SALAMANDERS — CAUDATA

***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender). TEMPORAL AND SPATIAL NICHE PARTITIONING.** *Cryptobranchus alleganiensis*, large, fully aquatic salamanders native to the eastern United States, are typically nocturnally active (Nickerson and Mays 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Museum Press, Milwaukee, Wisconsin. 106 pp.; but see Humphries 2007. Southeast. Nat. 6:135–140). In laboratory conditions, *C. alleganiensis* have been reported to have an activity peak corresponding to approximately 2–2.5 h after dark (Noeske and Nickerson 1979. Copeia 1979:92–95). However, few data appear to have been published concerning nocturnal emergence and behavioral differences among size classes of *C. alleganiensis*.

As part of a conservation-driven *ex situ* study, we collected four wild *Cryptobranchus alleganiensis alleganiensis* on 19 May 2016 from a tributary of the Susquehanna River in Pennsylvania (stream name and exact locality details are withheld due to conservation concerns) and placed them into captivity at the U.S. Fish and Wildlife Northeast Fisheries Center in Lamar, Pennsylvania. Individuals had total lengths (TL) of 29.7, 35.7, 42.0, and 45.0 cm. Housing consisted of two 8.4 m × 0.8 m indoor raceways, with the two larger individuals placed into one raceway and the two smaller individuals placed in the other raceway. The physical and chemical conditions of the raceways were set up to mimic those of the source stream. Raceways contained natural cobble substrate, slate and ceramic cover tiles, and reverse-osmosis water reconstituted to match the water chemistry of the source stream (Ettling et al. 2013. Herpetol. Rev. 44:605–610). Water temperature varied with ambient temperature and ranged between 18–20°C. A pumping system created a current through each raceway, simulating stream flow. Raceways received natural light and were subjected to natural light cycles through large windows within the building. Raceways were stocked with prey (crayfish, small fish) and *C. a. alleganiensis* were also presented with earthworms (*Lumbricus*) weekly to ensure that they could eat *ad libitum*. Prey organisms were subjected to species-specific decontamination treatments (e.g., saline solution treatment) prior to being introduced into the raceways following the protocol outlined by Ettling et al. (2013, *op. cit.*). Following a two-week acclimation period, after which all *C. a. alleganiensis* began feeding and pursuing prey, observations were conducted 1–2 nights per week during weekends from 4 June 2016 to 17 July 2016 from dusk (ca. 2045–2130 h) to 0030–0100 h. Raceways were inspected in the dark via a headlamp with red light, which appears to cause little or no disturbance to *C. alleganiensis* (Reese 1906. Biol. Bull. 11:93–99; Nickerson 1977. Proc. Am. Assoc. Zool. Parks Aqua. 1977–1978:396–399). Activity in *C. a. alleganiensis* was noted, and individuals were distinguished visually by size and unique natural spotting patterns.

The two largest *C. a. alleganiensis* consistently emerged at dusk (ca. 2045–2130 h) every night during observations. The 35.7-cm TL individual typically emerged at dusk, but emerged approximately 30 minutes after dusk (ca. 2115–2145 h) on 4 June 2016 and 9 July 2016. The smallest individual consistently emerged 60–120 minutes after dusk (ca. 2200–2330 h). Differences in behavior and habitat use after emergence were also observed. Each night, the three larger *C. a. alleganiensis* actively crawled around the raceway on top of substrate and were also observed swimming within and near the top of the water column. Larger

individuals would also retreat at intervals (ca. 20–60 minutes) under cover tiles and remain motionless with heads, necks, and occasionally the forelimbs protruding. When active, the smallest *C. a. alleganiensis* was observed to weave through interstices within the cobble substrate and rarely crawled on top of the substrate. This individual was observed to swim on only one occasion on 18 June 2016 at ca. 0015 h. In this case, the larger conspecific within the raceway was observed to enter a cover tile and the smaller individual immediately exited the cover tile and swam ca. 5–8 seconds (travelling approximately 2 m) and subsequently retreated within the interstices of cobble substrate.

While limited, these observations support hypothesized and observed *in situ* temporal and spatial niche partitioning between large and small *C. a. alleganiensis*. Large, adult *C. alleganiensis* have few predators (Nickerson and Mays 1973, *op. cit.*), but smaller individuals are likely prey items of large fish, reptiles, and larger *C. alleganiensis* (Nickerson and Mays 1973, *op. cit.*; Groves and Williams 2014. Herpetol. Rev. 45:108–109). A later emergence time of smaller *C. a. alleganiensis* may facilitate the avoidance of predators, including larger conspecifics. Use of interstices by smaller individuals may also facilitate predator avoidance as the habitat is less accessible by large predators (Pitt et al., *in press.* Herpetol. Bull.). Differences in behavior and habitat use between larger and smaller hellbenders may also reflect differences in diet. Larger (i.e., sub–adult, adult) *C. alleganiensis* predominantly consume crayfish, but may also consume fish, aquatic invertebrates, amphibians, reptiles, and carrion (Nickerson and Mays 1973, *op. cit.*; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Books, Washington, D.C. 592 pp; Hill 2011. Herpetol. Rev. 42:580), prey items typically found under cover rocks and within the water column. Smaller (i.e., larval, post–larval) *C. a. alleganiensis* consume aquatic insects (e.g., Megaloptera, Ephemeroptera, Diptera; Pitt and Nickerson 2006. Herpetol. Rev. 37:69) and small conspecific and heterospecific salamanders (Hecht-Kardasz and Nickerson 2013. Herpetol. Rev. 44:490) that also use interstitial spaces, thus use of interstices may also be a result of foraging for appropriately sized prey.

Our observations were conducted opportunistically in conjunction with a larger, conservation-driven ecological study, and are thus limited. However, such observational data could readily be collected in zoos already maintaining hellbenders in captivity.

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TESTUDINES — TURTLES

***RHINOCLEMMYS PUNCTULARIA* (Spot-legged Turtle). NESTING.** Little detailed information has been published on the reproductive biology of *Rhinoclemmys punctularia*, though females have been reported to deposit one or two eggs in March and April (Vogt 2008. Amazon Turtles. Gráfica Biblos, Lima, Peru. 104 pp.). *Rhinoclemmys pulcherrima* has been observed and photographed nesting in Costa Rica; although the nest reached the same depth of 10 cm, it was not as large in diameter and did not appear to have a body pit as seen with *R. punctularia* (Monje-Najera et al. 1988. Herpetol. J. 1:308). Monje-Najera et al. (1988, *op. cit.*) also claimed that *R. punctularia* does not dig a nest, and instead deposits eggs on the forest floor. In Belize and Mexico, *R. areolata* has been documented to deposit a single egg in leaf litter, but will also dig shallow 5-cm deep single egg nests; a *R. areolata* nest with two eggs was also recorded in Belize (Vogt et al. 2009. *In* Rhodin et al. [eds.], Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 022.1–022.7. Chelonian Research Foundation, Lunenberg, Massachusetts). A female *R. areolata* was collected while covering a one egg nest near Villahermosa, Tabasco, Mexico and afterwards dug three more nests at five-day intervals in captivity, depositing one egg in each nest (Perez-Higareda and Smith 1987. Great Basin Nat. 48:263–266). *Rhinoclemmys nasuta* has been reported to lay single egg clutches among the leaf litter in the forest without digging a nest (Carr and Giraldo 2009. *In* Rhodin et al. [eds.].

FIG. 1. Nesting female *Rhinoclemmys punctularia*. Note that the female is well within the body pit below the surface to deposit her egg, and manipulating the egg with her left hind foot. The egg was deposited at an angle, near the base of a succulent plant.

Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 034.1–034.6. Chelonian Research Foundation, Lunenberg, Massachusetts).

Here we describe the nest structure of *R. punctularia* in captivity. One of us (CSS) observed an adult female nesting in a terrarium in the Centro de Estudos de Quelônios da Amazônia (CEQUA), at the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil on 8 July 2016. The female (235 mm straight-line carapace length) is part of a colony of eight females and six males originally collected from the Manaus area that have been maintained in captivity for 21 months in a 10 × 10 m in an indoor terrarium with six ponds each measuring 1 m in diameter and 20 cm deep. The terrarium is maintained on natural light and temperature cycles, with two 2 × 4 m windows allowing natural light to enter the structure.

The female began digging at 1430 h and at 1741 h began depositing the first and only egg in a nest. The nest was dug in moist silica sand in an open area adjacent to a palm trunk, at the base of a succulent plant (see Fig. 1); no test holes were dug. The turtle dug an irregular-shaped body pit measuring 23 × 13 cm to deposit the egg at a depth of 10 cm. This is the first known description of a nesting *Rhinoclemmys* digging a body pit for nesting. The single egg weighed 38 g and measured 71 × 31 mm. By 1900 h the nest was completely covered. The egg was removed from the nest and placed in a 28°C incubator in a 1:1 mixture of vermiculite:water by weight for artificial incubation, where it is still incubating. The female had a post-oviposition mass of 2.2 kg.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). CLUTCH FREQUENCY.** Accurate data on clutch frequency and other life history characteristics is crucial for understanding population dynamics and provides valuable information for management plans needed for effective conservation (Congdon et al. 1994. Amer. Zool. 34:397–408). Production of two clutches annually is well known for *Terrapene carolina* (Dodd 2001. North American Box Turtles. University of Oklahoma Press, Norman). Triple clutches have been recorded for *T. bauri* (Florida Box Turtle) in Florida (Dodd 1997. Can. J. Zool. 75:1495–1507), *T. c. carolina* in a captive population in Louisiana (Messinger and Patton 1995. Herpetol. Rev. 26:193–195), and *Terrepene coahuila* (Coahuilan Box Turtle) in Mexico (Brown 1974. Bull. Florida St. Univ. Mus. Nat. Hist. 19:1–67). Based on current literature, production of three clutches per year appears to be limited to turtle populations at southern latitudes (Iverson 1992. Herpetol. Monogr. 6:25–42). In this note we document triple clutching in *T. c. carolina* at a mid-continent latitude (37.5407°N), and note the importance of high quality captive diets.

One of us (SF) has maintained a colony of *T. carolina* at her urban residence since 2003 when they were rescued from a construction site on a former garden center. SF recorded all nest events for all females in the population annually, although a few second clutches were missed because of some females' wariness and secrecy in site selection. In most years since capture, one female consistently laid two clutches annually 18–29 days apart with first oviposition between 28 May and 15 June during 2005–2014. In 2015, she oviposited on 24 May, 13 June, and 4 July. Clutch intervals were 20 and 21 days. Clutch sizes were 6, 5, and 4, respectively. The third clutch substantially increased her reproductive potential (15) over those in eight of the previous 10 yr (mean, SD: 8.5 ± 0.93, 7–10; second clutches were not recorded in yrs 3 and 5). We believe her ability to produce a third clutch was likely related to a high quality diet consisting of mixtures of approximately 50% animal protein (cooked lean ground beef or chicken), 30% vegetables (carrots, squashes, etc.), 20% fruit (assorted berries, melon, tomato, banana), and 10% leafy greens with good calcium:phosphorus ratios (usually collards) provided 3 times/wk. They have access to clean water at all times.

Use of captive assurance colonies for head-starting rare turtle populations has increased as conservation tools over the past decade (Buhlmann et al. 2015. Herpetol. Conserv. Biol. 10:436–454; Tuberville et al. 2015. Herpetol. Conserv. Biol. 10:455–471). Maintaining the health of turtles in such colonies is essential. The increase in one captive female's reproductive potential with a third clutch demonstrates that some individuals in well-maintained assurance colonies can enhance head-starting programs.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle). RESTRAINT TECHNIQUE.** *Sternotherus carinatus* is a small freshwater turtle that inhabits streams and creeks from southeastern Oklahoma, central Arkansas, and Mississippi, south to the Gulf of Mexico (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland;. Blankenship et al. 1995. Herpetol. Rev. 26: 106–107). While collecting genetic material from three wild caught *S. carinatus* by means of rear foot web clipping, a more manageable restraint technique was discovered. As many turtles in the family Kinosternidae readily bite to defend themselves (Ernst and Lovich 2009, *op. cit.*), it is imperative to avoid the jaws. A commonly used approach is to simply restrain the animal by hand or have someone else restrain while you perform the procedure. While working in the lab, I discovered the use of a drink koozie as a restraint device. The koozie was slipped over

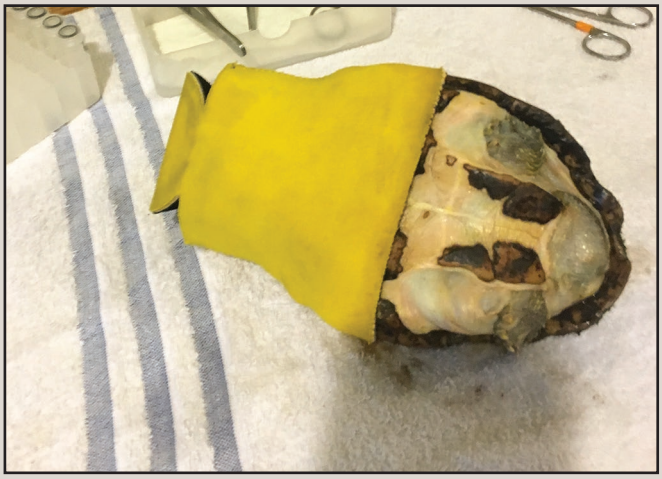

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FIG. 1. *Sternotherus carinatus* with front limbs and head restrained with drink koozie.

the head and slid mid-way down the body allowing for access to the rear legs and tail while covering the head and forelimbs (Fig. 1). The koozie's pliable material allows use on variable sizes of mud and musk turtles as well as other small turtles. Koozies are also exceptionally cheap, lightweight, small, and can be added into any researcher's arsenal of tools.

Animal collections were permitted by Louisiana Department of Fisheries and Wildlife (LNHP-16-067) and adhered to guidelines of the University of Southern Mississippi International Animal Care and Use Committee (protocol number 11092206).

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SQUAMATA — SNAKES

***CORALLUS HORTULANUS* (Amazon Tree Boa). NEONATE SIZE AND TIMING OF REPRODUCTION IN CAPTIVITY.** Courtship, combat, and breeding aggregations have been well documented for the Neotropical boids (Schuett and Schuett 1995. Herpetol. Rev. 26:101; Rivas et al. 2007. *In* Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 340–362. Eagle Mountain Publishing, Eagle Mountain, Utah). These behaviors have been documented for the genus *Corallus* both in nature and in captivity (Groves 1978. Herpetol. Rev. 9: 100–102; Osborne. 1984. Herpetol. Rev. 15: 50) with mating and birthing occurring nearly year-round (Meyer-HoIzapfel 1969. Int. Zoo Yearb. 9: 20–23; Murphy et al. 1978. J. Herpetol. 12: 385–390; Pizzatto and Marques 2007. S. Am. J. Herpetol. 2: 107–122; Valencia et al. 2008. Herpetozoa. 21: 91–94; Muñoz et al. 2013. Herpetol. Notes).

Corallus hortulanus usually gives birth between January and November and the litter size is related to the size of females (Pizzatto and Marques 2007. S. Am. J. Herpetol. 2:107–122; Bernarde and Machado 2010. Herpetol. Rev. 41:89), however there are variations in the period of reproduction of this species in different localities (Bartecki and Heymann 1987. Foli. Primatol. 48:199–202; Henderson 2002. Neotropical Tree Boas: Natural History of the *Corallus hortulanus* Complex. Krieger Publishing Co. Malabar, Florida. 228 pp.; Bernarde and Machado, *op. cit.*).

On 29 May 2014 at 2100 H copulation was observed in captivity between two male *Corallus hortulanus* with total lengths of 1550 mm and 1480 mm, and a female with a total length of 1640 mm. All three originated from the central Amazon region. The males did not enter into combat and both were seen to copulate at different times with the female. Copulation lasted approximately 37 minutes for both males. After mating the female was separated and kept under observation. During the entire gestation period the female refused to feed. On 11 November 2014 at 0010 h the female gave birth to two live offspring one of which measured 520 mm SVL with a TL of 644 mm and the other which measured 510 SVL with a TL of 632 mm.

I believe this report documents the largest neonates (TL of 644 mm and 632 mm) and the smallest litter (two offspring) known for *C. hortulanus*. Previously documented neonates have been between 282–593 mm TL and litter size of 3–24 neonates (Mendez 2001.www.urbanjungles.com/bamazontreeboasb.htm; accessed 28 Jan 2016; Pizzatto and Marques 2007. S. Am. J. Herpetol. 2:107–122; Bernarde and Machado, *op. cit.*).

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