MAMMAL FAUNA

The earliest contributors to information on the mammal fauna of Ngamiland and the peripheral Okavango Delta areas, comes from the published accounts of naturalist/hunter/trader missionary visits to Lake Ngami and its environs during the 1850's to 1860's (See HISTORY). Although none penetrated the actual study area, their accounts of previous large mammal distributions are of great value.

Up until the early 1900's various naturalist/hunters contributed minor written accounts of value, notably Selous (1881), Bryden (1893), Baldwin (1894) and Schultz and Hammar (1897), but again they only covered peripheral Delta areas. Following these accounts were Dollman (1910), Stigand (1923), Ellenberger (1931), Naus (1933), the Vernay-Lang Kalahari expedition of 1930 with results described by Roberts (1935) and Hill (1942); Davis (1946) and Pole-Evans (1948). Only Stigand, Ellenberger and Naus penetrated parts of the study area.

After this period, contributions were made by various members of the Smithsonian Institution, Washington, D.C. and the Mammal Research Unit, University of Pretoria; the Government Departments of Tsetse-fly Control, Veterinary Services and Wildlife and National Parks; as well as Safari and Taxidermy Companies and their staff, and the United Nations Development Programme (BOT. I) Survey 1972, either in published form, Departmental reports or personal communications.

The most comprehensive contributions came from Tinley (1966), Smithers (1971), Robbel and Child (1976) and the present FAO/UNDP Survey (1976).

Methods

Large and small mammals were recorded in the study area by direct observation, aerial survey, trapping and limited collection by shooting of some species. In some instances sight records were obtained from reliable persons resident in the study area, or from guides who were resident in the past in parts of the study area. Species not covered by aerial census population estimates were classified as rare, common or abundant according to observations during the study period.

Aerial survey utilised the method described by Jolly (1969) and referred to as "Jolly 3" – "Equal or unequal size units, selecting with probability proportional to size". This involved the use of a fixed high-wing aircraft, flying fixed units or transects and censusing a fixed strip width of 300 m; either on one but usually on either side of the aircraft flying at an altitude of 90 m and a speed of 112 to 128 km/h.

The total area censused embraces 1 812 km^2 and showed three distinctive zones governed by flooding pattern. These three zones were strip-census sampled individually, viz., the Eastern or M'borogha floodplains (670 km^2); Chief's Island and the associated northern islands (790 km^2) and the Western or Boro floodplains (352 km^2) (Table 21). The units to be sampled in any zone were selected by random pairs of co-ordinates within a grid totally embracing each zone. Only when a random point fell within one of the zones was it used for that zone. Any points outside the area, but within the grid, were discarded. This method was continued until sufficient transects were obtained for each zone in an attempt to obtain a more or less 20 per cent sample of the zone whilst remaining within the economic limitations of the excercise.

As a point fell within a zone, it was extended to the edges of that zone at right angles to the main axis of Chief's Island. Any subsequent random point on any existing line within a zone, simply allowed that unit to be used twice in the subsequent statistical treatment without the transect or unit being flown twice.

Following "Jolly 3" population estimates were computed from the following formulae:

$$\hat{Y} = \Sigma Z_i \bar{d}_i$$

$$\text{Var } \hat{Y} = \Sigma \frac{Z_i^2}{N_i} \; Sd_i^2$$

$$Sd_i = \frac{1}{N_i - 1} \left\{ \Sigma d_i^2 - \left(\frac{d_i^2}{N_i} \right) \right\}$$

where

$\hat{Y}$ = estimated population of animals

Z_i = total area of stratum i

$\bar{d}_i$ = average density of animals per unit area in particular transect of stratum i

Var $\hat{Y}$ = variance of the estimate

N_i = number of transects in stratum i

d_i = number of animals per transect unit area (= density/transect sampled)

Table 21 – Area, (km^2) number of transects and percentage of zone sampled in aerial strip survey for the study area, Okavango Delta, Botswana, 1973/74.

STRATUM	AREA	NUMBER OF TRANSECTS*	PERCENTAGE OF AREA SAMPLED	
			One observer	Two observers
Eastern floodplains	670	14	10,26	20,52
Chiefs' Island	790	18	7,80	15,60
Western floodplains	352	26	17,41	34,82
TOTAL	1 812	58	35,47	70,94
Average	604	19	11,82	23,64

*

Note: Each stratum has one doubled up unit.

and where: the standard error of $\hat{Y}$ = Var $\hat{Y}$ = SE
the 95 per cent confidence limit of $\hat{Y}$ = $\hat{Y} \pm (1,96)$ (S.E. $\hat{Y}$.)

Navigation was done by pilot and navigator from a 1:250 000 map with plotted transects by observation and magnetic bearings. The aircraft was marked for strip width following the method of Pennycuick and Western (1972) from the formula:

$$W = \frac{Wh}{H}$$

where
- w = Strip width on ground aircraft stationary (m)
- W = Strip width from air at H (m)
- h = height of observer's eye above ground with "aircraft stationary in flying attitude" (m)
- H = altitude above ground when flying (m)

The advantages of strip census over total census eliminates errors due to navigation and orientation – Grimsdell and Bell (1972a).

For the aerial survey conducted specifically on red lechwe in the conserved and adjacent areas a 2 x 2 km square grid was drawn up covering the total area to be surveyed. Transects were flown through the mid point of each 2 km block. The other flying and surveying conditions were exactly the same as before.

Results for this survey had to be calculated on the basis of "Jolly 2" – unequal sized units using the ratio method (Jolly, 1969), from a programme drawn up for an Olivetti Computer (Programma 101 P.203).

The population estimate is derived from

$$\hat{Y}_2 = \frac{\hat{Y}_1}{z_1} Z$$

Where

$\hat{Y}_1 = \sum_i N_i \bar{Y}_i$

N_i = total number of units in the i^{th} stratum

$\bar{Y}_i$ = average number of animals per unit over the n_i units samples

z_i = area of the i^{th} unit

Z = total area under survey

$$\text{Var } \hat{Y}_2 = \sum_i \frac{N_i (N_i - n_i)}{n_i} \quad (sy_i^2 - 2\hat{R}szy_i + \hat{R}^2 sz_i^2)$$

in which

$$\hat{R} = \frac{\hat{Y}_1}{\hat{Z}_1}$$

and

$$szyi = \frac{1}{n_i - 1} \left\{ \Sigma z_i y_i - \Sigma \frac{(\Sigma z_i)(\Sigma y_i)}{n_i} \right\}$$

and where Standard Error of $\hat{Y}_2$ = Var $\hat{Y}_2$

and the 95 per cent confidence limit of $\hat{Y}_2$ = $\hat{Y}_2 \pm (1{,}96)$ (SE $\hat{Y}_2$).

Trapping of small mammals involved the use of snap traps ('Museum special' breakback traps), Sherman live traps, and 'Macabee' traps for mole rats. Collection of bats and some of the larger small mammals was by means of a 12-Gauge shotgun.

Recorded data included mass and standard measurements in accordance with Smithers (1971), date, time, reproductive data and habitat type. Measurements are all in millimetres and include total length (TL) this being the length from tip of nose to last caudal vertibra of tail. In small mammals this is taken with the mammal lying ventrally and extended along the tape, whereas in large mammals the tape is extended from the tip of the nose and follows the central dorsal midline along the natural curvature to the last caudal vertebra. Length of the tail (T) is from the base of the tail to the last caudal vertebra. The length of hind foot (Hf) is the measurement taken from heel (or hock) to the end of the longest digit including nail hoof or claw ie. "cum ungue". Ear (E) is the straight length measured from the notch to the furthest extremity of the cartilage of the ear excluding hair or ear-tufts as the tip. The Mass is obtained from freshly killed weighing of mammals expressed either in Kilograms (large mammals) or grams (small mammals).

Salter hanging spring-scales of 0-200 Kilogram and 0-1 000 pounds were used for large mammals whilst an Ohaus triple-beam balance weighing up to 2 610 gram was used on small mammals.

The length of forearm (F/a) for Chiroptera only was measured from the end of the ulna to the end of the carpus.

Where foetuses were present crown rump (CR) measurements were taken, this being the straight distance between cranium and base of tail with the foetus in natural position as removed from the uterus. The mass of the foetus was recorded in grams with the umbilical cord severed at the body of the foetus. The position and number of foetusses were recorded from all pregnant females collected. For larger mammals collected condition indices based on Riney (1955) were obtained. This involved kidney fat index, back fat index, abdominal fat index and marrow index. Batcheller and Clark (1970) fault Riney's (1955) work on kidney fat index since they maintain that kidney mass fluctuates seasonally. This fluctuation in kidney mass was not accounted for in the present work. The visual method of determining physical condition in large mammals as developed by Riney (1960) and further verified by Child (1968a) was abandoned since it is only really valid in extreme cases and not well suited in assessing wild African ungulates.

Ten lechwe were captured by darting from a helicopter and marked with "sterkolite" collars and ear tags during October 1974 to facilitate movement studies during 1975 in the lower Khwai area (Table 22). Attempts were first made to herd groups of lechwe into an "Oelofse Plastic Kraal" (Oelofse, 1970; Densham, 1974) with the helicopter. Four lechwe were successfully herded into the kraal but showed no fear of the plastic 'walls' and escaped. Due to the severe reaction and non-recovery after antidote administration on the first individual (Table 22), the tranquilising agent was excluded in all subsequent attempts and the immobilising agent or analgesic M99 was used on its own. Care has to be exercised since lechwe often became immobilised in the water. No lechwe were known to have died as a result of the exercise. A single barrel Palmer Cap-chur gun using 0,22 "Ramset" medium and heavy charges and 5 ml dart syringes were used throughout.

All collected foetuses were weighed and conception and parturition dates were calculated according to the formula of Huggett and Widdas (1951).

Table 22 – Drug immobilisation data for lechwe darted and marked on the lower Khwai River floodplain, Okavango Delta, Botswana, October 1974.

DAY	COLLAR NUMBER	EARTAG NUMBERS		SEX	DRUG DOSAGE IN MILLGRAMS			REACTION TIME (MINUTES)	
					Analgesic: Etorphine hydrochloride	Neuroleptic Rompun	Antagonist: Nalorphine hydrobromide	Immobilisation	Recovery
5	1	1797	1798	M	2 + 2*	100 + 100	6 + 5	*	*
7	11	–	–	M	2,5	–	10	7,5	1,0
7	13	–	–	M	2,5	–	10	7,0	0,5
7	15 **	1757	1758	M	2,5	–	10	7,5	1,0
7	10	1759	1760	F	2,5	–	10	8,0	1,0
8	2	1737	1738	F	2,5	–	10	7,5	2,0
8	4	1739	1740	F	2,5	–	10	8,0	1,0
9	3 ***	1779	1780	M	2,5	–	10	7,0	1,0
9	6	1769	1770	F	2,5	–	10	8,0	1,0
9	5	1789	1790	M	2,5	–	10	7,5	1,0

* No reaction after 12 minutes, thus darted for a second time. Lechwe down but up again and eventually caught by hand. Only recovered after 5,5 hours and added treatment.

** Same group as number 10 when captured.

*** Same group as number 6 when captured.

$$t = \frac{W^{1/3}}{a} + t_o$$

Where t = post-conception age (days)

t_o = constant (dependant on average birth mass and gestation period for any particular species)

W = mass of foetus

a = foetal growth velocity

and a is established from $a = \frac{W^{1/3}}{t-t_o}$

using W = mean mass of foetus at birth

t = full gestation period

Results

A total of 63 mammal species were recorded within the actual study area boundaries. Doubtless more smaller mammals exist than are recorded.

The outline of classification used in this work follows Smithers (1971) whose work is based on Ellerman, Morrison-Scott and Hayman (1953) with some exceptions where Smithers followed the 'Preliminary Identification manual for African mammals', Smithsonian Institution, Washington D.C. (1966) now revised to 'An Identification Manual' (Meester and Setzer, 1971).

The orders Insectivora, Chiroptera, Primates, Pholidota, Carnivora, Tubulidentata, Proboscidea, Perissodactyla, Artiodactyla, Lagomorpha and Rodentia were represented; thus only Hyracoidea being absent. Each species is dealt with independently giving distribution and status, movement patterns, habitat requirements, feeding behaviour and general behaviour patterns. For the larger more common species where numerous observations and limited collection of individuals was carried out, further parameters of population structure, physical condition and breeding biology are given. Seasonal population estimates from aerial surveys are given for the larger mammalian species. Some internal and external parasites are recorded from specimens collected and identified by Onderstepoort Veterinary Research Institute, Pretoria[x] (internal and external parasites) and the South African Institute for Medical Research, Johannesburg* (external parasites.)

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*P.O. Box 1038, Johannesburg, South Africa.

Small mammal identifications were confirmed by preserved specimens or study skins sent to the National Museums of Rhodesia, Salisbury** and to the South African Institute for Medical Research, Johannesburg.* This does not preclude that mammals not occurring on this checklist are absent from the study area. It is only presumed that they are absent. Where possible, comparable data are given for adjacent areas either from other works or from my own observations.

Order Insectivora

The only insectivores found present during this study were some members of the Soricidae (Shrews), all being of the genus *Crocidura.*

Crocidura flavescens (I. Geoffroy, 1927)
Giant Musk Shrew.

Fairly widely distributed along the immediate verges of the mid-Boro River but none were captured on the verges of similar Outlet or Middle Channel Communties of the eastern floodplains. All specimens were captured during 1973 in extreme low flood conditions when this would have been the only suitable habitat available. Smithers' (1971) only records are for the Upper Okavango and Chobe Rivers and the mid Khwai River. Thus *C. flavescens* appears to be spreading southwestwards down the Delta, although Smithers' work was not concentrated in this study area.

Movement appears to take place as during high flood conditions of 1974 none were captured from localities where they were previously taken. It inhabits the fringes of well-watered areas in tall grass and sedge cover on the verges of Upper, Middle and Outlet Channel Communities. Meester (1963) reports captive species to be carnivorous on small mammals, birds, amphibians, reptiles and invertebrates.

Predominantly nocturnal as all specimens were captured at night, although Smithers *(op. cit.)* reports captures during daylight hours. No breeding data are available for Botswana.

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SIZES AND MASS

Male

TL = 218 mm; T = 81 mm; Hf c/u = 23 mm; E = 9 mm; Mass = 40,7 g; N = 1.

Females

TL $\bar{X}$	=	215;	N	=	8;	Range	196 – 230
T $\bar{X}$	=	80;	N	=	8;	Range	71 – 85
Hf c/u $\bar{X}$	=	23;	N	=	8;	Range	22 – 25
E $\bar{X}$	=	11;	N	=	8;	Range	10 – 13
Mass $\bar{X}$	=	46,72 g;	N	=	5;	Range	37,4 – 63,4 g

External parasites
(Acarina)
Haemaphysalis sp.
Dermacarus sp.
Eadiea crocidurae (Lawrence, 1951)
Laelaps sp
Ornithonyssus bacoti (Hirst, 1913)

Crocidura bicolor woosnami Dollman, 1915.
Tiny Musk Shrew

This shrew appears to be localised and probably does not occur in abundance. Only one male specimen was trapped at night in *Acacia tortilis* Savanna Woodland about 200 m from the verge of the floodwater extremity.

The subspecies is doubtful as conflicting material was described by Meester (1963) and Smithers (1971) from the Okavango region.

Smithers *(op. cit.)* reports the subspecies as showing a wide habitat tolerance, being mainly nocturnal but to some extent diurnal and insectivorous. No breeding data are available.

SIZE AND MASS

Male

TL = 107; T = 39; Hf c/u = 10; E = 8; Mass = 5,4 g, N = 1.

Crocidura mariquensis shortridgei St. Ledger, 1932
Black Musk Shrew

These shrews are fairly common and fairly widely distributed in the floodplain systems, but appears more common on the Western floodplains. Four specimens were captured during daylight hours and 22 at night, all in the ecotonal areas between Middle Channel or Outlet Channel Communities and Closed Riverine Woodland or Primary Floodplain Communities. Thus proximity of wet conditions and tall aquatic to semi-aquatic vegetation appear to be essential habitat requirements.

Black musk shrews are insectivorous and carnivorous, mainly nocturnal but also diurnal. Smithers (1971) reports gravid females from August to April with an observed range of two to five foetuses.

SIZES AND MASS

Males

TL	$\bar{X}$	=	136;	n	=	14;	Range	123	– 144
T	$\bar{X}$	=	55;	n	=	14;	Range	47	– 60
HF c/u	$\bar{X}$	=	15;	n	=	14;	Range	13	– 16
E	$\bar{X}$	=	7;	n	=	14;	Range	5	– 11
Mass	$\bar{X}$	=	9,1g;	n	=	8;	Range	7,2	– 10,0 g

Females

TL	$\bar{X}$	=	133;	n	=	11;	Range	122	– 141
T	$\bar{X}$	=	52;	n	=	11;	Range	47	– 60
Hf c/u	$\bar{X}$	=	14;	n	=	11;	Range	12	– 17
E	$\bar{X}$	=	7;	n	=	11;	Range	5	– 10
Mass	$\bar{X}$	=	8,8g;	n	=	7;	Range	7,9	– 10,6 g

External parasites

(Acarina)

Haemaphysalis sp.

Androlaelaps sp.

Ornithonyssus bacoti (Hirst, 1913)

(Anoplura)

Polyplax reclinata (Nitzsch, 1864)

Order Chiroptera

Few bats were collected due to lack of collection equipment and damage to collected specimens from a 12-Gauge shotgun.

Suborder Megachiroptera (Fruit Bats)

Epomophorus crypturus Peters, 1852

Peters' Epauletted Fruit Bat.

Commonly distributed throughout the areas of well-developed Closed Riverine Woodland in the study area, and similar areas of the Delta in general (Smithers, 1971). Movement appears to follow the abailability of fruit.

Found hanging during daylight hours in trees with dense foliage, especially *Garcinia livingstonei* and feed on the fruit of such as well as *Diospyros mespiliformis, Ficus* spp. and *Sclerocarya caffra.* No breeding records exist for Botswana (Smithers *op. cit.).*

SIZE AND MASS

Male

TL = 155; Hf c/u = 22; E = 26; F/a = 80; Mass 99,5 g; N = 1.

No female data are available as females were damaged extensively by the collection method.

Suborder Microchiroptera (Insectivorous Bats)

One specimen of the subgenus *Tadarida* was found dead in Closed Riverine Woodland, but due to decomposition the species could not be determined.

Order Primates

Family Lorisidae
Galago senegalensis bradfieldi Roberts, 1931.
Lesser Galago; Night Ape; mottwele.

Reported as fairly common throughout the Delta (Smithers, 1971); but nowhere fairly common in the study area. They occur mainly in Closed Riverine Woodland and Marginal vegetation types, and were recorded in these localities in the study area.

The subspecies is predominantly nocturnal, arboreal, largely insectivorous, and usually found occurring singly but occassionally in pairs. Smithers *(op. cit.)* suggests breeding throughout the year with one to two being the average number of foetusses present.

Family Cercopithecidae
Cercopithecus aethiops ngamiensis Roberts, 1932.
Vervet Monkey, Kgabo

Vervet monkey are fairly widely distributed on the margins of Chief's Island and the islands of the Boro floodplain system, but not common anywhere in the study area. On the M'borogha islands and floodplains, vervet monkey populations are low which can possibly only be attributed to the more permanent water levels and deeper channels of this eastern sector serving as a barrier to their expansion. The drier conditions of the lower-Delta areas show much higher vervet monkey populations and group size. Groups of 12 to 30 individuals were regularly encountered in the lower-Delta whereas a maximum of 15 in a group were found in the study area, only on isolated occasions. Movement seems localised and home ranges small.

Found to occur in all vegetation types except the aquatic vegetation types, and appears to display a dislike of wet conditions. Most commonly encountered on islands in Closed Riverine Woodland or Marginal vegetation types or *Sporobolus spicatus* Island Grassland, and Primary Floodplain Communities after seasonal inundation has ceased and the surface is dry.

The subspecies is diurnal and gregarious, but troops are small. None were found exceeding 15 individuals, but more commonly troops comprised seven to ten individuals. Vervet monkeys are predominantly vegetarian with the bulk of food material being made up of wild fruits and seeds. The abundance of fruit-bearing trees in the Closed Riverine Woodland should support higher vervet monkey populations. Termites and other insects were also observed to be fed on.

Juveniles were observed during most months and this suggests a non-seasonal reproduction for this sub-species which Smithers (1971) also suggests. Vervet monkeys give birth to a single juvenile, with no instances of twins observed.

Papio ursinus (Kerr, 1792)
Chacma Baboon, Tshwene

Widely distributed throughout the study area and commonly encountered. In some parts of the study area there appears to be an overpopulation of this species. Baboon utilise all the vegetation types, except aquatic vegetation types, but may be found utilising some of the latter communities during exceptionally dry seasons, viz. 1973. The particular plant community being utilised in time is dependent on food availability, and is thus tied up with flowering and/or fruiting of the various tree/shrub species, and with the recession of floodwaters in the floodplain vegetation types, viz. the heavy utilisation of almost dry or dry Primary Floodplain Communities.

Baboon move over a fairly small home range (5 to 6 km^2) in the study area due to the abundance of food. *(Borland **pers. comm.**). Daily movement patterns change with the availability of certain specialised food types, viz. when scale insect larvae (Coccidae) and pupae are present on *Colophospermum mopane* in August, September and October the baboon utilise this plant community heavily. During other seasons when scale insect is not available the *Colophospermum mopane* Woodland are not included in the daily feeding routine. Baboons show little fear of moving through shallow water and Child (1968a) reports that they readily take to water and are strong swimmers.

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*R. Borland, c/o Anglia Television, England.

The roosts (of which a troop may have more than one) are always located in Closed Riverine Woodland or dense marginal vegetation types. The general daily pattern was to come down from the roost shortly after light conditions prevail, and minor feeding then occurs in the roost area. They then move about slowly but feed opportunistically on their way to the major feeding area of that season. Copulation, playing and scolding may occur during progress to the site. Once reached dominance prevails over the most select feeding sites or the viance for such sites.

Baboons are vociferous and alert, and any potential danger always initiates warning barks during which time the females rapidly locate their young. During troop interaction for territory or home range, the subadult males do most of the 'performing shout' or bark (as opposed to warning), whilst adults often take to copulation.

After the main bout of feeding the baboons move towards water from 11h00 to 14h00, this usually presenting no problem in the swamp environment, where they drink and rest. Playing, copulation, nursing and scolding of juveniles by adults takes place. After this rest period at approximately 15h00 to 16h00 they again move, slowly feeding towards the roost which they reach towards sunset and enter such for the night.

The population is broken up into troops of various sizes but usually comprises 40 to 70 individuals in the study area. Stoltz (1977) reports troop sizes from the Northern Transvaal and eastern Transvaal lowveld to average approximately 40 individuals; thus showing fewer individuals comprising a troop when compared with the study area. A troop is made up of all age groups of both sexes but with a strict dominance hierarchy amongst the males. This dominance probably extends amongst the females as well; but is far less pronounced in constant expression, determination and maintenance of such. Stoltz *(op. cit.)* reports similar findings in Transvaal baboon troops. There appears to be an alpha dominant male, with several adult males of lower rank. Large males often chased non-oestrus females and treed them, only to give a characteristic bark and then leave the female; this being interpreted as a dominance show for other males. More dominant males often do the same to less dominant males. Single, large males were encountered on several occassions and would appear to be displaced old alpha dominant males. Stoltz *(op. cit.)* also reports single males, not necessarily old dominant males, but often males leaving their birth troop and trying to join a new troop, rejected, and in turn rejected by their birth troop.

Baboons are omnivorous but predominantly vegetarian. They feed on the flowers of *Acacia* spp., *Kigelia africana, Lonchocarpus capassa, L. nelsii* and *Grewia* spp. Fruits of *Diospyros mespiliformis, Garcinia livingstonei, Ficus* spp. and *Kigelia africana* are relished. The mesocarp of *Hyphaene ventricosa* is highly favoured. The seeds of *Acacia erioloba* and *A. tortilis* are consumed but the pods are bitten open and then rejected. Sedge bulbs and roots and some grasses and sedge seedheads are also consumed. Baboons eat a wide variety of invertebrates, birds eggs or nestlings and small mammals are sometimes caught and consumed, viz. *Paraxerus cepapi* which is often chased but seldom caught. If caught, the bush squirrel appears to be relished.

Visually the physical condition of baboons was fair to good, but several individuals in poor condition were seen. This appeared to be more as a result of injury or disease than lack of sufficient food, i.e. overpopulation since all troops contained individuals showing physical injury.

Baboons bred throughout the year but with a peak of births from June to September. Females displayed oestrus for about 10 days. During initial oestrus the main attention received seemed to stem from sub-adult males. After this initial period the oestrus female attaches herself to a dominant male who copulates frequently with her as also reported by Stoltz (1977). His failure to serve her leads to her copulating with any other male but usually with a less dominant one. During the last part of oestrus the female attaches herself to any suiting male, and even sub-adult to juvenile males try to mount and copulate with her. Copulation also takes place in the roost at night. On average copulation takes place up to 20 times per day and thus during oestrus a female may copulate up to 200 times (Borland, **pers. comm**). Immediately after copulation on the ground the female runs off making a characteristic call while the successful male grunts.

The population appears to be excessive on the Boro floodplain system during dry seasons when on average 44 troops were estimated from aerial survey, to be utilising this sector. During high flood conditions an average of 16 troops were present but when water levels dropped significantly towards the end of 1974, 33 troops were estimated to be present. The pattern on Chief's Island showed a much lower density with immigration during high flood and emmigration during dry periods, but overall sustaining the lowest density. The M'borogha floodplains showed a more stable population but with immigration during the drier periods (Appendices 1 to 17). Baboon move within the three areas as well as in and

out of the study area in accordance with season and floodlevels. Some troops always remain within the study area and baboon are probably in somewhat excessive numbers and in no danger whatsoever.

Order Pholidota

Family Manidae
Manis temmincki Smuts, 1832.
Pangolin, Kgaga.

Pangolin occur within the study area but can be considered rare. None were sighted by myself, but two sightings by reliable witnesses occurred in the study area, during the course of field work, and a further one in an adjacent area. Smithers (1971) considers them to be more common in the Delta than in other parts of the territory.

Nothing is known of their movement patterns. They appear to occur in a variety of habitat types, Smithers *(op. cit.)* and were recorded on a Secondary Floodplain Community, and Closed Riverine Woodland in the study area. The species is both nocturnal and diurnal, generally encountered solitarily or as a female with juvenile or sub-adult. Single births occur and the mother-juvenile attachment is very strong (Smithers *op. cit.*).

Stomach contents from Rhodesian specimens show a diet consisting mainly of Formicidae (ants) and secondly Isoptera (termites) with traces of sand, gravel and small sticks (Smithers, *op. cit.*), probably consumed whilst feeding on prey. The large populations of termites present in the Delta may account for the higher density of pangolin in the Delta.

Order Carnivora

Family Protelidae
Proteles cristatus (Sparrman, 1783)
Aardwolf, Thukwe, mMabudu

Occurs in the drier Secondary Floodplain Communities and dryland vegetation types, but nowhere common in the study area. Sightings were in Secondary Floodplain Communities

Grewia spp. – *Croton Megalobotrys* Scrub Savanna and *Sporobolus spicatus* Island Grassland Communities. Shortridge (1934) and Smithers (1971) also record aardwolf utilising similar vegetation types, but the species is more typical of the semi-arid areas in Botswana.

They are obviously affected by flooding regimes, as one known specimen lived in an old antbear hole in a Secondary Floodplain Community which remained dry throughout 1973. The same Secondary Floodplain Community was inundated for six to seven months during 1974 and under such circumstances aardwolf are forced onto the islands. Bothma (1971a) records movements of up to 35,4 km for this species, in stock-farming areas of the western Transvaal.

Aardwolf are generally nocturnal, but one specimen was observed at 12h00, and occur singly, in pairs or in small groups. Aardwolf take refuge in old antbear holes or enlarged springhare holes.

Food preference is strongly biased towards insects mainly Isoptera (Kruuk and Sands 1972) and due to the large prevailing termite population one would expect a fairly high aardwolf population, but this is probably curtailed by partial inundation of the more favoured Secondary Floodplain Community.

Insufficient data are available from Southern Africa on breeding seasons to reach any definite conclusions (Smithers, *op. cit.*).

Family Hyaenidae
Crocuta crocuta (Erxleben, 1777)
Spotted hyaena, Phiri

Widespread and common throughout the study area, occurring in all but aquatic vegetation types. Encountered commonly in dry Primary Floodplain and Secondary Floodplain Communities, *Sporobolus spicatus* Island Grassland Communities, Closed Riverine Woodland, Marginal vegetation types and all dryland vegetation types. Robbel and Child (1976) report the species as common in the Moremi Wildlife Reserve.

Movement may be localised or wide-spread (Eloff, 1964) depending on the availability of food and on audio reception of activities of other hyaenas and their associated vocalisations.

Kruuk (1972) reports packs or clans with definite territories and aggressive defense of such in the Ngorogoro Crater. Hyaenas cross shallow water readily and will also rather reluctantly take to deeper water.

Hyaenas are crepuscular and nocturnal mammals occurring either singly, in small groups, yet on one occassion a pack of 15 was recorded at a temporary camp in the verge of Chief's Island with no associated carrion. Most sightings of hyaenas in the study area were of solitary animals or of pairs, except in the cases where a carcass was present. They actively hunt either singly or in small groups but readily take to scavenging carrion from dead animals. Reedbuck and lechwe were recorded kills made by hyaenas, but doubtlessly they accounted for many other ungulates and smaller mammals. Hyaena readily locate temporary or semi-permanent camps in the Delta where they scavenge almost any article. Hyaenas usually became active during early evening and spend the night searching for carrion or hunting prey. Vocalisations seem to play a large role in communication of individuals or groups and hyaenas could be heard nightly at almost any spot in the study area. The number of hyaena spoor encountered in the study area attested to their abundance and widespread distribution. Their activity extended until early morning when they generally retired to disused antbear *(Orycteropus afer)* holes, unless they were in the vicinity of a carcass and had not yet fed, when activity extended well into the daylight hours.

The young are born in antbear *(Orycteropus afer)* holes, usually located at the base of a termitarium with the surroundings well-inundated. Evidence from Zambia (Ansell, 1960), seems to show no definite breeding season, and whilst Botswana evidence is still too scant there appears to be a breeding peak during the winter months. Two hyaenas were shot after causing large-scale damage to my camp; one was a mature female collected in August 1973 and she was lactating. Ovulation was from both ovaries and the uterine horns were still distended and highly vascularised. This female was in excellent condition for rearing pups, having a kidney fat index of 50 per cent. The other was a mature male having a kidney fat index of 15 per cent.

SIZES AND MASS

Male

TL = 1 535; T = 274; Hf c/u = 245; E = 109; Mass = 74 kg; N = 1.

Female

TL = 1 551; T = 310; Hf c/u = 246; E = 109; Mass = 76 kg; N = 1.

Family Felidae

Acinonyx jubatus jubatus (Schreber, 1775)

Cheetah, leTlotse

A reasonably healthy cheetah population occurs in the study area but these cheetah are widespread and sparsely distributed. Cheetah were recorded from the western floodplains and Chief's Island, but none were recorded from the eastern floodplain system of the study area. Found to occur largely associated with the drier Secondary Floodplain Communities, but also encountered in *Colophospermum mopane* Woodland and *Acacia tortilis* spp. Savanna Woodland, however never distantly removed from the more open Secondary Floodplain Communities.

Little is known about cheetah movement patterns, but in the study area they appear to move over a large home range. Cheetah were also encountered crossing shallowly inundated Primary or Secondary Floodplain Communities.

Cheetah are predominantly diurnal but do show some nocturnal hunting activity. Group size varied from single individuals, either male or female, but in the latter case usually heavily pregnant or possibly with hidden juveniles; to two or a maximum of five individuals. Due to their shy nature it was impossible to assess group sex structure. Single individuals or pairs of cheetah were most commonly encountered.

Recorded skills by cheetah include one sub-adult female lechwe (single cheetah), a lechwe juvenile, and adult female impala (three cheetahs) and a sub-adult warthog and an adult male warthog (2 cheetahs). Their prey species in general consist largely of the medium to smaller-sized ungulates, small mammals and birds (Kruuk and Turner 1967, Schaller 1968, Pienaar 1969). Adult cheetah hunting in groups are known to take prey up to the size of an adult female kudu. **(pers. observ.)**. An ostrich *Struthio camelus* was reported killed by cheetah near Tsau (Brown, In Smithers 1971).

The general visual physical condition of cheetah encountered was good. No accurate breeding data are available for Botswana but two single female encountered during April 1973 were heavily pregnant.

Panthera pardus pardus Linnaeus, 1758
Leopard, Nkwe

Leopard are widely distributed but apparently in low population density throughout the study area. From spoor evidence leopards show a preference for the dense Closed Riverine Woodlands. The assessment of the leopard situation is largely derived from spoor evidence, audio records and discussion with local hunters who had killed leopard in or adjacent to the study area.

Spoor evidence was mainly located in the Closed Riverine Woodlands, *Acacia tortilis* spp. Savanna Woodland, *Terminalia sericea – Combretum collinum* Savanna Woodland and scrub, *Colophospermum mopane* Woodland and Pyrophytic Scrub Savanna and Primary Floodplain, Secondary Floodplain and *Sporobolus spicatus* Island Grassland Communities. Leopards appear to reside in localised Closed Riverine Woodland and readily cross inundated areas.

Leopards are predominantly nocturnal and occassionally crepuscular, usually occurring singly, but occassionally in pairs. Leopard lie up during major daylight hours in Closed Riverine Woodland which affords suitable protection and large trees for resting up and storing unconsumed portions of prey species.

Recorded kills include impala (adult male and female), adult female lechwe and adult male kudu. In general leopards show a wide spectrum of prey species but largely from the smaller-sized antelope, small mammals and birds (Mitchell, Shenton and Uys, 1965). Child (1968b) records kills of duiker, baboon, impala, tsessebe, bushbuck, young roan and antbear from the Moremi Wildlife Reserve.

No information is available on breeding data or population density but judging by known numbers removed in hunting (six in or adjacent to the study area during 1974) and spoor evidence still present the population appears to be in no immediate danger.

Panthera leo (Linnaeus, 1758)
Lion, Tau

Lion are widely distributed and in fairly good population density throughout the study area. Encountered in most habitat types except aquatic vegetation types, but display no fear to

move through water. Lions penetrate to some of the smallest islands surrounded by well-inundated floodplain communities. Their movement is widespread and lions constantly move in and out of the study area.

Lions are largely nocturnal and crepuscular, occassionally occurring singly, but more often in small groups or prides of two to 12 individuals. Both single males and single females were encountered. In the latter case heavy pregnancy or early parturition is involved and in one instance as a relatively badly injured lioness, being the result of porcupine *(Hystrix africaeaustralis)* quill damage. The most common pride size encountered was two to five individuals but prides of up to twelve individuals were all recorded on isolated occassions. The sex composition and age structure of prides one was able to assess accurately varied greatly.

Once the morning temperatures rise, lions apparently seek the first suitable resting place, where they laze and sleep unless disturbed till the temperatures fall during the late afternoon. Opportunistic attempts at killing, or actual killing (but mostly unsuccessful), may take place during these hot hours if a chance arises. Most recorded kills took place during the general hours of movement.

Lions appear to take any available warm blooded-prey and also include such items as tortoise *(Testudo* spp.) and python *(Python sebae)* (Pienaar, 1969). Recorded skills include adult male and female giraffe, sub-adult and adult male wildebeest; adult female and male impala, sub-adult, adult female and adult male warthog, adult female kudu, adult female zebra and adult female and juvenile lechwe. On one occassion five buffalo calves were killed in the space of approximately one-sixteenth of a square kilometre.

Visual physical condition varied from good to fair but with predators this is mainly a function of when they had last fed. The only lioness found in poor condition was that mentioned as injured above. Breeding biology showed estimated births occurring in April, June and November, but apparently births can take place throughout the year (Shortridge, 1934; Ansell, 1960). Two to three cubs were found to be accompanying a single female and this seems to be the most common litter size in the study area.

Felis libyca griselda Thomas, 1926
Wild Cat, Tibe, Phage

Wild Cat appear to be sparsely distributed and apparently nowhere common in the study area. Only recorded from the Piajio area of Chief's Island on short grassed Secondary Floodplain Community associated with adjacent *Acacia tortilis* Savanna Woodland.

Smithers (1971) records a wide habitat tolerance for this species, and probably due to their small size and mainly nocturnal habits sightings are poor and their distribution may be greater especially over Chief's Island. Wild Cat occur singly or in pairs. Their diet consists mainly of Muridae, Solifugae, Orthoptera, Reptilia and Aves (Smithers *op. cit.).*

Felis serval serval Schreber, 1776.
Serval, Tadi

Serval occurs throughout the study area, but mainly on the eastern and western floodplains and the verges of Chief's Island. Fairly common and widely distributed. The proximity of water together with adjacent dense scrub, tall grass and sedge or reed cover appear to be essential habitat requirements.

Serval are largely nocturnal and lie up in fairly thick cover during daylight hours or in disused antbear holes. Odd individuals may be encountered during daylight hours but generally when disturbed from resting up. Occurrence is singly or in pairs, but three were sighted on one occassion. Nothing is known of their movement pattern or home range.

Their diet consists largely of Muridae with lesser quantities of Solifugae, Aves, Reptilia, Coleoptera and Orthoptera (Smithers *op. cit.).* No breeding data are available for Botswana, but an all-year breeding cycle seems possible if records from all adjacent territories are taken into account.

Family Canidae
Otocyon megalotis megalotis (Desmarest, 1822)
Bat-eared Fox, moTlhose

Locally distributed but not common in the study area. Observed on the western floodplains and marginally on Chief's Island but not on the eastern floodplains. Bat-eared foxes were

recorded on short to medium-height sandy Secondary Floodplain Communities and adjacent *Acacia tortilis* Savanna Woodland areas. They are essentially an open semi-arid dryland species, (Smithers 1971) and in heavy flood years their available range is restricted.

The subspecies is diurnal and nocturnal, occurring singly or in small groups. During the heat of the day they usually rest in self-excavated burrows or old antbear or springhare burrows.

They are avid diggers even in hard ground and bat-eared foxes feed largely on Isoptera, Coleoptera (adults and larvae), Orthoptera, Muridae, Scorpionidae and dry grass stems and leaves, a lesser quantity of wild fruits, Reptilia, Solifugae, Lepidoptera, Formicidae, Myriopoda and green grass is consumed (Smithers, *op. cit.*). Berry (1978) found insects (57 per cent) and fruit (33 per cent) to comprise greatest percentage of stomach content of bat-eared fox in the upper Limpopo River Valley. Carrion is also consumed. Mills (1977) is of the opinion that brown hyaena *(Hyaena brunnea)* show definite predatory instincts towards bat-eared foxes in the Southern Kalahari.

Females burrow extensively and the young are born in subterranean excavations, generally numbering four to six juveniles after a gestation period of 60 to 70 days (Asdell, 1946). The present population in the study area cannot be considered high, but this is largely due to lack of suitable habitat.

Lycaon pictus pictus (Temminck, 1820)
Wild Dog, LeThalerwe

Widely distributed and common throughout most of the study area, as well as the Okavango Delta and surrounding areas. Found in most vegetation types, except the aquatic vegetation types, but will readily take to shallow water in pursuit of prey. Wild dogs were most commonly encountered on the dry floodplains and also in the dryland communities. They move over large home ranges and are not normally restricted in movement unless juveniles are too young to accompany the packs (Van Lawick Goodall, 1970).

Wild dogs are gregarious and diurnal animals. On three occassions single wild dog were encountered, but more commonly packs varied from six to 14 individuals, with one pack

of 24 and another of 31 individuals recorded. Sex composition of packs varied considerably and in one instance a pack of six wild dogs comprised five adult males and one adult female. Wild dogs were the least wary of human presence of all the predators.

The four recorded wild dog kills were adult male and female impala and adult male and female lechwe. Wild dogs seem to prefer the medium-sized ungulate prey species, but packs are capable of killing large ungulates (Estes & Goddard, 1967). If in the vicinity of a wounded mammal, they are exceptionally quick to chase and capture such, but they apparently will not take carrion.

Mating was observed in late March and pups accompanying adults were recorded in September and October, usually in the larger packs. These juveniles were estimated to be three to four months old which would correspond to a breeding season of May to July as recorded for Zambia (Ansell, 1960). The litters are born in disused antbear holes.

Canis adustus adustus Sundevall, 1846
Side-striped Jackal; raNtalaje, seKgee

Side-striped jackal are fairly common and reasonably widespread throughout parts of the study area. They are more commonly associated with the open Primary and Secondary Floodplain Communities (when dry) and with adjacent dryland vegetation types, but seem tied in occurrence to the vicinity of well-watered areas. They were recorded in dry Primary and Secondary Floodplain Communities and most of the marginal and dryland vegetation types. Nothing is known of their movement patterns, but individuals do seem fairly localised but are forced to move when some of their habitat becomes inundated. They were more commonly encountered in the dry 1972/73 season, when compared with the wet 1973/74 season, and did seem to have migrated onto Chief's Island.

Side-striped jackal are predominantly nocturnal, but were often observed moving during daylight hours, and occurred singly or in pairs. Food commonly comprises Muridae and carrion and to a lesser extent wild fruits, Coleoptera, Isoptera, Orthoptera, Reptilia and Aves (Smithers, 1971).

No breeding data are available for Botswana but gravid females have been collected from Rhodesia during August, September and November (Smithers *op. cit.*).

Canis mesomelas arenarum (Thomas, 1926)
Black-backed Jackal; Phokoje

Black-backed jackal are fairly common in the drier parts of the study area adjacent to Chief's Island and especially on the Secondary Floodplain Community enclaves forming the ecotone of potential inundated areas and dryland, and in the dryland vegetation types of Chief's Island itself. There is a definite overlap in distribution in the study area of *Canis adustus adustus* and *C. mesomelas arenarum.* Bothma (1971a) showed adult black-backed jackals capable of extensive movement in stock-farming areas of the western Transvaal.

The subspecies is diurnal and nocturnal and cocurs singly or in pairs. In the vicinity of kills larger concentrations were encountered. In Botswana food in order of preference appeared to be Insecta, small mammalia, carrion, green grass, wild fruits, Solifugae, Scorpiones, Reptilia, Aves, Myriopoda and dry grass (Smithers, 1971). Bothma (1971b) showed food preferences from stock-farming areas in the Transvaal and Cape Province to be more biased towards domestic and wild Aves, Reptilia and domestic and wild Artiodactyla.

Young black-backed jackal appear to be born during the early summer months.

Family Mustelidae
Aonyx capensis capensis (Schinz, 1821)
Clawless Otter; leNyibi

Clawless otters were only recorded from the eastern floodplains where they were found in the dry, burnt, short Secondary Floodplain Community about 1 km from the M'borogha River. Recorded by Smithers *(op. cit.)* from the main Okavango River forming the sleeve of the Delta and from the Thamalakane River at the base and its eastern extensions. Thus apparently localised and not common in the study area.

Aquatic and semi-terrestrial mammals, the clawless otter generally seems to prefer the larger river systems viz. Upper and Middle Channel Communities and their associated floodplain and dryland vegetation types. They are nocturnal and diurnal and wander widely over dryland areas in the vicinity of floodplain systems and over swamp islands. A pair

was observed at least 0,5 km away from the nearest surface water at 08h00 heading towards an isolated pool in a drying-out Primary Floodplain Community. Smithers (1971) records most sightings of two, but up to four individuals at a time. Clawless otters are fairly shy, but more inquisitive than the spotted-necked otter *(Lutra maculicollis).*

Their food comprises fish, crabs and insects and apparently frogs, aquatic birds, eggs, mussels and rodents (Smithers, *op. cit.).*

No breeding data are available from Botswana, but young appear to be born in Rhodesia about April (Smithers, *op. cit.*), and about July or August in Zambia (Ansell, 1960).

Lutra maculicollis chobiensis Roberts 1932
Spotted-necked Otter; leNyibi

Spotted-necked otters are widely-distributed and fairly common in both the Middle Channel Communities of the eastern and western floodplain systems; and especially more common in the Outlet Channel Communities of the western floodplain system. Spotted-necked otters appear to prefer the smaller channels and lower water velocity present in the Outlet Channel Communities, their adjacent almost stagnant Sump Communities and adjacent offtakes to Primary Floodplain Communities. They occassionally move out into dryland verges or sandbanks but usually remain close to tall *Miscanthidium junceum, Phragmites australis, Typha latifolia* or *Cyperus papyrus* beds.

Spotted-necked otters are largely diurnal but also nocturnal and almost exclusively aquatic. Spotted-necked otters were often encountered from 08h00 to 11h00 and from 15h00 to 18h00, either singly or in groups of up to three individuals. They actively swim with just the head above water and characteristically dive after prey. They are very shy and the moment that they become aware of observers they dive, sometimes to re-surface well away, but usually they move off into the tall verging aquatic vegetation margins. Observed on dry sand banks at 09h00 thence moving into tall adjacent vegetation where they have definite runs.

Feeding records are scant but they appear to feed on fish and other aquatic animal life. A specimen collected at 16h00 had a completely empty stomach with only nematodes (*Cloeoascaris spinicollis* Baylis, 1923) present.

No breeding records are available for Botswana, but a nest was observed being prepared in September/October. Ansell (1960) records a litter born in November or December from Zambia.

SIZE AND MASS
Adult male
TL = 1 046; T = 415; Hf c/u = 127; E = 17; Mass = 4,25 kg; N = 1.

Mellivora capensis (Schreber, 1776)
Honey Badger; Ratel; Matshwane

The Honey badgers are widely-distributed in the study area but not common. Less evidence of honey badgers was found on the eastern floodplain system than on the western floodplain system. They are found more associated with the dryland vegetation types, the dry Primary and Secondary Floodplain Communities, the marginal vegetation types and Closed Riverine Woodland Communities. No particular habitat preference is shown except that they avoid aquatic vegetation types. Nothing is known of their movement patterns.

Honey badgers are nocturnal and diurnal, largely terrestrial but able to do limited climbing to reach some wild bees-nests. They were encountered on several occassions during day-light hours, in some instances showing some aggression, but more usually taking off when disturbed.

Their diet consists of honey and larvae, Scorpiones, Arachnidae, Muridae, Orthoptera, Reptilia, Aves, Myriopoda and carrion; (Smithers, 1971); but they are sometimes able to catch and kill newborn and small to medium-sized mammals (Ansell, 1960) and even large mammals (Stevenson-Hamilton, 1947). They are avid diggers and much of their prey seems to be caught by this means.

Limited available breeding data for Botswana and Zambia shows births during November, December and probably adjacent months (Smithers *op. cit.*).

Ictonyx striatus (Perry, 1810)
Striped Polecat; Nakedi

The striped polecat are widely-distributed throughout the dryland vegetation types of the study area and appear to be fairly common. Found mainly on the islands, dry floodplain and Chief's Island. Nothing is known of their movement patterns.

Striped polecats are nocturnal and terrestrial. They only appear to be active during the period from 22h00 onwards till early morning (Smithers, 1971). No observation of this species was made during daylight hours, and only on one occassion were they located prior to 22h00 at night. All recordings were of a single individual or of pairs.

Diet includes Coleoptera adult and larvae, Reptilia, Muridae, Orthoptera, Scorpiones, Solifugae and Myriopoda and limited breeding data suggests a late summer period, viz. January to March. (Smithers *op. cit.).*

Family Viverridae
Viverra civetta civetta Schreber, 1776
Civet; Tshipalore

Civet are widely-distributed throughout the study area except the main dryland mass of Chief's Island, but not common. Habitats include some aquatic, riverine marginal and floodplain vegetation types. Nothing is known of their movement patterns.

Civets are nocturnal and usually occur singly, but pairs may be found. They are terrestrial and secretive, lying up for most of the day in dense cover. Their occurrence in the study area seems largely dependent on water proximity as also for all Botswana records (Smithers *op. cit.).*

Feeding records include wild fruits, Amphibia, Orthoptera, Coleoptera and Solifugae (Smithers, *op. cit.*). Breeding records suggest births take place in the middle of the rainy season, January or February (Smithers, *op. cit.)* whereas Ansell's (1960) records for Zambia indicate an earlier October/November season.

Genetta genetta pulchra Matschie, 1902
Small-spotted Genet; Tshipa

Small-spotted genet are widely-distributed and fairly common in the study area. The major habitat occurrence is Closed Riverine Woodland and associated marginal vegetation types and to a lesser degree in the dryland vegetation types. Movement patterns appear to be fairly localised.

Small-spotted genets are nocturnal and occur singly, in pairs or in small family parties of up to five individuals. They are terrestrial and arboreal and are sometimes recorded during late afternoon.

Feeding records include Muridae, Orthoptera, Scorpiones, Solifugae, Reptilia, Isoptera, Coleoptera, Aves, Myriopoda, carrion, green grass, Amphibia, Chiroptera, Araneae, wild fruits, Lepidoptera, Soricidae, Dictyoptera and Muscardinidae descending in order of preference from stomach samples. (Smithers, 1971).

The breeding season occurs mainly from October to February or later, with an average of two to four juveniles born.

Genetta tigrina rubiginosa Pucheran, 1855
Rusty-spotted Genet; Tshipa; Thokolo

Rusty-spotted genet are widely-distributed and fairly common within the study area. They overlap in distribution and habitat requirements with *G.g. pulchra* within the study area. *G.t. rubiginosa* is however more confined to well-watered areas, whereas *G.g. pulchra* has a wider habitat tolerance and is independent of surface water. Rusty-spotted genets occur largely in Closed Riverine Woosland and associated marginal vegetation types. Movement patterns appear to be localised.

Habits are the same as for *G.g. pulchra.* Feeding records include Muridae, Coleoptera, Orthoptera, Isoptera, Solifugae, wild fruits, Myriopoda, Scorpiones, Aves, Anthropoda, Reptilia, Araneae and carrion (Smithers, *op. cit.).* Muridae form a large percentage of their diet.

Breeding season seems to occur from September to February.

Cynictis penicillata (G. Cuvier, 1829)
Yellow Mongoose; Moswe

Yellow mongose occurs within the study area, but only recorded on four occassions. Appears to be confined to the drier and more denuded Secondary Floodplain Communities and adjacent woodlands.

The yellow mongoose is diurnal and terrestrial. Smithers (1971) reports the species as gregarious and living in colonies, but all recordings in the study area were of single specimens.

Feeding records include Coleoptera (adult and larvae), Isoptera, Orthoptera, Muridae, Scorpiones, Reptilia, Solifugae, Myriopoda, Aves, Amphibia and carrion (Smithers, *op. cit.*). Breeding records indicate a breeding peak from October to March with sporadic recordings outside this period. Two to five juveniles are born in underground warrens. (Smithers, *op. cit.*).

Herpestes sanguineus Rüppel, 1836
Slender Mongoose; Ngano

Slender Mongoose are fairly widely distributed and are fairly common in the study area. They occur in the riverine, marginal, dry floodplain and dryland vegetation types. Movement appears to be very localised.

Slender mongoose are diurnal and normally solitary. All observations in the study area were of single individuals during daylight hours. Feeding records include Reptilia, Isoptera, Muridae, Orthoptera, Coleoptera, Aves, Scorpiones, Lepidoptera and wild fruits (Smithers *op. cit.*). Breeding data are scant but breeding appears to occur during November to March.

Atilax paludinosis (G. Cuvier, 1829)
Water Mongoose; Tshagane

Only one specimen of a water mongoose was recorded from the well-inundated eastern floodplains. The specimen was recorded in Closed Riverine Woodland adjacent to a Middle Channel Community's verge of tall aquatic vegetation.

Water mongoose are nocturnal, terrestrial and also aquatic to a degree. They are secretive and doubtless more are present in the study area but due to their habits not located. Feeding evidence is scant from Botswana but the food of Rhodesian specimens include Amphibia, Crustacea, Muridae, wild fruits and carrion (Smithers, 1971).

Mungos mungo grisonax Thomas, 1926
Banded Mongoose; leTototo

Banded Mongoose are widely distributed and common in most parts of the study area. Found in Closed Riverine Woodland and adjacent dry floodplain and dryland vegetation types.

Banded mongoose are gregarious, diurnal and terrestrial and usually occur in troops of from eight to 14 individuals, but larger concentrations of up to 30 individuals occurred. They move fairly widely in search of food and have a colonial warren.

Feeding records include Coleoptera (mainly larvae but also adults), wild fruits, Solpugidae, Orthoptera, Acrididae and Reptilia. No breeding data exists for Botswana, but evidence from adjacent territories indicates a season of November to February (Ansell, 1960).

Order Tubulidentata

Family Orycteropodidae
Orycteropus afer afer (Pallas, 1766)
Antbear; Thakadu

Antbear are widely distributed and rare to common throughout the study area. They were recorded from all but the aquatic vegetation types and movement appeared to be widespread.

Antbears are nocturnal but they were also recorded during late evening on two occasions. They are solitary, terrestrial and lie-up in self-excavated holes. These numerous holes form important refuge and breeding sites for a large variety of mammals and some reptiles.

Feeding records indicate a diet comprising Formicidae and Isoptera, with traces of other insects. Numerous holes are excavated during the course of searching for food. Breeding data are scant, but they appear to give birth to a single juvenile from May to August (Smithers, 1971).

Order Proboscidea

Family Elephantidae
Loxodonta africana africana (Blumenbach, 1797)
Elephant; Tlou

Elephant are widespread and common throughout the study area but mainly seasonally. They were less commonly encountered on the western floodplains, but elephant did seem to be making more use of this sector as the study progressed.

They were encountered in all vegetation communities. Movement is seasonal and herds of elephant migrate into the study area from the east and north. Some single bull elephant or small groups of three to six bull elephant remain in the area all year round, mainly utilising Chief's Island and the eastern floodplain system. During and after good rains the bulk of the elephant population migrates out of the study area moving mainly towards Moremi Wildlife Reserve, the Khwai and Maxwee concession areas and thence towards Mababe or Makalamabedi. There is less evidence available but others appear to move westwards to the Sepopa and Kuki West concession areas. These movements normally follow well-defined footpaths.

The elephants in the study area were found to be very shy probably due to adjacent hunting pressure, since large parts of the study area were hunted until recent years. Although Moremi Wildlife Reserve is also adjacent to hunting areas, elephants there are far less shy, probably as a result of adaptation to heavy tourist densities.

Elephants are generally gregarious mammals and usually occur in herds of 15 to 30 individuals. These comprise mainly cows and calves, but young bulls may still be present. One or more adult bulls may be present in these herds at any stage, but they only join the herd for possible mating. These bulls wander singly or in small groups of up to six or eight individuals, either all adult or of mixed aged males. The largest concentration en-

countered on Chief's Island comprised 160 individuals (26 September 1973); before the summer rains commenced. Aerial surveys also give the highest population density in the study area during or towards the end of the dry season (Appendix 1–17).

Elephants are diurnal and nocturnal. They rest up during the hotter part of the day under available shade and sleep (usually on their feet but occassionally lying down); and make use of the large pans in the southeastern sector of Chief's Island for drinking and bathing. Elephants drink daily where water is freely available, but otherwise do so every second or third day. Conditions within the study area preclude water from being a limiting factor to any movement except when the Chief's Island pans dry up.

Feeding records are given in Table 23 after Tinley (1966) with modifications. No large-scale elephant damage to vegetation was noted in the study area, but this is becoming apparent in the Moremi Wildlife Reserve to the west of Dombo lediba.

Mating and births seem to take place at any time throughout the year judging by the variation seen in calf size and the observation of small calves at widely divergent times of the year. Normally a single calf is born but isolated cases of twin births have been recorded (Liversedge, In: Smithers, 1971).

One census yielded no elephant in the study area, but generally about 10 to 20 are present in most seasons and during the dry season between 400 and 500 concentrate especially on Chief's Island.

Order Perissodactyla

Family Equidae
Equus burchelli antiquorum (H. Smith, 1841)
Burchell's zebra; Pitse yanaga

A number of zebra observed within the study area show leg markings either partially or wholly striped to the hooves and thus seem to conform to an intermediate between *E.b. antiquorium* and *E.b. chapmani*. Smithers *(op. cit.)* however adopts *E.b. antiquorum* and it is retained in this study.

Table 23 – Elephant feeding records (x), Okavango Delta, Botswana, 1973 - 1975.*

TYPE	SPECIES	PART CONSUMED				
		Leaves	Stem/branch	Bark	Fruit	Roots
Herb	*Plicosepalus kalaha-riensis*	x	x	–	–	–
Climbers	*Capparis tomentosa*	x	x	–	–	–
	Cocculus hirsutus	x	x	–	–	–
	Jasminum fliumensie	x	x	–	–	–
Shrubs	*Bauhinia macrontha*	x	x	–	–	–
	Colophospermum mopane	x	x	–	–	–
	Commiphora africana	x	x	–	–	–
	Dichrostachys cinerea	x	x	–	–	–
	Gardenia spathulifolia	x	x	–	–	–
	Grewia spp.	x	x	–	–	x
	Maytenus senegalensis	x	x	–	–	–
	Phyllanthus reticulatus	x	x	–	–	–
	Rhus spp.	x	x	–	–	–
	Terminalia sericea	x	x	–	–	–
Trees	*Acacia erioloba*	x	x	x	x	–
	A. Fleckii	x	x	x	–	–
	A. galpinii	x	x	–	–	–
	A. hebeclada	x	x	–	–	–
	A here roensis	x	x	–	–	–
	A leuderitziae	x	x	–	–	–
	A. nigrescens	x	x	x	x	–
	A. sieberana	x	x	x	x	–
	A tortilis	x	x	x	x	x
	Adansonia digitata	x	x	x	–	–
	Albizzia harveyi	x	x	x	–	–
	Boscia mossambicenses	x	x	x	–	x
	Colophospermum mopane	x	x	–	–	–
	Combretum collinum	x	x	x	–	x
	C. hereroense	x	x	–	–	–
	C. imberbe	x	x	–	–	–
	Diospyros mespiliformis	x	x	–	x	–
	Ficus burkei	x	x	–	x	–
	F. sycamorus	x	x	–	x	–
	F. verruculosa	x	x	–	x	–
	Hyphaene ventricosa	x	–	–	x	x
	Lonchocarpus capassa	x	x	–	–	x
	L. nelsii	x	x	–	–	–
	Phoenix reclinata	x	–	–	x	–
	Berchemia discolor	x	x	x	–	–
	Sclerocarya caffra	x	x	x	x	–
	Terminalia sericea	x	x	x	–	x
	Siziphus mucronata	x	x	x	–	–

*After Tinley (1966), with modifications.

Zebra are common in localised drier parts of the study area, but are not as well represented as in the drier adjacent parts of the Delta. Zebras show a definite preference for the drier, more open northern sectors of Chief's Island and the western floodplains when dry. Zebras were encountered mainly on *Acacia tortilis* and *A. erioloba* Savanna Woodlands and on dry Primary and Secondary Floodplain Communities with limited sightings in *Colophospermum mopane* Woodland and Pyrophytic Scrub Savanna. During extremely dry seasons two large groups of zebras were noted on the M'borogha floodplain system, but following excessive flooding of the same area only two zebra could thereafter be located on the eastern floodplain system.

Zebras tend to show a dislike for water, and migrate to the dryland vegetation types during flooding seasons or out of the study area to the south. Zebras are grazers, predominantly utilising the short grass area. They are partial to utilizing freshly burnt areas and quickly move to such areas. In one instance zebras were found to be grazing on a shallowly flooded floodplain (0,05 to 0,07 m) but all other observations were on areas devoid of surface water. Child (1968a) also describes the reluctance of zebras to utilise flooded habitat.

Zebra occurred in family groups comprising one adult stallion, several mares and their offspring. Sub-adult stallions approaching puberty are soon chased out and groups of young stallions were encountered. These family units vary from three to 17 individuals (average 10,7), but where several groups congregate at a watering point or in a local migration the appearance of larger herds is given. The largest such association in the study area was of 96 individuals.

A single young zebra is born from mid-May to January after a gestation period of 12 months, but isolated births occur outside of this time interval. Smuts (1974) gives the average gestation period of 375 days with a range of between about 360 and 390 days from various studies. Aerial surveys showed the greatest overall population estimate of 744 zebras to occur in the study area during the driest period (May, 1973). During peak flooded conditions (July 1974) this population dropped to 121 zebras. The study area carries an average of 384 zebras taking all seasons into consideration (17 surveys). Detailed population estimates appear in the appendices 1 to 17.

Order Artiodactyla

Family Suidae

Phacochoerus aethiopicus sundevalli Lonnberg, 1908

Warthog; Kolobe

Warthog are widely distributed throughout the study area and in good population numbers except for the central Chief's Island areas. The mid and lower-Delta in general carries a high warthog population. Warthog occur in all vegetation types and plant communities except for those aquatic communities carrying permanently deep water; or aquatic and floodplain vegetation types whilst they are deeply inundated. Warthogs appear to move over a limited home range in the Delta, and although able to swim, they are reluctant to take to deep water and rather take refuge in their holes. Child (1968a) describes similar behaviour of warthog during island formation in the Kariba Dam, Rhodesia.

Although warthogs are encountered in numerous habitat types they show a strong preference for certain plant communities for feeding purposes. During the drier months or seasons when most of the floodplain vegetation types are dry, warthogs are found feeding mainly on the Primary Floodplain Communities. Whilst these Primary Floodplain Communities are still green warthogs largely graze there, but when these floodplains are dessicated they resort largely to rooting up sedges, tubers and rhizomes. Tracts of dry Primary Floodplain Communities are ploughed up in this way and when the subsequent floods arrive, form open pools within the tall aquatic vegetation. These form important micro-habitats for certain mammal and bird species. At the commencement of the summer rains, warthogs move quickly onto the *Sporobolus spicatus* Island Grassland Communities and the herb layer of the Marginal and dryland vegetation types where they graze largely on fresh annual and perennial grass growth. In extremely heavy flood years warthogs are limited to *Sporobolus spicatus* Island Grassland Communities and marginal and dryland vegetation types where they resort to ploughing up large tracts of grassland. However, they also utilise the verges of the flooded area grazing in water of up to 0,25 to 0,30 m deep, and they follow the receding flood levels.

Warthogs are quickly attracted to burnt areas where they either uproot subterranean growth or graze off fresh growth. Concentrations of warthog at localized burns gives the impression of small herds of warthog, but these remain discrete individuals, groups or family units (Fig. 22). During rooting and feeding on subterranean vegetation, large amounts of

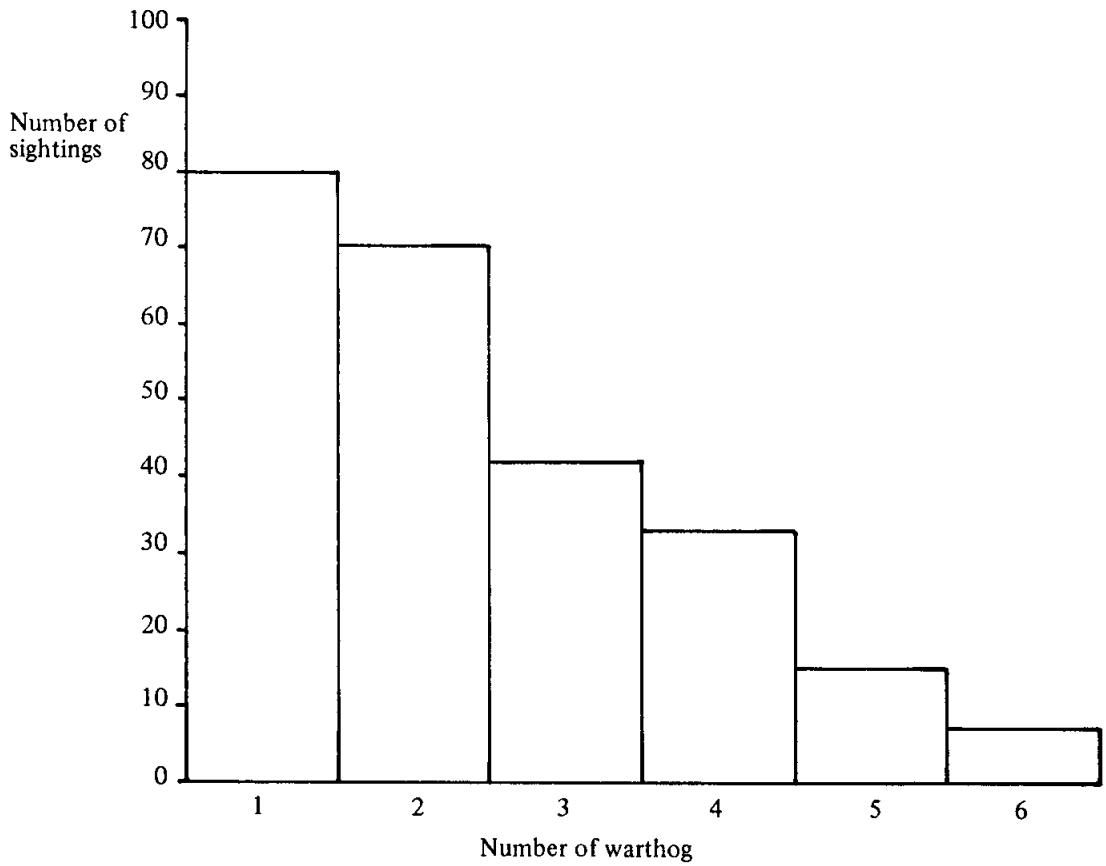

FIGURE 22 – Group size distribution of warthog in the study area, Okavango Delta, Botswana, March 1973 to November 1974.

soil are ingested. There is a definite feeding association with baboons who follow the warthogs' rooting activities and derive large quantities of subterranean vegetable and animal food material from the former's activities and in turn serve to alert the warthog to any potential danger in the vicinity. The warthogs function in creating and enlarging small pans also plays an important role in the Delta. Warthogs are grazers feeding on aerial and subterranean parts of grasses and sedges viz. leaves, culm/stem, roots, rhizomes and tubers. Recorded plant species utilised include the grasses *Chloris gayana, C. virgata, Cynodon dactylon, Digitaria eriantha, Imperata cylindrica, Leersia hexandra, Leptocarydion vulpicastrum, Panicum aphanoneurum, P. coloratum, P. repens, Sacciolepus typhura, Sporobolus spicatus* and the sedges *Cyperus articulatus, C. denudatus, C. fulgens, C. longus, C. sphacelatus, Fimbrystylis dicotoma, Kyllinga erecta, K. melanosperma, Mariscus cyperoides, M. squarrosus, Scirpus articulatus* and *S. inclinatus.*

Warthogs are strictly diurnal and occur solitarily or in groups of two to six individuals on average. Assessment of warthog group size from the study area is given in Fig. 4. One group of 10 warthogs was encountered in the Moremi Wildlife Reserve and it comprised two adult females, each with a litter of four juveniles. Warthogs rest up at night in disused antbear holes into which they "reverse" and move out soon after first light. In general they spend the morning hours grazing and/or rooting, till sufficient food is consumed and then rest up during the hotter midday periods in thickets or fairly dense vegetation. They move again during the later afternoon, actively feeding and retire to their holes before dark. Weather conditions or food availability may alter this general pattern. Warthogs drink daily and are fond of wallowing.

Table 24 illustrates warthog feeding habitat (or plant community) preference, providing for an overall 78 per cent occurrence on open, potentially flooded or dry grassland. The percentage occurrence on Primary Floodplain Community would have been higher, but due to the excessive floods of the 1974 season this habitat type could not be used by warthogs for almost the complete year. The sleeping holes are mainly located in closed Riverine Woodland or marginal vegetation types, less often in dryland vegetation types, or in a few instances on the verges of *Sporobolus spicatus* Island Grassland Communities.

Generally warthog were found to occur singly or in groups of up to six individuals (Fig. 22). Most single warthog where adult mates sightings of single adult female warthog occurred just prior to or after parturition. Approximately 25 per cent of single individuals comprised

Table 24 – Plant community (habitat) preference of warthog in the study area, Okavango Delta, Botswana, 1973 - 1974, from 954 sightings.

PLANT COMMUNITY	PERCENTAGE OCCURRENCE
Primary Floodplain Community	31
Secondary Floodplain Community	26
Sporobolus spicatus Island Grassland Community	21
Closed Riverine Woodland	8
Acacia tortilis Savanna Woodland	3
Acacia erioloba Woodland and Savanna Woodland	2
Grewia spp. - *Croton megalobotrys Scrub Savanna*	2
Acacia nigrescens - *Croton megalobotrys* Woodland and Savanna Woodland	2
Hyphaene ventricosa - *Croton megalobotrys* Palm Woodland and Palm Savanna Woodland	2
Colophospermum mopane Woodland and Poyrophytic Scrub Savanna	2
Combretum imberbe - *Croton megalobotrys* Woodland and Savanna Woodland	1

sub-adult males. Adult males and females were together during the May/June/July mating season but 37 per cent of pair sightings involved subadult warthog and 29 per cent and adult female accompanied by a subadult or juvenile. Fifty-eight per cent of sightings involving groups of three warthog showed an adult female with subadults or Juveniles accompanying. An all male group of three was recorded. All groups in excess of three warthog showed juveniles or subadults accompanying females.

Measurement of physical condition from Riney's (1955) internal fat parameters proved fairly successful for warthog, but warthog marrow, colour and texture visual estimates, as also noted by Child (1968a), require refinement as these differ markedly from other ungulate marrows in colour and texture. From Table 25 it is clear that adult male warthog maintain a fairly high condition index until the floods arrive in May and the majority of their prime feeding habitat is excluded from use due to high water levels. The individual collected on 20 August 1973 with high kidney fat index, was collected from a lightly inundated lower section of the study area where Primary Floodplain Community was still available or only lightly flooded. A slight condition improvement occurs after commencement of the summer rains when green grazing becomes available. (Table 25). The low kidney fat index held after this period is due to exclusion of prime habitat as a result of excessive flooding, except for the two individuals collected on 14 March 1975 and 15 June 1975 which came from areas only partially flooded. Adult female warthogs show a similar tendency to a general loss in kidney fat index during 1974, based also on excessive flooding (Table 26). Although subadults and juveniles do not build up large fat reserves, some comparable seasonal data can be derived also showing a lower condition during flooding periods. However insufficient specimens were collected in these age classes for meaningful results. In general, excessive flooding is thus detrimental to warthog condition since movement is curtailed and exclusion from their prime habitat occurs due to high water levels. Conversely the Primary Floodplain Communities require the rest from over-utilisation by warthog which flooding affords it.

Warthogs are strict seasonal breeders for approximately two months in any particular year in the study area (Table 27), and probably for the Delta in general (Robbel and Child, 1976). Almost all births take place within a two month period. During 1973 observed matings showed the rut to commence during May with a peak in rutting activity during June and no rutting behaviour after mid-July.

Table 25 – Seasonal condition of adult male warthog from the study area and surrounding areas Okavango Delta, Botswana, April 1973 – September 1975.

DATE	KIDNEY FAT INDEX (PERCENTAGE)	BACK FAT INDEX (MILLIMETRES)	COMBINED ABDOMINAL AND MARROW INDEX (PERCENTAGE)	REMARKS
4 April 1973	17,65	4,0	87	
16 May 1973	13,90	10,0	60	
24 May 1973	11,40	10,0	60	
24 June 1973	28,50	8,5	67	
25 June 1973	8,90	6,0	47	
12 July 1973	–	0,0	40	Kidneys damaged in collecting.
20 August 1973	4,40	1,0	40	
20 August 1973	21,20	12,0	53	Collected from a lightly inundated area.
21 August 1973	6,45	2,0	40	
17 October 1973	0,00	0,0	0	Old mate no trace of any fat.
28 November 1973	4,34	5,0	40	
29 November 1973	2,09	0,0	33	
19 December 1973	10,82	6,0	40	
6 April 1974	5,90	10,0	33	
15 May 1974	1,24	0,0	Trace	
11 August 1974	0,91	0,0	7	
19 October 1974	2,89	Trace	40	
14 March 1975 .	17,97	7,0	53	Area lightly inundated.
15 June 1975	14,17	3,0	40	
14 September 1975	2,79	0,0	14	

Table 26 – Seasonal condition of adult female warthog from the study area and surrounding areas, Okavango Delta, Botswana May 1973 – September 1975.

DATE	KIDNEY FAT INDEX (PERCENTAGE)	BACK FAT INDEX (MILLIMETRE)	COMBINED ABDOMINAL AND MARROW INDEX (PERCENTAGE)	REMARKS
9 May 1973	25,10	10	87	–
24 May 1973	21,20	13	67	–
20 August 1973	26,20	9	47	pregnant
9 September 1973	15,80	14	40	–
28 September 1973	6,85	0	47	pregnant
8 October 1973	11,45	11	47	pregnant
12 October 1973	23,70	17	53	pregnant
9 November 1973	3,64	Trace	33	pregnant
9 November 1973	5,40	Trace	33	pregnant
18 December 1973	10,70	4	40	given birth
18 December 1973	6,84	6	40	given birth
18 June 1974	3,60	2	40	pregnant
10 August 1974	6,19	0	27	pregnant
19 August 1974	4,27	0	40	pregnant
30 August 1974	1,99	0	13	–
10 March 1975	8,98	6	47	–
11 September 1975	1,94	0	20	pregnant

Table 27 – Warthog pregnant female and foetal data and conception and parturition dates after Huggett and Widdas (1951) for the study area Okavango Delta, Botswana, August 1973 – September 1975

DATE OF COLLECTION	FEMALE NUMBER	ESTIMATED AGE OF FEMALE (MONTHS)	NUMBER OF FOETUSES	MEAN MASS OF FOETUSES (GRAMMES)	MEAN CROWN-RUMP LENGTH OF FOETUSES (MILLIMETRES)	POST-CONCEPTION AGE (DAYS)	CONCEPTION DATE	PARTURITION DATE
1973:								
20 August	44	33	2	31,9	84,0	81	1 Jun.	20 Nov.
28 September	58	22	3	66,1	101,0	94	27 Jun.	17 Dec.
8 October	64	47+	4	510,6	218,3	152	10 May	1 Nov.
12 October	65	35	3	408,1	185,3	144	22 May	11 Nov.
9 November	76	36+	4	539,2	211,5	154	9 Jun.	28 Nov.
9 November	77	24	1	657,0	205,0	162	1 Jun.	20 Nov.
1974:								
18 June	128	43+	3	40,1	91,3	85	26 Mar.	15 Sep.
10 August	132	45+	4	243,9	167,0	126	7 Apr.	27 Sep.
19 August	136	45+	3	182,5	152,3	118	24 Apr.	13 Oct.
1975:								
11 September	209	22	3	328,6	–	136	29 Apr.	18 Oct.

Robbel and Child (1976) record the peak of rutting in the Moremi Wildlife Reserve in the second half of May and early June 1969, and extensive rutting in mid-June 1971. During the exceptionally good rainy season of 1973/74 a markedly advanced rutting season was observed, commencing in late March through April and ending in early May. This brought the 1974 farrowing season forward by 7,5 weeks and shows the influence of good nutrition on breeding season (Joubert, 1963). The first juveniles accompanying an adult female during 1973 were recorded on 20 December 1973; pointing to the fact that the first four to six weeks after birth are spent in the antbear hole prior to accompanying the female and foraging. (Tables 26 & 27).

Working on an average gestation period of 173 days (Brown, 1936; *Mason, **pers. comm.**) and using the formula of Hugget and Widdas (1951), Table 27 gives the conception and parturition dates for the 1973 and 1974 breeding seasons.

Multiple ovulation and multiple births occur in adult warthog. Available data from collected pregnant females point to single or double ovulation and similar implantation in subadult to young adult females. In two instances triple ovulation was recorded in females 18 to 22 months old at conception. Females of 24 to 26 months and older at conception usually show triple to quadruple ovulations with some crossing over to implantation and giving birth to three or four juveniles. In all cases the rate of ovulation corresponded with the number of foetuses present. In only one instance was one piglet of a triplet a 'runt' being approximately half the mass of the other two piglets. One adult female warhog was collected displaying neotony and on examination of the reproductive tract appeared never to have displayed ovulation or given birth. Sexual maturity thus seems to occur at 18 to 22 months of age. Table 27 gives foetal data and estimated female age.

The highest population of warthogs in the study area was found during the driest period (May, 1973) when 982 were recorded. This is considered an underestimate. During the wettest period (April to July 1974) the smallest accepted population of 305 was recorded. This figure is, however, considered a larger underestimate as most warthog at this time were occurring in marginal or dryland vegetation types where accurate aerial survey of this species is impossible. I nevertheless regard that a small but significant movement out of the area involving from 25 to 35 per cent of the warthog population occurred. A smaller total

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population for the study area of 166 individuals was recorded during December 1973 but this is not accepted due to observer error and some navigational difficulty in using a new pilot and no navigator. As conditions dried out a steady increase in warthog population size occurs, which can also be attributed to easier observation as more open warthog habitat becomes available. The study area carried an average of 511 warthog taking all seasons into account, but from ground observations this is considered to be a gross underestimate. Thus aerial survey of warhog is not reliable and can only provide a minimal population size (usually grossly underestimated).

Mass and measurements of collected warthog appear in Tables 28 and 29.

External parasites:
(Acarina)
Hyalomma truncatum Koch, 1844
Rhipicephalus simus simus Koch, 1844
R. capensis Koch, 1844
Ornithodorus moubata Koch, 1844

(Siphonaptera)
Echidnophaga larina Jordan and Rothschild, 1906
E. inexpectata Smit, 1950

(Anoplura)
Haematopinus phacochoeri Enderlein, 1908

Internal parasites:
Gastrodiscus aegyptiacus (Cobbold, 1876) Railliet, 1893
Oesophagostomum simpsoni Goody, 1924
O. mwanzi Daubney, 1924
O. eurycephalum Goodey, 1924
Cysticercus (regis) Baer, 1923
Ascaris phacochoeri Gedoelft, 1916
Paramphistomum sp.

Table 28 – Male warthog mass (Kg) and measurements (mm) from the study area, Okavango Delta, Botswana, April 1973 – September 1975

DATE	APPROXIMATE AGE IN MONTHS	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
								Zygomatic width	Total length
Adults									
1973:									
9 Apr.	29	52,0	1508	396	272	658	120	171	315
16 May	54+	81,0	1759	385	270	656	119	209	379
24 May	54+	83,0	1761	396	270	711	131	212	386
24 June	55+	76,5	1750	417	267	758	133	218	388
25 June	55+	81,0	1786	452	280	754	138	219	394
12 July	44	72,0	1682	431	265	745	135	207	383
20 Aug.	45	68,0	1722	415	272	765	130	–	–
20 Aug.	33	54,0	1645	460	261	633	121	–	–
21 Aug.	33	63,0	1624	434	271	701	125	187	357
17 Oct.	59+	60,0	1684	441	272	689	121	203	375
28 Nov.	36	58,0	1620	427	271	658	126	179	333
29 Nov.	60+	84,5	1753	487	262	774	133	214	384
19 Dec.	49+	78,0	1722	425	273	739	130	213	373
1974:									
6 Apr.	53+	84,0	1751	493	282	800	139	213	395
15 May	54+	75,5	1763	476	271	710	123	216	392
11 Aug.	45	66,5	1705	441	275	628	129	204	371
19 Oct.	47	70,5	1734	476	274	740	129	185	380
1975:									
14 March	66+	86,0	1762	440	276	745	134	237	399
15 June	30	50,5	1546	430	277	660	133	172	332
14 Sept.	22	48,5	1531	407	262	684	127	–	354
Sub-adults									
1973:									
24 June	19	43,5	1508	422	258	640	117	165	–
24 June	19	41,5	1478	378	260	621	120	166	328
19 Dec.	13	32,5	1426	362	252	562	121	150	294
21 Dec.	13	28,0	1392	374	269	632	109	154	300
1974:									
9 Apr.	17	42,0	1460	385	276	650	126	156	336
10 Aug.	9	16,5	1084	319	216	485	96	113	231

– = Damaged skull

Table 29 – Female warthog, mass (Kg) and measurements (mm) from the study area, Okavango Delta, Botswana, May 1973 – September 1975

DATE	APPROXIMATE AGE IN MONTHS	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
								Zygomatic width	Total length
Adults									
1973:									
9 May	54+	62,0	1534	364	254	730	124	174	312
24 May	54+	61,0	1602	391	254	660	120	181	337
20 Aug.	33	48,0	1491	337	235	587	98	–	–
9 Sept.	45	59,5	1591	379	249	643	124	–	–
28 Sept.	22	40,0	1493	352	238	577	109	–	–
8 Oct.	47+	70,0	1518	350	254	694	123	–	–
12 Oct.	35	49,0	1463	348	244	633	125	–	–
9 Nov.	36+	57,0	1597	431	250	641	126	–	348
9 Nov.	24	43,5	1437	387	243	608	120	158	304
18 Dec.	49+	53,0	1516	406	249	624	115	172	342
18 Dec.	37	53,0	1445	391	243	642	109	164	324
1974:									
18 June	55+	55,5	1597	423	261	631	125	183	351
10 Aug.	45+	49,0	1500	375	246	602	120	171	354
19 Aug.	45	53,0	1638	412	248	603	116	166	331
30 Aug.	21	36,0	1402	380	251	611	118	153	306
1975:									
10 March	28	47,0	1446	406	243	548	108	156	301
11 Sept.	22	42,0	1399	412	246	570	113	158	316
Sub-adults									
1973:									
23 Nov.	12	26,5	1255	342	228	542	101	–	–
1974:									
3 June	7	16,5	1065	286	206	409	95	113	219
18 June	7	11,0	919	232	187	384	84	96	197

– = damaged skull

Family Hippopotamidae
Hippopotamus amphibius capensis Desmoulins, 1825
Hippopotamus; Kubu

Hippopotamus are widely distributed, occurring in Middle and Outlet Channel Communities Madiba and some Shallow Backwater Communities, but not in good population size except at some localised spots within the study area. Hippopotami occur seasonally on some of the larger pans on Chief's Island. Represented by a good population of approximately 150 hippopotami in the Moremi Wildlife Reserve in high flood years and at other isolated points throughout the Delta (some upper and lower Madiba Communities and parts of the Upper Channel Communities).

Hippopatami move widely in accordance with prevailing water conditions, and more locally to graze. They will move over long distances (50 to 60 km) of dryland to reach a suitable pan isolated in a total dryland vegetation type. Hippopotami are often blamed for dislodging large quantities of floating sudd and debris, but more usually this occurs as a result of human disturbance by boat when hippopotami seek a flight path to escape. They are by nature inquisitive and somewhat aggressive but the latter characteristic may largely be due to old bullet wounds. Normally hippopotami follow well-defined paths in their movement in the channels or across islands to feeding grounds. Those paths occurring on dryland are characterised by their double track with a small central raised ridge cf. a 'middelmannetjie' as compared to flat elephant paths. These paths can play a significant role in flooding relatively distant off channel depressions and in some instances result in new channel development.

Hippopotami are predominantly grazers feeding on a wide variety of grasses in Closed Riverine Woodland, marginal vegetation types, *Acacia tortilis* Savanna Woodland and the floodplain vegetation types but largely on short *Sporobolus spicatus* Island Grassland Community which they and lechwe utilise heavily. Tinley (1966) reports hippopotami feeding on water lily tubers and this was also witnessed in the Dombo lediba of Moremi Wildlife Reserve. Plant species observed to be eaten by hippopotami are *Cynodon dactylon, Sporobolus spicatus, Vossia cuspidata, Echinocloa stagnina, Imperata cylindrica* and *Oryza longisteminata.* A large number of fringe grass and sedge species are also utilised in feeding.

During daylight hours hippopotami are usually found in the water, but occasionally they are found resting up on sand banks or small Delta islands. They are semi-aquatic and amphibious. Single individuals, usually adult bulls, are encountered, but more commonly groups of hippopotami usually comprised of eight to 14 individuals are found. Concentrations of up to 36 hippopotami are encountered in the Moremi Wildlife Reserve. At night hippopotami may be encountered in the channel communities but they are usually found out of water and grazing on the numerous islands. Its bulk enables a hippopotamus to keep channels open by constant movement along them. However, once a blockage is fairly consolidated hippopotami merely move around such and thus only really play a role in the removal of early stages of surface blockage. Their numbers seem to have declined in the last 20 years, probably from local hunting pressure and the utilisation of hippopotamus carcasses for crocodile bait by the crocodile hunters during the early 1960's. Both local and crocodile hunters admitted to illegal removal of hippopotami during this period. The removal of a large number of hippopotami can have far reaching effects in drainage patterns and conversely an excessive build-up of the population under strict protection may again alter the drainage patterns especially in the north-eastern areas where the highest population sizes thrive. Delta hippopotami populations are estimated to be about one third the size of Kwando/Linyanti populations, where the human factor is far less operative. Tinley (1977) gives population estimates for Urema Lake, Gorongosa of 2 301 hippopotamus per 15 km^2 of lake area.

Juveniles were recorded in February, May and October, pointing to a possible all-year breeding season. Ansell (1960) states that young may be born at any time of the year. Females with new-born calves were encountered on their own, and would appear to rejoin the herd when the calf is about two weeks old.

The highest population estimate of hippopotami occur in the M'borogha floodplain system and this during the driest times. During May 1973 the population estimate of 331 for this sector is considered an overestimate since the census overlapped into the northwestern parts of Moremi Wildlife Reserve. Nevertheless comparison of statistical results obtained from aerial surveys numbers 1, 4, 7, 11, 14 and 17 (Appendix 1 - 17) serve to illustrate how with increased water quantity the movement is predominantly out of the study area. This migration takes place towards the lower-Delta as its water levels rise and an estimated population of 21 hippopotami remain in this eastern floodplain section of the study area. The Madiba Communities to the north of Chief's Island always maintain a small hippopotami

population (10 to 20 individuals) and in good rainy seasons isolated individuals may utilise the pans on Chief's Island. The Boro floodplain system holds a low estimated population size of hippopotami in the study area with a maximum of 10 individuals. The study area probably carries on average about 30 hippopotami during high water level conditions and about 150 individuals during low water conditions.

Family Giraffidae
Giraffa camelopardalis angolensis Lydekker, 1903
Giraffe; Thutlwa

Giraffe are widely distributed throughout the study area and in good population size, but less common on the M'borogha floodplains. Movement is fairly localised and giraffe are not afraid to cross water 1,5 to 2 m deep when moving to fresh browsing areas. The largest population estimate is associated with the dryland vegetation types, followed by the marginal vegetation types and the Closed Riverine Woodland Community. Table 30 provides a breakdown of habitat preferences.

Table 30. Plant community (habitat) preferences of giraffe in the study area Okavango Delta, Botswana 1973-1975 from 584 sightings

PLANT COMMUNITY	PERCENTAGE OCCURRANCE
Acacia erioloba Woodland and Savanna Woodland	23
Acacia tortilis Savanna Woodland	21
Alterns between Closed Riverine Woodland and floodplain vegetation types	11
Closed Riverine Woodland	8
Acacia nigrescens – *Croton megalobotrys* Woodland and Savanna Woodland	8
Colophospermum mopane Woodland	7
Secondary Floodplain	6
Terminalia sericea – *Combretum collinum* Savanna Woodland	5
Combretum imberbe – *Croton megalobotrys* Woodland and Savanna Woodland	4
Primary Floodplains	3
Grewia spp. – *Croton megalobotrys* Scrub Savanna	2
Hyphaene ventricosa – *Croton megalobotrys* Palm Woodland	2

Giraffe are browsers, and feeding records observed are *Acacia erioloba, A. tortilis, A. hebeclada, A. hereroensis, A. sieberana, A. leuderitzii, A. fleckii, A. galpinii, A. nigrescens, Boscia mossambicensis, Combretum imberbe, C. molle, C. collinum, Albizzia harveyi, Dichrostachys cinerea, Sclerocarya caffra, Berchemia discolor, Terminalia sericea, Ziziphus mucronata, Grewia schinzii, G.* spp. *Lonchocarpus capassa* and *L. nelsii.* Hall-Martin (1974) shows slight use of tall grasses during the summer months and a marked seasonal change in the selection of tree utilized for feeding by giraffe in the Eastern Transvaal lowveld. Heavy giraffe browsing is locally apparent on parts of the northern third of Chief's Island.

Solitary individuals occur but more generally giraffes are gregarious, occurring in the study area in herds of two to seven individuals or less commonly from eight to 13 individuals. The largest herd observed comprised 20 individuals. The totals from all observations of adult males, adult females, sub-adults and juveniles were expressed relative to one another after each being reduced relative to the greatest total being reduced to one hundred. These figures are then compared with Robbel and Child (1976) sex and age data for Moremi Wildlife Reserve. For every hundred adult giraffe females in the study area 58 adult males, 42 sub-adults and 34 juveniles occurred. Robbel & Child *(op. cit.)* obtained figures of 65 adult male giraffe, 43 sub-adults and 36 juveniles per 100 adult female giraffe, thus providing close comparison to their adjacent study areas data.

Giraffes were generally in fair to good condition but two known adult males remained in very poor condition. One of these males was subsequently killed by lions, whilst the other never seemed to improve in condition throughout the study.

New-born giraffes were observed in May, July, August and October. The birth season appears to stretch throughout the year (Smithers, 1971) but with a peak during the winter months (May to August). Only single births are on record for Botswana after a gestation period of approximately 450 days (Dorst and Dandelot, 1970; Hall-Martin, 1975).

An average population estimate of 430 giraffe exists in the study area during all seasons and flood conditions. This provides for an average population density of 0,24 giraffe/km^2. Comparison of this with crude population densities from other regions of Africa which varies from 0,01 to 2,60 (Hall-Martin, 1974) shows a reasonable population strength. Local movement between Chief's Island and the floodplain systems exists and this occurs immaterial of floodwater levels. Chief's Island carries the bulk of this standing population,

about 310 individuals, followed by the Boro floodplain system with about 80 giraffe and the largely inundated M'borogha floodplains with an average of about 40 giraffe. During the driest conditions the M'borogha floodplains carries its lowest population density of giraffe.

Family Bovidae
Sylvicapra grimmia speldidula (Gray, 1871)
Common or Grey duiker; Phuti

Only two grey duiker were observed in the study area, whereas four were seen in lower-Delta areas. Thus nowhere in the Delta do they appear to be common.

Grey duiker tolerate a wide variety of habitat types (Smithers, 1971). Nothing is known of their movement patterns in Botswana but movements are supposedly localised as elsewhere.

Grey duiker usually occur singly or in pairs or as a female and her offspring. Mainly nocturnal in Botswana and adjacent territories, (Smithers *op. cit.*), but individuals may be recorded during daylight hours. Due to its nocturnal habits, the population may be larger than expected, but it probably still occurs in low densities in the study area. Grey duiker are predominantly browsers and appear to breed throughout the year.

Raphicerus campestris steinhardti (Zukowsky, 1924)
Steenbok; Phuduhudu

Steenbok are scarce in the study area where only seven individuals were recorded, six of these from aerial surveys. Recorded from Chief's Island and the eastern and western floodplains. Occurrences were in *Acacia eriobo or A. tortilis* Woodland or Savanna Woodland or dry Secondary Floodplain Communities. Steenbok appear to be confined to a relatively small home range.

Steenbok are predominantly browsers and consume a fairly high proportion of forbs (Cohen, 1972). They are predominantly diurnal and occur solitarily or in pairs or as a female with offspring. The subspecies breeds throughout the year (Smithers *op. cit.).* The population estimate probably does not exceed 30 individuals for the study area.

Tragelaphus strepsiceros strepsiceros (Pallas, 1766)
Kudu; Tholo

Kudu are common and well distributed throughout the study area. Eighty two per cent of the occurrences were in various woodland communities, mainly on the islands of the floodplain systems. The remaining occurrences were on dry or inundated floodplain communities.

Percentage occurrence in the various woodland vegetation communities was; Closed Riverine Woodland and marginal vegetation types 27 per cent, *Acacia tortilis* Savanna Woodland 18 per cent, *A. erioloba* Woodland and Savanna Woodland 16 per cent, *Colophospermum mopane* Woodland 13 per cent and *Terminalia sericea – Combretum collinum* Savanna Woodland 8 per cent.

Kudu move widely and show no fear of crossing shallow waters. Child (1968a) remarks that in operation Kariba "kudu were amongst the first animals to take to water when men landed on an island". This lack of fear of water explains their widespread distribution in parts of the more permanently inundated M'borogha floodplains.

Kudu are predominantly browsers, and observed feeding records include *Acacia erioloba, A. tortilis, Grewia* spp., *Croton megalobotrys, Boscia mossambicensis, Combretum* spp., *Terminalia sericea* and *Commiphora africana.* The pods of *Acacia* spp. are also utilised as well as various other fruits.

Kudu are diurnal and nocturnal and usually occur singly or in small herds. Herd sizes of two to 13 individuals were recorded and single individuals were most commonly adult bulls (53 out of 56 observations) but odd single cows were also noted. Adult bulls may be with a cow subadult/juvenile herd but they were more often absent. Adult male groups comprising two to four individuals were fairly common. In the study area kudu were found to be very shy and one of the first mammals to take to flight.

Although Smithers (1971) suggests an all-year breeding season, new-born juveniles were only noted in October, December, January, February and March in the study area.

Chief's Island supports the highest biomass of the kudu population but the population estimates (Appendix 1 - 17) are considered to be a gross underestimate due to the cryptic

nature of kudu in their favoured habitat. There is a marked movement of kudu from the islands of both adjacent floodplain systems onto Chief's Island during the rainy season. The average population estimate of about 190 kudu for the total study area is considered low.

Tragelaphus spekei selousi Rothschild, 1898
Sitatunga; Naakong

Sitatunga are widespread and reasonably common but only in the heavily inundated upper mid-Delta areas. Largest population estimate in the study area is on the M'borogha floodplains, and also on the mid-Boro floodplain system but chiefly in the margin and largely out of the gazetted western extension boundary of the Moremi Wildlife Reserve in the latter case. Their present distribution has diminished greatly when compared with their former range, viz. Andersson (1856) and Bryden (1893) record sitatunga from Lake Ngami. Leyland (1866) obtained the horns and skin of the ". . .Nakong, *(Antelope anderessoni)* . . . . I was informed that it had been procured a long way up the Tamunackle River" (Thamalakane) "which runs into the Zouga" (Boteti River). Selous (1881) records them from the Mababe and Thamalakane reedbanks and also the upper Boteti River.

The shrinkage of their distribution can be attributed largely to altered flooding patterns and the lack of suitable habitat in the above reference areas under present day conditions. Hunting pressure will have also played a lesser role, especially in the vicinity of Maun when a large influx of people moved in during 1915.

Habitat requirements and water levels are the most important factors governing the distribution of sitatungas. Sitatungas also require permanently flooded areas and their movement is governed by water levels. Favoured habitats are Sumps, Shallow Backwater and Flats Communities and medium to heavily inundated Primary Floodplain Communities but all studded with terminaria islands or small islands. Water levels of between 0,30 and 0,60 m are preferred. As floodwater levels recede sitatungas move northwards in the Delta, but they again move down as the floodwaters spread out, always remaining in the tall *Cyperus papyrus*, *Miscanthidium junceum* and sedge areas or in the associated open Sump Communities and small islands.

Sitatungas are largely grazers but they also browse. Feeding during daylight hours seems to take place largely in the water whilst at night they appear to utilise adjacent dryland verges viz. *Sporobolus spicatus* Island Grassland Communities. Feeding records include *Cyperus papyrus* umbels, *Nymphaea* spp. leaves and stems, *Nymphoides indica, Brasenia schreberi* leaves and stems, *Phoenix reclinata* leaf tips, *Cynodon dactylon, Sporobolus spicatus, Phragmites* spp leaves and shoots and numerous other aquatic and semi-aquatic grass species and sedge species.

Sitatungas are solitary or occur in small groups of two or three individuals. Smithers (1971) reports groups of five or six individuals in the upper-Delta, but within the study area the largest recorded group was three adult males. Sightings of two individuals include an adult male and adult female or adult female and sub-adult or juvenile accompanying. Sightings of single individuals, either adult male or adult female were the most common. Sitatungas are nocturnal and diurnal and apparently only move onto open ground at night or during very early daylight hours. During cooler daylight hours sitatungas prefer the open Sump Communities, but always those surrounded by tall aquatic vegetation. During the hotter parts of the day sitatungas retire to small thickly-wooded termitaria islands where they rest up, whence they move out to the Sumps, Shallow Backwater or Flats Communities to feed during the later afternoon. Sitatungas are shy antelopes and when disturbed issue a raucus growling alarm bark typical of the genus *Tragelaphus.* They are strong swimmers and will take to deep water on occasion, but more typically they take refuge in the tall aquatic vegetation always available in or adjacent to the favoured habitat types.

Two heavily pregnant females were observed during mid-August which looked as though they would calve before the end of September. Other records seem to indicate an all year round breeding season, with a peak during the dry season of April to September (Ansell, 1960).

An adult male sitatunga collected adjacently in Jao on a private hunting trip showed fresh crocodile teeth scar marks on the mid hing leg and Smith (pers.comm.). witnessed a crocodile unsuccessfully attempting to catch a sitatunga. Sitatunga fall prey to lions and probably to crocodile and leopard.

Sitatungas are extremely difficult to census in conjunction with other species by the methods used in this survey. A specialised type of census using low-speed and low-flying fixed-wing aircraft or helicopter covering their prime habitats would provide more accurate data. The only conclusions that can be drawn from this total studies census is that the M'borogha floodplains carry the bulk of the sitatunga population within the study area, and that the greatest concentration estimate of 62 sitatungas are recorded in it during the drier seasons. This is not totally borne out by ground observations as no sitatunga were recorded from this area during 1974 by aerial survey, but they were certainly located in the ground work. Aerial survey confirms ground work on the Boro floodplains, namely that not more than 15 sitatungas are within the western floodplains conserved area.

Tragelaphus scriptus ornatus Pocock, 1900
Chobe Bushbuck; Sekolo-botlhoko; Ngurungu

Chobe bushbuck are not common in the study area and the Okavango Delta in general. A total of only five Chobe bushbuck were recorded from the study area. All were recorded in Closed Riverine Woodland or in the adjacent Primary Floodplain Community verge, and all in the vicinity of permanent water.

Bushbuck occur singly, in pairs or as a female with her offspring, and are nocturnal and diurnal and extremely shy. Smithers (1971) suggests a long breeding season from November to June and possibly throughout the year.

Aepyceros melampus melampus (Lichtenstein, 1812)
Impala; Phala

Impalas are very common and widely distributed throughout the study area, but not occurring in flooded vegetation types. Impalas occurred in woodland communities in 57 per cent of observations preferring the more open savanna woodland; and on open grassland in 43 per cent of all observations. This high degree of occurrence on non-typical habitattype is due to the mosaic of vegetation communities and the dynamics of flooding patterns which provide green grazing in open areas when little is available on the islands. Where possible impala tend to remain in the ecotones or alterns when utilising open grazing. Smithers (1971) states that they tend to avoid open grassland or floodplains except marginally or

when in transit. Impalas are quick to take to flight into wooded areas when encountered in the floodplains. Notably impala made far more use of Secondary Floodplain Communities during the dry 1973 season, but during the excessive rains and floods of 1974 they were forced to utilise *Sporobolus spicatus* Island Grassland Communities as the former was inundated. Impalas show a strong dislike for water and would only under extreme pressure cross shallowly flooded areas to escape to another island.

Table 31 indicates impalas habitat preferences from one extremely dry and one extremely wet year. Coupling the Secondary Floodplain, Primary Floodplain and Closed Riverine Woodland Communities, or marginal vegetation types, the altern of which most impalas were encountered on provides a 37 per cent utilisation. There is a strong tendency to graze on these alterns and overutilisation occurs in parts of them. Considerable movement occurs from the floodplain systems onto Chief's Island during the summer rainy season, but only for three to four months. Impalas tend to overutilise short grazing and especially so during the high floods when they were limited to the islands by high water levels.

Table 31. Plant community (habitat) preference of impala in the study area, Okavango Delta, Botswana, March 1973 – November 1974 from 1 226 sightings

PLANT COMMUNITY	PERCENTAGE OCCURRENCE
Secondary Floodplain Communities (Mainly verges) Mainly dry years	20
Sporobolus spicatus Island Grassland Communities – Mainly wet years	16
Acacia tortilis Savanna Woodland	13
Acacia erioloba Woodland and Savanna Woodland	12
Closed Riverine Woodland – Mainly wet years	10
Primary Floodplain Communities (Mainly verges) – Mainly dry years	7
Colophospermum mopane Woodland and Scrub Savanna	6
Acacia nigrescens – Croton megalobotrys Woodland and Savanna Woodland	4
Combretum imberbe – Croton megalobotrys Woodland and Savanna Woodland	4
Hyphaene ventricosa – Croton megalobotrys Palm Woodland and Palm Savanna Woodland	3
Grewia spp. –*Croton megalobotrys* Scrub Savanna	3
Terminalia sericea – Combretum collinum Savanna Woodland and Scrub Savanna	2

Impalas in the study area are largely grazers with usually an estimated 80 to 90 per cent of rumen content comprising grass and the remainder browse. Robbel and Child (1976) report similar high grazing percentages for impala in the Moremi Wildlife Reserve. During high floodwater levels when impala are limited to the islands the percentage utilisation of browse appears to increase but grass is still predominant in the rumen contents.

Recorded plant specimens fed on by impala include *Acacia erioloba, A. fleckii, A. sieberana, A. tortilis, A. hebeclada, A. nigrescens, Combretum imberbe, C. hereroense, C. collinum, Ziziphus mucronata, Croton megalobotrys, Solanum* spp., *Grewia* spp., *Colophospermum mopane, Dichrostachys cinerea, Commiphora africana, Bauhinia macrantha, Boscia mossambicensis,* seed pods of *Acacia* spp. fruits of *Solanum* spp., *Diospyros mespiliformis, Sclerocarya caffra, Garcinia livingstonei;* flowers of *Kigelia africana* and *Lonchocarpus* spp. Grasses utilised include *Panicum aphanoneurum, P. coloratum, P. maximum, P. repens, Eragrostis lappula, E. biflora, Brachiaria humidicola, Cynodon dactylon, Sporobolus salsus, S. fimbriatus, S. spicatus, Chloris gayana, C. virgata, Imperata cylindrica, Oryza longistaminata, Urochloa brachyura, Acroceros macrum* and *Tricholaena monachne.*

Impalas are diurnal and nocturnal and occur in small or large herds, single adult males or batchelor herds. Herd size generally varies from six to 30 individuals although groups of up to 50 impalas were encountered fairly often. The largest herd encountered comprised 62 individuals, but it is thought that some of these larger herds comprise joining of two or even three smaller herds. Eighty-two per cent of single impalas observed were adult males, 11 per cent were sub-adult males and the remaining seven per cent were adult females. Batchelor herds usually comprised two to seven individuals, but larger groups of up to 22 individuals were encountered. Smithers (1971) notes larger impala herd sizes in the lower-Delta areas when compared with populations outside the Delta.

The condition of impalas as based on their kidney fat index ranged from excellent in 15 per cent of specimens to poor in 30 per cent, with 55 per cent of cases being in fair condition according to the prevailing season. Adult male impalas showed a definite peak in condition prior to the rut and a rapid decline in condition once the rutting season commenced. (Table 32). When floods are excessive and Secondary Floodplain and Primary Floodplain Communities cannot be utilised, condition indices maintain a lower level than if these habitat types were available. Adult females showed a similar trend under high flood conditions (Table 33).

Table 32 – Mean seasonal kidney fat indices (percentages) of adult male and female impala from the study and adjacent areas, Okavango Delta, Botswana, March 1973 – November 1975

YEAR AND MONTH	ADULT MALES	ADULT FEMALES	REMARKS
1973:			
Mar.	–	–	
Apr.	46,95	–	
May	–	–	Rut commences mid-May 1973.
Jun.	21,59	40,70	
Jul.	10,14	41,45	Flood-levels peak.
Aug.	6,72	47,10	
Sep.	8,92	36,70	
Oct.	22,30	15,60	
Nov.	8,22	19,35	
Dec.	24,17	5,30	Lambing commences.
1974:			
Jan.	–	12,83	Excessive rains and local floods.
Feb.	–	7,01	Excessive rains and local floods.
Mar.	–	16,74	Excessive rains and local floods.
Apr.	27,45	7,74	Rut commences mid-April 1974.
May.	7,28	7,90	Excessive floods restrict movement and vegetation types available
June	–	14,00	
Jul.	–	–	
Aug.	5,42	19,60	
Sep.	7,62	16,52	
Oct.	–	5,96	
Nov.	15,53	6,14	Lambing commences.
Dec.	–	–	
1975:			
Jan.	64,52	–	
Feb.	–	5,95	
Mar.	61,13	18,15	
Apr.	–	–	Rut commences mid-April 1975.
May	18,59	23,22	Excessive flood-levels.
Jun.	–	–	
Jul.	7,70	32,96	
Aug.	–	40,80	
Sep.	14,39	38,73	
Oct.	5,00	13,28	
Nov.	8,97	–	Lambing commences.

Note: During 1975 some impala were collected at the eastern base of the Delta where flooding does not effect their movement as it does in the study area.

Table 33 – Foetal impala data, conception and parturition dates after Huggett and Widdas (1951) for the study and adjacent areas, Okavango Delta, Botswana, June 1973 – October 1975.

DATE OF COLLECTION	MASS (GRAMMES)	SEX	CROWN-RUMP LENGTH (MILLIMETRES)	POST-CONCEPTION AGE (DAYS)	APPROXIMATE CONCEPTION DATE	APPROXIMATE PARTURITION DATE
1973:						
23 Jun.	7,5	?	44	57	27 Apr.	6 Nov.
2 Jul.	8,0	?	51	57	4 May	16 Nov.
22 Aug.	140,9	M	221	107	8 May	20 Nov.
9 Sept.	462,4	F	236	109	23 May	5 Dec.
8 Oct.	1 590,4	M	315	145	16 May	28 Nov.
9 Nov.	4 000,0	M	455	183	10 May	22 Nov.
1974:						
5 Jun.	3,5	?	35	53	11 Apr.	23 Oct.
13 Jun.	11,1	?	70	77	28 March	6 Oct.
5 Aug.	574,4	M	242	115	12 Apr.	24 Oct.
10 Sept.	1 433,3	F	350	142	21 Apr.	2 Nov.
14 Sept.	2 057,7	F	366	155	12 Apr.	24 Oct.
15 Oct.	5 750,0	M	551	195	4 Apr.	16 Oct.
19 Oct.	4 250,0	F	516	186	17 Apr.	29 Oct.
1975:						
19 Jul.	165,0	M	–	89	21 Apr.	2 Nov.
12 Aug.	486,6	M	232	111	24 Apr.	5 Nov.
12 Aug.	9,7	?	57	59	14 Jun.	26 Dec.
2 Sept.	1 193,8	M	331	136	19 Apr.	31 Oct.
12 Oct.	1 878,0	F	411	151	14 May	26 Nov.
12 Oct.	2 165,0	M	424	157	8 May	20 Nov.

Adult female impalas do not generally show condition loss during the rut, but rather show a steady condition build-up until the last month or two of pregnancy when condition drops and continues doing so in the early months after parturition. (Table 33). Robbel and Child (1976) found impala in poor condition from August to November 1969, with only 1,1 per cent of males and 2,1 per cent of females judged in better than poor condition, and in a year-round sample only one male was judged to be in good condition.

In general the population in the study area and that observed in Moremi Wildlife Reserve during 1975 should have been in better condition and should be monitored for overpopulation and habitat overutilisation, and some culling programme initiated.

Impalas are strictly seasonal breeders. The rutting takes place during April through May to June with a peak in either April or May. The commencement of rutting appears to be effected by the season and condition of the impala, and the rut only commenced about early May during 1973 whilst it had peaked during April in good seasons of 1974 and 1975 (Table 32). Robbel and Child *(op. cit.)* showed the peak of rutting in Moremi Wildlife Reserve during 1969 to occur between the 12th and 16th of May. Table 33 gives breeding data for impalas from the study and adjacent areas. Peak of births during good versus poor seasons are offset by about one month. The gestation period for impalas is 196 to 200 days (Brand 1963, Fairall 1969). All implantations occurred in the right uterine horn immaterial of whether ovulation occurred from the right or left ovary (10 left, 13 right; **(pers. observ)**. No cases of twinning were observed. Sub-adult female impalas were found to mate for the first time at about 16 months of age and thus produce their first juvenile at approximately two years of age.

The average population density on the Boro floodplains of 2,34 impalas/km^2 is approximately double that of the M'borogha floodplains (1,23 impalas/km^2) due to the latter's potentially greater inundated areas. During the driest times the M'borogha floodplains showed its highest impala average population density of 2,56 impalas/km^2 (May and December 1973) whilst during higher floodtimes the average density of 0,44 impalas/km^2 is about one fifth of that during drier periods. These impala either move westwards to Chief's Island or southwards out of the study area, but any large channel serves as a boundary to their movement. Chief's Island carries the overall annual highest average population density of 3,83 impalas/km^2 but the area is not equally utilised, resulting in local overgrazing. The Boro

floodplains carries the highest population density during driest period of 4,28 impalas/ km^2 (30 August 1973) but marked movement occurs onto Chief's Island once the summer rains have commenced. (Appendixes 1 - 17).

Mass and measurements of impala appear in Tables 34 and 35.

External parasites:
(Acarina)
Rhipicephalus evertsi evertsi Neumann, 1897
R. sanguineus (Latreille, 1906)
R. appendiculatus Neumann, 1901
R. tricuspis Dönitz, 1910
Boophilus decoloratus (Koch, 1844)
Amblyomma hebraeum Koch, 1844
Ixodes sp.

(Anoplura)
Linognathus nevilli Ledger, 1973

Internal parasites:
Agriostomum gorgonis Le Roux, 1929
Carmyerius mancupatus (Fischhoeder, 1901) Goedelst, 1911
Moniezia benedeni (Moniez, 1879) R. Blanchard, 1891
Haemonchus sp.
Stilesia hepatica Wolffhügel, 1903
Thysaniezia giardi (Moniez, 1879) Skrjiabin, 1926
Oesophagostomum sp.
Paramphistomum microbothrium Fischhoeder, 1901
Trichuris globulosa (Linstow, 1901) Ransom, 1911

Redunca arundinum arundinum (Boddaert, 1785)
Reedbuck; seBugatla

Reedbuck are widely distributed in all the floodplain systems of the study area and populations occur in good numbers. General distribution in the Delta is good. Reedbuck utilise dry or wet Secondary Floodplain and Primary Floodplain Communities, in general prefering tall open grass and/or sedge habitats. Old Secondary Floodplain Communities

Table 34 – Male impala mass (Kg) and measurements (mm) from the study and adjacent areas, Okavango Delta, Botswana, April 1973 – November 1975

DATE	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
							Zygomatic width	Total length
Adults								
1973:								
4 Apr.	59,0	1 755	286	459	911	153	112	280
27 Apr.	62,5	1 733	350	460	936	157	110	270
23 Jun.	52,0	1 672	285	438	925	149	108	259
23 Jun.	55,0	1 586	287	445	927	150	114	262
13 Jul.	50,0	1 620	294	445	925	155	108	266
13 Jul.	52,0	1 625	318	428	889	150	111	254
14 Aug.	56,0	1 746	354	449	931	148	114	268
20 Aug.	59,0	1 761	343	451	961	153	116	266
8 Sept.	56,0	1 650	320	445	875	148	–	–
16 Sept.	57,5	1 641	342	427	911	156	–	–
29 Sept.	56,5	1 712	347	444	872	149	112	255
13 Oct.	56,5	1 775	360	440	841	146	–	–
7 Nov.	55,0	1 692	359	441	940	154	111	264
7 Nov.	50,0	1 688	345	473	931	161	112	274
15 Dec.	57,0	1 753	372	459	995	158	115	267
19 Dec.	50,0	1 631	314	432	846	160	114	271
28 Dec.	51,0	1 614	362	446	929	146	109	270
1974:								
6 Apr.	64,0	1 736	388	481	940	159	117	283
11 Apr.	58,0	1 654	352	452	950	154	112	275
13 May	54,0	1 641	322	445	921	148	110	270
28 May	53,5	1 581	318	442	900	145	110	265
5 Aug.	51,5	1 691	346	457	960	156	115	270
8 Aug.	48,0	1 672	344	438	859	150	110	264
14 Aug.	58,5	1 720	349	447	914	152	114	273
2 Sept.	47,0	1 615	318	445	830	155	106	262
2 Sept.	54,5	1 706	359	459	911	155	111	265
13 Nov.	57,5	1 622	328	439	898	148	112	272
17 Nov.	58,0	1 721	366	451	880	150	113	269
1975:								
30 Jan.	54,5	1 589	322	419	905	156	111	259
3 March	67,0	1 683	351	454	996	153	115	279
7 March	70,5	1 794	418	463	980	151	112	286
11 March	57,5	1 644	373	433	885	153	111	270
26 March	65,0	1 732	352	469	998	159	113	277
5 May	52,5	1 688	366	437	871	149	108	263
7 May	61,0	1 786	336	456	942	162	112	275
19 Jul.	61,0	1 786	398	446	918	160	117	282
1 Sept.	59,0	1 624	352	440	911	151	116	274
8 Oct.	56,0	1 706	355	449	920	151	–	–
18 Nov.	54,0	1 775	381	459	888	154	–	–
Sub-adults and juveniles								
1973:								
24 Apr.	40,0	1 555	300	–	871	145	99	244
9 May	28,0	1 370	305	420	810	141	96	242
6 Nov.	38,0	1 505	310	431	878	150	107	257
1974:								
11 Apr.	18,5	1 190	279	371	715	135	85	186
26 May	42,0	1 620	350	466	779	150	108	262
28 May	41,5	1 583	345	439	887	151	105	256
21 May	25,0	1 331	285	405	784	144	–	–

– = damaged material.

Table 35 – Female impala mass (Kg) and measurements (mm) from the study and adjacent areas, Okavango Delta, Botswana, April 1973 – October 1975.

DATE	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
							Zygomatic width	Total length
Adults								
1973:								
11 Apr.	36,0	1 484	292	415	815	142	94	226
23 June	39,0*	1 535	272	417	871	136	101	249
2 Jul.	42,0*	1 547	298	420	863	141	94	241
5 Jul.	47,0	1 635	318	440	825	152	103	265
22 Aug.	43,0*	1 482	314	431	855	142	99	252
9 Sept.	40,0*	1 595	304	411	874	146	97	246
8 Oct.	40,0*	1 652	320	425	915	156	–	–
9 Nov.	42,5*	1 537	316	407	858	144	–	–
19 Dec.	37,5	1 560	328	431	800	146	96	252
24 Dec.	43,0	1 583	301	426	860	145	103	264
1974:								
9 Jan.	43,0	1 509	330	425	807	150	101	266
14 Feb.	44,0	1 575	318	422	825	155	102	259
24 Feb.	42,5	1 595	334	421	835	151	100	260
1 March	41,0	1 576	297	425	840	150	105	265
1 March	42,0	1 590	301	430	930	149	103	266
11 Apr.	36,0	1 486	300	421	860	140	93	248
9 May	40,0	1 641	345	434	865	149	101	276
15 May	43,5	1 619	333	427	874	155	106	265
5 June	45,5*	1 598	302	449	862	152	104	265
13 June	45,5*	1 703	330	432	878	149	109	270
5 Aug.	41,0*	1 607	315	427	881	148	102	258
10 Sept.	46,0*	1 612	314	433	868	151	99	265
14 Sept.	46,0*	1 601	334	440	891	149	103	258
15 Oct.	52,5*	1 684	330	441	910	159	104	273
19 Oct.	49,5*	1 611	326	436	850	158	99	261
20 Nov.	43,0	1 620	329	432	890	149	103	264
1975:								
2 Feb.	37,0	1 547	323	401	811	140	96	246
10 Feb.	43,0	1 534	320	421	826	150	100	255
7 March	42,5	1 628	332	424	802	145	91	255
26 March	40,0	1 601	305	423	898	141	100	259
5 May	40,5	1 560	314	429	835	142	96	257
12 May	40,5	1 574	311	428	870	145	99	247
19 Jul	52,0*	1 771	340	433	885	149	105	263
12 Aug.	46,0*	1 646	333	417	865	151	102	256
12 Aug.	38,0*	1 581	305	406	810	143	100	252
2 Sept.	46,0*	1 659	351	423	875	142	103	249
8 Oct.	43,0*	1 595	321	427	850	144	–	–
12 Oct.	45,5*	1 667	325	432	810	150	–	–
12 Oct.	45,5*	1 690	326	422	860	154	–	–
Sub-adults and juveniles								
1973:								
13 Sept.	28,0	1 367	265	401	704	139	90	225
1974:								
31 May	23,0	1 309	264	398	775	141	95	209
31 May	24,0	1 273	276	397	743	141	90	214
1975:								
3 Aug.	27,0	1 420	293	405	800	145	93	222

*Pregnant

– =damaged skull

in the early stages of evolving towards a savanna woodland Community, but still with tall grass, invariably contains reedbuck. Reedbuck are occasionally found in the adjacent marginal vegetation types or Closed Riverine Woodland Communities. They are localised and show little tendency to move even when floodlevels are fairly high. In Zululand reedbuck utilise either tall open grassland or woodland areas but with tall grass cover *pers. obsv.* Table 36 represents habitat preference of reedbuck in the study area.

Table 36. Reedbuck plant community (habitat) preference in the study area, Okavango Delta, Botswana, 1973 – 1975.

PLANT COMMUNITY (HABITAT)	PERCENTAGE OCCURRENCE
Primary Floodplain Community	55
Secondary Floodplain Community	22
Shallow Backwater Communities (when dry or nearly dry)	8
Termitaria in floodplain communities	6
Closed Riverine Woodland (verge)	4
Sporobolus spicatus Island Grassland Community	3
Outlet Channel Communities	2

Reedbuck are grazers and utilise grasses and sedges, and show some overlap with lechwe in habitat utilisation and grazing habits. Pienaar (1963) and Jungius (1971) report them as taking some browse including wild fruits, but this was not observed during this study.

Jungius *(op. cit.)* shows the following grasses and sedges which also occur in my study area, to be most utilised by reedbuck in the Kruger National Park: *Hyperthelia dissoluta, Panicum maximum, Trachypogon spicatus, Setaria sphacelata, Imperata cylindrica, Leersia hexandra, Cyperus fastigiatus* and *Kyllinga erecta.*

Reedbuck are diurnal and nocturnal and feed at night and during the early and later cooler daylight hours. They rest up in tall grass, termitaria verges or occassionally in Closed Riverine Woodland Communities. They occur singly, in pairs or in small groups of up to six individuals. Fifty five per cent of all observations were of single individuals, either adult males, adult females or sub-adult males, 28 per cent of the observations were of pairs, either as adult male and a female or a female with a juvenile/sub-adult, while 11 per cent of all observations comprised three individuals. The remaining 6 per cent is of group sizes of four to six individuals out of a total of 484 observations.

Reedbuck tend to 'hide' in tall grass and will only flush when one approaches closely, when they will give their characteristic alarm whistle. If utilising burnt grazing they will always lie up in adjacent cover. From visual estimates of condition parameters reedbuck were judged to be in poor to fair condition.

Mating activity in reedbuck was only once observed in mid-May and juveniles predominantly seen in August and September. One near full-term foetus was observed in a female in October. Smithers (1971) has recorded foetuses' from February, May and July and indications show a peak in births from August to December with isolated births at other times of the year. A single young is born at a time. Average reedbuck population densities of 0,12/km^2 are obtained from both floodplain systems but this is considered an underestimate due to the difficulties experienced in censusing this species, i.e. due to resting up in tall grass. Chief's Island itself does not hold any reedbuck except at the northern extremities where floodplains abut parts of this complex. The population in the study area appears to be on the increase probably due to decreased hunting activities. (*Wilmot *pers. comm.).*

Kobus ellipsiprymnus ellipsiprymnus (Ogilby, 1833)
Waterbuck; leTimoga (pl. maTimoga)

Waterbuck occur in isolated parts of the study area but nowhere in good population strengths, the total estimate being about 30 individuals. Larger numbers occur in the Moremi Wildlife Reserve and areas adjacent to it, viz. waterbuck appear to be the most abundant on the dry verges of the lower Khwai floodplain and adjacent woodlands. Apart from these areas no other waterbuck were located in the Delta.

Waterbuck were found to occur on Secondary Floodplain Communities, *Sporobolus spicatus* Island Grassland Communities, Primary Floodplain Communities, *Acacia erioloba* Woodland and Savanna Woodland, *A. tortilis* Savanna Woodland and Closed Riverine Woodland Communities and in marginal vegetation types. In the study area movement of some waterbuck males appeared to be very localised, whilst some mixed groups or female herds appeared to show much greater movement.

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*L. Wilmot c/o Crocodile Camp, Maun, Botswana.

Waterbuck occur as single individuals, groups or herds of up to 10 individuals in the study area, but more often single individuals or groups of up to four individuals were recorded. Waterbuck are predominantly grazers but some browsing is reported by Pienaar (1963) including wild fruits. Child and Von Richter (1969) mention heavy utilisation of *Cynodon dactylon*, *Brachiaria latifolia* and *Vossia cuspidata* by Chobe River waterbuck. Limited feeding observations from the study area show utilisation of *Bracharia humidicola* in place of *B. latifolia* plus the other two above-mentioned species.

No breeding data are available but two juvenile waterbuck observed in August were estimated on size to have been born in June or July. Child (1968b) states that waterbuck calve throughout the year with a peak in the cold, dry months.

The M'borogha floodplains were found to contain the highest waterbuck population estimate during the driest period (May 1973), but these largely appear to have moved out after the floods of that year had arrived and a resident population of no more than 25 to 30 individuals appears to exist. Only 10 waterbuck were located on the southern extremity of the Boro floodplains in the study area during October 1973 but these are known to move out of the conserved area. Two waterbuck later located higher up on the Boro floodplain during April 1974 were thought to be part of this same group of 10. Waterbuck require strict protection in the Delta if the populations are to increase as old hunters confirmed a much higher population density on the M'borogha floodplains during the 1960's.

Kobus leche leche Gray, 1850
Lechwe; leTswee (pl maTswee)

Lechwe are widely distributed throughout both floodplain systems in the study area. Well distributed throughout parts of the Delta especially the Khwai, Mokhogelo and Gomoti floodplains, but more limited in the western Delta and absent from the other lower Delta areas.

Lechwe distribution has altered drastically from what it was during the 1850's when lechwe were first recorded from the Boteti River in 1849 (Livingstone, 1857). Ellerman *et. al.* (1953) give the type specimen as collected from Toteng in 1850. Andersson (1856)

records "hundreds of lechwe near the Theoge mouth where it spilled into Lake Ngami". Baines (1864) reports nakong (sitatunga) and another new species (probably Lechwe) in the vicinity of the Thamalakane/Boteti junction. Leyland (1866) records several lechwe at different parts along the Zouga (Boteti) River. Baldwin (1894) saw and collected lechwe about 13 days by wagon from Lechulatebes town on the Beauclekky (Boteti) River. Today no lechwe can be found in any of the above-mentioned areas except where reintroduced into the Maun game sanctuary.

Elsewhere they occur down the Savuti channel almost to the Marsh, and on the Kwando/ Linyanti/Chobe floodplain, mainly on the Caprivi side. It is probable that the Okavango Delta population was in the past linked with the Linyanti Swamp population via the Selinda Spillway and the Mababe Marsh, but this is no longer the case, nor will it be unless drastic alterations occur in the present flood regimes to favour the relinking of these two drainage systems.

Changes in lechwe distribution are mainly due to the vast changes in water distribution and thus flooding pattern over the Delta. Tsetse fly control hunting operations between 1942 and 1963 has tended to contribute to a reduction in its former range (Child, Smith and Von Richter, 1970). Heavy local hunting, viz. the influx of refugees to the Estha area, places an increased pressure on hunting within this area. The highest populations are still found in protected areas or in areas where little local hunting takes place.

Today no lechwe occur on the Boteti River or in the vicinity of Lake Ngami. The Delta population exists from the vicinity of Seronga 18°45'S to 19°45'S and from 22°30'E to 24°E along the Khwai River drainage. A separate population recognised also by Child (1968b) exists along Botswana's northern boundary on the Kwando/Linyanti/Chobe/Savuti system, connecting with the Zambesi system.

Lechwe are grazers associated with the floodplain vegetation types, the riverine verges and the immediately adjacent riverine and marginal vegetation types. They utilise all aquatic vegetation types except deep water Madiba and Middle Channel Communities but occur immediately adjacent to them. Lechwe are found to occur in Outlet Channel Communities in low water level conditions. Sumps, Flats and Shallow Backwater Communities are all utilised, but the habitat type being utilised at any moment is dependent on water levels and thus the degree of inundation of a specific habitat type at a specific time. Primary Floodplain and *Sporobolus spicatus* Island Grassland Communities are heavily utilised.

Secondary Floodplain Communities do not form favoured habitat, and are only heavily utilised when water levels are too high in the favoured habitat types and thus force lechwe to utilise the shallower Secondary Floodplain Communities. During excessive flood years old drainage courses and floodplains which have not been inundated for several years and are evolving towards dryland types, usually *Acacia tortilis, A. erioloba* or *Combretum imberbe* Savanna Woodlands, become inundated and will also be utilised by lechwe.

Lechwe movement is thus in accordance with and directly controlled by water levels. Lechwe favour water levels of 0,15 to 0,60 m deep and although they occur in water levels exceeding this at times it is not favoured. In general they occur adjacent to favoured water level habitat types but spend a large proportion of their daily activity grazing or resting up on dryland areas, especially those surrounded by inundated areas, viz. flattened termitaria with a short grass covering, small to medium-sized islands lacking in woody vegetation cover and *Sporobolus spicatus* Island Grassland Communities surrounded by or adjacent to madiba.

Two groups of lechwe were found to be resident all year round in a specific area. These areas were generally adjacent to or enclosed by a lediba and are composed of short, open *Sporobolus spicatus* Island Grassland Community with a high water table, but which did not become excessively inundated and on which there were always dryland short grass areas available for resting up. In the areas which became submerged in excess of 0,60 m, the lechwe moved away from the adjacent Middle or Outlet Channel Communities towards the shallower margins of the flooded areas, or downstream on an Outlet Channel Community but remaining within the floodplain system, viz. the Khwai River extremity.

In the late 1950's lechwe still moved down the Kwai River as far as the start of the Mababe Depression (*Dandridge **pers.comm.**) when floodwaters reached that far. However even in the high floods of 1975 this was not the case, as no lechwe moved beyond the extremity of the floodplain system of the Khwai River (below Khwai River Lodge). Below this point only a single outlet channel occurs with suitable immediate margins but no floodplain. The same situation was found on the Mokhokelo/Zankuio River system where no lechwe moved beyond the limit of a clearly defined floodplain terminus. Lent (1969) states that lechwe in the Okavango exist only where the floodplain is over 100 m in width in the low water season. Lechwe today still move down the Savuti Channel which is comparable to the terminal sections of the Khwai and Mokhokelo Rivers.

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*D. Dandrige, Kerr, Downey and Selby, Box 27, Maun

The study of movement patterns from marked lechwe unfortunately only covered a high flood year which excluded large-scale movement. Males were found to be fairly localised and no male moved further than 11 km (No. 13) from their initial marking point. Three marked males remained in areas impenetrable due to excessive flooding and could therefore not be regularly observed for social organisation studies. Male No. 1 tended to stick fairly rigidly to his original area of marking, but due to the problems in getting this animal to recover from the immobilisation it may well be that he suffered brain damage as this lechwe showed marked atypical behaviour when subsequently sighted. Other marked males (No. 3 and No. 11) were sighted in different areas although they ranged no more than 5 km from the original marking site.

Females tended to move slightly greater distances and showed different group composition on several sightings. The greatest movement, shown by No. 4 was 13 km from the point of marking in January 1975 where she was found in a group of 63 females and juveniles. During late February 1975 No. 4 was sighted twice near the first locality but each time with a group of 40 females and sub-adults. No. 4 was again sighted on 4 September 1975, 5 km further east in a group of three adult females, two sub-adult females and one juvenile.

Female No. 6 was first located on the Khwai airstrip on 23 February 1975 in a mixed group of 50 lechwe. On the 27th March 1975 she was in a mixed group of 204 individuals in the same locality (with No. 2 female also present), and at this stage a juvenile was accompanying No. 6. On 7 May 1975, No. 6 was still present on the Khwai airstrip but after September she disappeared and was never relocated. Female No. 2 was not seen again on the airstrip but was relocated on 6 September 1975 opposite the north gate camp in a group of nine lechwe with one adult male present, having moved 7 km westwards.

On the Boro floodplains, during high water levels, the majority of lechwe move westwards out of the conserved area as more favourable habitat occurs in Khurunaragha area. On the M'borogha floodplains during high water conditions the majority of movement occurs down the Mokhokelo and Gomoti floodplain systems largely into the conserved areas of Moremi Wildlife Reserve.

Lechwe are grazers, feeding in the water on emergent aquatic to semi-aquatic herbaceous plants and on dryland and dry floodplain grasses and sedges. More time is spent on feeding

on non-flooded aquatic vegetation types, non-flooded *Sporobolus spicatus* Island Grassland Communities or marginal dried out areas, than is spent on actually feeding in the water.

Observed feeding records include *Cynodon dactylon, Sporobolus spicatus, S. acinifolius, S. salsus, Vossia cuspidata, Echinochloa stagnina, E. colona, E. holubii, Panicum aphanoneurum, P. repens, Brachiaria humidicola, Imperata cylindrica, Oryza longisteminata, Miscanthidium junceum, Ischaemum afrum, Sacciolepus typhura, Sorgum almum, S. verticilliflorum, Andropogon eucomis, Setaria sphacelata, Eulalia geniculata, Eragrostis rigidior, Acroceras macrum, Phragmites* spp. (young shoots), *Cyperus articulatus, C. fulgens C. haspan, C. compressus, C. sphacelatus, C. dives, C. longus, Scirpus inclinatus, S. muricinux, Kyllinga erecta, Fimbrystylis furruginea, F. dichotoma, F. hispidula, Fuirena ciliaris, Juncellus laevigatus, Eleocharis fistulosa, E. dulcis* and *Mariscus squarrosus.*

Lechwe are diurnal and nocturnal, occurring singly, in small groups or large concentrations. Concentrations may be found at any time of the year but are more prevalent in either extremes of low or high water conditions. In the former case they are forced to concentrate near channels still containing water or near madiba, whilst in the latter case they are forced into less typical shallowly flooded habitat as a result of extreme flooding in their more favoured habitat types. Concentrations in the Delta were never found to exceed 400 individuals per group but more usually between 100 and 200 lechwe which is low when compared with other lechwe concentrations. Child (1968b) estimates concentrations on the Chobe River to be of the order of 2 000 to 2 500 individuals. Sayer and Van Lavieren (1975) estimate some concentrations of Kafue lechwe to be in the order of 2 000 to 6 000 individuals and Grimsdell and Bell (1975) report concentrations of up to 3 000 black lechwe *(Kobus leche smithemani)* at certain seasons in the Bangweulu Basin of Zambia.

Although preferring open, short grass or sedge areas lechwe are never far removed from tall grass aquatic areas of *Miscanthidium junceum* or the sedge *Cyperus papyrus* where this latter occurs. They have clearly defined paths traversing such areas and connecting with open areas of either *Sporobolus spicatus* Island Grassland Communities flattened termitaria or the more open Shallow Backwater and Sumps Communities.

The hotter parts of the day are spent lying up on open, flattened termitaria or *Sporobolus spicatus* Island Grassland Communities in the floodplains but always adjacent to tall aquatic vegetation into which they can make effective escape. Lent (1969) reports early morning

and late evening bimodal daily activity for most individuals with less than 40 per cent active during the hotter afternoons. Lechwe make use of conical, partially flattened termitaria as a vantage point when alarmed in an effort to locate the adversary; and in doing so continually erode such to form the typical flattened island discs (old termitaria) scattered within the taller flooded grassed areas so typically seen from the air in parts of the Delta. When alarmed, lechwe amble off with head and nose held low to the ground, which probably results from the attitude adopted when moving along their paths through tall *Miscanthidium junceum.* When seriously disturbed, lechwe move off at a lumbering gallop, the males with their horns held low and laid back over their shoulders. If in water, they bounce in a series of plunges, with the well-developed hindquarter muscles lifting the animal out of the water and making efficient progress across medium flooded areas. Lechwe are strong swimmers and can move through deep water in this fashion, but they show strong reluctance to enter deep water (Child and Von Richter 1969), probably as a result of susceptability to crocodile predation under these circumstances (Robinette and Child, 1964). A nasal snort is issued as an alarm signal, or a long series of short, low grunts are issued by males normally after chasing females, or after males' challenge ritual encounters. Lechwe often defecate in the water, and this serves to fertilise waters (Tinley, 1966) for lower animals in the food chain.

Several authors have published on the general biology and behaviour of different subspecies of lechwe (Allen, 1963; Robinette and Child, 1964; De Vos and Dowsett, 1966; Child and Von Richter, 1969; Lent, 1969; Grimsdell and Bell, 1972b; Joubert, 1972; Bell and Grimsdell, 1973; Sayer and Van Lavieren, 1975 and Grimsdell and Bell, 1975) mainly covering populations in Zambia. De Vos and Dowsett *(op. cit.)* first reported territorial behaviour in lechwe from Zambia, whilst Lent *(op. cit.)* reported some territorial behaviour in Okavango lechwe, substantiated by Joubert *(op. cit).*

During the course of this study, territoriality in lechwe was observed in some instances, whilst the major social behaviour pattern appeared to be one of a dominance hierarchy amongst males in a mixed herd. Lent *(op. cit.)* describes Okavango lechwe from adjacent areas, (five kilometres from one another) showing two distinct forms of social organisation at the same time of the year.

Group or herd structure appears to be very loose amongst lechwe with frequent changes in her composition. Grimsdell and Bell *(op. cit.)* report the same for black lechwe in Zambia. Herd size in the Delta (Fig. 23) nowhere approaches that reported for Caprivi or Zambian lechwe concentrations, with groups in excess of 100 individuals being seldom encountered, except during either extremes of flood conditions.

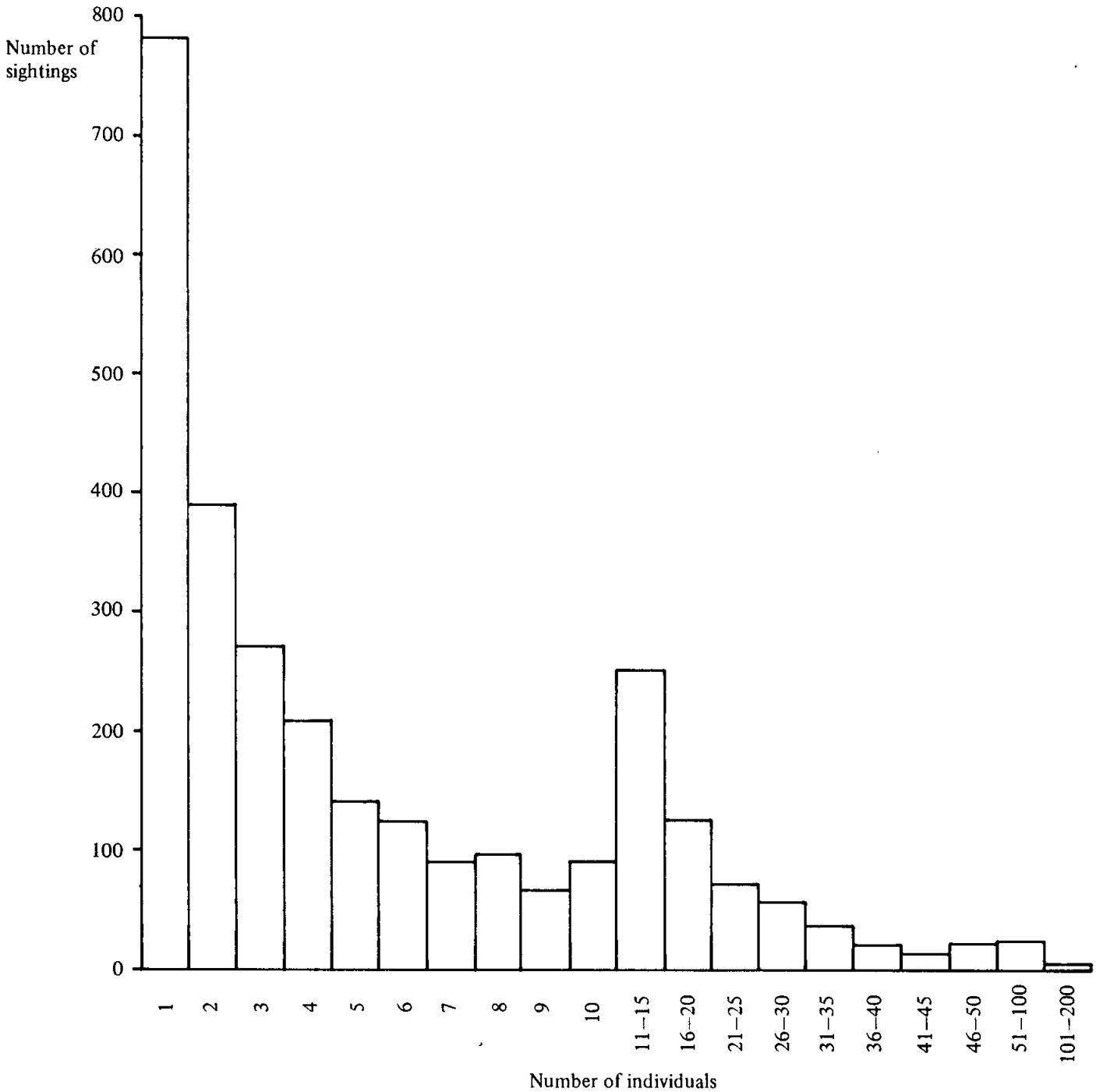

FIGURE 23 – Herd size of red lechwe in the conserved and adjacent areas Okavango Delta, Botswana, March 1973 to November 1975.

All mixed groups of lechwe containing more than one adult male (not obviously spatially arranged as in a territorial network) were classified within the dominance hierarchy social organisation. However, manifestation of this form of social organisation is far more evident in mixed herds containing several males of different ages. This is not always evident and large mixed groups at certain times show very little dominance behaviour. Males of similar age and conformation show light intensity challenge ritual, although isolated encounters are regarded as fairly heavy intensity challenge ritual. On several occassions when two lesser males were encountering each other, a more dominant male would come trotting up with nose held high in a threat display and disperse the challenging pair. As the most dominant male moves through the group, lesser males will often move towards him and indulge in peri-anal sniffing. The dominant male does not reciprocate but stands with nose held high and often displays an erection in a threat display, at which the lesser males appears submissive and accepts the alpha dominant males' position. In general these dominance challenge encounters are of short duration and position is established with the minimum of aggression or injury.

On several occassions the dominance hierarchy herds displayed mating behaviour. One female obviously in heat was checked by five different males in fairly close proximity and several attempts were made to mount her, but no serious aggression occurred amongst the males. Adult males often occur adjacent to each other or collectively in small groups under these circumstances and thus no territorial network seems to exist in these cases. The above observations took place during March 1975. On exactly the same area during October 1975 a definite territorial network was observed. An adult male made several attempts to herd a group of females and keep them in his territory. Whilst showing initial stages of challenge ritual to an adjacent male along their common territorial boundary, the females all left to a third adult male's territory on the other side. The first male unsuccessfully tried to prevent this, and the third male now herded the females which were moving towards the second male's area. These two males then met along the common territorial boundary and went into a high intensity challenge ritual in about 0,60 m of water. Heads went under water and clashed but were lifted quickly as they cannot spar underwater. The challenge ritual continued and whilst the males were thus occupied all the females moved to the second male's territory. On dryland territorial areas the same has been witnessed but the challenges are fairly vicious as male lechwe have extremely well-developed necks and severe injuries sometimes result. During such challenge rituals the various described

procedures (Lynch, 1971) of reverse parallel and mutual anal sniffing, horning, common boundary patrolling and displacement grazing were observed. It is noteworthy that 55 per cent of territorial behaviour was observed during October which is not the main rutting season. These territories where observed and did not exceed an average of 150 to 200 m. Joubert (1972) found similar sizes for territories in Moremi Wildlife Reserve, but De Vos and Dowsett (1966) found that lechwe territories in Zambia never exceeded 50 to 100 m. A few heterosexual encounters as described by Lent (1969) were observed, but these always involved sub-adult lechwe.

Group size (Fig. 5) showed a preponderance of single individuals. Within the smaller herds any sex and age structure could be encountered, some herds comprising only females and sub-adults, some only females, some a mixture of males, females and sub-adults and mainly during the rutting season a single adult male accompanying a group of females. Batchelor herds also comprise this group, the largest number encountered being 22 individuals. This number is low when compared with Kafue lechwe male herds (Robinette and Child, 1964) where groups of over 100 individuals are recorded. Larger herds comprised mixed groups or female and sub-adult individuals, but within the mixed groups there invariably was a predominance of females.

Lechwe in general have a shaggy, lean appearance. Tinley (1966) reports that during his field observation period in July 1964 many lechwe appeared to be in a poor condition and quotes P.R. Hill saying that lechwe have a scruffy appearance at any time. In spite of this apparently lean external condition, their internal kidney fat reserves show them to be in better condition than what their external appearance suggests (Table 37). Lechwe did not show the marked peak in condition which impala showed prior to the rut, nor did they reach that height of condition. They did however maintain a slightly higher average kidney fat index throughout the year when compared with impala. (Tables 32 and 37).

The peak in adult male lechwe condition occurred after the floods were receeding, and plenty of fresh prime habitat became available. Adult females were separated into two classes since it appears that their condition is directly related to their state of pregnancy or stage of rearing a juvenile. Pregnant females have a high kidney fat index (average 40 per cent) building up to a peak in condition two to three months prior to giving birth. Thus during the latter stages of pregnancy (as with the impala females) the condition index declines, but still maintains a fairly high level. After parturition condition drops rapidly until weaning and conception takes place again when a sharp build up in condition occurs (Table 38).

Table 37 – Average seasonal kidney fat indices (percentages) of lechwe from conserved and adjacent areas, Okavango Delta, Botswana, April 1973 – October 1975.

MONTH	YEAR	MALES	FEMALES		REMARKS
			Non-pregnant or lactating	Pregnant	
April	1973	17,04	–	–	
May	1973	6,55*	11,08	30,10	
June	1973	11,46	–	–	
July	1973	–	–	–	Flood levels peak
August	1973	11,58	–	49,35	
September	1973	12,49	–	38,35	
October	1973	29,06	12,70	35,20	
November	1973	–	12,30	24,80	
December	1973	–	–	32,61	
January	1974	–	–	–	Excessive rain and local flood
February	1974	–	–	–	Excessive rain and local flood
March	1974	–	–	41,80	Flood levels high
April	1974	–	21,50	–	Flood levels high
May	1974	–	–	–	Flood levels high
June	1974	29,08	–	–	Flood levels high
July	1974	–	–	–	Flood levels high
August	1974	24,72	–	–	Flood levels high
September	1974	13,69	6,06*	–	Flood levels dropping
October	1974	–	–	–	
November	1974	–	–	–	
December	1974	–	–	–	
January	1975	–	–	–	
February	1975	51,34	–	62,08	
March	1975	20,47	–	51,20	
April	1975	–	44,67	–	Floods arrive
May	1975	–	–	–	
June	1975	22,23	–	42,75	
July	1975	15,86	–	–	
August	1975	14,20	–	14,58	Second flood peak
September	1975	16,28	–	23,51	
October	1975	11,30	9,45	25,38	

*Young

Table 38 – Foetal lechwe data, conception and parturition dates after Huggett and Widdas (1951) for conserved and adjacent areas, Okavango Delta, Botswana, May 1973 – October 1975.

DATE OF COLLECTION	MASS (GRAM)	SEX	CROWN-RUMP LENGTH (MILLIMETRES)	POST-CONCEPTION AGE (DAYS)	APPROXIMATE CONCEPTION DATE	APPROXIMATE PARTURITION DATE
16 May 1973	3,4	?	32,5	58	19 Mar. 1973	25 Oct. 1973
16 Aug. 1973	4 750,0	F	440,0	197	1 Feb. 1973	8 Sept. 1973
17 Aug. 1973	465,3	M	215,0	114	25 Apr. 1973	1 Dec. 1973
6 Sept. 1973	3 800,0	F	405,0	186	4 Mar. 1973	11 Oct. 1973
15 Sept. 1973	5 000,0	F	445,0	199	1 Mar. 1973	6 Oct. 1973
16 Oct. 1973	3 000,0	F	382,0	175	24 Apr. 1973	30 Nov. 1973
2 Nov. 1973	316,1	M	203,0	106	19 July 1973	24 Feb. 1974
28 Dec. 1973	7 700,0	M	540,0	218	25 May 1973	31 Dec. 1973
3 Mar. 1974	99,7	M	141,0	85	8 Dec. 1973	16 July 1973
2 Feb. 1975	5 500,0	F	544,0	204	26 July 1974	18 Feb. 1975
12 Mar. 1975	145,3	M	166,0	92	10 Dec. 1974	18 July 1975
15 June 1975	4,1	?	39,0	59	17 Apr. 1975	23 Nov. 1975
15 June 1975	1 296,0	F	337,0	143	23 Jan. 1975	31 Aug. 1975
12 Aug. 1975	637,7	M	–	122	12 Apr. 1975	17 Nov. 1975
9 Sept. 1975	1 449,9	M	335,0	147	15 Apr. 1975	21 Nov. 1975
9 Sept. 1975	5 000,0	M	536,0	199	22 Feb. 1975	29 Sept. 1975
11 Sept. 1975	8 000,0	M	–	220	4 Feb. 1975	12 Sept. 1975
11 Sept. 1975	576,5	F	–	120	14 May 1975	19 Dec. 1975
14 Sept. 1975	3 000,0	M	483,0	175	23 Mar. 1975	29 Oct. 1975
14 Sept. 1975	5 000,0	M	569,0	199	28 Feb. 1975	6 Oct. 1975
20 Oct. 1975	6,1	?	47,0	61	20 Aug. 1975	28 Mar. 1976

Due to the difficulties experienced in collecting lechwe during the high floods of 1974, a paucity of recordings exists for that year. However, peak condition in females occurred approximately 66 per cent of the way through pregnancy and lowest conditions occurred in all lechwe when flooding conditions are at a maximum. Robbel and Child (1976) also found that the lowest condition prevailed in lechwe during the peak of flooding and further reported that at the best time of the year most animals were thin. This appears erroneous since individual lechwe with kidney fat indices of 52,6 and 46,1 (August 1973); 60,5 (September 1973); 41,6 (October 1973); 41,8 (March 1974); 80,70 and 62,1 (February 1975); 51,2 (March 1975); 44,7 (April 1975); and 63,3 (June 1975) are in good to excellent condition for African game animals when compared to Childs (1968) Kariba kidney fat indices.

The drop in condition at the peak of floods is expected and is a natural phenomenon in this wetland ecosystem in providing rest for some otherwise very overutilised floodplain and aquatic vegetation types, which would deteriorate if large mammals were not forced off them (See section on vegetation status and trends). Robbel and Child (1976) further suggest that lechwe on islands in the flooded areas maintain a better physical condition than lechwe on the floodplains. This was not found to be the case from specimens collected deep within the flooded areas, as habitat range was also limited by flood levels there and those lechwe consequently showed a similar drop in physical condition.

Lechwe breed throughout the year but show a definite peak during the late spring – early summer months from October to December. This occurs prior to the onset of the summer rains or during their early stages. Tinley (1966) states young lechwe are born in March and April. Child (1968b) records young lambs from the Chobe between July and January and states that peaks of births occurred in early September during 1965 and 1966. Lent (1969) states that it is likely that some births occur in all or nearly all months of the year with a peak of births during the rainy season. In Zambia the peak breeding season for Kafue lechwe is from mid-July to mid-October (Sayer and Van Lavieren, 1975). It thus appears that all lechwe populations are capable of giving birth in any month, but that definite peaks occur in Zambia (usually in August), in Chobe (usually in September) and in the Delta (usually in October/November).

Births during the early summer months are advantageous as floodwaters have normally receded then and a maximum of good quality favoured habitat is then available. The major rutting major rutting months are February, March and April (Table 38) and mating takes place on dryland or in shallow water.

Males show the typical vulva smelling, "laufsclhag" (Walter 1966) and the raising of the head in "flehmen"; but the well-pronounced curling of the upper lip was not witnessed to the degree that it is displayed by other ungulates, viz. impala or tsessebe. Females usually move their tails to one side and urinate and Lent (1969) describes the full behavioural patterns during mating.

Shortly prior to giving birth, pregnant females leave the herd and retire alone to the taller swamp vegetation of *Miscanthidium junceum* or *Cyperus papyrus.* In well-concealed dry areas of this tall vegetation they give birth and the lambs remain hidden for protection. They then spend the time grazing in open areas in the vicinity apparently only returning to nurse the lamb. Sometimes small groups of nursing females are found together, but it is unknown if the lambs are collectively hidden in one spot. Lent *(op. cit.)* records one lamb being born in a Closed Riverine Woodland Community, but this could have been caused by the presence of lions which killed another lechwe in the proximity. The lamb spends an estimated five to ten days hidden before accompanying the female. Shortly after accompanying the female, the pair will join up with a group or herd.

Male lechwe display puberty between one and two years of age, but only appear to be sexually mature when between two and three years old. Female lechwe appear to produce their first offspring at about 2 years of age and thus first conceive at about 17 to 21 months of age, but this is dependent on individual growth and the available nutrition.

Lechwe population density varies greatly in the study area being dependent on the flooding conditions of the study area and the adjacent areas to which the lechwe move. The highest population in the total study area is between 4 000 and 5 000 lechwe when Delta conditions are at their driest. The M'borogha floodplains carry 4,5 lechwe/km^2 and the Boro floodplains 2,8 lechwe/km^2. Chief's Island only carries insignificant numbers of lechwe and then only marginally in inundated floodplains which abutt into it during high floods. The lechwe population density dropped from both floodplain systems as more water became available. On the M'borogha floodplains the density dropped to 1,6 lechwe/km^2 during April 1974 and about 1,0 lechwe/km^2 during July 1974. On the Boro floodplains the density dropped to 0,7 lechwe/km^2 during April 1974 and 0,5 lechwe/km^2 during July 1974. By December 1974 as conditions were drying out the population density for both areas had doubled from what they were during July. (See Appendices 1-17).

Four surveys were carried out during 1975 in the conserved and adjacent areas of the Moremi Wildlife Reserve. The lowest water levels during February 1975 produced the lowest overall population density of 4,1 lechwe/km^2. During the higher water levels an average of 4,7 (April 1975) or 4,8 (July 1975) lechwe/km^2 was recorded. The mid-Delta stratum (Moanashira-M'borogha) showed the lowest average density of 3,4 lechwe/km^2 for the year. The population density in this area decreased as the water levels increased, except for October 1975 when water levels dropped as did lechwe density. The lower-Delta areas showed the highest average population densities of 5,4 lechwe/km^2 (Mokokhelo-Gomoti) and 4,4 lechwe/km^2 (Khwai). However in the year 1975 the Delta was heavily flooded in all these areas during the course of the aerial survey work and the population remained almost static between 6 500 and 7 500 lechwe. A marked reduction in lechwe population density would have been evident from the two lower-Delta areas in a dry year like 1973. (See Appendix 18). Total Delta population is estimated at 18 000 to 20 000 lechwe at a maximum.

Mass and measurements of lechwe are given in Tables 39 and 40.

External parasites:
(Acarina)

Rhipicephalus evertsi evertsi Neumann, 1897
R. appendiculatus Neumann, 1901
Boophilus decoloratus (Koch, 1844)
(Subcutaneous Diptera)
Strobiloestrus vanzyli Zumpt, 1961

Internal parasites:

Setaria bicornata (Linstow, 1901) Raillieit & Henry, 1911
S. boulengeri Thwaite, 1927
Avitellina centripunctata (Rivolta, 1874) Gough, 1911
Haemonchus contortus (Rudolphi, 1803) Cobb 1898
Fasciola gigantica Cobbold, 1855
Dictyocaulus sp.
Carmyerius mancupatus (Fischoeder, 1901) Goedelst, 1911
Paramphistomum calicophorum Fischoeder, 1901

Table 39 – Male lechwe mass (Kg) and measurements (mm) from conserved and adjacent areas, Okavango Delta, Botswana, April 1973 – October 1975.

DATE	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
							Zygomatic width	Total length
Adults								
1973:								
6 Apr.	78	1 789	348	455	952	146	129	279
11 Apr.	102	2 018	421	489	940	148	133	286
27 Apr.	115	2 101	437	484	1 015	154	134	303
21 Jun.	101	1 899	390	460	990	157	–	–
26 Jun.	101	2 004	412	480	1 073	144	134	287
17 Aug.	80	1 856	425	483	968	156	123	286
14 Sept.	102	1 951	453	489	994	155	130	286
8 Oct.	97	1 900	389	466	968	149	–	–
17 Oct.	103	2 039	420	477	976	154	130	–
1974:								
10 Jun.	90	1 843	370	466	980	143	132	281
21 Aug.	109	1 943	394	481	852	149	130	295
8 Sept.	87	1 918	446	481	946	149	133	289
19 Sept.	84	1 956	428	485	1 018	158	125	286
1975:								
14 Feb.	109	1 895	407	471	1 015	148	132	293
14 Feb.	127	2 113	434	470	1 007	156	134	310
11 Mar.	111	2 048	444	478	945	154	129	298
12 Mar.	96	1 944	444	471	950	144	128	291
12 Mar.	95	1 900	393	474	955	143	125	288
3 Apr.	108	2 004	404	470	921	159	136	310
11 Jun.	97	1 981	403	482	925	149	126	289
11 Jun.	108	2 002	444	506	1 070	160	134	300
28 Jul.	83	1 879	371	460	918	148	126	285
29 Jul.	91	2 076	441	486	1 020	154	135	306
11 Aug.	102	1 986	437	485	1 000	156	127	297
10 Sept.	111	1 965	423	462	1 000	151	130	297
10 Sept.	110	2 134	455	474	970	162	133	301
11 Sept.	96	1 960	401	482	935	153	127	300
13 Sept.	101	1 942	394	475	1 000	148	133	293
13 Sept.	87	1 956	436	476	955	150	124	287
12 Oct.	86	1 906	422	485	985	158	–	–
26 Oct.	83	1 961	406	480	997	149	–	–
Sub-adults								
1973:								
25 May	72	1 820	354	460	980	142	120	266
17 Aug.	62	1 691	374	466	915	146	121	272
29 Sept.	73	1 736	382	481	881	141	–	–
15 Oct.	72	1 810	383	483	916	150	–	–
1975:								
6 March	75	1 858	398	476	865	151	119	273

– = damaged skulls.

Table 40 – Female lechwe mass (Kg) and measurements (mm) from conserved and adjacent areas, Okavango Delta, Botswana, May 1973 – October 1975.

DATE	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL	
							Zygomatic width	Total length
Adults								
1973:								
7 May	64	–	–	–	856	146	110	265
7 May	72	1 729	340	443	920	151	116	282
16 May	54	1 573	330	441	844	137	108	246
16 May	84	2 035	439	500	995	151	119	284
16 Aug.	81	1 819	365	463	935	140	113	274
17 Aug.	75	1 819	345	462	960	146	120	275
6 Sept.	78	1 858	357	459	899	149	115	–
17 Aug.	54	1 656	342	439	930	144	109	255
15 Sept.	76	1 755	373	452	948	144	–	–
16 Oct.	78	1 785	304	437	830	144	–	–
2 Nov.	70	1 943	425	473	863	145	117	280
28 Nov.	81	1 910	412	467	945	149	–	–
28 Nov.	62	1 754	384	460	921	147	113	269
28 Dec.	86	1 844	362	466	954	150	121	283
1974:								
3 March	78	1 821	369	467	896	149	124	270
12 Apr.	78	1 835	375	472	891	144	120	267
19 Sept.	71	1 833	395	454	965	147	115	287
1975:								
2 Feb.	89	1 889	367	469	931	154	120	288
12 March	67	1 853	358	451	845	150	115	270
4 Apr.	73	1 745	307	452	885	150	114	274
15 Jun.	74	1 956	380	479	915	143	121	280
15 Jun.	75	1 788	366	437	895	146	120	262
12 Aug.	63	1 920	372	452	884	145	114	273
9 Sept.	70	1 798	382	453	887	143	117	274
9 Sept.	79	1 825	367	453	919	151	116	–
11 Sept.	79	1 846	394	459	885	142	123	294
11 Sept.	84	1 952	438	480	943	151	116	273
14 Sept.	80	1 881	390	465	890	148	116	280
14 Sept.	83	1 872	378	444	885	149	116	273
12 Oct.	82	1 973	399	474	923	149	–	–
20 Oct.	70	1 923	340	450	850	147	–	–
Sub-adults								
1973:								
6 Oct.	46	1 678	367	447	846	140	109	266
1975:								
6 Aug.	38	1 511	302	437	850	140	95	230

– = damaged skulls

Stephanopharynx coilos Dollfus, 1963
Stephanopharynx compactus Fischoeder, 1910
Schistosoma leiperi Le Roux, 1955
Schistosoma margrebowiei Le Roux, 1933
Trypanosoma congolense Broden, 1904
Trypanosoma spp.

External examination of lechwe for ticks showed low number of from zero to six ticks per lechwe out of a sample of 99, which is considered a light tick burden. Subcutaneous fly-larvae appear far more numerous in juvenile and sub-adult lechwe as very few were ever found in adult lechwe. Of the internal parasites only *Paramphistomoldea* was recorded in large numbers occurring in one or more of the stomach compartments.

Schistosoma leiperi and *S. margrebowiei* belong to the Trematoda and some congenerics (viz. *S. haematobium* and *S. mansoni*) are blood flukes of man causing bilharzia (Lapage, 1963). It is currently theorised that where lechwe occur in high population density either or both of the lechwe schistosomes may prevent the development of the human parasites (Pitchford, 1976).

Lechwe were in general found to carry a heavy load of *Trypanosoma* spp. in their blood. These were either *Trypanosoma rhodesiensis*, *T. congolense* or *T. brucei*. They are thought to be the latter and thus non-responsible for Trypanosomiasis (sleeping sickness) in man (*Drager **pers.comm.**), but tests will have to be carried out before this can be substantiated.

Hippotragus equinus cottoni Dollman and Burlace, 1928
Roan; Kwalata etshetlha

Roan are rare in the study area with only one adult male actually recorded. A group of five were also recorded in Khuranxaragha adjacent to the southwestern tip of the study area. Elsewhere in the Delta they occur around most of the drier fringes but not in the north, (Smithers, 1971). Tinley (1966) and Robbel and Child (1976) report roan present but uncommon in the Moremi Wildlife Reserve. They are more typical of the northern drier habitat types.

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Roan appear to favour scrub vegetation (*Colophospermum mopane, Terminalia sericea* and *Combretum* spp.) and sometimes occur in *Colophospermum mopane* or *Acacia* spp. Savanna Woodlands or Woodlands. Joubert (1976) states typical roan habitats to be lightly wooded or open grassland savannas from the Kruger National Park, National Parks in Angola and in Rhodesia, although relatively thickly wooded savanna is also utilised. Thus there is some limited habitat types available to roan in the study areas, especially on Chief's Island. Roan and sable habitat overlap and sable occur in greater numbers in Botswana although none were located in the study area. The extreme flooding conditions surrounding Chief's Island would possibly prevent these species from establishing themselves permanently in the area.

Roan are mainly gregarious, occurring in small herds of two to nine individuals, but also singly. They are largely grazers but do some limited browsing. Young are born chiefly in November but also from August to February (Tinley 1966).

Syncerus caffer caffer (Sparman, 1779)
Buffalo; nare (pl. diNare)

Buffaloes are widely distributed throughout the study area and occur on both the eastern and the western floodplains and on Chief's Island, but more seasonally on the latter. Buffaloes occur in virtually all the vegetation types but show a strong preference to utilise dry or lightly inundated Primary and Secondary Floodplain Communities, Closed Riverine Woodland and marginal vegetation types, *Acacia tortilis* Savanna Woodland, *Colophospermum mopane* Woodland and Pyrophytic Scrub Savanna, *Sporobolus spicatus* Island Grassland Community and Shallow Backwater and Outlet Channel Communities in drier periods.

Buffaloes move in and out of the study area but some herds appear to remain resident in the study area all the year round. Definite movement occurs between Moremi Wildlife Reserve and the M'borogha floodplain system and Chief's Island. The same can be said for Chief's Island and the Boro Floodplains and the Khuranxaragha/Jao areas. During the rains when pan water is available on Chief's Island, buffaloes seem to utilise the *Colophospermum mopane* Woodland and Pyrophytic Scrub Savanna for fresh annual and perennial grass growth to the greatest degree. During the winter (May to July) and spring periods (August to October) they are more associated with the floodplains and adjacent

islands. Towards the end of this period they are especially concentrated on the floodplain vegetation types. Tinley (1966) and Smithers (1971) report lack of floodplain utilisation by buffaloes during the day. This was not the case in the study area when they were encountered on this habitat type fairly often during daylight hours. This may be due to the more extensive floodplain systems in the study area and less persecution, as my own observations in the lower Delta areas confirmed crepuscular and night use of the floodplains.

Buffaloes are largely grazers on a wide variety of grasses but also do a limited amount of browsing (Sinclair and Gwynne, 1972). Recorded plant species eaten from observation include *Sporobolus spicatus, Cynodon dactylon, Chloris gayana, Vossia cuspidata, Echinochloa colona, Cenchrus ciliaris, Brachiaria humidicola, Panicum repens, Imperata cylindrica* and *Setaria verticillata.*

Buffaloes are gregarious and occur in herds of from 30 to 600 individuals in the study area. Solitary males or bull groups of up to 12 individuals occur. Bull groups varied from solitary individuals up to seven most commonly or less frequently up to 12. One group of 14 individuals comprised 12 adult bulls, one adult female and one sub-adult female, but this was only recorded once. The large herds are made up of all sex and age classes, with a fairly high percentage of adult bulls. During the heat of the day they actively seek shade and lie up under trees, in tall *Miscanthidium junceum* or in reedbeds *(Phragmites* spp.). Buffaloes are diurnal and nocturnal.

The physical condition of buffaloes was fair to poor for adult males, and fair to good for adult females (from limited specimens collected for a buffalo study in Botswana) depending on the stage of pregnancy. Buffaloes are largely seasonal breeders, the peak of calving falling from December to March, but scattered births take place outside these dates. The gestation period is 335 days (Brand, 1963).

The buffalo population in the study area varied between 1 500 and 7 000 individuals. All three habitat zones always harboured some buffalo but usually there were few on the floodplain systems during December and onwards when the main utilisation centred on Chief's Island whilst fresh grazing and pan water existed. Average population densities on the M'borogha floodplains were 1,4 buffalo/km^2, on Chief's Island and on the Boro floodplains 2 buffalo/km^2.

SIZES AND MASS

Males

No	TL	T	Hfc/u	E	Mass (Kg)
22	3 325	785	615	264	616
79	3 265	809	590	254	616
Female					
23	3 091	689	580	260	500

External parasites:
(Acarina)

Hyalomma marginatum Koch, 1844
H. truncatum Koch, 1844
Rhipicephalus evertsi evertsi Neumann, 1897
R. simus simus Koch, 1844

Internal parasites:

Moniezia benedeni (Moniez, 1879) R. Blanchard, 1891
Fasciolia gigantica Cobbold, 1855
Carmyerius mancupatus (Fischoeder, 1901) Goedelst, 1911
Paramphistomum microbothrium Fischoeder, 1901

Connochaetes taurinus taurinus (Burchell, 1832)
Blue wildebeest; Kgokong

Wildebeest are widely distributed and 300 to 1 000 occur within the study area. Greater numbers occur on the lower and less flooded peripheral Delta areas and in the Moremi Wildlife Reserve (Robbel and Child 1976), but movement from here is towards the Mababe Depression. The Boro floodplains had the highest average population size (298 individuals), and some local movement occurred between here and Chief's Island during the 1973 rainy season.

Wildebeest show a strong preference for open grassland either on the floodplains or on islands with 83 per cent of all sightings derived from such areas. Secondary Floodplain

Communities showed 44 per cent of occurrences, Primary Floodplain Communities 25 per cent of occurrences and *Sporobolus spicatus* Island Grassland Communities 14 per cent of occurrences. *Acacia tortilis* Savanna Woodlands showed an 11 per cent occurrence and *Acacia erioloba* Woodland and Savanna Woodland together with *Colophospermum mopane* Woodland and Pyrophytic Scrub Savanna made up the remaining 6 per cent.

Wildebeest are almost exclusively grazers (Owaga, 1975) and observed feeding records include *Cynodon dactylon, Digitaria eriantha, Ischaemum afrum, Setaria sphacelata, S. Woodii, Sprobolus spicatus, S. acinifolius, Panicum repens, P. coloratum, Dactylotenium aegypticum, Erasgrostis* spp., *Brachiara humidicola* and *B. brizantha.* Although wildebeest and zebra show an overlap in habitat utilization, wildebeest selectively take far more leaf material and zebra more coarse material viz. sheath and stem (Bell 1969, Owaga *op. cit.).*

Wildebeest occur either solitary or are gregarious, occurring in the study area in herds of from two to 30 individuals being encountered, but herds of 31 to 65 (the latter the largest recorded herd size) were fairly common (Fig. 24). There was no evidence of the mass concentrations of wildebeest in the study area which are so apparent during migrations in other parts of Botswana. Wildebeest are more strictly diurnal, but also nocturnal to a degree. The hottest parts of the day are spent resting up in shade, and they show no fear of crossing shallow to medium-inundated floodplains. Wildebeest show a strong tendency to associate with tsessebe. From a limited number of wildebeest collected, preliminary condition indices seem to show a similar tendency to other seasonal breeders viz. impala.

Wildebeest are strictly seasonal breeders and calving occurs in November to February with isolated births outside this period. Tinley (1966) gives the calving season as September to October. Mating takes place between March and June and the gestation period is 245 days (Watson, 1969).

The population in the study area varied between 300 and 1 000 wildebeest. The Boro floodplains showed the highest average population density of 0,8 wildebeest/km^2 as against an average of 0,2 wildebeest/km^2 for the M'borogha floodplains and Chief's Island. The highest population density was recorded from the driest periods and although movement takes place between the floodplain systems and Chief's Island, the greatest movement during high floods takes place out of the study area to the south. The tendency to move onto Chief's Island occurs during the early part of the summer months, substantiating the tendency to utilise a high percentage of leaf material.

Mass and measurements of blue wildebeest appear in Table 41.

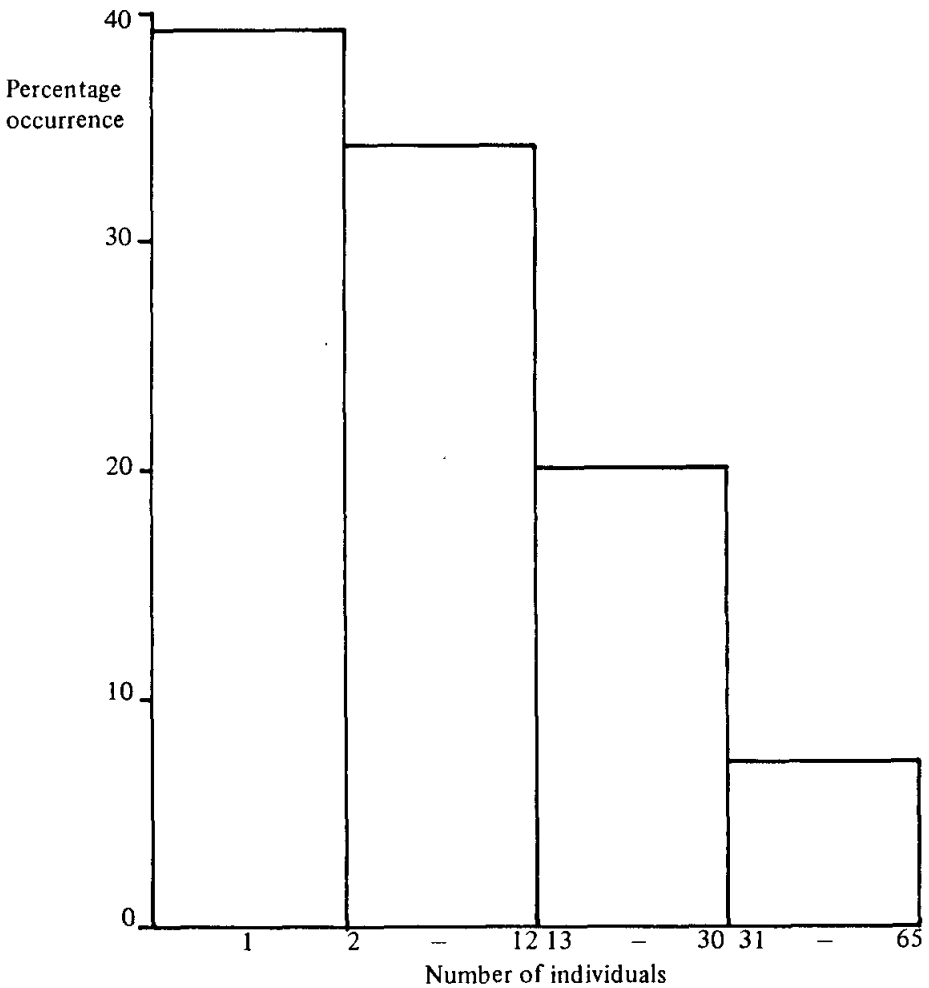

FIGURE 24 – Herd size distribution based on single individuals small, medium or large herds of blue wildebeest in the study area, Okavango Delta, Botswana, March 1973 to November 1974.

Table 41 – Mass (Kg) and measurements (mm) of wildebeest from the study area, Okavango Delta, Botswana, May 1973 – September 1974.

DATE	SEX	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL		REMARKS
								Zygomatic width	Total length	
15 May 1973	M	226	2 569	606	521	1 350	194	185	459	
22 Sept. 1973	M	198	2 446	625	530	1 342	202	170	451	
16 Nov. 1973	M	143	2 170	514	494	1 141	177	159	395	Subadult
12 Dec. 1973	M	181	2 320	532	496	1 268	187	167	428	
17 May 1974	M	188	2 390	650	519	1 277	210	171	445	
18 Jul. 1973	F	202	2 375	513	510	1 205	185	180	455	Pregnant
16 Sept. 1974	F	154	2 254	560	502	1 202	179	163	425	Subadult

External parasites:
(Acarina)

Rhipicephalus evertsi evertsi Neumann, 1897

(Cranial cavity Diptera)
Oestrus variolosus (Loew, 1863)

Internal parasites:

Fasciola gigantea Cobbold, 1855
Cysticercus (regis) Baer, 1923
Oesophagostomun sp.
Carmyerius mancupatus (Fischoeder, 1901) Goedelst, 1911
Stephanopharynx coilos Dollfus, 1963

Damaliscus lunatus lunatus (Burchell, 1823)
Tsessebe; Kabole

Tsessebes are widely distributed throughout the study area and are fairly common.

They are well represented on the M'borogha and Boro floodplain systems but not so, except on the verges, on Chief's Island.

Tsessebes show the highest preference for the open dry floodplain vegetation types and together with most other species viz. zebra, blue wildebeest and warthog; show a strong preference for freshly burnt areas. Thirty-six per cent of all tsessebe observations (531) were made on Secondary Floodplain Communities, 18 per cent on Primary Floodplain Communities, 18 per cent on alterns or ecotones between the floodplain vegetation types and Closed Riverine Woodland or marginal vegetation types, 13 per cent on *Sporobolus spicatus* Island Grassland Communities, 7 per cent on *Acacia tortilis* Savanna Woodland and 4 per cent each on termitaria or *Colophospermum mopane* and *Acacia erioloba* Woodland and Savanna Woodland. Tsessebes show no fear of crossing water 1 m in depth, and some appear to be more or less resident within the study area, whilst others show appreciable movement in and out of it. Elsewhere in Botswana, Child, Robbel and Hepburn (1972) report tsessebes as resident with restricted movement in the Chobe area.

Tsessebes are almost exclusively grazers although they have been observed to browse lightly (Child *et. al. op. cit.;* Grobler, 1973). They show a preference for short grass areas and

burns, but if these are unavailable they will make use of taller dry grass areas. Observed feeding records include *Sporobolus spicatus, Setaria sphacelata, Eragrostis* spp., *Panicum aphanoneurum, P. repens, Brachiaria humidicola, Cynodon dactylon, Chloris gayana* and *Imperata cylindrica.*

Tsessebes occur either solitary, in male bachelor herds of up to 11 individuals or in small to medium-sized breeding herds. Solitary males are common providing 20 per cent of all observations, groups of two to three individuals (either bachelor groups or all females or mixed) provided 23 per cent, groups of four to ten individuals provided 48 per cent of the observations and groups of 11 to 14 individuals provided 9 per cent of all observations. The largest bachelor group recorded was 11 individuals and the largest overall group of 14 individuals comprised seven adult females and seven juveniles. Smithers (1971) also recorded a maximum group of 14 tsessebes for Botswana and Grobler (1973) recorded 12 individuals in a breeding herd and a herd of 22 bachelors for Rhodesia, while Child, Robbel and Hepburn (1972) report bachelor herds of up to 31 individuals from other parts of Botswana. Tsessebes appear to adhere strictly to localised areas under favourable grazing conditions, the same herd often being encountered in the same area for three to four months.

Tsessebe males are probably territorial from limited observations of challenge rituals. However they do not occur in the same population densities as its congenerics, viz. Bontebok, *Damaliscus dorcas dorcas* (David, 1970), and Blesbok, *Damaliscus dorcas phillipsi* (Lynch, 1971). In the study area, tsessebe were found to be strict seasonal breeders, with calves born from mid-October to mid-January depending on the season in question. Generally the calving period is of short duration lasting about six weeks during which time 80 per cent of the calves are born with isolated births outside this period. Child *et al.* (1972) and Huntley (1972) report similar conditions for tsessebe populations in other parts of Botswana and the Transvaal respectively, whilst Fairall (1968) reports that 90 per cent of the claves are born in a 40-day period in the Kruger National Park.

The rut occurs during March and April or in a poor flood season as late as May. The gestation period is about 8 months (Huntley *op. cit.).* Females display puberty during their second year but sexual maturity during their third year of life. All adult females examined (33 months and older) were found to calve annually except one adult female which showed no signs of ever having ovulated or reproduced (Neotony), with masculine features and originally mistaken for a male. Only two pregnant females were collected and both showed right horn implantation and right ovary ovulation. Child *et al., (op.cit.)* records ipsilateral

implantation from 42 specimens collected in Botswana. All recorded births were single. Males apparently reach sexual maturity in time for the rut during their fourth year (Child *et.al.* 1972).

From the seven tsessebes collected, the condition pattern seems to follow that of impala closely (seasonal breeders). Adult males reach their maximum of condition (49,2 per cent Kidney Fat Index (K.F.I.) just prior to the rut, during which time condition drops off drastically, then maintenance of a fairly steady condition, with a build up in condition towards the end of the year. Adult females show a high average K.F.I. of 79,4 per cent approximately 4,5 months into pregnancy which occurs in August/September.

From aerial surveys results the population in the study area varies between 100 and 700 individuals. Tsessebe movement does not appear to be governed by floodlevels as with so many of the other mammalian species, since there was no correllation of numbers with water conditions. Thus peak dry periods showed populations of about 450 (May 1973) and 100 (December 1973) as against that of peak wet periods of 112 (April 1974) and 350 (July 1974). Average population densities throughout the study period were 0,25 tsessebes/km^2 for the M'borogha floodplains; 0,05 tsessebes/km^2 for Chief's Island and 0,35 tsessebes/km^2 for the Boro floodplains.

Mass and measurements for tsessebes appear in Table 42.

External parasites:
(Acarina)
Rhipicephalus evertsi evertsi Neumann, 1897
(Cranial Diptera)
Oestrus sp. (prob. *O. aureoargentatus* or *O. variolosus)*
Gedoelstia sp.

Order Lagomorpha

Lepus saxitilis F. Cuvier, 1823
Scrub Hare; Mmutla

Scrub hares are scarce in the study area, none having been recorded by myself. Two recordings from a reliable witness resident in the study area warrent its inclusion.

Scrub hares are nocturnal and seem to prefer the drier areas being more common from the lower-Delta and surroundings as observed whilst travelling in these sectors.

Table 42 – Mass (Kg) and measurements (mm) of tsessebe from the study and adjacent areas, Okavango Delta, Botswana, March 1974 – August 1975.

DATE	SEX	MASS	TOTAL LENGTH	TAIL	HIND FOOT CUM UNGUIS	SHOULDER HEIGHT	EAR	SKULL		REMARKS
								Zygomatic width	Total length	
1 Mar. 1974	M	143	2 175	469	512	1 271	193	168	394	
17 Jun. 1974	M	136	2 340	518	556	1 220	194	159	389	
17 Sept. 1974	M	139	2 214	545	517	1 319	187	162	390	
13 Feb. 1975	M	134	2 274	530	546	1 323	196	165	419	
19 Feb. 1975	M	104	2 030	478	518	1 156	190	144	367	Subadult
9 May 1975	M	140	2 246	535	536	1 260	190	148	398	
12 Aug. 1975	M	141	2 301	586	545	1 345	185	156	385	
3 Sept. 1975	M	128	2 255	535	535	1 270	191	148	393	Subadult
3 Sept. 1975	M	119	2 250	548	537	1 255	189	149	399	Subadult
6 Sept. 1974	F	147	2 257	482	537	1 202	192	159	389	Pregnant *
2 Aug. 1975	F	117	2 113	482	530	1 200	194	151	376	
2 Aug. 1975	F	155	2 212	491	545	1 260	191	153	416	Pregnant

Order Rodentia

Family Bathyergidae
Cryptomys damarensis (Ogilby, 1838)
Damara Mole-rat

Damara Mole-rats are common and widespread throughout the floodplain systems and on the islands. From their burrow mound evidence they are only present on the verges of Chief's Island and interdigitating floodplains. Damara mole-rats occur typically on the open areas devoid of woody vegetation, viz. Primary and Secondary Floodplain Communities and *Sporobolus spicatus* Island Grassland Communities.

Habitat utilisation at any particular time is directly dependent on floodwater levels. During the driest seasons their typical conical mounds in winding rows are present in the Primary Floodplain Communities. As water levels rise they move onto Secondary Floodplain Communities and as these become flooded, onto *Sporobolus spicatus* Island Grassland Communities. In exceptionally high flood conditions they are forced into adjacent Closed Riverine Woodland, marginal vegetation types or some dryland vegetation types. They move prior to surface flooding and their movements are strong indications of flooding conditions shortly to prevail.

Damara mole-rats predominantly feed on underground tubers, bulbs, rhizomes and roots of sedges and grasses. They are communal, living in an underground burrow system and throw up mounds at intervals along this winding system. These mounds have typical sausage-shaped rolls when fresh, proceeding to the form of a conical mound and finally flattened when old and abandoned. Smithers (1971) states that they are more active during the wetter months of the year, and within the study area their activity was found to be correllated with rising and falling flood levels affecting their prime habitat.

Freshest mounds were always found to be terminal in the line of the burrow, and mole-rats were easily captured by disrupting and placing the special "Macabee" trap in this terminal mound. Eighty three per cent of males were caught indicating that these tend to show a stronger tendency to investigate and remedy disruptence to their burrow mounds than the females. Smithers *(op. cit.)* indicates that births may take place throughout the year, and that females carry three to five foetuses.

SIZES AND MASS

Males

TL	$\bar{X}$	=	160;	n	=	25;	range	122	– 200
T	$\bar{X}$	=	14;	n	=	25;	range	8	– 22
Hfc/u	$\bar{X}$	=	25;	n	=	25;	range	21	– 30
Mass	$\bar{X}$	=	103;	n	=	7;	range	61	– 150 g

Females

TL	$\bar{X}$	=	177;	n	=	5;	range	142	– 199
T	$\bar{X}$	=	15;	n	=	5;	range	13	– 18
Hfc/u	$\bar{X}$	=	27;	n	=	5;	range	21	– 31
Mass	$\bar{X}$	=	123;	n	=	3;	range	84	– 148 g

External parasites
(Acarina)
Androlaelaps capensis (Hirst, 1916)

Family Hystricidae
Hystrix africaeaustralis Peters, 1852
Porcupine; Noko

From quill evidence and a few sightings porcupines appear to be widely distributed on the M'borogha and Boro floodplain systems. Some evidence of porcupines exists on Chief's Island and due to their wide tolerance of habitat types (Smithers, 1971) they may occur there in high population numbers.

Porcupines were encountered in Closed Riverine Woodland, marginal vegetation types, *Acacia tortilis* and *A. erioloba* Savanna Woodland and dry Primary and Secondary Floodplain Communities. Nothing is known of their movement patterns in the study area.

All live individuals were located at night occurring either singly or in pairs. During daylight hours they rest up in disused antbear holes. Breeding data for Botswana do not exist, but Ansell (1960) records juveniles from Zambia in August, December and March.

Family Pedetidae
Pedetes capensis damarensis Roberts, 1926
Springhare; Ntole

Springhares are widespread and common in the sandier portions of southern Chief's Island and the lower half of the Boro floodplains. Isolated sightings or droppings were found from sandy parts of northern Chief's Island and the adjacent Secondary Floodplain Communities. No evidence of springhare presence was found from the M'borogha floodplain system but they may be present in the northern sandy portions where dessication is advancing.

Springhares occur especially on the downgraded Secondary Floodplain Communities and nearly all specimens were recorded from this habitat. There is a strong tendency to remain in such areas except when flooding forces them to move to adjacent higher lying habitats.

Springhares are strictly nocturnal and occur singly, in pairs or groups but the latter may be interpreted as collections of singles and pairs in a confined floodplain (12 recorded as a group). They feed on bulbs, roots and young shoots of plants (Dorst and Dandelot, 1970).

Breeding occurs throughout the year and a single young at a time is born in Botswana (Smithers, 1971). No evidence ixists amongst the local population of the heavy utilisation of this species which is reported as a food source for the central and southern areas of Botswana (Silberbauer, 1965; Butynski, 1974).

Family Muscardinidae
Graphiurus murinus (Desmarest, 1822)
Dormouse

Only one specimen of dormouse was captured on the northwestern sector of Chief's Island in *Acacia tortilis* Savanna Woodland, close to the verge of Closed Riverine Woodland. Dormice are granivorous and insectivorous, nocturnal and arboreal (Smithers, *op. cit.*).

Family Sciuridae
Paraxerus cepapi maunensis Roberts, 1932
Bush Squirrel; seThora

Widespread and common throughout the islands of both floodplain systems and on Chief's Island. Bush squirrels are localised mainly in all the woodland communities, but are most common in Closed Riverine Woodland, *Colophospermum mopane* Woodland, *Acacia nigrescens – Croton megalobotrys* Woodland, *A. tortilis* Savanna Woodland and *A. erioloba* Woodland. They occur less commonly in *Combretum imberbe – Croton megalobotrys* Woodland and *Terminalia sericea – Combretum collinum* Savanna Woodland.

They are vegetarians, eating a wide variety of wild fruits, berries and seeds; and are avid thieves from bush camps, being especially fond of mealie meal. Smithers (1971) reports them eating fresh green shoots of *Acacia* spp., forbs and green *Cynodon dactylon.*

Bush squirrels are mainly arboreal but terrestrial to a lesser degree. They are strictly diurnal and occur singly, in pairs or in family units. The subspecies appears capable of breeding throughout the year, but there is a marked increase in breeding throughout the summer months, and lowest breeding peak during the winter months. Births are singles, twins or triplets (Smithers, *op. cit.*)

Family Octodontidae
Thryonomys swinderianus (Temminck, 1827)
Greater Cane Rat; QaQadi

No cane rats were observed in the study area, but local guides claimed that the species exists in the northern well-watered margins of Upper and Middle Channel Communities *(Phragmites* spp. and *Miscanthidium junceum).* Observed by myself outside of the study area at Matlapaneng and Smithers *(op. cit.)* also records them from here, from the northern Moremi Wildlife Reserve and from the "sleeve" of the Delta.

Cane rats are vegetarian, largely nocturnal and gregarious, but may occassionally be encountered during daylight hours.

Families Cricetidae and Muridae
Rats and Mice referred to collectively in seTswana as Peba
Otomys angoniensis maximus Roberts, 1924
Angoni Vlei Rat

Angoni vlei rats were captured along the Boro River verges of the western floodplains. Attempts to establish their presence in the same habitat type on the eastern floodplains were unsuccessful. However suitable habitat types do exist and they should be present in it as Smithers (1971) records them from lower down on this same system.

Angoni vlei rats appear to be confined to the margins of permanently inundated areas of tall grass and/or sedge vegetation i.e. the margins of Middle or Outlet Channel Communities, some Madiba, Sumps and Shallow Backwater Communities. They are largely vegetarian and granivorous, predominantly nocturnal and all specimens were collected during the hours of darkness. They occur singly, in pairs or in small family parties (Smithers, *op. cit.)*

Smithers *(op. cit.)* gives the breeding season for these rats as probably confined to between the months of August and March but states that births outside this period are possible. Three females captured in June were all non-gravid.

SIZES AND MASS

Males (n = 2)

TL	$\bar{X}$	=	255;	range	224	–	285
T	$\bar{X}$	=	90;	range	88	–	91
Hfc/u	$\bar{X}$	=	34;	range	32	–	36
E	$\bar{X}$	=	22;	range	20	–	24
Mass	$\bar{X}$	=	168,3g	range	161,2	–	175,4 g

Females (n = 3)

TL	$\bar{X}$	=	258;	range	198	–	300
T	$\bar{X}$	=	89;	range	65	–	111
Hfc/u	$\bar{X}$	=	32;	range	30	–	34
E	$\bar{X}$	=	21;	range	20	–	22
Mass	$\bar{X}$	=	199,7g	range	182,8	–	223,4g

External parasites:

(Acarina)

Androlaelaps zulu (Berlese, 1918)

Listrophoroides womersleyi (Lawrence, 1951)

Ornithonyssus bacoti (Hirst, 1913)

Haemaphysalis sp.

(Anoplura)

Polyplax otomydis cummings, 1912

Pellomys fallax rhodesiae Roberts, 1929

Creek Rat

Only one specimen of creek rat (a sub-adult male) was trapped on the verges of the central Boro River. Smithers (1971) mentions the difficulties in trapping this subspecies and their absence in his records from apparently suitable habitat in the central Delta areas. They seem to overlap in occurrence with *Otomys angoniensis* and doubtless there must be more present from the verges of Middle or Outlet Channel Communities in the study area.

Creek rats are vegetarians, feeding on green plants, semi-aquatic and almost wholly diurnal (Smithers, *op. cit.*) states that the only available breeding records are from juveniles recorded between August and April.

Dasymys incomtus nudipes (Peters, 1870)

Water Rat

Five water rats were collected in the central area of the Boro floodplains. All were collected on the margin of an Outlet Channel Community in tall aquatic and semi-aquatic grasses and sedges. Although suitable similar habitat exists on the M'borogha floodplains, no specimens of water rat were collected there. All specimens were collected at night.

Water rats are largely nocturnal, but Smithers *(op. cit.)* reports some diurnal activity for the Kasane population. They are more strictly confined to the wet areas than *Otomys angoniensis.* Smithers *(op. cit.)* again postulates an August to March breeding season.

SIZES:

Male (n = 1)

TL = 310; T = 143; Hfc/u = 40; E = 20.

Females (n = 4)

TL	$\bar{X}$	=	297;	range	237 –	332
T	$\bar{X}$	=	149;	range	140 –	158
Hfc/u	$\bar{X}$	=	37;	range	36 –	37
E	$\bar{X}$	=	20;	range	18 –	22

External parasites:
(Acarina)

Laelaps roubaudi Taufflieb, 1954
Listrophoroides dasymus Radford, 1942

Leggada minutoides induta (Thomas, 1910)
Pygmy mouse

Only one specimen of pygmy mouse was collected on the verge of Closed Riverine Woodland adjacent to the Boro River. Smithers (1971) reports the pygmy mouse to occur from a wide variety of vegetation types and his distribution map confirms this. It is difficult to understand why so few occur in this wetter environment.

Pigmy mice are graminivorous, nocturnal and terrestrial. Smithers *(op. cit.)* reports them as breeding throughout the year, but with a peak in the summer months.

Praomys natalensis microdon (Peters, 1852)
Multimammate Mouse

Widely distributed and common throughout the study area and they show a wide tolerance of vegetation types, occurring in all but aquatic vegetation types. They were found to be especially common around camps and villages as the multimammate mouse is a commensal with man. Smithers *(op. cit.)* reports them as widely distributed throughout Ngamiland.

They commonly occurred on islands in Closed Riverine Woodland, all marginal vegetation types and the ecotone of adjacent floodplain or aquatic vegetation types. On Chief's Island they were recorded from all dryland vegetation types present.

Multimammate mice feed on grass seeds, *Acacia* spp. pods and seeds and other wild fruits. Where habitation is available they are omnivorous and feed on virtually all household edibles and gnaw on all plastics. They are nocturnal and terrestrial, and soon establish runs under groundsheets or any fixed camp equipment resting on the ground and are pests in any semi-permanent camp.

Smithers (1971) reports multimammate mice to breed in all months except that no record exists for June, but with a peak of activity in March. Of a sample of seven females caught in September 1973, six were gravid, carrying from seven to 17 foetuses.

SIZES AND MASS

Males

TL	$\bar{X}$	=	217;	n	=	22;	range	172	– 273
T	$\bar{X}$	=	105;	n	=	22;	range	80	– 132
Hfc/u	$\bar{X}$	=	23;	n	=	22;	range	20	– 32
E	$\bar{X}$	=	19;	n	=	22;	range	15	– 23
Mass	$\bar{X}$	=	49,8 g;	n	=	6;	range	33	– 81,8 g

Females

TL	$\bar{X}$	=	209;	n	=	19;	range	174	– 248
T	$\bar{X}$	=	99;	n	=	19;	range	75	– 117
Hfc/u	$\bar{X}$	=	22;	n	=	19;	range	20	– 24
E	$\bar{X}$	=	18;	n	=	19;	range	16	– 20
Mass	$\bar{X}$	=	57,8 g;	n	=	10;	range	24,3	– 88,9 g

External parasites:

(Acarina)

Androlaelaps marshalli Berlese, 1911

Cheyletus sp.

Laelaps roubaudi Taufflieb, 1954

Subfamily Gerbillinae
Tatera leucogaster (Peters, 1852)
Bushveld Gerbil

Widely distributed and plentiful especially on the sandy areas of Chief's Island and the larger islands. Some small islands with suitable sandy substrate also hold lesser populations.

Bushveld gerbils occur in *Acacia tortilis* Savanna Woodland, *A. erioloba* Woodland and Savanna Woodland, *Grewia* spp. – *Croton megalobotrys* Scrub Savanna, *Terminalia sericea* – *Combretum collinum* Savanna Woodland and Scrub Savanna and *Colophospermum mopane* Woodland and pyrophytic Scrub Savanna. Lesser numbers were found to occur on Secondary Floodplain Communities, marginal vegetation types and Closed Riverine Woodland.

They feed on fruit of grasses, fruit and seeds of shrubs and trees, grass rhizomes and bulbs (Smithers, 1971). They are terrestrial, nocturnal and live in warrens displaying well worn runs between the burrow openings. Young are born throughout the year with two to nine being the observed range of foetuses (Smithers, *op. cit.*).

SIZES

Males (n = 4)

TL	$\bar{X}$	=	235;	range	191	–	276
T	$\bar{X}$	=	119;	range	95	–	143
Hfc/u	$\bar{X}$	=	33;	range	30	–	36
E	$\bar{X}$	=	20;	range	19	–	21

Females (n = 14)

TL	$\bar{X}$	=	261;	range	221	–	308
T	$\bar{X}$	=	137;	range	115	–	164
Hfc/u	$\bar{X}$	=	34;	range	30	–	38
E	$\bar{X}$	=	20;	range	19	–	22

Tatera brantsi griquae Wroughton, 1906
Brants' Gerbil

Only one specimen of Brants' Gerbil was collected from the southern end of Chief's Island in a *Colophospermum mopane* Woodland ecotone with *Acacia erioloba* Woodland. The habits and food are much the same as for *T. leucogaster*, but *T. brantsi griquae* seems to tolerate drier conditions. The range of foetuses carried was lower (one to five) and the breeding season seems more restricted (Smithers, *op. cit.*) than in *T. leucogaster*.