Shining a Light on the Blind: Evolutionary Regression and Adaptive Progression in the Micro-vertebrate Ramphotyphlops braminus, a Model for Understanding Brain Organization and Complex Neurological Disorders

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Efforts like the Human Brain Initiative aim to understand the incredible complexity of our intricate nervous system to solve challenging neurological problems including epilepsy and autism. However, complexity imposes impediments, while simpler systems can provide fundamentally important insight. The brahminy blindsnake (Ramphotyphlops braminus) is among the smallest vertebrate animals on Earth, and possesses an extraordinarily simplified nervous system. This comprehensive analysis of what may be the simplest nervous system in any terrestrial vertebrate animal aims to understand the fundamental components of vertebrate nervous system organization. Using the tiny, subterranean brahminy blindsnake to study its brain and its micro-ophthalmic eye as an approachable part of the brain, the goals were to produce a brain atlas, assess the functional architecture of its rudimentary eye, and determine how light exposure may modify blindsnake behavior. Histology revealed a brain structurally similar to other reptiles, but highly miniaturized, and with many fewer cells. Immunofluorescence and confocal microscopy of the retina identified both rod and cone opsins, indicating the existence of photoreceptor cells. The blindsnake eye was measured to be less than 0.25mm in diameter, yet contained all normal retinal layers, and a series of behavioral experiments revealed that blindsnakes likely cannot see but use negative phototaxis, and may be blinded by sudden light levels changes. This research provides a platform for understanding the fundamental architecture of vertebrate nervous systems, creates new knowledge of behavior in one of the world’s smallest vertebrate animals, and provides new insight into evolutionary regression and adaptive progression in micro-vertebrate life.