ENVIRONMENTAL HETEROGENEITY AS A FACTOR IN GROUP SIZE DETERMINATION AMONG GRAZING SHEEP

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SUMMARY

A study was made of grazing behaviour of Merino sheep on two contrasting rangelands in western New South Wales. One site was a relatively homogenous stand of *Atriplex vesicaria* (bladder saltbush) which was flat and treeless; the other site was a *Danthonia caespitosa-Stipa variabilis* grassland which had an overstorey of low *Acacia pendula* trees.

Although both sites were grazed by sheep of the same breed, age and physiological status under the same environmental conditions and observed simultaneously, there were differences in behaviour particularly in the degree of social cohesion. The sheep on the saltbush grazed as large flocks (200 to 300 sheep) with a minimum of subgroup formation. The mean distance between individuals was 2.9 m. Sheep on the grassland grazed as separate subgroups comprised of as few as four sheep with a mean distance of 4.4 m between individuals and an average of 187 ± 34 m between groups.

Shade was a major determinant of the grazing distribution patterns and the possible implications of manipulating this variable are discussed.

INTRODUCTION

The pattern of subgrouping and flocking among grazing sheep has received little attention but has considerable relevance in terms of rangeland utilization (Lynch and Alexander, 1973). Subgrouping in sheep of various breeds and ages was studied by Arnold and Pahl (1967). With Merinos they found that subgroups, of variable size, and of no fixed composition, occur among young sheep under abundant feed conditions. British breeds, such as Dorset Horns or Border Leicesters, form smaller subgroups than Merinos at a given age. Some breeds develop a very loose flock structure, appearing almost randomly scattered over the pasture (Jones and Paddock, 1966).

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Group size and degree of isolation of subgroups seem to be a function of individual recognition (McBride, 1964) but is also related to forage availability and habitat (Dudzinski and Arnold, 1967; Lynch, 1974). Poor forage conditions can cause subgrouping and, under extreme conditions, sub-groups as small as two or three sheep have been observed with distances of 2 to 3 km between subgroups (Dudzinski and Arnold, 1967; Lynch, 1974).

The featureless tracts of the riverine plain of south-west New South Wales provide an opportunity to assess the implications of the degree of spatial heterogeneity on sub-grouping among grazing sheep. Areas of flat land with large fenced paddocks grazed by Merino sheep of a common genotype are available for comparison. On some areas disclimax grasslands have replaced the original climax of a chenopod shrub steppe. The disclimax communities are more heterogeneous.

This paper reports observations on the behaviour of Merino ewes grazing either an *Atriplex vesicaria* shrubland or a *Danthonia-Stipa* grassland during summer.

STUDY SITES

Two sites were chosen within an 80 km radius of Deniliquin, N.S.W. The terrain was flat and there were no large trees to obscure visibility. Stock waters were derived from subartesian bores of moderate salinity. Although each site had supplementary surface dams these were fenced to prevent livestock access.

Saltbush Site

This paddock was 1310 ha in area, 4.8 km long and over 2.4 km wide with a watering point of low salinity (0.4% total soluble salts) on the southern boundary. The vegetation was an almost uniform stand of *A. vesicaria* with the aftermath of cool season forbs and grasses as a field layer. There were no trees. A full site description is given by Squires (1974).

Grassland Site

This paddock was 910 ha in area, 4 km long and almost 2 km wide with a watering point of 0.6% salinity on the eastern boundary. The vegetation was a mixture of the cool-season perennial grasses; *Danthonia caespitosa* and *Stipa variabilis* with associated forbs. The distribution and abundance of each species were influenced by soil type. In some areas of the paddock slight depres-

sions occurred which contained the grass, *Stipa aristiglumis* (1.5 to 2 m high). In addition there was a sparse overstorey of low (2 to 4 m high) *Acacia pendula* trees. In several restricted areas near the perimeter of the paddock quite large (20 m high) *Eucalyptus largiflorens* trees occurred in swampy depressions. A full site description is given by Squires (1973).

PROCEDURE

Simultaneous comparisons were made on the two sites of sheep activity patterns and grazing distribution during summer. Observations were made concurrently on three consecutive days during the months of December, January, February and March which spans the period from early to late summer (the "dry" season).

The sheep were observed during the daylight hours from a 10 m high tower which was erected near the centre of each paddock. A system of grid markers, at 0.8 km intervals provided an aid to fixing the location of the sheep. Other landmarks such as roads, dams and tracks were also employed. Twelve sheep in each flock of about 500 ewes were colour-coded to facilitate individual identification. Binoculars were used as a field aid in following the movements of the sheep.

Field observations were supplemented by aerial photography from an altitude of 300 m, but between-site comparisons were possible on only one occasion. Measurements of group size, distance between individual sheep within a group, and distance between groups were taken from 20 × 20 cm enlargements (scale 1:1000). Cine cameras were also used to photograph sheep from an observation tower.

RESULTS AND DISCUSSION

Saltbush Site

The sheep grazed either as a single flock or as sub-flocks of 200 to 300 sheep, with a mean distance between individual sheep of 2.9 m. Where splitting of the flock occurred, the two sub-flocks were sometimes up to 1 to 2 km apart. These subflocks amalgamated at the camp site or at a water trough. Despite a good forage supply, little topographic variation, and soils which were only variants of heavy clay, some areas received more grazing pressures than others. As trees were absent, the sheep sought the sparse shade offered by small areas of *A. nummularia,* a shrub most com-

monly only 1 to 2 m high. The day camps of the sheep were established near these *A. nummularia* thickets.

Grassland Site

The sheep grazing this paddock were often seen in groups of five or six separated from each other by distances of up to 200 m. They commonly came together as a single flock at the watering point at the end of each day's grazing but remained as discrete subgroups even at the day camps which were set up under the shade of the indiivdual *Acacia* trees or in the eucalypt groves. The large eucalypt trees, located at each end of the paddock, provided dense shade which was used every day. The smaller but widely scattered *Acacia* trees were also used for shade. As well as providing shade, the trees acted as a barrier to visual contact (Fig. 1). Tall (1 m high) grass *S. aristiglumis* which grows in slight depressions also acted as a visual barrier.

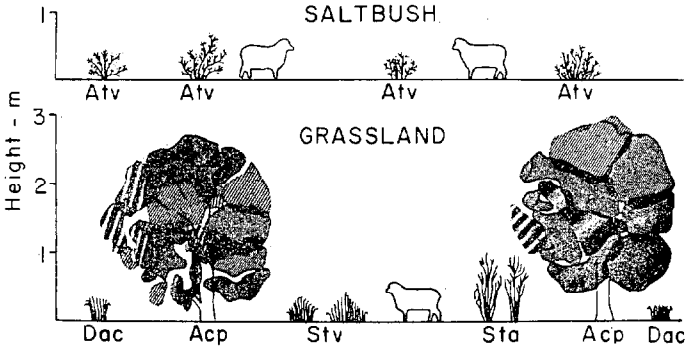

Fig. 1: *Profiles of the grassland and saltbrush rangelands.*
Atv, *Atriplex vesicaria.* Dac, *Danthonia caespitosa.* Acp, *Acacia pendula.* Stv, *Stipa variabilis.* Sta, *Stipa aristiglumis.*

When sheep were grazing, some members would drift apart so that contact had to be renewed at intervals by one or more sheep looking up at other group companions and walking toward them. Temporary separations where contact calls had to be made by one animal before it became reunited with the rest of the group were frequent. When visual contact was lost and vocalization was not used to renew contact sheep drifted off to form small subgroups. These groups generally remained separated until the flock returned to the watering point.

The composition of the subgroups was not completely fixed as two groups could merge. But it was common for the subgroups to become more widely dispersed and fractionated as the day progressed and chances of mixing were reduced. The mean distance between individual subgroup sheep was 4.4 m while the distance between subgroups was 187 ± 34 m. The splitting or amalgamation of groups occurred during the day but a major redistribution of flock members took place after the gathering at the day camps or the watering point, so, despite the dynamic nature of subgrouping, and their dispersion, there was a whole flock organization.

Mechanisms in such "flock integrity" behaviour are unknown. From empirical studies with birds, Hamilton and Gilbert (1969) found that flock size was larger in more homogenous habitats. Heterogeneity imposed by physical barriers to spatial movement or spatial variations in resources (feed, water, shelter, camp sites, etc.) reduces flock cohesion but the degree of dispersal varies with each species. For example, mountain slopes grazed by livestock may be too steep or too rocky for complete coverage by cattle but may be accessible to sheep or goats. From the present study it appears that the barriers need not be strictly physical as visual obstructions have a disrupting effect.

Leadership did not appear to be strong. Flock dispersion under conditions of deteriorating feed supplies would be advantageous. When forage supplies reached a low level in March, the spacing between individuals was greater and the group size smaller than in January. It is unfortunate that aerial photographs were not available for this period since the oblique view afforded from the vantage point of the tower precluded any quantification of these observations.

CONCLUSIONS

The two sites in the present study represented situations which gave quite different results. Although both sites were grazed by sheep of the same breed, age, and physiological status under the same environmental conditions and observed on the same days, there were marked differences in behaviour, particularly social cohesion. The sheep on the more homogenous saltbush community grazed as large flocks with the minimum of subgrouping. The mean distance between individuals was small when compared with the sheep on the grassland site.

Shade was a major determinant of the grazing distribution patterns. It also determined the choice of camp sites. The sheep

on the saltbush established their camp sites near the few scattered *A. nummularia* bushes while the sheep on the grassland made use of the eucalypt groves at each end of the paddock or the widely scattered *Acacia* trees.

When resources such as shade or water are localized, limitations to group size may occur. Because of the dispersed feed, scattering of a large flock occurs during feeding, but, as the groups commence to return to the watering point, amalgamation of small flocks increases rapidly.

The behaviour of the sheep needing to camp in shade provides possibilities for manipulating grazing distribution patterns to avoid some of the consequences of localized grazing pressure which normally develop around focal points such as watering points (Squires, 1970). It seems surprising that shelter-seeking behaviour of sheep under extensive pastoral conditions has not been studied. It is known that sheep will seek shade in hot weather and, in absence of shade, will form small, tight groups and tend to hold their heads in the shade provided by the bodies of other animals (Lynch and Alexander, 1973). Quite commonly on treeless plains sheep will camp on the top of the bank of an excavated tank (dam) where they can catch a breeze.

The direct and indirect effects of the environment on the utilization of rangelands by sheep may be additive or may interact; the combined effects can be partly investigated by studying the behaviour of the free-grazing animal. The gathering of quantitative information on movement, distribution and grazing by sheep in large paddocks on the rangelands of Australia could assist with the development of improved management strategies.

ACKNOWLEDGEMENTS

Valuable assistance was given by G. T. Daws in every phase of this project. The aerial photographs were taken by Colin Totterdell, CSIRO Division of Plant Industry, Canberra. The co-operation of the landholders, Theo McCaw, Caroonboon Station, Wanganella, and G. Wright, McCaughey Institute, Jerilderie, is appreciated. This material forms part of a Ph.D. dissertation submitted to the Department of Range Science, Utah State University, Logan, Utah. During 1971-73 I was the holder of an Australian Meat Research Committee Overseas Studentship while on leave from CSIRO.

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