

## DIURNAL RHYTHM OF ACTIVITY IN THE NILE CROCODILE

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## Introduction

Diurnal or circadian rhythms of activity have been described in a number of reptiles, including turtles, lizards and snakes (Cloudsley-Thompson, 1961). The majority of species that have been investigated appear to be diurnal in habit, seeking their prey during the hottest part of the day, and nocturnal activity takes place only in warm weather.

In the case of crocodiles, Cott (1961) has described a general diurnal rhythm in the Nile crocodile, *Crocodilus niloticus* L. Observations in Uganda and Northern Rhodesia have shown that the night is usually spent in water and the haul out to land begins in the hour before sunrise. There are two main basking periods: between 07.00 and 09.30 hours, and between 14.30 and 17.30 hours. In the heat of the day there is a secondary return to the water or into shade. These observations were supported by counts made at 15-minute intervals of the crocodiles seen ashore and afloat throughout the day. No experimental investigation, however, appears to have been made concerning the activity of individual crocodiles over longer periods of time.

## Material

Experiments were carried out on two Nile crocodiles, *Crocodilus niloticus* L. kept in captivity at Khartoum. The smaller specimen, measuring approximately 2 feet in length, was captured ashore at Jebel Aulia some 30 miles south of Khartoum on the White Nile, early in October, 1961. It was placed in one of the toad ponds of the Department of Zoology, University of Khartoum, and left for three weeks to become adjusted to its new surroundings before any experiments were carried out. Small fishes, toads and insects were available as food, but the crocodile was not observed to feed. The water in the pond was about 3 inches deep and the crocodile had access to dry land in the form of piles of bricks, between which the toads normally secreted themselves. It never left the water during the daytime although it sometimes crossed from one part of the pond to another during the night.

The second crocodile was considerably larger, and measured about 6 feet in length. It was trapped in a fisherman's net in the Nile near Omdurman during November, 1961, and housed in a large circular pool, about 15 feet in diameter, in the grounds of the Sudan Natural History Museum. Again, three weeks were allowed to elapse before any experiments were undertaken. Although offered food in the form of living and dead fishes and raw meat, the animal did not feed at all until mid-April, 1962, from which date it ate a quantity of fish. On occasions, this crocodile would leave the water and bask on the cement side of the pool, as described below.

## Methods

Activity was measured by means of a simple aktograph apparatus. This consisted of a corked tube, partially filled with water, which acted as a float and was connected by a thread to a lever writing on a clockwork kymograph drum revolving once per week. Distinct movements of the crocodile, resulting in vertical strokes on the smoked record, were analysed over 3-hour periods and plotted as block histograms (Fig. 1 Nos. 1 and 2). During experimental periods, the temperature and relative humidity of the air at the edge of the pool were noted by means of a recording thermo-hygrograph. In later experiments, the temperature of the water was taken with a mercury thermometer at frequent, but irregular intervals throughout the 24 hours. The majority of experiments were unsuccessful, either because the crocodiles became entangled in the cotton thread attached to the float, knocked the apparatus into the water, or obliterated the kymograph records before they could be analysed. Nevertheless, it was often observed that they did not differ noticeably from the records that were obtained and which are therefore representative of more extensive data that was not recorded. The basis of selection of data for presentation in Nos. 1 and 2 was that these were the most perfect 5-day records.

## Results

Some typical results are given in Nos. 1 and 2, from which it can be seen that the individual crocodiles did not show a particularly well marked rhythm of activity as compared with

many other animal species. When activity was averaged over a period of several days, however, (Nos. 3 to 6) a 24-hour periodicity of activity and rest became apparent with a peak in the early hours of the evening.

Nos. 3 to 6 show the activity rhythm of the crocodiles, both in cooler weather (Nos. 3 to 5) and during a hot spell (No. 6) during which the official day temperature in Khartoum reached 44°C. (111°F.) while the air temperature recorded beside the pool was considerably higher—52.5°C. (126°F.). During the latter period, the rhythm became less marked than during cooler weather.

During the experimental periods, the smaller crocodile never left the water to bask on land in daytime. The larger animal did so on one day out of 7 during the month of November, on 6 days out of 15 in January and not once during the 10 hot days in March.

## Discussion

The results quoted above are comparable with Cott's (1961) observations. Temperatures in

Uganda and Rhodesia are generally cooler than those that occur in the Sudan. Cott gives mean water and air temperatures (in the shade) recorded at Murchison. These varied between 23.5° to 25.0°C. and 18.7° to 29.3°C. respectively. The water and air temperatures in January at Khartoum, when the larger crocodile several times left the water, varied between 13.5° to 17.5°C. and 17.5° to 24.0°C. respectively. During March, when the larger crocodile did not haul out on land, they averaged 19.0° to 27.0°C for water and 21.0° to 52.5°C for air (in the shade). Consequently, it appears that the optimum air temperature for crocodiles lies above about 24.0°C and probably well below 50°C.

According to Cott (1961) the early morning basking of crocodiles plays an important role in restoring heat lost during the night. The exodus to land begins before the air temperature has risen to that of the water they have left. Nevertheless, the time of the early morning haul out apparently depends to some extent upon

weather as it occurs later on cool days. It is suggested that crocodiles bask until the body temperature has been raised to a point near the upper limit of the normal activity range, after which they crawl into the shade, lie at the water edge or enter the water and so dissipate heat. The cloacal temperatures of crocodiles recorded immediately after they had been shot—under widely different conditions and by day and night—showed a mean temperature of 25.6°C with a range of 6°C, with fluctuations from the mean of +3.4°C and -2.6°C.

A further experiment with the larger crocodile was begun in May, 1962, when the official air shade temperature in Khartoum exceeded 47°C (117°F). During a period of two days no clear rhythm of activity was observed. Then a sand storm ('haboob') blew up. During the night the crocodile, which had eaten a number of small fishes that morning, broke out of its cage and wandered down the

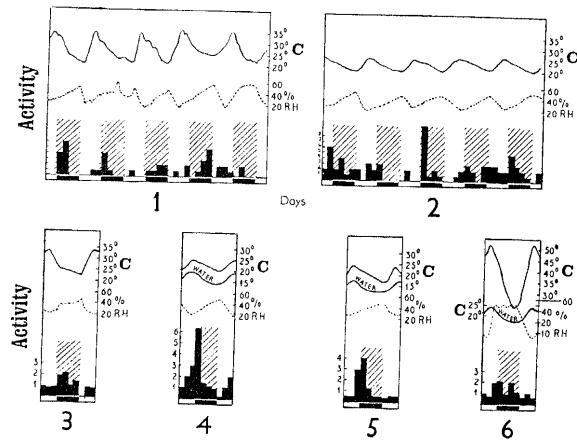


Fig. 1. Nos. 1-6. Rhythmic activity in the Nile crocodile. Ordinates: activity on the left, air temperature, water temperature and relative humidity (broken line on the right). Abscissa: time in days. The black strips below the histograms represent 12-hour periods from 18.00 to 06.00 hours. 1. Part of typical record of 2-ft. crocodile in October, 2. Part of typical record of 6-ft. crocodile in November, 3. Mean activity of 2-ft. crocodile over 5 days in October, 4. Mean activity of 6-ft. crocodile over 7 days in November, 5. Mean activity of 6-ft. crocodile over 15 days in January, 6. Mean activity of 6-ft. crocodile over 10 days in March. Further explanation in the text.

main street causing consternation among the populace. The police were summoned and shot it. During July, 1960, a 10 foot crocodile walked at least a mile from the White Nile to the Mogren goods station in Khartoum where it was found the following morning and also shot by the police. More recently a large crocodile has crawled out of the Blue Nile and entered the precincts of the Ministry of Foreign Affairs. It seems, therefore, that crocodiles show a tendency to wander far from water at night.

#### Summary

By means of a simple kymograph consisting of a float attached to a needle writing on a kymograph drum, it has been shown that the Nile crocodile exhibits a weak diurnal rhythm of activity. When the results of several days are averaged the periodicity becomes more apparent, with a peak in the early hours of the evening.

The rhythm is less marked in hot than in cooler weather. Crocodiles show a greater tendency to haul out of the water and bask in the sunshine on days when the air temperature lies above about 24°C than in cooler or hotter weather.

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