

Chelonian Conservation and Biology, 2001, 4(1):223–224
© 2001 by Chelonian Research Foundation

**Investigations of the Ecology of
Graptemys versa and *Pseudemys texana*
in Southcentral Texas.
Linnaeus Fund Research Report**

PETER V. LINDEMAN¹

¹*Department of Biology and Health Services,
150 Cooper Hall, Edinboro University of Pennsylvania,
Edinboro, Pennsylvania, 16444 USA
[Fax: 814-732-2593; E-mail: plindeman@edinboro.edu]*

Ernst et al. (1994) published an exhaustive compendium of literature citations for the chelonian fauna of North America. Perusal of species accounts with regard to text length and the number of cited ecological works reveals that two of the most neglected species with regard to ecological study are partially sympatric: the Texas map turtle, *Graptemys versa*, and the Texas river cooter, *Pseudemys texana*. *Graptemys versa* is endemic to the Colorado River system of Texas, while *P. texana* is found in the Brazos, Colorado, Guadalupe, San Antonio, and Frio drainages of Texas (Iverson, 1992; Lindeman et al., 1999). The two species are syntopic in the South Llano River, the southernmost tributary of the Colorado drainage.

A field study of diet, life history, and habitat use was initiated on the South Llano River in 1998. In addition, dissection of 21 *G. versa* collected from the river in 1949 and housed in the Strecker Museum (Baylor University) supplements the dietary and life-history data, and will eventually allow a comparison of these attributes from before and after invasion of the habitat by the Asian clam (*Corbicula fluminea*), which was first recorded in Texas rivers in 1972 (McMahon, 1982).

Methods. — During May 1998 and May 1999, turtles were captured in the South Llano River south of Junction, Texas, using fykenets (Vogt, 1980), basking traps (MacCulloch and Gordon, 1978), wading, and snorkeling. The South Llano River is a clear, spring-fed river with alternating riffles and pools. Stomach flushing and collection of feces were used to obtain dietary samples. Clutch sizes and egg sizes of gravid females were determined using a combination of radiography (Gibbons and Greene, 1979) and injection with oxytocin (Ewert and Legler, 1978). Midline plastron length (PL) was measured and turtles were marked (Cagle, 1939) and released at the site of capture.

Life History. — Mature male *G. versa* ranged from 57–79 mm PL (mean 65.7 mm, $n = 31$). Female *G. versa* ranged from 59–163 mm PL (mean 110.0 mm, $n = 31$). The minimum size of females determined to be gravid by palpation or dissection was 115 mm PL and the mean size of females this size or larger was 136.5 mm PL ($n = 21$). Clutch size of 13 females (nine X-rays from 1999 and four sets of oviductal eggs from dissected museum specimens) aver-

aged 5.6 eggs (range 4–9 eggs). Average egg dimensions for 32 eggs obtained by oxytocin injection were 35.26 mm for length (range 33.0–38.4 mm) and 20.87 mm for width (range 18.4–22.2 mm).

Mature male *P. texana* ranged from 78–162 mm PL (mean 122.2 mm, $n = 62$). Female *P. texana* ranged from 95–234 mm PL (mean 178.8 mm, $n = 54$). The minimum size of gravid females was 213 mm PL and the mean size of females this size or larger was 222.6 mm PL ($n = 13$). Clutch size of four females radiographed in 1999 averaged 8.3 eggs (range 7–9 eggs). Average egg dimensions for 23 eggs obtained by oxytocin injection were 42.19 mm for length (range 39.9–44.7 mm) and 26.96 mm for width (range 26.0–27.6 mm).

Diet. — Mollusks were abundant in the diet of 12 female *G. versa* from 1949 and 16 females captured in 1998–99. Insects were abundant in the diet of male *G. versa* (which are much smaller than females, as in other *Graptemys*; Ernst et al., 1994); in 1998–99, 25 males fed predominantly on soft-bodied aquatic invertebrates, especially trichopteran larvae, and 7 dissected males from 1949 also yielded aquatic insect remains.

Graptemys versa has previously been regarded as a “narrow-headed” map turtle (Bertl and Killebrew, 1983; Ernst et al., 1994), which would imply a presumed diet of algae and soft-bodied invertebrates, with few mollusks, based on the diets of other *Graptemys* with narrow heads and narrow alveolar surfaces of the jaws (Ernst et al., 1994; Lindeman, 2000). Scant dietary data suggest a predominance of insectivory in juveniles (Bertl and Killebrew, 1983), although gastropod mollusks were reported in the feces of a female of record body size (Kizirian et al., 1990). Measurements of head width in all 12 species of the genus has revealed moderately broad head widths in adult female *G. versa*, making them comparable to *G. geographica*, *G. pseudogeographica kohnii*, and *G. caglei*, all of which are species in which females are moderately to nearly exclusively molluscivorous (Lindeman, 2000).

Stomach contents of 60 *P. texana* captured in 1998–99 were composed primarily of leaves and algae, and also contained ephemeropteran larvae, aggregate fruits, and sponges. The only published account of diet in *P. texana* is an assertion that dissected specimens fed almost exclusively on mollusks (Strecker, 1927), although herbivory is the rule in other species of *Pseudemys* (Ernst et al., 1994). Strecker (1927) may have confused a molluscivorous *Graptemys* such as *G. versa*, *G. caglei*, or *G. pseudogeographica kohnii* with *P. texana*.

Ongoing Research. — Habitat use of *G. versa* appears to differ sexually, as has been reported for other species of *Graptemys* (e.g., Pluto and Bellis, 1986; Craig, 1992; Jones, 1996). One objective of continuing field work is to use data from small females to determine whether sexual differences in habitat can be attributed to dietary differences or body size differences. In addition, growth of *G. versa* is being studied with the objective of comparing its growth parameters in nonlinear models with those of congeners (Lindeman, 1999). Finally, acanthocephalan parasites were recovered from dissected *G. versa* specimens taken in 1949, and were

abundant in some specimens. An investigation of how sexual differences in diet influence parasite load is nearing completion.

Acknowledgments. — I thank Tara Allen, Damien Edwards, Julie Lovell, and Luke Lovell for their assistance in the field during 1999. David Lintz of the Strecker Museum graciously allowed me to dissect specimens from 1949, and Bryce Brown shared his field notes with me regarding those collections. Cindy Skaggs volunteered her time to radiograph turtles, and Martha Richardson and Bill Durbon were gracious hosts during our stay at the Texas Tech Center in Junction, Texas. Field work in 1998 and a visit to the Strecker Museum were supported by a Linnaeus Fund Turtle Research Award.

LITERATURE CITED

- BERTL, J. AND KILLEBREW, F.C. 1983. An osteological comparison of *Graptemys caglei* Haynes and McKown and *Graptemys versa* Stejneger (Testudines: Emydidae). *Herpetologica* 39:375-382.
- CAGLE, F.R. 1939. A technique for marking turtles for future identification. *Copeia* 1939:170-173.
- CRAIG, M.J. 1992. Radio-telemetry and tagging study of movement patterns, activity cycles, and habitat utilization in Cagle's map turtle, *Graptemys caglei*. M.S. Thesis, West Texas State Univ., Canyon.
- ERNST, C.H., LOVICH, J.E., AND BARBOUR, R.W. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C.
- EWERT, M.A. AND LEGLER, J.M. 1978. Hormonal induction of oviposition in turtles. *Herpetologica* 34:314-318.
- GIBBONS, J.W. AND GREENE, J.L. 1979. X-ray photography: a technique to determine reproductive patterns of freshwater turtles. *Herpetologica* 35:86-89.
- IVERSON, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately published, Richmond, Indiana.
- JONES, R.L. 1996. Home range and seasonal movements of the turtle *Graptemys flavimaculata*. *J. Herpetol.* 30:376-385.
- KIZIRIAN, D.A., KING, W.K., AND DIXON, J.R. 1990. *Graptemys versa* (Texas map turtle). Size maximum and diet. *Herpetol. Rev.* 21:60.
- LINDEMAN, P.V. 1999. Growth curves for *Graptemys*, with a comparison to other emydid turtles. *Amer. Midl. Nat.* 142:141-151.
- LINDEMAN, P.V. 2000. Evolution of the relative width of the head and alveolar surfaces in map turtles (Testudines: Emydidae: *Graptemys*). *Biol. J. Linn. Soc.* 69:549-576.
- LINDEMAN, P.V., ALLEN, T.P., EDWARDS, D., LOVELL, J., AND LOVELL, L. 1999. Geographic distribution. *Pseudemys texana*. *Herpetol. Rev.* 30:233.
- MACCULLOCH, R.D. AND GORDON, D.M. 1978. A simple trap for basking turtles. *Herpetol. Rev.* 9:133.
- MCMAHON, R.F. 1982. The occurrence and spread of the introduced Asiatic freshwater bivalve, *Corbicula fluminea* (Mueller) in North America: 1924-1981. *Nautilus* 96:134-141.
- PLUTO, T.G. AND BELLIS, E.D. 1986. Habitat utilization by the turtle, *Graptemys geographica*, along a river. *J. Herpetol.* 20:22-31.
- STRECKER, J.K. 1927. Observations on the food habits of Texas amphibians and reptiles. *Copeia* 162:6-9.
- VOGT, R.C. 1980. New methods for trapping aquatic turtles. *Copeia* 1980:368-371.

Received: 5 May 2000

Reviewed: 13 March 2001

Revised and Accepted: 30 March 2001

Molecular Systematics of Emydine Turtles. Linnaeus Fund Research Report

CHRIS R. FELDMAN^{1,3} AND JAMES FORD PARHAM²

¹Department of Biology, San Francisco State University,
San Francisco, California 94132 USA;

²Department of Integrative Biology, University of California,
Berkeley, California 94720 USA;

³Present Address: Department of Biological Sciences, University
of Maryland Baltimore County, Baltimore, Maryland 21250 USA
[Fax: 410-455-3875; E-mail: elgaria@biology2.wustl.edu]

The emydid turtles (Emydoidea: Emydidae: genera *Clemmys*, *Emydoidea*, *Emys*, and *Terrapene*) are among the most familiar and well-studied chelonians in the world. This small turtle subfamily contains only ten species, yet exhibits greater ecological and morphological diversity than its more speciose sister group, the Deirochelyiinae. Some species are fully aquatic (e.g., *Clemmys marmorata*) while others are almost entirely terrestrial (e.g., *Terrapene ornata*). In addition, species in the genera *Emydoidea*, *Emys*, and *Terrapene* possess shells with a movable plastron (plastral kinesis) while members of the genus *Clemmys* lack this trait.

Although emydoidea are extensively studied, popular, and of recent conservation concern, they lack a robust phylogeny. Morphological treatments of the Emydidae (Bramble, 1974; Gaffney and Meylan, 1988) hypothesized that the box turtles and other hinged genera form a monophyletic group (Fig. 1A). By default, the species without plastral kinesis were lumped into the genus *Clemmys*. Mitochondrial sequence data from the 16S ribosomal gene (Bickham et al., 1996) suggested that the genus *Clemmys* is not monophyletic (Fig. 1B). An attempt to combine these data with ecological, behavioral, biochemical, and additional morphological characters did not fully resolve the conflict between the morphological and molecular phylogenies (Burke et al., 1996). Despite the fact that some consensus has emerged from these studies, most hypothesized arrangements could be clarified and strengthened with additional molecular data.

Our objective was to shed light on the evolutionary history of emydoidea using all ten extant species, suitable sister taxa, and appropriately evolving molecular markers.

Materials and Methods. — We obtained liver tissue from museum specimens and blood samples from living zoo specimens for all 10 extant emydoidea species and 2 deirochelyiine outgroup species (Appendix 1). We isolated genomic DNA from liver tissue and blood samples by standard proteinase K digestion and phenol/chloroform purification (Maniatis et al., 1982). We amplified a 1200 bp region of the mitochondrial genome encoding the entire cytochrome *b* gene and part of the adjacent transfer ribonucleic acid, threonine (tRNA^{thr}) via polymerase chain reac-