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Literature Cited

BOLTEN, A.B., MARTINS, H.R., BJORNDAL, K.A., AND GORDON, J. 1993. Size distribution of pelagic-stage loggerhead sea turtles (*Caretta caretta*) in the waters around the Azores and Madeira. Arquipelago 11A:49-54.

CARR, A.F., JR. 1986. New perspectives on the pelagic stage of sea turtle development. NOAA Tech. Mem. U.S. Dept. Commerce NMFS-SEFC-190.

CARR, A.F., JR. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Mar. Poll. Bull. 18:352-356.

CARR, A.F., JR., AND MEYLAN, A.B. 1980. Evidence of passive migration of green turtle hatchlings in sargassum. Copeia 1980:366-368.

COLLARD, S.B. 1987. Review of oceanographic features relating to neonate sea turtle distribution and dispersal in the pelagic environment: Kemp's ridley (*Lepidochelys kempi*) in the Gulf of Mexico. Final Report Nat. Mar. Fish. Serv., Southeast Fish. Center, Panama City Lab., 71 pp.

DODD, C.K., JR. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish Wildl. Serv., Biol. Rep. 88(14).

FLETEMEYER, J.R. 1978. Underwater tracking evidence of neonate loggerhead sea turtles seeking shelter in drifting sargassum. Copeia 1978(1):148-149.

HILDEBRAND, H.H. 1983. Random notes on sea turtles in the western Gulf of Mexico. In: Owens, D.W. et al. (Eds.). Western Gulf of Mexico Sea Turtle Workshop Proceedings. College Station, Texas: Sea Grant, Texas A&M University, TAMU-SG-86-402.

MEYLAN, A.B. 1982. Sea turtle migrations - evidence from tag returns. In: Bjorndal, K.A. (Ed.). Biology and Conservation of Sea Turtles. Washington, DC: Smithsonian Institution Press, pp. 91-100.

PLOTKIN, P.T. 1989. Feeding ecology of the loggerhead sea turtle in the northwestern Gulf of Mexico. M.S. Thesis, Texas A&M University.

PLOTKIN, P.T., WICKSTEN, M.K., AND AMOS, A.F. 1993. Feeding ecology of the loggerhead sea turtle *Caretta caretta* in the northwestern Gulf of Mexico. Mar. Biol. 115:1-5.

RICHARDSON, J.I., AND MCGILLIVARY, P. 1991. Post-hatchling loggerhead turtles eat insects in Sargassum community. Mar. Turtl. Newsl. 55:2-5.

SHAVER, D.J. 1991. Feeding ecology of wild and head-started Kemp's ridleys sea turtles in south Texas waters. J. Herp. 25(3):327-334.

VAN NIEROP, M.M., AND DEN HARTOG, J.C. 1984. A study on the gut contents of five juvenile loggerhead turtles, *Caretta caretta* (Linnaeus) (Reptilia, Cheloniidae), from the south-eastern part of the north Atlantic Ocean, with emphasis on coelenterate identification. Zool. Meded. 59(4):35-54.

WITHERINGTON, B.E. 1994. Some "lost-year" turtles found. In: Schroeder, B.A., and Witherington, B.E. (Compilers). Proc. Thirteenth Ann. Symp. on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFC-341, pp. 194-195..

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First Record of *Heosemys spinosa* from the Philippines, with Biogeographic Notes

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Heosemys spinosa, the spiny turtle, is a widespread southeast Asian batagurid, distributed from Tenasserim in southern Myanmar, south to the tip of the Malay Peninsula, and also on the islands of Sumatra, Borneo, and Natuna (Smith, 1931; Pritchard, 1979; Iverson, 1992). It is apparently absent from Indo-China, and not previously known from the Philippines.

Two specimens of *H. spinosa* collected in the Philippines have now been identified in the collection of the Herpetology Division, Philippines National Museum (PNM). These include an adult male (Fig. 1) (identifiable from the deep plastral concavity and everted cliteropenis) and an adult female (showing a flat plastron and a wide postanal gap). They were collected on Mindanao Island by ornithologists Robert Kennedy and Pedro Gonzales. This comprises the first record of *H. spinosa* for the Philippines.

Measurements taken with vernier calipers to the nearest 0.1 mm of the larger adult male, PNM 2233, followed by the smaller adult female, PNM 2232, and descriptions of the two turtles are given below.

Straight carapace lengths 193.6 and 179.3 mm; straight carapace widths 161.3 and 141.5 mm; greatest plastron lengths 181.2 and 179.7 mm; median plastron lengths 164.1 and 167.0 mm; anterior plastron lobes 85.3 and 85.3 mm; posterior plastron lobes 107.5 and 97.1 mm; head widths 31.3 and 30.4 mm; tail lengths (vent to tip) 21.4 and 27.0 mm; plastral concavity depths 8.8 and 0.02 mm. Lengths of vertebral scutes, anterior to posterior: 43.3, 34.9, 32.0, 32.9, 35.7 and 37.7, 33.0, 30.2, 30.2, 33.9 mm. Lengths of plastral seams, anterior to posterior: 25.7, 12.3, 39.4, 38.3, 34.0, 14.8 and 18.9, 16.4, 40.8, 39.8, 36.8, 16.3 mm.

Shell moderately elevated, with a flattened vertebral region. A distinct vertebral keel, but lacking lateral keels. The anterior margin of the carapace is unserrated, the posterior margin weakly serrated. Nuchal small and triangular. Vertebral I constricted anteriorly. All vertebrals broader than long, and as broad as the costals. Plastron large, the greatest length approximately as long as the carapace, emarginated anteriorly and notched posteriorly. The longest median suture in the plastron is between the abdominals, the shortest between the anals. Both anterior and posterior lobes of the plastron are narrower than the median plastron length, the posterior lobe wider than the bridge. Both specimens have 27 annuli on costal III. Head small, upper jaw weakly

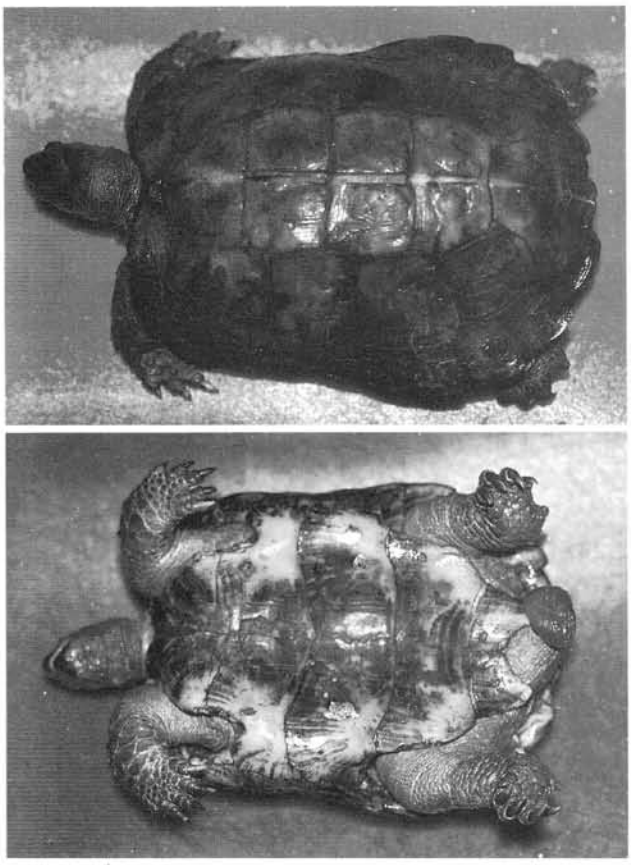

Figure 1. *Heosemys spinosa* from Mindanao Island, Philippines; adult male (PNM 2233) in dorsal and ventral views.

bicuspid. Forelimbs with enlarged scales, especially anteriorly. Round, flattened scales present on the sole and on the palmar region.

Carapace mahogany brown above, the vertebral keels darker. Plastron yellow with dark brown striations that thicken towards the middle of the plastron in the male (Fig. 1), while the female has fine dark striations especially evident at the borders of the scutes. Bridge with dark striations on a yellow-brown ground color. Neck and head unstriped grayish. Limbs grayish, with yellow scales.

This record of *H. spinosa* from Mindanao in the Philippine archipelago, which, with the exception of the Palawan and Sulu group, has had a long history of isolation from the Sundas (discussed by Brown and Alcala, 1970), is of considerable biogeographic interest. It represents an extension in range of the species by at least 360 km eastwards from the northeast coast of Borneo, the previously known easternmost limit of the range of the species (see Iverson, 1992), across the Sulu Sea to the tip of the Zamboangan peninsula of Mindanao (Fig. 2).

The presence of *H. spinosa* on Mindanao is surprising. Mindanao is part of the eastern Sámar Arc (Bemmelen, 1949) extending from southeastern Luzon along the east coasts of Sámar and Mindanao, but not extending to Borneo, where the nearest populations of the species are found. On the other hand, *H. spinosa* is not known from any of the islands associated with the western Luzon Arc, which extends from Palawan (a mere 150 km from Borneo's east coast), the Calamians, Mindoro, and western Luzon. It is therefore assumed that the species may have reached Mindanao through island hopping across the Sulu archipelago, as suggested for the dispersal of the salt-water resistant *Varanus salvator* by Gaulke (1991), although a waif dispersal scenario is surprising for this highly terrestrial chelonian which is largely restricted to hills.

During the Pleistocene Holarctic glaciation period, land bridges formed when sea levels fell 120 to 200 m below current levels, exposing the entire Sunda shelf (Ollier, 1985; Wang and Wang, 1990). Inger (1954) and Heaney (1991) provide generalized paleontological reconstructions of the Philippine archipelago during the Pleistocene. There have been suggestions (e.g., Inger, 1966) that the land connection between Mindanao and Borneo may have been either a narrow isthmus or a series of narrowly separated islands, acting as a filter bridge that limited the number of forms that could successfully migrate. Heaney (1985) showed that a narrow but deep (205 m) channel runs between Jolo and Basilan in the Sulu Islands group, and based on current geological and zoogeographic data, argued that there were no land bridges to the main body of the Philippines during the Middle or Late Pleistocene (except a mid-Pleistocene connection to Palawan from Borneo). The present record suggests the occurrence of *H. spinosa* on the intervening smaller islands of the Sulu archipelago, whose snake fauna is more similar to the Borneo fauna than the rest of the Philippines (Gaulke, 1994), except perhaps Palawan, whose faunal source is also Borneo (Everett, 1889; Boulenger, 1894).

Lovich (1994) considered the turtle fauna of the Philippines to be depauperate, and only the following species of batagurids have been recorded from these islands by earlier workers (Alcala, 1986; Taylor, 1920, 1921): *Cuora*

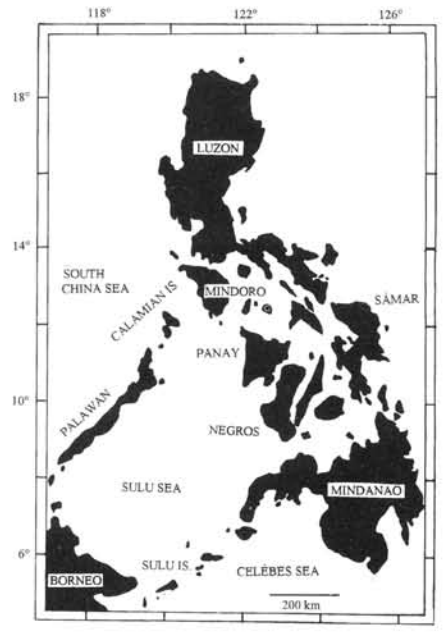

Figure 2. The Philippine archipelago, showing the main island groups; *H. spinosa* has been recorded from Borneo and Mindanao.

amboinensis, *Cyclemys dentata*, and *Heosemys leytensis*. Casto De Elera (1895) listed many more turtle species from the Philippines that are totally undocumented: *Platysternon megacephalum*, *Callagur borneoensis*, *Ocadia sinensis*, *Chinemys reevesii*, *Siebenrockiella crassicollis*, *Geoemyda spengleri*, *Cuora trifasciata*, *Cuora flavomarginata*, *Pelodiscus sinensis*, and *Chitra indica*. Although most of these are surely in error, being far out of their known geographical ranges as compiled by Iverson (1992), field work is urgently needed in the face of massive deforestation in these islands (Hyman, 1984; Myers, 1988) to inventory the turtle fauna, which may also result in the discovery of species hitherto both new to the archipelago and unknown to science, as suspected by Taylor (1920), as well as clearing up "mystery" species such as *Heosemys leytensis* and *Pelochelys cumingii*.

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Literature Cited

ALCALA, A.C. 1986. Guide to Philippine Flora and Fauna. Vol. X. Amphibians and Reptiles. Manila: Natural Resources Management Centre, Ministry of Natural Resources and University of the Philippines, 195 pp.

BEMMELEN, R.W. VAN. 1949. The Geology of Indonesia. Vol. 1A. General geology of Indonesia and adjacent archipelagoes. The Hague: Martinus Nijhoff.

BOULENGER, G.A. 1894. On the herpetological fauna of Palawan and Balabac. Ann. Mag. Nat. Hist. (6)14:81-90.

BROWN, W.C., AND ALCALA, A.C. 1970. The zoogeography of the herpetofauna of the Philippines Islands, a fringing archipelago. Proc. Calif. Acad. Sci. (4)38:105-130.

CASTO DE ELERA, R.P.F. 1895. Catalogo sistematico de toda la fauna de Filipinas conocido hasta el presente. Vol. I. Vertebrados. Manila: Colegio de Santo Tomas, 701 pp.

EVERETT, A.H. 1889. Remarks on the zoo-geographical relationships of the island of Palawan and some adjacent islands. Proc. Zool. Soc. London 1889:219-228.

GAULKE, M. 1991. Systematic relationships of the Philippine water monitors as compared with *Varanus s. salvator*, with a discussion of dispersal routes. Mertensiella 2:154-167.

GAULKE, M. 1994. Contribution to the snake fauna of the Sulu Archipelago, with the description of a new subspecies of *Dendrelaphis caudolineatus* (Gray, 1834). Herpetol. J. 4:136-144.

HEANEY, L.R. 1985. Zoogeographic evidence for Middle and Late Pleistocene land bridges to the Philippine Islands. Modern Quaternary Res. SE Asia 9:127-143.

HEANEY, L.R. 1991. A synopsis of climatic and vegetational change in Southeast Asia. Climatic Change 19:53-61.

HYMAN, E. 1984. Forestry administration and policies in the Philippines. Environ. Mgmt. 7:511-524.

INGER, R.F. 1954. Systematics and zoogeography of Philippine Amphibia. Fieldiana Zool. 34:389-424.

INGER, R.F. 1966. The systematics and zoogeography of the Amphibia of Borneo. Fieldiana Zool. 52:1-402.

IVERSON, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Richmond, Indiana: Privately printed, 363 pp.

LOVICH, J.E. 1994. Biodiversity and zoogeography of non-marine turtles in south-east Asia. In: Majumdar, S.K., Brenner, F.J., Lovich, J.E., Schalles, J.F., and Miller, E.W. (Eds.). Biological Diversity: Problems and Challenges. Easton: Pennsylvania Academy of Science, pp. 380-391.

MYERS, N. 1988. Environmental degradation and some economic consequences in the Philippines. Environ. Consv. 15:205-214.

OLLIER, C.D. 1985. The geological background to prehistory in island Southeast Asia. Modern Quaternary Res. in SE Asia 9:25-42.

PRITCHARD, P.C.H. 1979. Encyclopedia of Turtles. Neptune, NJ: T.F.H. Publications, 895 pp.

SMITH, M.A. 1931. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. I.- Loricata, Testudines. London: Taylor and Francis, 185 pp.

TAYLOR, E.H. 1920. Philippine turtles. Phil. J. Sci. 16:111-144.

TAYLOR, E.H. 1921. Amphibians and turtles of the Philippines. Phil. J. Sci. 15:1-193.

WANG, L., AND WANG, P. 1990. Late Quaternary paleoceanography of the South China Sea: glacial-interglacial contrasts on an enclosed basin. Paleoceanography 5:77-90.

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Neural Bones in Australian Chelid Turtles

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Neural bones are median elements of the turtle carapace overlying the dorsal vertebrae. The ancestral condition is thought to be a series of eight relatively narrow, hexagonal neural bones with short sides anteriorly placed, forming a continuous series from the nuchal bone anteriorly to the first suprapygal posteriorly (Pritchard, 1988). This condition is retained in many extant species of the Bataguridae, Emydidae, and Cheloniidae, but frequently modified, for example, by elimination of elements at the ends of the series, formation of one or more octagonal elements, or alteration to a series of hexagons with short sides posteriorly.

Neural bones are probably structurally important for resisting downward pressure in high-domed species, but may be a disadvantage where lateral forces in flatter forms cause torsion among carapacial elements (Pritchard, 1988). Hence, strong swimmers that move by alternating thrusts of the rear limbs, and marine turtles that alternate strokes on land, tend to have reduced neural series with areas of median contiguity between opposing pleural bones (Pritchard, 1988). Neurals are often seemingly absent in Chelidae, where a fixed pelvic girdle and extensive plastral buttressing provide alternative structural resistances to downward pressure and lateral torsion caused by the sideways action of neck extension and withdrawal.