

SEASONAL CHANGE IN BODY FAT OF THE HYRAX  
*Procavia capensis* (Pallas, 1766) USING A BODY FAT  
RANKING INDEX

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*Abstract* — Changes in the body fat content of the hyrax *Procavia capensis* were used as an indicator of physiological condition. Body fat rankings for the different sexes showed seasonal variations related to physiologically stressful periods (rutting, gestation and lactation). The subjective body fat rankings were correlated significantly with total body fat.

*Introduction*

Physiological condition, as defined by Hanks (1981), is linked to an individual's chances of living or dying. A commonly used criterion for the description of physiological condition in mammals is the quantification of deposited fat reserves. Total body fat can be determined in small mammals by processing the whole animal (Perrin 1981), whereas in large mammals a kidney fat index (KFI) may be used as an indicator of total body fat (Caughley 1970; Hanks, Cumming, Orpen, Parry & Warren 1976; Monro & Skinner 1979). Alternatively bone marrow fat (BMF) can be determined (Neiland 1970; Franzmann & Arneson 1976; Brooks, Hanks & Ludbrook 1977). Bone marrow fat, however, is mobilized sequentially (Brooks *et al.* 1977; Reich 1981) and therefore values can only be compared if obtained from a specific bone. Since BMF is the last fat reserve to be mobilized (Hanks 1981), it is not a good index for determining the overall physiological condition of a

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population. Ransom (1965) has proposed that in order to assess the entire range of physiological condition of a population a combination of both KFI and BMF is required.

This paper reports on seasonal variation in physiological condition of hyrax *Procavia capensis*, in relation to sex and age, in the Mountain Zebra National Park. Body fat content is used as an indicator of physiological condition. The investigation formed part of a wider study conducted during 1980-1983 on the population dynamics of the hyrax (Fourie 1983).

### *Methods*

Fat deposits are a commonly used criterion for the quantification of physiological condition (Hanks 1981). However, the removal of body fat (and the expression of this fat as a percentage of the carcass mass) is an expensive, tedious and time consuming task. An alternative method is to remove the fat immediately around the kidneys and to calculate the kidney fat index (KFI) (Caughley 1970; Monro & Skinner 1979). Kidney fat index can also be visually assessed.

Since fat is not formed extensively around the kidneys of the hyrax (Steyn 1980), but around the gonads, the use of a KFI is not justified. The method used in this study was to subjectively apply a body fat ranking (BFR) on a scale from 1-5 as follows:

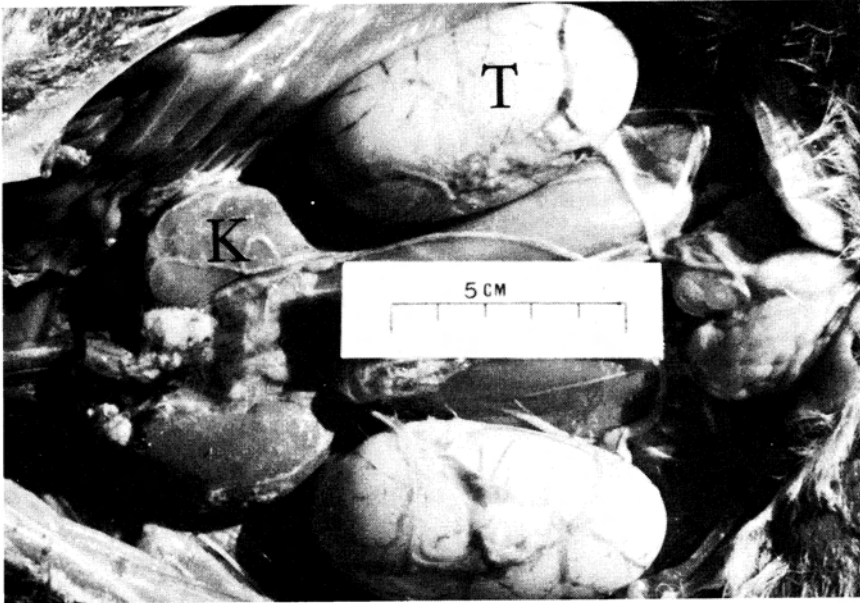
- (a) BFR1 — no visible fat around the kidneys, gonads or in the lower abdomen (Fig. 1a).
- (b) BFR2 — a small amount of visible fat around the posterior portion of the kidneys as well as around the gonads.
- (c) BFR3 — fat covering posterior portion of the kidneys and extending into the body cavity but not entirely covering the gonads (Fig. 1b).
- (d) BFR4 — visible fat extending towards the proximal portion of the kidneys and completely covering the gonads.
- (e) BFR5 — large amounts of fat around the anterior and posterior portions of the kidneys and completely covering the gonads (Fig. 1c).

Juveniles (0-12 months old) had little or no visible fat deposits and were not used for comparative purposes.

In order to quantify the subjectively assigned BFRs, 27 hyrax were analysed for total body fat. Five hyrax belonging to each BFR were used for study, except for the first category, where seven hyrax were used. Each was cleaned of gastrointestinal contents, and the entire carcass was dried at 70 °C in a draught oven to constant mass. The carcasses were sectioned into blocks of 30 mm x 30 mm by means of a circular saw and finely ground in a Spencer Larson mill. Body fat was extracted using Soxhlet ether-distillation (Allen, Grimshaw, Parkinson & Quarmby 1974). Body fat ranking and total body fat content were then subjected to correlation analysis. The seasonal patterns of BFR are interpreted in relation to rainfall and physiological stressful periods such as rutting, gestation and lactation.

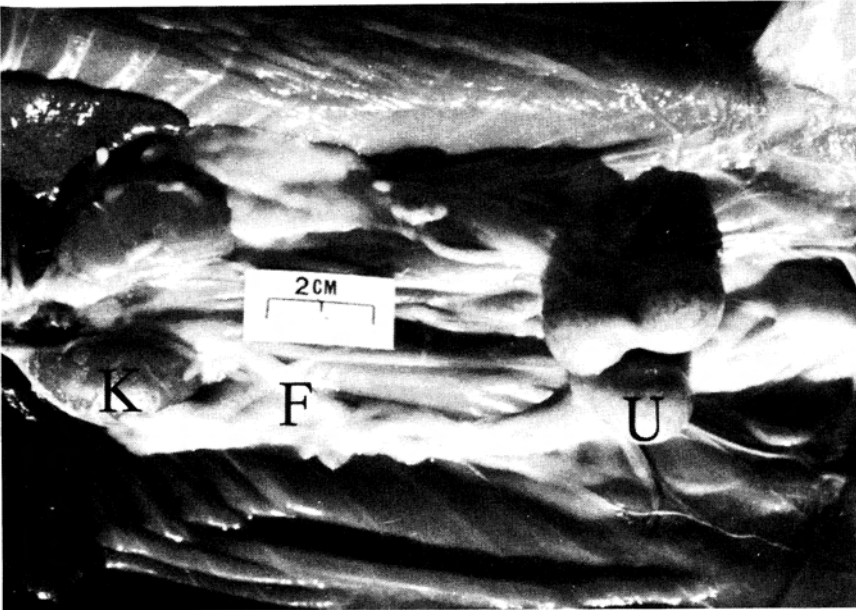
## Results

The results of the total body fat analyses of the 27 hyrax belonging to the five different body fat rankings are summarized in Table 1. The correlation between total crude body fat and the subjective BFR is highly significant ( $y = 18,34x^{0,3081}$ ;  $r = 0,86$ ;  $p < 0,001$  where  $y =$  total crude body fat and  $x =$  BFR).



(b)

(a)





(c)

Fig. 1a-c: Ventral view of the lower abdomen of the hyrax illustrating three different Body Fat Rankings: (a) no visible fat = rank one; (b) intermediate amount of fat = rank three; (c) large amount of fat = rank five (K — kidney; T — testis; F — fat; U — uterus).

Body fat rankings for male ( $n = 196$ ) and female hyrax ( $n = 218$ ) during the period April 1980-May 1982 are presented graphically in Figure 2a & b. Physiologically stressful periods and the occurrence of seasonal rainfall are indicated on the graphs. A comparison between the mean monthly BFR for male and female hyrax showed a significant difference over the entire period ( $p < 0,05$ ; t-test). The mean monthly BFR of males for the May-July (1980 and 1981) period (following peak rutting) was significantly lower than that of females during the same period ( $p < 0,05$  and  $p < 0,01$ ; t-test). The BFR of females during gestation declined from May-November/December (1980 and 1981) and these values differed significantly from values of males during the same period ( $p < 0,05$  and  $p < 0,01$ ; t-test). The mean monthly BFR values of females during lactation were consistently but not significantly lower than those of males collected during the same months ( $p > 0,1$ ) (Figs. 2a-b). No statistically significant correlations were found between rainfall and the BFR of either male or female hyrax ( $p > 0,5$ ).

### *Discussion*

The physiological condition of juvenile hyrax appeared consistently low and very little abdominal fat was deposited. The absence of extensive fat deposits in juveniles is most probably related to their rapid growth. In adult hyrax, fluctuations in fat deposits are correlated with the annual reproductive cycle.

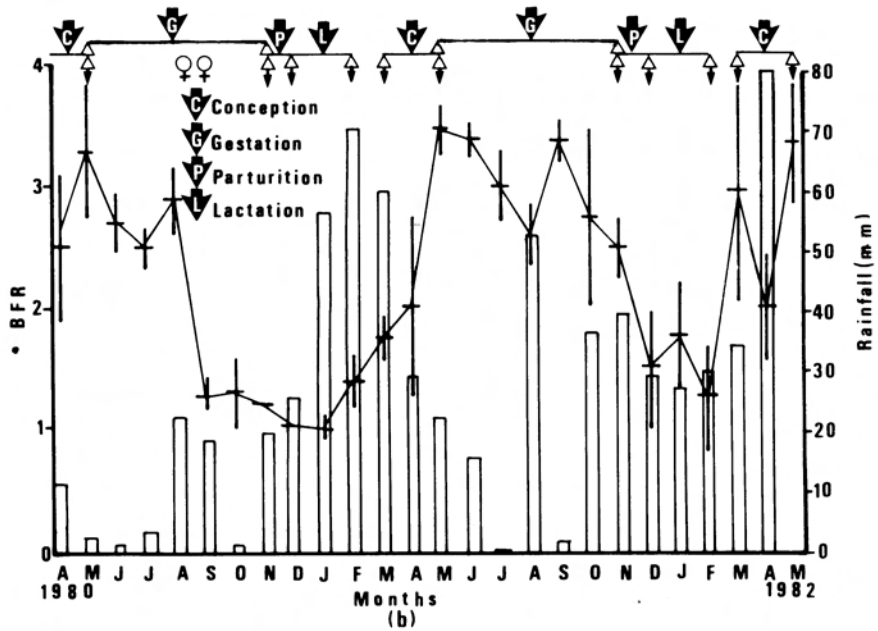
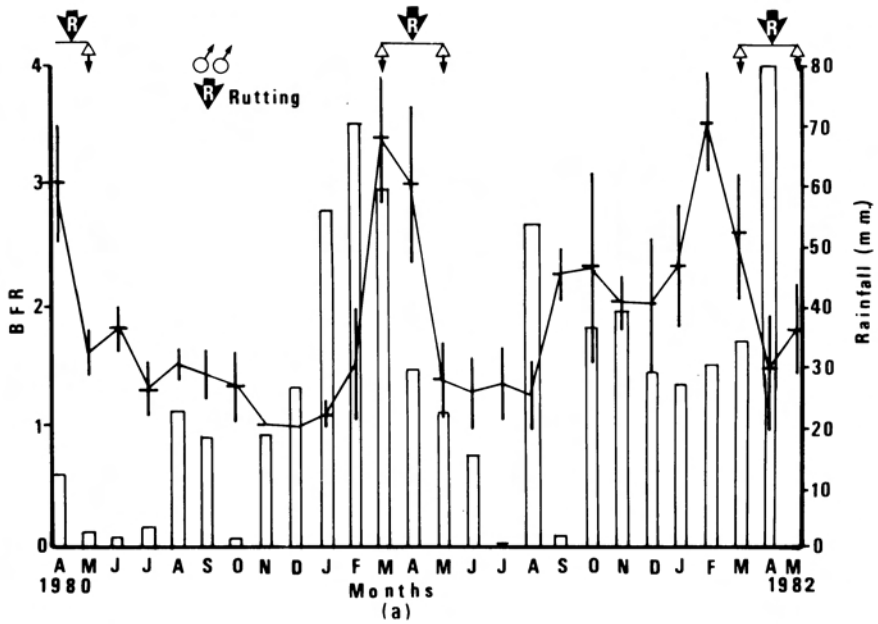


Fig. 2a & b: Mean ( $\pm$ S.E.) monthly BFR values (a) for male and (b) female hyrax during a 26 calendar month period. Mean monthly rainfall (mm) and the different reproductive phases are superimposed on the graphs.

Table 1

The mean ( $\pm$  S.E.) total crude body fat values (% of dry mass) of 27 hyrax belonging to five different Body Fat Rankings (BFRs)

BFR	1	2	3	4	5
$\bar{x}$	18,33	23,54	26,04	27,87	29,72
$\pm$ S.E.	1,41	0,81	0,33	0,59	0,86
n	7	5	5	5	5

This finding agrees with that of Hanks *et al.* (1976) who reported a marked decrease in physiological condition in male impala *Aepyceros melampus* after the rutting season.

Slobodkin & Richman (1961) noted that body fat is a "luxury" item in natural systems since evolutionary processes have channelled "excess" metabolic energy into reproduction and growth rather than into storage. This may be true for small mammals. In larger mammals, however, the absence of any stored fat reserves will markedly affect their resilience during periods of stress and may seriously affect the survival of progeny and the animal itself.

When considering physiological condition in terms of the whole population, a distinction must be drawn between male and female hyrax. Females have a low resilience in late gestation and during lactation whereas males have a low resilience just after the rutting period. This implies that the sexes within a population will be affected at different times by adverse conditions. Although the absence of abdominal fat in a hyrax does not imply that the animal is on the verge of death, since BMF may still be mobilised to varying degrees, it is surely less resilient to environmental or social stresses.

### Conclusion

The subjective BFR used in the present study was significantly and positively correlated with total crude body fat content. It is useful in field studies, and can be obtained without delay or cost. Any attempt to assess the condition of a hyrax population, however, must make allowance for the different levels of fat deposition by the sexes and age groups, or the results may be subject to serious bias.

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### REFERENCES

- ALLEN, E.S., H.M. GRIMSHAW, J.A. PARKINSON and C. QUARMBY. 1974. *Chemical analysis of ecological materials*. Oxford: Blackwells.

- BROOKS, P.M., J. HANKS and J.V. LUDBROOK. 1977. Bone marrow as an index of condition in African ungulates. *S.Afr. J. Wildl. Res.* 7: 61-66.
- CAUGHLEY, G. 1970. Fat reserves of Himalayan thar in New Zealand by season, sex, area and age. *N. Z. Jl. Sci.* 13: 209-219.
- FOURIE, L.J. 1983. *The population dynamics of the rock hyrax Procavia capensis (Pallas, 1766) in the Mountain Zebra National Park.* Ph.D. thesis, Rhodes University, Grahamstown.
- FRANZMANN, A.W. and P.D. ARNESON. 1976. Marrow fat in Alaskan moose femurs in relation to mortality factors. *J. Wildl. Mgmt.* 40: 336-339.
- HANKS, J. 1981. Characterization of population condition. In: FOWLER, C.W. (ed.). *Dynamics of large mammal populations.* New York: John Wiley & Sons.
- HANKS, J., D.H.M. CUMMING, J.L. ORPEN, D.F. PARRY and H.B. WARREN. 1976. Growth, condition and reproduction in the impala ram (*Aepyceros melampus*). *J. Zool. Lond.* 1979: 421-435.
- MONRO, R.H. and J.D. SKINNER. 1979. A note on condition indices for adult male impala (*Aepyceros melampus*). *S. Afr. J. Anim. Sci.* 9: 47-51.
- NEILAND, K.A. 1970. Weight of dried marrow as indicators of fat in caribou femurs. *J. Wildl. Mgmt.* 34: 904-907.
- PERRIN, M.R. 1981. Seasonal changes in the body fat content of two co-existing rodents, *Rhabdomys pumilio* and *Otomys irroratus*. *S.Afr. J. Wildl. Res.* 11: 21-27.
- RANSOM, A.B. 1965. Kidney and marrow fat as indicators of white-tailed deer condition. *J. Wildl. Mgmt.* 29: 397-398.
- REICH, A. 1981. Sequential mobilization of marrow fat in the impala (*Aepyceros melampus*) and analysis of condition of wild dog (*Lycan pictus*) prey. *J. Zool. Lond.* 194: 409-419.
- SLOBODKIN, L.B. and S. RICHMAN. 1961. Calories /gm in species of animals. *Nature* 191: 299.
- STEYN, D. 1980. *Reproduction in the hyrax, Procavia capensis, in relation to environmental factors.* M.Sc. thesis, University of Natal, Pietermaritzburg.