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LOCOMOTORY BEHAVIOUR DURING BASKING AND SPOOR FORMATION IN THE GHARIAL (*GAVIALIS GANGETICUS*)

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Cott (1961) reported three distinct terrestrial gaits in crocodilians—the high walk, the belly run and the gallop. In the wild none of these methods has yet been noticed for the gharial because a basking gharial is never far from water. On one occasion a basking gharial 5.5 m in length was observed to wheel about and move into the water when our boat approached it nearly 45 m away. All three terrestrial gaits have however been observed in young captive gharial studied up to 10 months of age: the high walk in relation to suspicious circumstances, and the belly run and gallop as a response to sudden fright. Zug (1974) has suggested that galloping is infrequent and has described the locomotory pattern in a single juvenile specimen of *Crocodylus porosus* in captivity. However, in addition to these methods, a slow and leisurely belly walk is seen in both captive and wild gharial during basking. This belly walk is responsible for spoor formation, which we use to estimate body size (unpublished).

All three species of Indian crocodilian—*Gavialis gangeticus*, *Crocodylus porosus* and *C. palustris*—occur in Orissa but with different habitat preferences, so all three species never occur together. Compared with the other two species, gharial move and bask frequently. The Satkoshia Gorge of the River Mahanadi in Orissa at present harbours two juvenile muggers (*C. palustris*), three adult muggers, one juvenile gharial and four adult gharial—two males and two females. Muggers are seldom seen out of the water, probably because the water is deep enough (10 m in the dry season) to keep them warm. By contrast, the gharial, particularly the juvenile and the males, bask a few hours after sunrise and sometimes during other times in the day. Basking occurs daily in the winter but rarely in the summer. The characteristic basking movements described below leave a compact, inverted U-shaped spoor.

We recognise six behavioural phases associated with basking:

(i) *Preparatory phase.* Before emerging, a wild gharial surfaces near the basking site three or more times at 10–30 min intervals and then suddenly moves onto the bank. The young captive gharial swim to a pool edge and come up for basking without the preparatory phase.

(ii) *Emergence phase.* The gharial climbs up the sand slope of the basking site with the help of the forelimbs. Then it lies on the shore with half the body or the tail remaining in the water. At this stage the body makes almost a right angle or an acute angle to the edge of the basking site. When the slope of the basking site is steeper the greater is the tendency to make a right angle (Fig. 1). The duration of the phase depends on the position of the sun. If the sun falls laterally then the gharial may remain longer in the same position; if the sun is in line with the body axis then the emergence phase is short.

(iii) *Pre-basking phase.* This involves the complete emergence of the body in the same line as in phase (ii). It is accomplished by a backward push of the fore and hind limbs against the ground with slight lifting of the body to facilitate forward movement. The paws and feet make deep impressions depending upon the ground. No good scute spoors are formed because the body and tail move in a straight line without any lateral movement.

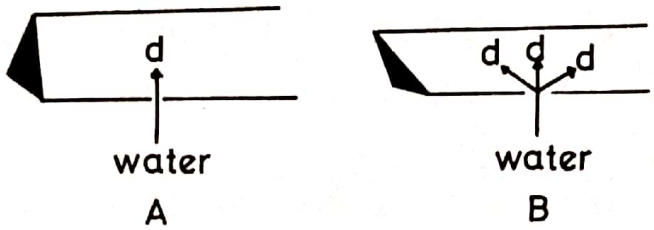

FIG. 1. Relation between the nature of the basking site and the direction of emergence. When the ground is a steep slope (A), the direction of emergence (d) makes almost a right angle with the edge of the basking site. When the ground for basking is almost flat (B), there is equal possibility for the direction of emergence to describe a right or an acute angle with the edge of the site.

(iv) *Basking phase.* Actual basking begins with the gharial turning to the side so that the body axis during basking forms an obtuse angle to the body axis upon emerging. This initial part concludes with a lateral sliding of the body and tail so that the body axis remains perpendicular to the axis upon emergence. These movements drag the tail over the sand and leave a spoor, formed by that part of the tail bearing single ventral scutes. However, spoors from this phase are not clear since during the movements the tail does not touch the ground completely due to the effect of a lifting force F_2 travelling the whole length of the tail in the form of a wave (Fig. 2).

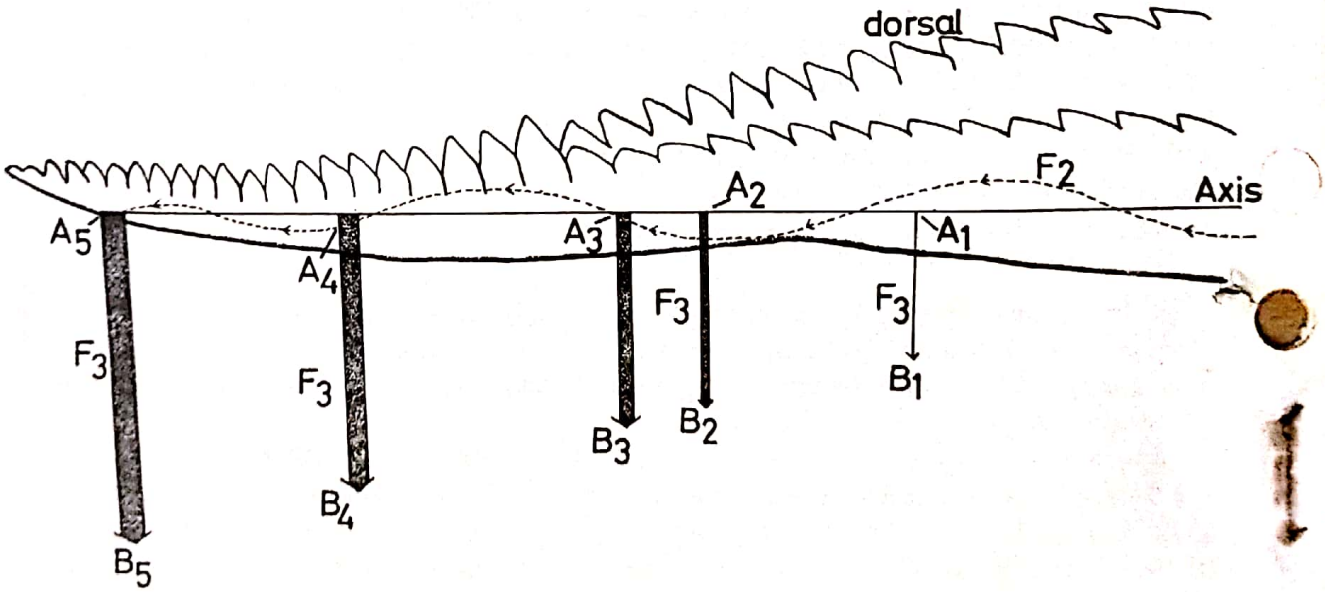

FIG. 2. Forces in action during the basking phase proper. A_5 to A_1 are imaginary points on the tail axis to demonstrate the nature of the lateral force (F_3) when it travels from these points to the respective limiting points B_5 to B_1. Play action of F_3 is limited up to a line drawn through these limiting points. F_2 is the lifting force travelling the whole length of the tail.

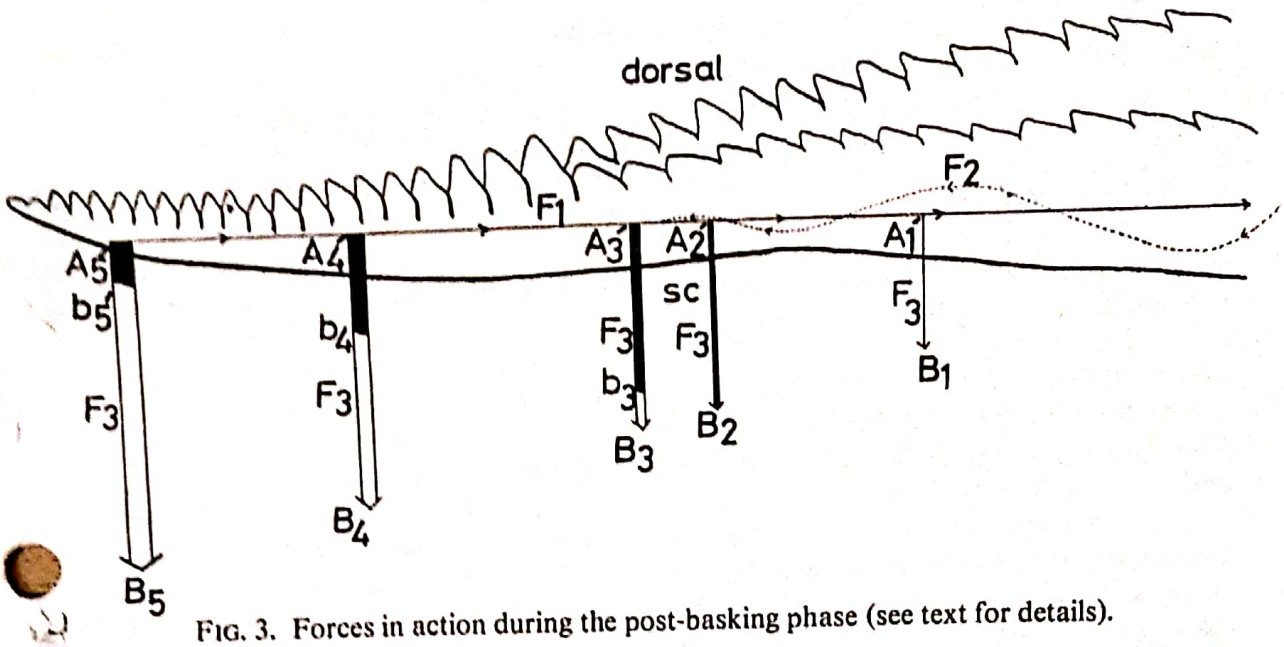

FIG. 3. Forces in action during the post-basking phase (see text for details).

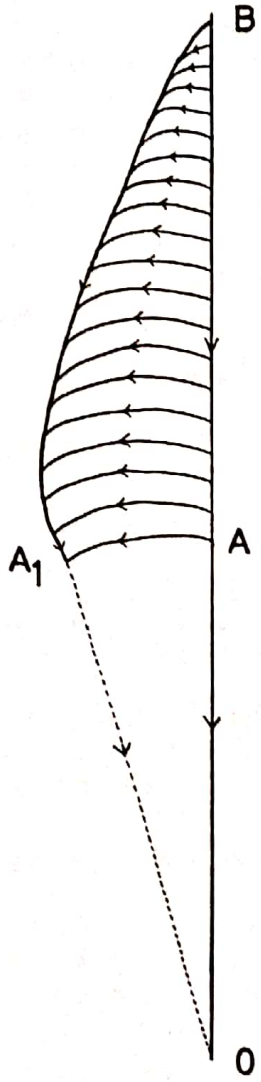

FIG. 4. Mechanism and nature of spoor formation during the post-basking phase (see text for details).

(v) *Post-basking phase.* The gharial moves forward and laterally from the position during phase (iv). In so doing three forces act concurrently (Fig. 3): (a) a forwardly-directed dragging or propulsive force (F_1) acting in a straight line to the body axis and originating from limb movements, (b) a lifting force (F_2) directed posteriorly in the form of a diminishing wave and originating from muscular movements at the base of the tail (the diminishing nature of this force is due to F_1 and the weight of the tail), (c) a lateral force (F_3) originating at the base of the tail due to muscular action. F_3 in the absence of the other forces would bring the tail to a position along B_5–B_1 from A_5–A_1. However, due to F_1 the extent of F_3 is reduced to b_5–b_4–b_3–B_2–B_1. The tail is dragged along this line producing spoor marks of the pattern shown in Fig. 4 (B to A). It should also be noted that the lifting force F_2 produces effects approximately up to A_2 which marks the region from where the tail begins to have ventral scutes arranged in a single row. In the portion of the tail anterior to A_2 all three forces are in action. Due to the action of F_2 in the anterior region the tail in this region seldom touches the ground and should it do so does not leave a spoor of the scutes because the effective strength and range of F_3 is low and F_1 is also in action. Thus even if this portion of the tail makes some lateral movement it does not leave any spoor (Fig. 4, AO). In Fig. 4, OB represents the body axis in which F_1 acts in the direction BO; BA_1O is the path in which the tail is dragged.

(vi) *Re-entry phase.* This phase is usually short although it may be prolonged by brief pauses. Usually the gharial enters the water with a single sliding movement. The extent to which the limbs are used depends on the nature of the basking site, the greater the slope the lesser is the use of the limbs. Thus there is less probability of observing good pugs at this stage, and the movements do not leave a caudal scute spoor. However, the sliding spoor is important to surveyors in detecting the basking site.

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