The Effects of Sward Height, Bulk Density and Tiller Structure on the Ingestive Behaviour of Red Deer and Romney Sheep

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ABSTRACT

The ingestive behaviour of Red deer and/or Romney sheep was examined in relation to two major components of sward structure, height (HT) and bulk density (DEN), by measuring the depth, area and rate of biting on a series of artificial swards.

HT and DEN effects were examined in a series of four short-term indoor grazing experiments using two novel mini-sward techniques, developed to minimise confounding of HT with DEN and other differences in tiller structure. The first experiment used the deep, leafy horizon of tall vegetative sorghum swards, whereas the next three experiments used seedling wheat swards. A fifth experiment using both ryegrass and wheat swards built upon the previous four experiments (examining HT and DEN effects), by measuring the bite dimensions of sheep in relation to changes in tiller structure down the sward profile.

Wheat seedlings grew on seed reserves and achieved a high degree of separation of HT and DEN variation, enabling the description and conceptualisation of how bite parameters respond to independent HT and/or DEN variation. However, when compared to natural grass swards these seedling swards, with 100% green matter and low shear strength, resulted in large bite volumes and high bite rates.

Bite depth increased rapidly and linearly with increasing HT, and at a slightly greater rate the sparser the sward, although on very short swards (<3-4 cm) bite depth was insensitive to even large changes in DEN. High levels of dead matter had no influence upon the bite depth of sheep grazing ryegrass swards. Similarly, the tops of the pseudostems had little if any influence upon the bite depth of deer or sheep grazing wheat or ryegrass swards. However, sheep avoided penetrating the tough rigid pseudostem at the base of ryegrass swards when leaf-like immature pseudostem was available in the overlying strata. Bite depth averaged 70% of HT on the sorghum and seedling wheat swards, appreciably deeper than that typical for natural grass swards.

As the HT of wheat swards increased from minimum grazable levels, bite area increased rapidly as increasing tiller length enabled greater horizontal displacement of tillers. However, the rate of

increase soon declined and bite area plateaued as mouth dimensions rather than HT (tiller length) constrained the area of herbage which animals could efficiently prehend per bite. As DEN increased, animals reduced bite area so that HT became less of a constraint; consequently, bite area plateaued at lower maxima on shorter swards.

The rate of increase in bite area was low relative to the rate of decline in DEN (or tiller shear strength), probably in part reflecting the way mouth dimensions limit the ability of animals to adjust bite area upwards as DEN or tiller strength decline to low levels. Further, there was evidence that the forces required to sever a bite differed considerably across sward treatments.

The potential influences of bite depth, HT and mouth dimensions upon the efficiency of tiller capture per bite, were examined in simple models. These indicated that by penetrating to around 40-50% of HT, as is commonly the case, animals appear to optimise grazing efficiency in terms of the number, length and quality of tillers captured, per unit of grazing effort.

Bite weight increased linearly in relation to HT and DEN, but HT had the dominant influence, because bite volume increased with HT but declined with DEN. However, bite weight still increased rapidly with DEN, because the rate of reduction in bite volume was much lower than the rate of increase in DEN.

Bite rate declined linearly in relation to increasing HT and DEN, primarily because of their influence upon bite weight. However, bite rate was slightly more sensitive to increases in bite weight due to HT than DEN, evidently because bites of dense herbage required less gathering, while bites of long herbage required extra jaw movements to draw them into the mouth and/or reduce particle size.

Rate of intake increased at a declining rate with HT. The effects of HT and DEN were interactive on short swards but became largely independent and additive as HT increased.

Deer and sheep grazed the sorghum and wheat swards representing a very wide range of HT and DEN variation to a similar depth. However, sheep were able to graze 1 cm swards, whereas the minimum HT grazed by deer was 2 cm. Further, not only did sheep have larger mouths in relation to body size, they also appeared to be superior at prehending short swards compared to deer. However, the bite area of deer increased more rapidly with HT, and to higher peak levels in line with their larger mouth dimensions. Reflecting these differences, bite weight per kg $LW^{1.0}$ was much higher for sheep than deer on short swards, but the proportional difference declined with increasing HT. Practical implications are that deer would require more HT than sheep to obtain equivalent intakes.

The results are considered in relation to evidence on the foraging strategy of free grazing ruminants.

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ABBREVIATIONS

AHD	Actual horizontal displacement (cm)
BA	Bite area (cm^2)
BD	Bite depth (cm)
BR	Bite rate (bites min^{-1})
BV	Bite volume (cm^3)
BW	Bite weight (mg DM)
DEN	Herbage bulk density (mg DM cm^{-3})
DHI	Daily herbage intake (mg DM day^{-1})
dwt	Dry weight (mg)
fwt	Fresh weight (mg)
ha	Hectare (10 000 m^2)
HM	Herbage mass (mg DM cm^{-2})
HT	Sward height (cm)
IAW	Incisor arcade width (cm)
IHT	Incisor height (cm)
LC	Tiller length captured (cm)
LL	Tiller length lost (cm)
LW	Liveweight (kg)
MLC	Mean tiller length captured (cm)
N	Newtons (kg x m sec^{-2})
PBA	Maximum potential bite area for a given bite depth and height (cm^2)
PHD	Potential horizontal displacement of tiller (cm)
RHT	Height of grazed residual (cm)
RI	Rate of intake (mg DM min-1)
t	Tonne (1000 kg)
T	Treatment (eg. T1 = treatment one)
TPHD	Total potential horizontal displacement of tillers (cm)

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