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Submergence behavior in June by female ornate box turtles (*Terrapene ornata*) from southern Kansas

Dawson V. Kosmicki[1,*], Joseph W. Paysen[1], Carter Kruse[2], and Keith Geluso[1]

[1]*Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849*
[2]*Turner Institute of Ecoagriculture, Bozeman, MT 59718*

Abstract.—The ornate box turtle (*Terrapene ornata*; family Emydidae) is a terrestrial species that occurs in arid and semiarid grasslands throughout much of the Great Plains. Early literature suggested that ornate box turtles do not often use open water resources, but more recent literature suggests at least occasional use. Herein, we detail observations of female ornate box turtles fully and partially submerged in edges of shallow water bodies in southern Kansas during June 2023 and 2024. While multiple uses for open water resources are suggested in the literature for this species, use by only females during the nesting season suggests a reproductive function for this behavior. Hydration relating to nesting appears likely associated with submergence during the nesting season. Human-made earthen and stock ponds serve multiple purposes for wildlife species in arid and semiarid environments, including providing water and food resources, and these pond resources also appear important for terrestrially adapted ornate box turtles during their nesting season.

Resumen.—La tortuga de caja adornada (*Terrapene ornata*; familia Emydidae) es una especie terrestre que se encuentra en pastizales áridos y semiáridos en gran parte de las Grandes Llanuras. La literatura temprana sugería que estas tortugas no utilizaban con frecuencia cuerpos de agua abiertos, no obstante, recientemente se ha sugerido al menos un uso ocasional. En este documento, detallamos observaciones de hembras de tortugas de caja adornada, que se encontraron total o parcialmente sumergidas en las orillas de cuerpos de agua poco profundos en el sur de Kansas durante junio de 2023 y 2024. Si bien la literatura sugiere que esta especie utiliza estos cuerpos de aguas abiertos de varias maneras, el uso exclusivo de las hembras durante la temporada de anidación sugiere una función reproductiva de este comportamiento. La hidratación relacionada con la anidación pareciera estar asociada con la inmersión durante la temporada de anidación. Los estanques de tierra y de almacenamiento artificiales sirven varios propósitos para las especies de vida silvestre en ambientes áridos y semiáridos, incluidos recursos hídricos y alimentarios, pero estos recursos también son importantes para las tortugas de caja adornada, adaptadas a la tierra durante su temporada de anidación.

Ornate box turtles (*Terrapene ornata*) are a grassland species occurring throughout much of the central and southern Great Plains as well as in some arid areas of the Southwest (Ernst and Lovich 2009). Across their distribution, ornate box turtles inhabit semiarid and arid prairies, including sandy plains, rolling brush grassland, fringes of woodlands, and edges of deserts (Ernst and Lovich 2009). Ornate box turtles are terrestrial in nature and appear superficially similar to tortoises in morphology but are in the family Emydidae with pond turtles (Legler 1960, Ernst and Lovich 2009). Although terrestrially adapted, ornate box turtles are known to use water resources occasionally (e.g., Clarke 1950, Legler 1960, Ernst and Lovich 2009).

Early literature suggested that ornate box turtles avoid water (Pope 1939, Hudson 1942, see Dodd 2002), but recent observations have demonstrated occasional use of open water resources by these turtles. Water resources appear to be used for at least 3 functions. The most discussed use of water resources by ornate box turtles is for thermoregulation in hot summer weather (Hudson 1942, Dodd 2002, Converse and Savidge 2003, Ernst and Lovich 2009). Another well-documented use is for drinking (Brumwell 1940, Blair 1976, Dodd 2002, Ernst and Lovich 2009). Lastly, water resources occasionally play a part in reproductive activities and behaviors (Brumwell 1940, Converse and Savidge 2003, Forrester et al. 2020). For a

*Corresponding author: kosmickid@lopers.unk.edu

KG orcid.org/0000-0003-1209-043X

closely related species, eastern box turtles (*Terrapene carolina*), use of open water resources is common (Overton 1916, Donaldson and Echternacht 2005). Aside from the known aquatic nature of the Coahuilan box turtle (*Terrapene coahuila*; Dodd 2002), little to no information regarding water habits of other species of *Terrapene* is mentioned in the literature.

Several references note that ornate box turtles congregate at water bodies in summer (Clarke 1950, Norris and Zweifel 1950, Dodd 2002). Herein, we discuss observations of multiple female ornate box turtles in water at edges of water bodies in southern Kansas during the nesting season and discuss a reproductive purpose for such a behavior.

Our observations occurred at the Z Bar Ranch in Barber County, Kansas. This property occurs in the Gypsum Hills region of northern Oklahoma and south-central Kansas. The area is composed of red rock mesas, buttes, and escarpments topped with gypsum originating from the Permian Blaine Formation. More specifically, our survey area was composed primarily of prairies dominated by little bluestem (*Schizachyrium scoparium*; Paysen et al. 2023). This area lies within the Lower Arkansas River basin and includes the Salt Fork Arkansas River and the smaller Big Sandy Creek. In areas of the ranch without natural water sources, human-made stock tanks and ponds have been created for livestock use.

While conducting an inventory of herpetofauna, we commonly walked around various water bodies to search for water snakes, anurans, and turtles. For the specific observations noted below, all but one of our observations were associated with earthen ponds (i.e., stock ponds). These water bodies were formed by building dams across natural drainages. Ponds generally had gently sloping shorelines except on the side with dams, with water levels mainly responding to local precipitation events (Candelaria and Wood 1981).

Observations of submerged turtles occurred at 3 locations. In 2023, turtles were observed in a small pond about 20 × 50 m created by a 2-track road embankment across a small drainage (37.0996°N, 98.9933°W; WGS84). Vegetation along the pond edge included some cattails (*Typha* sp.) and buttonbush (*Cephalanthus occidentalis*) with generally little vegetation along the edge of the shoreline. In 2024, all turtles but one were observed on the west and north sides of a small earthen pond fed in part by overflow from a stock tank and bounded by a gravel road that crossed the drainage (37.1389°N, 98.8571°W; WGS84). This pond featured short grasses, rushes, and some forbs around the entire pool of water. The north and west sides had gentler slopes extending down to the water's edge. The final turtle was discovered along the water's edge of Big Sandy Creek (37.0978°N, 98.8517°W; WGS84) in a sandy embankment with grasses and sparse trees including black walnut (*Juglans nigra*). We examined every turtle to determine sex via color of eyes and front legs (Ernst and Lovich 2009). Photographs were taken of most individuals and on some days were used to distinguish individuals by differences in shell patterns.

At night on 27 June 2023 at 01:00 (Central Daylight Saving Time), we walked around a small earthen pond and observed 3 female box turtles in the water, all <7.5 cm from the shoreline. One turtle had the top of her carapace exposed to air, whereas the other 2 were fully submerged with <1.25 cm of water covering the tops of their carapaces (Fig. 1). These turtles were >2 m from each other and located on the north and west sides of the pond. We returned to this pond at 08:00 later that morning and were unable to locate any of the original 3 turtles. Instead, we observed a smaller adult female fully submerged along the edge of the pond. We returned again that evening at 17:00 and 20:30 and observed the same smaller female from the morning in the water both times. Upon returning the following evening at dusk on 28 June, no turtles were observed, but after dark that night we again observed the smaller female in shallow water along the pond's edge.

On 17 June 2024 at 21:30, we walked around another earthen pond and observed a single female turtle actively excavating a small depression that filled with water (Fig. 2). This depression was near the edge of the pond but not in the main body of the water. We returned to the pond at 09:15 the following morning and observed a total of 5 female turtles (Fig. 3), including the one from the previous night, scattered along the north and west sides of the pond in similar muddy depressions filled with water. A different individual was using the depression excavated by the female from the previous night. This female had her head sticking up out of the water but quickly withdrew it upon our approach so that only the top of her carapace was above water. All 4 other turtles had only the tops of

Fig. 1. Three female ornate box turtles (*Terrapene ornata*) observed at an earthen pond at night on 27 June 2023 in southern Kansas. These and other turtles observed in this pond were >2 m from each other.

their carapaces exposed to the air. We returned once again that afternoon at 17:30 and observed 4 turtles around the earthen pond in different locations from the morning. Again, all 4 turtles were female and had only the tops of their carapaces exposed to the air. Based on shell patterns, 2 of these individuals were not observed in the morning and appeared to represent 2 additional females.

On 18 June 2024 at 18:15, we walked along Big Sandy Creek and observed a single female ornate box turtle partially submerged in shallow water along the creek's edge (Fig. 4), similar to other individuals in depressions described above.

In early June 2023 and late July and early August 2023 and 2024, we walked around one of these ponds and others both in the day and night. During a particularly warm period from 31 July to 2 August 2024, we returned to both of the ponds several times and did not observe any box turtles submerged in the water in the day or night.

Observations of only female ornate box turtles submerged in open water bodies in June was interesting due to the lack of observations at other times of the summer and the lack of males. A literature search revealed other observations of ornate box turtles using open water for thermoregulation, drinking, feeding, reproduction, and escape from predators (e.g., Hudson 1942, Clarke 1950, Norris and Zweifel 1950, Legler 1960, Blair 1976, Forrester et al. 2020). However, only 2 papers linked water use to reproduction, as Forrester et al. (2020) observed a pair copulating in water and Converse and Savidge (2003) noted use of open water in May by nesting females in Nebraska. Herein, we propose 2 hypotheses to explain our behavioral observations that also appear to explain similar observations by others (Hudson 1942, Clarke 1950, Legler 1960, Blair 1976).

One explanation for our observation of only female turtles is that submergence increases or aids in water intake for use in nesting and egg laying processes. Ornate box turtles nest from May through mid-July, peaking in June (Legler 1960, Ernst and Lovich 2009). Water resources are important to nesting turtles for a few reasons. Fewer females reproduce during dry years as opposed to wet years (Nieuwolt-Dacanay 1997). Female hydration is important in ornate box turtles as their eggs are proportionally larger than most other emydids because the body size of females is smaller than most other female turtles in that family (Packard et al. 1985), suggesting that each egg requires proportionally more water from females during the reproductive process. Additionally, egg water content is an important factor for embryo development, as higher water content produces larger hatchlings, whereas drier conditions can result in smaller hatchlings with abnormalities, lower survival rates, and lower hatching success (Tracy et al. 1978, Packard et al. 1985, 1987, Miller et al. 1987, Packard 1999). Larger hatchlings have the advantages of being able to retain more mass in their early days and being able to move faster to

Fig. 2. Earthen pond where most ornate box turtles (*Terrapene ornata*) were observed in June 2024. The farthest edges of the pond in the photograph represent the west and north sides where all the female turtles were observed at the site.

avoid predators (Miller et al. 1987). Hydration thus appears important for gravid female turtles so that they can produce eggs with high water content, especially for ornate box turtles, a species that incubates eggs in more xeric environments than other turtles do (Packard et al. 1985). We hypothesize that, with all turtles being female in our observations, females are submerging themselves to increase the water content in their bodies for early or late-stage egg production. Flexible-shelled eggs in many species of turtles can imbibe water from their surroundings once the eggs are laid in nests (Packard et al. 1981, 1985, 1987), but eggs also might absorb water in the reproductive tracts of females.

An alternative explanation is that females used these open water resources for hydration prior to embarking on treks to find suitable nest sites or for rehydration after completion of nesting. In search of nest sites, female ornate box turtles make journeys lasting days to over a week (Legler 1960, Dodd 2002, Ernst and Lovich 2009). Legler (1960) stated that nesting activities, including journeys lasting up to 23 days and excavation of multiple trial nest cavities, are demanding in terms of water consumption, resulting in frequent drinking from water resources. Legler (1960) observed that gravid females in June traveled farther distances than nonreproductive females in June, males in June, and females in July and October. Given that our observations were from mid- to late June, female turtles might have been hydrating themselves via submersion in water immediately before undertaking nesting activities or after completion of nesting. Our observations of female turtles submerged at night also would support the nesting hypothesis as it aligns with Tucker et al. (2014) that ornate box turtles rarely move at night except for engaging in nesting activities. Although a number of other similar observations of submersion are known for ornate box turtles (e.g., Clarke 1950, Dodd 2002, Ernst and Lovich 2009), only Converse and Savidge (2003) suggest that such a behavior is related to reproduction. Similar observations of submersion by females or males outside the nesting season (Clarke 1950, Converse and Savidge 2003) likely can be attributed to other functions.

Several sources cite cooling during hot summer months (i.e., thermoregulation) as the principal reason for box turtle submergence in water (Hudson 1942, Dodd 2002, Converse and Savidge 2003, Ernst and Lovich 2009). However, others have contested this explanation. For example, Clarke (1950) noted submergence of ornate box turtles during “the wettest July on

Fig. 3. *Top left,* Female ornate box turtle (*Terrapene ornata*) observed excavating depression at night on 17 June 2024. All other photos represent females observed around an earthen pond in the morning on 18 June 2024.

record for Kansas and one of coolest," which contradicts the use of water for cooling. Legler (1960) noted observations of submergence during the hottest part of the day but further noted that thermoregulation likely was not the reason for submergence as shallow puddles and pools had higher temperatures during the day than more shaded, protected microhabitats on land. Thus, thermoregulation in shallow water would be less efficient than other options. Supporting this hypothesis, Jacobs et al. (1998) reported that in summer months, shallow water, at least to a depth of 4 cm, exceeds air temperature over nearly the entire 24-hour day. Absence of turtle submergence in late July and early August 2024 further supported this hypothesis, as the weather at that time was hotter than it was at the time of our visit earlier in the summer. Use of shallow water for cooling, based on these facts, appears unlikely, which would suggest that submergence in shallow water has a function other than thermoregulation.

Most of our observations reported congregations of turtles, which have also been mentioned by several others (Norris and Zweifel 1950, Blair 1976, Dodd 2002). Our turtles always were >2 m from each other in both ponds, suggesting that no social interactions occurred among individuals. This observation is similar to Dodd's (2002) description of congregating nesting females as "associative but not socially mediated." In contrast, other research has noted close interactions of ornate box turtles in shallow water bodies (Clarke 1950, Forrester et al. 2020). Clarke (1950) noted 2 females within about 15 cm of each other in early July in Kansas, but it was unclear whether the individuals were interacting socially. Forrester et al. (2020) noted copulation between a male and a female in Nebraska. Limited open water resources on the landscape in southern Kansas likely facilitated and concentrated use by multiple individuals at this time of year. If our observations were associated with increasing water consumption for reproductively

Fig. 4. Female ornate box turtle (*Terrapene ornata*) at the edge of Big Sandy Creek in the late afternoon on 18 June 2024.

active females, then there should be no need for social interactions with other individuals.

Most of our observations were made at earthen ponds constructed for livestock. Such anthropogenic water resources in arid and semiarid environments have many additional purposes for wildlife. Examples include feeding, breeding, and stopover sites for waterfowl (Lokemoen 1973, Candelaria and Wood 1981, Rosenstock et al. 1999), breeding sites for amphibians (Candelaria and Wood 1981, Rosenstock et al. 1999, Swartz and Miller 2019), and drinking resources for mammals and birds, to name a few (Rosenstock et al. 1999, Jackrel and Matlack 2010). Our observations further demonstrate use of earthen ponds by a terrestrial species of turtle, potentially for reproductive purposes. Human-made water structures in arid and semiarid areas likely have affected the local distribution and abundance of wildlife species (Geluso 1978), and such water bodies need to be conserved in such habitats (Converse and Savidge 2003). Similar to management needs of eastern box turtles (Donaldson and Echternacht 2005), accessible water resources for ornate box turtles in the Great Plains should be part of conservation and management decisions where appropriate.

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