

TERRESTRIAL LOCOMOTION IN THE INDIAN MUGGER ( Crocodylus palustris )

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The Indian mugger ( Crocodylus palustris ) is known to walk great distances over land when the water of its habitat dries up. At such time muggers may be found at distances of 10/12 km from the nearest water ( Bustard, Un pub.obs. ). In view of this, and as a contribution to the study of terrestrial locomotion in Crocodylia experiments were carried out to ascertain the locomotory patterns involved and their relative speeds. The present paper supplements the work of Cott (1961) and Zug (1974) on crocodile gaits.

MATERIALS AND METHODS.

Six juvenile Crocodylus palustris being reared in captivity under natural condition were used in the study. The experimental individuals, aged 9 to 10 months, ranged from 414 mm to 627 mm in length and 295 to 929 gm in weight. Experiments were carried out between 11am and 3.30pm in late February ( early summer ) when the temperature of the brown lateritic substrate ranged from 42-47C. The experimental area was of a uniformly flat and measured x mts. 32 journeys were recorded using these six animals; in some of these several types of locomotion were recorded. The time of experiment was selected as being one when the animals could be expected to be active.

The precise distance covered by the crocodile was calculated by measuring the spoor. The time taken to cover the distance recorded with a stopwatch in order to calculate speed. To minimise experimental errors in timing walks were recorded over the maximum distance possible. This averaged mts, ranged

RESULTS

Four different categories of locomotion were recorded during the experiment. Though gallop was not seen by us, this has been described by Cott (1961) and Zug (1974). Thus a total of Five

different categories of terrestrial locomotion can be distinguished. These are listed in Table I together with the range of speed attained.

1. BELLY WALK :- This can be sub-divided into three types depending on the place of movement and its speed, namely typical belly walk, cryptic belly crawl and tobogganing. In typical belly walk the trunk and tail touch the ground and both the fore and hind limbs are spread sideways from the belly, in what is generally considered to be the typical "splayed" form of reptilian locomotion. Since the whole body, except the head, drags on the ground a wide track is left. This type of walk is slow. Most of the animals exhibit this locomotory pattern while leaving the water of the rearing pools. During this motion the crocodile observes the surroundings minutely. Thus it may be called an exploratory walk. Since this walk was not exhibited under the experimental condition no speeds are available.

The cryptic belly crawl is similar to the belly walk but is executed in a slow and stealthy fashion, the crocodile lying very flat on the ground. The limbs move extremely slowly and deliberately so that the animal's body seems to slide forward in a stalking attitude. Tracks are as for the belly crawl. This ~~is~~ could also be called a defensive walk, used to escape unnoticed from danger as well as for cryptic approach to prey. Speed recorded ranged from .11 - .28 km/hr (mean .20 km/hr). This type of walk comprised 9.3% of the recordings.

Tobogganing is adopted by the crocodiles to come down sloping banks into the water. The belly is used as a sledge, and with the aid of the limbs, predominantly the hind limb, the animal slides down into the water. This walk could not be observed under experimental condition.

2. LOW WALK :- In low walk the front half of the body is raised above the ground. The four limbs are straightened and brought in towards the body while the belly and the entire tail touch the ground as a result of the hind limbs remaining splayed out sideways. During the stride the hind limbs are placed down well behind the fore limbs and the marks left by the hind limbs are further away from the tail track than those of the fore limbs. Speeds recorded range from .32 - .50 km/hr (mean .41 km/hr). This type of walk comprised 25.6% of the recording.

3. High Walk : In high walk the crocodile raises its body high off the ground by swinging the limbs inwards and downwards, and observation confirmed by examination of the track in which the foot marks are much closer together than those made in the belly crawl and low walk. Only the tail tip touches the ground, leaving a narrow straight trail. In each stride the hind limb swings far forward to almost touch the forelimb. (Fig ). During fast high walk the tail tip makes a sinuous mark as it swings from side to side. Zug (1974) describes the locomotory pattern of the high walk as follows " the body maintains a tripodal or quadrapodal support posture nearly 70% of the stride and there is no period of unipodal or no support".

In typical high walk, speeds recorded varied from .56 - to 1.02 km/hr and (mean .72 km/hr). This type of walk comprised 53.1% of total recordings.

For fast high walk, speeds varied from .99 -.24 km/hr (mean 1.5 km/hr). Fast high walk comprised 12% of the recordings.

4. Run : In the experiment described here the animals usually increased their speed by going through some of the methods of locomotion outlined above i.e, low walk, high walk, fast high walk before run. As with the high walk both slow and fast varieties of run were observed. Efforts were made to make the animals run by surprising and frightening them, however, their nature is such that instead of running they turn abruptly to face the aggressor in a defensive attitude.

The run is a sort of trotting in which both the hind and forelimbs are lifted right off the ground during each step, leaving very little 'drag' marks. The tail mark is sinuous with alternate thick and thin bands, indicating a left and right sweeping of the tail.

For slow run speeds varied from 2.4 km- 4.3 km/hr (mean 3.36 km/hr). This type of locomotion comprised 6.25% of the recordings.

Fast run was seen only once. It was not possible to make an accurate measurement of the speed attained. It was estimated to be 10 km/hr . Accordingly fast run is very much faster than slow run. The fore and hind legs do not leave the ground at the same time. The hind feet ~~called~~ fall on the prints made by the fore feet. It is considered

likely this type of run resulted from panic.

5. Gallop : Gallop was not observed in this experiment.

#### DISCUSSION.

Additional forms of Crocodylian locomotion were discovered during the course of this experiment. Previously Crocodylian locomotion was divided into belly run, high walk and gallop. The description of belly run given by Cott(1961) is here called belly walk - tobogganing. Since the animal moves at a slow speed with no period of running during the locomotory pattern we prefer to categorise it as a form of walk. Cryptic belly walk is likewise a modification of ~~high walk~~ belly walk described in the text.

Low walk recorded in 25.6% of recordings is the locomotory pattern usually adopted prior to high walk. However, the crocodile may precede many metres using this gait or, alternatively, only a few steps may be taken before typical high walk takes over.

High walk here divided into typical high walk and fast high walk remains basically unchanged from description of Cott(1961) and Zug (1974).

Run, a new form of locomotory pattern falls between high walk and gallop where the speeds are very modest ( Table I ).

The observed locomotory pattern falls into a logical sequence when their rate is considered. They are arranged in increasing order of speed in Table I. It is not-worthly that it was possible to observe the distinctive locomotory patterns and on subsequent examination of speed recordings to confirm that they fitted in to a natural sequence. The various walks described cover a range of speed 0.20 to approximately 10.0 km/hr. It should be noted that the fast locomotory patterns were seldom observed and then merely for a short distance ( - mts, mean mts ).

Since all the observed walks are relatively slow the defensive posture readily adopted even by C. palustris juveniles may have survival value as may be the cryptic belly walk.

Zug (1974) has described galloping based on a single individual of C. porosus and reports speeds of up to 64.8 km/hr (mean 48.9; range 28.8 to 64.8 km/hr). Such speeds lie far outside

the range here observed, although we admit that we did not observe galloping. However, the method of measurement of speed adopted by Zug ( time taken to move through one crocodile length ) would appear to be open to large error of measurements. Here we have time-locomotion over long distances, to minimise potential errors. The distance involved        mts, (ranged -        mts ).

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#### LITERATURE CITED

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TABLE - I

SPEED (km/hr) DURING DIFFERENT FORMS OF TERRESTRIAL LOCOMOTION IN

G. PALUSTRIS ( N = Number of observations )

FORM OF LOCOMOTION	SUB TYPE	N	MEAN (km/hr )	RANGE (km/hr)
1. BELLY WALK	(a) CRYPTIC BELLY WALK	3	0.20	0.11 - 0.28
	(b) BELLY WALK PROPER	±	-	-
	(c) BOBAGCONING	-	-	-
2. LOW WALK	-	5	0.41	0.32 - 0.50
3. HIGH WALK	TYPICAL HIGH WALK	17	0.72	0.52 - 1.02
	FAST HIGH WALK	4	1.50	0.99 - 2.24
4. HUI	SLOW HUI	2	3.36	2.40 - 4.32
	FAST HUI	1	10.0 *	-
5. GALLOP	-	-	-	-

\* Fast run was observed once but it was not possible to obtain an accurate timing.

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Pool - 6  
 Gir Crocodiles

Order's  
 number →

Transverse  
 row  
 ↓

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

(7) (8) (9) EP  
 \* \* \*

1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	5	5	4	5	5	5	5	6	5	4	6	6	4	4
4	6	4	4	5	6	6	6	4	6	4	4	6	4	5
5	4	5	5	6	5	5	5	4	5	7	4	5	6	6
6	5	5	4	5	4	4	5	5	6	4	4	4	4	5
7	4	4	4	4	4	5	4	4	5	4	4	4	5	4
8	4	5	4	6	4	4	4	4	6	4	4	4	4	5
9	4	4	4	6	4	4	5	5	5	6	6	4	4	5
10	5	6	5	6	4	5	5	8	7	5	5	4	4	4
11	6	6	5	6	6	6	7	6	7	6	6	6	6	5
12	6	4	5	6	6	5	7	6	6	6	6	6	6	6
13	5	4	4	4	6	5	6	6	6	4	6	4	6	4
14	4	4	4	4	4	4	4	4	4	4	4	4	4	5
15	4	4	4	4	4	4	4	4	4	4	4	4	4	5
16	4	4	4	4	4	4	4	4	4	4	4	4	4	4
17	4	4	4	4	4	4	4	4	4	4	4	4	4	4

~~18~~  
 19

Part 7  
Gir mobile

Exercise number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	5	4	5	6	6	6	5	6	6	6	5	5	6	
4	6	4	4	4	6	7	5	5	4	5	4	4	6	
5	5	1	6	5	6	6	5	5	6	5	5	4	5	
6	4	4	5	5	4	4	4	4	6	4	5	4	5	
7	4	5	6	5	4	4	4	4	5	4	4	4	6	
8	4	5	6	4	6	5	5	4	4	4	4	5	5	
9	6	4	6	4	5	5	4	4	5	5	4	5	5	
10	6	5	6	4	6	5	5	5	6	5	4	5	6	
11	6	6	6	5	5	5	6	5	6	5	4	6	6	
12	6	5	6	5	6	5	6	6	6	6	5	6	6	
13	4	5	6	4	5	5	4	6	5	5	4	4	5	
14	4	4	4	4	4	4	4	4	4	4	4	4	4	
15	4	4	4	4	4	4	4	4	4	4	4	4	4	
16	4	4	4	4	4	4	4	4	4	4	4	4	4	
17	4	4	4	4	4	4	4	4	4	4	4	4	4	

18  
19  
20



D

Dorsal Scute variation in *Hypos*  
*Crocodile* -

2 *Levivipala* proposed these subspecies Limbale & P  
*Sri Lanka*  
① *C. palmarum* was described by Leeson 1839 and the laws  
of jungle distribution metway (Neill)  
on the basis of dorsal scute count and he stated that  
the typical form possessed "more transverse scute rows  
with jaw <sup>cutaneous</sup> dorsal scutes than with size" whereas  
in Ceylon usually "the number of transverse rows with  
one <sup>cutaneous</sup> scutes exceed those with four" the  
before that the Ceylon form might possibly also  
occur in South India *Levivipala* (1953)  
In the course of work on ~~*C. palmarum*~~ differences  
with in Indian fields of the species we have included  
examination of dorsal scutes for instance

in the population of southern India, of N. Arcot - dit  
TN (Fig 1) we examined 112 individuals and found  
58 individuals with four rows and fifty four with six  
rows of enlarged dorsal scute.

Method - There are fourteen rows of the enlarged  
scutes on the back commencing just <sup>posterior</sup> to the  
forelimbs. The intermination at the junction of the  
tail. The 1st and 2nd row were discarded. Then always  
forward 2 of scutes respectively. The number of  
scutes rows in the remaining 12 rows was scored as

juveniles were allotted to either group  
then passing on the preponderance of one or the other  
scute pattern. It is invariably easy  
to quickly allocate individuals to either group  
on the basis of visual inspection for country.  
~~The~~ Both scute numbers frequently occur  
within groups, 9 still juveniles from the same  
nest.

N. Indian data

1. Gir population
2. Chambal

While there is an extensive Sri Lanka network  
and a recent comment on *Serriniggala* 1953 joining  
that the typical (N. Indian) form "the two median  
or vertebral ones of scutes are strongly widened."  
The difference in the form is evidently as to  
area available for the scutes is the same and  
if regular determinations are not fed in their  
number, the space is not available for

brooding. *Serriniggala* (1953) further states that  
the typical form is generally found whereas  
the Ceylon animal tends to be infrequently  
in sewage manure and often frequents stony

-2-

saline regions. He quotes Smith (1931) as  
evidence that in India the muggie is usually  
found above the limits of salt water. We  
concur with Ivanizygal's comment concerning  
the muggie in India. It is generally in opinion  
it belongs to the fresh water group of  
Cnidaria ~~that~~ but - we know of its  
occurrence in Goa in the blue cuttings of  
mangrove creeks where the water is strongly  
saline (about 40‰ for example) one of us (HOB) has  
examined and photographed one such individual  
which is undoubtedly a muggie.

Carey Ivanizygal's statement - that  
in Ceylon the animal "is infrequently a *manic*  
*manic*" we feel certain this results in  
confusion of this species and *C. parsons*. It is  
quite easy for most inexperienced people to  
confuse these species as the muggie grows  
occur in large & short - stout forms and  
there is also considerable variation in  
jaw shape in *parsons*. Evidence for all  
this confusion is given by Ivanizygal himself.  
(1953)  
In the section of a book dealing with  
*C. parsons*, Iribarne he quotes on page 32

"one of the earliest references to a mermaid  
creatures from Ceylon is the tradition that  
King Raja Sinha 1658! ~~thought~~ his grandson  
is to the jaws of a large ~~specimen~~ which  
attached him as he attempted to cross the  
Galleys river on the same page

Legends of the South & North  
from *Devanagala* (1137) <sup>Fig 27A</sup> page 55 of ...



observe the myser for  
front leg - find the appearance.

Southampton

Post-6

21

row  
4 seats

6 rows

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Post-7

19

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

Post-8

21

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Post-9

21

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

Post-10

20

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

102

6 Schubs

Post-5:

6 Schubs

~~1, 1, 1, 1, 1, 1~~

1, 1, 1, 1, 1, 1

~~1, 1, 1, 1, 1, 1~~

1, 1, 1, 1

Time 10

one Pariah kite caught by 1977 yearling  
15 min in flight over the Post + kiosk.

Kite was killed at 2 PM - Isken was at  
5 PM, didn't start feeding in the kite.

Deed has floating in water.

58:4

54:6

1. Check for sentes of  
Gujrat and -

2. Write to Buhant for 10 Chambers  
Mysore Jerson Santa Camp -

3. Delhi 20 origin

4. Check for fringes on the front leg

1. Sathnam TN

2. All Stock

Deraniyale (1953) A Colours Atlas  
Page 26 of *C. jaliscoi* *limbata* with  
seen to be parsons.