A New Subspecies of the Turtle *Graptemys nigrinoda* Cagle

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Graptemys nigrinoda delticola **n. ssp. occurs in the interconnecting streams and lakes of the delta of the Mobile Bay drainage, in Baldwin and Mobile counties, Alabama. It differs from the nominate race chiefly in having an extensive, elaborate plastral figure, a postorbital mark that is neither crescent shaped nor strongly recurved laterally, and a preponderance of dark color on its soft parts. The new subspecies resembles *G. oculifera* and *G. flavimaculata* more closely than does the nominate form.**

The known range of the species is extended to include the Cahaba, Coosa, and Tallapoosa rivers northward to the Fall Line.

WHEN originally described, the black-knobbed sawback, *Graptemys nigrinoda,* was known from two Alabama localities, the type-locality (17.5 miles S of Tuscaloosa, Tuscaloosa County) on the Black Warrior River, and 5.5 miles E of Gosport, Monroe County, on the Alabama River (Cagle, 1954). More recently Tinkle (1958), citing no specific localities, reported the species in the Tombigbee River in Alabama, and Shoop (1967) gave localities in the Tombigbee at Eutaw, Green County, Alabama; and near Waverly, Lowndes County, Mississippi.

Collecting by the writers and students at Auburn University has rather clearly established the range limits of this species and has revealed the presence of two well-defined subspecies, one of which is described below.

Museum abbreviations are: AUM = Auburn University Museum; UF = University of Florida, Florida State Museum; FMNH = Field Museum of Natural History; UMMZ = University of Michigan Museum of Zoology.

The subspecific epithet alludes to the range of the new race, a region of branching and anastomosing rivers, interlacing lakes and expansive deltaic deposits which converge toward Mobile Bay. The epithet is a hybrid word, derived from the Greek *delta,* triangle, referring to the traditional concept of the shape of river mouth deposits, and from the Latin *colere,* inhabit.

Graptemys nigrinoda ***delticola*** n. ssp.
Southern Black-Knobbed Sawback
(Figs. 2A, B; 4)

Holotype.—UF 26238 (formerly AUM 9229), an adult male, collected by James Byford at Hubbard's Landing on Tensaw Lake, 2.6 air miles SW of Latham, Baldwin County, Alabama on 4 May 1968.

Allotype.—UF 26239 (formerly AUM 8750), an adult female, collected by James Byford at the type-locality on 6 April 1968.

Paratypes.—Twenty-four specimens (2 adult females, 5 adult males, 17 unsexed juveniles) from the type-locality, AUM 8749, 8968–8970, 8979–8981, 9228, 9230–9238, 9334–9336, 9366, 9399–9401.

Diagnosis.—A subspecies of *G. nigrinoda* with a complex extensive dark plastral pattern, expanded along borders of plastral sutures, and occupying more than 60% of plastral area; postorbital mark neither crescent-shaped nor strongly recurved laterally, often disconnected from narrow longitudinal light stripes on head; soft parts mostly black; whitish or light yellow longitudinal stripes much narrower than black interspaces; shell relatively higher than in nominate subspecies (see "*Comparisons*").

Description of holotype.—Carapace length (from anterior margin of nuchal to apex of notch at junction of two hindmost marginals) 84.5 mm; carapace width at widest point 77.5 mm; plastron length 77.6 mm; width of posterior lobe of plastron 41.0 mm; shell height (measured vertically at point midway between second and third spines) 37.3 mm; head width (at anterior edge of tympanum) 13.0 mm.

Ground color (in alcohol) of carapace dark olive gray; edge of carapace serrate, with each marginal projecting beyond anterior corner of next posterior one; each marginal with faint, dark-bordered, pale angular mark; each costal with pale, dark-bordered, narrow ring; plane of plastron 15.0 mm below most lateral point of junction of fifth and sixth marginals; ground color of plastron cream; plastron marked with extensive complex pattern consisting essentially of two concen-

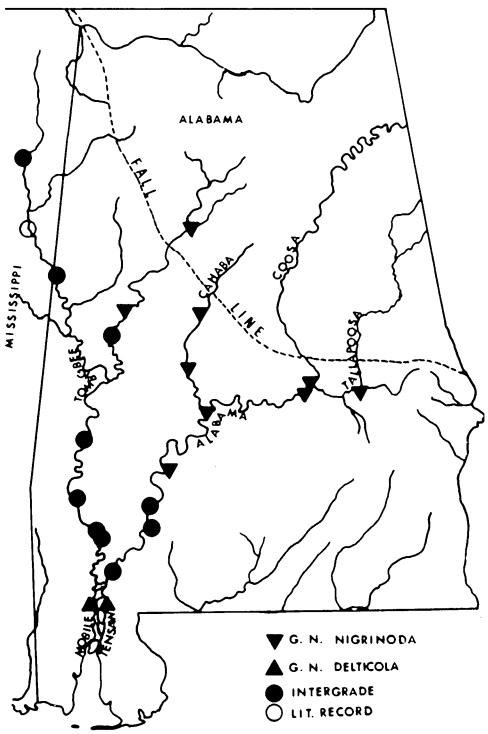

Fig. 1. Distribution of the subspecies of *Graptemys nigrinoda*.

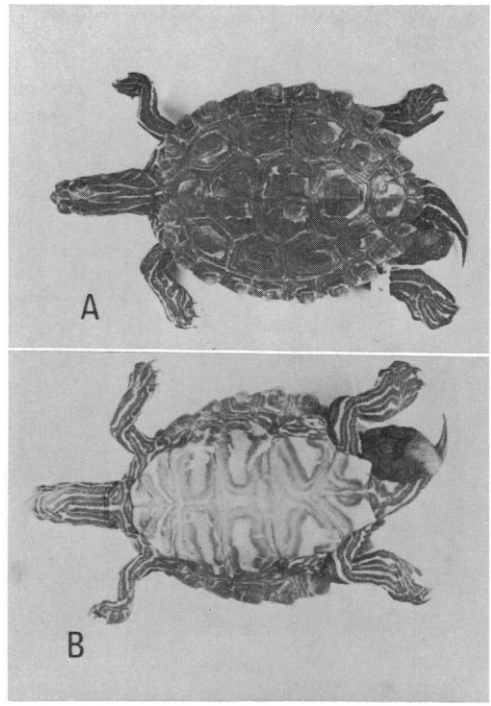

Fig. 2. Holotype of *Graptemys nigrinoda delticola* (UF 26238), male, Baldwin County, Alabama. Carapace length 84.5 mm. A, dorsal view; B, ventral view.

tric dark areas expanded along borders of each suture; entire plastral pattern including approximately 65% of plastral area; axillary and inguinal scutes and undersides of marginals mostly black; basal portion of neck with 12 conspicuous, longitudinal, narrow white stripes with indistinct light stripes between them; light stripes on ventral surface wider and more conspicuous than on dorsum; two white lines entering orbit, upper one interrupted once on left side and twice on right; postorbital white mark not strongly recurved laterally and joined to mark on opposite side by median Y-shaped mark; ventral surface of lower jaw with two posteriorly directed, crescent-shaped lines, anterior one most conspicuous; anterior surface of foreleg with two conspicuous narrow white stripes connected by narrow vertical white line at knee.

Description of allotype.—Carapace length 181 mm; carapace width at its widest point 156 mm; plastron length 168 mm; width of posterior lobe of plastron 91.0 mm; shell height 82.0 mm; head width 25.4 mm.

The allotype agrees with the holotype in major pattern features. Postorbital marks separated from Y-shaped mark on head; both narrow longitudinal lines reaching eyes uninterrupted on both sides of head; plastral pattern faded in center but evident peripherally; shell swollen in bridge region; medial projections of carapace reduced to shallow pointed swellings, neither distally enlarged nor knoblike; carapace edge smooth anteriorly, serrate behind the seventh marginals; alveolar surfaces 5.5 mm wide.

Additional specimens.—In addition to the types series, four other specimens are available. Three (AUM 8948–8950) are from Upper Bryant's Landing, 3.7 miles NNW of Stockton, Baldwin County, Alabama. The fourth (AUM 5983) is from Bucks Landing at Bucks on the Mobile River, Mobile County, Alabama.

Range.—*G. n. delticola* occurs in the Mobile, Tensaw and other anastomosing fresh water streams and lakes which constitute the delta of the Mobile Bay drainage in Baldwin and Mobile counties, Alabama

(Fig. 1). Specimens from Jackson, Clarke County, Alabama, a more northerly locality on the Tombigbee River, show some influence from *G. n. nigrinoda*, but nonintergrading populations of the new form may occur in the Tombigbee farther south in Washington and Clarke counties. In the Alabama River, two specimens from 5 miles WSW of Chrysler, Baldwin County, show some influence from *G. n. nigrinoda*.

The area of intergradation between the subspecies is extensive. In the Alabama River, influence from *G. n. delticola* is evident in specimens from as far north as northern Monroe County. In the Tombigbee system, the area of intergradation is even more extensive and includes the entire Tombigbee River and the Black Warrior River as far north as Hale County, Alabama.

Variation.—The range in carapace length (see above) for 17 juveniles of the new subspecies is 34.3–62.4 mm; for six adult males, including the holotype, 84.5–109.0 mm; and for three adult females, 179–192 mm. The largest female constitutes a size record for the species (maximal carapace length, 204 mm).

Plastral markings are most evident in juveniles. In adult males the plastral pattern tends to be slightly diffused but is still quite evident. In two of the three adult females, the plastral pattern is faded medially.

In the 30 specimens of *G. n. delticola* we have examined, there is little ontogenetic variation in the markings on the carapace and soft parts. Variation in carapace pattern among six juveniles is shown in Fig. 5.

The marginal serration of the carapace becomes less marked with age, and in large adults of both sexes there is little serration anterior to the juncture of the seventh and eighth marginals.

Details of the head pattern vary considerably. Five specimens have the postorbital mark on each side detached from the median Y-shaped mark. In three specimens the mark is attached on one side and unattached on the other. One specimen (AUM 9228) has the postorbital mark recurved and thus is not typical of the subspecies. In most of the specimens the lines reaching the eyes are interrupted once or several times at varying places along their length. In all specimens the distinctive plastral pattern is extensive, occupying from 60–85% of the plastral area.

Comparisons.—In contrast to *G. n. delticola*, *G. n. nigrinoda* lacks an extensive complex plastral pattern. In the latter the plastron is usually marked with narrow dark lines bordering the sutures. The markings are seldom expanded with undulate margins as in *G. n. delticola*, and the entire figure never occupies more than 30% of the plastral area. In the nominate form the postocular mark is typically crescent-shaped and strongly recurved (Fig. 3). One Montgomery County specimen (AUM 6307) lacks this characteristic and in this trait resembles *G. n. delticola*. Collectively, the soft parts of living *G. n. nigrinoda* are predominately yellow. The widest yellow stripes on the head, neck, and appendages are usually as wide, or wider than, the dark interspaces. Yellow is especially dominant on the undersurfaces. In *G. n. delticola* the dark color predominates on all soft parts. The dark color on the soft parts of *G. n. nigrinoda* is chocolate brown in living specimens, whereas in *G. n. delticola* it is black.

The two light lines that reach the eye are seldom interrupted in *G. n. nigrinoda* but

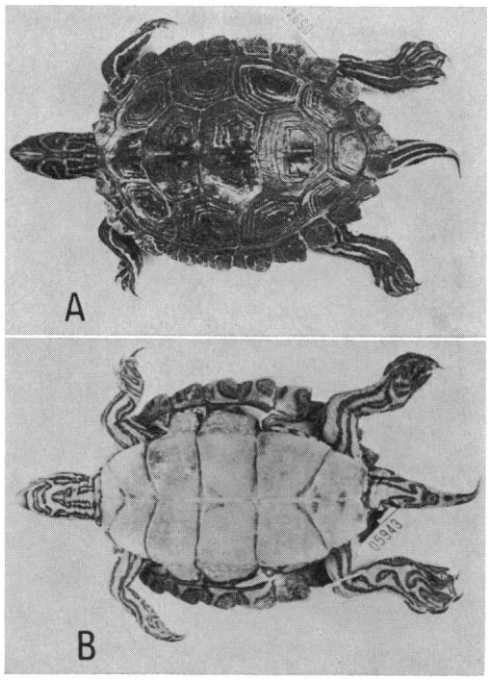

FIG. 3. *Graptemys nigrinoda nigrinoda* (AUM 5943), male, Montgomery County, Alabama. Carapace length 85.5 mm. A, dorsal view; B, ventral view.

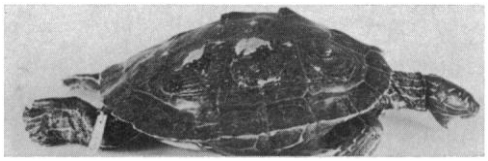

Fig. 4. Allotype of *Graptemys nigrinoda delticola* (UF 26239), female Baldwin County, Alabama. Carapace length 181 mm.

are broken at least at one point in more than half of the *G. n. delticola* examined.

Relative shell height in *G. n. delticola* tends to be greater than in the nominate race. This characteristic is most evident in males and juveniles, but also appears in females (Fig. 6).

Among the specimens examined the largest individuals are of the southern subspecies. The largest *G. n. nigrinoda* is a female (carapace length 150 mm) from Elmore County, Alabama. The largest *G. n. delticola* is a female paratype 192 mm in carapace length. A female 165 mm in length from Marengo County, Alabama is the largest intergrade.

The intergrades examined possess various combinations of characters intermediate between the subspecies. The plastral pattern usually occupies between 30 and 60% of the plastral area, the soft parts vary from dark brown to black, the narrow longitudinal stripes often are tinged with yellow and vary from narrow to wide depending on the comparative proximity of the populations to the ranges of the subspecies proper. In gross aspect most intergrades tend to resemble *G. n. nigrinoda* more than they do the southern subspecies.

Relationships.—The new form differs from *G. n. nigrinoda* most notably in plastral pigmentation and in the amount of dark color on the soft parts. In these characters *G. n. delticola* more closely resembles *G. nigri-*

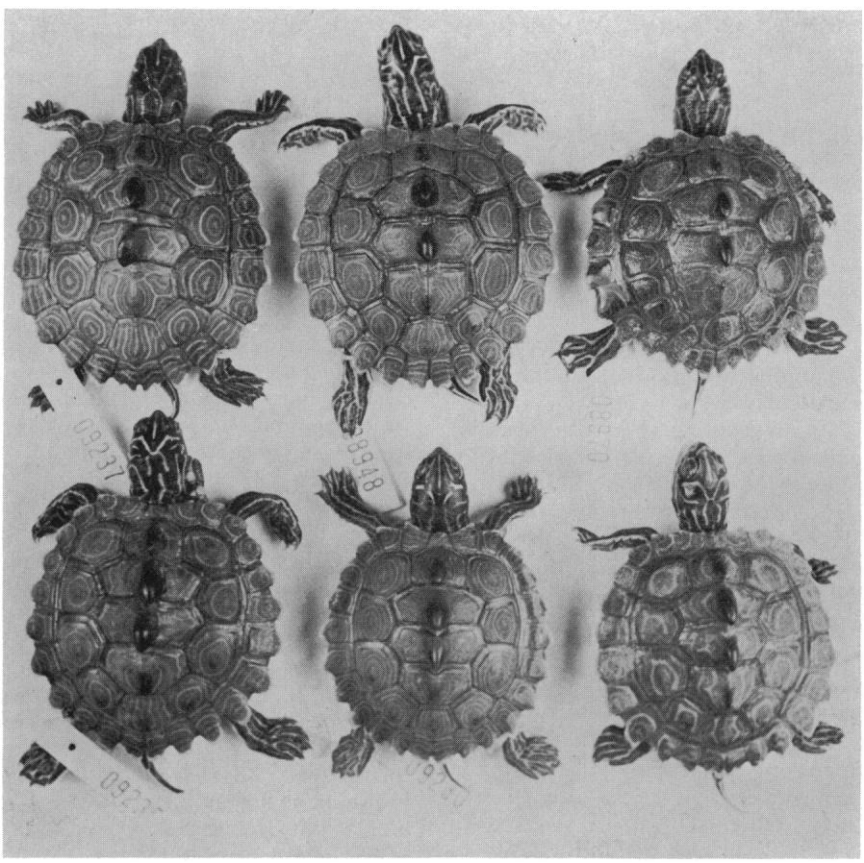

Fig. 5. Variation in carapace pattern among juveniles of *G. n. delticola*.

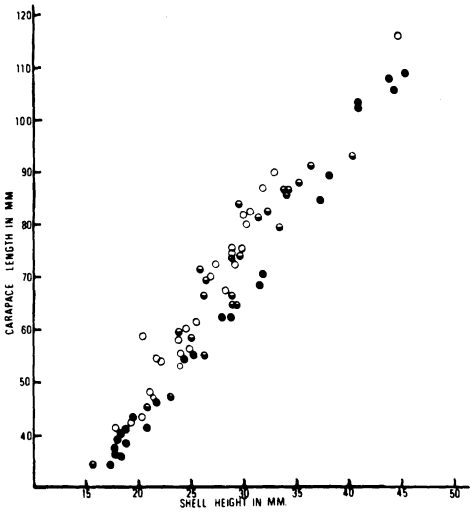

Fig 6. Variation in length-height relationship in juvenile and male *Graptemys nigrinoda*. Solid symbols = *G. n. delticola*, hollow symbols = *G. n. nigrinoda*, half-circles = intergrades.

noda's close relatives, *G. flavimaculata* and *G. oculifera*, than does *G. n. nigrinoda*. We think the extensive complex plastral pattern shared by *G. n. delticola*, *G. flavimaculata*, *G. oculifera* and probably by the *G. pseudogeographica*-like stock that gave rise to this complex is primitive. Reasons for reduction of the plastral pattern in *G. n. nigrinoda* are not evident. Perhaps in the sluggish, turbid streams inhabited by *G. n. delticola*, the complex plastral figure is obliterative, tending to conceal the animal from potential predators beneath it. Natural selection would then favor the retention of this feature in that subspecies. Upstream, where the rivers are, or were, clearer and swifter, elaborate plastral markings may make the turtle more conspicuous from beneath. This could account for the reduction found in *G. n. nigrinoda*. The tendency for a reduction in plastral pattern among other forms of *Graptemys* inhabiting swift waters may be similarly explainable.

The existence of this new form lends support to Cagle's (1954) conclusions that *G. nigrinoda*, *G. flavimaculata* and *G. oculifera* are closely related. Its presence also tends to support Cagle's view that *G. nigrinoda* is the oldest of the three, since two well-differentiated subspecies have arisen in this species. On the other hand, the polytypic nature of *G. nigrinoda* could reflect the greater heterogeneity of habitat within its range than is found in those of the other two related species.

Range of the species.—The black-knobbed sawback is confined to the Mobile Bay drainage, where it prefers relatively large streams. In the Alabama River system its range is limited sharply by the Fall Line in the Cahaba, Coosa, and Tallapoosa rivers. In the Tombigbee system it occurs as far north on the Black Warrior River as Taylor's Ferry, Jefferson County, a locality slightly above the Fall Line. In the Tombigbee River itself, *G. nigrinoda* has been collected as far north as the bridge at State Hwy. 6 near Amory, Monroe County, Mississippi. We did not find it in the Noxubee or Sipsey rivers.

Specimens examined (92).—*G. n. nigrinoda*: ALABAMA.—Bibb Co., Cahaba River at Co. Hwy. 27, NNE of Centreville (AUM 9268). Dallas Co., jct Cahaba and Alabama rivers (AUM 6292, 6307, 6308, 6442). Elmore Co., Coosa River at Ft. Toulouse, S of Wetumpka (AUM 5964, 5965, 5985, 5986); Tallapoosa River at Co. Hwy. 229, near Milstead (AUM 5989, 9241, 9242, 9157). Jefferson Co., Black Warrior River at Taylor's Ferry, 3.4 miles N of Gilmore (AUM 5665). Montgomery Co., Alabama River at U. S. Hwy. 82 (AUM 5941–5945, 5963, 5982, 6146). Perry Co., Cahaba River at Co. Hwy. 183, E of Marion (AUM 9263–9267). Tuscaloosa Co., 17.5 miles S of Tuscaloosa on the Black Warrior River (FMNH 73304, UMMZ 108572–108574). *G. n. nigrinoda* × *delticola*: ALABAMA.—Baldwin Co., Alabama River, 5 miles WSW of Chrysler (AUM 5947, 5948). Clarke Co., Tombigbee River at Jackson (AUM 5939, 9252–9255); Tombigbee River at Coffeeville (AUM 9269–9271). Monroe Co., Alabama River, 5.5 miles E of Gosport (FMNH 73306); Alabama River, 4 miles WNW of Franklin (AUM 8846). Hale Co., Black Warrior River at St. Hwy. 14, E of Eutaw (AUM 8741, 9239, 9240). Marengo Co., Tombigbee River at St. Hwy. 10, W of Nanafalia (AUM 9256–9262, 9272). Pickens Co., Tombigbee River at Pickensville (AUM 8789–8791). Washington Co., Tombigbee River at St. Stephens (AUM 6303–6304). Wilcox Co., Alabama River at Nellie (specimen alive). MISSISSIPPI.—Monroe Co., Tombigbee River at St. Hwy. 6 near Amory (AUM 9344); Tombigbee River at U. S. Hwy. 278, near Amory (AUM 9345). *G. n. delticola*: ALABAMA.—Baldwin Co., Hubbard's Landing on Tensaw Lake,

2.6 air miles SW of Latham (UF 26238, 26239; AUM 8749, 8968–8970, 8979–8981, 9228, 9230–9238, 9334–9336, 9366, 9399–9401); Upper Bryant's Landing on Tensaw Lake, 3.7 miles NNW of Stockton (AUM 8948–8950). Mobile Co., Mobile River at Bucks (AUM 5983).

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LITERATURE CITED

CAGLE, F. R. 1954. Two new species of the genus *Graptemys*. Tulane Stud. Zool. 1(11): 167–189.

SHOOP, C. R. 1967. *Graptemys nigrinoda* in Mississippi. Herpetologica 23(1):56.

TINKLE, D. W. 1958. The systematics and ecology of the *Sternothaerus carinatus* complex. Tulane Stud. Zool. 6(1):1–56.

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Hematology of the Leopard Frog, *Rana pipiens*

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A study of the hematology of *Rana pipiens* including blood cell counts, blood volume, pH, hematocrit, hemoglobin, coagulation time and fragility was made. Red blood cell counts varied from 120,000 to 470,000 (mean 319,400); white cell counts 2000–9800 (mean 5500) and thrombocytes 3500–15200 (mean 7300) per mm^3. The white cell differential count was also made. Blood counts were found to be highly variable and it was not possible to determine any seasonal influence in the total count. The pH of the blood was between 7.2 and 7.6 (mean 7.36), hematocrit reading 13–39% (mean 24.65), hemoglobin 2.4–9.6 g/100 ml (mean 6.75), coagulation time 60–90 seconds (mean 70), and fragility 0.175–0.250% of NaCl (mean 0.215). The description of the various types of blood cells and blood cell photographs are given for the first time for *R. pipiens*.

INTRODUCTION

MOST studies on hematology in various species of *Rana* have been limited to blood cell counts (Alder and Huber, 1923; Klieneberger, 1927; Arvy, 1947; Kaplan, 1951, 1952; Stephan, 1954; Schermer, 1954; Hutchison and Szarski, 1965) and in only one study (Prosser and Weinstein, 1950) is reference made to blood volume and hematocrit for *Rana* species. Of the many blood cell count investigations, only one author has studied *Rana pipiens* Schriber (Kaplan, 1951, 1952). The available information is also very scattered. The blood cell counts reported by many authors vary greatly and most of these were based on a small number of samples. Also, there is no information on fragility and pH of this frog's blood. This study was instituted to help rectify certain of these deficiencies in our knowledge of *R. pipiens* hematology. Actual blood cell photographs rather than diagrams and drawings are presented for the first time for *R. pipiens*.

MATERIALS AND METHODS

This study was extended over a one year period to include possible seasonal differences in the various blood values. Healthy frogs were obtained throughout the year from the Lemberger Co. at Oshkosh, Wisconsin and kept at 4°C for about two weeks until sacrificed. According to the supplier, these frogs were collected in Wisconsin.

Blood samples were obtained by aortic puncture from pithed and dissected frogs. Cardiac punctures usually stopped the heart, making it difficult to obtain sufficient blood. In the hematological studies, usually the first few drops or the first 0.5 ml of blood