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Accepted: 1 February 1989.

*Journal of Herpetology*, Vol. 24, No. 1, pp. 99–100, 1990


## Notes on the Feeding Behavior of the Gharial (*Gavialis gangeticus*) Under Semi-natural Conditions

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Numerous studies have examined the diet of wild crocodilians (e.g., Chabreck, 1972; Taylor, 1979; Seijas and Ramos, 1980; Webb et al., 1982; Delany and Abercrombie, 1986). However, little is known about the techniques crocodilians use to capture prey (Schaller and Crawshaw, 1982). I here present data on the feeding behavior of the gharial (*Gavialis gangeticus*) under semi-natural conditions.

The gharial is probably the most thoroughly aquatic of the crocodilians; they are rarely seen far from the water's edge (Singh and Bustard, 1977), and larger individuals are apparently incapable of using the "high walk" posture usually seen in crocodilians moving on land (Singh and Bustard, 1977; Whitaker and Basu, 1982). Mostly anecdotal accounts indicate that this species feeds principally on fish (reviewed in Whitaker and Basu, 1982), although at times bird or mammalian prey may be taken (Smith, 1931). Other than a brief account in Neill (1971), almost no information on prey catching behavior of this unusual species has been published.

Behavioral observations were made on eight subadult gharials (2.0–2.4 m total length) housed in the Jungle World exhibit of the Bronx Zoo, New York Zoological Society. The gharials were hatched in the Kukrail captive rearing center, Uttar Pradesh, India, and brought to New York in 1985. The exhibit consists of a realistic stream habitat running through a simulated lower montane rain forest. Two waterfalls (1.8 m high) divide the stream into three pools: large upper and lower pools (depth ca. 2 m); and a smaller central pool (ca. 1.5 m deep). The stream water is clear, and visibility extends to a depth of about 1 m. The total length of the stream exhibit is 40 m.

At the time of the observations, gharials in the exhibit were fed live brook (*Salvelinus fontinalis*) or rainbow trout (*Salmo gairdneri*) three times per week. During each feeding approximately 100 15–20 cm long trout were transferred from holding tanks (water temperature 12 C) into the stream environment (water 27 C). The fish swam actively for 5–10 min before exhibiting obvious signs of thermal shock (slow, uncoordinated swimming, frequently in an inverted position). Thermally-shocked fish captured by gharial were excluded from the data analyses.

Feeding observations were made on a single gharial, or on a tight group of gharial, usually in the lowermost of the three pools. From one to three gharials were under observation at any one time. Observations were started 2–3 min after the introduction of the fish, and continued until all remaining fish exhibited signs of thermal shock. Data recorded were: number of strikes at fish; number of successful strikes; and the position on the snout of the gharial at which each fish was captured. Observations were made on six days between 19 December 1986 and 1 January 1987.

*General Feeding Behavior.*—During non-feeding periods gharials would regularly assume two passive foraging postures. In the first the gharial positioned the rear half of the body in shallow water or on land, with the anterior body floating in open water and the mouth held partially open. In this position the animal was motionless, but alert.

In the second foraging posture the gharial were submerged (often at the bases of the waterfalls) with their mouths slightly open and oriented into the current. They remained in this posture for long periods, with their limbs extended in a relaxed fashion and eyes open, lifting their snouts every few minutes to breathe.

When fish were introduced into the stream the gharials (including those on the banks) assumed the second foraging position and began making slow, lateral sweeping motions with the head and anterior half of the body, presumably to locate fish. These slow sweeps were easily distinguished from the rapid lateral strikes used to capture fish. Almost all strikes observed took place underwater from this posture. Only two of 160 observed strikes (1.25%) were made with the head at the water surface.

Lateral strikes were extremely rapid, and made principally with the head and neck; body movement was minimal. The maximum lateral angle of strikes approached 90°. Prior to striking, the gharial's head was usually resting on the pool bottom, while most fish were swimming in the water column well above the substrate. Consequently, many "lateral" strikes had a vertical component, which was accomplished by a rotation up to 90° of the head and neck. On two occasions gharials were observed to catch fish swimming near the surface directly above the snout.

After capture fish were manipulated in the jaws and moved posteriorly by a tossing motion involving inertial feeding movements of the head and neck (Gans, 1969). Fish were always swallowed head first.

*Striking Success Rate and Position on Snout.*—A total of 109 min of active feeding observations of one or more gharial was made, for a total of 291 min. During this time 160 feeding strikes were recorded, an average of 0.55 strikes/gharial/min. Of the 160 strikes 55 were successful, constituting an average success rate of 34.4%.

The position of fish capture on the snout was noted for 127 successful strikes. Ten fish (7.9%) were captured on the basal third of the snout, 60 (47.2%) on the middle third, and the remainder on the distal third.

None of the fish were captured after direct physical contact with the jaws of the gharial; rather, they were taken while swimming in the water column adjacent to the gharial's head. Prey capture appeared to be elicited visually. Nevertheless, Singh (1976) noted that juvenile gharials seemed to rely on tactile cues when feeding on fish and tadpoles. Whitaker and Basu (1982) also reported that gharial can capture fish in water that is virtually opaque. Gharials, like all members of the Crocodylia, have integumentary sense organs (ISOs) on the head (Brazaitis and Garrick, unpubl. obs.). Gharials and members of the Crocodylidae also have ISOs on the scales of the trunk, limbs and tail (Brazaitis and Garrick, unpubl. obs.). Histological evidence indicates that these ISOs are structurally similar to mechanoreceptors (von During, 1973*a*, *b*), and they may play a role in social communication (Brazaitis and Garrick, unpubl. obs.) as well as their potential use in prey localization.

Although it is difficult to compare the data from this study to other quantitative observations on feeding efficiency in crocodilians, they do suggest that gharials have a relatively higher success rate in fishing strikes than do species with broader snouts. In wild populations of *Caiman crocodilus* the surface efficiency of feeding attempts is less than 20% (Schaller and Crawshaw, 1982, 15.9%; Thorbjarnarson, unpubl. obs., 10.0%).

*Acknowledgments.*—F. Wayne King, K. Vliet, and P. Brazaitis offered useful comments on this manuscript. Permission to make observations on feeding behavior was provided by J. Behler and P. Brazaitis. B. Foster kindly tailored the feeding schedule of the gharial to allow my work.

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Accepted: 9 February 1989.

*Journal of Herpetology*, Vol. 24, No. 1, pp. 100–103, 1990


# Notes on the Population Ecology of the Large Herbivorous Lizard, *Trachydosaurus rugosus*, in Arid Australia

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Studies on lizard populations have become increasingly prominent in recent attempts to test and refine

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