Pre- and Post-rut Body Composition of Red Deer Stags

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Abstract

Six sexually mature red deer (*Cervus elaphus*) stags were slaughtered, 3 immediately preceding, and 3 after the rut. The right side of each carcass was dissected and individual muscles, bones, and fat depots were weighed. The 5 major fat depots were sampled and analysed for mean fat cell diameter and cell number. Five muscles were sampled and the mean fibre transverse sectional area and the fibre number were estimated. These and 10 other muscles were further analysed for water content.

The stags slaughtered post rut had 72% less fat than those slaughtered pre-rut but with no significant loss or change in distribution of musculoskeletal tissue. Loss of fat was accomplished mainly by a decrease in fat cell size. The subcutaneous depot lost most weight and also had the greatest decline in fat cell number. There was no significant change in muscle fibre size or number, or in muscle water content.

Keywords: Cervus elaphus, *stags, fat, muscle, reproduction, starvation*

Introduction

Red deer stags (*Cervus elaphus*) have a seasonal pattern of food intake which coincides with their seasonal sexual activity (Pollock 1974; Kay 1979). During the mating season the food intake of a stag drops to starvation level. No previous study has measured the effect of the rut on body composition in red deer.

In particular, it is pertinent to enquire what effect this type of starvation might have with regard to fat proportions and distribution, to fat cell size and number, to the muscle:bone ratio, to muscle and bone distribution, and to muscle fibre size and number. Studies have been directed towards some of these characters during loss of body weight in laboratory and in meat producing animals, but the effects of acute starvation on all of these characters has been investigated for no species to date.

This study attempts to determine the body composition changes occurring in the red deer stag during the rut.

Materials and Methods

Three stags were killed before the rut in March, and 3 after the rut in late May and early June. Originally wild, they had been maintained on good pasture for 2 – 4 years. The right side of each carcass was dissected, leaving the bones of the sternum and vertebral column intact; 10 visceral, 85 muscle, 38 bone, and 8 fat components were dissected and weighed individually. Five muscles (longissimus, semitendinosus, splenius, rhomboideus, and longissimus capitis) were sampled for estimation of mean fibre area and fibre number. These muscles and 10 others were sampled in a standardised manner for estimation of water content. Five fat depots (Tables 2 and 3) were sampled for estimation of mean fat cell volume and fat cell number. Details of methods, including the statistical treatment of the data, have been published by Wallace (1983).

Results and Discussion

The effects on body composition during the mating season were mainly on fat proportion, fat distribution, fat cell size, and the weight of the gut after removal of the ingesta (Table 1). Apart from the thoracic vertebrae, which were significantly lighter relative to total bone weight in the post rut animal, the proportion and distribution of muscle and bone, and the size and number of muscle fibres showed no clear effects. The muscle:bone ratio decreased slightly during the rut. This could have been associated with the fall in fat content of the carcass or with the estimated overall loss of 0.5 kg (1.6%, Table 1) of muscle water, but regressions of muscle:bone ratio on these characters were not significant.

In an attempt to eliminate all other nutritional effects, gut weights were expressed as percentages of heart plus lung weight (Table 1). The loss of weight of the empty gut was 20%. This may correspond to the seasonal changes in the mucosal

Table 1: Liveweight, dissected components, and gut weights for 6 red deer stags

	Pre-rut (3)	Post-rut (3)	s.e.m.
Liveweight (kg)	171	145	9.1
% bone in fat-free carcass	14.9	15.5	1.1
Muscle:bone	5.7	5.5	0.5
% muscle in fat-free carcass	85.1	84.5	1.0
Mean % water in muscle[1]	25.7	24.1	0.5
% fat in carcass	19.0	5.2	3.7
Gut weights (% of heart plus lung weight)			
Full	1033	773	146
Empty	246	193	11.5*

[1] 15 muscles per stag

Table 2: Mean weight of fat depots

Depot	% of carcass weight Pre-rut	Post-rut	s.e.m.	% of total fat Pre-rut	Post-rut	s.e.m.
Cavity	2.5	0.9	0.8	12.7	14.3	4.3
Omental	1.3	0.4	0.3	7.2	6.2	2.5
Mesenteric	2.6	1.0	0.6	14.1	18.2	2.0
Intermuscular	5.2	1.6	0.6*	27.8	45.5	5.7
Subcutaneous	6.1	0.2	1.6	30.7	5.1	2.0*

* Characteristics for which means for pre- and post-rut stags are significantly ($P < 0.05$) different, as tested by Student's *t* test

Table 3: Estimated mean fat cell number and size

	Pre-rut	Post-rut
Fat cell number ($\times 10^8$)		
Omental fat	15.8	8.2
Cavity fat	33.0	21.7
Mesenteric fat	39.7	42.6
Intermuscular fat	30.0	23.1
Subcutaneous fat	30.9	4.4
Mean fat cell size (μm^3)	710×10^3	46.2×10^3

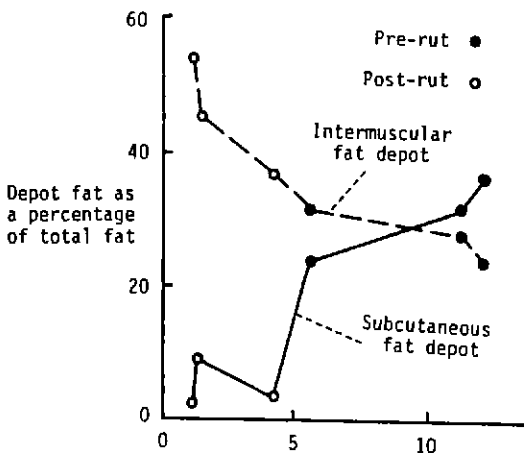

Fig. 1: Effect of the rut on distribution of fat in red deer stags.

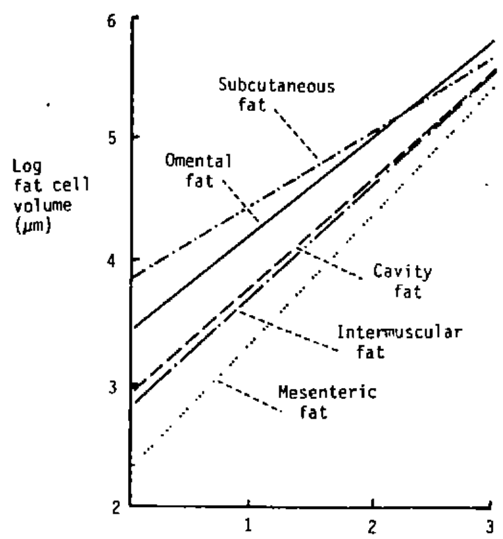

Fig. 2: Cellular changes in the fat deposits of red deer stags during the rut; the smaller regression coefficient for subcutaneous fat indicates a loss of observable fat cells from this depot during starvation.

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Weight loss occurred in all the fat depots measured (Table 2). Relative weight loss was greatest for the subcutaneous depot (34% loss, Fig. 1 and Table 2), and this depot also had the greatest loss of measurable fat cells after the rut (86% loss, Table 3). For all depots, there was a large decrease in fat cell size (93%, Table 3). The greater lability of the subcutaneous depot (Fig. 2) corresponds to its faster growth and greater cellular multiplication rate during normal postnatal growth in both cattle (Tan 1980) and sheep (Broad *et al* 1980). Overall, the stags slaughtered post rut had 22% less fat than those slaughtered pre-rut.

A species intensely seasonal in breeding such as red deer provides an insight into possible body composition and cellular adjustments in other species experiencing hormonal or nutritional changes. Relevant to the use of deer as meat animals is the conclusion that stags slaughtered after the breeding season are much leaner, but no less muscular, than those slaughtered before the rut.

References

Broad T E, A S Davies and G Y Tan 1980 Pre- and postnatal study of the carcass growth of the sheep. 2. The cellular growth of adipose tissues. *Anim. Prod. 31:* 73 – 79.

Hofmann R R, G Geiger and R Konig 1976 Vergleichend-anatomische Untersuchungen an der Vormagenschleimhaut von Rehwild (*Capreolus capreolus*) und Rotwild (*Cervus elaphus*). *Sonderdruck aus Zeitschrift für Säugetierkunde 41:* 167 – 193.

Kay R N B 1979 Seasonal changes of appetite in deer and sheep. *Agric. Res. Council Res. Rev. 5:* 13 – 15.

Pollock A M 1974 Seasonal changes in appetite and sexual condition in red deer stags maintained on a six-month photoperiod. *J. Physiol. 244:* 95P – 96P.

Tan G Y 1980 Carcass development and cellular growth of muscle and fat in male and female cattle. *Ph.D. thesis*, Massey University, Palmerston North.

Wallace V 1983 Pre- and post-rut body composition of the red deer stag. *B. Phil. thesis*, Massey University, Palmerston North.