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Nesting Crawls and Associated Behaviors of Turtles in the Genus *Batagur* along the Chambal River, India

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Abstract.—The pattern of nesting crawls and related behaviors can play a very important role in the survival of the eggs as well as the emerging hatchlings. Studies on marine turtles suggest that nest location can increase exposure to predation, cause thermal stress and dehydration, and consume valuable stored energy in emerged hatchlings, all of which decrease the likelihood of survival. Red-crowned Roofed Turtles (*Batagur kachuga*) and Three-striped Roofed Turtles (*Batagur dhongoka*) are listed as critically endangered on the IUCN Red List. We surveyed a 30-km stretch of sandbank along the Chambal River during *Batagur* nesting seasons in February to early April 2017–2019 and encountered a total of 640 nests along eight sand banks. Nesting crawls of *B. dhongoka* from the water's edge to successful nesting sites were significantly longer than those of *B. kachuga*. We observed only one type of nesting crawl pattern for *B. kachuga*, whereas four types of such crawls were recorded for *B. dhongoka*. Moreover, nest shapes differed significantly between the two species.

Turtles are facing global population declines with approximately 61% of all species threatened with extinction or already extinct (Lovich 2018), largely attributable to hunting and trade where turtles represent food and income for local populations. Most turtles deposit eggs in excavated cavities, the substrate, depth, and distance from the water's edge of which reflect local conditions, with incubation moisture playing an important role in successful hatching and hatchling fitness. Nests deposited close to the water's edge are more vulnerable to inundation, erosion, and excessive moisture, whereas nests far from water have a greater chance of desiccation (Whitmore and Dutton 1985).

Nest site selection is an important event in the life of a female turtle because it requires a substantial amount of energy and could be life-threatening (Tucker et al. 1999). In addition, for sea turtles, nest location influences offspring survival (Horrocks and Scott 1991; Resetarits 1996), size of hatchlings (Packard et al. 1988), growth rate (Joanen et al. 1987; McKnight and Gutzke 1993; Bobyn and Brooks 1994), sex determination (Ewert and Nelson 1991; Janzen and Paukstis 1991; Spotila et al. 1994), and the likelihood of nest predation (Fowler 1979). Herein we describe attributes of nest sites in critically endangered Red-crowned Roofed Turtles (*Batagur kachuga*) and Three-striped Roofed Turtles (*B. dhongoka*) along the lower Chambal River, in the National Chambal Sanctuary, Uttar Pradesh, India, to facilitate the protection of nesting sites.

Methods

Study area.—The study was conducted during three consecutive nesting seasons in 2017, 2018, and 2019 along the lower Chambal River within the National Chambal Sanctuary, Uttar Pradesh. The area is semi-arid with a subtropical climate (Sharma and Dasgupta 2013). Annual precipitation is 639 mm, most of which falls from July through September (Verma et al. 2012). The Chambal River features scattered deep pools of water connected by shallow riffles. The relatively pollution-free water (Saksena et al. 2008) provides habitat for threatened aquatic vertebrates such as the Gangetic Dolphin (*Platanista gangetica*) and Gharial (*Gavialis gangeticus*) in addition to turtles and aquatic birds.

Data collection.—We surveyed eight vegetation-free sandbanks along a 30-km-long stretch of the river between the villages of Mau and Badpura (Fig. 1) for signs of turtle nesting. These sandbanks are marginally affected by cattle movement. We walked 12–15 km of the river each morning from 0500 to 0900 h throughout the nesting season (February to early April) in 2017–2019. In addition, during the peak of the nesting season (latter half of March), we patrolled 25–30 km of the river from a boat. The number of nests laid by both turtle species was observed and counted. We recorded the number of turtle nests, distances of nests from the water's edge, and GPS coordinates using a handheld GPS device (Garmin etrex 20x accurate to ±3 m).

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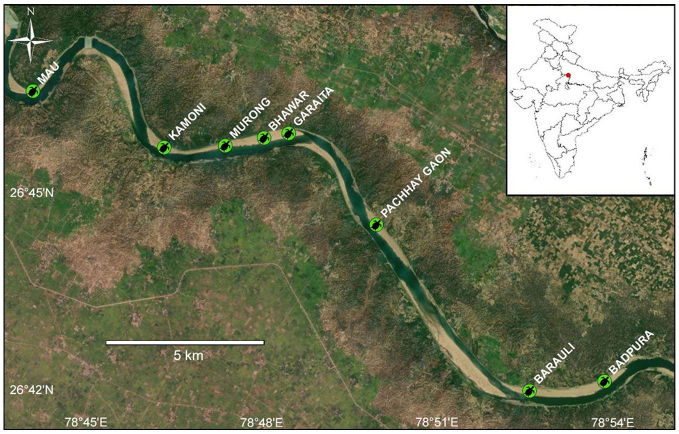

Figure 1. A map of the lower Chambal River in the National Chambal Sanctuary, Uttar Pradesh, India. Symbols mark the turtle nesting banks monitored during this study.

Nest identification.—Nesting impressions of *B. kachuga* are larger than those of *B. dhongoka* and can be distinguished by the direction and amount of sand thrown during egg-chamber excavation. *Batagur kachuga* throws the sand as far as 1–2 m in all directions from the egg chamber, whereas *B. dhongoka* throws it up to 15–30 cm in a single direction, resulting in a much smaller nesting impression (Fig. 2).

Crawl identification.—Emergence and return segments of nesting crawls are readily distinguished by the direction of claw points or spoors. In addition, most emerging segments show evidence of the plastron dragging in the sand, possibly reflecting the difficulty of crawling with a body full of heavy eggs (Fig. 3).

In *B. kachuga* we observed only a single type of nesting crawl pattern (Fig. 4). Females emerge from the water and crawl in a straight line until they reach the desired nesting site. After successful deposition, females make a steep turn and return to the water near the same location from which they emerged (within 0.5–5.0 m). In some cases, before digging the actual nest, females excavate a small chamber, possibly for checking substrate quality or confusing potential nest predators by digging a false nesting pit.

On the other hand, we observed four types of nesting crawl patterns (Fig. 5) in *B. dhongoka*: (A) Females crawl a substantial distance in a straight line, deposit the eggs, and

Figure 2. Typical nesting impressions of the Red-crowned Roofed Turtle (*Batagur kachuga*) (left) and the Three-striped Roofed Turtle (*Batagur dhongoka*) (right). Photographs by Authors.

Figure 3. Emerging (right) and returning (left) nesting crawls of turtles in the genus *Batagur*. Photographs by Pawan S. Pareek.

Figure 4. Nesting crawl pattern of the Red-crowned Roofed Turtle (*Batagur kachuga*). The inset shows "false" nest pits. Photograph by Pawan S. Pareek.

return to the water very near (3–5 m) the point of emergence; (B) females crawl to the nesting spot, deposit the eggs, and then cross the emerging track when returning to the river (distances between emerging and returning points range from 5 to 15 m); (C) females emerge and then crawl parallel to the river, desposit the eggs, and return to the water in a straight line some 3–20 m from where they emerged; (D) during the peak of the nesting season, multiple (6–7) females emerge within 3–15 m on the same bank during the same night, with trails crisscrossing one another and females even crawling over nests, the distinction between tracks and nests of individual females is often difficult.

Results and Discussion

***Nesting season.*—**We found a total of 640 nests on eight sandbanks, 300 in 2019, 122 in 2018, and 217 in 2017. Nesting activity began in February and ended in early April (70–80 days). Peak activity was between days 30–60 of the nesting season for both species, although that of *B. kachuga* began a bit later than that of *B. dhongoka* (Fig. 6).

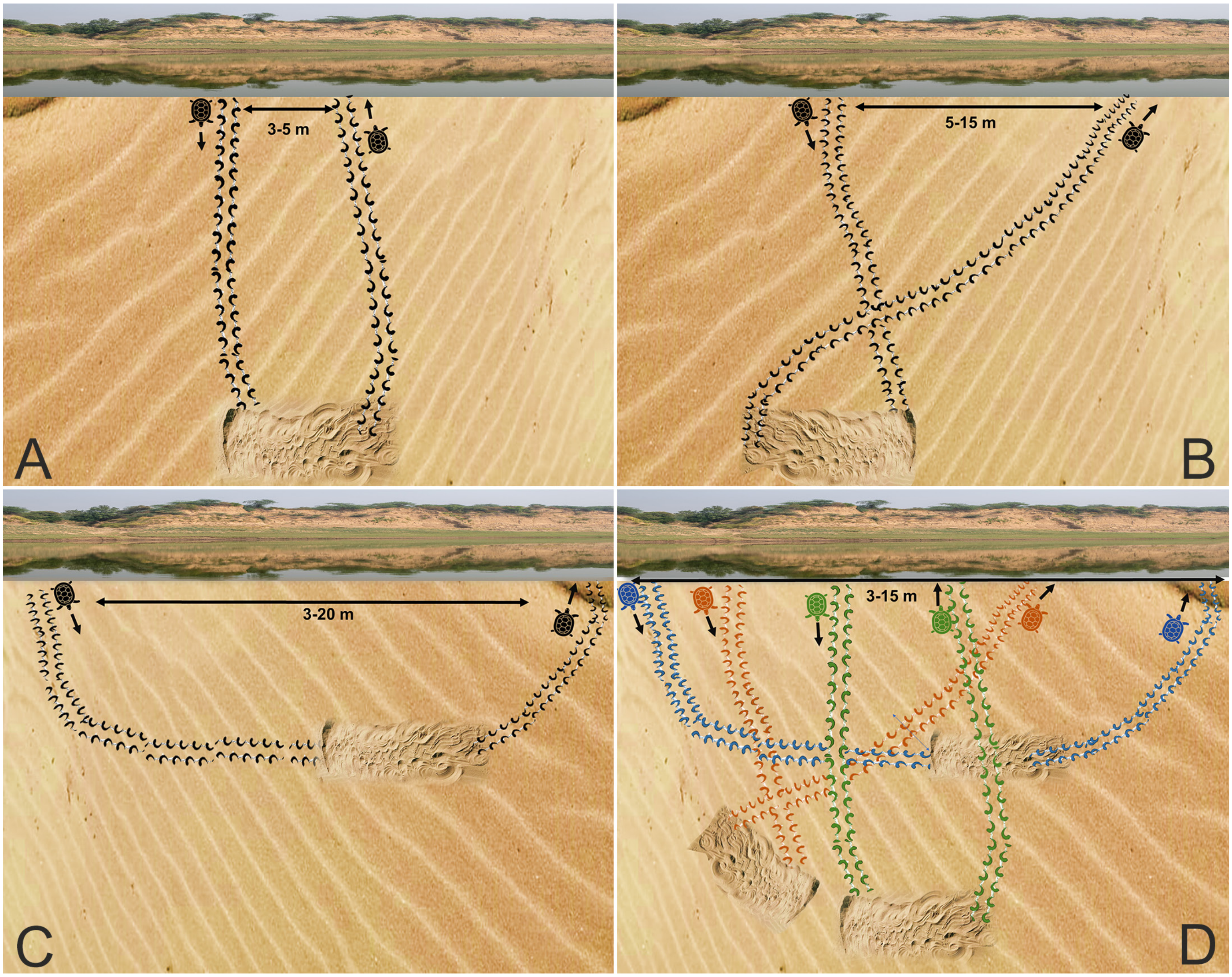

Figure 5. Four types of nesting crawl patterns observed in Three-striped Roofed Turtles (*Batagur dhongoka*).

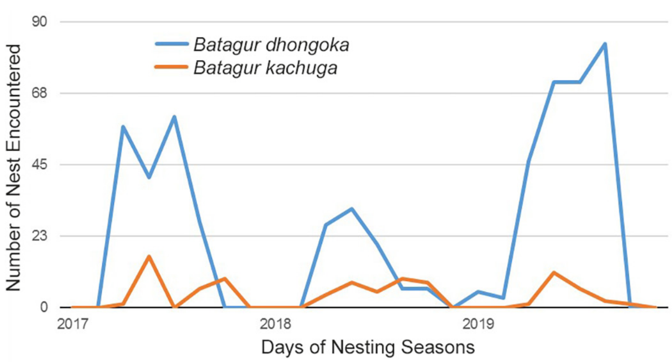

Figure 6. Numbers of Red-crowned Roofed Turtle (*Batagur kachuga*) and Three-striped Roofed Turtle (*Batagur dhongoka*) nests encountered during the nesting seasons in 2017–2019.

Table 1. Distances travelled (m) to nests by Red-crowned Roofed Turtles (*Batagur kachuga*) and Three-striped Roofed Turtles (*Batagur dhongoka*).

Red Crowned-roofed Turtle (*B. kachuga*)

Year	Minimum	Maximum	Average
2017	1	70	13.3
2018	1	55	12.0
2019	1.5	45	14.5
Three Striped-roofed Turtle (*B. dhongoka*)			
2017	1	120	27.3
2018	2	102	29.4
2019	1	140	25.3

Nest locations.—Although Moll (1986) mentioned some differences in the lengths of nesting crawls of both species, we found that crawls of *B. kachuga* were significantly shorter than those of *B. dhongoka* ($t = 2.04$, $p = 0.05$; Table 1, Fig. 7), albeit at sites higher above water level. Mean distance travelled by *B. kachuga* was 13.25 ± 0.72 m, that of *B. dhongoka* 27.33 ± 1.18 m.

During the three-year study, over 90% of *B. kachuga* nests were on only three of the eight sandbanks and no nests were on two flat banks with coarse sand and gravel adjacent to shallow stretches (3–4 m) of the river, whereas *B. dhongoka* nests were more equitably distributed on all eight sandbanks (Table 2).

Nesting turtles travelling farther from water's edge, forming loops or crossing crawls of other females when returning to the river, digging "false" nests, or scattering sand over areas much more extensive than the mouth of the nest cavity all appear to be strategies designed to confuse predators. Nevertheless, in the three years of the study we observed predation by Indian Golden Jackals (*Canis aureus*) (identified by footprints) on five female turtles (two *B. kachuga* in 2018 and 2019 and three *B. dhongoka*, one in 2017 and two in 2019).

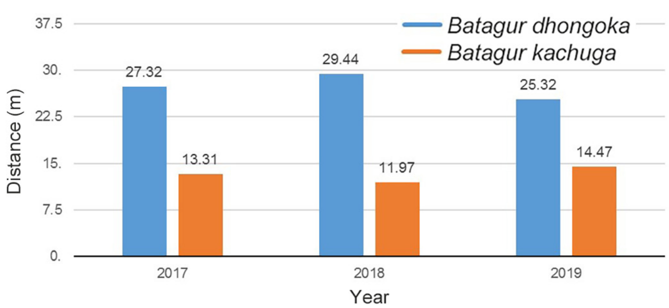

Figure 7. Distances from water's edge to the nests of Red-crowned Roofed Turtles (*Batagur kachuga*) and Three-striped Roofed Turtles (*Batagur dhongoka*).

Female *B. kachuga* disproportionately nested on sandbanks with steep slopes and fine to very fine sand particles adjacent to deep pools in the river, which also are utilized by Gharials (*Gavialis gangeticus*) for nesting. *Batagur dhongoka* were less selective for banks with steep slopes and fine sand. Taigor and Rao (2020) analyzed physicochemical characteristics of nesting and basking sites of turtles along the Chambal River and noted that sand-particle compactness, distance from water's edge, and depth of the egg chamber not only facilitate development but also hatchling emergence and movement to the river. However, how these turtles monitor and select sites with appropriate substrates is still unknown.

Timing of nesting activities.—We observed increases in the number of nesting events prior to periods of heavy rain, suggesting that declining atmospheric pressure could serve as a trigger. Heavy rain could obliterate signs of nesting along with chemical cues while predators are less active. Immediately before periods of rain, females moved shorter distances from the water's edge before nesting.

Although nocturnal nesting appears to reduce encounters with potential predators, Rao and Singh (1987) noted that, depending on water temperature, other environmental conditions, and past experiences with predators, turtles will sometimes nest during the day.

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Table 2. The number of Red-crowned Roofed Turtle (*Batagur kachuga*) and Three-striped Roofed Turtle (*Batagur dhongoka*) nests per year with nesting percentages (%) per sand bank.

	Red Crowned-roofed Turtle (*B. kachuga*)					Three Striped-roofed Turtle (*B. dhongoka*)				
Sand Bank	**2017**	**2018**	**2019**	**Total**	**Percent**	**2017**	**2018**	**2019**	**Total**	**Percent**
Mau	1	0	5	6	6.9	18	7	65	90	16.3
Kamoni	0	0	1	1	1.1	14	0	43	57	10.3
Murong	0	3	0	3	3.5	52	14	57	123	22.2
Bhawar	0	0	0	0	0.0	13	2	26	41	7.4
Garaita	18	28	12	58	66.7	17	27	49	93	16.8
Pachhay Gaon	0	0	0	0	0.0	2	0	5	7	1.3
Barauli	11	3	3	17	19.5	18	34	34	86	15.6
Badpura	2	0	0	2	2.3	51	5	0	56	10.1

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Literature Cited

Bobyn, M.L. and R.J. Brooks. 1994. Interclutch and interpopulation variation in the effects of incubation conditions on sex, survival and growth of hatchling turtles (*Chelydra serpentina*). *Journal of Zoology* 233: 233–257. https://doi.org/10.1111/j.1469-7998.1994.tb08586.x.

Das, I., B.C. Choudhury, P. Praschag, M.F. Ahmed, and S. Singh. 2019. *Batagur dhongoka* (errata version published in 2019). *The IUCN Red List of Threatened Species* 2019: e.T10953A152042542. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T10953A152042542.en.

Ewert, M.A. and C.E. Nelson. 1991. Sex determination in turtles: diverse patterns and some possible adaptive values. *Copeia* 1991: 50–69. https://doi.org/10.2307/1446248.

Fowler, L.E. 1979. Hatching success and nest predation in the green sea turtle, *(Chelonia mydas*) at Tortuguero, Costa Rica. *Ecology* 60: 946–955. https://doi.org/10.2307/1936863.

Horrocks, J.A. and N.M. Scott. 1991. Nest site location and nest success in the hawksbill turtle (*Eretmochelys imbricate*) in Barbados, West Indies. *Marine Ecology Progress Series* 69: 1–8. https://doi.org//10.3354/meps069001.

Janzen, F.J. and G.L. Paukstis. 1991. Environmental sex determination in reptiles: ecology, evolution, and experimental design. *The Quarterly Review of Biology* 66: 149–179. https://doi.org/10.1086/417143.

Joanen, T., L. Mcnease, and M.J.W. Ferguson. 1987. The effects of egg incubation temperature on post-hatching growth of American alligators, pp. 533–537. In: G.J.W. Webb, S.C. Manolis, and P.J. Whitehead (eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons, Chirping Norton, Australia.

Lovich, J.E., J.R. Ennen, M. Agha, and J.W. Gibbons. 2018. Where have all the turtles gone, and why does it matter? *BioScience* 68: 771–781. https://doi.org/10.1093/biosci/biy095.

McKnight, C.M. and W.H. Gutzke. 1993. Effects of the embryonic environment and of hatchling housing conditions on growth of young snapping turtles (*Chelydra serpentina*). *Copeia* 1993: 475–482. https://doi.org/10.2307/1447148.

Moll, E.O. 1986. Survey of the freshwater turtles of India Part I: the genus *Kachuga*. *Journal of the Bombay Natural History Society* 83: 538–552.

Packard, G.C., M.J. Packard, K. Miller, and T.J. Boardman. 1988. Effects of temperature and moisture during incubation on carcass composition of hatchling snapping turtles (*Chelydra serpentina*). *Journal of Comparative Physiology B* 158: 117–125. https://doi.org/10.1007/BF00692735.

Praschag, P., M.F. Ahmed, I. Das, and S. Singh. 2019. *Batagur kachuga* (errata version published in 2019). *The IUCN Red List of Threatened Species* 2019: e.T10949A152043133. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T10949A152043133.en.

Rao, R.J. and L.A.K. Singh. 1987. *Kachuga* (Reptilia, Emydidae) in National Chambal Sanctuary: Observations on diurnal nesting emergences and unsuccessful nesting crawl. *Journal of the Bombay Natural History Society* 84: 688–691.

Resetarits, W.J., Jr. 1996. Oviposition site choice and life history evolution. *American Zoologist* 36: 205–215. https://doi.org/10.1093/icb/36.2.205.

Saksena, D.N., R.K. Garg, and R.J. Rao. 2008. Water quality and pollution status of Chambal River in National Chambal Sanctuary, Madhya Pradesh. *Journal of Environmental Biology* 29: 701–710.

Sharma, R.K. and N. Dasgupta, N. 2013. Status and population trends of gharial in the Chambal River, National Chambal Sanctuary, pp. 74–77. In: World Crocodile conference. P*roceedings of the 22nd Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN, Gland, Switzerland.

Spotila, J.R., L.C. Zimmerman, C.A. Binckley, J.S. Grumbles, D.C. Rostal, A. List, Jr, E.C. Beyer, K.M. Phillips, and S.J. Kemp. 1994. Effects of incubation conditions on sex determination, hatching success, and growth of hatchling desert tortoises, (*Gopherus agassizii*). *Herpetological Monographs* 8: 103–116. https://doi.org/10.2307/1467074.

Taigor, S.R. and R.J Rao. 2020. Assessment of sand quality of nesting and basking sites of crocodile and turtles in the Chambal River, India. *International Journal of Chemical Studies* 8: 1175–1180. https://doi.org/10.22271/chemi.2020.v8.i1p.8411.

Tucker, J.K., N.I. Filoramo, and F.J. Janzen. 1999. Size-biased mortality due to predation in a nesting freshwater turtle, *Trachemys scripta*. *The American Midland Naturalist* 141: 198–203. https://doi.org/10.1674/0003-0031(1999)141[0198:SBMDTP]2.0.CO;2.

Verma, T.P., S.P. Singh, R. Gopal, R.P. Dhankar, R.V.S. Rao, and T.A.R.S.E.M. Lal. 2012. Characterization and evaluation of soils of Trans-Yamuna area in Etawah District, Uttar Pradesh for sustainable land use. *Agropedology* 22: 26–34.

Whitmore, C.P. and P.H. Dutton. 1985. Infertility, embryonic mortality and nest-site selection in leatherback and green sea turtles in Suriname. *Biological Conservation* 34: 251–272. https://doi.org/10.1016/0006-3207(85)90095-3.