International Grassland Congress Proceedings | XIX International Grassland Congress

The Effect of Progressive Grazing of a Pasture on the Spatial Distribution of Herbage Mass and Utilization by Cattle

Masahiko Hirata
University of Miyazaki, Japan

S. Ogura
University of Miyazaki, Japan

The XIX International Grassland Congress took place in São Pedro, São Paulo, Brazil from February 11 through February 21, 2001.

Proceedings published by Fundacao de Estudos Agrarios Luiz de Queiroz

ID # 07-03

THE EFFECT OF PROGRESSIVE GRAZING OF A PASTURE ON THE SPATIAL DISTRIBUTION OF HERBAGE MASS AND UTILIZATION BY CATTLE

M. Hirata and S. Ogura

Faculty of Agriculture, Miyazaki University, Miyazaki 889-2192, Japan

Abstract

To develop an understanding of the spatially heterogeneous grazing of a pasture by large herbivores under progressive grazing, the herbage mass, herbage consumption and ingestive behavior by cattle were monitored daily at ninety-one 50 × 50 cm permanent locations in a bahiagrass (*Paspalum notatum* Flügge) pasture during a 6-day grazing period. With the progress of grazing, the mean pre-grazing herbage mass over the locations decreased. Responding to this, the mean number of visits and the mean rate of biting increased, and the mean residence time and the mean rate of defoliation decreased. The pre-grazing herbage mass became more heterogeneous, whereas the number of visits and the rate of defoliation became more homogeneous, based on the coefficient of variation. The overall spatial heterogeneity was ranked: rate of defoliation > number of visits ≥ residence time ≥ pre-grazing herbage mass > rate of biting. The results have provided some new information about the spatially heterogeneous grazing by cattle in a monospecific grass pasture, though further analyses and studies are necessary for fully understanding the mechanisms behind the diverse responses of the spatial heterogeneity of the variables to grazing.

Keywords: Spatial distribution, spatial heterogeneity, herbage mass, herbage consumption, ingestive behavior

Introduction

Vegetation in grazing systems is spatially heterogeneous at various scales ranging from individual plants to landscape (Vallentine, 1990). It is well recognized that selective (spatially heterogeneous) grazing by animals is a crucial factor in the development and maintenance of this heterogeneity. However, few studies have quantified the spatial distribution of both vegetation and grazing, and investigated their interactions in a pasture (Hirata, 2000a, b). In this study, the spatial distribution of herbage mass, herbage consumption and ingestive behavior as a determinant of consumption was monitored daily at a small-patch scale in a bahiagrass (*Paspalum notatum* Flügge) pasture during 6-day grazing with cattle, to develop an understanding of the spatially heterogeneous grazing of a pasture by large herbivores under progressive grazing.

Material and Methods

The measurements were carried out on a 1.1-ha paddock of a bahiagrass (cv. Pensacola) pasture at the Sumiyoshi Livestock Farm (31°59'N, 131°28'E), Faculty of Agriculture, Miyazaki University, Japan. The vegetation was highly dominated by bahiagrass, and virtually monospecific during the measurements.

From 18 to 23 July 1998 (Days 1 to 6), the paddock was grazed by 32 Japanese Black cows between 0900 and 1600 h. The spatial distribution of herbage mass, herbage consumption and ingestive behavior was measured every day for ninety-one 50 × 50 cm locations which existed at

1-m intervals along the 90-m permanent line transect crossing the paddock (Transect 2 in Hirata, 2000a). The herbage mass and the rate of defoliation at the individual locations were estimated using the technique developed by Hirata (2000b). Ingestive behavior of animals at the individual locations was measured by 7-8 observers. Whenever each location was visited and grazed by an animal, the position of the location, the time during which the animal grazed the location and the number of bites that the animal took from the location were recorded. From these data, the number of visits, the mean residence time per visit and the mean rate of biting at the individual locations were calculated. 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 the pre-grazing herbage mass, the rate of defoliation and the three ingestive behavior variables along the transect was well quantified as shown by an example on Day 1 (Fig. 1). On this first day of the 6-day grazing period, 60 locations out of the 91 were visited and grazed by the animals, as indicated by the number of samples for the residence time and the rate of biting. The rate of defoliation sometimes resulted in negative values because of some errors in the estimation (Hirata, 2000b). Nevertheless, its spatial pattern clearly illustrates which locations of the pasture were heavily defoliated or lightly defoliated. Similarly, we can understand which locations of the pasture were highly available (in terms of herbage mass), frequently visited, and so on. The rate of defoliation was most heterogeneous, whereas the rate of biting was most homogeneous, as shown by the CV values.

With the progress of grazing, the mean pre-grazing herbage mass in the pasture decreased

(Fig. 2a). The animals responded to this decline in feed resource by visiting more locations (Fig. 2e, f) with the shorter residence time (Fig. 2g), i.e. more frequently shifting from one location to another and visiting the locations more evenly (Fig. 2f). The mean rate of biting tended to increase (Fig. 2i), also reflecting the decrease in the mean pre-grazing herbage mass (Higashiyama and Hirata, 1995). The mean rate of defoliation decreased (Fig. 2c), suggesting a decline in the daily herbage intake by animals.

With grazing, the pre-grazing herbage mass became more heterogeneous (Fig. 2b), and the rate of defoliation became more homogeneous (Fig. 2d). The increased spatial heterogeneity in the herbage mass may be partly attributable to the tendency that animals graze locations with lower herbage masses with higher degrees of defoliation (Hirata, 2000a). The decreased spatial heterogeneity in the rate of defoliation is taken to show that the animals became less selective with the decreasing feed resource (Hirata, 2000b), which is supported by the decreased heterogeneity in the number of visits (Fig. 2f) discussed above. The overall spatial heterogeneity of the variables based on the CV meaned over the grazing period (Days 1-6) was ranked: rate of defoliation (1.23) > number of visits (0.77) ≥ residence time (0.64) ≥ pre-grazing herbage mass (0.45) > rate of biting (0.16).

Thus, the present study has provided some new information about the spatially heterogeneous grazing by cattle in a monospecific grass pasture. It was shown that the grazing variables, except for the rate of biting, were more heterogeneous than the herbage mass, whose heterogeneity has been well recognized and quantified (e.g. Shiyomi et al., 1983, 1984; Hirata, 2000a, b). It was also shown that the spatial heterogeneity in the rate of defoliation and the number of visits varied with progressive grazing, whereas the heterogeneity in the residence time and the rate of biting remained almost constant. Although some mechanisms behind such responses of the spatial heterogeneity to grazing were explained above, further analyses and studies are necessary for fully understanding the mechanisms and deepening our knowledge about grazing as plant-animal interactions.

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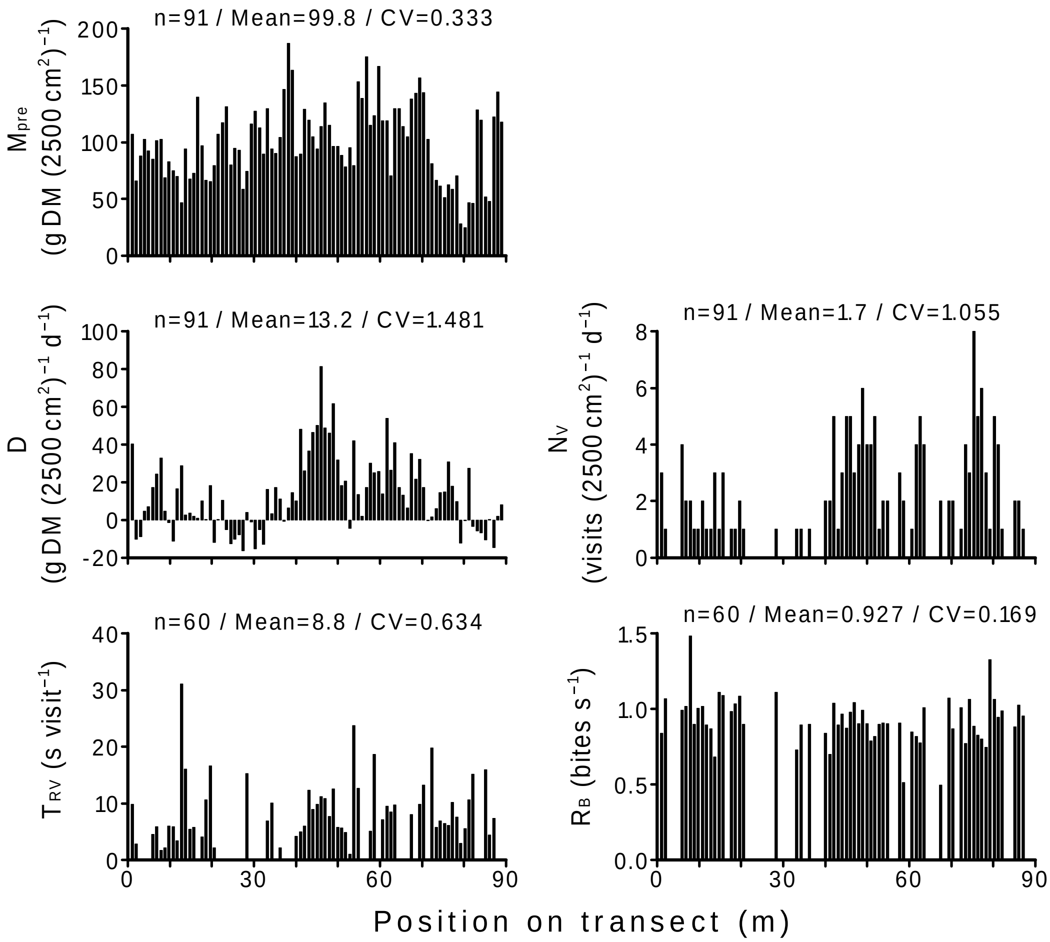

Figure 1. Spatial distribution of pre-grazing herbage mass (M_{pre}), rate of defoliation (D), number of visits (N_V), residence time per visit (T_{RV}) and rate of biting (R_B) along the transect on Day 1. The statistical parameters are the number of samples (n), mean and coefficient of variation (CV, fraction).

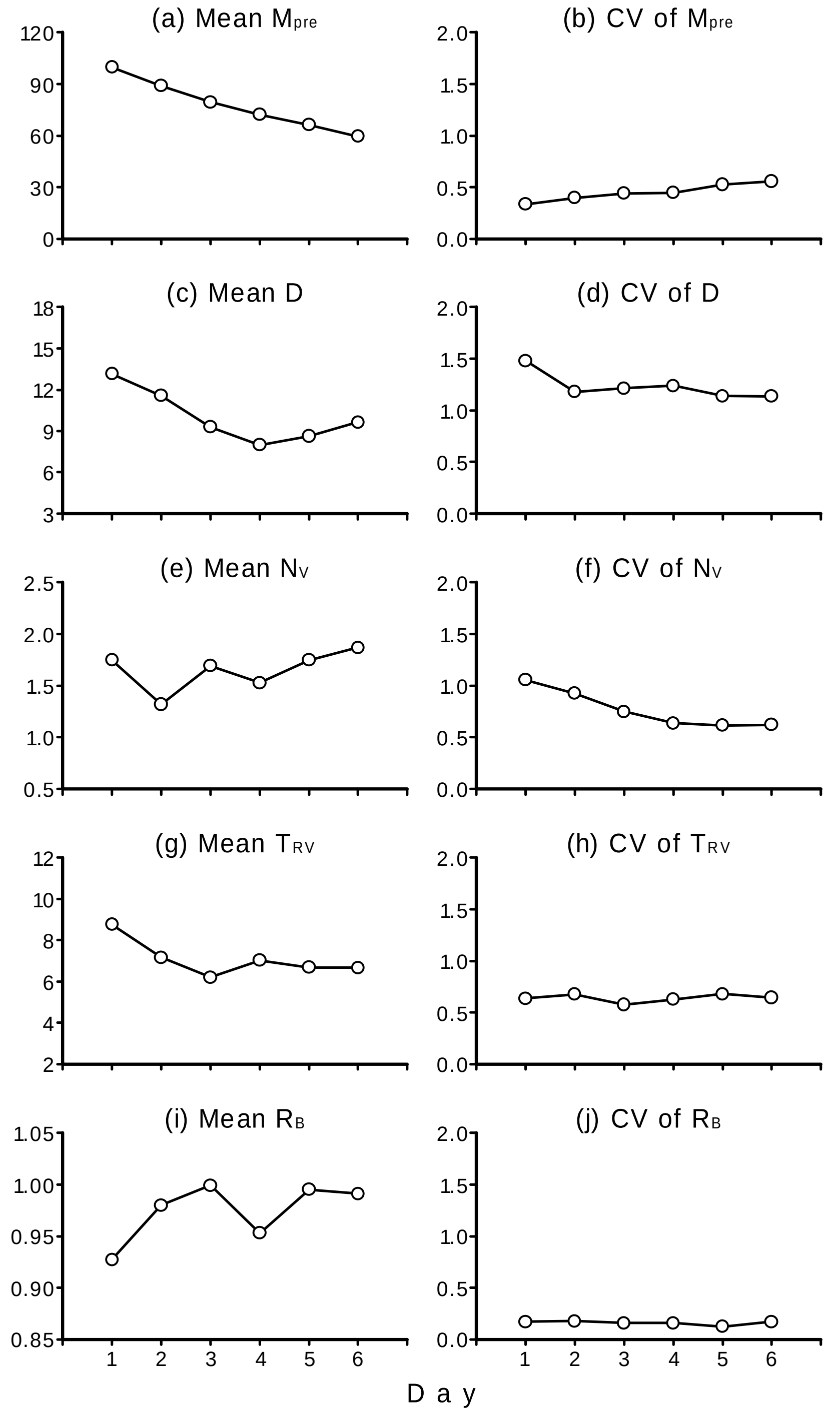

Figure 2. Changes in the mean and coefficient of variation (CV, fraction) of pre-grazing herbage mass (M_{pre}), rate of defoliation (D), number of visits (N_V), residence time per visit (T_{RV}) and rate of biting (R_B) with the progress of grazing (Days 1 to 6). The unit of the mean is g DM (2500 $cm^2)^{-1}$ for M_{pre}, g DM (2500 $cm^2)^{-1}$ d^{-1} for D, visits (2500 $cm^2)^{-1}$ d^{-1} for N_V, s $visit^{-1}$ for T_{RV} and bites s^{-1} for R_B.