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THE EFFECT OF HERBAGE MASS OF A PASTURE ON THE SPATIALLY HETEROGENEOUS GRAZING BY CATTLE

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Abstract

To obtain information on spatially heterogeneous grazing by large herbivores at different time scales, spatial distribution of herbage mass and rate of defoliation was investigated on a bahiagrass (*Paspalum notatum* Flügge) pasture grazed by cattle during 4 to 5-day grazing periods in May, August and October. Pre-grazing herbage mass (M_{pre}) showed decreasing mean values and increasing spatial heterogeneity with the progress of grazing in all grazing periods,

while the rate of defoliation showed inconsistent changes with season. Spatial distribution of the rate of defoliation was always more heterogeneous than that of M_{pre}. The correlation coefficient between M_{pre} and rate of defoliation increased with decreasing mean M_{pre} on the seasonal basis. The same trends also appeared with the daily progress of grazing in August and October. However, in May when the mean M_{pre} was less than 40 g DM/2500 cm^2, the correlation remained almost constant at significant levels. It was shown that cattle consumed more herbage from locations with greater M_{pre} as the mean M_{pre} of the pasture decreased to the critical amount (40 g DM/2500 cm^2), but they did not increase their selectivity for higher M_{pre} locations when the mean M_{pre} fell below the critical amount.

Keywords: Bahiagrass pasture, herbage mass, herbage consumption, progressive grazing, seasonal variation, spatial distribution, spatial heterogeneity

Introduction

It is well known that grazing of pasture by animals is spatially heterogeneous. Studies for two-day grazing periods from spring to autumn have shown that animals tended to consume more herbage from locations with higher pre-grazing herbage mass (M_{pre}) as the mean M_{pre} of the pasture decreased (Hirata and Fukuyama, 1997; Hirata, 2000a). Our previous study (Hirata and Ogura, 2001b) showed a similar trend on the daily basis with the progress of grazing in summer. However, the spatial pattern of grazing on the daily basis may differ with seasons because of seasonal variations in pasture quantity and quality, and their spatial distribution (Liu and Hirata, 1995; Ogura and Hirata, 2001). Therefore, we investigated the spatial distribution of M_{pre} and herbage consumption and their relationships in a pasture under progressive grazing by cattle in spring, summer and autumn.

Material and Methods

The pasture, animals and their management were the same as described by Ogura and Hirata (2001).

The measurement was carried out during 3 grazing periods, 22 to 25 May, 3 to 7 August and 22 to 25 October 1999. The spatial distribution of herbage mass and rate of defoliation was measured every day for 91 locations on the permanent line transect as described in the previous paper (Hirata and Ogura, 2001a). The spatial heterogeneity of the variables was expressed by the coefficient of variation (CV) of data from the locations.

Results and Discussion

The spatial distribution of M_{pre} and the rate of defoliation along the transect was quantified as shown by Fig. 1. In some locations, the rate of defoliation showed negative values because of some errors in the estimation (Hirata, 2000b). Mean M_{pre} decreased with the progress of grazing

in all seasons. On the contrary, CV of M_{pre} always tended to increase with the progress of grazing. This indicates that spatial heterogeneity of herbage mass always increased with the progress of grazing which changed ingestive behavior of cattle (Hirata and Ogura, 2001b).

The change of mean and CV of the rate of defoliation with the progress of grazing differed with season (Figure 1). In all measurement dates, CV in the rate of defoliation was greater than that in M_{pre}. This greater spatial heterogeneity in the rate of defoliation might be due to spatial heterogeneity of M_{pre} and ingestive behaviour which affected the rate of defoliation (Hirata and Ogura, 2001a, b).

Correlation coefficients between M_{pre} and the rate of defoliation over the locations along the transect varied with season, showing a negative correlation with mean M_{pre} over the transect ($r=-0.714$, $p<0.01$) (Figure 2). In May when the mean M_{pre} was low (approximately < 40 g DM/2500cm^2), the rates of defoliation were higher at the locations which had greater M_{pre}, however, in October when the mean M_{pre} was high (approximately > 70 g DM/2500cm^2), the

correlation between M_{pre} and the rate of defoliation weakened. These results mean that the relationship between M_{pre} and the rate of defoliation could be explained with the mean M_{pre} on the seasonal basis. Similar trends were shown on the daily basis with the progress of grazing in August and October; however in May, the correlation between M_{pre} and the rate of defoliation was almost constant at significant levels. It was suggested that there was a critical amount of mean M_{pre} (40 g DM/2500cm^2) which strongly associated M_{pre} with herbage consumption at individual locations. The above trends in the correlations between M_{pre} and the rate of defoliation are recognized in Fig. 1, as similarity or dissimilarity of patterns.

It was concluded that, when the mean M_{pre} on the pasture was relatively high (40 g DM/2500cm^2), cattle increased their selectivity for locations with higher M_{pre} as the mean M_{pre} decreased with the progress of grazing both on the daily and seasonal basis. This was consistent with the previous suggestions (Hirata and Fukuyama, 1997; Hirata, 2000a). At the same time, the present study suggested that, when the mean M_{pre} was less than the critical amount (40 g

DM/2500 cm^2), cattle stopped increasing their selectivity for higher M_{pre} locations. To fully understand the mechanisms of such spatially heterogeneous grazing by herbivores, further works are needed to investigate seasonal variation of the spatial distribution also in terms of ingestive behaviour of animals.

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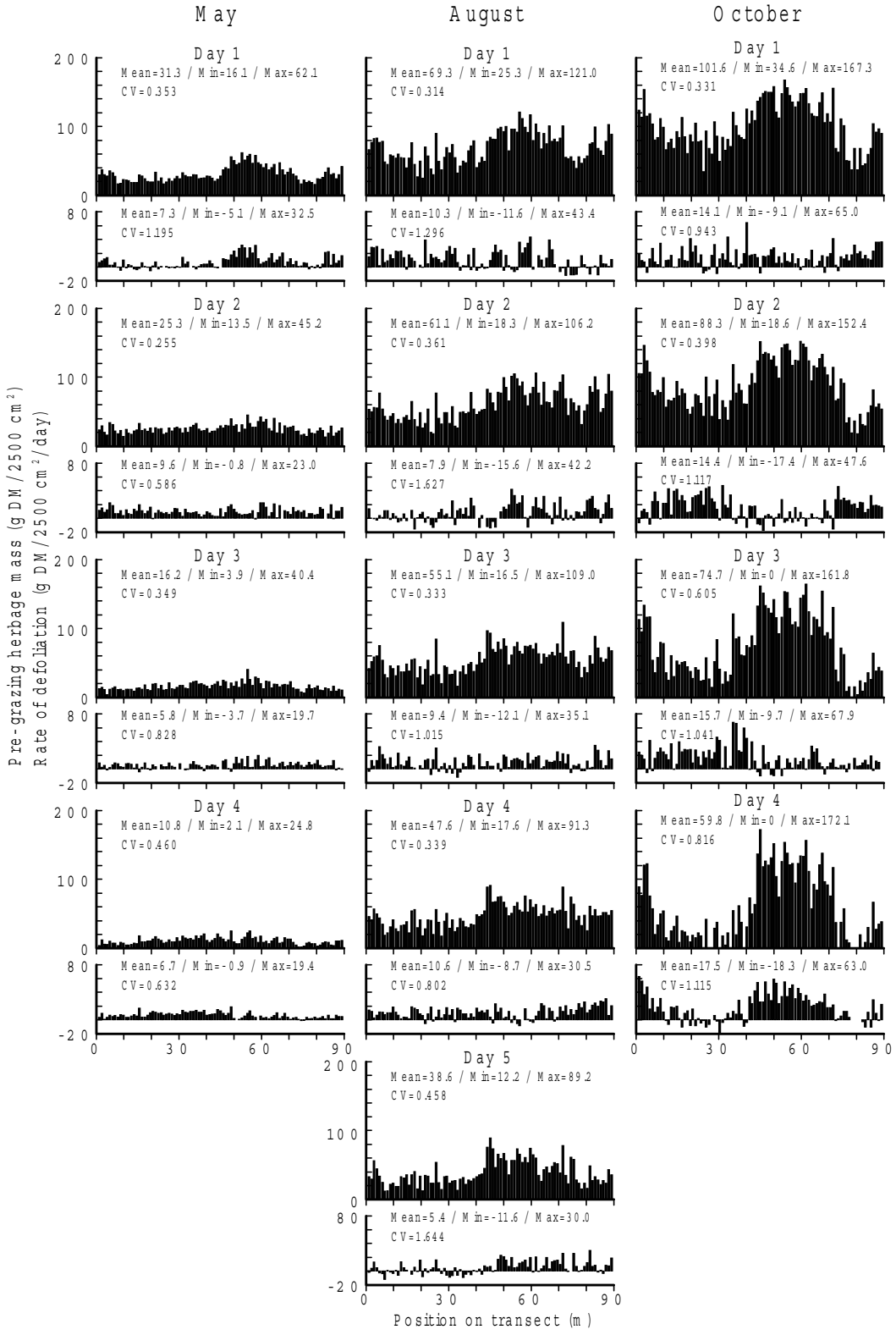

Figure 1 - Spatial distributions of pre-grazing herbage mass and rate of defoliation along the transect. The statistical parameters are the mean, minimum (Min), maximum (Max) and coefficient of variation (CV). The upper and lower vertical axes for each measurement date show the pre-grazing herbage mass and the rate of defoliation, respectively.

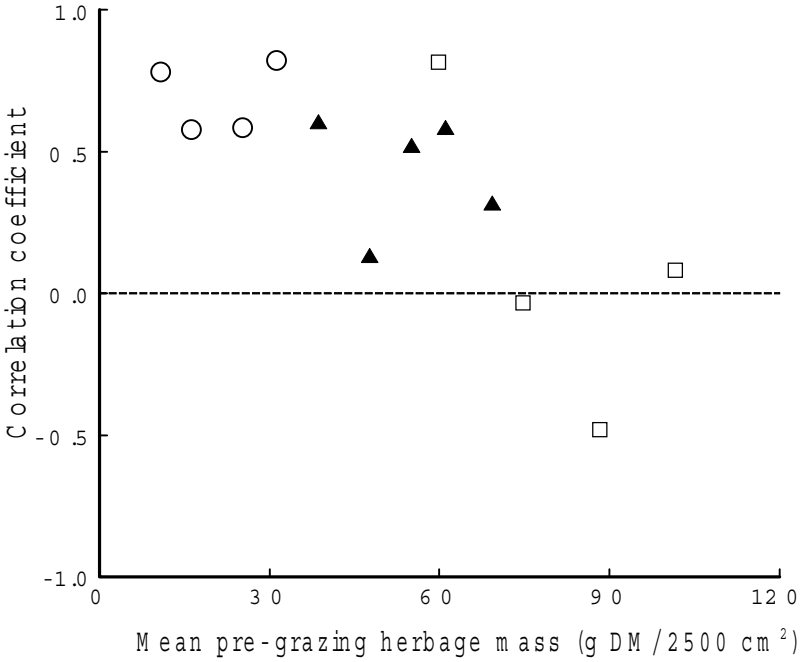

Figure 2 - Effect of the mean pre-grazing herbage mass over the transect on the correlation coefficient between the rate of defoliation and the pre-grazing herbage mass along the transect in May (○), August (▲) and October (□).