Botanical composition and seasonal trends of cattle diets in central Argentina

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Abstract

About 40,000 km² of the Caldenal in central semiarid Argentina are rangelands where the most important economic activity is cow-calf operations. Some information on forage species, mainly regarding taxonomy, ecophysiology, and nutritive value, is available, but detailed studies on composition of free-ranging cattle diets are lacking. The objective of this work was to study the botanical composition and seasonal trends of cattle diets in the southern Caldenal. Diets were studied through microscopic analysis of cattle feces collected monthly in a typical plant community during a 12-month period. Grasses were the bulk of the diets, except in November when more than 50% of the diet was *Medicago minima* (L.) Grufberg. Highest consumption among the grasses was of *Piptochaetium napostaense* (Speg.) Hack., one of the dominants in the grass layer. High consumption of *Pappophorum mucronulatum* Nees, one of the few warm-season grasses in the region, was found during the summer. Caldén (*Prosopis caldenia* Burk.) pods, consumed in late summer and fall, were the only woody fragments found in appreciable amounts. Classification and ordination techniques were used to analyze seasonal trends. In spite of a relatively high homogeneity in the diets, 2 well-defined seasonal trends were detected, one in the fall-winter period and another in the spring. Cattle diet diversity was minimum during the coldest months of the year.

Key Words: Caldenal, free-ranging cattle, classification, ordination

The Southern Espinal (Fernández et al. 1989) or District of the Caldén (Cabrera 1976), commonly called the Caldenal, is a region in central Argentina characterized by the presence of *Prosopis caldenia* Burk. Vegetation of the Caldenal has been described at a regional scale in La Pampa by Cano et al. (1980); other local studies are those by Bóo and Peláez (1991), Cano (1975), and Esterlrich et al. (1985). The most common vegetation type in the southern Caldenal is shrubland with a very rich grass layer. The eastern and more humid portion of the Caldenal has been used as farmland and the driest portion, covering about 40,000 km² at present, is almost entirely utilized as rangeland in cow-calf operations. Poor range management, with very few exceptions, is the rule and signs of deterioration have been mentioned (Bóo and Peláez 1991, Fernández et al. 1989). Information on forage species is scarce and limited to nutritive quality or ecophysiology of some species assumed to be important components of cattle diets, but studies on cattle diets are lacking. The objective of this work was to analyze the botanical composition and seasonal variation of cattle diets in a typical plant community of the southern Caldenal.

Study Site

A 600-ha pasture was selected for the study. The site is located in the southeast portion of the province of La Pampa (Argentina) at 38°45'S, 63°45'W, and 80-m elevation. Average annual rainfall is 448 mm concentrated in spring and fall, and average annual potential evapotranspiration is 800 mm (Peláez 1986). Average annual temperature is 15.3° C with June the coldest month (7° C) and January (23.6° C) the warmest. Soils are classified as Calciustolls with a petrocalcic horizon ("tosca") at an average depth of 0.60 m (Fernández et al. 1989).

Vegetation at the site has been described by Bóo and Peláez (1991). Woody species cover varies between 50 and 70% with *P. flexuosa* DC. and *P. caldenia*, the only tree in the area, the most abundant. The herbaceous layer cover varies between 40 and 50% with *Piptochaetium napostaense* (Speg). Hack. and *Stipa tenuis* Phil. as the dominant species; *S. speciosa* Trin. et Rupr. and *S. gynerioides* Phil. are very frequent, and *S. longiglumis* Phil., *Poa ligularis* Nees and *Pappophorum mucronulatum* Nees are less abundant. Bare ground is 30–40% and during wet years is colonized by annuals, mostly *Medicago minima* (L.) Grufberg and *Erodium cicutarium* L'Herit. Above-ground net primary production in this plant community for *S. tenuis* was 86.2 g/m²-year, and 68.4 g/m²-year for *P. napostaense* as measured for a 12-month period totalling 532 mm of rainfall (Distel 1987, Distel and Fernández 1986). These 2 species accounted for 70% of the total herbaceous cover.

Materials and Methods

Botanical composition of cattle diets was studied by microscopic analysis of fecal samples (Sparks and Malecheck 1968). A previous study (Lindström, unpublished) provided microhistological information on the species present in the area and training in the technique. Fifteen independent fecal samples from the same number of observed mature cows were collected monthly during 12 successive months. Five microscope slides were prepared from each sample and 40 systematically selected fields per slide were observed using 100x magnification. This sampling intensity allowed 20% ($P<0.05$) precision in the estimation of the mean for individual species with more than a 7% contribution to the total sample composition (Bóo et al. 1991). In spite of criticisms due to differential digestibility among forage species, fecal analysis is considered an adequate method for studying food habits of free-ranging herbivores (McInnis and Vavra 1987, Migongo-Bake and Hansen 1987).

A data matrix consisting of the percent relative density of identified components of the monthly diets was prepared, which is considered a good estimation of the relative amounts of forage species present in the diets. A secondary matrix of Euclidian dis-

tances (ED_{jk}) between all pairs of months was calculated and classified using complete linkage (Sneath and Sokal 1973), an agglomerative hierarchical cluster analysis technique. McInnis et al. (1990) have discussed the potential of this technique in the analysis of seasonal variation of herbivore diets. Distortion of the classification procedure was evaluated through calculation of the cophenetic correlation coefficient ($r_{x,y}$) as described by McInnis et al. (1990), and through ordination of the data matrix with DECO-RANA (Hill 1979). Rainfall was measured at the site with an automatic rain gauge. Daily maximum temperature was measured with a thermometer. Monthly total rainfall and monthly averages of daily temperatures were calculated and used to perform regression analyses on the axes produced by DECORANA. Monthly diversity (N_2) of cattle diets was calculated as the reciprocal of Simpson's index (Hill 1973), and regressions analyses of monthly rainfall and temperatures on monthly diet diversity were performed.

Results and Discussion

A total of 602 mm of rainfall was measured at the site during the 12-month period of the study. Rainfall monthly totals and monthly averages of daily maximum temperatures are shown in Figure 1.
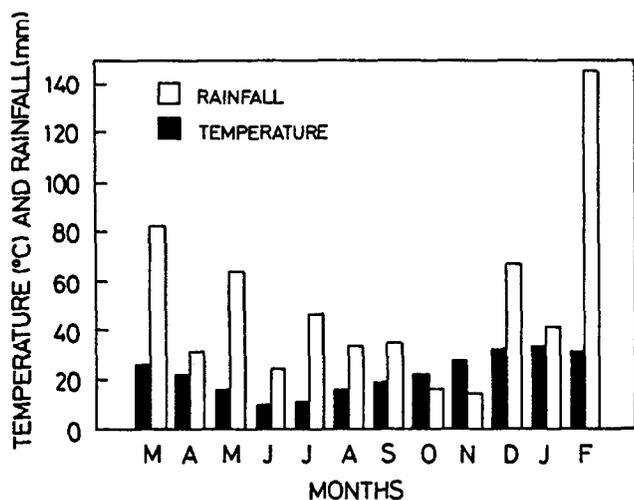

Fig. 1. Totals of monthly rainfall (mm) and monthly averages of daily maximum temperature (° C).

Grasses were the most important contributors to cattle diets throughout the year, with a maximum of 91% in January, a minimum of 31% in November and a monthly average of 74%; this finding is coincident with many food habit studies (Holechek et al. 1982, McInnis and Vavra 1987) on free-ranging cattle. *P. napostaense,* one of the dominant grass species in the southern Caldenal, was very abundant in the diets (Fig. 2a) throughout the year, except in mid spring when it was partially replaced by *M. minima. S. tenuis,* The other dominant and highly productive cool-season perennial grass in this community (Distel and Fernández 1986) was always present, but with substantial amounts only in late winter and early spring (Fig. 2b). The rest of the grasses showed low abundances, with the exception of *P. mucronulatum* (Fig. 2d), the only warm-season perennial grass present, which reached 48% in February and showed marked seasonal use.

Two annuals frequently mentioned as a good forage resource and highly productive in this community during the spring (Fresnillo-Fedorenko 1990) are *M. minima* and *E. cicutarium.* Only the former (Fig. 2e) made a substantial contribution to the diets. Among the rest of the forbs, only *Sphaeralcea* spp. St. Hil. (Fig. 2h) are found in low but appreciable amounts, whereas the rest are very scarce or traces.
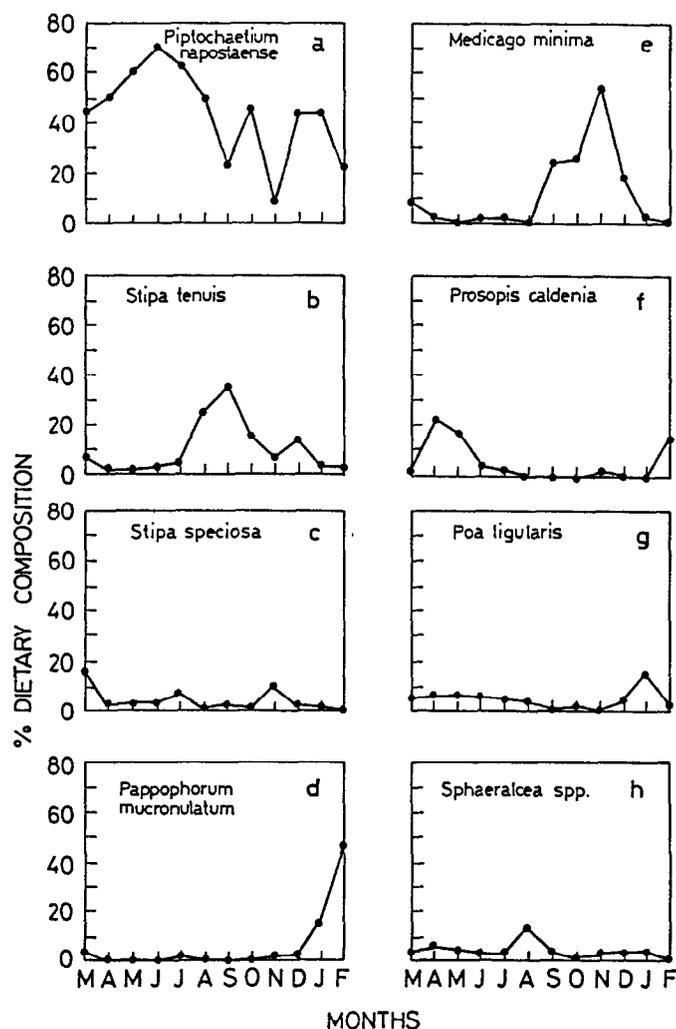

Fig. 2. Monthly variation of species with a contribution of more than 10% in any one month.

Caldén *(P. caldenia)* pod fragments were the only abundant woody materials found in the diets. There was a marked seasonal use (Fig. 2f) from mid-summer through late fall, with a peak of 23% in April. Caldén pods have been mentioned as an important forage resource and experimental work (Menvielle and Hernández 1985) has demonstrated their nutritive quality. However, consumption of caldén pods by free-ranging cattle, in terms of amount and season of use, has never been documented. Consumption of pods is also important because one of the mechanisms responsible for caldén dispersion and shrub encroachment in the Caldenal (Peláez et al. 1992) could be seed scarification through the digestive tract of cattle, and provision of an adequate habitat for seed germination in livestock manure.

Cattle diets have been reported to be more diverse with increased forage availability in late spring (Holechek et al. 1982). Monthly diversity of cattle diets (Fig. 3) decreased from March through June, the coldest month, and then increased until September. Monthly diversity of diets was relatively stable during the rest of the study period, except for November when the minimum diversity for the warmer months was reached; this was coincident with the maximum consumption of *M. minima.* Even though forage biomass was not measured in this study, it can be safely assumed that temperature and water conditions favorable for vegetation growth will increase forage availability. However, a significant correlation was found only between diversity and monthly average
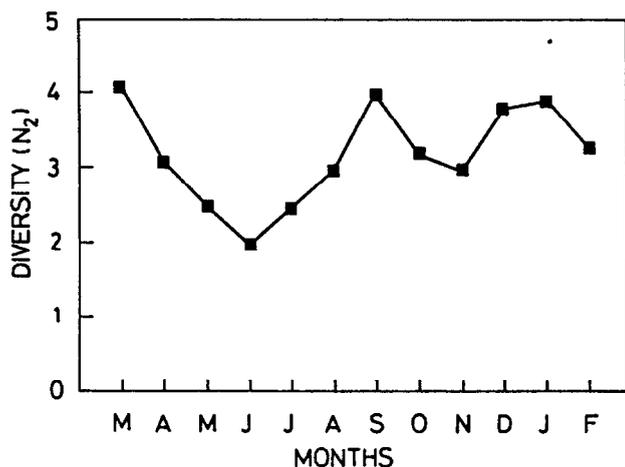
Fig. 3. Monthly diversity of diets calculated as the reciprocal of Simpson's index.

maximum temperature ($r_{x,y} = 0.73$, $P<0.01$) and not between diversity and rainfall. This suggests that diet diversity depends on phenological development as well as on forage availability, but the design of this study does not permit us to be more conclusive.

As McInnis et al. (1990) pointed out, there are no defined criteria to stop divisions in the cluster analysis procedure. Since the objective of this study was to analyze seasonal trends, the classification should relate to season. By cutting the tree in the range $31<ED_{jk}<53$ (Fig. 4) 3 clusters are formed (A, B, and C), and February is isolated from the rest behaving as an "outlier" (sensu Gauch 1982).
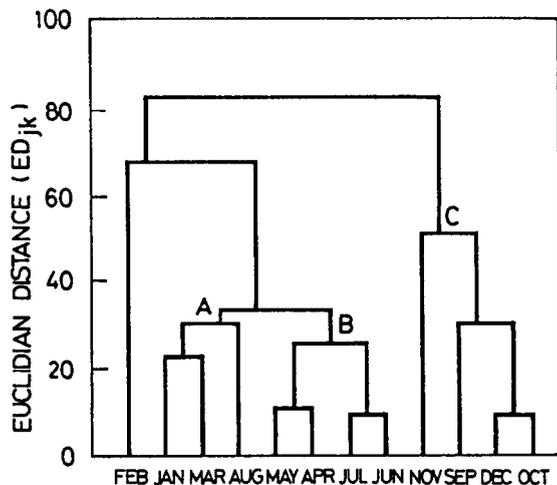

Fig. 4. Dendrogram resulting from classification of monthly diets. A, B, and C indicate defined diet clusters.

In February, almost half of the diet was *P. mucronulatum* making this month very different from the rest.

Cluster C groups all months from late winter through early summer when the highest consumption of forbs was detected, ranging from 24% to 61%. Diets in this cluster are characterized by higher abundance of *M. minima*, relatively higher content of *S. tenuis* and lower consumption of *P. napostaense* than in the other clusters. Within cluster differences seem to be due to the relative amounts of these species. Thus, November would be segregated from cluster C at $ED_{jk}<52$ with the highest abundance of *M. minima* and the least of *P. napostaense* for the entire study period.

Cluster B, which includes most of the fall and the first half of winter, has a high within-cluster homogeneity, or close proximity as measured by the ED_{jk} scale. This coincides with the period of

minimum diet diversity (Fig. 3). This cluster shows a well-defined seasonal grouping, including the months with the highest consumption of *P. napostaense*, and important contributions of caldén pods to the cattle diets.

Cluster A does not represent a single season, except that January and March are summer months. August showed the highest consumption of *Sphaeralcea* spp. and a relatively high consumption of *S. tenuis*.

The cophenetic correlation coefficient ($r_{x,y} = 0.71$) was relatively low, indicating a certain distortion between the resemblance matrix and the classification procedure, but it does not provide any indication of the nature of such distortion. The use of classification and ordination on the same set of data is recommended (Gauch 1982) as they are considered complementary. Ordination may be useful in the interpretation of clusters and the orthogonal axes are adequate to explore relationships between the data and environmental variables.

Regression analysis of temperature and rainfall on the axes from DECORANA yielded a significant relationship between the first axis and rainfall ($r_{x,y} = 0.64$, $P<0.05$), and between the second axis and monthly average maximum temperature ($r_{x,y} = 0.58$, $P<0.05$). These results suggest that rainfall has a greater influence on the seasonal trends of cattle diets than does temperature.

Results from DECORANA are summarized in Figure 5 prepared with the first 2 axes of the ordination, with corresponding eigenvalues of 0.38 and 0.08. Clusters produced by the classification are also shown in the figure. There is a close grouping of
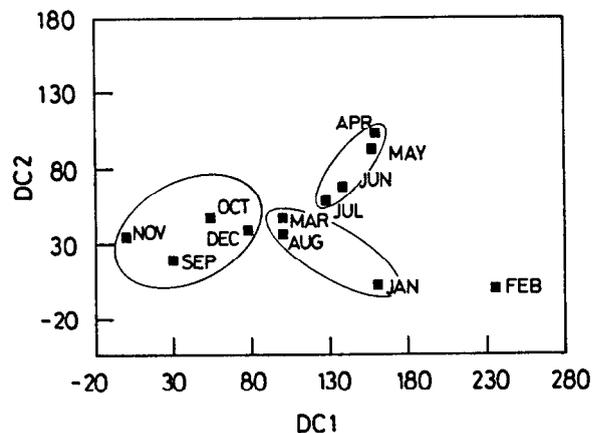

Fig. 5. Distribution of monthly diets in the space defined by the first 2 axes from DECORANA (DC1, DC2). Circled months indicate clusters defined in the classification procedure.

months in cluster B (see Fig. 4) confirming results from the classification. Cluster C, less homogeneous than cluster B, is also evident in the figure. Cluster A, which groups January, March, and August, is heterogeneous as compared to clusters B and C. Of course, this heterogeneity is relative to the total heterogeneity in the data which is indeed very low as the range of the first axis from DECORANA, explaining most of the variation in the data set, covers only 240 units. Two samples separated by 400 units in the axes would have no species in common. Cluster A covers a range of 61 units on the first axis denoting an intrinsically high homogeneity. Perhaps a relatively low cophenetic correlation indicating some distortion could be due to the proximity of March and August to samples in clusters B and C. In addition, considering scores on the first axis, there is not a clean separation between clusters A and B mainly due to the position of January. This month, with a relatively high content of *P. mucronulatum*, is the closest to February. The ordination also shows the separation of the February diet from the diets for the rest of the study period. It

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can be concluded that the ordination confirmed the grouping and seasonal trends from the classification and provided a better understanding of relationships among clusters.

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