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A New Batagurid Turtle from Northern Sulawesi, Indonesia

WILLIAM P. MCCORD[1], JOHN B. IVERSON[2], AND BOEADI[3]

[1]East Fishkill Animal Hospital, Hopewell Junction, New York 12533 USA [Fax: 914-221-2570];
[2]Department of Biology, Earlham College, Richmond, Indiana 47374 USA [Fax: 317-983-1497; E-mail: JohnI@earlham.edu];
[3]Department of Mammals, Museum Zoologicum Bogoriense, Bogor, Indonesia

ABSTRACT. – **A new species of batagurid turtle, *Geoemyda yuwonoi*, is described from northern Sulawesi, Indonesia. It differs from all other batagurids by the following combination of characters: relatively large size; relatively low, tricarinate, orange-brown carapace; unhinged and unstreaked plastron; very short intergular and very long interanal seams; well-developed bony bridge; distinctive, dark brown and white, sexually dichromatic head coloration; laterally cusped upper tomium; hooked beak supported by anterior contact of the maxillae; and lack of a postorbital bar.**

KEY WORDS. – **Reptilia; Testudines; Bataguridae; *Geoemyda yuwonoi*, sp. nov.; turtle; taxonomy; description; zoogeography; Indonesia**

Seven specimens of a distinctive new batagurid turtle were recently purchased from local people at Gorontalo on the Minahassa Peninsula of northern Sulawesi in Indonesia by Frank Yuwono, an Indonesian tropical fish exporter from Djakarta. Realizing the significance of his discovery, Yuwono deposited four specimens in the Bogor Museum in Indonesia and forwarded three to the senior author. Subsequently Yuwono obtained a single young male specimen from Poso on the north coast of central Sulawesi, which remains in his possession. Our examination of the morphology of five of the original specimens suggests that the species belongs to the *Geoemyda* complex (*sensu* McDowell, 1964) and is most closely related to the genus *Geoemyda* (*sensu* Moll et al., 1986).

To determine more definitively the generic relationships of the new form, we performed a preliminary cladistic analysis (Table 1; Fig. 1) of members of the genera *Geoemyda* and *Heosemys* (based on data from Moll et al., 1986; Yasukawa et al., 1992; and our own unpublished data), the monotypic genus *Pyxidea* (sister genus to *Geoemyda* according to Hirayama, 1984; data from Yasukawa et al., 1992, and Iverson, unpublished), the genus *Cyclemys* (based on specimens of *C. dentata* in our collections and information provided by E.O. Moll), and the new form. That analysis suggests: (1) that the genus *Heosemys* (including at least *H. spinosa* and *H. grandis*) is phylogenetically divergent from the other taxa; (2) that the clade including *G. silvatica* is a sister group to the clade including *G. spengleri* and *G. japonica* (in agreement with Moll et al., 1986, but contrary to Yasukawa et al., 1992); (3) that *depressa* and *leytensis* should not be included in the genus *Heosemys* (contrary to current taxonomy; see Iverson, 1992); and (4) that *spengleri*, *japonica*, *mouhoti*, *silvatica*, *depressa*, *leytensis*, and the new form belong to the same clade. However, until a thorough phylogenetic analysis of all known species of the *Geoemyda* complex is completed, the relationships revealed in our cladogram must be considered preliminary. Nevertheless, they support the tentative placement of our new species within the genus *Geoemyda*, along with *spengleri*, *japonica*, *mouhoti*, and *silvatica*, as well as *depressa* and *leytensis*. It therefore seems appropriate to name this distinctive new turtle in honor of Frank Yuwono as:

Geoemyda yuwonoi, sp. nov.
Sulawesi Forest Turtle
(Fig. 2)

Holotype. — Museum Zoologicum Bogoriense (MZB) 10295, an adult male, preserved in alcohol; reported to have been collected near Gorontalo [0°33'N, 123°05'E] on the Minahassa Peninsula, northern Sulawesi [Celebes], Indonesia; purchased from local people by Frank Yuwono in the fall of 1993.

Paratypes. — MZB 10296 and University of Florida, Florida Museum of Natural History (UF) 97333 (adult male, liquid preserved), 97334 (adult female, liquid preserved), and 97335 (adult female, complete skeleton). MZB 10296 was purchased with the holotype and bears the same data. The UF specimens were purchased at the same locality but in the spring of 1994.

Diagnosis. — A large batagurid species, tentatively assigned to the genus *Geoemyda*, but distinguishable from all other batagurids by the combination of: (1) relatively large size; (2) relatively low, tricarinate, orange-brown carapace; (3) unhinged and unstreaked plastron; (4) very short inter-gular seam (less than 50% of interanal seam length) and nearly parallel anterior and posterior gular margins; (5) very long interanal seam; (6) well-developed bony bridge; (7) distinctive, sexually dichromatic head coloration; (8) laterally cusped upper tomium; (9) hooked beak; (10) maxillae contacting anteriorly, below the premaxillae; and (11) lack of a postorbital bar.

Description. — The following description of external morphology is based on the type series, with the UF specimens also being examined when alive. Carapace length (CL) to at least 256 mm in males and at least 221 mm in females,

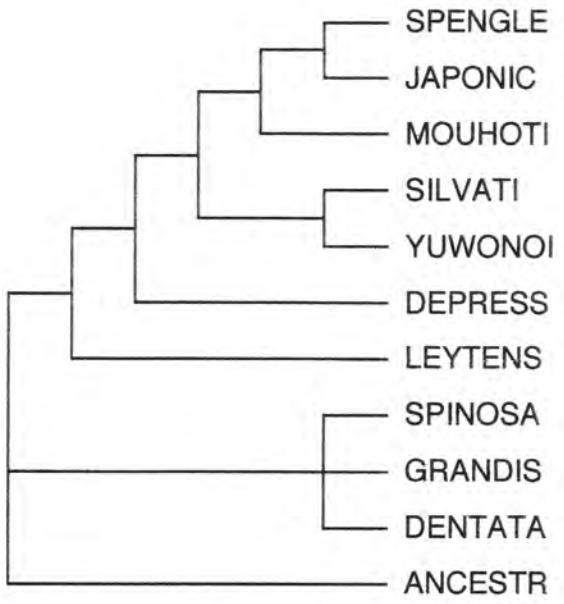

Figure 1. Cladogram generated by PAUP 3.0 (Swofford, 1990) based on the 22 characters scored for the batagurid taxa in Table 1. The cladogram is a strict consensus tree of the two shortest trees generated by exhaustive search rooted with a hypothetical ancestor and using unweighted characters. Tree length = 35 steps; consistency index = 0.63.

elongate (more so in males), relatively low (maximum carapace height/CL = 0.327 to 0.362; mean = 0.345), moderately tricarinate, widest at the level of marginal (M)7 or 8 in females and M8 or 9 in males (maximum carapace width/CL = 0.711 to 0.774; mean = 0.745, with males slightly narrower than females), with a strongly serrated posterior margin (more so in males), and with fairly obvious growth annuli. Marginals 1, 3, and 8–12 longest, all nearly equal in length; M5 or 6 shortest; M9 tallest, with M10 and 11 nearly as tall; at least M9–11 flared (more so in males); M12 much less flared. Anterolateral corner of M1 projecting beyond M2. Lateral margins of M3 through M8 or 9 upturned, forming a shallow dorsal trough. Nuchal scute small, nearly square, but slightly wider posteriorly than anteriorly. Vertebrals (V) 2–5 wider than long; V1 about as wide as long, reaching laterally only to the middle of M1; V5 reaching laterally only to middle of M11. Medial and lateral keels obvious on all scutes, but lateral keels least obvious on first costal scutes and most obvious on fourth costals. Carapace orange to horn-brown, with the most elevated parts of the keels slightly more yellowish in color (possibly due to shell wear), and seams distinctly darker brown. Ventral surfaces of marginals yellow-brown, lacking distinctly darker blotching.

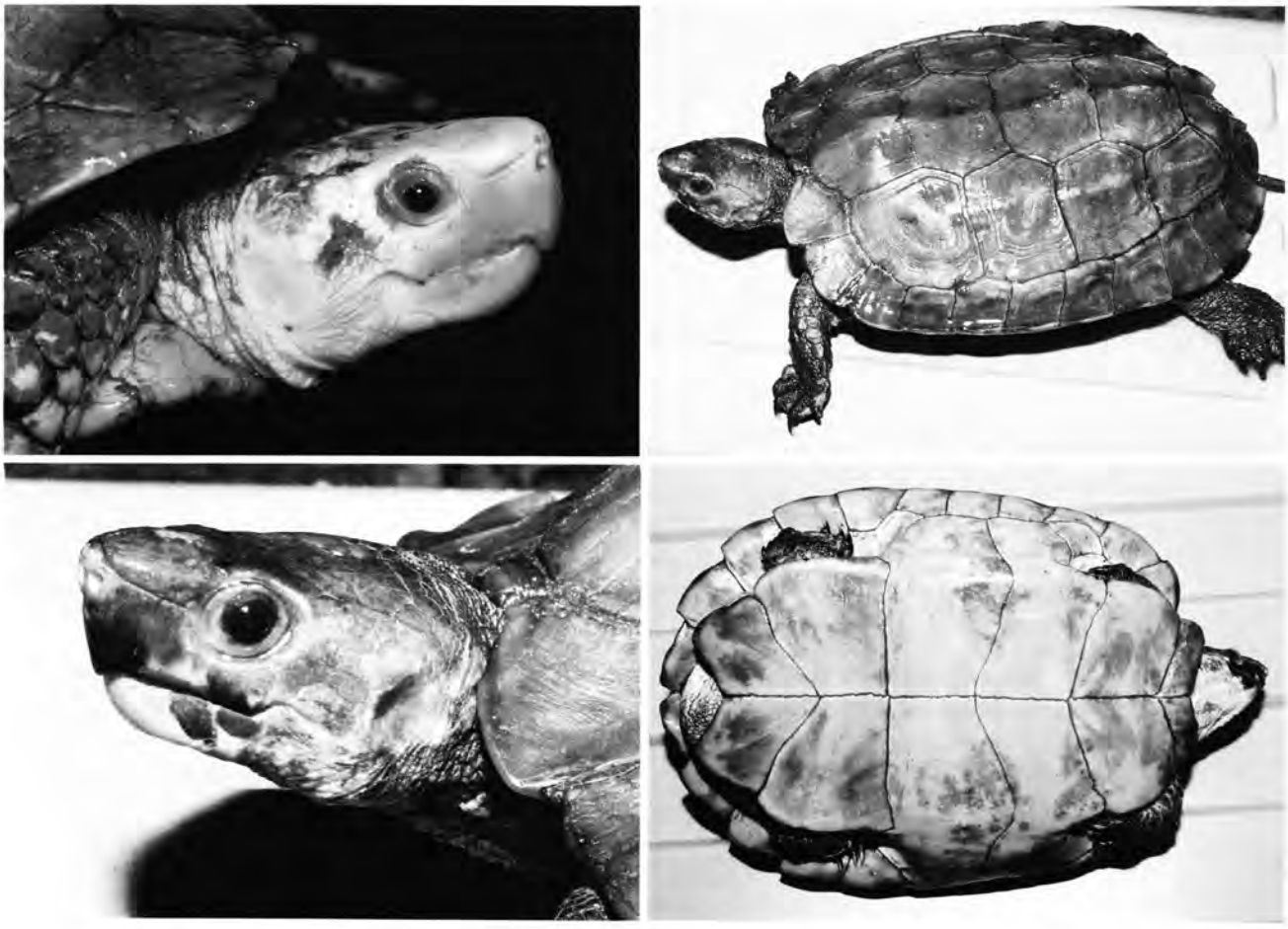

Figure 2. Head, shell, and plastral patterns of paratypes of *Geoemyda yuwonoi*. **Upper left**: male, UF 97333, 256 mm carapace length; **lower left**: female, UF 97334, 213 mm carapace length; **upper and lower right**: female, UF 97335, 206 mm carapace length.

Table 1. Characters (22) and character states used in construction of cladogram in Figure 1. Character states for hypothetical ancestor are based on primitive conditions identified by Hirayama (1984) or by our comparisons with other members of the *Geoemyda* complex (latter marked with *). Most character states follow Moll et al. (1986) and Yasukawa et al. (1992); any not reported by them are based on our own observations or those of E.O. Moll (*pers. comm.*). Character states recorded as "±" entered as unknowns in the cladistic analysis.

Character	*Geoemyda spengleri*	*Geoemyda japonica*	*Geoemyda silvatica*	*Geoemyda depressa*	*Geoemyda yuwonoi*	*Geoemyda leytensis*	*Pyxidea mouhoti*	*Cyclemys dentata*	*Heosemys spinosa*	*Heosemys grandis*	Hypothetical ancestor
Hooked beak without notch	+	+	+	+	+	+	+	–	–	–	–
Maxillae contacting anteriorly	+	+	+	?	+	?	–	–	–	–	–
Pterygoid contacting jugal	±	±	–	?	+	?	–	+	+	+	–
Small foramen posterius palatinum	+	+	±	?	–	?	+	–	–	–	–
Fissura ethmoidalis narrow (not key-shaped)	+	+	–	?	–	?	–	–	–	–	–
Quadratojugal present	+	+	–	–	–	–	+	+	–	–	+
Ventrally narrowed cranial cavity	+	+	±	?	+	?	+	+	–	–	–
Prootic exposure reduced dorsally	+	+	–	?	–	?	+	–	–	–	–
Large size	–	–	–	+	+	+	+	+	+	+	+*
Carapace with three keels	+	+	+	+	+	–	+	+	–	–	–
Posterior carapace serrated	+	+	–	+	+	+	+	+	+	+	–
Axillary scute	–	+	±	+	+	+	±	+	+	+	+*
Plastral hinge in adult	–	–	–	–	–	–	+	+	–	–	–
Sexually dimorphic plastral kinesis	+	+	+	–	–	?	–	–	+	±	–*
Humeropectoral seam across entoplastron	+	+	–	?	–	?	+	+	+	+	+
Rays in plastral pattern	–	–	–	–	–	–	–	+	+	+	–
Interabdominal longest or near longest seam	+	+	+	+	–	+	+	+	+	+	+*
Gular very short, anterior and posterior parallel	+	+	+	+	+	+	–	–	–	–	–*
Interfemoral seam ≥ interanal seam	+	–	+	+	–	+	+	+	+	+	+*
Posterior head with scales	–	–	+	+	+	+	+	+	+	+	+*
Choanae marked with ridges (type C; Parsons, 1968)	+	+	+	+	+	?	+	–	–	–	+*
Cloacal bursae	–	?	–	+	?	?	–	+	+	+	+

Figure 3. Distribution of the genus *Geoemyda* (excluding *Pyxidea mouhoti*) in southeast Asia, Indonesia, and Japan. Solid dots = *G. spengleri*; squares = *G. japonica*; triangles = *G. leytensis*; and stars = *G. yuwonoi*.

Maximum plastron length (PL) shorter than carapace length (PL/CL = 0.88–0.89 for males; 0.89–0.93 for females). Plastron upturned anteriorly, without a hinge, and firmly connected to carapace by a solid bony bridge. No plastral kinesis evident in either sex. Plastral forelobe width (PW1) at level of junction of humeropectoral seam and lateral plastral margin 38% to 41% (mean = 39.7%) of carapace length. Anterior width of plastral hindlobe (PW3) at lateral junction of abdominofemoral seam 47 to 49% of carapace length in females, 43% in males. Plastral hindlobe with shallow but distinct anal notch (medial depth of notch 33 to 37% of interanal seam length in females, 38 to 42% in males). Bridge length (BL) moderately long (BL/CL = 0.34 in females, 0.30 in males; BL/PW3 = 0.69 to 0.72, mean = 0.71); single, relatively large axillary and inguinal scutes on each bridge, vaguely triangular, not in contact. Modal plastral formula: interanal seam ≥ interpectoral seam ≈ interabdominal seam ≥ interhumeral seam > interfemoral seam >> intergular seam. Length of seam between gulars averages only 55% of interhumeral seam length (range 50 to 59%) and 46% of interanal seam length (range 38 to 54%). The humeropectoral seam does not cross the entoplastron. Plastron light orange-brown (Fig. 2), with seams dark brown and distinctly marked. Vague darker brown smudges variably present on lateral regions of plastral scutes, most obvious on anal and gular scutes. Males with a slightly concave plastron; females with a flat plastron.

Head moderately broad (especially in males); upper jaw slightly hooked in females, strongly hooked in males, with obvious cusp on tomium below each eye. Triturating surfaces narrow, lacking ridges. Head strongly sexually dichromatic. Dorsum and sides of head of females dark brown, vaguely mottled with darker pigment, but tympanic region cream colored; upper tomium dark brown to black, but with small cream-colored area medially; chin creamy yellow, without obvious dark pigment; lower tomium dark brown to

black laterally, but with broad cream-colored band across medial beak area (Fig. 2). Posterior dorsum of head of males dark brown, but anterior dorsum and upper tomium creamy yellow; tympanum, most of side of head, and chin whitish cream; dark brown blotch present between orbit and tympanum. Preorbital dorsum of snout much broader in males than females. Skin on posterior dorsum of head divided into scales.

Forearm and manus relatively large. Anterior surface of anterior antebrachium of both sexes covered with very large, imbricate scales in five or six rows; five scales on hindlimb at heel distinctly enlarged but smaller than largest forelimb scales. Upper limbs and base of tail finely scaled. Post-anal tail covered with scales of moderate size. Scales on exposed parts of forelimbs, hindlimbs, and tail dark brown to nearly black, except in male holotype on which the anterior surface of the forelimbs is creamy white extending distally to the manus. Recessed areas of skin creamy white. Tail of moderate length, much longer in males than females, and with cloaca at (females) or beyond (males) the carapacial margin.

The single skeletal female has the maxillae in contact anteriorly, below the premaxillae, and separating the latter from the labial margin of the mandible; pterygoid barely in contact with the jugal; foramen posterius palatinum small and similar in size to the foramen orbito-nasale; fissura ethmoidalis narrow, but distinctly key-hole shaped; processus trochlearis oticum consisting mainly of the greatly exposed prootic; cranial cavity ventrally narrowed by the processi inferiores parietales; and no quadratojugal (or postorbital bar). Shell with eight neurals, the anterior six all hexagonal, with the shortest sides directed posteriorly. The seventh neural is quadrangular, and the eighth is hexagonal with the shortest sides directed anteriorly; the latter contacts the large anterior suprapygal that exceeds the eighth costal bone in size. The posterior suprapygal is tiny (half the size of the seventh neural) and triangular. The free margins of the first two and last three peripheral bones are serrated.

Other Material. — Two additional adult topotypic specimens preserved in formalin are in the MZB but were not available for examination.

Comparisons. — The new species is most similar to *Geoemyda silvatica*. See Table 1 for a comparison among *Geoemyda yuwonoi*, *G. silvatica*, *G. spengleri*, *G. japonica*, *G. depressa*, *G. leytensis*, *Pyxidea mouhoti*, *Cyclemys dentata*, *Heosemys spinosa*, and *H. grandis*.

Distribution. — Known from the type locality in northern Sulawesi, and apparently also from "near Poso" [1°23'S, 120°45'E] in central Sulawesi (Fig. 3; specimen purchased by Yuwono in January 1995; F. Yuwono, *pers. comm.*), although we have not verified the identity of the individual from the latter site. The precise localities could not be determined at either site since the turtles were collected by local people.

Zoogeography. — *Geoemyda yuwonoi* represents only the second batagurid turtle (after *Cuora amboinensis*) known east of Wallace's Line (Iverson, 1992). However, given the intimate geologic (Audley-Charles et al., 1972; review in Auffenberg, 1980) and zoogeographic relationships (see Auffenberg, 1980; Yoshii and Greenslade, 1993) between northern Sulawesi and Borneo, this distribution is not surprising. In addition, our preliminary cladistic analysis suggests a vicariant explanation for the current distribution of the tentative members of the genus *Geoemyda*. Except for *Pyxidea mouhoti* in southeast Asia (northeastern India to Vietnam and southwestern China), those species are distributed allopatrically in hilly, forested regions from southwestern India (*G. silvatica*), to southwestern Burma (*G. depressa*), to China and Vietnam (*G. spengleri*), to the Ryukyu Islands (*G. japonica*), to Palawan and Leyte in the Philippines (*G. leytensis*), and to Sulawesi in Indonesia (*G. yuwonoi*) (Fig. 3). This generalized track seems to be corroborated by the distribution of the forest tortoises of the genus *Indotestudo*, which also range from southwest India to Sulawesi (Hoogmoed and Crumly, 1984; Iverson, 1992). Although some authors question the natural occurrence of *Indotestudo forsteni* in Indonesia (e.g., Hoogmoed and Crumly, 1984), the distribution of the genus *Geoemyda* argues that such a distribution is at least zoogeographically reasonable. This distribution also suggests that other members of the *Geoemyda* clade may await discovery in other remote, forested, mountainous regions in southeast Asia. Perhaps the early, supposedly erroneous records of "*Geoemyda spengleri*" from Borneo (Boettger, 1893) and Sumatra (de Rooij, 1915) refer to undescribed members of this clade.

Husbandry Notes. — In captivity these turtles show a decided preference for a semiaquatic existence. They seem to prefer shallow water (5–7 cm) and a herbivorous diet. They relish strawberries, bananas, and romaine lettuce. The turtles are not at all shy, and their primary defensive behavior seems to be escape. When approached they run away rapidly and make no attempt to withdraw into the shell even when being held. They are excellent climbers.

Acknowledgments

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