Koedoe 27: 147-149 (1984)

PLASMA TESTOSTERONE LEVELS IN RELATION TO MUSTH IN THE MALE AFRICAN ELEPHANT

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A long-term study of the behaviour and ecology of the African elephant *Loxodonta africana* was begun in the Addo Elephant National Park in 1976. During the period June 1976 to March 1979 regular observations were made on all animals. Every individual elephant could be recognised (the population was less than 100 animals) and every individual was seen several times a month. From the start of the study records were kept of whether the temporal gland was secreting or not for every animal at every observation. It soon became apparent that secretions from the temporal gland in females occurred during excitement, stress of social interactions with higher-ranking animals, and competitive situations such as around drinking troughs (there being no natural water supplies in the park). This was not the case with males as temporal gland secretion was limited to only two bulls initially; these were the highest ranking and second ranking males in the population. Periods of temporal gland secretion in these males were accompanied by increased aggression, longer and more continuous movements through the limited park area and more time spent with breeding herds. There was also a constant dribbling of fluid from the penis with frequent small urinations with the penis sheathed rather than the less frequent, larger volume urinations with the penis extruded which was typical of all other bulls.

This phenomenon in these two adult males was recognised as the condition of musth which is well known in the Asian elephant *Elephas maximus* (Jainudeen, Katongole & Short 1972, *J. Reprod. Fert.* 29: 99-103) and has only recently been described as occurring in the African elephant (Poole & Moss 1981, *Nature* 292 (5826): 830-831). Jainudeen *et. al.* (1972) showed that plasma testosterone (T) levels in the Asian elephant were low (0,2 to 1,4 ng/ml) when there was no sign of musth; during the onset of a musth period T levels rose (4,3 to 13,7 ng/ml) and when the animals were in full musth the

levels were extremely high (29,6 to 65,4 ng/ml). As the behaviour of the Addo bulls seemed similar to that of Asian bulls in musth a one-off operation was conducted in June 1979 to compare plasma T levels in Addo bulls at different phases of the musth cycle.

Three bulls of known hierarchical status were included in the sample (Table 1), only one of them, M2 experienced musth periods. Observations made a few days prior to the darting operation indicated that he was approaching the end of a musth period. Though his temporal glands were still secreting his penis was no longer dribbling and his legs were dry. The penis sheath, however, was still the grey/white colour which is typical at the time of musth. His age was established after his death in 1982 using the method of Laws (1966, *E. Afr. Wildl. J.* 4: 1-37). The ages of the other two animals were estimated by comparisons of body size confirmed by measurements at the time of darting. At the time of the operation M2 was the dominant of 14 sexually mature males in the park, M4 was subservient to M6 and three other bulls in the park. The bull M6 was subservient to M2 and the other musth bull; but his age, size and behaviour suggested that he might have been in a pre-musth condition.

These three elephant bulls were immobilised using Etorphine hydrochloride (M99 – Reckitt). Blood samples were drawn from an ear vein and transported to a nearby laboratory. The samples were centrifuged, whereafter the plasma was frozen at –20 °C. Plasma samples were shipped to the laboratories of the South African Institute for Medical Research in Johannesburg for testosterone determinations using standard radioimmunossay techniques.

The results (Table 1) indicated a close parallel to the situation found in the Asian elephant *i.e.* there is an increase in plasma T levels as the African elephant bull approaches musth with the highest level of 19,80 ng/ml in the musth bull. That plasma T levels may also be correlated with, or are responsible for hierarchical status as exhibited in the male-male rank order of the three subjects, is also suggested by these results.

Table 1

Plasma testosterone (ng/ml) levels from Addo elephant bulls

Bull	Age yrs	Rank	Musth state	T	Free-T
M4	23	Low – 6th	Non-musth	3,48	0,45
M6	26	High – 3rd	Non-musth	9,47	1,14
M2	30	Dominant	Musth	19,80	2,97

Other workers have reported findings which strengthen the above conclusions. Rasmussen, Buss, Hess & Schmidt (1984, *Biol. Reprod.* 30: 352-362) also showed that serum T concentrations in Asian elephant bulls increased with the onset and development of musth. They reported plasma-T-values for two bulls of 1,84 – 5,35 ng/ml in non-musth condition, increasing to 19,20 – 21,00 ng/ml in moderate musth and 40,00 ng/ml when in heavy musth. For

a series of African elephant bulls they reported a range of 0,38 – 0,68 ng/ml for five animals which were 14 – 30 years old, with a value of 6,64 ng/ml for a single 25 year old animal. They reported that this animal had been recognised in the field as a high ranking animal and suggested that high T levels could be correlated with aggression and dominance rank. Poole, Kasman, Ramsay & Lasley (1984, *J. Reprod. Fert.* 70: 255-260) found that urinary testosterone concentrations were significantly greater in African elephant males that were in or close to musth than those not in musth.