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Diets of 3 cattle breeds on Chihuahuan Desert rangeland

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Abstract

Diet botanical composition, fecal nitrogen percent, and fecal phosphorus percent were determined seasonally during 1991 and 1992 for 3 cattle breeds (Barzona, Brangus, Beefmaster) grazing late-seral Chihuahuan Desert rangeland in southcentral New Mexico. These 3 cattle breeds are considered to be well adapted to harsh environments. Cattle breed main effect was non-significant ($P > 0.05$) for diet botanical composition. However, season main effects ($P < 0.05$) did occur for some diet botanical composition components. Total grasses in cattle diets were highest in January and lowest in June. Dropseeds (*Sporobolus* sp.), black grama (*Bouteloua eriopoda* Torr.), and threeawns (*Aristida* sp.) were the primary grasses consumed by cattle. Forb consumption was highest in June lowest in January. Honey mesquite (*Prosopis glandulosa* Torr.) consumption by cattle was highest in August and lowest in January. It was the primary shrub in cattle diets. Breed × season interactions ($P < 0.05$) occurred for a few diet botanical composition components, but the small magnitude of the values and lack of consistency prevented drawing definite management implications. Fecal nitrogen values showed differences ($P < 0.05$) among breeds in some seasons. However due to lack of consistency no definite conclusions could be drawn regarding superiority of 1 breed compared to another in diet nutritional quality. Both fecal nitrogen and phosphorus concentrations showed cattle diets to be lowest in quality in winter and highest in summer. From a practical standpoint, this study showed no definite advantage of any breed studied in diet botanical composition or in diet quality.

Key Words: ruminants, forage, nutrition, grazing management, cattle breeding

Resumen

La composición botanica de la dieta, el porcierto de nitrogeno fecal, y el porcierto de fósforo fecal fueron determinados en diferentes epocas del año durante 1991 y 1992 para tres razas de ganado (Barzona, Brangus, Beefmaster) en pastizales en buenas condiciones en la región centro-sur del estado de Nuevo México. Se considera que estus tres razas esta bien adaptadas a las severas condiciones del medio ambiente. El efecto medio de la raza sobre la composición botanica de la dieta no fue significativo ($P > 0.05$). Sin embargo, la época del año afectaron ($P < 0.05$) algunos compoenetes de la composición botanica de la dieta. La cantidad de pastos en la dieta fue mas alta durante Enero y mas baja en Junio. Los principales pastos consumidos fueron zacaton (espp. *Sporobolus*), navajita megra (*Bouteloua eriopoda* Torr.), y tred aristas (espp. *iAristida*). El consumo de hierbas fue mas alto durante Junio y mas bajo en Energo. El consumo de mesquite (*Prosopis glandulosa* Torr) fue mayor en Agosto y menor en Enero. Mesquite fue el principal arbusto consumido por el ganado. Interacciones entre raza × epoca del año ($P < 0.05$) ocurrieron solamente para algunos componentes de la dieta, pero la pequeña magnitud de los valores y la falta de consistencia impiden derivar implicaiones de manejo defnitivas. Los valores de nitrogeno fecal mostraron diferencias ($P < 0.05$) entre razas en algunas epocas del año. SIn embarog, debido a la falta de consistencia no se pudo concluir sobre la ssuperiordad de una raza en calidad nutricional de la dieta. Las concentraciones de nitrogeno y fósforo fecal nostraron una inferior calidad dietetica durante el invierno y superior durante el verano. Desde un punto de vista practico, este estudio no mostro ninguna ventaja definitiva de alguna de las razas en composición botanica de la dieta o en la calidad dietetica.

In the Chihuahuan Desert, large amounts of grazing land are required per animal unit due to low forage productivity (Holechek 1992, 1996). Under these conditions investment in fence and watering points to improve grazing distribution must be minimized to improve the economic viability of livestock grazing (Holechek 1992). However Chihuahuan Desert ecosystems are very susceptible to damage from spot overgrazing and(or) species selectivity by grazing beef cattle (Paulsen and Ares 1962). Research by Herbel and Nelson (1966a, 1966b) and Winder et al. (1996) has indicated breed selection may be a mechanism to achieve more uniform utilization of Chihuahuan Desert range sites and forage plants.

Research on diet selectivity comparisons among breeds of cattle is limited. In eastern Colorado, Walker et al. (1981) observed no important differences among diets of Hereford, Hereford × Charolais, and Hereford × Angus cattle. However, Herbel and Nelson (1966b) observed some important differences between diets selected by Hereford and Santa Gertrudis cows in the Chihuahuan Desert. In another Chihuahuan Desert study Winder et al. (1996) found important breed differences among Hereford, Angus, and Brangus cattle. Brangus cows had a stronger prefer-

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ence for shrubs than either Hereford or Angus cows. Brangus cows also showed a greater preference for dropseeds (*Sporobous* sp.) than Hereford or Angus cows. It was concluded that genetic composition of the animal is an important factor determining the utilization of key forage species on Chihuahuan Desert ranges.

Today, more than 85 breeds of cattle are known to exist in the U.S. (Taylor 1994). This represents a tremendous reservoir of germplasm and potential genetic variation. Range forage utilization might potentially be improved through selection of cattle breed (Winder et al. 1996). The objectives of our study were to evaluate diet botanical composition and fecal nitrogen and phosphorus concentrations of 3 breeds of cattle (Barzona, Brangus, Beefmaster) during different seasons and years on Chihuahuan Desert rangeland in southcentral New Mexico.

Materials and Methods

Study Area

The study area (3,130 ha) used for this experiment is located on the NMSU Chihuahuan Desert Rangeland Research Center (CDRRC) 37 km north of Las Cruces, New Mexico in Dona Ana County. It is in the southern portion of the Jornada del Muerto Plains between the San Andres Mountains to the east and the Rio Grande Valley to the west. Elevation varies from 1,188 to 1,371 m with level or gently rolling hills.

Soils of the study site are mainly light loamy sandy loams underlain by calcium carbonate hardpan (caliche) at depths varying from a few centimeters to 1 m or more (Valentine 1970). In areas where the ground cover is sparse, sand dunes are formed around invading mesquite plants (Wood 1969).

The climate on the CDRRC is arid with an average frost-free period of 200 days. The only permanent water sources are wells and pipelines used to water livestock. Temperatures are high in summer, with a mean maximum of 36°C during June, and a mean maximum of 13°C during January (Pieper and Herbel 1982). Diurnal variation in temperature is often 20°C. The annual precipitation is bimodal with peaks in January and August. The total annual precipitation in 1991 was 410 mm (171% of $\bar{x}$) and 395 mm (165% of $\bar{x}$) in 1992 (Table 1).

Table 1. Monthly precipitation (mm) during the study on the Chihuahuan Desert Range Research Center in southcentral New Mexico.

Month	1991	1992	1930–1990 Average
		(mm)	
January	10.7	40.4	11.9
February	12.0	3.6	10.4
March	17.1	6.7	6.3
April	0.0	20.6	5.4
May	4.7	79.4	8.3
June	4.8	11.7	12.2
July	91.3	26.5	43.0
August	65.2	102.9	48.4
September	63.6	11.7	38.3
October	0.0	32.2	23.3
November	24.8	12.5	13.7
December	114.7	46.4	17.8
Total	408.9	394.6	239.0

Primary grass species on our study pasture include black grama (*Bouteloua eriopoda* Torr.), dropseeds (*Sporobolus* sp.), threeawns (*Aristida* sp.), bush muhly (*Muhlenbergia porteri* Kunth.), fluffgrass (*Erioneuron pulchellum* Tateoka), and tobosa (*Hilaria mutica* Buckley). The most commonly encountered shrub species is honey mesquite (*Prosopis glandulosa* Torr.) which dominates the overstory (Pieper and Herbel 1982). Other shrubs commonly found are snakeweed (*Gutierrizea sarothrae* Pursh), souptree yucca (*Yucca elata* Av.), creosote (*Larrea tridentata* [Pursh] Nutt.), and fourwing saltbush (*Atriplex canescens* [Push] Nutt.). Leatherweed croton (*Croton pottsii* Lam.) is the primary forb occurring on the CDRRC and is an important food for livestock and pronghorn. Data on forage standing crop, relative plant cover, ecological condition, and forage use for the study area were collected in 1991 and 1992 by Smith et al. (1994). We have used data from Smith et al. (1994) on standing crop and relative cover in Table 2.

Ecological condition of the study area is late seral (good) with about 65% remaining climax vegetation using the quantitative climax approach (Dyksterhuis 1949) based on standing crop and cover data (Smith et al. 1994). Utilization of key forage species (black grama, mesa dropseed) by cattle during the study period (1991, 1992) was 25–35% (Smith et al. 1994).

Table 2. Vegetation botanical composition on the study area and mean cattle diet botanical composition for data pooled across seasons and cattle on good condition Chihuahuan Desert rangeland.

	Vegetation composition		Cattle diet composition[3,4]		
	Standing crop[1]	Relative cover[2]	Barzona	Brangus	Beefmaster
	(kg/ha)	(%)	(%)		
Grasses:					
Black grama	240	26	13.9	13.8	16.2
Dropseeds	213	21	28.2	28.0	28.1
Threeawns	175	10	18.3	16.5	17.9
Tobosa	t	t	3.8	3.9	3.4
Fluffgrass	t	t	1.4	1.2	1.8
Lovegrass	t	t	0.2	0.1	0.1
Muhly	t	t	5.9	6.9	6.1
Vine mesquite	t	t	0.3	0.1	0.2
Other grasses	31	2	3.8	4.1	4.2
Total grasses	659	59	75.7	74.6	78.0
Forbs:					
Leatherweed croton	10	t	6.3	7.4	5.1
Globemallow	3	t	3.3	2.6	2.3
Other forbs	8	2	6.2	6.6	6.2
Total forbs	21	2	15.8	16.6	13.6
Shrubs:					
Broom snakeweed	246	15	0.1	0.0	0.0
Honey mesquite	NS	18	6.0	4.9	4.6
Soaptree yucca	NS	5	1.6	2.8	1.1
Mormon tea	NS	t	0.5	0.7	0.5
Total shrubs	NS	38	8.2	8.4	6.2

[1]Data pooled across fall 1991, spring, and fall 1992 (Smith et al. 1994).
[2]Data pooled across spring 1992, and fall 1992 (Smith et al. 1994).
[3]Data pooled across August 1991, November 1991, January 1992, June 1992, and November 1992.
[4]There were no significant ($P > .05$) breed effects for any component of cattle diet botanical composition.
NS = Not sampled.
t = trace

Experimental Animals

The 3 breeds of cows used in this study were Barzona, Brangus, and Beefmaster. Barzona cattle have a red color and are a combination of Hereford, Angus, Santa Gertrudis, and Africander breeds (Ensminger 1976). Brangus cattle include 5/8 Angus + 3/8 Brahman and are characterized by black color, moderate size, and moderate milk production. Beefmaster include 1/4 Hereford, 1/4 Shorthorn, and 1/2 Brahman (Ensminger 1976). Cows used in the study were 1–2 years of age. They calved in the spring (March–April of 1992) and calves were weaned in the fall (October).

There were 5 periods of fecal sampling: August 1991, November 1991, January 1992, June 1992, and November 1992. Cattle used in this study were a subsample of a larger population (50 animals per breed) that was used to evaluate productivity of Brangus, Barzona, and Beefmaster cattle (Winder and Bailey 1995). In each sampling period 30 cows (10 cows per breed) were used for fecal sampling with the exception of the last period (November 1992) when only 18 cows (6 cows per breed) were sampled. The same 30 cows were used for sampling throughout the experiment. Cattle were moved to the corrals early in the morning of each collection date. Fecal grab samples were collected between 9 a.m. and 12 p.m. After sampling, cows were returned to the pasture.

Laboratory Methods

Samples were dried at 50°C on a forced air oven for 72 hours. Feces were then ground in a micro-Wiley mill with a 1-mm screen. Dry matter and ash content were determined using standard procedures (AOAC 1984). The Kjeldahl method was utilized to obtain nitrogen content in feces (AOAC 1984). The Spectrophotometric calorimetric system was used to determine phosphorus concentration (AOAC 1984).

Dietary composition was determined using fecal microhistological procedures (Holechek et al. 1984). Five slides were prepared from each sample using the method developed by Sparks and Malechek (1968), as modified by Holechek (1982). Hoyer solution was used as the mounting medium. Two tablespoons of ground sample were soaked in 20 ml hot water for 10 minutes to soften cell tissues, drained and rinsed in a 200 mesh tyler standard screen. Next, the sample was soaked in 20 ml chlorine bleach for 5 minutes to remove pigments and nondiagnostic particles, then rinsed again. Bleach was rinsed from the sample to avoid latent lightening of fecal material. The sample portion was drained and spread on microscope slides.

Slides were analyzed systematically with a compound, phase-contrast binocular microscope until 100 fragments were identified and quantified by point sampling on pre-determined stops (Holechek and Vavra 1981, Holechek and Gross 1982b). The observer was trained with formulated diets using procedures by Holechek and Gross (1982a). Size and shape of stomata, general cell patterns and structural peculiarities were used to distinguish cell tissues (Baumgartner and Martin 1939). Frequency addition procedures described by Holechek and Gross (1982b) were used to calculate the percentage composition of digested dietary components in the feces. Plant composition was categorized by species when possible. In some cases, however, only genera could be determined.

Statistical Analyses

Statistical analyses were conducted using ANOVA and GLM procedures of SAS (1988). Plant species, forage classes, and chemical components of feces were analyzed in a repeated measures design with cattle breeds and seasons as main effects. Botanical and chemical components of feces were analyzed using GLM procedures to detect differences among breeds, season and/or interactions. The LSD test was used to separate the means at the 5% significance level (Steel and Torrie 1980).

Results and Discussion

Diet Botanical Composition

Cattle breed main effects were not significant ($P > 0.05$) for any diet botanical composition component (Table 2). However season main effects (Table 3) and breed × season interactions ($P < 0.05$) did occur for some diet components.

Cattle diets were dominated by perennial grasses, primarily black grama, threeawns, and dropseeds which were also primary plants in the standing crop (Table 2). Shrubs accounted for 38% of the plant canopy cover on the study area but comprised only 8% of mean cattle diets (Table 2). Cattle showed a preference for forbs based on consumption relative to availability. Other cattle diet studies in the Chihuahuan Desert have shown cattle prefer forbs with some avoidance of shrubs in most seasons (Hakkila et al. 1987, Daniel et al. 1993, Smith et al. 1994). Leatherweed croton has consistently been important in cattle diets.

Significant ($P < 0.05$) seasonal shifts occurred in cattle diet botanical composition (Table 3). Grass consumption was highest in winter and lowest in spring and summer. Cattle consumed primarily dropseeds, black grama and threeawns in the winter. This is in agreement with other cattle food habit studies from good

Table 3.Seasonal cattle diet botanical composition main effects (data pooled across cattle breeds) on good condition Chihuahuan Desert rangeland.

	August 1991	November 1991	January 1992	June 1992	November 1992
Blackgrama	11.4[b]	11.9[b]	22.2[a]	15.0[b]	12.3[b]
Dropseeds	34.7[a]	26.0[b]	32.0[a]	22.5[a]	25.3[b]
Threeawns	17.4[b]	19.0[b]	21.4[a]	12.0[c]	17.8[b]
Tobosa	0.2[c]	9.6[a]	1.2[c]	6.4[b]	1.0[c]
Fluffgrass	1.7	1.1	2.3	1.2	1.0
Lovegrass	0.0	0.0	0.2	0.0	0.2
Muhly	0.2[d]	15.6[a]	4.8[c]	0.7[d]	10.0[b]
Vine mesquite	0.0	0.0	1.1	0.0	0.0
Other grasses	3.5	3.4	5.2	4.2[e]	3.8[c]
Total grasses	69.1[d]	87.3[b]	90.4[a]	62.1[e]	71.9[d]
Forbs:					
Leatherweed croton	9.3[a]	3.9[b]	2.9[b]	10.6[a]	4.7[b]
Globemallow	2.0[b]	0.5[b]	0.5[b]	8.5[a]	2.3[b]
Other forbs	6.9	2.8	2.3	8.9	9.7
Total forbs	18.2[b]	7.2[c]	5.7[c]	28.0[a]	13.7[b]
Shrubs:					
Broom snakeweed	0.3	0.1	0.0	0.0	0.0
Honey mesquite	10.6[a]	2.6[d]	0.7[d]	4.9[c]	7.1[b]
Soaptree yucca	0.8[b]	2.0[a]	2.6[a]	0.9[b]	2.8[a]
Mormon tea	0.7	0.4	0.5	0.8	0.5
Total shrubs	12.4[a]	5.1[bc]	3.8[c]	6.6[b]	10.4[a]

*Means within rows with different superscripts are significantly different ($P < 0.05$).

condition Chihuahuan Desert rangelands (Rosiere et al. 1975, Daniel et al. 1993, Smith et al. 1994). Cattle diets were highest in forbs in summer and lowest in winter (Table 3).

Shrub consumption by cattle in our study was greatest in summer and lowest in winter. Other Chihuahuan Desert cattle diet studies have been inconsistent regarding consumption of shrubs. Smith et al. (1994) found cattle diets were highest in shrubs in summer and fall while Daniel et al. (1993) found shrub use to be highest in winter. Rosiere et al. (1975) found shrub consumption was highest in spring. Shrub consumption is generally lower than grasses and forbs throughout the year (Hakkila et al. 1987, Daniel et al. 1993, Smith et al. 1994).

Honey mesquite was the most important shrub consumed by cattle in our study. It was most heavily used in the summer. Other studies on Chihuahuan Desert rangelands have generally shown honey mesquite to be the dominant shrub in cattle diets during spring and summer (Hakkila et al. 1987, Smith et al. 1994) with one inconsistency. Rosiere et al. (1975) found cattle made heavy use of soaptree yucca blooms during the spring.

Significant ($P < 0.05$) breed × season interactions occurred for some diet constituents. The importance of these interactions is difficult to interpret because of inconsistency among seasons and low magnitude of differences. Barzona cattle did consume more ($P < 0.05$) honey mesquite than Brangus or Beefmaster during summer 1991 (13%, 9%, and 9% of the diet, respectively). This may indicate they have greater potential to use honey mesquite than the other 2 breeds. Repeating this study on mid seral and early seral condition rangelands with higher shrub and lower grass levels would permit more thorough testing of shrub consumption by the 3 cattle breeds.

Fecal Nitrogen and Phosphorus

Breed main effects were not significant ($P > 0.05$) for either fecal nitrogen or phosphorus concentration. However season main effect was significant ($P < 0.05$) for both fecal nitrogen and phosphorus concentration (Table 4). A significant interaction ($P < 0.05$) occurred between breed and season for fecal nitrogen concentration.

Brangus had a higher ($P < 0.05$) fecal nitrogen concentration than Barzona in August (1991). However, an increase in diet quality was not confirmed by fecal phosphorus concentration. Therefore we doubt it has practical significance. Winder et al. (1996) found no difference in fecal nitrogen or phosphorus concentrations among Angus, Brangus, and Hereford cattle on New Mexico Chihuahuan Desert rangeland similar to that in our study. It appears there are no meaningful nutritional differences in diet selected by different cattle breeds in the Chihuahuan Desert. This, however, needs to be studied using other rangeland ecological condition classes and sites.

Fecal nitrogen and phosphorus concentrations in our study showed cattle diet quality was highest in spring and summer, lowest in winter, and intermediate in fall. This has been the general pattern of seasonal trend in cattle diet quality on the Chihuahuan Desert based on studies with fistulated animals and fecal chemical components (Hakkila et al. 1987, 1988, King 1991, King et al. 1993, Smith et al. 1994) with some exceptions due to climatic fluctuations (Rosiere et al. 1975).

Linear correlation and regression analyses showed significant ($P < 0.05$) correlations between fecal nitrogen and phosphorus concentrations. Correlation coefficients (r) for Beefmaster, Brangus, and Barzona cattle were 0.94, 0.90, and 0.83, respectively. Hakkila et al. (1988) also found fecal nitrogen and phosphorus concentrations were well correlated (r = .83) for cattle on Chihuahuan Desert rangeland.

Table 4. Fecal nitrogen and phosphorus concentrations for 3 breeds of cattle for 5 seasons on good condition Chihuahuan Desert rangeland.

Breed	Fecal nitrogen (OMB)[1,2,3]	Fecal phosphorus (OMB)[1,2,3]
August 1991 (Summer)		
Barzona	2.24b	0.31a
Brangus	2.67a	0.33a
Beefmaster	2.31b	0.31a
Mean	2.41A	0.32A
November 1991 (Fall)		
Barzona	1.35a	0.21a
Brangus	1.31a	0.20a
Beefmaster	1.34a	0.18a
Mean	1.33BC	0.20B
January 1992 (Winter)		
Barzona	1.15a	0.12a
Brangus	1.07a	0.13a
Beefmaster	1.09a	0.13a
Mean	1.10C	0.13C
June 1992 (Spring)		
Barzona	2.18a	0.33a
Brangus	2.48ab	0.33a
Beefmaster	2.85b	0.34a
Mean	2.50A	0.33A
November 1992 (Fall)		
Barzona	1.25a	0.15a
Brangus	1.35a	0.17a
Beefmaster	1.22a	0.16a
Mean	1.88AB	0.16C

[1]OMB = organic matter basis.
[2]Means for cattle breeds within columns and seasons with different small letters are different ($P < 0.05$).
[3]Means for seasons within columns with different capital letters are different ($P < 0.05$).

Concentrations of nitrogen in the feces are related to the nutritional status of the ruminant animal (Moir 1960, Holechek et al. 1982, Squires and Siebert 1983, McCollum 1990). The concentration of nitrogen in the fecal organic matter of ruminants shows a strong linear association with diet crude protein content (Moir 1960, Holechek et al. 1982, Hakkila et al. 1988, McCollum 1990). Weight changes by cattle have also been correlated with fecal nitrogen concentration (Holechek et al. 1982, Squires and Siebert 1983). Diet and fecal phosphorus concentrations are also strongly correlated for cattle (Moir 1960, Holechek et al. 1985). On Chihuahuan desert rangeland similar to that in our study, Hakkila et al. (1988) found both fecal nitrogen and fecal phosphorus concentrations were well correlated with diet crude protein concentrations (r = .81 and r = .92, respectively).

Studies conducted and reviewed by Nunez-Hernandez et al. (1992) show that animals consuming browse diets high in essential (volatile) oils or tannins can have elevated fecal nitrogen levels relative to diet nitrogen values. However, cattle and sheep on most ranges generally will starve before consuming forages high in essential oils and/or tannins. Browse species palatable to cattle and sheep generally do not cause elevated fecal nitrogen values (Holechek et al. 1982, Arthun et al. 1992, Rafique et al. 1992). The primary plant species consumed by cattle in our study have

low levels of essential oils and tannins (Arthun et al. 1992, Rafique et al. 1992).

Management Implications

Our study showed little difference in diet botanical composition and fecal nitrogen and phosphorus concentrations among Barzona, Beefmaster, and Brangus cattle over a 2-year period on good condition Chihuahuan Desert rangeland. Although significant ($P < 0.05$) breed × season interactions did occur for a few diet botanical composition components, their practical importance is doubtful due to low magnitude and lack of consistency among seasons. Our results are somewhat inconsistent with Herbel and Nelson (1966b) and Winder et al. (1996) who indicated cattle breeds do have differences in diet selection that are of practical importance. Winder et al. (1996) found Brangus cattle had higher shrub consumption in winter than Hereford or Angus cattle on Chihuahuan Desert rangeland similar to that in our study. They also found Angus consumed more forbs in summer than Hereford or Brangus cattle.

All breeds in our study are "synthetic" containing at least some Brahman influence. These breeds were developed in hot arid (Barzona) or hot humid (Brangus, Beefmaster) climates. It is conceivable that adaptations to semidesert environment may be similar among these breeds. Thus, differences observed by Herbel and Nelson (1966b) and Winder et al. (1996) in studies of biologically diverse breeds may not be present in this study population.

We also believe differences among breeds in our study might have been observed if the study were to be repeated on rangeland lower in ecological condition with more shrubs. During summer 1991, Barzona consumed more honey mesquite than Brangus and Beefmaster cattle indicating they may have some potential to improve use of rangelands with a high mesquite component.

Initial results from the population of Brangus, Beefmaster, and Barzona cattle being studied on the CDRRC have shown Beefmaster cows produced more calf weaning weight than Brangus or Barzona cows (Winder and Bailey 1995). Individual animal behavior and physiology rather than diet botanical composition and quality would appear to explain any productivity differences that exist among the cattle breeds we studied.

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