

Observations of yawning behaviour in the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*)

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Yawning behaviour has been observed in a variety of vertebrate taxa, including fish, mammals, reptiles, amphibians, and birds (reviewed by Baenninger, 1997). Yawning by salamanders has been documented in the families Ambystomatidae, Plethodontidae, and Salamandridae (reviewed by Bakkegard, 2017). While conducting an ex situ, conservation-driven study regarding behaviour of eastern hellbenders (*Cryptobranchus alleganiensis alleganiensis*), large (up to 74 cm total length), fully aquatic salamanders native to cool, highly oxygenated streams and rivers in the eastern United States (Nickerson & Mays, 1973), we incidentally observed instances of behaviour consistent with yawning.

As part of a larger study, we used GoPro Hero 4 camcorders (GoPro Inc., San Mateo, CA) to record video of *C. a. alleganiensis* within raceways set up to simulate the source stream of the hellbenders. Following recording, we reviewed video footage and quantified behaviour of *C. a. alleganiensis*. During the video review, we noted four instances during which a *C. a. alleganiensis* produced a “gaping-like” behaviour lasting for one or more seconds (Bakkegard, 2017) and in which a slow opening of the mouth was followed by a more rapid closing (Baenninger, 1997). All four instances of yawning behaviour were displayed by the same individual, an adult *C. a. alleganiensis* measuring 45.0 cm total length. All observations occurred on the same night (30 July 2016, beginning at 23.36 h) over a period of about 1.5 h when the *C. a. alleganiensis* was positioned with only its head protruding from a ceramic tile used by the animals in our study as a source of cover. The *C. a. alleganiensis* yawned four times at intervals of approximately 26, 37, and 34 minutes between yawns, respectively. Yawn duration ranged between 3 and 8 seconds (mean duration = 5.75 seconds).

To our knowledge, this appears to be the first report in the primary literature of yawning behaviour in *C. alleganiensis* and may be the first report in the primary literature for the Cryptobranchidae, although several online videos exist of Japanese giant salamanders (*Andrias japonicus*) engaging in behaviour consistent with yawning (e.g., <https://youtu.be/u5gdoom6wdI>). The causative mechanisms of yawning in vertebrates is presently unclear, but the stimulus and function of yawning likely varies among taxa (Baenninger, 1997). Bakkegard

(2017) observed instances of yawning behaviour in the salamander *Phaeognathus hubrichti* while the salamanders remained with only their heads and forelimbs protruding from burrows, presumably waiting for passing prey. Thus, yawning behaviour in these salamanders was interpreted to function as a means of heightening arousal (i.e., increasing olfaction and/or prepping jaw musculature) in anticipation of feeding (Bakkegard, 2017). The position (i.e., only the head protruding from cover) of the *C. a. alleganiensis* while yawning occurred is consistent with a sit and wait foraging position, a typical behaviour of this species (Nickerson & Krysko, 2003). Thus, both salamander species might employ yawning behaviour for similar reasons. Alternatively, yawning behaviour in *C. a. alleganiensis* may serve as a means of adjusting ballast. *Cryptobranchus alleganiensis* possess lungs, although respiration in this species is primarily cutaneous (~90%). The lungs are thought to serve primarily a hydrostatic function (Nickerson & Mays, 1973). Yawning could change the water volume in the lungs and so adjust ballast. Although our observations are limited and incidental, further observational data could readily be collected in zoos already maintaining salamanders in captivity to further explore details of yawning behaviour in *C. a. alleganiensis* and other salamanders.

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