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CARCASS COMPOSITION OF THE GIRAFFE *GIRAFFA CAMELOPARDALIS GIRAFFA*

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OPSOMMING: KARKASSAMESTELLING VAN DIE KAMEELPERD *GIRAFFA CAMELOPARDALIS GIRAFFA*

Kameelperde, *Giraffa camelopardalis giraffa*, wat geskiet is tydens wildbeheer, is so ver moontlik volgens standaard karkassnitte opgesny en hulle massa is bepaal. Karkassamestelling en vleiskwaliteit is bestudeer deur middel van boud-disseksies en spierveseldikte. Die gemiddelde liggaamsmassa van volwasse bulle was 1 174,3 ± 31,5 kg en dié van koeie 791,8 ± 17,6 kg. Daar was betekenisvolle verskille tussen seisoene in liggaamsmassa, en in die geval van koeie het die hoeveelheid vet in die karkas gedaal gedurende die warm droë seisoen, blykbaar as gevolg van 'n laer voedingsvlak. Die uitslagpersentasie van bulle was 61,9% en dié van koeie, 56,6%. Karkassamestelling was redelik goed met 'n hoë boud gedeelte maar wel ook met lae vet- en hoë beeninhoud. Ten spyte van hul stadige groei, en die ongewenste hoë spierveseldikte in ouer diere, bied die kameelperd nogtans 'n betreklike goeie moontlikheid vir diversifikasie van vleisproduksie in droë savannagebiede deurdat die spesies 'n unieke ekologiese nis beklee.

SUMMARY:

Culled giraffes *Giraffa camelopardalis giraffa* were dissected into standard cuts as far as possible and their mass was determined. Carcass composition was studied by means of buttock dissections and meat quality by means of muscle fibre diameter measurements. Mean total body mass of adult males was 1 174,3 ± 31,5 kg and of adult females was 791,8 ± 17,6 kg. There were significant seasonal differences in total body mass and in the case of females the amount of fat present in the carcass declined during the hot dry season, probably as a result of lower nutritional levels. Male carcasses dressed out at 61,9% and females at 56,6% with a fairly good conformation yielding a high proportion of buttock, but with a low fat and high bone content. Despite their late maturing and undesirably high muscle fibre diameter in older animals, the species nevertheless holds great promise for diversifying meat production in semi-arid savanna areas because it occupies a unique ecological niche.

The meat production potential of wild ungulates in South Africa has been subjected to close investigation in recent years (Von La Chevallerie, 1970; Huntley, 1971a; Von La Chevallerie, Erasmus, Skinner & van Zyl, 1971; Von La Chevallerie & Van Zyl, 1971; Irby, 1975). The significance of live body mass in assessing this potential has been stressed by von La Chevallerie (1970). However, unless live body mass as a parameter of meat production is related to body composition, it may well be an unsatisfactory indicator of the potential of animals and of the productivity of the flora on which they live (Ledger, 1965). During the course of giraffe (*Giraffa camelopardalis giraffa*) culling in the eastern Transvaal Lowveld, data on body mass and body composition were obtained. Though inadequate for a definitive statement on meat production of the species, the data provides useful information on the carcass composition of giraffe and a basis for comparison with domestic stock and other wild ungulates.

The animals used in this study were shot on privately owned land in the eastern Transvaal Lowveld from June 1971 to July 1972. The salient environmental features are a tropical climate with a unimodal temperature, radiation and rainfall peak per annual cycle. Mean annual rainfall is 554 mm. The vegetation consists predominantly of savanna formations dominated by *Combretum apiculatum* or *Acacia nigrescens* and *Colophospermum mopane* shrub savanna and woodland. Most watercourses are seasonal and support a belt of thicket along their banks; termite mound thickets are also common.

The climatic cycle has important influences on the phenology of the woody plants which are the principal food source of the giraffe (Hall-Martin, 1974; 1975a). Thus during the hot wet season (November to March) most plants are actively growing, during the cool dry season (April to July) growth largely ceases and leaf fall sets in. During the hot dry season (August to October) nearly all deciduous plants are bare. Towards the latter part of the hot dry season and the beginning of the rains new leaves appear. The effect on giraffe ecology of this seasonal rhythm is that the animals have to cope with a varying period of time during each dry season when there is a shortage of their preferred foods and during which the nutritional value of the available food is lower than the rest of the year (Hall-Martin & Basson, 1975). Poor nutrition during the late dry season is manifested by a loss of physical condition resulting in increased predation mortalities and deaths due to climatic stress (Hall-Martin, 1975a; 1975b).

Procedure

Carcass dissection

Only adult giraffes were used for the carcass composition studies, of these 25 were females (over 6 years old) and 19 males (over 8 years old). For the study on meat quality an additional foetus, six calves and seven immature animals were included. The giraffes were shot in the head, early in the mornings, using a 30'06 calibre rifle and 180 gr soft nosed or expanding bullets. The animals collapsed instantly onto their sternum or side and their throats were cut within seconds. No animals were wounded and the carcasses were well-bled.

Due to the large size of the animals and the lack of suitable scales or hoisting apparatus the animals were butchered where they fell (after being pulled over onto their side if they had collapsed onto their sternum) and their mass measured in pieces. The limited equipment made it impossible to follow the carcass dissection proposed by Ledger (1963). A procedure using four men, based on the traditional butchery of the indigenous Shangaan people was therefore adopted and modified to accord with Ledger (1963) where possible. After skinning the exposed side of the animal in panels or in one piece the body was dissected as follows:

1. The exposed foreleg was first removed as suggested by Ledger (1963). A vertical cut was made commencing at the olecranon process of the ulna alongside the caudal edge of the *m. tensor fasciae antibrachii*, continued to the caudal angle of the scapula, cutting into the *m. latissimus dorsi* where it runs inferior to the caudal edge of *m. triceps*. Then while the leg was lifted a lateral cut was made through the pectoral muscles close to their junction with the forelegs. This cut was continued along the leading edge of the forelegs as indicated by the cranial edge of the *m. biceps brachii* and the *m. supraspinatus* and then round the dorsal end of the scapular cartilage cutting through the *m. trapezius*. The foreleg could then be raised clear of the thorax and the final cut made by severing the connection of the scapular cartilage to the thorax so that the inferior surface of the scapular cartilage itself was clear of muscular tissue. The foot was then removed from the foreleg at the carpal joint.
2. The hindleg (buttock) was next removed in a manner similar to that described by Laws, Parker & Archer (1967) for the African elephant *Loxodonta africana*. The leg was removed at the acetabulum and included the muscles lying exterior to the dorso-lateral surface of the pelvis and lateral to the sacrum. This muscle mass is made up of the *m. gluteus, m. biceps femoris, m. tensor fasciae latae, m. iliacus, m. semitendinosus, m. sartorius* and *m. semimembranosus*. A cut was begun along the lateral edge of the sacrum and continued medio-distally severing the muscle attachments between the *tuber coxae* and the *tuber ischii*, the muscles being cleanly removed from the bone and obturator membrane. As the muscle attachments were severed the muscle mass was reflected away from the bone. This cut was continued ventrally along the caudal edge of the *tuber coxae* severing the attachments of the *m. tensor fasciae latae* and the patellar ligament. It was possible then to rotate the leg so as to disarticulate the head of the femur. The leg was finally freed by a cut through the remaining muscle attachments and the foot removed at the tarsal joint.
3. Next *m. longissimus lumborum* and *m. longissimus thoracis* were removed from their attachments to the sacrum and ileum as far cranially as the seventh certical vertebrae exposing the capitulae of the thoracic ribs.;
4. The head was removed by severing it from the neck at the atlas joint and continuing the cut along the caudal line of the jaw.
5. A horizontal cut was then made through the capitulae of the thoracic ribs and vertically down through the sternum which was split ventrally. The cut was continued caudally through the abdonimal muscles as far back as the pelvis and then a vertical cut was made along the cranial edge of the pelvis to join the dorsal cut. The rib cage with the attached flank and abdominal muscles was removed, cutting through the diaphragm as close to the ribs as possible, which exposed the viscera.
6. The body was then eviscerated and the genitalia removed. The oesophagus was ligated and severed close to the cardiac sphincter. The duodenum was also ligated near the pyloric sphincter and severed from the stomach. The rectum was ligated and severed. The kidneys and kidney fat were removed from the body cavity with the viscera.
7. The neck was severed from the thorax by a cut running between the seventh cervical and first thoracic vertebrae. When dealing with large bulls the neck also had to be divided between the fourth and fifth cervical vertibrae as it was too unwieldly to be handled in one piece.
8. The remainder of the carcass was then turned over and the foreleg, hind leg, *m. longissimus lumborum, m. longissimus thoracis* and the rib cage of the other side removed.
9. The chine and pelvis were separated by a cut between the last thoracic and first lumbar vertebrae. The tail was removed at the junction of the sacral and coccygeal vertebrae.

The mass of all the body components was determined using a Salter spring balance with a capacity of 200 kg. The balance was regularly checked for accuracy against a known mass standard. The time elapsed between shooting and mass measuring varied according to the size of the animal. Blood and body fluids lost during butchery were not measured. The total body mass of giraffe used in this study is, therefore, the sum of the mass of the body components as determined on the spring balance with no correction for blood and fluids lost and no overnight cooling and also include the mass of the reproductive tract and its contents in females.

Buttock dissection

The composition of the buttock in steers has been shown to closely approximate the composition of the whole carcass (Butterfield, 1962). The left buttock of 23 giraffes were therefore dissected after cooling in a shady place for some hours, into muscle, fat, connective tissue and bone to assess the composition of the carcass. Bone is classified as that which remains after all muscular tissue and fatty tissue has been removed from a hindleg as dissected from the body in the manner described above. This component is similar to the butchers bone defined by Ledger (1965) and consists of the femur, tibia, tarsus, patella plus the tendon ends, cartilage and coarse connective tissues thicker than 4,0 mm such as the patellar ligaments.

Muscle fibre diameter

Meat samples were taken from the *m. longissimus lumborum* and the third lumbar vertebra before the removal of the muscle from the body. The samples were about 8,0 cm^3 and were fixed in 10% formalin. Muscle fibre diameter was later measured from subsamples of these meat cubes as described by Joubert (1956).

Results

Body mass

The mean body mass of adult giraffe is shown in Table 1, together with the standard error and range for three different age groups. These data are a close approximation to to the live mass of the giraffe, but have been affected by several sources of bias – the most important of these being the blood and evaporation loss after shooting and during butchering. Small scraps of tissue were also lost and have not been accounted for. In addition to the bias during mass determination there are several other factors which influence the total body mass of a given animal at a given time. Some of these were investigated and are briefly discussed.

Sex

There is marked sexual dimorphism in the giraffe with the heaviest males having a mass more than 150% of that of the heaviest female (Table 1). This dimorphism is a feature of most African ungulates (von La Chevallerie, 1970).

Age

The differences in body mass found among the present study animals could have been due to an age effect. However, because the majority of the specimens fell into the lower age classes (8 to 10 years in males, 6 to 11 years in females) and samples were small it seemed likely that the age effect may be masked. The data were therefore divided as nearly as possible into three equal-sized groups representative of young adults, prime adults and old adults (Table 1) – age was determined following Hall-Martin (1976). When t-tests (Simpson, Roe & Lewontin, 1960) were done on total body mass of male giraffe in the three different groups it was found that there was no significant difference between the first and second group but the difference between the third and second groups was significant at the 5% level ($t = 2{,}534$; d.f. $= 9$). In the case of female giraffe the younger group was significantly lighter than the next older group ($t = 5{,}1586$; d.f. $= 17$, $P < 0{,}001$). There was no significant difference in mass between the two older groups. In view of these findings it becomes possible to examine mass differences on a seasonal basis with greater confidence.

Season

Several recent studies on production of wild ungulates in South Africa have focused attention on the effects of season on live mass (von La Chevallerie & van

Table 1

Total body mass (kg) of adult giraffe of different age groups from the eastern Transvaal Lowveld, June 1971–1972

Group	Age (years)	n	Mean	S.E.^{x}	Range	Differences†
Males						
I	8 – 9	8	1 096,6	46,1	849 – 1 250	-
II	10	6	1 183,3	34,2	1 202 – 1 303	-
III	11 – 23	5	1 287,6	60,4	1 056 – 1 395	>I* >II*
	All males	19	1 174,3	31,5	849 – 1 395	
Females						
I	6 – 8	9	752,0	27,2	636 – 884	<II** <III**
II	9 – 11	10	773,3	30,5	635 – 895	
III	12 – 20	6	863,1	28,1	779 – 950	–
	All females	25	791,8	17,6	635 – 950	

x = standard error

†* = significant at 5% level;

** = significant at 0,1% level

Table 2

Total body mass (kg) of adult giraffe in different seasons, eastern Transvaal Lowveld, June 1971 – July 1972

Season	n	Mean	S.E.	Range	Differences †
Males					
a. Hot wet	3	1 329,0	21,5	1 306 – 1 372	–
b. Cool dry	11	1 152,3	43,1	849 – 1 395	–
c. Hot dry	5	1 129,8	47,9	973 – 1 250	<a*; <b**
Females (including foetal mass)					
a. Hot wet	5	791,8	55,6	677 – 950	–
b. Cool dry	15	801,6	20,9	636 – 907	
c. Hot dry	5	762,6	36,6	635 – 860	<b***
Females (excluding foetal mass)					
a. Hot wet	5	741,4	32,9	673 – 843	–
b. Cool dry	15	793,2	18,9	636 – 885	–
c. Hot dry	5	730,4	35,9	626 – 835	<b***

† * = significant at 5% level;
** = significant at 1% level
*** = significant at 0.1% level

van Zyl, 1971; Huntley, 1971b; von La Chevallerie *et al.*, 1971; Irby, 1975).

Statistical t-tests were done on total body mass for giraffes collected during the three seasons as previously defined and it was found (Table 2) that the hot dry season male group was significantly lighter than the cool dry season group (T = 3,115; d.f. = 14; P < 0,01) and the wet season group (t = 3,029; d.f. = 6; P < 0,05) respectively. In the case of females the hot dry season group was significantly lighter than the cool dry season group (t = 9,2938; d.f. = 18; P < 0.001), but not significantly different from the wet season group, irrespective of whether or not foetal mass is excluded.

The ages of the animals in the different seasonal groupings were compared and it was found that the male giraffe shot during the hot wet season were significantly older than the hot dry season group at the 5% level (t = 2,7556; d.f. = 6). There were no other significant age differences among season groups. Among the females no differences in age between the three groups were found using Student's t-test. These data, in addition to the small differences found in mass of adults of different ages, support the hypothesis that the lower masses of those shot during the dry season are a result of the lowered plane of nutrition.

Stomach fill

The mass of the stomach contents was measured for each animal and included in total body mass. In the case of adult males the stomach plus its contents as a percentage of total body mass ranged from 8,5% to 13,6%; in females there was a much wider range from 8,2% to 20,7%. It is therefore clear that stomach fill would have a greater influence on total mass of females than of males (Table 3).

Body composition

For studies of meat production the dressed carcass composition rather than body composition is judged. However, body composition data are useful in studies of the amount of meat, viscera and other body parts consumed by predators, scavengers or decomposers; and as a means of assessing live mass of an animal by prediction methods. The percentage of total mass of the body components of adult giraffe are given in Table 3.

Carcass composition

The available data from dressed carcasses of adult giraffe can, for comparative purposes, only be discussed in terms of four major components; these are buttock foreleg, neck and a component referred to as 'rest of carcass'. This latter category included pelvis, chine, *m. l. lumborum, m. l. thoracis*, ribs and fillets. The data are presented in Table 4. In females the buttock as a percentage of carcass mass is significantly greater than in the male (t = 7,7188; d.f. = 41; P < 0,001). There is no significant difference,

Table 3

Body composition of adult giraffe from the eastern Transvaal Lowveld, June 1971–July 1972

	Males (n = 19)			Females (n = 25)		
	Mean	S.E.	Range	Mean	S.E.	Range
Total body mass (kg)	1 174,3	31,5	849 – 1 395	791,8	17,6	635 – 950
As % of total body mass						
Dressed carcass	61,9	0,3	58,7 – 64,3	56,6	0,4	53,2 – 60,2
Buttocks	17,7	0,2	16,5 – 19,4	17,7	0,1	16,4 – 20,0
Forelegs	15,9	0,1	15,1 – 17,1	14,6	0,3	13,5 – 16,9
Chine, pelvis fillets, ribs & *m.l.* & *m.l. lumborum; m.l. thoracis*	20,7	0,5	17,0 – 23,7	18,4	0,2	16,7 – 21,1
Neck	7,6	0,3	5,1 – 9,9	5,9	0,1	4,8 – 7,7
Offal	38,1	0,3	35,7 – 41,3	43,4	0,4	39,7 – 48,6
Skin	11,2	0,2	10,0 – 13,3	10,1	0,1	8,0 – 11,7
Feet	4,2	0,05	3,8 – 4,7	3,9	0,07	3,2 – 4,5
Head	2,9	0,07	2,6 – 3,5	2,5	0,05	1,8 – 3,0
Intestines	5,0	0,01	4,1 – 5,7	5,9	0,1	4,5 – 8,6
Organs	3,3	0,09	2,6 – 4,3	7,1	0,9	3,4 – 20,8
Stomach & contents	11,5	0,3	8,5 – 13,6	13,9	0.5	8,2 – 20,7

Table 4

Carcass composition of adult giraffe, Transvaal Lowveld, June 1971–July 1972

	Males				Females			
	n	Mean	S.E.	Range	n	Mean	S.E.	Range
Total dressed carcass mass (kg)	19	726,7	19,9	502,1 – 857,2	25	447,2	94,2	360,7 – 514,8
Dressed carcass as % of total body mass	19	61,9	0,3	58,7 – 64,3	25	56,6	0,4	53,2 – 60,2
As % of dressed carcass mass								
All adults								
Buttocks	19	28,6	0,34	26,2 – 31,1	25	31,4	0,20	29,8 – 34,0
Forelegs		25,8	0,20	24,3 – 27,1		26,0	0,12	25,2 – 27,4
Neck		12,2	0,59	8,0 – 16,9		10,4	0.25	8,2 – 13,6
Rest of carcass		33,6	0,68	28,8 – 38,5		32,1	0,31	28,1 – 35,2
†Group I								
Buttocks	8	29,4	0,54	27,4 – 31,1	9	31,4	0,38	30,3 – 34,0
Forelegs		25,6	0,34	24,5 – 27,1		26,4	0,20	25,5 – 27,4
Neck		12,7	0,76	8,2 – 14,9		9,8	0,18	8,8 – 10,6
Rest of carcass		32,4	0,91	28,8 – 36,1		32,3	0,42	29,9 – 33,9
Group II								
Buttocks	6	28,2	0,32	27,1 – 29,1	10	31,6	0,24	30,0 – 32,0
Forelegs		25,6	0,20	24,7 – 26,1		25,6	0,14	25,2 – 26,5
Neck		10,9	0,97	8,2 – 14,6		10,9	0,40	9,8 – 13,6
Rest of carcass		35,2	1,09	30,8 – 38,5		31,8	0,58	28,1 – 34,7
Group III								
Buttocks	5	27,3	0,30	26,2 – 28,0	6	31,1	0,48	29,8 – 32,9
Forelegs		26,3	0,50	24,3 – 27,1		25,9	0,24	25,3 – 27,0
Neck		12,9	1,44	8,0 – 16,9		10,6	0,71	8,2 – 11,6
Rest of carcass		33,4	1,56	29,0 – 37,2		32,3	0,67	30,8 – 35,2

† Age groups as given in Table 1

Table 5

Seasonal mass changes in buttock components of adult giraffe from the eastern Transvaal Lowveld, August 1971–May 1972

	Cold buttock mass (kg)				As % of cold buttock			
Season	n	Mean	S.E.	Range	Muscle	Bone & sinew	Fat	Differences† (for fat)
Females								
a. Hot wet	5	67,2	3,3	59,4 - 75,5	77,1	21,4	1,39	–
b. Cool dry	8	68,5	1,3	66,2 - 72,6	78,3	20,6	1,17	–
c. Hot dry	4	69,0	2,3	64,5 - 74,7	77,0	21,5	0,52	< a*
Males								
All seasons	6	106,0	3,1	92,3 - 115,7	75,6	23,9	0,46	

†* = significant at 1 % level.

Table 6

Kidney fat (kg) as a percentage of total mass (kg) of adult giraffe from the eastern Transvaal Lowveld, August 1971–June 1972

Season	n	Mean	S.E.	Range
Males				
Hot wet	3	0,096	0,014	0,067–0,114
Cool dry	3	0,060	0,013	0,035–0,083
Hot dry	3	0,096	0,021	0,055–0,124
Females				
Hot wet	5	0,121	0,021	0,074–0,196
Cool dry	9	0,133	0,162	0,068–0,202
Hot dry	4	0,110	0,148	0,083–0,152

however, in the contribution of the foreleg to carcass mass. The neck contributes a significantly greater proportion to carcass mass in males ($t = 3{,}038$; d.f. $= 42$; $P < 0{,}01$) and so do the rest of the carcass components ($t = 2{,}0719$; d.f. $= 42$; $P < 0{,}05$). When carcass composition within the three age groups was examined it was found that there were no significant changes in the relative importance of the different components with age in females. In the case of males, however, the buttock contributed significantly more ($t = 3{,}1683$; d.f. $= 11$; $P < 0{,}01$) to the carcass in the younger animals than in the oldest animals. This was due in part to the increase in size of the neck. There were no other significant differences.

When the amount of fat in the buttock of cows shot during each of the three seasons was compared (Table 5), it was found that there was significantly less fat present in the hot dry season ($t = 4{,}0027$; d.f. $= 7$; $P < 0{,}01$) than in the wet season. No differences in buttock fat could be ascribed to the physiological influence of pregnancy. No seasonal differences were found in the muscle, bone and sinew components of the buttock reflecting loss of condition of females (Bable 5). Seasonal comparison could not be made for adult male giraffe as the sample was too small (Table 5). When kidney fat mass as a percentage of total mass of nine adults male and 18 adult female giraffe was examined (Table 6) it was found that there were no significant differences between the seasons in males or females.

The data for pregnant and non-pregnant females were compared and it was found that the latter had significantly more kidney fat as a percentage of total body mass ($t = 2{,}1969$; d.f. $= 15$; $P < 0{,}05$).

Muscle fibre diameter

Measurements of muscle fibre diameter in giraffe are presented in Table 7. Fibre diameter of the *m.l. lumborum* in only one male foetus was measured and although it was less than in other males it was greater than a 1-week-old female calf which had a muscle fibre diameter of only 32,0 μm. With increasing age

Table 7

Muscle fibre diameter (μm) from M. Longissimus lumborum *of giraffe from the eastern Transvaal Lowveld, July 1971 – July 1972*

	n	Mean	S.E.	Range	Differences†
Males					
a. Foetus	1	43,6			
b. Calves (< 1 year old)	3	50,4	1,2	48,2 – 52,4	< d*, e*
c. 1 – 6 years	4	53,2	0,6	52,0 – 54,4	< d*, e*
d. 7 – 10 years	2	61,8	1,2	60,2 – 63,0	
e. > 10 years	3	65,5	3,1	61,6 – 71,6	
Females					
a. Calves (< 1 year old)	3	37,6	5,4	32,0 – 48,4	< c*, d*
b. 1 – 6 years	3	50,3	4,2	43,0 – 57,6	
c. 7 – 10 years	6	50,3	1,3	46,2 – 54,2	
d. > 10 years	5	54,0	1,5	52,6 – 58,0	

† * = significant at 1% level.

in both males and females the muscle fibre diameter increased. Though the samples are small the differences between the means of the various groups were tested. It was found that the difference between male calves and males up to 6 years old was not significant at the 5% level; the difference between the young group (1–6 years) and older animals, (7–10-years-old), was significant ($t = 7{,}4853$; d.f. $= 4$; $P < 0{,}01$). The difference between the 7- to 10-years-old group and the oldest animals was not significant. In females the ranges in the different age groups show considerable overlap. No statistically significant differences were found between the age groups, except between calves and adults over 6 years old ($t = 4{,}3118$; d.f. $= 12$; $P < 0{,}01$).

Discussion

Body mass

There are few data available on body mass of giraffes from elsewhere; nevertheless, the mass of two adult males (1 269 kg and 1 097 kg) given by Wilson (1968) and Sachs (1967) fall within the range of the eastern Transvaal data, so also do two captive females of 797 kg and 605 kg reported by Crandall 1964). The mass of an adult female from Zambia, 1 126 kg (Wilson, 1968), is considerably greater than the heaviest female from the eastern Transvaal. There may, however, also be differences among sub-species as the mean mass of 28 adult females Masai giraffe (*G.c. trippelskirchi*) collected by Kayanja & Blankenship (1973) was 676 ± 12 kg which is significantly less than that of the Transvaal females ($P < 0{,}001$).

The data given in Table 1 are, however, not a precise measure of live mass due to several sources of mass loss inherent in the techniques used in this study such as blood loss and evaporation loss during dissection. As the most important carcass components such as legs and neck have a relatively small surface area to volume ratio, the evaporation loss from them is likely to be less than from the viscera which have a large surface area. Several workers (Smith & Ledger, 1965; Laws *et al.*, 1967; Huntley 1971a) have found evaporation losses on cooling in various African ungulates to vary between 1,4% and 4% of live body mass. Fewer data are available on the mass of blood lost during slaughtering, but Callow (1961) puts it at 3,3% to 3,9% of live body mass in dairy cattle (*Bos taurus*). It seems reasonable therefore to suppose that if at least 4% were added to the total body mass as given in Table 1, a more accurate estimate of live mass in eastern Transvaal giraffe would be arrived at.

The variation in live mass of ungulates due to differences in digestive tract fill is a factor which can vary due to the eating and drinking habits of a particular species and the time of day, relative to these habits when its mass is measured (McCulloch & Talbot, 1965; Smith & Ledger, 1965; Van Zyl, 1968). The variation found in giraffe in this study (8,5% to 13,6% in males, 8,2% to 20,7% in females – Table 3) falls within the range for the ungulates from East Africa. The greater range in females is probably related to the physiological requirements of lactation and pregnancy (Hall-Martin, 1975a).

The mass of the gravid uterus is often subtracted from the total live mass of females so as to eliminate the effect of varying stages of pregnancy (Ledger, 1963; Smith & Ledger, 1965; Sachs, 1967; Grimsdell, 1973). Other reported live body masses either include the mass of the gravid uterus or else make no mention of its subtraction (Skinner, von La Chevallerie & van Zyl 1971; Robinette & Archer, 1971). In other cases authors distinguish between mass of pregnant and non-pregnant females (Wilson, 1968; Hanks, 1969; von La Chevallerie, 1970). In the present study it was found that the uterus and its contents could have a mass of up to 169 kg and comprise up to 18,8% of the live mass of the female. Nevertheless, the mass of adult females as given in this report is always intended as the closest approximation to the total live mass (= liveweight) of the animal in the field at the time of collection. Therefore the mass includes the reproductive tract and its contents. In all cases where the mass of a large foetus might have biased the range of data for a particular grouping e.g. age, or season, separate computations were done excluding foetal mass. No change in the significance of any data were found.

Seasonal fluctuation in body mass is a feature of African ungulates (von La Chevallerie, 1970; Skinner, 1973) and usually reflects the decline in nutritive value of the veld. In the case of giraffe the data presented on lower body mass (Table 2) and lower proportion of fat in the buttock (Table 5) during the hot dry season correspond with changes in diet (due to decreased availability of preferred species) and a drecrease in the nutritive value of the species eaten (Hall-Martin, 1974, Hall-Martin & Basson, 1975).

Carcass composition

It is unfortunate that the carcass cuts in giraffe did not conform to the standard cuts used by other workers (e.g. Ledger, 1963; 1965; von La Chevallerie *et al.*, 1971; von La Chevallerie & van Zyl, 1971; Huntley, 1971a) but this was impossible in the circumstances pertaining to the field butchery. However the dressing percentages in Table 4 refer to the same parts of the body as other workers and giraffe fall within the range for most African ungulates summarized by von La Chevallerie (1970). Male giraffe having a markedly higher dressing percentage than females.

It has been mentioned above that the composition of the buttock has been taken to reflect the composition of the carcass, as shown by Butterfield (1962) for steers. However in cattle subcutaneous fat is uniformly distributed and forms an important component of total body fat. Most wild African ungulates, in order to facilitate radiation of heat, have little or no subcutaneous fat. If this is true for giraffe then it is possible that Butterfield's (1962) method will result in an underestimate of total body fat. Nevertheless, subcutaneous fat layers up to 1,5 cm thick were noted under the belly of females, but these deposits were less conspicuous in males.

The range of lean meat in giraffes (77,0–78,3% in females; 75,6% in males – Table 5) is close to that given by Ledger, Sachs & Smith (1967) for 17 East African ungulate species, but lower than that of eland *Taurotragus oryx* (von La Chevallerie *et al.*, 1971) blesbok *Damaliscus dorcas phillipsie* and kudu *Tragelaphus strepsiceros* (Huntley, 1971a) and springbok *Antidorcas marsupialis* (von La Chevallerie & van Zyl 1971). The fat content of the giraffe carcasses (0,46% to 1,39%) Table 5) is also lower than that found in these other species and any of the wild ungulates listed by McCulloch & Talbot (1965), Ledger *et al.* (1967) and von La Chevallerie (1972).

The giraffe carcass also contains a relatively much higher proportion of bone and sinew (Table 5) than the other species. This situation is partly explained by the long limbs and therefore longer bones of giraffe as compared with other species. The neck, which in all animals has a relatively high percentage of bone, is extremely massive in giraffe and substantiates the general tendency that giraffe seem to have a higher percentage of bone in the carcass than other game species.

The buttock, which is considered a high quality cut, comprised 28,6% of the mature male giraffe carcass and 31,4% in the mature female carcass (Table 4). These values are of the same order as those found in other species by von La Chevallerie *et al.* (1971), Huntley 1971a) and von La Chevallerie & van Zyl (1971). The foreleg of giraffe, which is not a desirable cut, as it contains flat muscles, lots of tendon and connective tissue and a high percentage of bone, contributes a much higher proportion to the carcass than any of the other wild ungulates investigated in South Africa.

Though the sample of animals for which kidney fat mass was available is small it nevertheless seems as if this fat deposit may not be as suitable an index of condition in the giraffe as in other species (von La Chevallerie & van Zyl, 1971; Huntley, 1971b).

Muscle fibre diameter and meat quality

From the data presented in Table 7 it can be seen that muscle fibre diameter increases relatively slowly in females above 1 year of age. In the case of males there is a relatively greater increase after the age of about 6 years. By contrast, in springbok the major increase in muscle fibre diameter takes place early in the animals' life (von La Chevallerie & van Zyl, 1971).

The muscle fibre diameters of giraffes can be compared with those of other wild ungulate species as given by von La Chevallerie & van Zyl (1971) and von La Chevallerie (1972). Giraffe females compare favourably with all species except springbok. Male giraffe do not fare as well, though the mean muscle fibre diameter of giraffe over the age of 10 years is nevertheless lower than that of eland and gemsbok *Oryx gazella* bulls. Muscle fibre thickness is an important aspect of meat quality as experienced by the consumer as it determines the coarseness of grain and texture of the meat (von La Chevallerie, 1972). From a consumer viewpoint giraffe meat would be most acceptable if it comes from males less than 6 years old or from females. The differences in flavour and colour between young and old giraffe; the odour of old males, and the late maturity of giraffe (Hall-Martin, 1975a) must in any case favour the use of younger animals in any programme which seeks to market giraffe meat.

The observation that fibre diameter increases with body mass (viz. males against females, old against young) is in agreement with the findings of Joubert (1971) and von La Chevallerie (1972).

Conclusions

Despite the small sample studied it can be concluded that giraffe have a fairly good carcass conformation and that the meat, especially from younger animals would be acceptable to consumers. The carcass yields a high proportion of buttock, but the relatively low fat and high bone content of the carcass, the relative late maturity and toughness of meat from mature animals are disadvantages. However, as a result of the unique ecological niche occupied by this species, they compete minimally with more palatable wild animals and domestic stock which more than compensates for the above disadvantages. In addition, the tractable nature of these animals, the fact that they are easily restrained by a standard game fence, and can cross ordinary cattle fences onece they are familiar with them, are additional considerations in favour of this species for diversifying and increasing animal production over large areas of the semi-arid savanna regions of Southern Africa.

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