SHEEP FAECES AS AN INDEX OF ANIMAL ACTIVITY OR INTRAPADDOCK USAGE PATTERNS

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ABSTRACT

Animal activity and the distribution of faeces were studied on a small paddock grazed intensively by Merino sheep. Irrespective of whether sites were used for camping or grazing, the pattern of faeces weight differences across the paddock was focussed on the camp and reflected total sheep time per unit area. However, defaecation was observed to be associated with activity on the camp and the amount of faeces on the paddock at large found to be a function of the time at which a site was traversed following a period of rest.

Introduction

The number of faecal units (Riney 1957, Donald and Leslie 1969, Lange 1969), the volume (White 1960, Rawes and Welch 1966, 1969) and weight (Warren 1971, Cadwalladr and Morley 1973, Andrew 1978) of faeces per unit area have been widely used as indices of sheep density, intrapaddock usage patterns and relative stocking pressure. In situations where observation of flock activity was difficult, such indices have been employed to explain the role of the animal in the creation of intrapaddock vegetation patterns (Gillingham and During 1973, Andrew 1978, Graetz and Ludwig 1978). However, these indices are based on rather tenuous assumptions about sheep behaviour and its relationship to the spatial and temporal distribution of faeces. For example, the assumptions that faeces are dropped where an animal grazes and/or that the amount voided is proportional to the time spent grazing there, are common (Rawes and Welch 1966, Warren 1971). These in turn are based on the assumptions that defaecation activity is either more or less regular (Riney 1957), or occurs at random (England 1954). Data to support any of these assumptions are scant.

Lange and Willcocks (1978) have studied the distribution of sheep faeces over a 1.25 hectare arid-zone paddock and shown that faeces weight was positively and linearly related to total sheep time spent per unit area. The activities of grazing, ruminating, resting and idling occur at different sites in a paddock and encompass different intensities and proportions of the ecologically important effects of the animal (viz. defoliation, treading and excreta deposition); both in a spatial and a temporal sense. Therefore depending upon whether the sheep were grazing or resting at a site for a given time, their effect on the pasture is likely to be different. Thus for meaningful interpretations using faeces distribution, one really needs to know how the faecal index reflects both the animals' activity and its ecological impact on the vegetation. Reports of such relationships are scant.

This paper reports on a study of the occurrence of defaecation events, sheep activity and faeces distribution, and the relationships among these in an intensively grazed pasture on the Northern Tablelands of New South Wales.

Methods

Site

A 0.1 hectare portion of an 0.4 hectare Shannon Vale Nutrition Station paddock was fenced off from the remainder of the paddock. This portion was chosen because of its uniformity in terms of botanical composition and herbage mass. In addition, two weeks before the study commenced, the pasture was mown to a height of 2.5cm. A water point was located at the centre of the paddock. Otherwise the paddock was free of obstructions and an unimpeded view of the whole area was possible.

Sheep

Ten, four-rising-six tooth Merino wethers were used in the experiment. They had been grazing together as a flock for a week prior to the experiment and were accustomed to small paddocks and handling.

Location and activity of sheep

The axes and co-ordinates of a 7 x 9 grid were marked with pegs and numerals along the paddock fence. Cells of the grid were approximately 16 square metres in area. The location of sheep was recorded with respect to the grid, through the marked perspex window of an observation tower, in a modification of the method of Kilgour *et al.* (1975).

At ten minute intervals, animal location, defaecation and drinking activity, along with an instantaneous characterization of each animal's activity as walking, standing or lying, were recorded. An animal's location was taken as the cell in which the greater number of the animal's feet were observed. Notes were made as to whether those animals standing were grazing or resting. Animal location and activity was recorded from 32 to 40 hours of a 72 hour period. Such data were collected over four consecutive 72 hour periods and resulted in 8040 animal activity/location records being available for analyses.

Supplementary observations were made of diurnal activity to describe the flock's general activity and record the occurrence, location and time of any observed defaecation event. A spotlight was required for observation between 1950 and 0540 hours and these times were taken to delineate the diurnal and nocturnal periods of a day.

Faeces sampling

Within each grid cell four quadrat positions were systematically and permanently located. The area was cleared of faeces before grazing commenced and on four occasions at 72 hour intervals, all whole pellets of faeces were collected from within an 'X' shaped quadrat (0.2 sq. m.), dried at 70^{o}C for 48 hours and weighed. Data for the four quadrats in each grid cell were accumulated for analyses.

Data analysis

Relationships among the various categories of animal activity and weight of faeces were examined by regression analysis. Simple linear, logarithmic and quadratic forms were fitted and by inspection of the fit and variance accounted for by the different forms, relationships were chosen for discussion. As a simple indication of the strength and nature of any relationship, the correlation coefficient only is given. Where a test of parallelism indicated a non-significant difference between the slopes of the regression for each time period, only the overall correlation coefficient has been presented. Otherwise, the correlation coefficients for each of the four time periods are given.

The small amount of additional variation accounted for by multiple regressions did not warrant their inclusion in the discussion.

Results and Discussion

Sheep activity

A sheep camp is a place where sheep regularly and habitually rest; in this paddock there was only the one. Soon after daylight and before sunrise the sheep moved off the camp and commenced the first of several periods of grazing, interspersed with periods of standing and lying, ruminating and idling on the camp (Figure 1). The times spent grazing (Figure 1) agree well with those of Southcott *et al.* (1962) and Lynch and Hedges (1979) for a nearby centre, Armidale.

Over the seven full days of observations a mean of 36 percent (range 28-45%) of the flock's time was spent grazing in the paddock at large (Table 1). Sheep were walking and occasionally standing whilst grazing. The remainder of the day (64 percent, range 55-72%) was spent camping on those animal observation cells that account for 14.3 percent of the paddock area (Table 1). This area was used 3.7 times on average (range 2-5) in the diurnal period (Figure 1), and virtually continuously in the nocturnal period (Table 1). In moving to the camp the flock would either continue grazing to the edge of the

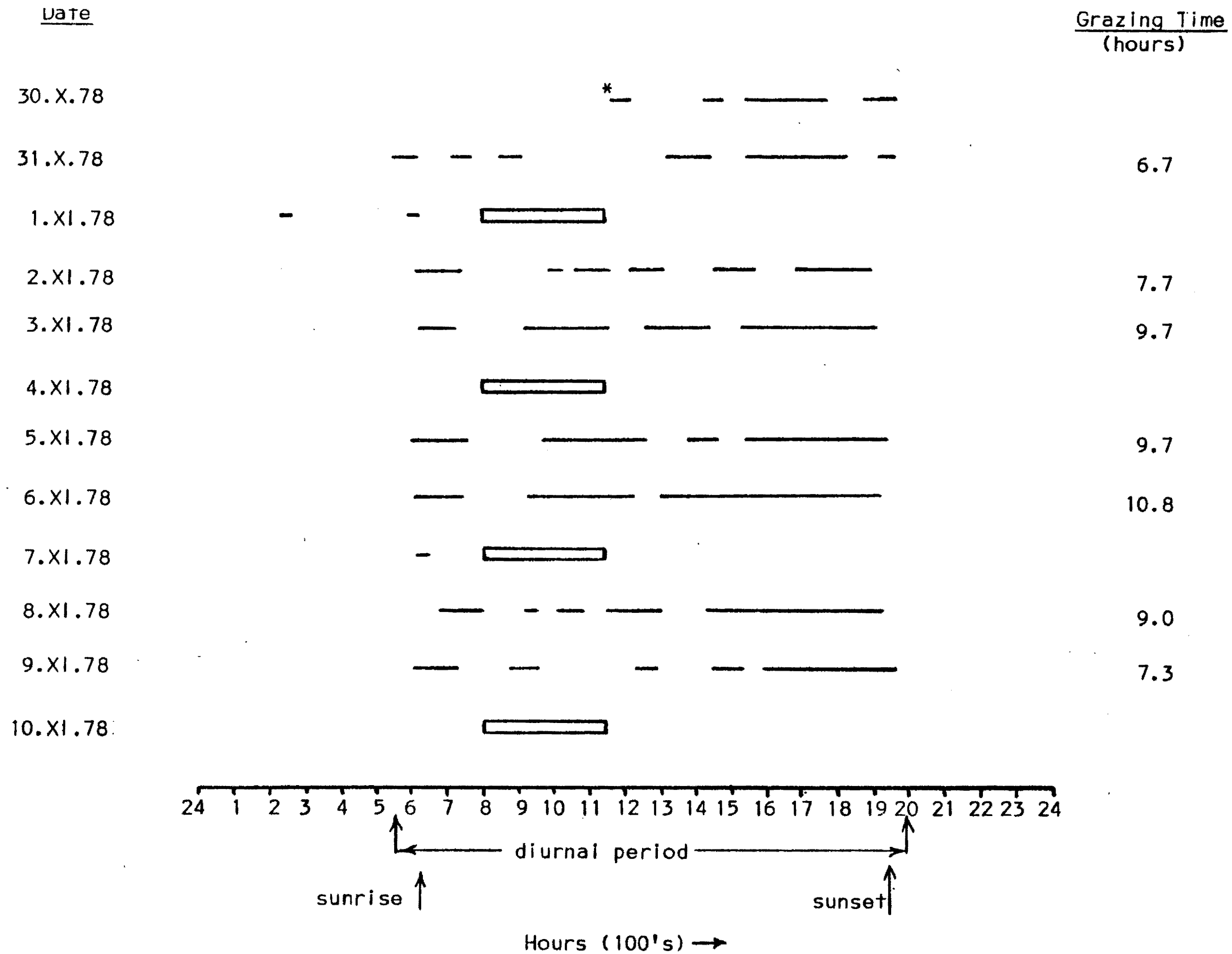

Figure 1 Periods when the greater proportion of the flock was traversing the paddock at large, grazing (——), resting on the camp ( ) and when pasture/faeces sampling was conducted (▭) from the time sheep were introduced to the paddock (*).

TABLE 1

Mean percentage of time spent in different paddock cells during both the diurnal (0540-1940 hours) and nocturnal (1950-0530 hours) periods of two of the seven days of observations. The nine cells used for either diurnal or nocturnal camping are delineated.

DAY: 31.X.78-01.XI.78

a) Diurnal Period

Grid Columns

Grid Rows	1	2	3	4	5	6	7	8	9
1	0.94	0.94	0.82	0.00	0.71	1.18	1.65	3.18	16.59
2	0.94	0.94	1.29	0.71	1.18	1.18	2.82	2.47	29.65
3	0.00	0.00	0.71	0.82	0.82	0.47	2.24	0.59	5.18
4	0.82	0.12	0.00	0.35	1.18	0.94	0.35	0.71	2.12
5	0.47	0.35	0.59	0.12	1.41	0.71	1.53	0.71	1.53
6	0.00	0.47	0.24	0.24	1.29	1.29	0.24	0.47	1.41
7	0.00	0.00	0.00	0.47	0.48	0.12	0.00	0.12	1.06

b) Nocturnal Period

Grid Rows	1	2	3	4	5	6	7	8	9
1	0.51	0.85	0.00	0.00	3.39	4.92	5.08	14.75	60.68
2	1.02	0.34	0.00	0.00	0.00	0.00	0.00	0.34	7.80
3	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DAY: 06.XI.78-07.XI.78

a) Diurnal Period

Grid Rows	1	2	3	4	5	6	7	8	9
1	6.82	1.88	2.24	0.94	1.65	6.71	6.35	7.06	5.18
2	2.82	0.47	1.88	3.18	0.59	1.41	1.65	2.35	1.41
3	2.71	0.82	1.88	1.41	1.06	0.47	0.94	0.71	0.82
4	1.29	1.65	0.47	0.24	0.71	0.82	1.41	1.18	1.29
5	0.47	0.12	0.59	1.88	1.76	1.29	0.71	0.47	0.94
6	3.18	0.24	0.59	1.06	1.29	0.94	0.47	0.94	2.35
7	0.71	1.29	1.18	1.29	0.24	0.71	0.12	0.00	0.71

b) Nocturnal Period

Grid Rows	1	2	3	4	5	6	7	8	9
1	0.00	0.00	0.00	0.00	0.00	16.44	24.58	18.31	34.24
2	0.00	0.00	0.00	0.00	0.00	0.51	0.68	0.00	5.42
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

camp or stop grazing and walk head-up toward the camp. Sheep were recorded grazing in the nine cells designated as camp in only 15 of the 8020 animal observations.

Faeces distribution

From 49 to 62 percent of the weight of faeces collected on the paddock was estimated to be on the camp area. The total weight of faeces collected on the camp was 31 to 39 times that of the paddock average (36.2 gm^{-2}). The mean weight of defaecations (defined as a heap of faecal pellets) on an off the camp were 50.3 g (range 29.5-72.9 g) and 17.0 g (range 13.0-23.2 g) respectively.

Biologically relevant as well as statistically significant relationships were recorded for the regression of time spent in various activity states on the weight of faeces (Table 2). No additional variation was explained by using log faeces in the regression, however in this case the slopes of the regression lines were parallel (Table 2). In the case of the simple linear regressions, the slopes of the regressions for the four time periods were significantly different indicating a change over time in the strength of the relationships (Table 2). Inspection of the raw data suggested that the variability in the small scale distribution of faeces largely accounted for these inconsistent differences. Changes in temperature and wind speed and their concommitant effects on the pattern of animal activity also appeared to be important. Time spent in the diurnal activity states tended to account for less variation in the distribution of faeces than time spent in activities in either the nocturnal period or during the whole day (Table 2).

Clearly the intrapaddock concentrations of sheep faeces are not related to grazing activity but a function of time spent on the camp. Yet animal observations indicate that while on the camp sheep spent virtually all of their time either standing or lying. Time spent in these activity states accounted for a high proportion of the variation in the distribution of faeces (Table 2).

The relationships between faeces weight and total sheep time per unit area were similar in nature but not as strong as those reported in Lange and Willcocks (1978). This may reflect differences in intensities of animal observation and the scales of the two studies.

TABLE 2

Correlation coefficients (r) for the regression of faeces weight on sheep time spent in various activity states per unit area.

Relationship	ANIMAL ACTIVITY STATES											
	Walking			Standing			Lying			Total		
	Diurnal	Nocturnal	Total Day	Diurnal	Nocturnal	Total Day	Diurnal	Nocturnal	Total Day	Diurnal	Nocturnal	Total Day
Log faeces overall t	0.07		0.08	0.43	0.43	0.48	0.52	0.56	0.54	0.43	0.49	0.54
Linear overall t	-0.01											
Linear individual												
t1			-0.09	0.71	0.80	0.82	0.46	0.83	0.77	0.60	0.82	0.81
t2			0.37	0.80	0.85	0.85	0.89	0.90	0.91	0.88	0.90	0.90
t3			0.06	0.38	0.84	0.82	0.89	0.73	0.81	0.83	0.86	0.88
t4			-0.10	0.28	0.56	0.62	0.49	0.69	0.77	0.42	0.65	0.75

where r with $(n-1) = 62$ and t = time period(s)

$P < 0.05 = 0.25$

$P < 0.01 = 0.32$

$P < 0.001 = 0.40$

Occurrence of defaecation events

At the first faeces sampling the number of distinct heaps of faeces across the paddock were counted. Assuming that each heap represents a defaecation event, then an average of 7.97 events occurred animal^{-1} day^{-1}. This value agrees well with those given by England (1954) and Hafez and Scott (1962).

In the course of observations 75 defaecation events were recorded. We thus estimate that 11.7% of the defaecation events that occurred over the course of the experiment were actually seen. The occurrence of these events in relation to animal activity both on and off the camp are given in Table 3. Thirty-four percent of defaecations occurred within one minute of each other. This is taken as evidence of some alleomimetric behaviour in defaecation activity. Clearly the majority of defaecation events occur on or near the camp and the amount of faeces on the paddock at large is primarily a function of the time at which a cell was traversed in relation to the cessation of a period of rest.

Conclusions

The large amount of faeces found on sheep camps (Hilder 1964, Gillingham and During 1973) is a function of three factors; total time spent the larger quantities of faeces being voided and animal activity on the camp. Whilst the weight of faeces reflects total sheep time per unit area, it is more a function of camping activity and the time at which a site was traversed since camping, at least on the Northern Tablelands. It follows that the amount of faeces is unlikely to be proportional to the defoliation pressure at a site, but may reflect the impact of trampling or nutrient enrichment.

We thus suggest that the major intrapaddock floristic differences that characterize sheep camps (Whalley *et al.* 1978) are perhaps created more by trampling and nutrient enrichment and less so by grazing. In terms of creating such intrapaddock differences it appears that resting behaviour may be more important than grazing behaviour.

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TABLE 3

Occurrence of defaecation events in relation to animal activity both on and off the camp.

On camp defaecations:	%
on standing after lying	33
whilst standing	20
after disturbance	11
Off camp defaecations:	
within 10 minutes after an on-camp rest period	10
within 20 minutes after an on-camp rest period	5
within 30 minutes after an on-camp rest period	3
within 40 minutes after an on-camp rest period	1
More than 40 minutes after an on-camp rest period†	17
	100%

† 90 minutes was the longest time interval between cessation of a period of rest and when a defaecation event was recorded.

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