THE ROLE OF PLANT DISTRIBUTIONS ON HERBIVORE DIET CHOICE: A COMPARISON OF WILD AND DOMESTIC SPECIES

GARY E. BELOVSKY and J.B. SLADE

Belovsky, G.E., and J.B. Slade. 1987. The role of plant distributions on herbivore diet choice: a comparison of wild and domestic herbivores. In Rose, M. (ed.), Harbivore Nutrition Research. Second International Symposium on the Nutrition of Herbivores. Occasional Publication of the Australian Society of Animal Production. pp. 87-90

Summary

Diets for livestock (Bos taurus, Equus caballus, Ovis aries) can be predicted using the same model and foraging constraints which explain the diets of wild mammalian herbivores (see this volume). The cropping rates are different for wild herbivores in natural communities and domestic herbivores in managed pastures because of different distributions of food plants.

I. INTRODUCTION

In a review of herbivore diets (Belovsky 1986a), domestic and wild herbivores of the same family and similar body size were often observed to differ in their diet choices, even when the plant biomass and composition of their habitats were similar. Wild herbivore diets can be predicted using a model that maximizes their daily energy intake given constraints for daily digestive capacity, feeding time and nutritional requirements (this volume; Belovsky 1986a). Given diet differences, do domestic herbivores also choose diets that are consistent with this model? This seems likely since domestic herbivores should have the same foraging constraints as wild species and man's artificial selection should strongly select for individuals that maximize energy intake, a major determinant of productivity. Therefore, the foraging model parameters for domestic species were examined for differences with wild species.

II. METHODS

Cattle, horse and sheep were studied near Moiese, Montana, U.S.A. Horses were studied on native Palouse prairie, the site used to study wild species. Cattle and sheep were studied on irrigated and seeded pastures.

The foraging model and its parameters are presented and discussed elsewhere in this volume. The methods employed to measure model parameters are presented elsewhere (Belovsky 1986b). The observed livestock diets were measured as the proportion of dry wt intake of grasses and forbs using microhistological techniques for feces (Belovsky 1986b), and compared with the diet predicted using the model. Cattle and sheep diets were compared with the diets of comparable wild herbivores on the native prairie, bison (Bison bison) and bighorn sheep (Ovis canadensis), respectively.

Vegetation on the prairie (10 sites) and pastureland (1 site) were compared (Belovsky 1986b). A minimum of ten 0.1 m2 plots were clipped at each site. Biomass (g dry/m2) and percent grass by biomass were measured. Distribution of grasses and forbs was measured in terms of "patchiness" (contagious vs. dispersed) and association between grasses and forbs (positive vs. negative). Patchiness is measured by skewness (Sokal and Rohlf 1981). A significant positive skewness coefficient indicates a "patchy" (contagious) distribution. Association is measured by Spearman Rank Correlation; a significant negative value denotes that grasses and forbs occur in different places.

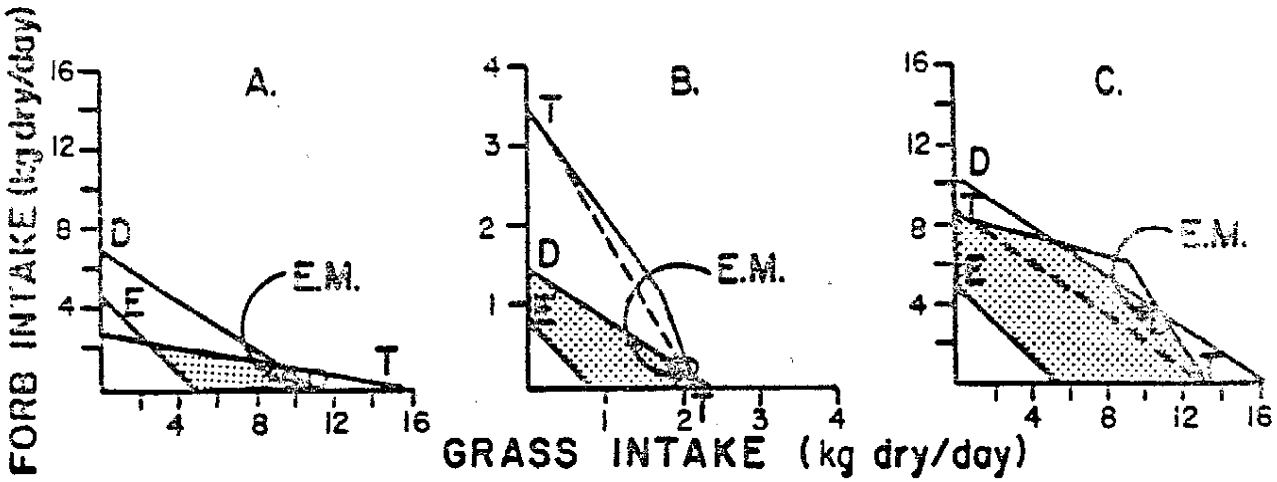
III. RESULTS AND DISCUSSION

The wild and domestic species pairs have differences in their diets (cattle vs. bison: 0.77±0.07 grass, N=5, vs. 0.93±0.04, N=25; $t=7.72$, $p<0.05$; sheep vs. bighorn: 0.89±0.07 grass, N=5, vs. 0.26±0.05, N=5; $t=16.63$, $p<0.01$). This occurs although no differences in the relative abundance (0.85

School of Natural Resources, Univ. of Michigan, Ann Arbor, MI 48109-1115 USA

grass vs. 0.70±0.26, N=10, t=0.55, N.S.) or biomass of vegetation (116 g/m² vs. 189±70 g/m², N=10, t=1.0, N.S.) exist in the pasture vs. native prairie.

The foraging models for the domestic species appear in the figure. As for wild species, the predicted diets which maximize energy intake are not different from the observed diets, using a χ^2 goodness of fit test.



Linear programming models for a horse (A), sheep (B) and cattle (C) are presented. Each constraint equation is marked: digestive (D), time (T) and energy (E). The energy-maximized diet is marked (EM); the observed diet is marked with o. Diets satisfying the constraints are in the shaded region. The dashed line is described in the text.

Digestive capacity and nutritional constraints for comparable wild and domestic herbivores are similar. However, major differences in feeding time constraints exist. These differences arise in the cropping rates, since the wild and domestic species have comparable daily feeding times (min/day). Cropping rates differences are due to how feeding time is utilized rather than cropping rate magnitudes since relative and absolute abundances of vegetation in prairie and pasture are the same.

Feeding time constraints for wild herbivores (this volume) are based on forbs and grasses being in different locations (negative associations) so they cannot be searched for at the same time (non-simultaneous search). The vegetation in the prairie and pastures are not different in the "patchiness" of their distributions (Skewness Coefficients, respectively: 1.6±1.1, N=20 vs. 1.6, N=2, t=0, N.S.). However, they do differ in their associations of grasses and forbs (Spearman Rank Correlation: -0.31±0.17, N=10 vs. 0.23, t=3.2, $p \leq 0.05$). In the pasture they co-occur (positive association), enabling the cattle and sheep to search for them at the same time (simultaneous search). The shapes of the feeding time constraints will be different under these search modes (Belovsky, submitted); compare the horse (A) for non-simultaneous search and cattle (B) and sheep (C) for simultaneous search.

Simultaneous search provides greater energy intake than non-simultaneous search, because the forager can search for both grasses and forbs at the same time. This is shown using the dashed lines in the figure (B,C) which present the hypothetical non-simultaneous search feeding constraint for comparison. Simultaneous search increases energy intake by a multiple of 0.02 for sheep and 0.12 for cattle. Therefore, vegetation distributions can be as important as changing forage abundance and digestibility for herbivore productivity; an important management consideration for wildlife and livestock.

BELOVSKY, G.E. (1986a). Am. Zool. 26, 51-69.
BELOVSKY, G.E. (1986b). Oecologia (Berlin) 70, 35-52.
BELOVSKY, G.E. (submitted). Oecologia
SOKAL, R.R., AND ROHLF, F.J. (1981). 'Biometry.' (W.H. Freeman: San Francisco.)