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A Key to the Eggs and Nests of Iowa Turtles

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Biologists often need to identify destroyed turtle nests where a predator has excavated and eaten the eggs. We present a dichotomous key to the eggs and nests of Iowa's turtles based on egg or nest morphology and known range of the species. Egg and nest morphology clearly separated most nests of the families Chelydridae and Kinosternidae and many of the Emydidae. However, egg morphology must be combined with known range to distinguish wood turtles (*Glyptemys insculpta*) from other emydids. These factors will also separate most false map turtles (*Graptemys pseudogeographica*) from other species. Similarities among egg morphologies, nest morphologies, and ranges make the map turtles (*Graptemys* spp.) and red-eared sliders (*Trachemys scripta*) difficult to separate in southeastern Iowa.

INDEX DESCRIPTORS: turtles, turtle nests, turtle eggs, turtle natural history, nest predation, key.

Biologists are often called upon to identify the organisms occupying a specific geographic area for environmental impact statements, surveys of habitat modification, and numerous ecological studies. In such studies, turtle nests are often found with few indications as to the species that made them. Such nests are usually partially or entirely excavated, and the eggs are destroyed by mammals such as raccoons (*Procyon lotor*), foxes (*Vulpes* spp.), skunks (*Mephitis mephitis* or *Spilogale putorius*), or mink (*Mustela vison*) (Fig. 1). This paper describes how to utilize egg counts, egg measurements, nest location, nest shape, and knowledge of the range of Iowa's turtles in identifying the species that created the nest. Even with all this information, there are a few situations where it is possible to identify the nest only to genus or closely related genera.

Turtles are long-lived animals wirh low adult mortality but high mortality in the egg and embryo stage (Iverson 1991, Congdon et al. 1994, Wilbur and Morin 1988). For example, snapping turtle (*Chelydra serpentina*) nesting behavior is particularly well studied, and the proportion of snapping turtle nests destroyed by predators averaged 70% and ranged from 30% to 100% in two different years during a six year study in southeast Michigan (Congdon et al. 1987). In a South Dakota marsh, there was a 59% predation rate on snapping turtle nests, with raccoons and mink being the primary predators (Hammer 1969). Snapping turtle nests in a northern New York marsh experienced a 94% predation rate (Petokas and Alexander 1980), and 113/134 (84%) of nests were destroyed by predators (65.5% striped skunks (*Mephitis mephitis*), 12.5% for both mink and raccoons) in a study in Quebec, Canada (Robinson and Bider 1988). These high nest predation rates appear to be typical for most turtle species (Ernst et al. 1994).

When and where turtles lay their eggs certainly influences whether their nests will persist until hatching. Several studies found higher nest predation with nests close to the water (e.g., Kolbe and Janzen 2002), but some (e.g., Robinson and Bider 1988) did not find this correlation. It seems that foxes (*Vulpes* spp.) find nests further from water, whereas raccoons desrroy more nests close to the water. Nests thar are clustered also may (Robinson and Bider 1988) or may not (Burke et al. 1998) succumb to higher predation rates than isolated nests. Many studies have documented a decreased risk of predation with the age of the nest, the greatest predation risk to turtle eggs being in the first 24 hours after deposition. Late predation on nests may be related to rainfall events in both snapping turtles (Congdon et al. 1987) and Blanding's turtles (*Emydoidea blandingii*) (Congdon et al. 1983). Also, nesting location may be a compromise between minimizing female mortality when nesting and maximizing offspring fitness (Spencer 2002). A few locations in eastern Iowa may have predation problems caused by burrowing snakes, specifically western hognose snakes (*Heterodon nasicus*). These snakes may ingest an entire clutch of eggs below ground, and, in one study in western Nebraska, destroyed 48.9% of 229 monitored yellow mud turtle (*Kinosternon flavescens*) eggs (Iverson 1991). Both these and bullsnakes (*Pituophis catenifer*) may approach a turtle nest from the surface as well, ingest the turtle eggs leaving no shell behind, and often leave little evidence that a turtle nest existed (JLC, personal observation).

Our key may also be used to identify nests recently abandoned by hatching turtles, mammals having excavated the egg shells remaining. In eastern Iowa we found that all yellow mud turtles (*Kinosternon flavescens*), most painted turtles (*Chrysemys picta*), map turtles (*Graptemys geographica*), and false map turtles (*Graptemys pseudogeographica*) emerge from their nest in spring, having overwintered underground. In contrast, all smooth and spiny softshell turtles (*Apalone mutica* and *A. spinifera*) and snapping turtles (*Chelydra serpentina*) emerged in the fall of the nesting year (Christiansen and Gallaway 1984). Our later observations revealed that red-eared sliders (*Trachemys scripta*) and Blanding's turtles (*Emydoidea blandingii*) also tend to emerge in spring. It is likely that during warm extended autumns, most turtles with the exception of mud turtles may leave their nests in the fall.

There are nine species of snake in Iowa that lay eggs as large as turtle eggs: the eastern and western hognose snakes (*Heterodon nasicus* and *H. platirhinos*), black rat snake (*Elaphe obsoleta*), fox snake (*Elaphe vulpina*), blue racer (*Coluber constrictor*), bullsnake, milksnake (*Lampropeltis triangulum*), and prairie and speckled kingsnakes (*Lampropeltis calligaster* and *L. getula*). Although the eggs look similar, they should rarely be misidentified because snakes do not dig holes to deposit their eggs as most turtles do. Eggs of racers (Fitch 1963) and hog-

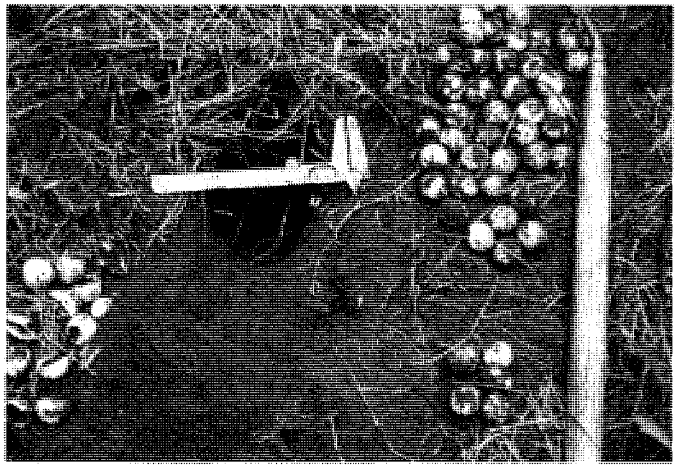

Fig. 1. Partially destroyed snapping turtle (*Chelydra serpentina*) nest, with the intact eggs dug up to the right. Muscatine county, Iowa 1985.

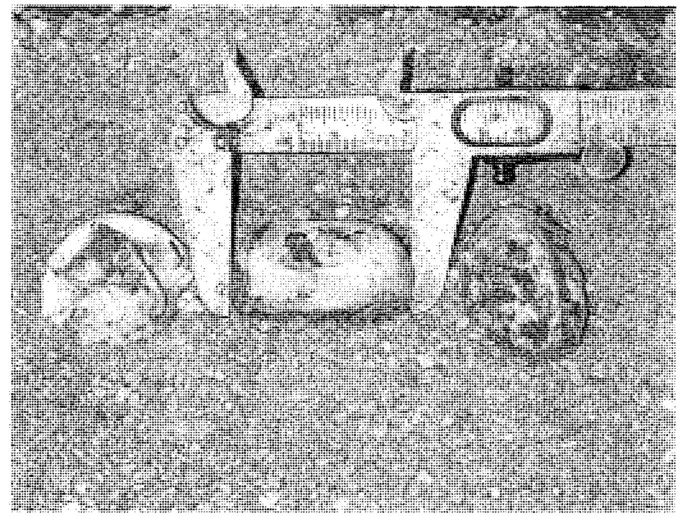

Fig. 2. Turtle eggs filled with wet sand for measurement, the one on the left is empty.

nose snakes (Platt 1969) have been plowed up in fields from apparently 8–20 cm below the soil, but the leathery eggs of most snakes are usually deposited under logs and boards, within rotten logs or stumps, in piles of wood chips or vegetation, or very shallowly in the substrate (Greene 1997). Although not a useful field characteristic, turtle eggs differ from snake and lizard eggs chemically in that the inorganic layer of the eggshell consists of calcium carbonate in the form of aragonite instead of calcite (Packard and DeMarco 1991).

There are 14 species of turtle in Iowa (Christiansen and Bailey 1997). While it is possible to identify the adults and juveniles through the use of keys generally available (e.g., Conant and Collins 1991, Ernst et al. 1994), no key to turtle eggs has been published. One reason for this is undoubtedly the fact that the eggs of many turtle species are so similar that a great many would be impossible to separate entirely by morphological criteria. In recent years, the availability of more complete knowledge of the ranges of turtles in Iowa, the number of eggs they usually lay, and the habitats they choose for their nests has enabled the construction of a key that separates all but a few species. The few nests that cannot be distinguished can at least be reduced to a small number of choices.

FINDING NESTS AND COLLECTING DATA

Most species of turtle will construct nests within 200 m of a pond or deep, quiet part of a stream between 15 May and 15 July. They will be in a clearing having good exposure to the sun and will usually be in sandy soil. The only indication of a newly made nest is often a circle of disturbed sand or soil with turtle tracks leading toward and away from it. Often the filled excavation will be adjacent to or slightly beneath a clump of grass. Nests destroyed by raccoons and skunks will have broken eggs strewn about the excavation. Such nests should be carefully excavated by hand to a depth of 30 cm (1 foot) to locate eggs the predator may have missed and to determine the shape of the underground cavity. Broken eggs often remain in one piece, and these should be counted and measured as well as possible. Fragments can be grouped to give a good estimate of egg number. Soil type, distance from water, description of water (pond, stream, river, lake), soil (sandy, organic, etc.), number of eggs, length and width of eggs (if nearly spherical, one measurement is enough), and hardness of shell should all be recorded. Hardness of shell can be determined by pressing lightly with the fingers.

Measurement of Broken Eggs

Well-calcified eggs such as those of the mud turtle (Kinosternidae) and softshell turtles (Trionychidae), and to a lesser extent snapping turtles (Chelydridae), will retain their shape when broken. The eggs of the rest of Iowa's turtles (Emydidae) are more leathery, and their fragments usually curl badly when dry. To obtain the best possible estimate of the original length and width of the eggs, it is better to average the best two reconstructed broken eggs in the clutch than to try to measure several badly curled egg shells. If all eggs are badly curled, it may be necessary to rehydrate the most complete fragments in a cup of water for several minutes. The shell can then be filled with moist sand to restore the original shape and allow measurement (Fig. 2). Length and width measurements are best taken with calipers.

Measurement of Nests

It is also useful to excavate the nest carefully to determine the original nest depth and shape. Nests often retain their shape through the summer following nesting. The soft soil can carefully be removed from the interior of the nest, and the cavity can be bisected with a spade. Depth from the top of the nest to the bottom and maximum width of the nest can be taken with a plastic ruler. Most turtle nests are wider below the surface than at the surface and are generally flask-shaped (Ernst et al. 1994).

Hatching Turtle Eggs

Should whole eggs be found, two or three can be removed for hatching in the laboratory, and the nest can be re-covered with loose soil to protect the remainder after they are measured. The eggs removed should be placed in a plastic bag in moist (but not wet) sand for transfer from the field. Care must be taken not to rotate the eggs. A tag with pertinent data should be placed in the bag. In the laboratory, the eggs can be transferred to moist (not saturated) cotton, sawdust, or vermiculite in a plastic shoebox or tray and left in a warm (20–35°C), dark environment until mid-September when hatching usually takes place. The substrate should be kept moist through the incubation period. For most Iowa species, maintaining the eggs near the center of this range (28–30°C) produces both males and females while incubating the eggs at 25°C or less produces mostly males and 31°C or greater produces all females (Paukstis and

Janzen 1990). Snapping turtles are an exception where eggs will produce females at both extremes and males at the intermediate temperatures (Vogt and Bull 1982).

Infertile eggs are usually light orange or pinkish and often moldy. Fertile eggs develop a dorsal white air spot that enlarges to cover the top of the egg, and the lower embryonic portion becomes dark. Handling or rolling eggs, or exposing them to light can inhibit or prevent hatching. Contact the authors for additional information on hatching and caring for the young.

KEY TO IOWA TURTLE NESTS

Wherever possible, this key is based on data from Iowa turtles. Several studies have shown geographic differences within species in egg size and number of eggs per clutch as well as number of clutches laid per year (e.g., Tinkle 1961, Christiansen and Moll 1973). When Iowa data were unavailable or judged to be insufficient, we relied heavily on data from surrounding states. More research is needed on turtle reproduction in Iowa and future research on turtle nest predation could involve observations of captive predators destroying turtle nests as has been done with duck nests (Sargeant et al. 1998) or monitoring nests with cameras. We provide maps of the distribution of Iowa turtles to separate some species with similar clutch sizes, egg sizes, and nest locations.

1. a) Eggs spherical—Families Chelydridae and Trionychidae (2)
   b) Eggs ellipsoidal or oval—Families Kinosternidae and Emydidae (5)
2. a) Eggs average 33 mm diameter or more and deposited in the largest nest cavity for any Iowa species, 28–39 cm deep and 15–25 cm wide.—**Alligator Snapping Turtle,** *Macrochelys temminckii.* 9–44 eggs per nest. If present in Iowa, limited to sandy, river-side areas along the Mississippi, possibly extreme lower Iowa, Skunk, and Des Moines rivers. Egg shell hard, chalky white, with a rough, granular appearance. No Iowa data, 33–51.8 mm egg diameter and nest dimensions are from Ernst et al. (1994) and Dobie (1971). This species has been found in the Mississippi River but is not known to breed in Iowa. (Fig. 3)

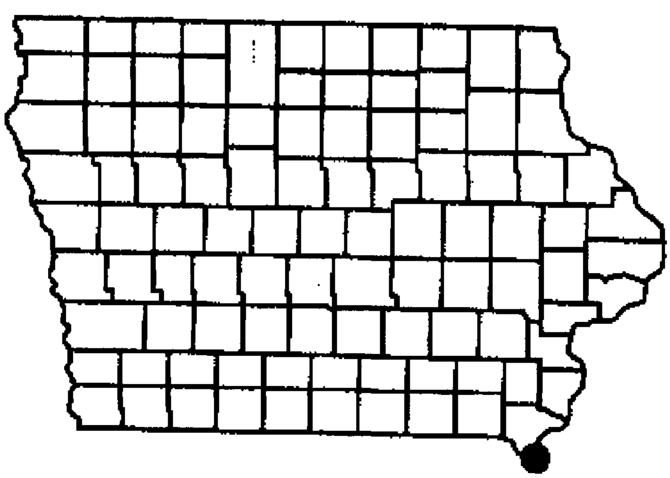

Fig. 3. Distribution of the Alligator Snapping Turtle in Iowa.

   b) Spherical eggs average less than 33 mm diameter (3)
3. a) Eggs with tough, but pliable, slightly calcified shell. Dent when slightly dehydrated or can be dented with finger with only slight cracking of shell. Six to 104 eggs/clutch, mean: 20–40; in Iowa nests had 21–47, mean: 37.5 eggs.—**Snapping Turtle,** *Chelydra serpentina.* Eggs 22–32 mm diameter; in Iowa eggs 25.9–30 mm diameter (93 eggs from 3 turtles). Nests in any unconsolidated soil, along streams, rivers, ponds or lakes throughout Iowa, often considerable distances from water. These turtles often migrate a kilometer or more from their home range to a nesting area. Most nests are more than 8 cm greatest width and often the female leaves two small but obvious piles of dirt behind her hind legs even after the nest is completely covered. (Fig. 4)

Fig. 4. Distribution of the Snapping Turtle in Iowa.

   b) Eggs with thicker, brittle shell, do not dent when dehydrated; spherical shell cracks severely when depressed with finger. Nests have 4–39 eggs.—**Softshells,** *Apalone* (4)
4. a) Found in sandy soil and large sand bars usually within 100 m of rivers, streams, and lakes throughout Iowa. Egg diameter 22–32 mm (mean: 28) (One Iowa nest: egg diameter 22–29 mm, mean: 23 mm). This is the only softshell found in Iowa's small streams and the only softshell in most of the interior of Iowa.—**Spiny Softshell,** *Apalone spinifera.* Nests have 4–32 (mean: 18–20) eggs. Flask-shaped nests are 10–25 cm deep and 7–12.5 cm widest diameter. (Fig. 5)

Fig. 5. Distribution of the Spiny Softshell Turtle in Iowa.

   b) Found in sandy soil and large sand bars along large rivers (at least 100 m width) such as southern half of Des Moines, southern third Cedar, Iowa, Skunk and a few others, all of Mississippi and Missouri rivers. Egg diameter: 20–27 mm (26 Iowa *A. mutica* eggs from four turtles were 20–26.8 mm, mean: 24.0 mm).—**Smooth Softshell,** ***Apalone mutica.*** Nests have 4–33 (mean: 18–20) eggs. *Apalone mutica* eggs and nests are difficult to distinguish from those of *A. spinifera.* (Fig. 6)

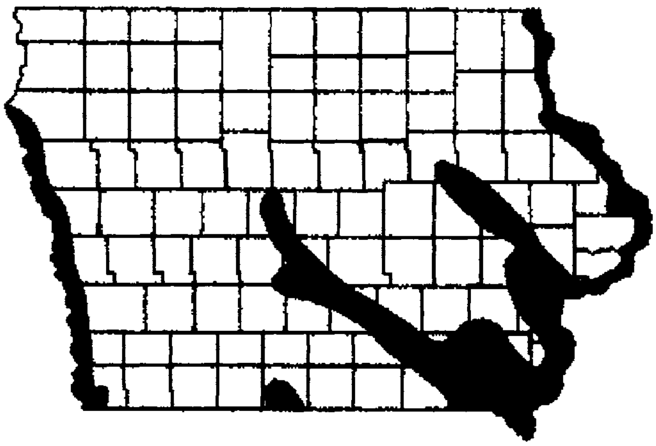

Fig. 6. Distribution of the Smooth Softshell Turtle in Iowa.

5. a) Elongated eggs hard-shelled, do not dent when dehydrated, can not be dented with finger without cracking calcium coat and severely breaking egg. Family **Kinosternidae** (6)
   b) Eggs soft-shelled, feel leathery or slightly chalky but always dent when dehydrated. Nests are similar and flask-shaped. Family **Emydidae** (7)
6. a) Found in extremely sandy soil or sand dunes along woodland ponds, marshes, and river inlets in Muscatine, Louisa, Des Moines, and Lee counties. Nests are usually created after the female has buried herself in the sand (Iverson 1990). The nest cavity is 5–23 cm below soil surface; 4–6 eggs (mean: 5). [16 eggs from 3 Iowa clutches were 27.8–32 mm (mean: 29.6) long × 16.8–17.9 mm (mean: 17.3) wide].—**Illinois Mud Turtle,** ***Kinosternon flavescens.*** Yellow mud turtle eggs elsewhere were 22.7–31.4 mm × 14.1–18.3 mm in size, with a clutch size typically two to five eggs (Iverson 1991). (Fig. 7)

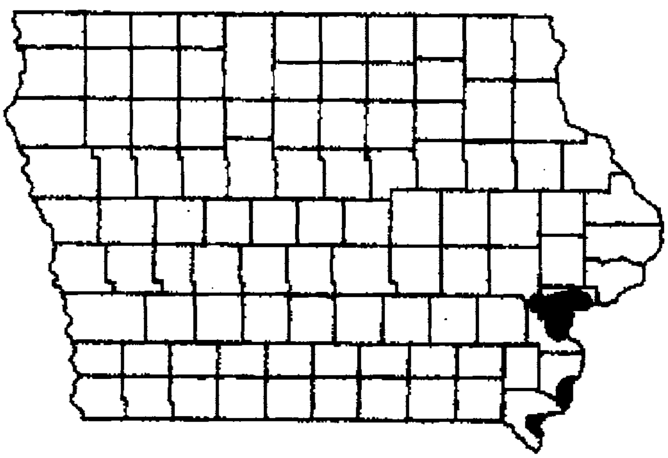

Fig. 7. Distribution of the Illinois Mud Turtle in Iowa.

   b) Found in moderately sandy soil only along deep, quiet inlets of major rivers or adjacent tributaries in Muscatine, Louisa, and possibly Des Moines and Lee counties. At least one population exists in the Mississippi River and these turtles nest on the banks in Jackson Co. Nests very shallow or under logs or rotting vegetation or in shallow cavities less than 10 cm deep. Usually only three eggs per clutch but may have 1–6.—**Stinkpot,** ***Sternotherus odoratus.*** Five eggs from two Iowa turtles were 27.3–30.0 × 16.9 mm wide. Eggs were 22–31 × 13–17 mm in Wisconsin (Vogt 1981). (Fig. 8)

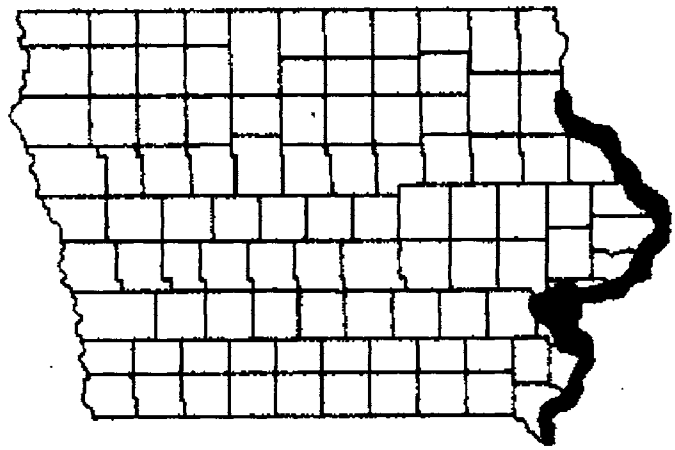

Fig. 8. Distribution of the Stinkpot in Iowa.

7. a) Egg surface rough and nodular, more calcified than other emydid turtles, egg ellipsoidal and large.—**Blanding's Turtle,** ***Emydoidea blandingii.*** 29 eggs from four Iowa turtles were 33–40.5 (mean: 38.4) × 22.5–25.2 (mean: 24.0) mm. Found throughout Iowa except western and southern counties. In Wisconsin eggs were 34–41 × 21–28 mm, with clutch sizes ranging from 6 to 15 (Vogt 1981). A study of over 280 clutches in Michigan found an average of 10.2 eggs per clutch (range: 3–19) that were on average 37.5 × 23.2 mm (Congdon and van Loben Sels 1991). Nests are ½ to 1 km from shallow marsh habitats or, rarely, from ponds that may be constructed when marshes are drained. Nests are usually in a sandy loam. (Fig. 9)

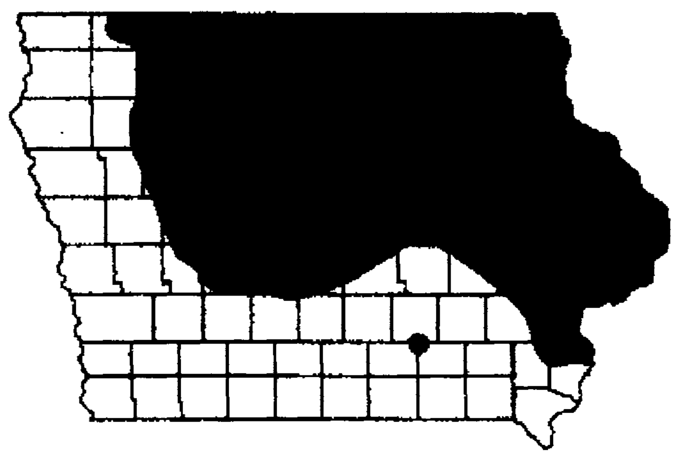

Fig. 9. Distribution of the Blanding's Turtle in Iowa.

b) Eggs smooth, poorly calcified (8)

8. a) Eggs per nest usually five or fewer and large, 31.3–40.9 × 20–26 mm. Nest distance to water's edge is random.—**Ornate Box Turtle,** *Terrapene ornata.* Eggs somewhat brittle, laid in sandy or loess soil and mostly limited to sandy or loess areas near Mississippi, Cedar, southern portion Iowa, and Missouri rivers. **Eastern Box Turtle** (*Terrapene carolina*) eggs are similar in size; specimens found in Iowa are believed to be recent introductions and successful reproduction of the species has not been documented in the state. Nine eggs from two Iowa Ornate Box Turtles and two eggs from one Iowa specimen of *T. carolina* were 30.0–40.6 (mean: 36.7) × 20.7–23.8 (mean: 22.4) mm. The average number of eggs/clutch for *T. ornata* was 3.5 in Wisconsin (Vogt 1981) and 4.7 in Kansas (Legler 1960). (Fig. 10)

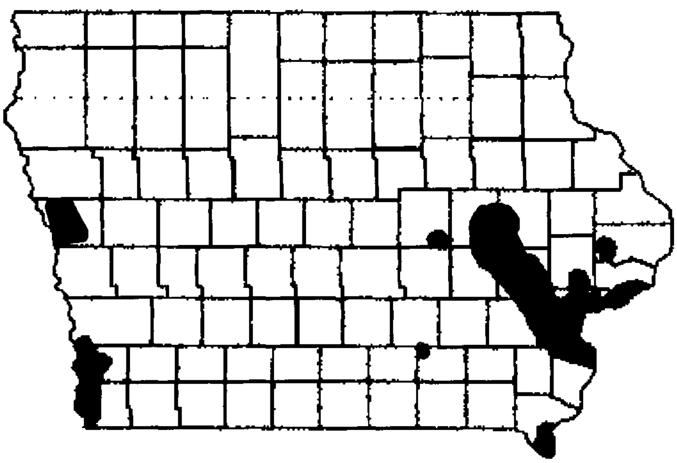

Fig. 10. Distribution of the Ornate Box Turtle in Iowa.

b) Eggs per nest usually five or more, nest associated with bodies of water. (9)

9. a) Leathery eggs in clutch average less than 32 × 20 mm. Eggs are smooth and slightly pitted. Measurements from 22 eggs from 3 Iowa turtles: 28–33 (mean: 31) × 14–20 (mean: 18.9) mm. Nine southeastern Iowa nests had clutches of 3–14 eggs (mean of 10). Ten nests in northwestern Iowa averaged 8.8 (5–13) eggs/clutch (Blanchard 1923). Found statewide in the greatest possible variety of soil types, the only turtle with eggs this size and shape likely to inhabit small farm ponds.—**Painted Turtle,** *Chrysemys picta.* Painted turtles are often sympatric with *Graptemys geographica* and *G. pseudogeographica* and the nests and eggs of *C. picta,* while slightly smaller, may be difficult to distinguish from them. Clutches in Wisconsin contained 4–20 eggs (usually 8) that averaged 30 × 19 mm (Vogt 1981). Christiansen and Moll (1973) found Wisconsin clutches averaged 10.2 eggs, similar to those of adjacent Iowa. (Fig. 11)

b) Leathery eggs in clutch average 33 × 21 mm or greater (10) This group contains several species with similar eggs and nests. They usually must be separated by nest habitat and known range of the turtle.

10. a) Found only in clearings in wooded valleys of the Cedar and Shell Rock rivers and nearby marshes north of Waterloo. In Iowa associated with relatively cold, clear, unpolluted areas of rivers but sometimes in associated marshes.—**Wood Turtle,** *Glyptemys*

Fig. 11. Distribution of the Painted Turtle in Iowa.

insculpta. Very rare. The only species with similar eggs in the Iowa range of wood turtles is the painted turtle (*Chrysemys picta*). Painted turtle eggs are smaller (egg width less than 20 mm). Eggs 27–49 mm long, and 19–26 mm wide. Clutch size varies from 4–18, with an average clutch size of 10.4 in Michigan (Ernst et al. 1994) and 11 (Ross et al. 1991) or 8 (Vogt 1981) in Wisconsin. (Fig. 12)

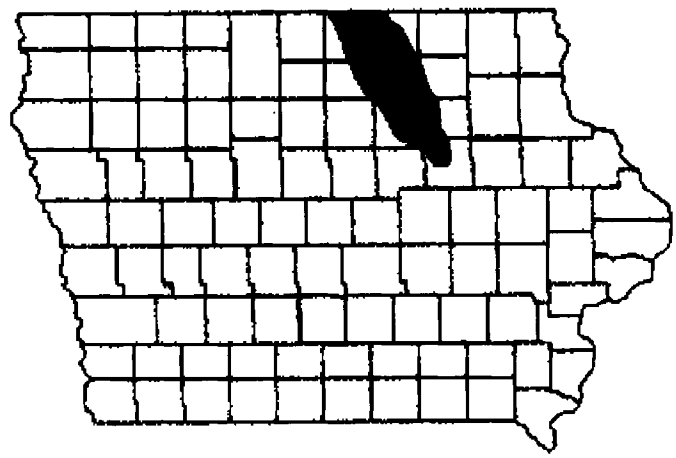

Fig. 12. Distribution of the Wood Turtle in Iowa.

b) Range includes Cedar River south of Waterloo and all of Missouri, Mississippi, the Iowa River south of Tama, the Des Moines River south of Des Moines, and lower parts of large tributaries of these rivers.—**False Map Turtle,** *Graptemys pseudogeographica.* This is the widest ranging species in Iowa with eggs averaging 33 × 21 mm or greater. (Measurements are from 25 *G. pseudogeographica* eggs from six Iowa nests and from the report by Cahn (1937) on Illinois *G. pseudogeographica.*) In Wisconsin, Vogt (1981) found the eggs to average 34 × 22 mm and clutch sizes were 8–22 (usually 12–16). Occupying smaller portions of this range are three species whose eggs will often be indistinguishable from false map turtles (11) (Fig. 13)

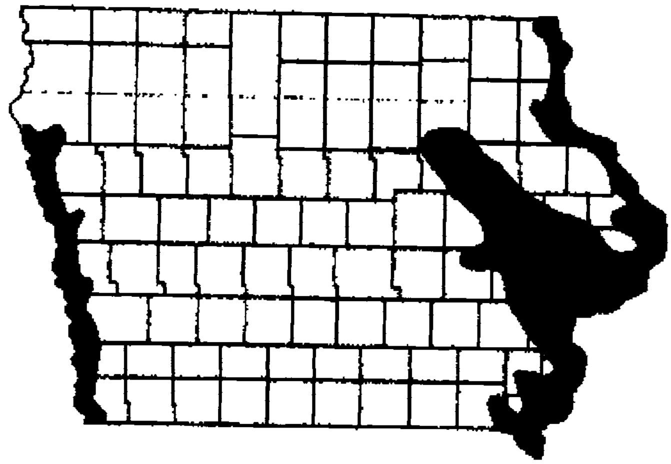

Fig. 13. Distribution of the False Map Turtle in Iowa.

11. a) Eggs are large and more elongated (36 × 21 mm), oval, thin-shelled, with a smooth surface. Found only in southeastern Iowa but could occur in suitable habitat in other parts of extreme southern Iowa.—**Red-eared Slider,** *Trachemys scripta.* Eggs per nest usually nine or more in Iowa and ovoid. Clutch size in Illinois ranged from 5–22 (mean: 10), with egg dimensions of 36 × 21.5 mm on average (Cagle 1944, Smith 1961). The nests are limited to areas of sandy or unconsolidated soil near quiet pools in large rivers or ponds adjacent to them. (Fig. 14)

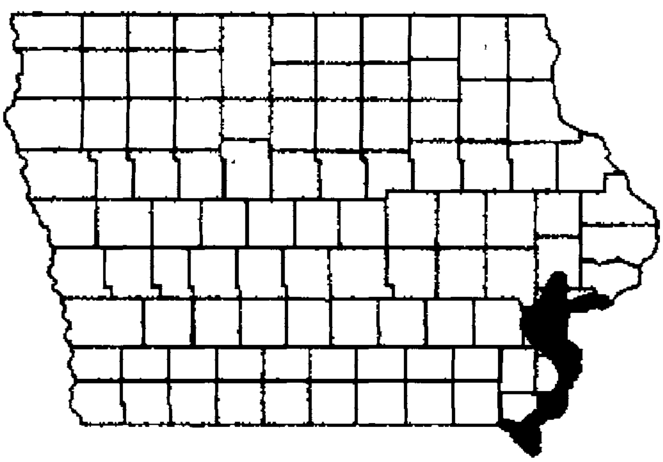

Fig. 14. Distribution of the Red-eared Slider in Iowa.

b) Egg and clutch size similar to sliders but limited to sandy areas bordering the Mississippi River and lower Des Moines, Cedar, and Iowa rivers.—**Map Turtle,** *Graptemys geographica.* In Missouri clutch size averaged 10.1 (White and Moll 1991), in Wisconsin 13.6 (10–20), with eggs 34–38 × 22–26 mm in size (Vogt 1980 and 1981). (Fig. 15)

c) As above (10b) but limited to the Mississippi river.—**Ouachita Map Turtle,** *Graptemys ouachitensis.* In Wisconsin clutch sizes were 8–22 (usually 12–16) for *G. pseudogeographica* and 8–15 for *G. ouachitensis,* with egg sizes for both averaging 34 × 22 mm (Vogt 1981).

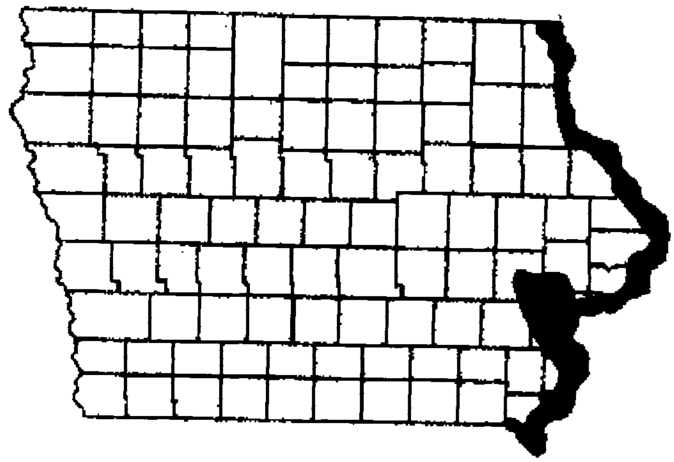

Fig. 15. Distribution of the Map Turtle in Iowa.

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