EFFECT OF DIFFERENT GRAZING SYSTEMS ON HILL COUNTRY PASTURE COMPOSITION

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Abstract

The effect of different grazing systems on the botanical composition of North Island hill sheep pastures was examined in three experiments over a period of four to eight years. In two experiments on steep, developed hill country the effects of mob-stocking did not differ markedly from those of set-stocking. In the third experiment, unimproved and improved pastures were maintained at two heights by hard and lax set-stocking. In Improved pastures, perennial ryegrass (*Lolium perenne)* increased under hard grazing and Yorkshire fog (*Holcus lanatus*) increased under lax grazing. In unimproved pastures weeds increased under hard grazing.

INTRODUCTION

EARLY WORK in England showed how duration and intensity of grazing could alter pasture composition (Jones, 1933). In New Zealand, these effects have been studied in cultivated pastures of simple botanical composition by Brougham (1959, 1960), Brougham and Harris (1967), Harris and Brougham (1968), and on steep, unploughable hill country by Suckling (1954, 1962, 1964) . Suckling (1954) compared low and high rates of set-stocking with sheep as part of an extensive appraisal of grazing managements. However, his grazing treatments, which were conducted over three years, were necessarily unreplicated and only slight differences in pasture composition were recorded.

This paper presents measurements of botanical composition on three unrelated experiments in North Island hill country (Fig. 1) where sheep pastures were subjected to mob-stocking and various intensities of set-stocking.

The effect of grazing systems on pasture composition was examined to complement the main purposes of the experiments, namely, sheep performance and hydrology. Sheep performance at Tangoio and Waerenga-o-Kuri has been reported by Collin (1966) and at Waerenga-o-Kuri by Kissock (1966) . Rainfall run-off relationships at Makara have been examined by Toebes *et* al. (1968) and Yates (1971).

It is generally believed that the benefits of any particular grazing system (apart from ease of management) are reflected in a larger proportion of more productive and digestible plants in the pasture, which, if utilized by the grazing animal, benefit animal

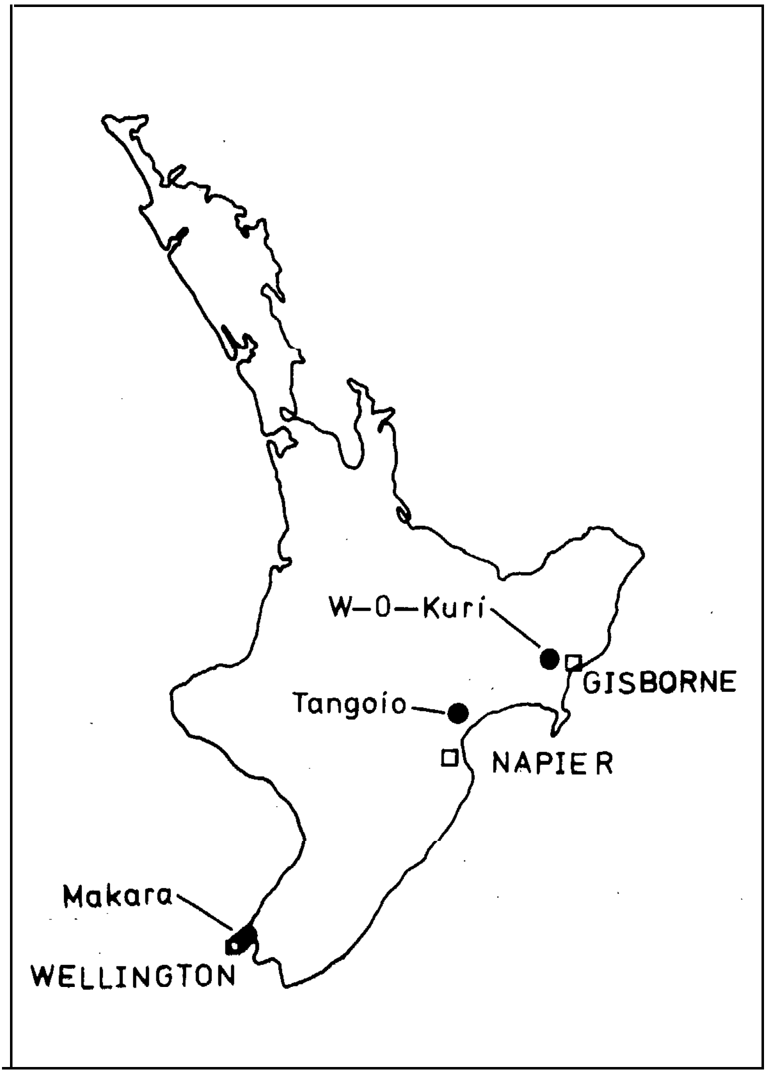

FIG. 1: Locution of sites.

performance. The weaknesses of comparing grazing systems by monitoring only animal performance have been presented by Campbell (1961) who stressed the need for accompanying measurements of pasture production and utilization. However, it was not practicable to measure production at Tangoio or Waerenga-o-Kuri and although production was measured at Makara no measurements were made of utilization by animals. Therefore botanical composition was measured at all sites to see if any grazing system increased the proportion of more productive plant species.

EXPERIMENTAL

Some experimental details are given in Table 1.

TABLE 1: DETAILS OF GRAZING SYSTEMS

Site and Grazing System	No of ha/ Treatment	No. of Paddocks/ Treatment	(ewes/ha) Start	(ewes/ha) Finish
Tangoio:			(1962)	(1965)
Mob-stocking	40.5	12	12.4	14.8
Heavy set-stocking	21.9	6	12.4	14.8
Light set-stocking	19.0	6	8.6	11.1
Waerenga-o-Kuri:			(1961)	(1965)
Mob-stocking	18.2	15	12.4	18.5
Set-stocking	7.3	5	12.4	18.5
Makara:			(1961)	(1969)
Set-stocking				
1. Hard-grazed unimproved	2.2	2	5.9	7.2
2. Lax-grazed unimproved	2.6	2	3.0	4.1
3. Hard-grazed improved	1.7	2	4.4	18.6
4. Lax-grazed improved	1.7	2	2.5	9.1

Botanical Composition

The area covered by plant species was measured by point analysis before grazing systems began and at one- or two-yearly intervals thereafter. The point analysis equipment with 10 cm spacing between points was described by Radcliffe and Mountier (1964a) and first hits on a species (*i.e.,* “cover hits”) were recorded. Treatment effects were statistically analysed for each measurement date, and the correlation between point analysis data and years was examined, at Makara.

TANGOIO

Site

This site was on steep to very steep country 210 to 300 m in altitude and subject to severe soil erosion. The soil is a Rissington sandy loam hill soil (Soil Bureau, 1954) on sandstone, mudstone and some ash. Pastures comprised mostly low to moderate fertility-demanding species although ryegrass (*Lolium perenne*) was locally abundant in high fertility areas such as stock camps. White clover *(Trifolium repens)* and subterranean clover (*T. subterraneum)* were oversown in 1948. Thereafter superphosphate (250 kg/ha) was applied annually.

Management

Three grazing systems, mob-stocking and heavy and light set-stocking *(i.e.,* high and low sheep numbers/ha), were compared on self-contained farmlets.

The grazing treatments began in 1962 after four years of set-stocking with 8.6 ewes/ha. Details of the stocking experiment are given in Table 1. In the mob-stocked treatment, ewes were moved around the paddocks in one mob and the frequency of movement was adjusted to the animals' requirements. In the set-stocked treatments, ewes were set-stocked from mid-May until mid-March of the following year. During tupping, From March to May, the ewes were run as one or more mobs.

Pasture Sampling

Measurements were confined to two pasture associations based on visually dominant grass components. These covered substantial areas in most paddocks and occurred in all grazing treatments. The "ratstail/danthonia" association (*Sporobolus Africanus/ Notodanthonia* species) often occurred on sunnier, drier slopes, while the "fog/vernal" association (*Holcus lanatus/Anthoxanthum odoratum*) often occurred on shadier and steeper slopes.

Boundaries of these associations in each paddock were marked on aerial photographs, then 10 positions within each boundary were selected from random co-ordinates. At each position, 20 points along a transect were sampled by point analysis. Measurements were made in early spring (September/October) when pasture height was 3 to 8 cm.

WAERENGA-O-KURI

Sife

This site was on steep to moderately steep country at 300 to 360 m in altitude. The soil is a Gisborne sandy loam hill soil on pumice and mudstones (Soil Bureau, 1954). Pastures were generally similar to those at Tangoio and typical of much improved Hawke's Bay hill country. Superphosphate (250 kg/ha) was applied biennially up to 1961 and annually thereafter.

Management

Two grazing systems, mob-stocking and set-stocking, were compared on self-contained farmlets. These grazing systems were managed similarly to those at Tangoio, and began in 1961 after three years of uniformity grazing during which the carrying capacity increased from 3.7 to 12.4 ewes/ha. Surplus growth in both grazing treatments was controlled in January to March by grazing with cattle.

Pasture Sampling

Paddocks were separated into gentle slopes (< 12°), moderate slopes (12 to 25") and stock camp areas (5 to 12") on spurs and ridges for botanical analyses. Forty-six transects were selected to give a representative coverage of all slope categories, and each transect was-sampled by 50 points in winter, when pastures were generally below 8 cm.

MAKARA

Site

This site was on rolling, unimproved country at 260 to 290 m in altitude. The soils are dominantly Makara steepland soils on greywacke with Korokoro hill soils on the easier slopes (Soil Bureau, 1954). Pastures were dominated by danthonias and flatweeds (mainly *Hydrocotyle* species).

Management

Four land management systems (Table 1) were compared after four years of uniform grazing. These systems were:

(1) Two levels of set-stocking in which pasture height was maintained below 4 cm ("hard grazed"), and above 8 cm ("lax grazed"), by adjusting sheep numbers within paddocks.

(2) Improved pastures v. unimproved pastures, where improve. ment was effected by oversowing (by hand) more productive species, namely 'Grasslands Ruanui' perennial ryegrass *(Lolium perenne)*, 'Grasslands Apanui' cocksfoot *(Dactylis glomerata)* white clover, subterranean clover (Mt Barker and Tallarook) and lotus *(Lotus corniculatus)*. Improved pastures were topdressed with lime (2510 kg/ha) and molybdenized superphosphate (376 kg/ha) in March 1961, superphosphate (376 kg/ha) in September 1961 and thereafter superphosphate at 376 kg/ha each autumn.

Cattle grazed the taller pastures in late summer to control rank growth and minimize patchy grazing.

Pasture Sampling

Paddocks were segregated into slopes and shallow gullies for purposes of botanical analyses, and sampled by sixty-four 15 m transects which were subjectively sited to give a representative coverage of each paddock. Each transect was sampled by 50 points in March before the main flush of autumn growth. Before analysis, pasture was trimmed to 3 cm above ground to create uniform pasture heights in all treatments.

RESULTS

Rainfall

Annual rainfall during the study period is shown in Table 2. 1964 was exceptionally dry at Tangoio and Waerenga-o-Kuri, and 1969 was dry at Makara.

TABLE 2: ANNUAL RAINFALL (mm) DURING STUDY PERIOD

Year	Tangoio	*Waerenga-o-Kuri*	*Makara*
1959		1422	1041
60	1727	2007	1168
61			
62	1575 1575	1372 1651	1067 1473
63	1651	1118	1041
64	787	914	1041
65	1397	1499	1321
66			1499
67			1092
68			1295
69			787
Average'	1524	1270	1194

*N.Z. Meteorological Service (1966).

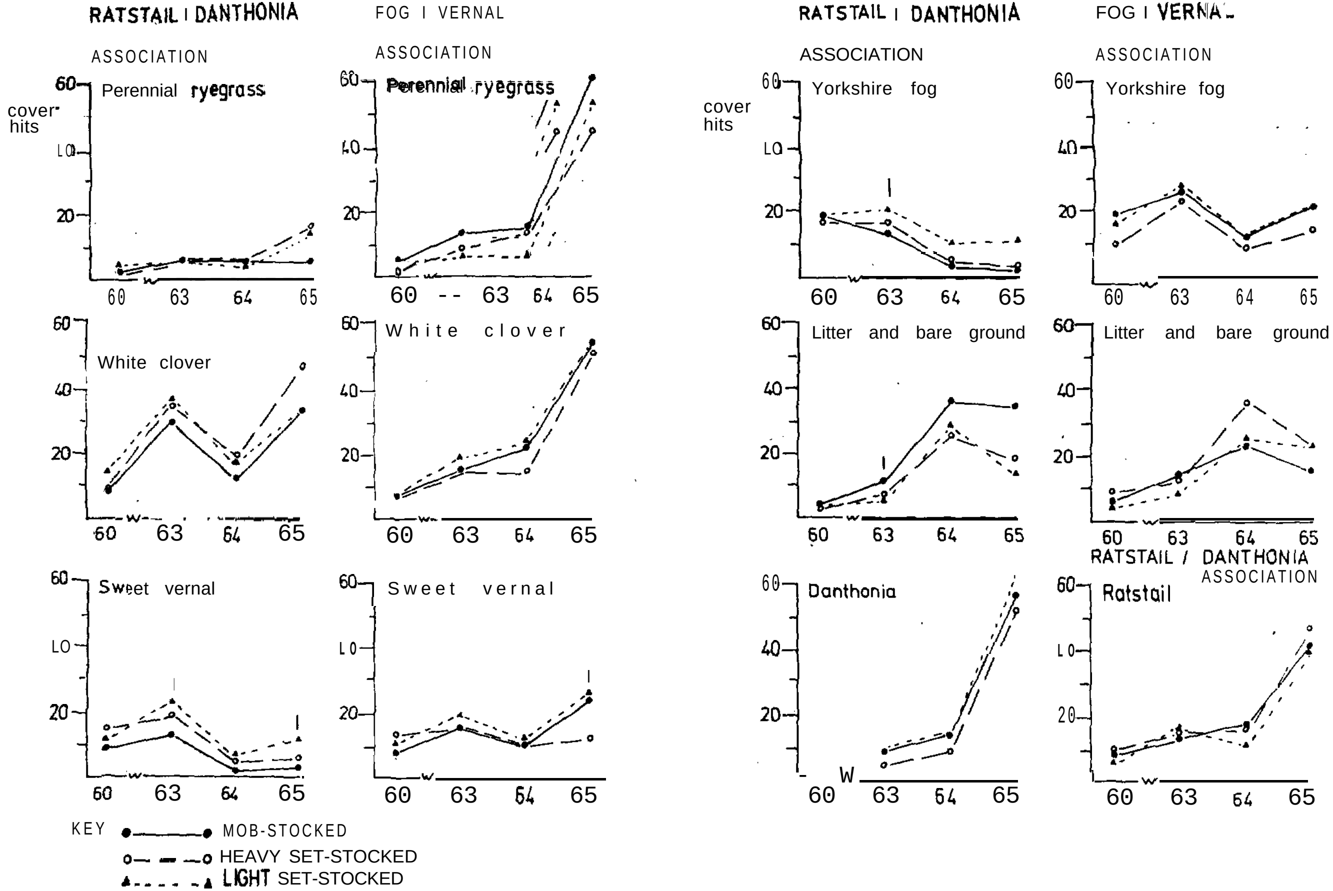

FIG. 2: *Point analysis, Tangoio (cover hits/100 points). Vertical bar indicates that treatments differed significantly at P < 0.05.*

The effect of rainfall on major pasture components was examined at Makara where rainfall data were available for the individual paddocks. Positive correlations between cover hits and the preceding year's rainfall (January to December) were found for perennial ryegrass in hard-grazed improved pastures (r = 0.56, $P < 0.05$), and in lax-grazed improved pastures (r = 0.48, $P > 0.05$). Similar correlations were obtained between the preceding 3-monthly rainfall (December to February) and botanical composition.

White clover was positively correlated with rainfall in hard-grazed improved pastures (r = 0.60, $P < 0.05$) and lax-grazed unimproved pastures (r = 0.68, $P < 0.05$).

TANGOIO

Point analysis results (Fig. 2) show few clear-cut treatment effects for major pasture components.

In the ratstail/danthonia association: mob-stocked paddocks compared with light set-stccked paddocks had significantly less sweet vernal and Yorkshire fog and more bare ground and litter in 1963 ($P < 0.05$) ; these trends continued in subsequent years but were only statistically significant for sweet vernal in 1965 ($P < 0.05$) . .

In the fog/vernal association, mob-stocked paddocks tended to have more ryegrass than set-stocked paddocks. Heavy set-stocked paddocks tended to have the least Yorkshire fog in all years and had significantly less sweet vernal in 1965 ($P < 0.05$). Ryegrass and white clover appeared to increase in all treatments over the measurement period; this trend was most marked in 1965.

WAERENGA-O-KURI

Point analysis results of major components are presented in Fig. 3.

On gentle slopes, mob-stocked pastures had significantly more ryegrass in 1964 and 1965 and significantly less browntop (*Agrostis tenuis*) in 1962 and 1963 ($P < 0.05$). Over the study period browntop and sweet vernal tended to decrease.

On moderate slopes mob-stocked pastures had significantly less white clover in 1962 and 1963 ($P < 0.05$) but tended to have more ryegrass in all years.

On stock camps ryegrass was dominant and different grazing systems did not appear to affect composition. Pasture records for 1962 in mob-stocked treatments are not available.

Yorkshire fog and weeds were minor components in all slope categbries-with no significant treatment effects.

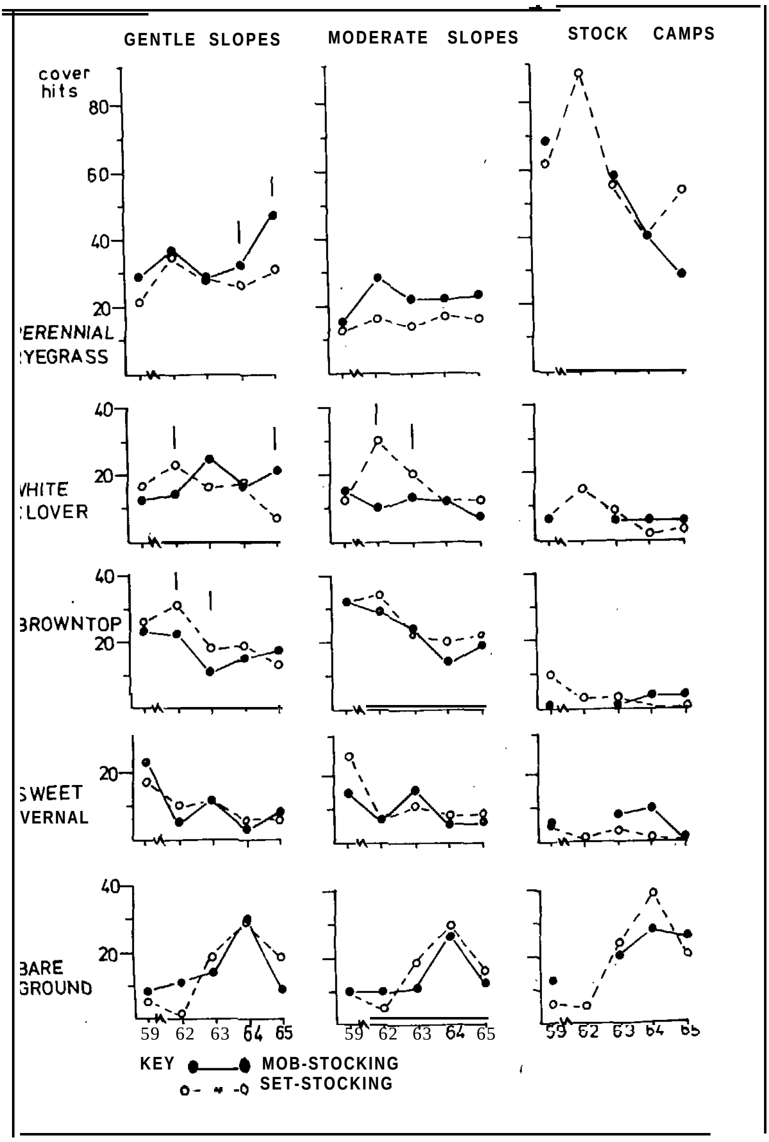

FIG. 3: *Point analysis, Waerenga-o-Kuri (cover hits/100 points). Vertical bar indicates that treatments differed significantly at P < 0.05*

MAKARA

The first year after topdressing and oversowing, gullies in improved pastures had more white clover and Yorkshire fog than did slopes, but, in later years, gully and slope composition became similar. Point analysis results have therefore been combined for slopes and gullies and are presented in Fig. 4.

Topdressing and oversowing substantially increased white clover and ryegrass and reduced flatweeds (P < 0.05). Hard grazing favoured ryegrass in improved pastures, and favoured weeds in unimproved pastures, whereas lax grazing favoured

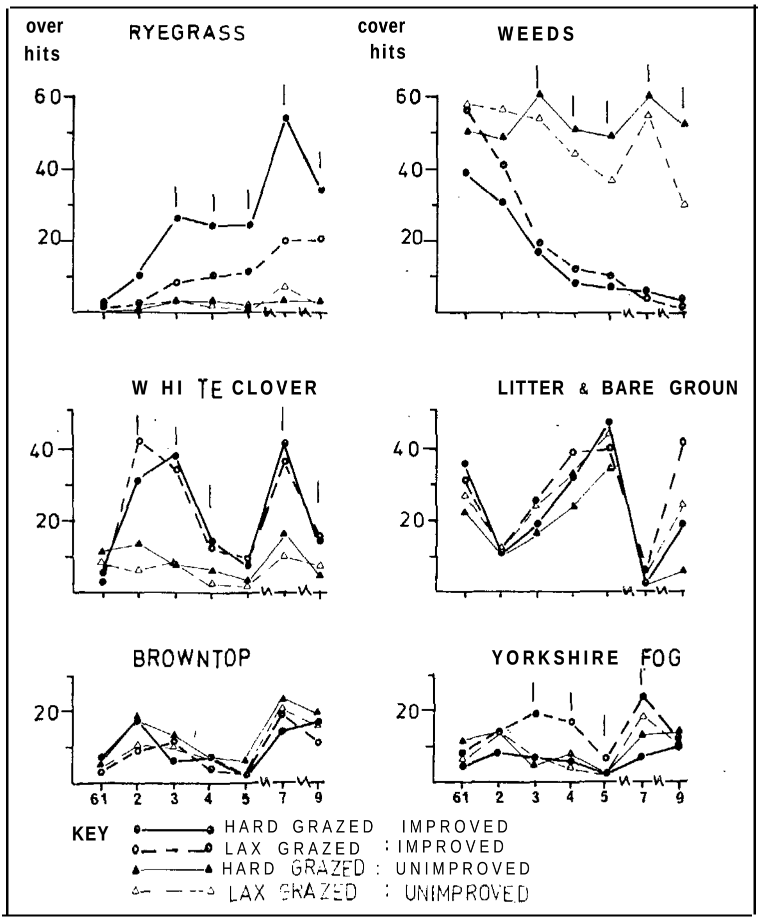

FIG. 4: hits/100 points). Vertical bar indicates that treatments differed significantly at $P < 0.05$.

Yorkshire fog in improved pastures. Grazing management did not appear to affect white clover in either pasture treatment.

Sweet vernal, danthonias and *Poa* species were minor components and treatment effects were not apparent. Only few lotus and cocksfoot plants established but the annual subterranean clover grew well later in the year with no visual differences between grazing treatments. When the relationship between ryegrass and years was examined in improved pastures, a highly significant positive correlation ($P < 0.01$) was found; $r = 0.79$ and $r = 0.92$ under hard and lax grazing, respectively. No significant time trends were found for white clover.

DISCUSSION

At Tangoio and Waerenga-o-Kuri, the effects of mob-stocking on botanical composition did not differ markedly from those of set-stocking, although Collin (1966) has recorded better animal performance per hectare under high set-stocking at Tangoio, and superior animal performance under mob-stocking at Waerenga-o-Kuri. In the latter case, this may have been associated with the tendency for ryegrass to increase under mob-stocking (on some slopes) and browntop to decrease: But, in general, better animal performance must have been caused by factors other than changes in botanical composition: for example, increased pasture growth and digestibility and, most importantly, utilization of this herbage.

The apparent failure of different grazing systems to markedly modify composition may have been due to these systems being conducted within self-contained farmlets at a fixed stocking rate. Within each farmlet, as in many practical farming situations, inevitably there were periods of pasture shortage and abundance so that grazing pressures fluctuated widely throughout the year. Therefore, management conditions necessary to modify composition (such as duration and intensity of grazing), may not have coincided with physiological stages of pasture growth which were sensitive and responsive to these factors.

Another contributing factor may have been the floristic diversity of the pastures. Such pastures must have been. adapted to a wide range of grazing pressure and so they may have had a higher threshold for botanical changes than cultivated pastures of simple composition. Also, relatively small differences in sheep density between grazing systems, limited numbers of pasture samples, variable pasture height and its effect on point analysis results (Radcliffe and Mountier, 1964b) and even the time of year selected by expediency, for analyses, may 'have affected results.

At Makara, following pasture improvement, minor sward components remained stable while ryegrass and white clover increased and browntop decreased. These findings agree with those of Suckling (1959) . This increase of productive species (especially under hard grazing) gave higher rates of pasture growth and supported more stock (Yates, 1971).

The small effect of grazing treatments in unimproved pastures and the greater effect in improved pastures with a good ryegrass content suggest that, before grazing treatments can affect composition, there must be responsive species in the sward, with suitable conditions (such as soil fertility) for responses to occur.

The effect of cattle grazing on Waerenga-o-Kuri and Makara pastures is not known, although Suckling (1964) found that pastures grazed by sheep had more white clover and coarse weeds and less Yorkshire fog, than pastures grazed by sheep plus cattle.

It is reasonable to assume that, as stock carrying capacity of all treatments increased over the study period (Table 1), there was a concurrent build-up of soil fertility and an increase in treading pressure. Thus ryegrass ingress, under mob-stocking in the fog/vernal association at Tangoio, on slopes at Waerenga-o-Kuri, and in the improved pastures at Makara, probably reflects its higher fertility. requirements and its resistance to treading damage (Edmond, 1964). Similarly, the increase of Yorkshire fog under light set-stocking in the ratstail/danthonia association at Tangoio, and in the laxly grazed improve'd pastures at Makara, probably reflects its susceptibility to treading damage (Edmond, 1964).

At all sites, composition fluctuated markedly between years and at Makara, where this effect was examined in connection with preceding rainfall, high correlations between rainfall and species cover were found. Therefore it is likely that rainfall and soil moisture have affected species cover at all sites — e.g., droughts probably reduced white clover cover at Makara in 1965 and 1969 and caused an increase in ratstail and danthonia at Tangoio in 1965, although, in the latter case, a contributing factor may have been taller pasture increasing cover values. The low correlation of white clover with time at Makara, and its high dependence on rainfall, highlights the difficulties of interpreting time trends from point analysis data.

Pasture species may differ in their sensitivity to grazing managements, &pending on their ecological niche. For example, white clover and Yorkshire fog reacted differently to grazing in the two pasture associations at Tangoio. Similarly, white clover reacted differently to grazing on two slope categories at Waerenga-o-Kuri. These results emphasize the need to consider botanical changes within an ecological entity.

Results from these three diverse experiments suggest that pasture composition on New Zealand hill country is unlikely to be markedly influenced, solely, by grazing management under the stocking rates considered. However, where pastures have been improved and contain appreciable quantities of ryegrass, constant hard grazing (at least within the first few years) will improve the cover of this more productive grass and reduce the cover of less productive flatweeds.

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