PRENATAL DEVELOPMENT OF THE IMPALA *Aepyceros melampus*. LICHT.

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INTRODUCTION

The use of growth curves is a convenient means of establishing the age of an animal where some measurements can be taken on the specimen. This is especially true in the case of the foetus, as in the prenatal state growth is not greatly influenced by external factors, and is therefore reasonably constant for a given species.

Where foeti can be accurately aged, it greatly facilitates the determination of important events, such as the breeding season, usually with greater accuracy than can be achieved by field observation.

In the Kruger National Park a large number of Impala foeti are currently available, and these have been used to provide some criteria whereby the foetal age may be determined.

MATERIALS AND METHODS

GENERAL

A total of 379 Impala foeti were utilised in this study. They were collected at weekly intervals throughout the period of gestation from ewes destroyed in culling operations during 1966 and 1967.

The first measurable foeti were considered to be four weeks old. This estimation was based on the observation of corpora lutea in the ewes and on figures quoted for merino sheep by Cloete (1939). The end of gestation was determined when the average weight exceeded 5,000 grams, which is the average birthweight determined locally.

The gestation period determined in this manner is 196 days and agrees with the figure published by Brand (1963). It is considerably higher, however, than the 150-170 days quoted by Kenneth and Ritchie (1953).

MEASUREMENTS

The smaller foeti were fixed in formalin and measured subsequently at a convenient time. During the first year of the study period the same procedure was followed with the older specimens. Foeti older than 12 weeks in the 1967 sample were measured in the fresh condition.

An electrical balance was used for specimens weighing less than 800 grams while heavier foeti were weighed on a spring balance measuring to one-tenth of a pound: the weights obtained were then converted to grams.

Length was measured from the base of the skull to the root of the tail along the body curve, shoulder height at right angles to the body from the tip of the hoof to the highest point of the shoulder and heart girth directly behind the shoulder.

ANALYSIS

Weekly averages were computed for each measurement and confidence limits determined using students t distribution according to Snedecor (1965).

RESULTS

MEASUREMENTS

The weekly averages for each measurement are presented together with their confidence limits in Table 1. It may be seen that the same tendency is evident in each measurement for any particular week. During some weeks the measurements were smaller than those of in the preceding period. This undesirable feature is to be expected when averages of small samples are used but is offset by the fact that in other cases the figures are obviously too high.

In figures 1 and 2 arithmetic growth curves are fitted to the data for weight and length. From figure 1 it is evident that the increments in weight are of such magnitude as to make the plotting of one graph for the whole period impractical and therefore it has been drawn from 10 weeks.

PREDICTION EQUATIONS

In an attempt to derive equations for the growth curves the data were transformed logarithmically. The fitting of straight lines was, however, not particularly successful. Growth appeared to be devided into two periods, separating at about 10 weeks.

Huggett and Widdas (1951) derive a formula for the prediction of age from mammalian foeti of known weight according to the formula: $W^{\frac{1}{3}} = a(t-t_o)$ where weight is W, a is the specific foetal growth velocity, t_o is the intercept of the line on the time axis and t is time in days.

Using the criteria they developed for determining a, and t_o on the present data the formula for impala reads $W^{\frac{1}{3}} = 0.11\ (t-39)$. This equation gives satisfactory prediction in weekly intervals.

TABLE I

WEEKLY AVERAGE WEIGHTS AND BODY MEASUREMENTS OF IMPALA FOETI

Week	N*	Weight	CL**	Length	CL	Shoulder height	CL	Heart Girth	
4	11	0.4	± 0.12	1.5	± 0.07				
5	5	1.9	± 1.9	2.3	± 0.8				
6	16	2.9	± 1.1	3.0	± 0.1				
7	13	12.2	± 3.9	5.1	± 0.5	2.9	± 0.5		
8	4	10.6	± 8.3	5.0	± 1.7	3.5	± 1.1		
9	10	28.9	± 9.0	7.5	± 1.1	5.6	± 0.5		
10	18	45.4	± 10.6	8.5	± 0.7	6.7	± 7.5	7.5	± 0.5
11	6	56.5	± 9.0	9.6	± 0.6	7.6	± 1.0	8.2	± 0.5
12	43	105.8	± 2.4	11.0	± 0.6	9.7	± 0.7	10.0	± 0.6
13	15	111.0	± 24.5	11.6	± 0.7	9.9	± 1.0	10.2	± 0.8
14	22	150.6	± 60.0	15.7	± 1.2	13.7	± 1.1	13.2	± 0.9
15	18	320.8	± 70.0	18.2	± 1.6	14.3	± 1.3	13.7	± 1.4
16	16	395.0	± 65.0	19.5	± 0.9	17.4	± 1.3	15.3	± 1.0
17	10	340.0	± 64.5	18.5	± 1.2	15.7	± 0.8	15.3	± 1.5
18	9	855.0	± 150.0	23.6	± 1.9	21.3	± 1.5	19.4	± 1.2
19	21	852.0	± 102.0	25.6	± 2.9	21.9	± 2.2	19.5	± 2.0
20	20	1245.0	± 152.0	28.0	± 1.5	22.7	± 2.5	17.7	± 1.3
21	20	1430.0	± 113.0	30.0	± 1.5	28.9	± 1.1	24.1	± 0.8
22	33	2150.0	± 114.5	34.0	± 0.6	35.4	± 0.8	25.4	± 1.0
23	14	1881.0	± 171.0	37.4	± 1.1	33.7	± 2.8	27.1	± 1.9
24	18	2335.0	± 194.0	35.4	± 1.4	38.8	± 1.4	27.3	± 1.2
25	15	2739.0	± 432.0	40.1	± 1.3	40.2	± 2.5	29.5	± 2.2
26	15	3105.0	± 425.0	41.5	± 2.8	42.4	± 1.8	29.3	± 2.3
27	5	4160.0	± 83.4	44.6	± 2.8	48.5	± 2.6	32.9	± 3.7
28	2	5370.0	± 36.0	49.9	± 2.6	49.4	± 1.7	33.9	± 0.0

* The number of specimens per sample.

** Confidence limits at $p = 0.05$.

MORPHOLOGICAL CHARACTERISTICS OF FOETI AT DIFFERENT AGES

Certain external morphological characteristics become evident in the developing foetus and can be usefully applied in determining age. These are presented in chronological sequence below.

Age	Description
3 weeks	Embryo translucent. Heart and aorta visible. Limb buds visible. Neural canal open. Tail formed.

	Description
4 weeks	Embryo whitish, acutely bent. Heart ± 3 mm. internal bloodvesels evident. Limb buds clearly formed. Eye just visible as a thin black ring.
5 weeks	Body plump and opaque. Limb buds well formed and digits evident. Most facial features formed, mouth is open and ear flaps are evident. Eye is a definite black ring with translucent centre. Nostrils are evident. The visceral area protrudes to give the embryo a herniated appearance.
6 weeks	Little change in relative proportions. Heart and abdominal bloodvessels no longer visible. Proliferation of subcutaneous blood vessels begins. The genitalia are just evident.
7 weeks	Mature form now evident, visceral area no longer protrudes and neck is clearly formed. The cranial part of the head is still exaggerated, the mouth is closed and the nostrils perfectly formed. The black eye ring is becoming dulled and the first indication of eyelid formation is apparent. The genitalia are now differentiated, scrotum is formed in the male and four white dots represent the mammae in the female.
8 weeks	Body proportions nearly normal, the head is still large in proportion to the rest of the body. Eyelid formation is clear but eye ring is still visible. The follicles of the tactile hairs are visible on the eylids and above the lips.
10 weeks	Body is more plump. Pigmentation of the nose and skin of nasal region is just visible.
12 weeks	Pigmentation proceeding over whole face but not pronounced except in region of nose and nasal skin.
14 weeks	Pigmentation reaches crown of head but ears are not yet affected. Lips are white, nose clearly black, or white marks above eyes are evident. Eyes are no longer visible through eyelid. Horn buds are discernable in the males.

	Description
16 weeks	Pigmentation of face is complete and reaches down the neck. Pigmentation pattern of body is faintly visible. Tactile hairs are just evident. The tarsal gland region is discernible.
18 weeks	Pigmentation more complete, pigment also evident in hooves. Tactile hairs clearly visible. Tarsal gland area clearly demarcated.
20 weeks	Pigmentation pattern now complete. First body hair visible on crown, in ears, behind shoulder, on the tail and around the hoof crown.
22 weeks	Hair growth more distinct on previously mentioned areas, it is also evident over the rest of the body except the skin covering the lateral aspects of the buttock, shoulder and the lower limbs.
24 weeks	Hair covering of body complete except in carpal, metacarpal and tarsal metatarsal regions. Tarsal gland is pigmented and hair is evident. Incisor teeth have erupted.

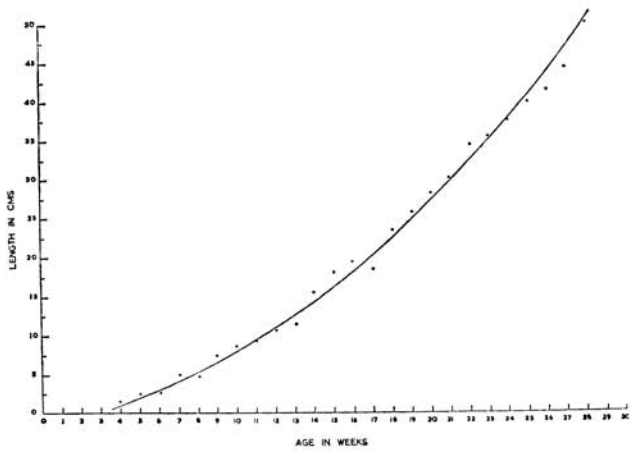

Fig. 1. *The growth in weight of the impala foetus.*

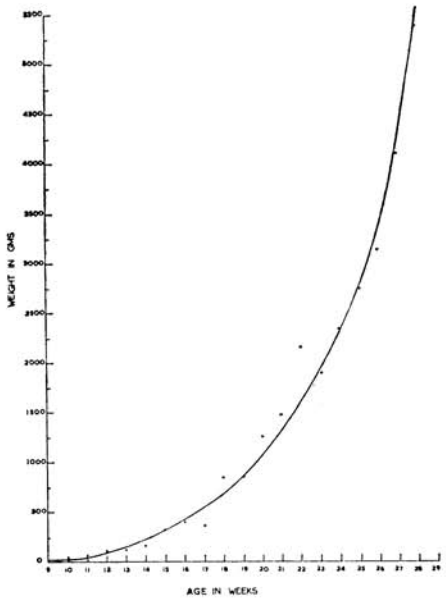

Fig. 2. *The growth in length of the impala foetus.*

DISCUSSION

In view of the fact that the absolute length of the gestation period is not known and averages have been used in deriving the growth curves, the accuracy of the figures may be questioned. Two checks for accuracy were available however, namely the calculation of the data separately for the two periods, and a comparison with the theoretical straight line equation of Hugget and Widdas (1951).

In the first instance the weight and length data for the two years were compared, in the case of body measurements there was no significant difference. The weight of the unfixed foeti of the second group was however consistently higher than the formalin fixed first group. This weight difference was not significant and for the purpose of this paper the results obtained for the two periods were pooled in all the calculations.

To apply the second test, weights were read from the growth curve for each week and age determined according to the formula. In each case the predicted value corresponded with the age in weeks. The data may therefore be considered to satisfy the limits of accuracy according to these two tests.

Neither of these procedures however provides an indication of the accuracy of the gestation period assumed* as this figure is an integral part of the calculations. It is however considered that the method used in

determining the gestation period should be accurate to within one week, and therefore the overall accuracy should be within the confidence limits presented in Table 1.

Cloete (1939) concludes from his study of prenatal development in the sheep that length of the vertebral column is the best single measurement to use in this type of study, his measurement includes the tail. In the present work tail length was not taken into consideration, it is nevertheless evident from the results that this is still the best measurement to use. The confidence limits are more satisfactory and the curve applies over a longer range in time.

Where more than one measurement is possible, it is suggested that all measurements as well as morphological data be used in age determination.

SUMMARY

The growth of the Impala foetus was investigated by weighing and measuring 379 foeti at weekly intervals. The average weights and measurements for each week are tabulated and growth curves for weight and length are presented together with a cronological description of changes in the external morphology.

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* Since writing the gestation period has been confirmed in two captive animals.