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Atypical Head Markings of the Ouachita Map Turtle (*Graptemys ouachitensis*) in the Upper Ouachita River of Arkansas

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Running title: Head Markings of Ouachita Map Turtle

Turtles of a clade historically known as false map turtles (*Graptemys pseudogeographica*) occur throughout the Mississippi River drainage, but phenotypic variation throughout their range has precipitated taxonomic confusion since their original description (Lindeman 2003). Currently, two forms are known in Arkansas and both occur statewide and often in the same body of water.

Graptemys pseudogeographica kohnii (Mississippi Map Turtle) is the designation for a form that possesses a yellowish crescent that originates dorsally behind each eye then descends laterally and curves forward, terminating in a position below the back of the eye. The crescent is comprised of the connection between markings located behind the eye (postorbital) and under the eye (subocular or supramandibular). Connection of these marks creates a barrier that prevents any other of the yellow head stripes from reaching the eye, and this characteristic was used as a diagnostic device to identify most specimens of this southern subspecies.

This crescented form was described originally as a unique species (Carr 1949). However, Vogt (1993) lowered its status from species to subspecies. Analysis of mitochondrial DNA (mtDNA) found no differences within *G. pseudogeographica*, including *G. p. kohni* (Lamb et al. 1994), supporting Vogt's view. Lindeman (2003) noted that the taxonomic changes were not universally accepted.

A very similar form, the Ouachita Map turtle was described originally as a subspecies, *G. pseudogeographica ouachitensis* (Cagle 1953). However, Vogt (1993) considered *G. ouachitensis* to be a distinct species, and analysis of mtDNA demonstrated differences between *G. pseudogeographica* and *G. ouachitensis*, also supporting their distinction (Lamb et al. 1994). The postorbital, subocular, and mandibular (located at the back of the lower jaw) marks tend to be independent so appear as three distinct dots in *Graptemys ouachitensis* – at least in southern populations – which allows 1-3 lines from the neck to reach the orbit, and this has been a primary characteristic used in keys to aid in identification of this form (Trauth et al. 2004, Ernst and Lovich 2009). However, northern populations of *G. ouachitensis* tend to have the postorbital and subocular spots widely joined, though the resulting bar is wider than in *G. pseudogeographica kohnii* (Vogt 1993, Lindeman 2003, 2013).

Potential identification of *Graptemys* species is further confounded by the observation that some of the species in the genus can hybridize in sympatry (Godwin et al. 2014, Lindeman 2003), and the primary isolating mechanism preventing hybridization may be allopatry (Godwin et al 2014). Still, Vogt (1993) had argued that head markings likely were important for species recognition during courtship, and Lindeman (2003) believed that use of combinations of characters would allow accurate discrimination of these taxa.

We collected 15 juvenile *G. ouachitensis* and 5 juvenile *G. pseudogeographica kohnii* syntopically from Lake Hamilton and the Ouachita River in Clark and Garland counties during 2014, and compared characteristics with available literature. Because most of our specimens of *G. ouachitensis* did not conform to written descriptions for southern populations (but did more so for northern populations), we followed Lindeman's (2003) approach for discrimination. Here, we propose some new means of discrimination in Arkansas, particularly adding considerations regarding juvenile characteristics not previously available in the literature.

Via examination of juvenile specimens, we found differences between these taxa based on coloration and shape of head stripes, eye coloration, and degree of pigmentation of the plastron. Further, large yellow markings on the chin tended to form a chin bar on *G. ouachitensis* but were only small spots on *G. p. kohnii*, similar to the differences found between *G. barbouri* and *G. ernsti* (Godwin et al. 2014). Lindeman (2013) did note large chin spots in *G. ouachitensis*, but did not report examples of the spots joining to form chin bars.

The following group of characteristics, taken together, should allow distinction of specimens of either species in Arkansas (particularly if juveniles are available). For comparisons, see Figures 1 and 2. It should be noted that Lindeman (2003) found many of these same characters in populations of both forms in Kentucky Lake, and suggested that several characters taken together should lead to accurate identification, although there is much variation seen in coloration patterns. However, characters seen in juveniles, but that disappear during ontogeny, have not been discussed and compared between these species previously in the literature for southern populations. For example, Ernst and Lovich's (2009) summary of literature noted that plastron patterns of juvenile *G. ouachitensis* fade with age, and they noted characters of hatchling *G. pseudogeographica kohnii* from Wisconsin, but no comparisons of juvenile traits were given.

Figure 1. Dorsal, lateral, and ventral views of the head, and views of the plastron of juveniles of *Graptemys pseudogeographica kohnii*.

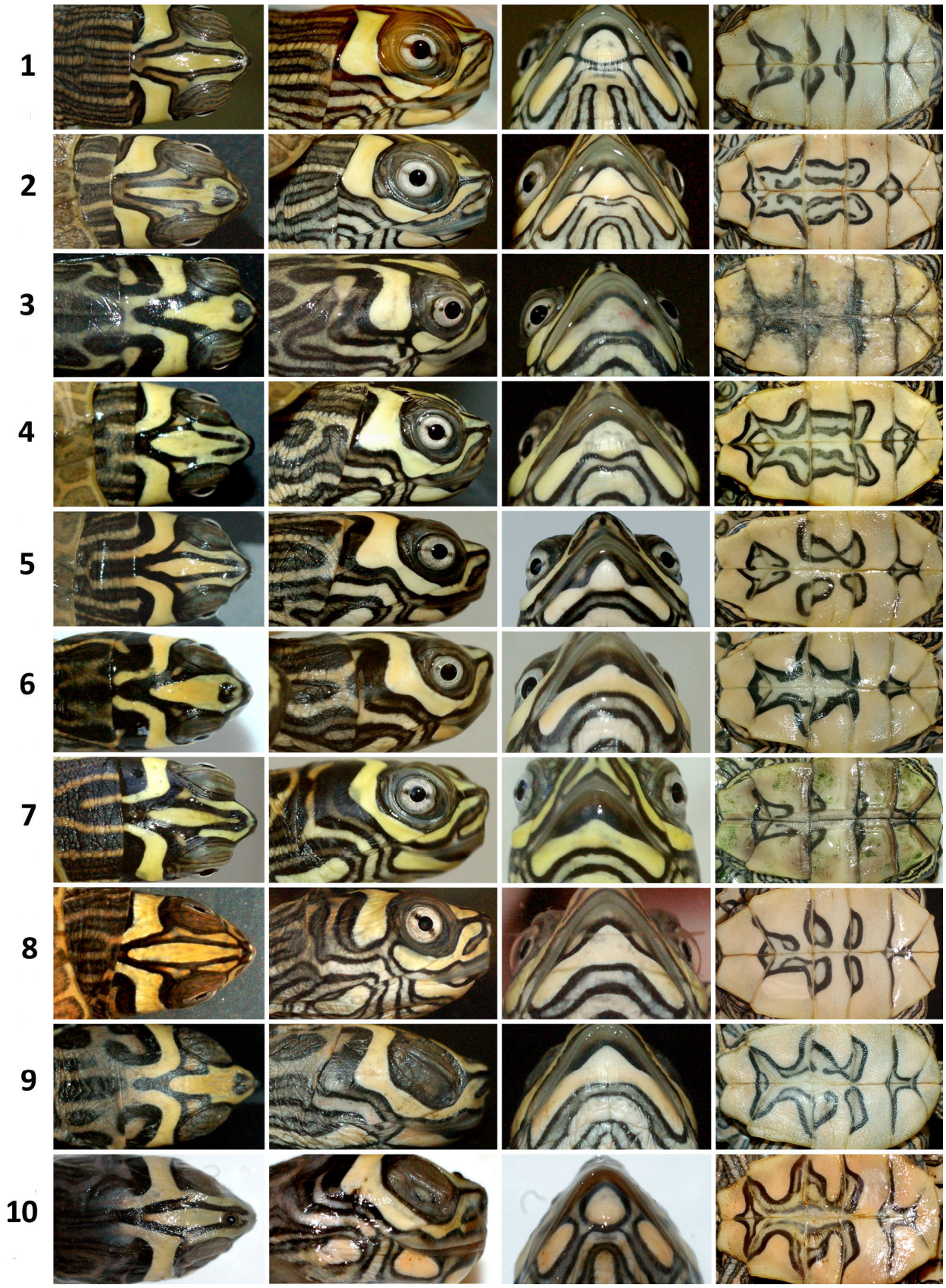

Figure 2. Dorsal, lateral, and ventral views of the head, and views of the plastron of juveniles of *Graptemys ouachitensis*.

1a. Iris white, lacking any black stripe; a light crescent around the back of the eye prevents any yellow lines on neck from reaching the margin of the eye (crescent is about the width of the pupil of the eye); crescent terminates under the eye; crescent orange with lighter border in juveniles but may fade to yellow in adults; ventral chin markings most commonly with 3 small orange or yellow spots (1 central and 2 near angles of jaw, Figure 1); plastron of juveniles more extensively pigmented with thick lines (plastral pigment diffuses with age) ……..*Graptemys pseudogeographica kohnii.*

1b. Black stripe, or at least a line of black pigment flecks, present in iris; postorbital and subocular spots separate, allowing yellow lines on neck to reach the margin of the eye, or if these spots are joined the resulting crescent is irregular in shape and about twice as wide as the pupil of the eye; postorbital and subocular spots straw yellow whether joined or distinct; if crescent present, it underscores the eye and joins with another stripe, terminating on the snout; ventral chin markings most commonly with 3 large spots that usually coalesce to form a wedge-shaped bar (Figure 2); plastron of juveniles less extensively pigmented with narrow lines (plastral pigment diffuses with age) ……..…*Graptemys ouachitensis.*

Specimens used in this study were photovouchered (as presented in the figures) and a few specimens were catalogued into the Henderson State University collection of vertebrates: *G. pseudogeographica kohnii* HSU 1746 – 1748 and *G. ouachitensis* HSU 1731 – 1733. Carapace lengths of specimens examined were less than 50 mm.

Acknowledgments

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