within these images. The lateral line system was composed of IO (Fig. 1.2; Fig. 3.2), SO (Fig. 1.2; Fig. 2.2), MD (Fig. 1.2; Fig. 3.2), PO (Fig. 1.2; Fig. 3.2), ST (Fig. 1.2; Fig. 2.2), RO (Fig. 1.2), VO (Fig. 1.2), and T (Fig. 1.2; Fig. 3.2) superficial neuromasts. It is clear that there are over 100 superficial neuromasts located on the head alone (Fig. 1.2). From lateral and ventral views, it can be seen that there is a clear line of superficial neuromasts located along the trunk of the specimen. The entire line runs ventrally across the trunk and is composed of repeated lines of 3-4 superficial neuromasts arranged vertically.

Discussion

The photographs produced in this study show that *T. albonubes* exhibits a lateral line system comprising a significant number of superficial neuromasts on the head and trunk, visible in lateral, dorsal, and ventral views.

While canal neuromasts are present in *T. albonubes*, they are embedded in bony canals that are not immediately visible in this external imaging method. Further investigation and imaging are required in order to accurately depict and describe canal morphology. Given the imaging quality and the lack of replicates, a detailed description is not yet possible. Additional studies, including canal descriptions, may accurately depict the entire morphology of this lateral line system. It must also be noted that with time.

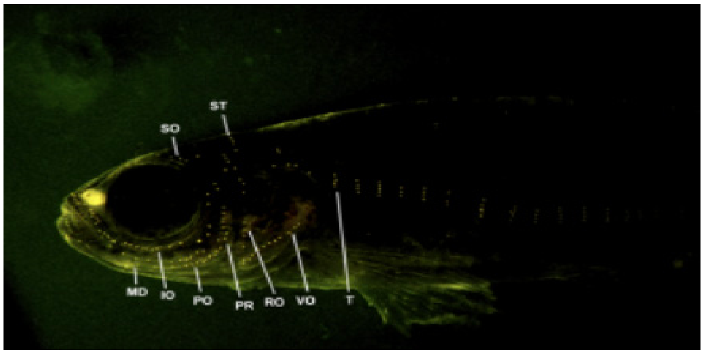

Figure 1.2. *Lateral Line Imaging of Tanichthys albonubes.* Distribution of the lateral superficial neuromasts of Tanichthys albonubes (White Cloud Mountain Minnow), visualized under fluorescent lighting using 4-di-2-ASP staining and magnified at 8x magnification. While present, canal neuromasts are not clearly visualized in this image.

The fluorescence of neuromasts decreases, requiring Figures 2.2 & 2.3 to be supplied by other researchers conducting the same experiment. It can be seen that the localization of neuromasts along the head mirrors that of *C. auratus*, with ST, RO, and VO neuromasts occurring on the head, which are not present in all fish (Webb, 2011). Additionally, the neuromasts along the trunk mirror those of *C. auratus,* with linear rows of superficial neuromasts ventrally along the trunk scales. This finding supports the hypothesis that the lateral line morphology of *T. albonubes* resembles that of its distant relative, *C. auratus, rai*sing the question of whether other relatives in the Cypriniformes order exhibit these similarities as well.

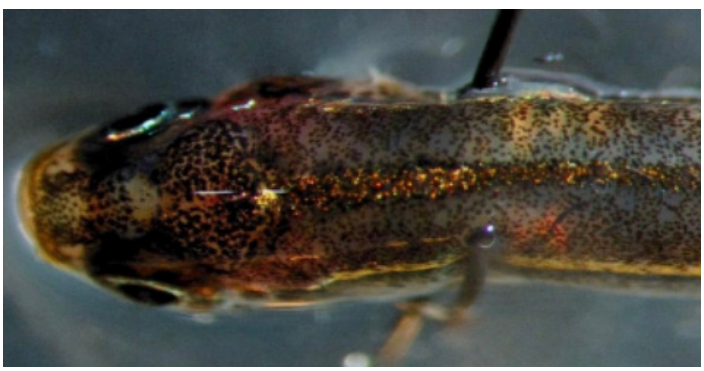

Figure 2.1. Dorsal Imaging of Tanichthys albonubes. A dorsal view of the front half of Tanichthys albonubes (White Cloud Mountain Minnow) under bright light at 12x magnification, freshly euthanized with MS222.

C. auratus has been described as possessing roughly 1000 superficial neuromasts across the body, with roughly 52-60 canal neuromasts (Kasumyan, 2003). However, a full-grown *C. auratus* is much larger than a full-grown *T. albonubes*, suggesting the potential for the number of neuromasts to differ with size. Alternatively, other species of minnow in the Cypriniformes order have also shown similar localization of superficial neuromasts along the head. *Ericymba buccata* displays hundreds of superficial neuromasts distributed across the head, suggesting that mechanosensory input received near the head may contribute to the detection and localization of prey (Jones et al., 2024). The morphology of the lateral line system of *T. albonubes* may serve a similar function.

Data collected in this experiment provides insight into the lateral line system of *Tanichthys albonubes*, showing similarities to distant relatives *Carassius auratus* and *Ericymba buccata*, specifically in the distribution and localization of superficial neuromasts on the head. Despite the limitations of this study, this data contributes to understanding lateral line morphology, particularly for this species and for small cyprinids. This experiment contributes to the growing body of research on the sensory adaptations of freshwater fish.

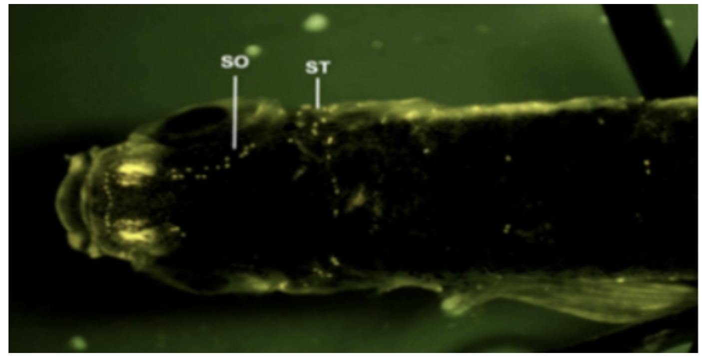

Figure 2.2. *Lateral Line Imaging of Tanichthys albonubes.* Distribution of the dorsal superficial neuromasts of Tanichthys albonubes (White Cloud Mountain Minnow), visualized under fluorescent lighting using 4-di-2-ASP staining and magnified at 12x magnification. While present, canal neuromasts are not clearly visualized in this image.

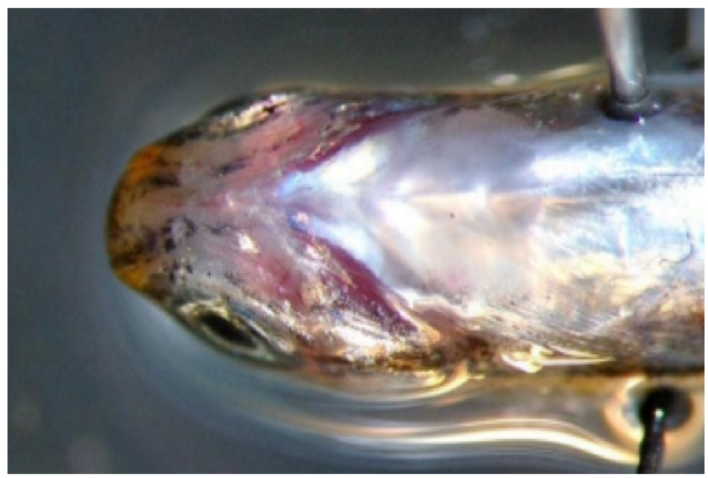

Figure 3.1. *Ventral Imaging of Tanichthys albonubes.* A ventral view of the head of Tanichthys albonubes (White Cloud Mountain Minnow) under bright light at 12x magnification, freshly euthanized with MS222.

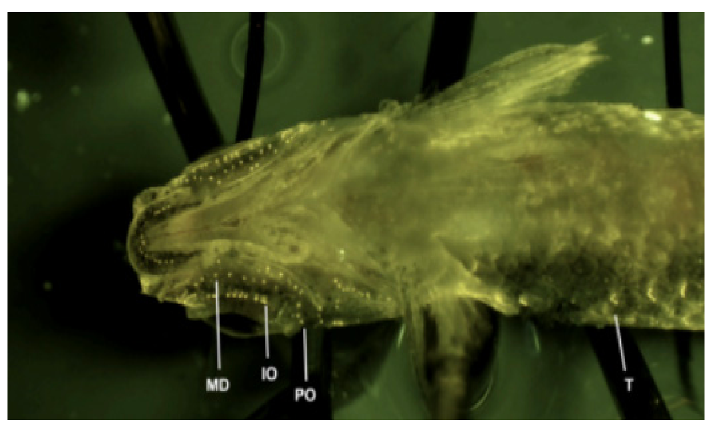

Figure 3.2. *Lateral Line Imaging of Tanichthys albonubes.* Distribution of the ventral superficial neuromasts of Tanichthys albonubes (White Cloud Mountain Minnow), visualized under fluorescent lighting using 4-di-2-ASP staining and magnified at 12x magnification. While present, canal neuromasts are not clearly visualized in this image.

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