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SOME OBSERVATIONS OF PASTURE MANAGEMENT EFFECTS ON GRASS GRUB, PORINA AND EARTHWORM POPULATIONS

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ABSTRACT

Changes in management practices will automatically alter the equilibrium between organisms making up the pasture ecosystem with results not necessarily beneficial to the economic production of the system. Indications of these interactions were observed and monitored in pasture management pasture species trials at Palmerston North.

Grass grub attack developed more rapidly, and populations reached higher levels under rotational grazing than set stocking. Porina caterpillar populations tended to show the reverse with higher populations under set stocking than rotational grazing. Earthworm populations were higher under set stocking with a greater proportion of burrowing types, compared to rotational grazing which favoured more of the surface feeding species.

These changes are discussed in terms of differences in pasture structure and defoliation patterns affecting microclimate and food supplies for the survival of these organisms.

Keywords: Pasture management, rotational grazing, set stocking, grass grub, porina, earthworms, pasture structure, pasture biomass.

INTRODUCTION

The most realistic approach to research on pasture management, is to either investigate problems under existing commercial farm conditions or establish small scale systems within specified conditions and aims. Either way the resource required is considerable, and from a research viewpoint the wider the range of studies that can be integrated the better for later interpretation of results. Following this philosophy, when a grazing management × pasture species experiment was established, several other detailed studies on plant ecology were included. It soon became apparent that other organisms within the pasture ecosystem, namely grass grub (*Costelytra zealandica* White), porina caterpillar (Wiseanna spp) and possibly earthworms, were reacting differentially to the various treatments. Populationsof these organisms were monitored and form the subject of this paper.

Trial details

The soil was a free draining, Manawatu fine sandy loam, susceptible to drying out in summer.

A. The Management Systems (MS) trial, consisted of three grazing managements, established as three self contained farmlets, all stocked at 22.5 ewe equivalents (e.e)/ha, as follows:

1. Rotational grazing (RG) all year on a 12 paddock system (0.37ha)
2. Set stocked (SS) all year (0.18ha)
3. Combination (C) of rotational grazing with a period of set stocking from lambing to weaning (August-December) (0.18ha).

Within each farmlet there were two main pasture types, sown in spring 1978 and separately fenced:

1. Perennial ryegrass (*Lolium* perenne) and white clover (*Trifolium repens*).
2. Cocksfoot (*Dactylis glomerata*) with white clover and red clover (*T. pratense*).

Grass grub and porina populations were monitored in July of 1982, 1983 and 1984, using the soil coring method of Kain and Young (1975) and Kain and Atkinson (1976). Cores were 100 mm diameter by 200 mm deep taken at a frequency of 1/6-8 m^2, crumbled on site and numbers of grass grub and porina recorded.

Earthworms were sampled in late June 1983, 1984 and 1985, using the same corer as for grass grub, taking 32 cores/treatment under RG and 16 under SS and C. Cores were crumbled on site and earthworms extracted and stored in water overnight to reduce gut soil fill, then preserved in 5% formalin for subsequent sorting and weighing.

B. A Stocking Rate (SR) trial, an adjacent self contained farmlet study of stocking rate (15, 20 and 25 ee/ha) and pasture species (perennial ryegrass, tall fescue (*Festuca* arundinacea), phalaris (*Phalaris* aquatica) with white clover) under rotational grazing, was also monitored for grass grub, porina and earthworms in 1983 only.

GRASS GRUB AND PORINA CATERPILLAR

Changes in pasture management often have unexpected and sometimes serious consequences. For example, the removal of organochlorine insecticides (e.g. DDT) in 1970was quickly followed by the rapid development of two of our most serious pests of improved pasture today, grass grub and porina caterpillar (Kain 1980). With the replacement organophosphate insecticides proving costly and unreliable, integrated systems of pasture management and biological control agents have been advocated as the most realistic control alternative (East *et al.* 1985), with the aim of keeping pest and predators in viable equilibrium but at a sub-economic level of pasture damage.

TABLE 1: Mean grass grub densities and pasture characteristics in spring (1982-84).

Trial	Grass grub (/m²)			Tiller Density (m^2)	Pasture Height (cm)	Total biomass' (kg/ha)		Grazing interval (days)
	1982	1983	1984			Grass	Clover	
A. Management System								
Rotational	84b	160a	79b	4-5000	20-25	2330c	520a	24
Set stocked	6c	81b	94b	12-17000	5	3820a	270b	cont.
Combination	30c	140a	149a	8-10000	5-10	3020b	3156b	cont.
B. Stocking Rate								
	15ee	20ee	25ee					
(1983 only)	250a	225a	195b					20-30

'Mean annual total shoot yield dissected from soil cores.
*Values followed by different letters are significantly different at $P<0.05$. (applied to Tables 2 and 3).

GRASS GRUB

Management

Visual signs of pasture damage were first observed in winter 1980 as small isolated patches in the rotationally grazed ryegrass treatment, and had increased considerably by 1981. There was no visible sign of damage in any other treatment until 1983 when all managements showed damage suggesting populations in excess of 30/m² were required before visual symptoms became apparent (Table 1). Grass grub populations were highest in rotational grazing, but declined considerably in the third year, whereas grub density built up more slowly under set stocking. Several factors could be involved. The higher white clover content in rotationally grazed pastures would favour grass grub (Kain and Atkinson 1970). Kelsey (1968) indicated that pasture disturbance by grazing animals during egg laying in late spring reduced grass grub numbers, rather than amount or type of pasture cover. The 24 day spell between grazings in the rotational system would be sufficient to allow more successful egg laying to occur, than was possible under the continual disturbance of set stocking. In addition, the lower density though taller pasture cover of rotational grazing through summer, may have aided the survival of young larvae by surface shading reducing the chances of lethal soil temperatures developing (East and Willoughly 1980). The role of pasture management appears to be in altering the speed of development and magnitude of the grass grub attack.

On the SR trial population levels were higher and exhibited only a small decline with increasing stocking rate similar to the effect found by Dixon and Campbell (1978).

Pasture species

There was no difference in grass grub density under ryegrass or cocksfoot pasture (100 vs $98/m^2$ respectively) although there was never any visual signs of damage to cocksfoot illustrating its tolerance to grass grub (Kain et al. 1980, East et al. 1980). Tall fescue also showed similar tolerance to grass grub ($255/m^2$ cf ryegrass $275/m^2$) (East et al. 1982), while phalaris showed a marked degree of resistance to grass grub with a significant reduction in density (145/m*), similar to the results of Kain and Atkinson (1970).

PORINA

The method of sampling used was not suitable for accurate sampling of porina caterpillar due to their deep burrowing habit and rapid movement. The densities recorded therefore are likely to be underestimates of the true populations, but nevertheless the results indicate differences of interest.

Management

Population levels were below those necessary for significant economic damage to pastures to occur (20-$40/m^2$ Savage and French 1981) and no visual signs of damage were observed, except in the detailed plant ecology studies (W. Hunt pers comm).

In general the porina population followed the opposite trend exhibited by grass grub (Table 2). Porina were lowest under RG treatmentsand highest under SS treatments with C intermediate. Rotational grazing during the young larval stages before burrowing (late spring to early autumn) is important in porina control (French and Savage 1981). Removal of herbage reduces cover and lowers moisture in the sward adversely affecting larval survival (Pottinger 1968). The higher plant density and constant biomass under SS would favour young larval survival. This would suggest that porina numbers should be higher under lower stockingrate but the reverse result occurred in the SR trial.

Species

Porina density tended to be higher under ryegrass than cocksfoot (12 vs $9/m^2$ MS trial), tall fescue and phalaris (17, 7 and $6/m^2$ respectively — SR trial), similar to the results of Farrell et al. (1974) except for tall fescue which they found to be similar to ryegrass.

TABLE 2: The effect of pasture management on the density of porina caterpillar ($/m^2$).

	Management system			Stocking Rate (ee/ha)		
	Rotation	Set stocked	Combination	15	20	25
Mean	3c	18a	10b	6b	14a	11a

EARTHWORMS

Among the more beneficial organisms in the pasture ecosystem are the earthworms. They have proved to be important agents in stimulating pasture production, such that even in well managed high producing pastures, the introduction of earthworms have resulted in considerable increases in production (Stockdill and Cossens 1966). The effect is primarily on the grass component, operating through the removal of blocks to the decomposer system, stimulating organic matter breakdown and recycling processes (Syers and Springett 1983). Both physical mixing and incorporation of organic matter, and increased nutrient availability are involved.

During studies on the growth habit of white clover on the MS trial, it became evident that stolon burial and renewal was an important feature of the life cycle of the clover plant (Hay 1983, Hay et *al. 1983).* Surface casting by earthworms (25-30 tonnes/ha in this environment, Sharpley and Syers 1977) and stock treading were considered to be the major factors contributing to the burial of stolons, which reached levels of 95% below soil surface by late winter.

Comparison of data on earthworm populations at Palmerston North 30 years ago (Waters 1955) with data from the current survey (Table 3), shows that total earthworm biomass was similar but species composition has changed from 80% Allolobophora caliginosa, and 20% Lumbricus *rubellus,* to 53% A. *longa,* 41% *A.* caliginosa and 4% L. *rubellus.* It would appear that *A. longa* has partially displaced both other species, particularly *L. rubellus.*

TABLE 3: Mean earthworm counts (/m²) and biomass (kg w.w/ha), and pasture biomass (kg/ha) on the Management Systems Trial, compared with the survey by Waters (1955).

	Rotation	Set stocked	Combination	Mean	Waters (1955)
Earthworm counts					
L. Rubellus	43a	17b	8b	23	230
A *longa*	160a	195a	215a	190	
A. *caliginosa*	580b	750a	665ab	665	1025
Total	800b	975a	904ab	880	1255
Earthworm biomass					
L. *rubellus*	115a	40b	30b	60	540
A longa	1570a	1715a	1870a	1720	
A caliginosa	1230h	1530h	1470ab	1410	2170
Total	2980a	3320a	3425a	3240	2750
Pasture biomass					
Grass etc.	2130c	3490a	2860b		
Clover	630a	310c	430b		
Total	2760b	3800a	3290ab		

Information on the interaction of new earthworm species added to existingresident populations is scarce. Experiments by Syers and Springett (1983) and Springett (1984) in which A. *longa* (30% by weight or 100/m² respectively) was added to large resident population (≃2 500 kg/ha) dominated by *A. caliginosa,* resulted in a 20% increase in pasture growth after one year, possibly through the exploitation of a greater soil volume. *A. caliginosa* is a shallow burrowing (5-10 cm) subsurface dwelling type, feeding on decaying root material, whereas *L. rubellus* is a surface dweller feeding on decaying shoot material and dung (Waters 1955), while the larger A. *longa* is a much deeper burrowing type (15-20 cm) feeding on both surface and subsurface material and may well compete with L. rubellus for food supply. Also present at this site is the deep dwelling *Octolasium cyaneum,* rarely seen closer than 10-15 cm from soil surface except during wet weather, hence doesn't feature in this survey. With the burrowing zones of A. *longa* and 0. cyaneum overlapping, there is considerable prospect of organic matter being distributed through a much deeper soil volume. This may favour white clover growth which is a poor competitor for nutrients with grass in the shallow surface layers (Jackman and Mouat 1972), but is more effective at greater depth due to its more taprooted rooting system. The soils at this site are relativley low in organic matter and total nutrient, yet the pastures are highly productive indicating that the high earthworm biomass, particularly of the deep burrowing A. *longa*, may be stimulting distribution and rapid mineralisation and turnover of organic matter, particularly N (Keogh 1979).

Information on the effects of pasture management on earthworm populations is also scarce, but one comparison with a hill country study is possible (Lambert 1986). Earthworm biomass was positively correlated with pasture growth as found previously (Waters 1955, Stockdill and Cossens 1966), and the large difference in earthworm biomass between the twosurveys (3250MS trial of 900 kg/ha hill country) reflects the large difference in carrying capacity (22.5 vs 11.6 ee/ha respectively). While *A. longa* was absent in the hill country, these were marked similarities in the distribution of the other species related to pasture management. In the hill country there was a 10% greater biomass under set stocking than rotational grazing with sheep, made up of 26% more A. caliginosa but 40% less *L.* rubellus. The equivalent values for the lowland MS trial were 11% more biomass, 24% more *A.* caliginosa and 65% less *L. rubellus*. Rotational grazing with cattle in the hill country further reduced total biomass (53%).

Several points of interest arise concerning suitable habitat and food supplies for earthworms under various grazing managements. In the current survey, pasture utilisation was equal as all managements were under the same stocking rate, yet differences in size and species distribution of earthworm populations occurred. Earthworms live and feed in the residual pasture and root zone below grazing level, and measurement of residual shoot yield would be more relevant to earthworms. Residual shoot yields were highest under set stocking (Table 3), and as set stocked plants are small the roots would presumably be more concentrated near the soil surface resulting in a greater biomass of burrowing earthworms, particularly A. *caliginosa* under set stocking than rotational grazing. Intensive grazing and heavy treading pressure during rotational grazing tends to produce large amounts of damaged shoot material (J. Brock unpub.) some of which is directly incorporated into the soil during grazing, particularly with cattle (D. Causley, pers comm) all adding to the pool of surface litter available to *L.* rubellus. Rotational grazing also favours higher white clover content in the pastures than set stocking (Table 3), and this would further encourage *L. rubellus* which has a preference for clover (Sears and Evans 1953). The taller pastures between grazings could also provide better cover from predation by birds compared to the shorter set stocked pastures (Table 1). Together these factors obviously outweight losses that may be caused by the heavy trampling during grazing. In the current survey, as well as having a larger biomass under rotational grazing, individual worm weights of *L. rubellus.* were considerably higher (0.24 cf 0.09g/worm under SS).

SUMMARY

The pasture ecosystem is a complex interaction of many factors and organisms in delicate balance and the alteration of any factor through management must affect the other components of the system. This study has highlighted but a few of these more obvious interactions with economic consequences such as grass grub and porina, but also illustrates that the more benign but equally important beneficial members are also affected (e.g. earthworms). Pasture managers should always be aware of these intereactions, taking them into account in decisions where they are known, and always being observant to detect these that may develop unexpectedly.

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