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Behavioural observations of the Burmese flapshell turtle (*Lissemys scutata*) with comments on the functional significance of Rathke's glands

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ABSTRACT.–The Burmese flapshell turtle (*Lissemys scutata*) is a poorly-studied chelonian endemic to Myanmar. We found a turtle buried in a shallow excavation at Minzontaung Wildlife Sanctuary and villagers living nearby unearthed 10 turtles from the mud of a drying pond; these are apparently the first reports of aestivation by *Lissemys scutata*. An adult *Lissemys scutata* we captured at Lawkanandar Wildlife Sanctuary emitted jets of mild-tasting, odorless (to us) fluid from carapacial pores of Rathke's glands. We question the oft purported defensive role of these secretions and suggest intraspecific pheromonal signaling is a more likely function.

KEYWORDS.–Trionychidae, Myanmar, aestivation, secretion, pheromonal signaling.

Introduction

The Burmese flapshell turtle (*Lissemys scutata* Peters, 1868) is endemic to the Ayeyarwady (formerly Irrawaddy) and Thanlwin (formerly Salween) basins of Myanmar, occurring at least as far north as Mandalay (Smith 1931; Iverson 1992) where it inhabits natural and anthropogenic wetlands (Platt *et al.* 2012). With the exception of a single, brief paragraph in Smith (1931; as *L. punctata scutata*) containing general information on abundance, nesting phenology, and egg size, nothing appears to be known concerning the ecology of *L. scutata*. We here report observations of previously undescribed aestivation and defensive (or alarm) behaviours of *L. scutata*.

Materials and Methods

Our observations were made opportunistically during fieldwork in central Myanmar, an arid region in the rain shadow of the western mountains where most precipitation (500 to 1000 mm) occurs from June through September (Terra 1944; Platt *et al.* 2003). We measured turtles with a tree caliper and present morphometric data as straight-line carapace length (CL) and plastron length (PL).

Results

On 5 December 2014, we encountered a village dog excavating an aestivating female *Lissemys scutata* at Minzontaung Wildlife Sanctuary (Mandalay Region; site described by Platt *et al.* 2003). The turtle (CL = 118 mm; PL = 112 mm), which appeared alert and well-hydrated, was buried in a shallow depression (bottom ca. 10 cm below soil surface) excavated in hard, compact clay soil at the base of a *Tectona hamiltoniana* tree. Based on the dimensions of the depression and debris scattered about the site, the aestivating turtle was probably covered with 2–3 cm of soil and leaf litter before this material was removed by the dog. The aestivation site was located in scrub forest about 100 m (straight-line distance) from a drying irrigation reservoir that contained some water (< 1.0 m deep) at the time of our observation. To avoid further attention from the dog, we released the turtle in the reservoir.

In addition to our observations, villagers at nearby Mya Taung (21°26.90'N; 95°26.63'E) reported unearthing 10 living *L. scutata* while deepening an existing livestock pond during April 2011. At that time, the pond contained a layer of deep mud, but very little water; the turtles were found buried in the mud. We visited the village on 19 September 2011 and observed at least five adult and juvenile *L. scutata* in the pond, which was filled to capacity by wet season rains.

Our observation of defensive (or alarm – see below) behaviour by *L. scutata* occurred at Lawkanandar Wildlife Sanctuary, an urban park on the outskirts of Bagan (Mandalay Region) on 16 July 2015. At 1304 hr we encountered an adult female *L. scutata* (CL = 190 mm; PL = 180 mm) moving overland towards a pond (0.8 ha) housing a captive-breeding colony of Burmese roofed turtles, *Batagur trivittata* (Duméril & Bibron, 1835). About one minute after picking up and carrying the turtle a short distance, two fine jets of fluid were ejected approximately 10–15 cm from the carapace and away from the turtle. No discernible odor was associated with the discharge. A closer inspection revealed droplets of a viscous, yellow-brown fluid beside two small pores on the rim of the carapace above each foreleg (Fig. 1A). At the same time we also noted similar droplets emanating from four pores (two pores about 10 mm apart and 10–15 mm from edge of carapace on each side of the body) in the inguinal region (Fig. 1B). One of us (SGP) tasted droplets of the almost odorless, oil-like fluid; the taste was mild and akin to an uncooked chicken egg.

Discussion

Aestivation by *Lissemys scutata* is not unexpected. All flapshell turtles (*Lissemys* spp.) are morphologically well-adapted for aestivation with the femoral flaps and movable anterior lobe of the plastron allowing complete shell closure, thereby reducing the likelihood of desiccation during dormancy (Bhupathy *et al.* 2014). Aestivation has already been reported in the congeneric Indian flapshell turtle, *Lissemys punctata* (Bonnaterre, 1789), which like *L. scutata* inhabits ephemeral waterbodies in highly seasonal environments (Auffenberg 1981; Bhupathy & Vijayan 1994; Bhupathy *et al.* 2014). Similar to our observation, Auffenberg (1981) found that *L. punctata* (N = 86) moved overland an average of 237 m (±1SD = 78 m; maximum overland movement = 1050 m) from drying water bodies to aestivate in shallow depressions (carapace 3–6 cm below substrate) under grass tussocks, fallen logs, and among tree roots in grassland and forest. The discovery by villagers of *L. scutata* in a drying pond during the late dry season (April) suggests that some turtles remain buried in mud until the onset of wet season rains (early June) rather than move to terrestrial aestivation sites (see also Annandale 1912). By doing so, turtles could avoid potentially hazardous overland movements with the associated threat of predation, but risk entombment and death if the mud should dry and harden (Auffenberg 1981; Bhupathy *et al.* 2014).

Auffenberg (1981) observed *L. punctata* discharging a fluid resembling "egg yolk" when harassed by foraging white vultures, *Neophron percnopterus* (Linnaeus, 1758), noting the "smell is very objectionable" and "the taste is probably vile". Auffenberg (1981) watched vultures repeatedly drag turtles through grass before consuming them, and speculated this behaviour stimulated evacuation of the glands and wiped away the distasteful secretions, rendering the turtle more palatable. Similarly, Khan (2006) stated that *L. punctata* voids foul-smelling secretions when handled. These secretions are produced by Rathke's glands (Ehrenfeld & Ehrenfeld 1973; Plummer & Trauth 2009; Trauth & Plummer 2013; Bhupathy *et al.* 2014) and consist of a carbohydrate-protein compound rich in yellowish lipids, hence the resemblance to egg yolk (Ehrenfeld & Ehrenfeld 1973; Eisner *et al.* 1977; Weldon *et al.* 2008). Some report the secretions of Rathke's glands are strongly malodorous (e.g., Legler 1960; Eisner *et al.* 1977; Auffenberg 1981; Khan 2006), although Ehrenfeld & Ehrenfeld (1973) described the compound as only faintly odiferous when excised from the glands, and others have been unable to detect any odor associated with the secretions (Plummer & Trauth 2009; this study). Although the function of Rathke's glands remains largely unknown (Plummer & Trauth 2009; Trauth & Plummer 2013), various roles have been suggested, including excretion, courtship and mating, facilitating social aggre-

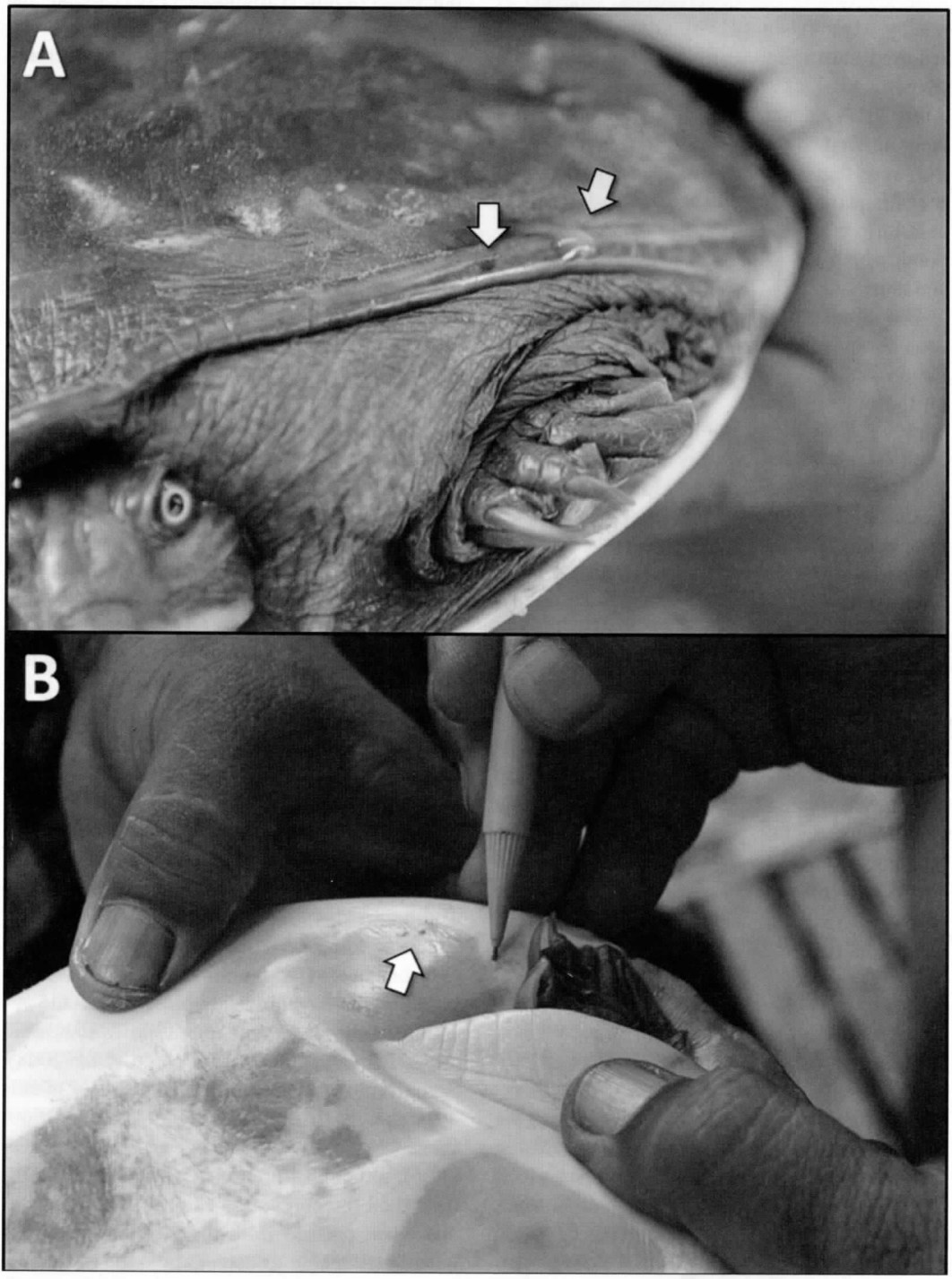

Figure 1. Arrows (white) denoting location of pores on the carapacial rim (A) and inguinal region (B) of a Burmese flapshell turtle (*Lissemys scutata*) at Lawkanandar Wildlife Sanctuary, Myanmar. Note droplets of fluid remaining on rim of carapace (yellow arrow) and inguinal region (tip of pencil) after being discharged from pores.

gations, intraspecific alarm, individual recognition, orientation, shell maintenance, and predator deterrence (Ehrenfeld & Ehrenfeld 1973; Eisner *et al.* 1977; Kool 1981; Krishna *et al.* 1995; Plummer & Trauth 2009) with the latter being favored by many authors (Neill 1948; Ehrenfeld & Ehrenfeld 1973; Auffenberg 1981; McCord *et al.* 2001; Bhupathy *et al.* 2014).

While recognizing that potential compositional differences in Rathke's gland secretions and consequently different functions may exist among species (Weldon & Tanner 1990; Krishna *et al.* 1995; Weldon *et al.* 2008; Trauth & Plummer 2013), we question a defensive role for these compounds in *L. scutata*. A compound with a mild egg-like taste (to humans) seems unlikely to deter predators, especially vultures that consume carrion in varying stages of putrefaction and successfully feed on turtles that produce odiferous secretions (Auffenberg 1981). Furthermore, the olfactory abilities of Old World Vultures (Aegypiinae and Cypaetinae) as well as most other birds are poorly developed (Stager 1964; Birkhead 2012) and the reported foul odor of this compound (indiscernible to us) would therefore seem of little deterrence to most avian predators. That said, it should be noted that the "wiping behaviour" described by Auffenberg (1981) could be explained by an unpleasant taste (to the avian palate) of the secretions produced by *L. punctata*. Nor in our opinion does such a compound appear capable of discouraging reptiles (*Varanus* spp.) or mammals (*Canis aureus* and *Sus scrofa*) reported to prey on flapshell turtles. Indeed, Eisner *et al.* (1977) suggested the quantity of secretions produced by common musk turtles (*Sternotherus odoratus* Latreille *in* Sonnini & Latreille, 1801) was insufficient to chemically deter predators, and in a series of laboratory trials Kool (1981) found that mixing Rathke's gland secretions with food provided to captive test subjects did little to discourage its consumption by various reptile, avian, and mammalian predators of the eastern long-necked turtle (*Chelodina longicollis* Shaw, 1794).

We instead hypothesize that intraspecific pheromonal signaling (perhaps as an alarm) rather than predator deterrence is more likely the function of Rathke's gland secretions, at least in *L. scutata*. Ehrenfeld & Ehrenfeld (1973) noted that an intraspecific alarm function is consistent with the rapid emptying of Rathke's glands, but discounted this hypothesis because turtles are "asocial organisms", an assumption called into question by more recent findings (e.g., Ferrera *et al.* 2012, 2014). Given the limitations of field observations, we concur with Ehrenfeld & Ehrenfeld (1973); questions about the functional significance of Rathke's gland secretions are probably best resolved through controlled laboratory experimentation.

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