main river and its floodplain. A survey of the distribution and exploitation of turtles and tortoises in southwestern Yunnan and Myanmar is urgently needed. Knowledge of their present status is necessary to assess possible conservation needs.

Acknowledgments. — I thank Professor Kou Zhi-Tong, Yunnan University, for access to his turtle collection and for sharing his knowledge of local turtles with me. I thank Oscar Shiu for help in organizing my trip to China and for sharing his knowledge of turtles, and I thank him, his family, and his staff for their hospitality. Drs. Franz Tiedemann and Heinz Grillitsch kindly facilitated my study of turtles in the Vienna Museum of Natural History. Valuable comments by Peter Paul van Dijk and an anonymous reviewer improved the manuscript.

Literature Cited

ANDERSON, J. 1879. Anatomical and Zoological Researches: Comprising an Account of the Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875; and a Monograph of the Two Cetacean Genera, *Platanista* and *Orcella*. First Volume. London: Bernard Quaritch, 985 pp.

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

ZHAO, E., AND ADLER, K. 1993. Herpetology of China. Soc. Stud. Amph. Rept., Contr. Herpetol. No. 10, 505 pp.

Accepted: 16 October 1994

Chelonian Conservation and Biology, 1995, 1(3):226–227

Reproductive Biology of the Indian Roofed Turtle, *Kachuga tecta*, in Bangladesh

MD. LOKMAN HOSSAIN[1] AND MD. SOHRAB UDDIN SARKER[1]

[1]*Department of Zoology, University of Dhaka, Dhaka 1000, Bangladesh*

The Indian roofed turtle, *Kachuga tecta*, is a common species in Bangladesh, occurring in nearly all freshwater habitats, including the brackish waters of coastal areas, and excluded only from some hilly areas of Chittagong district. The roofed turtle plays an important role in the local ecology, feeding on a variety of aquatic vegetation, such as water hyacinth and other aquatic weeds, and aquatic animal pests like crabs, snails, etc. The turtles are also scavengers and feed on dead animals and sometimes human waste, thereby helping to reduce environmental pollution and infectious diseases. The turtles are consumed by Hindus and Tribals, thus helping to maintain a source of protein for these people. Turtle eggs, oil, and shell have a very high commercial value (Khan, 1982) and large numbers are exported from Bangladesh annually.

Preliminary studies have been done on the reproductive biology of *Kachuga tecta* in India, Pakistan, and elsewhere by Chaudhuri (1912), Smith (1931), Minton (1966), Duda and Gupta (1982), Khan (1982), Daniel (1983), Moll (1987), and Fugler (1984). However, no detailed studies have yet been done in Bangladesh. The purpose of the present study was to collect data on the reproductive biology of *Kachuga tecta* in Bangladesh.

Materials and Methods. – A total of 212 adult female *Kachuga tecta* were examined for the annual cycle of gonadal development, egg formation and maturation, and the numbers of mature and immature eggs, dissecting six to seven animals per month for several years. Specimens were either collected by the authors in different parts of Bangladesh or dissected in export processing centers at Dhaka, Baiddair Bazar, Chandpur, and Narayngani.

Reproductive condition was determined by the presence or absence of mature or immature eggs in both oviducts. The first egg-laying period was defined by the presence of mature and immature eggs; the second egg-laying period was ascertained when only mature eggs were found in both oviducts. Observations were made both in nature and captivity.

Weight, length, and width of both eggs and turtles were measured by spring balance, metal tape, and slide calipers. Four living individuals were kept in four aquaria measuring 30 x 47 cm each. The eggs laid in the aquaria were measured, as were eggs collected from nature. On 5 February 1993, 142 shelled eggs were dissected out from the oviducts of 21 turtles. All were measured and 20 were buried in sandy soil in the bank of a well at the University of Dhaka, and 12 others were buried in sandy soil elsewhere.

Results and Discussion. — Shelled oviducal eggs were found in dissected specimens from December to March. An initial egg-laying period occurred between the beginning of December and the middle of January, and a second egg-laying period occurred between mid-February and the end of March.

In an aquarium a female of 780 g body weight laid 8 eggs from 14 to 17 March 1988. Another female laid 12 eggs in a sweet potato field on 24 December 1987, and 10 eggs were found in the bank of a pond on 15 March 1992 in the village of Dingabanga, Chandpur. On 11 February 1993 a female laid 10 eggs in loose soil near a bush. Still another turtle laid 12 eggs in fallow land near a bush on 22 March 1992 in the village of Kalady, Chandpur. Fugler (1984) reported that the nesting season of *K. tecta* was in the winter months and that single or multiple clutches were produced. He did not mention the number of eggs per clutch. Minton (1966) reported the nesting season to be early October in Pakistan, and Rao and Singh (1985) mentioned nesting from October to January in India.

Turtles use sweet potato fields, vegetable gardens, elevated land, banks of ponds, and mustard seed fields for nesting. Typically they select sites in undisturbed areas of loamy soil away from marshy areas. The depth of the flask-shaped nest did not exceed 4 to 6 cm.

Based on the presence of eggs, females become sexually mature at carapace lengths (CL) between 185 and 192

mm, carapace widths (CW) between 162 and 175 mm, and body weights (BW) from 450 to 550 g.

Pronounced sexual dimorphism in size of *K. tecta* has been noted by other researchers who have reported that females are much larger than males. Moll (1987) measured two females and one male in India, recording CL of 183 and 153 mm for the females and 66 mm for the male. Minton (1966) measured two females and a male in Pakistan at respective CL of 173, 164, and 84 mm. Das (1991) also noted that females are much larger than males in India. The current study on *K. tecta* in Bangladesh recorded that females are only slightly larger than males, with the following means, standard deviations, and ranges: females ($n = 36$), 217 ± 1.7 (186–224) mm CL, 194 ± 4.03 (177–200) mm CW, 176 ± 2.2 (167–187) mm PL [plastron length], 84 ± 1.0 (76–85) mm CD [carapace depth], and 1050 ± 4.1 (830–1100) g BW; males ($n = 16$), 206 ± 4.0 (192–212) mm CL, 185 ± .5 (180–190) mm CW, 174 ± .5 (171–177) mm PL, 88 ± .5 (86–89) mm CD, and 935 ± 1.5 (842–950) g BW.

Usually, the two oviducts contained unequal numbers of eggs (mostly mature and shelled, but in some cases also immature ones). Out of 21 specimens dissected on 5 February 1993, only one specimen had equal numbers of eggs in the two oviducts. Females of 500 to 750 g BW lay a total of 14 to 26 eggs per season in two separate clutches. The first clutch consisted of 9 to 15 eggs, and the second clutch 7 to 11 eggs. Moll (1987) mentioned a clutch containing 8 eggs. Chaudhuri (1912) recorded that the roofed turtle laid 5 to 8 eggs at a time. Duda and Gupta (1982) reported a mean clutch size of 6.9, with a range of 4 to 10.

All eggs were ovoid with one end slightly pointed and the other blunter, whitish in color, and becoming slightly bluish at hatching time. The mean length of 44 eggs was 50.09 ± 0.25 mm (range 50–51 mm), mean width 20.45 ± 0.25 mm (range 20–21 mm), and mean weight 10.75 ± 0.04 g (range 10.4–10.9 g). Moll (1987) found eggs to average 37 x 21 mm and 10.74 g in India.

The 20 eggs placed in soil on 20 March developed visible blood spots after 18 days and embryos within 28 days, but failed to hatch as a result of red ant predation. The 12 eggs placed in 4 cm of sandy soil on 17 February developed blood spots within 15 days, embryos with eye spots within 25 days, moving embryos by the 40th day, and emergence of 4 hatchlings on the 71st day, for a hatching success of 33.3 %. The average hatchling weight was 16.2 g. Incubation temperatures varied between 27–30°C.

Literature Cited

Chaudhuri, B.L. 1912. Aquatic tortoises of the Middle Ganges and Brahmaputra. Rec. Indian Mus. (Calcutta) 7:212-214.

Daniel, J.C. 1983. The Book of Indian Reptiles. Bombay: Bombay Natural History Soc., 141 pp.

Das, I. 1991. Colour Guide to the Turtles and Tortoises of the Indian Subcontinent. Avon, England: R & A Publishing Ltd., 133 pp.

Duda, P.L., and Gupta, V.K. 1982. Transabdominal migration of ova in the freshwater turtles. Proc. Indian Acad. Sci. Anim. Sci. 91(2):189-197.

Fugler, C.M. 1984. The commercially exploited Chelonia of Bangladesh: taxonomy, ecology, reproductive biology and ontogeny. Bangladesh Fish. Inf. Bull. 2(1):1-52.

Khan, M.A.R. 1982. Chelonians of Bangladesh and their conservation. J. Bombay Nat. Hist. Soc. 79:110-116.

Minton, S.A., Jr. 1966. A contribution to the herpetology of West Pakistan. Bull. Amer. Mus. Nat. Hist. 134:27-184.

Moll, E.O. 1987. Survey of the freshwater turtles of India. Part II: The genus *Kachuga*. J. Bombay Nat. Hist. Soc. 84:7-25.

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.

Accepted: 9 October 1994

Chelonian Conservation and Biology, 1995, 1(3):227–231

Incubation Period and Sex Ratio of Hermann's Tortoise, *Testudo hermanni boettgeri*

Bert T. Eendebak[1]

[1]*Tortoise Study Centre Oosterbeek, van Limburg Stirumweg 22, 6861 WL Oosterbeek, The Netherlands*

The influence of temperature on the incubation period and sex of chelonians, especially aquatic species, has been studied by different authors. Extensive studies on *Emys orbicularis* have been published by Pieau (1971) and on various Emydinae species by Bull et al. (1982a). A recent review of temperature-dependent sex determination (TSD) in squamate reptiles is given by Spotila et al. (1994) and of TSD in turtles by Ewert et al. (1994). However, little detailed work has been published on measurements of the effect of incubation temperature on the incubation period and sex ratio of tortoises (Testudinidae). In this paper the author reports on a study of the incubation and sex determination of 741 eggs of *Testudo hermanni boettgeri* from which 312 tortoises hatched successfully.

Materials and Methods. — Eggs of *Testudo hermanni boettgeri* were laid from 1982–1994 by a group of 10 adult females kept in an outdoor terrarium in The Netherlands. The study was planned to investigate the effects of environmental parameters on the incubation period and sex ratio of *T. hermanni boettgeri*. Apart from the temperature, many other parameters were studied, e.g., characteristics of the parental female, nest location, time of nesting, order of laying within a clutch, egg weight, and humidity during the incubation period.

Nesting by the colony of captive *T. hermanni boettgeri* took place in the months of May, June, and July, usually between 1000 and 1200 hrs. All eggs were removed from the nests, marked with a pencil, weighed, inspected, and placed in incubators within one to three hrs after laying.

Incubation periods of the eggs were measured at constant incubation temperatures. Three different types of incubators were used. One incubator used bi-metal control,