Kyphosis of *Emydura macquarii krefftii* (Testudines: Chelidae) from Townsville, Queensland, Australia

DANE F. TREMBATH

1Research Associate, Museum and Art Gallery of the Northern Territory, GPO Box 4646, Darwin, Northern Territory, 0801, Australia [dane.trembath@nt.gov.au]

**ABSTRACT.** – Three kyphotic *Emydura macquarii krefftii* that appeared in good health were recorded. Kyphotic turtles from other studies also appear to be able to feed and reproduce readily, thus showing this deformity may have minimal affects on a turtle’s biology.

Kyphosis (humpback) spinal deformity has been recorded in the following turtles: *Apalone* spp. (Stuart 1996), *Apalone spinifera* (Burke 1994), *Chelonia mydas* (Rhodin et al. 1984), *Chelydra serpentina* (Wilhoft 1980), *Chrysemys* spp. (Plymale et al. 1978; Stuart 1996), *Clemmys guttata* (Ernst 1976), *Glyptemys insculpta* (Harding and Bloomer 1979), *Lissemys punctata* (Duda and Gupta 1977), *Sternotherus odoratus* (Nixon and Smith 1949; Saumure 2001), *Terrapene carolina* (Lynn 1937), and *Trachemys scripta elegans* (Tucker 1997; Tucker et al. 2007). Kyphosis appears to be more common in cryptodiran turtles because only one record has been documented for pleurodiran turtles. Limpus et al. (2006) reported the presence of kyphosis in *Emydura macquarii krefftii* but provided few details of the specimen. Herein, I report on kyphosis from *E. m. krefftii*.

During natural history studies of wild *E. m. krefftii*, three kyphotic individuals were found (Table 1). An adult male was caught 30 August 2001 at the James Cook University Rowing Shed, Ross River, Townsville, Queensland, Australia (19°18′59″S, 146°45′05″E). This individual was recaptured 6 August 2002 at the same site and found to have no difference in carapace length or mass, but the plastron length had increased by 2 mm. An adult female (Fig. 1) was caught 14 April 2003. This individual was recaptured 30 December 2004 and found to have grown 1 mm in both carapace and plastron length. Another male was captured 13 May 2005 at the Palmetum Bridge, Ross River, Townsville, Queensland, Australia (19°18′34″S, 146°45′57″E).

Although kyphosis occurs in many turtle genera, it is a rare occurrence. I documented kyphosis in only 0.36% of

---

**Table 1.** Morphometrics of kyphotic *Emydura macquarii krefftii* from Ross River, Townsville, Queensland, Australia.

<table>
<thead>
<tr>
<th>Date</th>
<th>Sex</th>
<th>Carapace length (mm)</th>
<th>Plastron length (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Aug 2001</td>
<td>♂</td>
<td>173</td>
<td>149</td>
<td>680</td>
</tr>
<tr>
<td>14 Apr 2003</td>
<td>♀</td>
<td>254</td>
<td>188</td>
<td>2100</td>
</tr>
<tr>
<td>13 May 2004</td>
<td>♂</td>
<td>208</td>
<td>157</td>
<td>400</td>
</tr>
</tbody>
</table>

---

**Figure 1.** A kyphotic female *Emydura macquarii krefftii* from Ross River, Townsville, Queensland, Australia.
the turtles captured during the study \((n = 833)\) in the Ross River. The cause of kyphosis is thought to be a premature asymmetric fusion of the thoracic vertebrae, which results in disproportionate shell growth (Rhodin et al. 1984). Therefore, this allows the vertebral column to dramatically arch, thus permanently deforming the shell (Burke 1994). Although dramatic, kyphosis does not seem to have any affect on either male or female sexual maturity. Both males captured displayed the large tails typical of sexually mature male \(E. \text{m. kreffitt}\) (unpubl. data). Unfortunately, sexual maturity could not be determined by palpation of the female because she was captured in April when \(E. \text{m. kreffitt}\) are not gravid (unpubl. data). However, other turtles with severely deformed shells have been found to be reproductively viable (Burke 1994; Dietz and Ferri 2003) and healthy in most respects (Odum 1985; McLeod 1994), thus, showing that kyphosis may have minimal effects on the turtles.

**ACKNOWLEDGMENTS**

Thanks to the following people for their help with marking turtles: K. Clover, J. Elliott, S. Fearn, D. Freier, A. Hayward, E. Isaacson, A. Lorenz, C. Luder, M. Mucci, and D. Poppi. Many thanks to my supervisor, A. Georges, for providing permits to work on turtles in Queensland. Also, sincere thanks to D. Barton for supporting the project over its many years. This work was conducted under Queensland National Parks and Wildlife Permit F1/000415/01/SAB and Environmental Protection Agency Permit WISP00283102.

**LITERATURE CITED**


Received: 28 January 2008

Revised and Accepted: 24 June 2008

---

On the Type Locality and Type Specimen of *Testudo geographica* LeSueur 1817

**PETER V. LINDEMAN**

1Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444 USA [plindeman@edinboro.edu]

**ABSTRACT.** – Charles Alexandre LeSueur discovered the common map turtle *Graptemys geographica* in 1816. He named the species *Testudo geographica* in 1817 and described it with a drawing of a specimen he collected from a Lake Erie marsh, but further details on the collecting locality were not given. I designate the drawn specimen as the lectotype of the species and review historical documents and specimen records that allow restriction of the type locality to the peninsula of Presque Isle and adjacent Presque Isle Bay in Erie County, Pennsylvania.

Charles Alexandre LeSueur (1817a) (sometimes written Le Sueur) described *Testudo geographica*, the species known today as the common map turtle (*Graptemys geographica*), based on a specimen collected in 1816. No type specimens are mentioned in the article nor are any known to have ever been deposited into a natural history collection, but LeSueur’s publication includes a drawing showing excellent detail of a typical adult female...
G. geographica, notwithstanding the peculiar bull’s-eye striping depicted on the tail (Fig. 1). LeConte (1830) first noted the absence of such striping in specimens, raising the possibility that LeSueur, an outstanding artist, may have worked from a damaged specimen (R. Bour, pers. comm.). Additional drawings of G. geographica in the LeSueur collections of the Muséum d’Histoire Naturelle in Le Havre, France, are believed to be based on specimens LeSueur took from the Wabash River, after he resettled in New Harmony, Indiana, in 1825, as 4 of LeSueur’s 5 stuffed specimens of G. geographica in the Museum National d’Histoire Naturelle collections are labeled “Wabash River” (Bonnemains and Bour 1996; R. Bour, pers. comm.). To facilitate discussion of the type locality of the species below, the specimen drawn by LeSueur for his publication is herein designated the lectotype, following International Commission on Zoological Nomenclature (ICZN) Article 74.4 and Recommendation 73F; the specimen either was not preserved or has been lost. Following ICZN Article 75.2, no neotype is designated because there is no doubt as to which taxon the name applies and thus no reason to designate a neotype.

LeSueur (1817a:86) did not state the type locality for his new species, other than mentioning that the species was collected “in a marsh, on the borders of Lake Erie.” Here I review the travels of LeSueur during the summer of 1816 and argue that the locality where the pictured specimen was captured was likely the peninsula known as Presque Isle or the body of water it forms, Presque Isle Bay, in Erie County, Pennsylvania.

LeSueur was born in Le Havre in 1778. He came to Philadelphia in 1816 after serving as naturalist on geologist William Maclure’s expedition to the Lesser Antilles (Vail 1938). In June of 1816, he and Maclure traveled on a collecting expedition in the northeastern United States. LeSueur’s handwritten itinerary, archived in the Muséum d’Histoire Naturelle in Le Havre (Fig. 2), indicates that their travels took them through Pittsburgh, Pennsylvania, to Lake Erie, and on to the Niagara River, Lake Ontario, Saratoga Lake, Lake George, Lake Champlain, and the east coast before they returned to Philadelphia. Apparently on the basis of the itinerary, Bonnemains and Bour (1996) concluded that LeSueur’s specimen of G. geographica was collected between the towns of Erie, Pennsylvania, and Buffalo, New York. Erie was clearly an important stopover point in the travels of

Figure 1. The illustration of Testudo geographica that accompanied its description by LeSueur (1817a).

Figure 2. LeSueur’s 1816 itinerary (LeSueur Collection, Muséum d’Histoire Naturelle, Le Havré, France, item 39 023 P).
LeSueur and Maclure, as there are several drawings in the Le Havre collection that were done by LeSueur in Erie (e.g., items 39 043 P recto and 39 042 P) and he mentions being in Erie and collecting on Presque Isle in his publications on fish species (LeSueur 1822, 1824).

Along the Lake Erie shoreline in Erie County, Pennsylvania, the only collection localities noted by Hulse et al. (2001) for *G. geographica* are the lagoons and embayments of Presque Isle and Presque Isle Bay. Presque Isle has long supported an abundant population of the species (e.g., Atkinson 1901; Lindeman 2006; Ryan and Lindeman 2007). Specimens from Presque Isle in natural history collections date back to 1894 (USNM 51192) and 18 specimens were collected in 1900 (CM R3006–R3008, R3040.1–3040.4, R3199.1–3199.11). Either the peninsula or the bay might qualify as the “marsh” where LeSueur caught his specimen. Although the species has been observed in recent years at 2 locations in Erie County, Pennsylvania just east of Presque Isle (East Avenue Boat Launch and North East Marina; M. Lethaby, pers. comm.), the Pennsylvania lake shoreline east and west of Presque Isle is wave-tossed, rocky, and adjacent to steep bluffs (Herendorn 1992) and seems therefore unlikely to have supported a marsh in the early 1800s. Shoreline marshes inhabited by *G. geographica* do occur farther west in Ohio (e.g., Tran et al. 2007). None of the artifacts in the Le Havre collection indicate that LeSueur and Maclure visited sites in Ohio between their stops in Pittsburgh and Erie, however, and Erie’s location due north of Pittsburgh puts it on the most direct line of travel toward Lake Erie.

LeSueur (1817b, 1818a, 1818b) collected fish from Lake Erie near Buffalo and may also have stopped at other localities along the lakeshore between Erie and Buffalo. As in most of Pennsylvania, much of the New York shoreline of the lake is lined with high bluffs where marshes would not likely have occurred historically (Herendorn 1992); although, there were estuarine marshes historically at the mouths of Cattaraugus Creek and the Buffalo River in New York (K. Roblee and M. Lethaby, pers. comm.). However, although range maps for *G. geographica* commonly shade the entire southern shoreline of Lake Erie (e.g., McCoy and Vogt 1990; Collins and Conant 1991; Ernst et al. 1994), no specimens of *G. geographica* are known to have ever been collected or observed along the New York shoreline of the lake (Gibbs et al. 2007). Records for the species in New York sections of the Laurentian Great Lakes and rivers begin in the Niagara River (Gibbs et al. 2007), which has wetlands associated with Grand Island (Herendorn 1992). The Ontario shoreline of Lake Erie has populations of *G. geographica* associated with marshy habitats on its peninsulas at Point Pelee (Browne and Hecnar 2005), Rondeau Provincial Park (Logier and Toner 1961), and Long Point (Adams and Clark 1958), but these areas were not visited by LeSueur and Maclure. It is therefore highly probable that LeSueur’s specimen came from a disjunct population of *G. geographica* that inhabits the peninsula of Presque Isle and adjacent Presque Isle Bay in Erie County, Pennsylvania, to which I restrict the type locality.

**Acknowledgments**

I thank Gabrielle Baglione of the Muséum d’Histoire Naturelle in Le Havre for information on the items archived in the LeSueur Collection. The manuscript was improved by the comments of R. Bour, M. Lethaby, and P. Pritchard.

**Literature Cited**


LeSueur, C.A. 1817b. A new genus of fishes, of the order Abdominales, proposed, under the name of *Catosostomus*; and the characters of this genus, with those of its species, indicated. Journal of the Academy of Natural Sciences of Philadelphia 1: 88–96.


Lindeman, P.V. 2006. Zebra and quagga mussels (*Dreissena* spp.) and other prey of a Lake Erie population of common map...
Diamondback Terrapin Mortality in Crab Pots in a Georgia Tidal Marsh

ANDREW M. GROSSE1, J. DANIEL VAN DIJK1, KERRY L. HOLCOMB1, and JOHN C. MAERZ1

1Daniel B. Warnell School of Forestry and Natural Resources, The University of Georgia, Athens, Georgia 30602 USA [grossea@warnell.uga.edu (corresponding author); vandijkj@warnell.uga.edu; holcombk@warnell.uga.edu; jmaerz@warnell.uga.edu]

Abstract. – Recreational and commercial crab pots are considered major threats contributing to recent declines in diamondback terrapin populations. In a single Georgia (USA) tidal marsh, 133 diamondback terrapin (Malaclemys terrapin centrata) carcasses were observed in abandoned crab pots, consisting of more than double the remaining estimated population. We suggest that the potential for just a few neglected or abandoned crab pots to significantly deplete a terrapin population makes enforcement of explicit soak laws and implementation of a derelict crab-pot removal program a priority for conservation of diamondback terrapin populations in Georgia.

The accidental capture of diamondback terrapins (Malaclemys terrapin centrata) in recreational and commercial crab pots has long been documented among biologists. Davis (1942) first described crab pots as a potential threat to diamondback terrapins, and today crab pots are considered the primary threat to diamondback terrapin populations throughout their range (Seigel and Gibbons 1995).

Roosenburg et al. (1997) described 2 levels of terrapin mortality in crab pots. The first being a “constant background mortality” for crab pots that are regularly fished over a long period of time, while the second includes crab pots that have been lost or abandoned (“ghost” or derelict crab pots). Regularly fished crab pots have the potential to consistently capture small numbers of terrapins over time, while derelict crab pots tend to capture more terrapins over a shorter time period. Although both levels have the potential to negatively affect terrapin abundance collectively, only baited crab pots have been shown to be detrimental to diamondback terrapin populations throughout their range (Seigel and Gibbons 1995; Roosenburg et al. 1997; Wood 1997; Hoyle and Gibbons 2000; Roosenburg 2004; Dorcas et al. 2007).

Less well-documented are the effects of unbaited derelict pots on terrapin mortality. Guillory et al. (2001) estimated that 250,000 derelict crab pots are added to the Gulf of Mexico and Atlantic coast annually. Bishop (1983) reported a ghost crab pot in South Carolina that contained the carcasses of 29 terrapins. Roosenburg (1991) found a ghost pot in Chesapeake Bay that contained 49 dead terrapins, which he estimated accounted for 1.6%–2.8% of the local population.

Though many derelict pots are added to coastal habitats annually, a small subset may pose the greatest risk to terrapin populations depending on their specific location within a marsh. Bishop (1983) noted that ghost pots are frequently transported through tidal current action to shallow waters, and pots in shallow water have a higher probability of capturing large numbers of terrapins during the spring months (March, April, and May). Additionally, Roosenburg et al. (1999) observed that larger sized terrapins, generally female, utilize the deep, open water more frequently than the smaller sized males and juvenile females. Therefore, expectations are that abandoned crab pots in shallow marsh habitats have great potential to catch and kill large numbers of male and immature female terrapins during spring periods.

On 4 April 2007, while sampling for diamondback terrapins in a tidal marsh at low tide near St. Simons Island, Georgia, USA (Glynn Co), a crab pot was observed just below the water’s surface. The water depth was < 1 m and a mixture of mud, algal and barnacle growth, and turtle carcasses were visible within the trap. The trap was pulled from the water, revealing the carcasses of 94 dead M. t. centrata (Fig. 1). On 4 May, we observed 23 dead and 1 live M. t. centrata in second trap approximately 100 m from the first trap.

By law, we were prohibited from removing the traps from the water, and during the remainder of our 2-month sampling period, we visited this site 3 additional times. During each visit we observed additional dead terrapins in the derelict crab pots. Over 5 visits between 4 April and 30 June 2008, we documented 133 dead turtles between the 2 derelict crab pots.
During each of our visits we were conducting a mark–recapture study of terrapins, and based on that data, we estimated there were 73 (Standard Error = 15.07) live terrapins still in the creek (White and Burnham 1999). The number of dead turtles documented was nearly twice the estimated remaining live population. We were able to accurately sex and measure carapace lengths for 97 of the dead terrapins. Of these, 83% were male with carapace lengths ranging from 74 mm to 148 mm ($\bar{x} = 119$ mm). By comparison, 66% of live turtles captured in the creek were male, with sizes ranging from 97 mm to 133 mm ($\bar{x} = 117$ mm). Finally, we used carapace measurements to estimate the mass (g) for dead terrapins. Using methods from Congdon et al. (1986), we estimated the terrapin biomass for this particular tidal creek to be 257.02 kg/ha, consisting of 167.06 kg/ha female and 89.96 kg/ha male. Based on these estimates we determined that 91% of the total terrapin biomass in this tidal creek was lost as a result of neglected crab pots.

The Gulf Coast states have recognized the threats of derelict crab pots and successfully initiated crab-pot cleanup programs, in which they collectively removed 58,611 abandoned ghost pots from 2002 to 2007 (Perry et al. 2008). On the southeast Atlantic coast, North Carolina is the only state that has established a successful crab-pot cleanup program. In 1995, North Carolina began its crab-pot removal program by collecting approximately 4600 crab pots (Guillory et al. 2001). In comparison, in 1996 Georgia attempted to establish a pilot crab-pot recycling program that lasted for just 4 months before being discontinued (Guillory et al. 2001).

Figure 1. An abandoned crab pot with 94 drowned diamondback terrapins.
Georgia needs to reestablish a crab-pot recycling program in order to remove derelict crab pots from its coastal waters. Further, Georgia needs to develop a more effective soak requirement to identify derelict commercial and recreational crab pots, and enforce state and federal laws governing reasonable soak times and the discarding of pots in public waters. Currently, Georgia has no requirement for how long a crab pot can soak before being checked (Code of Georgia 2008), while North Carolina’s soak law requires all pots to be checked every 5 days (North Carolina Administrative Code 2008). Federal law prohibits the discarding of waste, which would include derelict crab pots, in public waters. Providing positive mechanisms to remove derelict crab pots, and developing and enforcing regulations to reduce negligence of crab pots could be a major first step in preventing additional inhumane mortality of terrapins and contributing to the species’ long-term conservation.

LITERATURE CITED


CODE OF GEORGIA. 2008. Use of crab traps; identification of boats or vessels; closure of salt waters authorized. 27-4-151.


NORTH CAROLINA ADMINISTRATIVE CODE. 2008, Department of Environmental and Natural Resources, Leving devices unattended. Chapter 3, subchapter 03I, section .0105b.


Received: 6 February 2008
Revised and Accepted: 7 February 2009

The Occurrence of Ectopic Cloaca Deformity in the Green Turtle in Eastern Australia

COLIN J. LIMPUS1, JEFFREY D. MILLER2, and DUNCAN J. LIMPUS1

1Department of Environment and Resource Management, PO Box 15155, City East, Queensland 4002, Australia {col.limpus@epa.qld.gov.au, duncan.limpus@epa.qld.gov.au}; 2The American University in Cairo, PO Box 2511, Cairo 11511, Egypt; Current Address: University of Central Arkansas, 6 Chicot Cove, Maumelle, Arkansas 72113 USA {jmillerar@gmail.com}

ABSTRACT. — We report on a green turtle, Chelonia mydas, captured along central coastal Queensland, Australia, that had a cloacal opening on the dorsal side of its tail. Here we describe the internal anatomy and possible embryonic development of this abnormality and discuss the functional and reproductive implications for this turtle. To our knowledge, this is the first report of an ectopic cloaca (supra-caudal vent) deformity occurring within any turtle, tortoise, or terrapin species.

During foraging ground studies of green turtles, Chelonia mydas, at Shoalwater Bay (22°23’S, 150°15’E)
in central coastal Queensland, Australia, a turtle (individual K49367) was captured on 4 July 2002 with no cloacal opening on the ventral side of its tail. The sex and maturity of the turtle was confirmed by gonad examination using laparoscopy (Limpus et al. 1994). This individual was determined to be a prepubescent, immature female with curved carapace length of 70.4 cm. Superficially, the turtle appeared healthy and to be functioning normally. The vent opened dorsally on the tail (Fig. 1). There was a gap in the vertebral column through which the cloaca passed that was identified by finger examination within the cloaca. The cloaca was very tight and muscular. Internally the reproductive system consists of a white straight oviduct that entered the anterior of the pelvic arch in a normal fashion and the ovary that contained large numbers of very small previtellogenic follicles. This is the first case of an ectopic cloaca (supracaudal vent) deformity observed out of 11,127 adult and immature green turtles that have had their tails examined during foraging area studies in Eastern Australia (Moreton Bay, Hervey Bay, Shoalwater Bay, Repulse Bay, coral reefs of the southern Great Barrier Reef and Clack Reef) during 20 years from 1983 to 2002. Likewise, this type of deformity has not been recorded among the approximately 1000 hawksbill turtles, Eretmochelys imbricata, and 1500 loggerhead turtles, Caretta caretta, examined in foraging areas of eastern Australia during the same period. Likewise, this type of deformity has not been recorded among the approximately 1000 hawksbill turtles, Eretmochelys imbricata, and 1500 loggerhead turtles, Caretta caretta, examined in foraging areas of eastern Australia during the same period. The authors are unaware of any previous report of this abnormality occurring within any turtle, tortoise, or terrapin species.

The normal appearance and position of the oviducts leading into the pelvic arch together with the normal function of the anus suggests that the condition originated during early embryogenesis before the formation of the tail bud. Normal anal positioning occurs as the caudal rudiment extends into the amniotic cavity (Stage 14; Miller 1985). This extension moves the double layered (endoderm and ectoderm) cloacal membrane from its dorsal position at the posterior of the caudal rudiment to be ventrally directed at the base of the extending tail. It appears that this did not happen. The likely scenario is that the cloacal membrane remained in place and that the extending somatic mesoderm of the tailbud was induced to develop posterior to the cloacal membrane. This presumed induction accounts for both the position of the ectopic anus and the otherwise normal shape of the tail, while not requiring radical intrusion of the developing cloacal chamber through the mesoderm of the caudal somites because the normal cloacal chamber forms in coordination with the position of the cloacal membrane (see Raynaud and Pieau 1985).

Evidence of this process was gained via palpation of the tail that demonstrated the bones did not extend on either side of the cloaca and anus; the posterior tail vertebrae were totally separated from the anterior portion of the tail. The nerve chord and peripheral nerves arising anterior to the ectopic anus would not be affected by this arrangement.

Obviously, this deformity has not had a serious impact on the survival of the turtle through its early years. At a functional level, this deformity has not impeded defecation and urinary excretion via the cloaca. However, male green turtle copulatory behavior is directed to facilitating the male’s insertion into the female’s cloaca from the ventral side of her tail. Therefore, with this dorsally placed ectopic cloacal opening, this female turtle will probably not be able to successfully copulate when it reaches adulthood and should be excluded from the breeding population.

ACKNOWLEDGMENTS

All research including laparoscopic examination of this turtle was conducted in accordance with Environmental Protection Agency Animal Research Ethics Committee approval SRAEEC010 for the Queensland Turtle Conservation Project.

LITERATURE CITED


Received: 11 December 2007
Revised and Accepted: 9 March 2009