

Introduction

The family Ictaluridae is comprised of 51 species of freshwater catfish indigenous to North America, which occupy diverse habitats and exhibit numerous adaptations for those habitats. The genus *Noturus*, commonly referred to as madtoms, are small, highly nocturnal catfishes that typically are found under cover objects. Many species of *Noturus* are jeopardized and protected at the state or federal level. In contrast, the genus *Ictalurus*, which includes the Channel Catfish, are large, strong swimmers, often occupying open water. Previous comparative brain morphology studies of North American minnows and catfishes have identified brain adaptations associated with diverse feeding modes and habits, but madtom catfish (*Noturus*) brains have not been examined.

The purpose of our study was to compare the gross brain morphology of two madtom species (*Noturus*) to the brain of Channel Catfishes (*Ictalurus*) and identify patterns between brain morphology and ecological behavior.

Methods

- Brains exposed by dissection of preserved catfish specimens.
- We examined four specimens each of three species: Channel Catfish, *Ictalurus punctatus*; Stonecat, *Noturus flavus*; Brindled Madtom, *Noturus miurus* (Figure 1).
- Standard length (SL) (see Figure 1A) eye length were measured to 0.1 mm with a digital calipers.
- Twelve brain distances (Figure 2) were measured to the nearest 0.1 mm with an ocular micrometer.
- Data were analyzed with Principal Component Analysis (PCA).

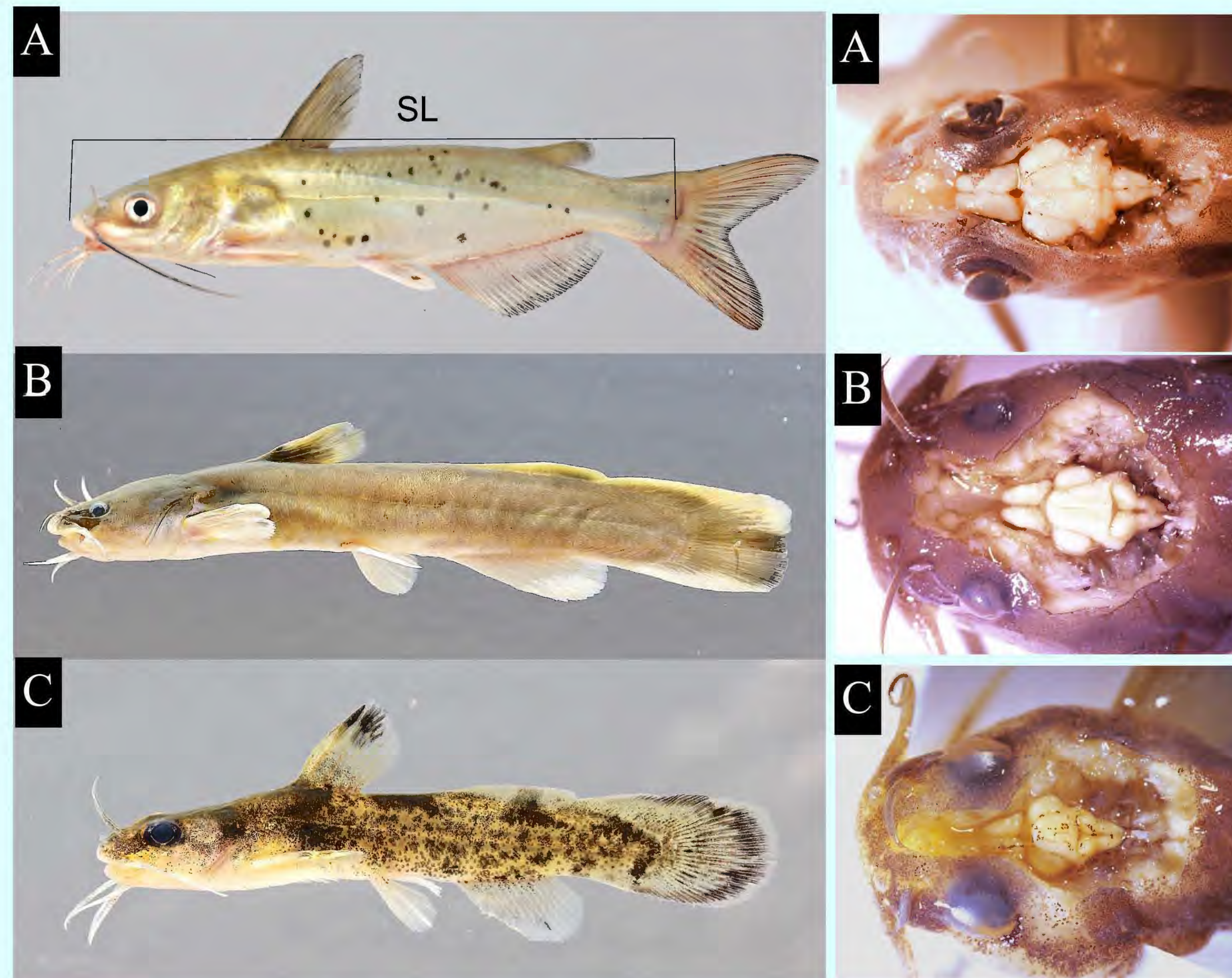


Figure 1. Whole specimens (left) and dissected brains (right) of: A) *Ictalurus punctatus*, Channel Catfish; B) *Noturus flavus*, Stonecat; and C) *Noturus miurus*, Brindled Madtom.

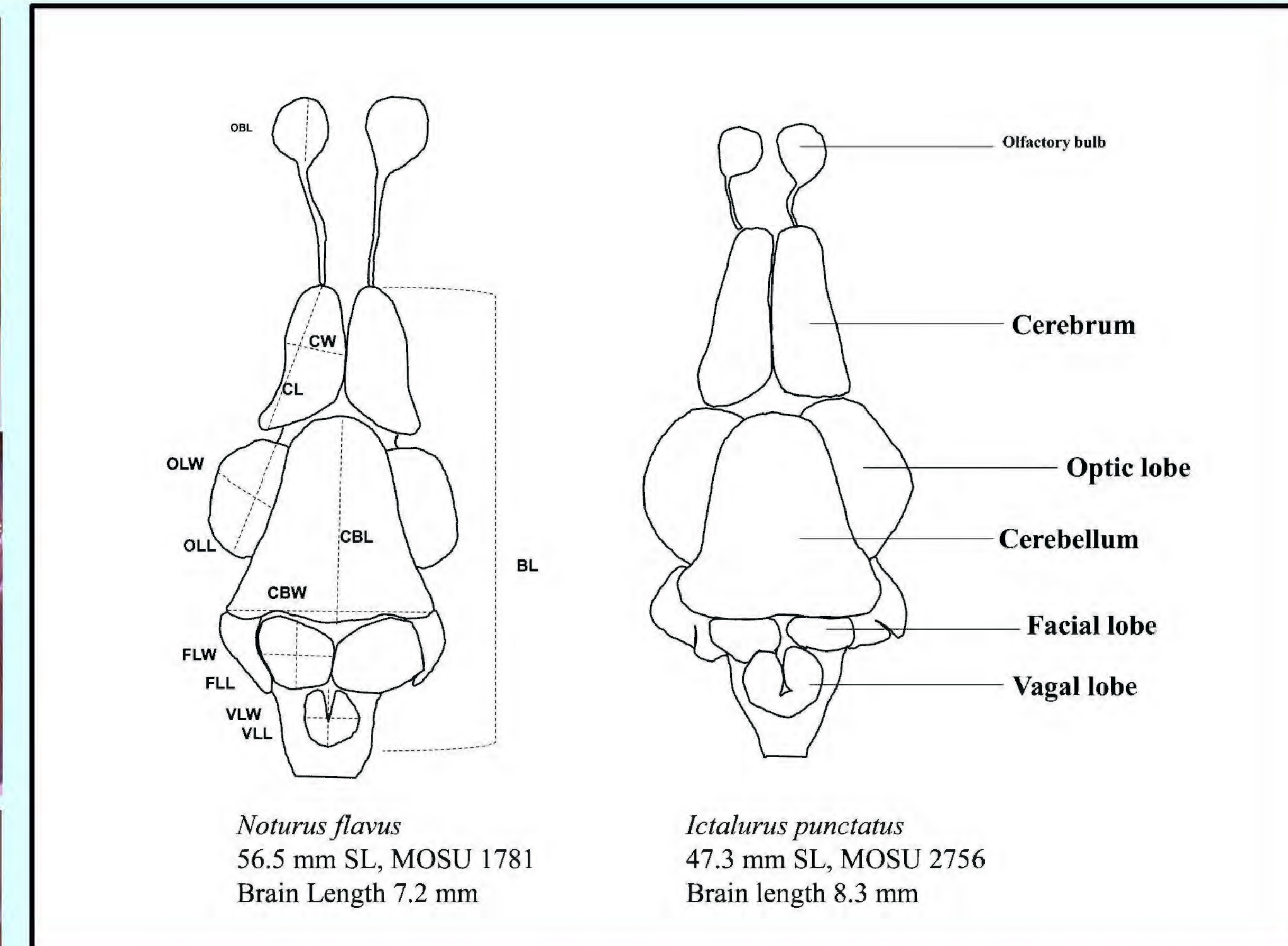


Figure 2. Left, brain measurements used in this study. Right, brain region of catfishes.

Results

Principal Component Analysis indicates the three catfish species have distinct brain morphologies (Figure 3). The principal component loadings indicate *Ictalurus punctatus* has smaller facial lobes, vagal lobes, and olfactory bulbs than the two madtom (*Noturus*) species. Among madtoms, *Noturus flavus* exhibits markedly smaller optic lobes and a larger cerebellum than *Noturus miurus*. This variation is easily apparent on gross visual inspection of the exposed brains (Figure 1).

Ictalurus has the largest eyes of the three, while *Noturus flavus* has the smallest eyes (Figure 4).

Summary

Large olfactory bulbs, facial lobes, and a vagal lobe suggests madtoms (*Noturus*) rely more on chemoreception and less on vision than do *Ictalurus*. Olfactory lobes process olfactory cues, while facial and vagal lobes process information from oral and cutaneous taste receptors. Optic lobes, as their name suggests, process visual information. Madtoms have a benthic (bottom-dwelling) habit, often living a cryptic (hidden) life among logs and stones, emerging at night to feed. In contrast, *Ictalurus* is more pelagic (open water), and relatively more day-active. Thus, the brain morphology of these fishes strongly reflects adaptations to their ecology.

Brain morphology adaptations are well-documented in other studies of catfish brains; the troglitic (cave-dwelling) catfishes *Satan* and *Trogloglanis* exhibit a similar hypertrophy of chemosensory brain regions, with almost complete loss of optic regions (Langecker and Longley 1993; Copeia 1993:976-986).

Acknowledgements

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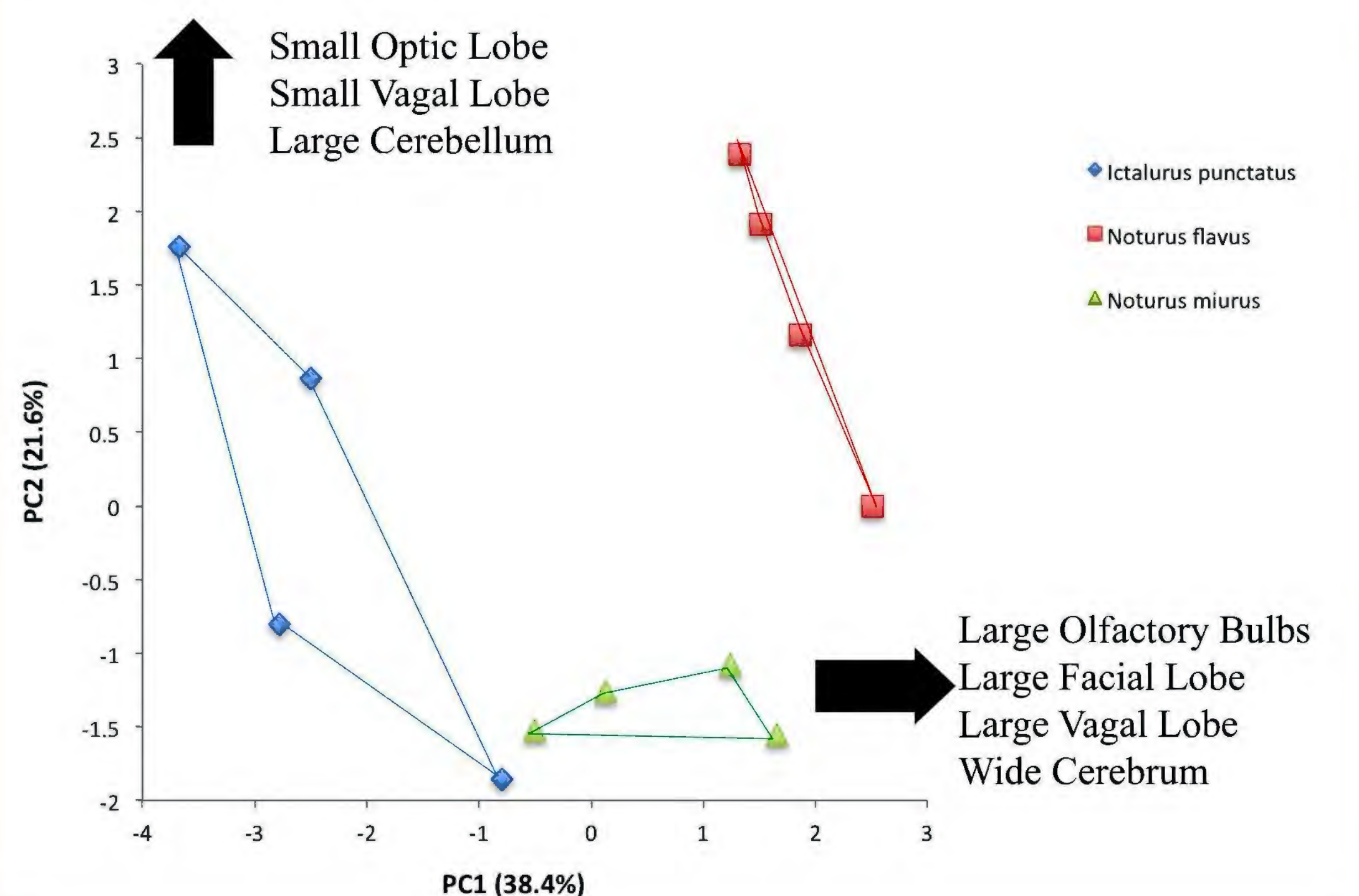


Figure 3. Brain morphometric scores on Principle Component (PC) axes 1 and 2 for 12 catfish specimens.

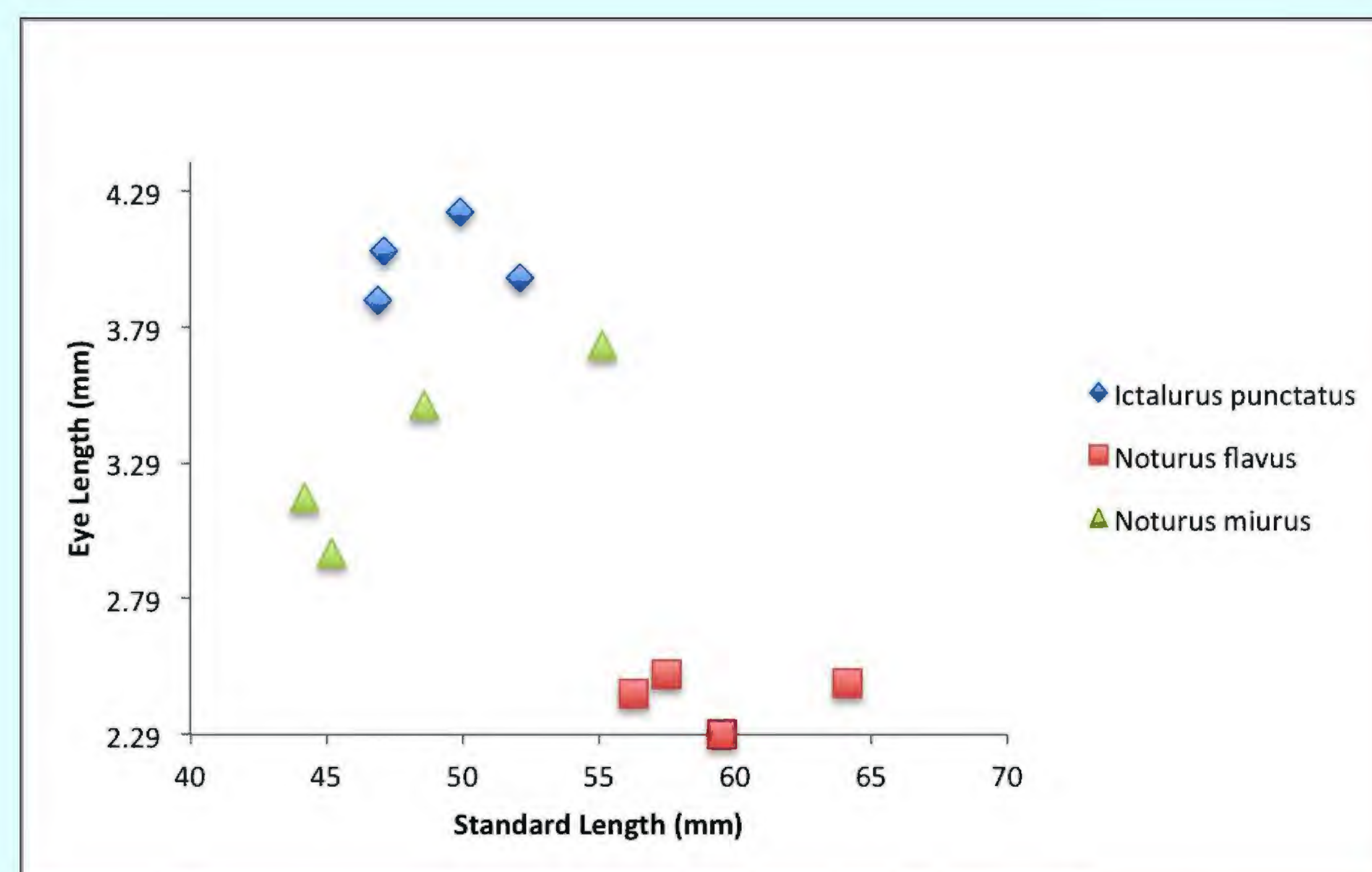


Figure 4. Comparison of body size (SL) and eye size for 12 catfish specimens, illustrating the difference in eye size among these three catfish species.