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THE SIGNIFICANCE OF SHEEP DIET STUDIES IN A SEMI-ARID WOODLAND IN NEW SOUTH WALES

Graham Harrington

CSIRO Division of Land Resources Management, Deniliquin, N.S.W. 2710

Abstract

Sheep diet at a plant species level for seven occasions during 1974-76 is presented for a woodland community under four different managements.

The wide variation in grazing preference with treatment and/or time indicates that species manipulation of the herbage may be possible. The fact that sheep, goats, cattle and kangaroos can be expected to have some different preferences gives added managerial possibilities but complicates an already difficult situation.

Such diet studies are an essential prerequisite to the formulation of effective grazing management but require complementary understanding of plant phenology (growth and reproductive phases), productivity and survival under different forms of management.

Introduction

The *Eucalyptus populnea* (poplar box) woodlands cover 60,000 sq. km in N.S.W. and are noted for the shrub encroachment that has taken place since sheep were introduced *ca.* 1870 (Anon. 1969). CSIRO have established an ecosystem study aimed at identifying the crucial factors in management of the vegetation. Potential management has two main components, the reduction in the mass of shrubs in order to promote herbage growth and the manipulation of the herbs to maximise stability and long term animal productivity. Heretofore vegetation management in this area has been restricted to clearing of shrubs and ringbarking trees. Generally speaking the woody vegetation has subsequently reasserted dominance and in some cases ringbarking has appeared to promote shrub encroachment.

Sheep diet studies are used here to indicate the usefulness of this approach in assessing whether a plant community is susceptible to management.

Methods

A 500 ha area of poplar box woodland on "Oakvale", Coolabah, N.S.W. was selected for the wide variety of shrubs it exhibited, arranged in a fairly homogeneous manner.

Two blocks of four 40 ha paddocks were established and the following treatments were applied as from August, 1974:

Treatment 1: Grazed by Merino wethers at 8 ha/sheep. (A moderate stocking rate for this class of country).

Treatment 2: Feral nanny goats at 2 ha/sheep.

Treatment 3: As treatment 2 with additional wethers introduced periodically to consume herbage and enforce a high browsing pressure (goat blitz).

Treatment 4: As treatment 2 with all shrubs and trees <30 cm trunk diameter bulldozed in June-July 1975.

Treatment 5: An exclosure of 100 ha was attached.

Herds of five goats, sheep and cattle, which were habituated to human beings, were introduced to the paddocks at the seven times indicated in tables 1, 2 and 3. The animals were given from 2-7 days to settle into the paddock, as was deemed necessary. The animals were familiar with all the paddocks and were permanently grazed in adjacent paddocks (excepting the cattle) and were, thus, subject to the same array of plants and seasons as other local animals.

The observer moved within the herd, recording the plants eaten, being careful to remain stationary when the observed animal was stationary and move alongside it rather than follow it. In this way any distortion of behaviour due to the presence of the observer was minimised.

At 30 second intervals the plant actually bitten was recorded. The plants "on offer" were then taken to be those in an imaginary 2 m x 1 m quadrat, constructed with the feet of the animal forming the base and centre of one long side. In the type of herbage on this site, where plants are usually discrete, this was not a difficult task on the great majority of occasions. The observed animal was allowed 10 seconds in which to take a bite and if he failed to do so that 30 second period was abandoned. Four animals were observed in a rotation of blocks of 10 records from each animal. Thus the first animal would be recorded for 10 consecutive 30 second periods, followed by the second animal and so on. The information was spoken into a tape recorder and care had to be exercised that the recorder was switched on, that the tape was not exhausted and that a goat had not bitten through a microphone lead!

Initially the animals were recorded for the duration of daylight but as no change in diet with time of day was observed, subsequent records were limited to 100 per animal. Between five and six hours of recording from dawn onwards was normal and included the mid-morning period for rumination.

On completion of the diet records, the observer hand plucked simulated grazed samples from six plants of the species most frequently eaten. This was assumed to be a better measure of diet quality than whole plant samples. Chemical analyses were carried out on these samples.

Each paddock was sampled for herbage at 10 locations previously selected on a 100 m grid which covered the paddock. The eucalypt tree nearest to the grid point was used as the focus for sampling. The ranked quadrat method was used (McIntyre 1952) and four 1 m x 0.5 m quadrats were cut beneath the eucalypt canopy and half way to the next tree in a N, S, E and W direction.

Results

The most commonly occurring plant species and their contribution to the diet of sheep are listed in tables 1-3. On most occasions the figures are averages of 100 recordings for four animals and can be viewed as percentages. "O" is the percentage of times the species was "on offer", "E" is the percentage of times it was eaten and "P" is the "preference rating", i.e. the percentage of times when "on offer" that that species was eaten. Where less than 400 recordings were made the number is indicated.

Attempts to study sheep diet on the goat blitz treatment were abandoned after July 1975 when the sheep grazed desultorily for 1.6 hr on dead spear grass stubble (63%) and litter (34%) but apparently realised they were better off saving their energy for plaintive bleating, which won them a reprieve after four days.

Although large data matrices are wearisome there seems to be no alternative to the publication of such data if we are to build up an understanding of plant/animal relationships and field layer plant dynamics.

Shrubs frequently on offer, which were never acceptable were *Eremophila mitchellii* (budda), *E. sturtii* (turpentine), *E. bowmannii* (silver turkey bush), *Myoporum desertii* (dogwood), *Geijera parviflora* (wilga), *Cassia nemophila* (punty), *C. artemesioides* (silver cassia). Litter from the following species was found highly acceptable on some occasions: *Acacia aneura* (mulga), *A. excelsa* (ironwood), *Apophyllum anomalum* (warrior bush), *Santalum acuminatum* (quandong), *Capparis mitchellii* (wild orange), *Heterodendrum oleifolium* (rosewood), *Eucalyptus intertexta* (red box) and *Ventilago viminalis* (supplejack).

Data from the herbage sampling on the paddocks is not presented here but is an essential requisite to a fuller understanding of the plant/animal relationships.

The nitrogen (N) content of the simulated grazing samples is presented in table 4. Nitrogen content is associated with palatability and diets with a N content less than *ca.* 1.2% usually cause a reduction in the DM intake. Thus inadequate protein nutrition is usually associated with inadequate energy intake.

Fig. 1 depicts the rainfall experienced over the experimental period.

Discussion

Notes on sheep diet

The main purpose of this paper is to present a case for this type of work in our important rangeland pasture types. A classification of plant species order of acceptability to sheep, cattle and goats will be proposed in the Australian Rangeland Journal.

It is clear that to consider sheep diet in terms of grass, forbs, browse etc. is not very useful. Some species within those classifications are acceptable and others are not.

Stipa variabilis (spear grass) was in the flower emergence stage at the first sampling time. The sheep consumed the flowering heads, whilst ignoring the leaves. Three weeks later the heads had all emerged and sheep avoided this species entirely. Sheep were observed to eat green seedlings of this species in December 1975 (table 1) but ignored the dry mature plants (0.58% N in DM). Similar quality, dry spear grass was eaten in July 1975, 63% of the time, when the only alternative was tree litter but the rate of feeding and mass intake was low.

The appearance of large quantities of *Euphorbia drummondii* (caustic weed) and *Boerhavia diffusa* (tar vine) after heavy rains early in 1976 reduced the intake of more perennial herbs such as *Hibiscus sturtii* (hill hibiscus). The growth of these perennial herbs also responded to the rains, however, and this demonstrates how changes in dietary preference can relax grazing pressure on one species for a period, even when that species is actively growing and of high DM quality.

In paddocks cleared of shrubs the rains in early 1976 promoted a greater mass and variety of herbs than on other treatments. This resulted in changes in sheep diet (cf. tables 1 and 3) and a wider variety of species eaten in small quantity, which are represented in the 26% of the diet unaccounted for in table 3. It would seem that most forbs are acceptable when in an immature state, although a notable exception is *Chenopodium cristatum* (desert goosefoot). Once mature, however, some annuals are reduced in acceptability whilst the perennials are subject to great changes in both their growth rate and acceptability. It is interesting to compare the records for March - April 1976 in tables 1 and 2. Due to differential grazing pressure between the two treatments the condition of the various species was quite different. Caustic weed had a lower preference rating on the heavily grazed paddock (table 2) because *H. sturtii*, *Calotis cuneifolia* (purple burr daisy) and *Paspalidium constrictum* (boxgrass) were making fresh growth from stubble, which was attractive to the sheep. On the moderately grazed paddock the fresh growth from these species may have been less easily selected because it was mixed with older material, whereas caustic weed was entirely composed of fresh growth from seeds.

Factors influencing dietary preferences

The above notes on sheep diet are only a sample of detailed discussion that could be made on the different array of species eaten on each occasion. In such a complicated situation, it is sensible to search for some underlying principle to diet selection.

In a field experiment such as this it is impossible to separate the influences of plant species quality, frequency-of-occurrence and alternatives-on-offer (if any) from those of taste, smell and physical properties of the plant, the physiological condition of the animal (which may alter its nutritional requirements and hence its diet), its instinct and experience.

The data does indicate that high DM quality or high frequency-on-offer or a combination of those two factors, even for a species that has a high preference rating under certain conditions, is no guarantee that that species will be frequently eaten, e.g. *H. krichauffianus*.

Arnold (1964) concluded that an understanding of the criteria for diet selection was critical for range management, but was unable to separate them from the available evidence. To my knowledge the situation has not improved. Westoby's (1974) suggestion that diet selection is driven by a demand to optimize the "nutrient mix" and that a long-delay learning mechanism is involved in the pursuit of this aim, is not satisfactory. From our knowledge of the nutrient content of the plant species eaten here, it seems most unlikely that the dietary changes could be explained in this way.

Conclusions

In view of the difficulty of assessing what influences herbivore diets, we are forced to the empirical approach of recording which plant species herbivores are eating at any one time. In order to use this information to forecast the grazing pressure on the different pasture species, phenological and DM quality information is also required. An ability to forecast grazing pressure *on a plant species basis* is essential if we aspire to manage vegetation, rather than the current concept of property management which is geared to the animals alone.

This aim is complicated by the observed, but insufficiently explained, phenomenon of extreme differences in the botanical composition of the field layer from year to year. Whilst it can often be explained by differences in rainfall patterns, this does not provide a complete explanation. This phenomenon is worthy of further study. It would appear that therophytes, normally thought to act as annuals in this environment (e.g. *Calotis, Bassia* spp. are capable of surviving for many years (Cunningham, personal communication). Such plants appear to be capable of surviving short dry periods and resuming growth when soil moisture conditions are favourable. Very often the only viable parts of the plant are below ground and it is not apparent whether the plants which develop come from seed or root stocks after a short period of growth. With the inevitable competition for moisture in a semi-arid environment, survival of short lived perennial herbs through dry periods could have a marked influence on the survival of seedlings resulting from rainfall events. It can be surmised that a flora resulting from a successful germination event might inhibit survival from one or more subsequent events, until the original plants become senile. It is also possible that some species would reach the senile stage earlier than others. Early deaths might be replaced with seedlings or by greater growth from the survivors.

Superimposed on such considerations is the influence of stock grazing the various plant species differentially and the independent influence of different types of stock.

For the flora under consideration Cunningham's forthcoming publication of the phenology of the herbs in the Cobar area will be a foundation for any subsequent success in field layer management. The diet studies presented here for sheep and subsequently for cattle and goats, whilst incomplete, will also be a contribution as are associated studies on field layer plant dynamics, productivity and demography under different managements. More information is required for this vegetation type and could probably be simply acquired by records of herb phenology at marked sites in any paddock that is conveniently visited regularly, provided meteorological and stocking records are available.

Similar information is required for other major Australian rangeland vegetation types that are susceptible to management.

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References

Anon. (1969). *Report of the Inter-Departmental Committee on Scrub and Timber Regrowth in the Cobar-Byrock District and Other Areas of the Western Division of New South Wales.* Government Printer: Sydney.

Arnold, G.W. (1964). Some principles in the investigation of selective grazing. *Proc. Aust. Soc. Anim. Prod.* 5, 258-271.

McIntyre, G.A. (1952). A method for unbiased selective sampling, using ranked sets. *Aust. J. Agric. Res.* 3, 385-390.

Stoddart, L.A., Smith, A.D. and Box, T.W. (1975). *Range Management.* 3rd Edition. McGraw-Hill, N.Y.

Westoby, M. (1974). An analysis of diet selection by large generalist herbivores. *Am. Nat.* 108, 290-304.

Table 1. Frequency on offer (O), per cent eaten (E) and preference rating (P) of the important dietary components of sheep diet on a moderately grazed woodland pasture

	15.9.74†			7.10.74			5.3.75			9.7.75			9.9.75			6.12.75			27.3.76		
	O	E	P	O	E	P	O	E	P	O	E	P	O	E	P	O	E	P	O	E	P
Amphipogon caricinus	36	25	68	27	17	62	21	1	4	5	tr	10	7	1	16	12	5	40	5	-	-
Bassia diacantha	16	tr	2	29	3	12	26	6	25	50	33	66	34	24	70	31	9	29	32	1	4
Boerhavia diffusa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	tr	-	-	29	11	39
Calotis cuneifolia	58	4	14	68	6	9	14	1	7	-	-	-	-	-	-	3	-	-	26	6	22
C. lappulacea	22	12	54	14	4	31	1	tr	-	-	-	-	-	-	-	-	-	-	8	2	21
Chenopodium anidiophyllum	10	1	14	14	1	8	9	-	-	19	9	48	5	3	50	6	1	-	7	tr	-
Eragrostis lacunaria	20	tr	-	26	3	11	29	13	47	12	2	19	3	1	-	4	tr	-	14	tr	-
Euphorbia drummondii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	44	67
Goodenia spp.	21	9	25	17	5	29	-	-	-	-	-	-	-	-	-	-	-	-	18	8	46
Hibiscus krichauffianus	3	tr	-	38	tr	tr	54	4	8	37	24	66	36	19	53	20	8	41	27	6	24
H. sturtii	2	-	-	9	-	-	16	3	22	-	-	-	1	-	-	57	37	65	56	2	3
Monacather paradoxa	17	4	37	20	11	52	6	3	56	2	-	-	3	tr	-	3	-	-	3	tr	-
Panicum effusum	13	1	15	29	19	65	46	29	62	-	-	-	-	-	-	-	-	-	7	tr	-
Paspalidium constrictum	6	tr	-	12	tr	-	30	10	33	14	1	-	8	tr	-	28	8	27	27	3	13
Stipa variabilis	51	14	35	67	1	1	54	-	-	59	-	-	53	tr	-	37	2	6*	13	-	-
Thyridiolepis mitchelliana	9	1	-	26	6	23	22	13	42	2	-	-	2	tr	-	9	2	29	10	-	-
Acacia aneura	22	3	13	17	6	36	14	8	58	25	19	77	33	25	75	22	9	43	13	2	13
Dodonaea viscosa	12	-	-	14	-	-	16	3	19	8	4	47	13	10	79	11	3	24	12	2	14
Litter		-			-			-			-			5			7			tr	
Other		26			16			9			8			22			9			13	

† 360 observations

* All the *S. variabilis* eaten was green occurring with a frequency of 6% and a preference rating of 36

Table 2. The important components of sheep diet on a woodland pasture heavily grazed by goats

	4.7.75			11.9.75			4.12.75			10.4.76		
	O	E	P	O	E	P	O	E	P	O	E	P
Amphipogon caricinus	4	-	-	12	3	26	4	2	50	4	2	36
Bassia diacantha	56	43	77	31	25	80	15	11	75	2	1	-
Calotis cuneifolia	2	1	-	-	-	-	-	-	-	42	34	79
Chenopodium anidiophyllum	12	2	21	2	1	33	3	2	50	-	-	-
Eragrostis lacunaria	10	5	50	10	7	70	1	1	-	1	1	-
Euphorbia drummondii	-	-	-	-	-	-	-	-	-	52	9	17
Hibiscus krichauffianus	29	21	78	33	26	80	6	3	58	10	4	46
H. sturtii	-	-	-	-	-	-	2	2	78	41	20	48
Paspalidium constrictum	14	2	14	9	2	26	12	6	53	17	11	61
Stipa variabilis	65	-	-	59	8	13	54	24	45	9	2	28
Grass stubble (green)*	-	-	-	-	-	-	11	7	67	-	-	-
Forb stubble (green)	-	-	-	-	-	-	6	5	81	-	-	-
Acacia aneura	18	14	74	8	2	23	2	tr	-	8	2	23
Dodonaea viscosa	11	4	34	17	12	74	11	7	65	6	5	81
Litter		2			3			24			1	
Other		7			17			12			10	

* Mainly *Eragrostis lacunaria* but not positively identifiable at a distance

Table 3. The important components of sheep diet on a woodland pasture cleared of shrubs

	1.7.75			7.4.76		
	O	E	P	O	E	P
Alternanthera denticulata	-	-	-	21	3	12
Amphipogon caricinus	8	5	71	6	-	-
Bassia diacantha	1	-	-	8	tr	-
Boerhavia diffusa	-	-	-	28	8	28
Calotis cuneifolia	-	-	-	36	4	11
Chenopodium cristatum	-	-	-	26	-	-
Eragrostis lacunaria	4	3	80	26	1	-
Erodium crinitum	-	-	-	35	24	67
Euphorbia drummondii	-	-	-	55	27	49
Goodenia spp.	-	-	-	39	7	23
Panicum effusum	5	4	68	24	tr	-
Paspalidium constrictum	16	10	62	25	-	-
Stipa variabilis	52	4	8	14	-	-
Grass stubble (green)	32	29	89			
Herb stubble (green)	8	7	85			
Acacia aneura	4	2	62	2	-	-
Apophyllum anomalum	9	8	91	-	-	-
Dodonaea viscosa	25	14	56	10	-	-
Other	14			26		

Table 4. Nitrogen (N) content of DM of simulated grazed samples of important components of sheep diet. Figures in brackets apply to table 2 where they differ from samples from table 1 by more than ± 0.1%. Figures in italics indicate a whole plant sample instead of a simulation grazing.

	Oct.74 %N	Mar.75 %N	July 75 %N	Sept.75 %N	Dec.75 %N
Amphipogon caricinus	1.36	0.46	*0.84* (0.31)	0.98	-
Bassia diacantha	2.97	3.15	2.33 (1.98)	1.97	2.90
Boerhavia diffusa	-	-	-	-	2.83
Calotis cuneifolia	-	-	-	-	-
C. lappulacea	1.36	-	-	-	-
Chenopodium anidiophyllum	3.10	3.10	2.52 (1.40)	-	3.63
C. cristatum	-	1.47	-	-	-
Eragrostis lacunaria	*1.09*	1.16	0.95 (1.15)	- (1.12)	-
Goodenia spp.	2.44	-	-	-	-
Hibiscus krichauffianus	1.87	2.84	2.22	1.53 (1.32)	3.04
H. sturtii	2.18	-	2.36	-	2.77
Monacather paradoxa	1.48	-	-	- (0.63)	-
Panicum effusum	2.14	1.48 (dry)	0.87	-	2.38
Paspalidium constrictum	*1.10*	1.72	1.57	*1.34* (1.22)	2.33
Stipa variabilis	1.36	0.60 (dry)	0.92 (0.75)	0.66 (0.84)	0.58
Acacia aneura	-	2.17	1.82	1.99	2.15
Apophyllum anomalum	-	2.31	1.92	2.45	-
Exocarpus aphylla	-	0.80	0.92	1.09	2.56
Dodonaea viscosa	-	1.70	1.72	1.95	2.37
Myoporum desertii	-	1.60	1.92	1.70	2.27
Capparis mitchellii (litter)	-	-	-	2.54	3.48
Cassia seeds	-	-	-	3.32	3.30
S. variabilis seeds	-	-	-	0.40 (1.13)	-
Eucalyptus intertexta (litter)	-	-	-	-	1.14