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The relationship between wool production, live weight and liveweight change in four specialty carpet wool breeds, Romneys and Merinos

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ABSTRACT

128 carpet wool ewes, Romneys and Merinos of between 12 and 30 months of age, were set stocked for 13 months on a property at Oberon NSW. Live weights (LW) for Carpetmasters, Drysdale, Romneys and Tukidales were similar with Elliottdales being slightly lighter and the Merinos lighter again, giving rise to significant breed effects for maximum live weight (LW_{MAX}) and minimum live weight (LW_{MIN}). Wool growth (WG) of each breed was similar during winter, with significant differences between breeds appearing during summer. Breed had a significant effect on amplitude of live weight (LW_{AMP}) and wool growth (WG_{AMP}). There was a strong positive correlation between LW_{MAX} and LW_{MIN} and negative correlations between LW_{MIN} and LW_{AMP} , and minimum wool growth (WG_{MIN}) and WG_{AMP} . Regression analysis for predicting WG from LW and change in LW was unsuccessful with low R^2 (%) values especially during winter. It appears that nutritional influence on WG during winter may be minimal.

Keywords: Carpetmaster; Drysdale; Elliottdale; Tukidale; Merino; Romney; wool growth; live weight.

INTRODUCTION

Wool production varies throughout the year due to factors such as climate, physiological state, rhythms inherent to the breed, nutrition and photoperiod. Breeds differ in their response to photoperiod (Doney, 1966; Bigham *et al.*, 1978). In Merinos the effect is believed to be either minimal, (Nagorcka, 1979) or absent (Doney, 1966), but the effect can be substantial in Romneys (Hawker and Crosbie, 1985; Woods and Orwin, 1988) and specialty carpet wool breeds (Reid, 1981; Williams, 1981; Sumner, 1983).

Live weight and liveweight change are interrelated with wool growth rate through the effects of voluntary feed intake (Aldren, 1979). The relationship is however, likely to be complex for sheep with a pronounced pattern of seasonal wool growth (White *et al.*, 1979).

This paper looks at the interrelationships between wool growth and live weight in Carpetmaster (C), Drysdale (D), Elliottdale (E) and Tukidale (T) ewes for which there are no published Australian data, and compares the amplitude (rhythm) of their wool growth and live weight cycles with that of the Romney (R) and Merino (M) grazing together.

MATERIALS AND METHODS

Animals and Management

The experiment was conducted on a commercial carpet wool property at Oberon, 200km west of Sydney using 19 C, 20 D, 19 E (each 18 months old), 20 fine wool M (12 months old), 23 R and 27 T (both two and a half years old) ewes. The ewes of each breed were attained from a single source and acclimatised at Oberon for approximately three months before the commencement of the study. The ewes were set stocked from 17 April 1993 to 26 September 1994. Beginning on 15

July 1994 the sheep were supplemented with approximately 1kg/h/d of meadow hay until the end of the experiment to offset the initial effects of drought. Sheep were shorn in April 1993, and again on 14 December 1993, 10 May 1994 and 27 September 1994, individual fleeces being weighed and recorded at each shearing.

Wool Growth

Midside wool patches (approx. 10cm x 10cm) were clipped from each animal every five weeks, from 23 July 1993 until 26 September 1994; a total of 13 samples. Seasonal wool growth rate was measured for a subset of 15 C, 15 D, 13 E, 13 M, 16 R and 20 T due to some missing data points through missing samples and animal death or ill-health. Clean wool clipped from the patches was used to divide clean fleece weight proportionally between experimental periods and calculate wool growth rate.

Statistical Analysis

LW_{AMP} of the periodic rhythm in wool growth rate (Nagorcka, 1979) was calculated using the formula shown below, taken from Nagorcka (1979). This calculated variate is sometimes referred to as rhythm.

$$LW_{AMP} = (LW_{MAX} - LW_{MIN}) / (0.5 \sqrt{LW_{MAX} + LW_{MIN}})$$

WG_{AMP} was also calculated by replacing the LW values in the above formula with the corresponding WG values.

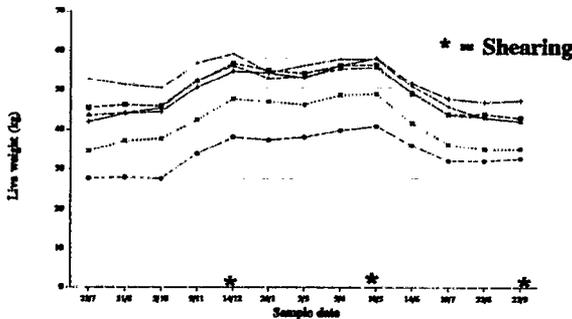
Linear regression analysis and correlations were calculated using a Minitabtm statistical package. A one-way analysis of variance was used to analyse wool growth, live weight and amplitude data.

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RESULTS

Live weight (LW) followed a cyclic pattern for all breeds (Figure 1.) with M and E having the lowest and second lowest mean live weight at all sampling times. Means for maximum live weight (LW_{MAX}), minimum live weight (LW_{MIN}), amplitude of the liveweight cycle (LW_{AMP}), and their standard deviations (SD) are shown in Table 1a. There was a breed effect on both LW_{MAX} and LW_{MIN} ($P < 0.001$), with C, D, R and T having similar values, but E and M values being lower for both ($P < 0.05$).

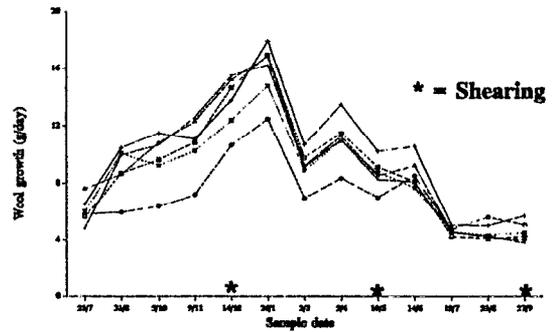
FIGURE 1A: Mean live weight (kg) for Carpetmaster (—+—), Drysdale (—▲—), Elliottdale (—*—), Merino (—○—), Romney (—□—) and Tukidale (—△—) ewes over 14 months.



A breed effect ($P < 0.01$) was found for LW_{AMP} with E having the largest LW_{AMP} , followed by M. The other breeds had similar values although the E LW_{AMP} was larger ($P < 0.05$) than that of the R and T.

M mean wool growth rate was less than the other breeds until 14 June 1994, and E mean wool growth rate was below that of the other breeds until 2 March 1994 (Figure 2). Means for maximum wool growth rate (WG_{MAX}) and minimum wool growth (WG_{MIN}) expressed as g/head/day, and the amplitude of the wool growth cycle (WG_{AMP}) are given in Table 1b.

FIGURE 1B: Mean live weight (kg) for Carpetmaster (—+—), Drysdale (—▲—), Elliottdale (—*—), Merino (—○—), Romney (—□—) and Tukidale (—△—) ewes over 14 months.



There was a breed effect for WG_{MAX} ($P < 0.001$) with M WG_{MAX} less than all breeds except the E ($P < 0.05$), and the E WG_{MAX} less wool than the C ($P < 0.05$).

When WG_{AMP} was calculated (in the same way as LW_{AMP} , replacing $LW_{MAX/MIN}$ with $WG_{MAX/MIN}$), breed was a significant effect ($P < 0.001$). M WG_{AMP} was less ($P < 0.05$) than that for D, R and T, while the E WG_{AMP} was less than that for R ($P < 0.05$).

Strong correlations were found within breeds, between LW_{MAX} and LW_{MIN} (Table 1a) and all were significantly different from zero ($P < 0.001$), except for E. There were no significant within breed correlations between LW_{MAX} and LW_{AMP} , but those between LW_{MIN} and LW_{AMP} were all significant and negative (C, D, M and T, $P < 0.01$; E $P < 0.001$ and R $P < 0.05$). The relationship between WG_{MAX} and WG_{MIN} were not as strong as for the respective WG parameters, with significant correlations only for C and M. There was a significant correlation for T between WG_{MAX} and WG_{AMP} ($P < 0.01$). C, E, R and T ($P < 0.001$) and D and M ($P < 0.05$) had significant negative correlations between WG_{MIN} and WG_{AMP} .

In an attempt to further clarify the importance of nutrition as exhibited through the effect of live weight and

TABLE 1: (a) Mean values (\pm SD) for maximum (MAX) and minimum (MIN) live weights (kg), the amplitude (AMP) of the liveweight cycle and the correlations between these parameters for Carpetmaster (C), Drysdale (D), Elliottdale (E), Merino (M), Romney (R) and Tukidale (T) ewes. (b) Mean values (\pm SD) of maximum (MAX) and minimum (MIN) wool growth rates (g/head/day), to amplitude of the wool growth cycle (AMP) and the correlations between these parameters for Carpetmaster (C), Drysdale (D), Elliottdale (E), Merino (M), Romney (R) and Tukidale (T) ewes.

a) Parameter	Breed					
	C	D	E	M	R	T
LW_{MAX}	58.3 \pm 5.6	59.7 \pm 6.8	50.4 \pm 5.8	41.2 \pm 3.6	57.6 \pm 5.5	56.5 \pm 5.5
LW_{MIN}	41.1 \pm 5.7	41.7 \pm 6.2	31.8 \pm 7.4	27.7 \pm 3.6	41.7 \pm 4.5	40.5 \pm 4.7
LW_{AMP}	0.35 \pm 0.07	0.36 \pm 0.06	0.46 \pm 0.22	0.40 \pm 0.07	0.32 \pm 0.05	0.33 \pm 0.08
$r_{(MAX,MIN)}$	0.881***	0.916***	0.423	0.843***	0.880***	0.702***
$r_{(MAX,AMP)}$	-0.368	-0.377	0.177	-0.291	-0.051	0.156
$r_{(MAX,AMP)}$	-0.760**	-0.713**	-0.847***	-0.759**	-0.517*	-0.593**
b) Parameter	Breed					
	C	D	E	M	R	T
WG_{MAX}	17.9 \pm 2.5	17.5 \pm 2.9	15.2 \pm 1.9	13.4 \pm 2.5	17.2 \pm 0.9	17.0 \pm 2.9
WG_{MIN}	4.7 \pm 1.4	3.9 \pm 0.8	4.3 \pm 1.6	4.2 \pm 1.0	3.6 \pm 0.7	3.7 \pm 1.0
WG_{AMP}	1.18 \pm 0.15	1.27 \pm 0.13	1.13 \pm 0.23	1.04 \pm 0.14	1.30 \pm 0.11	1.28 \pm 0.19
$r_{(MAX,MIN)}$	0.577*	0.398	0.413	0.574*	-0.007	-0.125
$r_{(MAX,AMP)}$	-0.129	0.422	-0.061	0.248	0.294	0.601**
$r_{(MAX,AMP)}$	-0.857	-0.652*	-0.929***	-0.640*	-0.957***	-0.862***

*** = $P < 0.001$, ** = $P < 0.01$ and * = $P < 0.05$.

liveweight change on wool growth rates, two models were considered for regression analysis. Simple linear models were used to establish whether these could be adopted by farmers for predicting wool growth simply from live weight and liveweight change, and hence use the results to adjust management practices. The models were:

$$\text{Model 1: } WG_n = a + bLW_{n-1}$$

$$\text{Model 2: } WG_n = a + bLW_{n-1} + cDLW_{n-1}$$

where WG = wool growth g/head/day

LW = live weight (kg)

ΔLW = absolute liveweight change(kg)

n = sample number, i.e. the sample taken at the end of period n .

The $R^2(\%)$ values indicated that insufficient variation in the data was explained by these linear models for them to be useful prediction tools. Model 2 appeared to explain more of the variation in the data, however the $R^2(\%)$ were nearly all less than 50%, and so no further analyses of these relationships were carried out.

DISCUSSION

The similar values of C, D, R and T live weights supports Bigham et al (1978) who found that once established, breed differences in LW remained, despite cyclic movement of LW with season. Maintenance of between breed LW differences throughout the year was reflected in the significant breed effect for both LW_{MAX} and LW_{MIN} .

R, E and T had similar live weights in the two winters of the experiment, despite pasture quality and quantity differences between the two years. In contrast, in the second winter D LW was lower, and C and M LW was higher. In the case of M this was probably due to the animals being immature upon their entry to these experiment.

There was a clear seasonal wool growth cycle with a sharp increase to WG_{MAX} in summer, but an extended trough around WG_{MIN} in winter. This seasonality is similar to that reported by Bigham et al (1978), Geenty et al (1984), Hawker and Crosbie (1985), Hawker and Thompson (1987), Reid and Sides (1984), and Sumner (1979 and 1983). The similar WG values for the carpet wool breeds and the Romneys throughout the experiment are perhaps due to these carpet wool breeds being derived from the Romney (D, E, T) or the Perendale (C) which itself is related to the Romney, as it was developed through the crossing of the Romney and Cheviot.

WG_{AMP} varied between breeds as reported by Doney (1966), but was larger than reported by Sumner (1983) for D and R. Also WG was lower than reported by Hawker and Crosbie (1985) in winter, but higher in summer (17.2 vs. 11.5 g/day). These variations are most probably due to the seasonal conditions experienced during the various experiments.

The lack of difference between breeds at WG_{MIN} agrees with the report of Bigham et al. (1978), which states that the major differences in fleece weight arise during summer. This supports the concept that winter feeding for WG may not be of much benefit. The addition of lamb bearing to the system, and consequently feeding to minimise decreases in ewe LW may not be necessary since Hawker and Thompson (1987)

found that with R small falls in maternal weight did not affect lamb birth weights or ewe LW at weaning.

The strong positive correlation between LW_{MAX} and LW_{MIN} , except for the E, indicates that animals with high winter LW also had high summer LW. The strong negative relationship between LW_{MIN} and LW_{AMP} , indicates that as winter live weight increases, amplitude decreases.

The correlations between WG_{MAX} and WG_{MIN} are not nearly as high as those for LW, indicating that the mechanisms of control for LW and WG are separate. The attempts to relate LW and WG through regression models, especially in winter, appear to support this and indicate that a better model must be sought to explain a greater degree of the variation.

There is a strong negative correlation between WG_{MIN} and WG_{AMP} , indicating that as WG_{MIN} increases, WG_{AMP} decreases. There was a significant correlation between WG_{MIN} and WG_{MAX} in C and M, and between WG_{MAX} and WG_{AMP} in T. In other breeds these correlations were non-significant indicating that the highest producers in winter, may not be the highest producers in summer, and that the relationship between different aspects of the wool growth cycle varies between breeds. This poor relationship between summer and winter wool growth in most breeds indicates difficulty in selection of animals based on short term performance.

As the data indicates that winter wool growth is only weakly responsive to nutrition, probably due to the interaction of photoperiod (Kajons, 1991; Williams, 1991). As a result, large and costly supplementary feeding programmes, either through the provision of supplements or conserved pasture, may not be warranted in carpet wool or R flocks. Further work is clearly required to understand the factors controlling WG in winter and their interaction with nutrition. The sharp peak of WG_{MAX} indicates a short period of maximum wool production that appears to mirror pasture conditions and hence is probably both a nutritional and photoperiodic response. Supplementary feeding may therefore be better employed in late summer to lengthen the period of maximum wool growth rate, as longer periods of high WG are possible under grazing conditions (Bigham et al., 1978).

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