Seasonal Fluctuations in Nutrient Content of Feral Burro Forages, Lower Colorado River Valley, Arizona

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Highlight: Nutrient contents of wooly Indianwheat, white bursage, desertthorn, and foothills paloverde were determined seasonally during 1974 and 1975 in the Havasu Resource Area, California-Arizona. Gross energy content showed the least seasonal variation. Crude protein, phosphorus, and β-carotene contents increased during the pulse of growth produced by winter precipitation, then slowly declined. Although the forage species analyzed appeared to be deficient in phosphorus, feral burros in the study area appear to be in excellent health.

Determination of carrying capacity of desert ranges for feral burros (*Equus asinus*) has recently become a major concern of land managers in the southwestern United States. However, the feral burro has received little scientific attention, and ecological investigation of animal-forage relationships has concentrated on more productive rangelands. In 1974, studies were initiated in the Havasu Resource Area, Lower Colorado River Valley, California-Arizona, investigating feral burro population parameters (Woodward 1976) and carrying capacity relationships (Hanley 1976).

Forage quality has a direct bearing on the quantity of forage that must be consumed to meet animal nutritional requirements. Nutritional studies of browse species in Arizona have involved mule deer (*Odocoileus hemionus*) forages, particularly in the chaparral vegetation type (Swank 1956; Reynolds 1967; Urness 1969; Urness and McCulloch 1973). Hot desert shrub species have received little attention. Woodward and Ohmart (1976) have reported results of fecal analysis of feral burros, and Watkins (1976) has determined in vitro digestibility of major forage species. In the present study, seasonal fluctuations in nutrient content of four major forage species for feral burros were investigated.

Study Area and Methods

The study was conducted in the Havasu Resource Area, 27 km north of Parker,

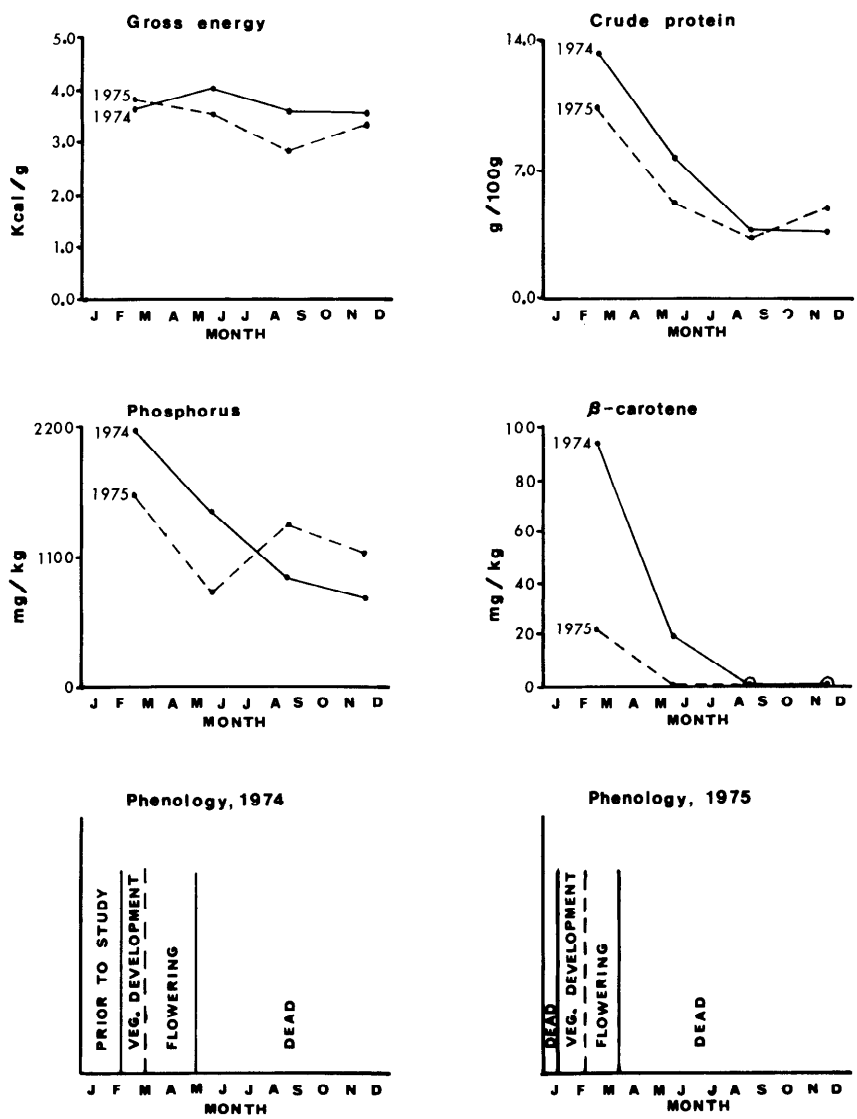

Fig. 1. *Seasonal fluctuations in nutritional quality and phenology of* Plantago insularis *in lower Colorado River Valley, Arizona (1974-75).*

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Arizona. The study area is a gentle sloping alluvial plain draining into the Colorado River at Lake Havasu. Soils are entisols and aridisols, ranging in texture from sand to sandy loam.

Vegetation of the washes is dominated by foothills paloverde (*Cercidium microphyllum*), white bursage (*Ambrosia dumosa*). cheesebush (*Hymenoclea salsola*), and creosotebush (*Larrea tridentata*). The interfluves are sparcely vegetated with creosotebush and scattered cholla (*Opuntia* spp.) plants. Riparian vegetation, dominated by saltcedar (*Tamarix* spp.), mesquite (*Prosopis juliflora* and *P. pubescens*), and arrowweed (*Pluchea sericea*), fringes the lake shore at the mouths of the washes. Perennial grasses are absent from the flora. Herbaceous cover varies with precipitation, but is dominated by the winter annual, wooly Indianwheat (*Plantago insularis*).

Elevation of the study area ranges from 140 m to 330 m above sea level. Mean annual precipitation at Parker, Ariz., is 116 mm. Ambient air temperatures generally range from winter lows around 0°C to summer highs around 42°C. The summers of 1974 and 1975 were particularly dry; only 70.1 mm of precipitation occurred in 1975.

Nutrient evaluation of forage on most rangeland can be based on protein, energy, phosphorus, and carotene contents of the forage species (Cook 1972). Preliminary reconnaissance in February, 1974, indicated burro use of four major forage species, wooly Indianwheat and the woody perennials desertthorn (*Lycium andersonii*), foothills paloverde, and white bursage.

Nutrient contents were determined at the end of February, May, August, and November. Wooly Indianwheat was clipped at ground level. Live stems of white bursage, desertthorn, and foothills paloverde were clipped within 15 cm of the apical meristems. All samples were collected from several individuals. Forage samples were refrigerated until ground in a Wiley mill and analyzed for gross energy with an adiabatic calorimeter, crude protein (Chapman and Pratt 1961), phosphorus (Chapman and Pratt 1961), and β-carotene (Association of Vitamin Chemists 1966) contents on an oven-dry weight basis. Data was collected over the 2-year period of February, 1974, through November, 1975.

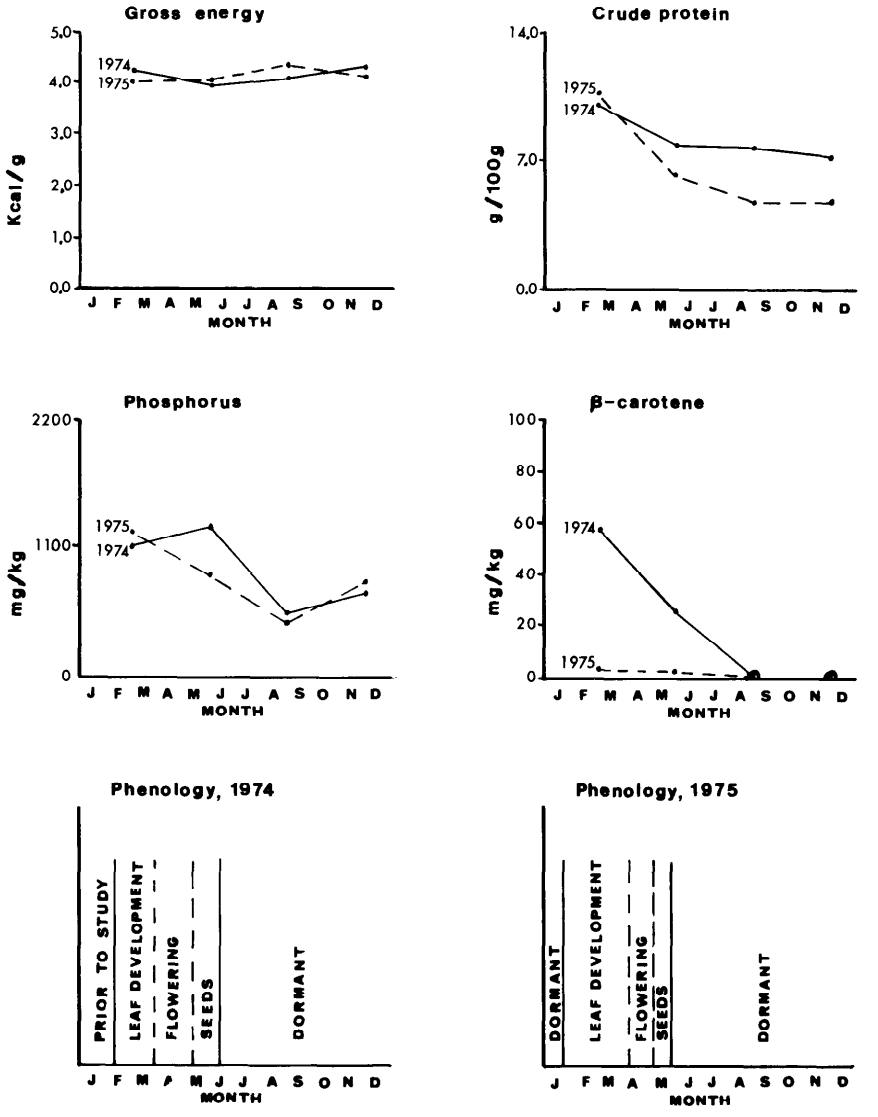

Fig. 2. *Seasonal fluctuations in nutritional quality and phenology of* Ambrosia dumosa *in lower Colorado River Valley, Arizona (1974-75).*

Results and Discussion

Changes in nutritional quality generally paralleled changes in phenology (Figs. 1, 2, 3, and 4). Gross energy content was the least variable on a seasonal basis. Crude protein, phosphorus, and β-carotene contents tended to follow the pattern generally expected, with nutritional quality increasing following the pulse of growth produced by winter precipitation, then slowly declining.

Gross energy content was similar in all four species studied. Wooly Indianwheat had the lowest gross energy values which declined with age of the plant. Values of 4.0 and 5.0 kcal/g are similar to those reported for other forages (Dietz 1972; National Academy of Sciences 1971). However, gross energy values alone can be misleading if the forage is high in nondigestible essential oils, resins, or waxes (Cook 1972).

Protein is generally considered the most important nutrient because serious deficiencies result in failure of the body to maintain itself, and slight deficiencies interfere with normal reproduction, growth, and fattening processes (Morrison 1957). Crude protein content of the forages studied increased in the spring and decreased through summer, fall, and early winter. The range of values was greatest in wooly Indianwheat, as would be expected since it is an annual forb. Crude protein content in the summer and fall were similar to values reported for browse species in Arizona chaparral (Swank 1956; Reynolds 1967; Urness and McCulloch 1973), Arizona ponderosa pine forest (Urness et al. 1975), and the Black Hills of South Dakota (Dietz 1972). However, high values in the spring were lower than maximum values reported in the other vegetation types.

Both calcium and phosphorus are essential to skeletal growth and cellular function. Calcium supplies are generally adequate on western ranges in the United Sates (Morrison 1957). However, phosphorus deficiency in forage is widespread (Halls 1970). Phosphorus generally decreased in the summer and fall in the present study; but in foothills paloverde, maximum values were recorded in late November of both years. Morrison (1957) has recommended that feed given to cattle should contain not less than 1,700 mg/kg of phosphorus. No browse species analyzed in this study contained this amount of phosphorus. Only wooly Indianwheat during active growth met this requirement. All phosphorus contents of the browse species analyzed were considerably lower than values reported for browse species elsewhere (Swank 1956; Reynolds 1967; Dietz 1972; Urness and McCulloch 1973; Urness et al. 1975).

Animals require vitamins in only minute amounts; however, vitamin A deficiencies often occur on shrub ranges when the forage species are dormant (Dietz 1972). Vitamin A is necessary for ephithelial maintenance. Deficiencies interfere with successful reproduction, growth, eyesight, and normal functioning of the nervous system (Morrison 1957). Vitamin A is formed from β-carotene, which is present in green plant tissue.

β-carotene appeared to be the most sensitive to climatic conditions of the nutrients analyzed in this study. Greatest amounts were present in late winter, when growth was active. The content decreased as the seasons progressed, and β-carotene was available in minute quantities only in foothills paloverde and desertthorn in late summer and fall. β-carotene content was greatest in wooly Indianwheat in February, 1974 (94.4 mg/kg). Animals can store considerable amounts of vitamin A in the liver and body fat (Riggs 1940). β-carotene contents of the four forages analyzed were similar to those reported by the National Academy of Sciences (1971) for other common range forage species.

In vitro digestibilities of nine major forages used by feral burros in the Havasu Resource Area have been determined by Watkins (1976). Forage samples collected in September, 1975,

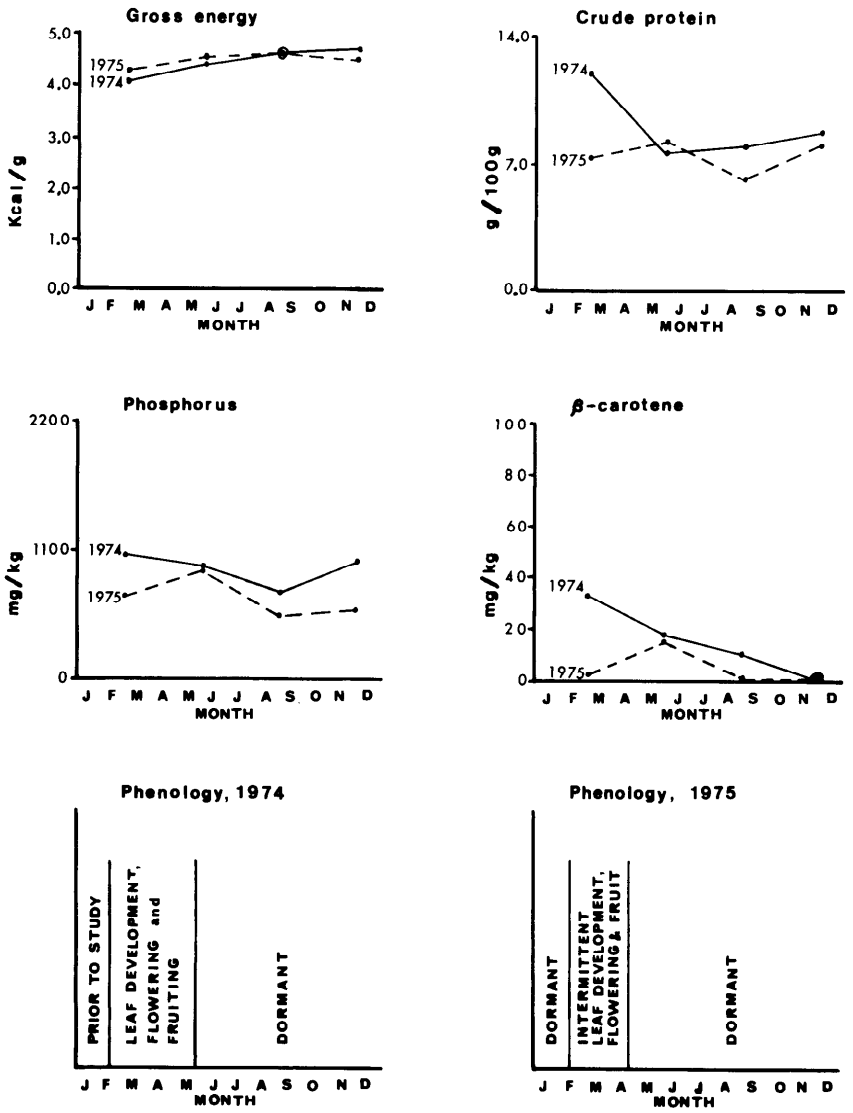

Fig. 3. *Seasonal fluctuations in nutritional quality and phenology of* Lycium andersonii *in lower Colorado River Valley, Arizona (1974-75).*

were digested with bovine rumen fluid. Digestibilities were 39.8, 35.3, and 51.4% for white bursage, desertthorn, and foothills paloverde, respectively. Cured wooly Indianwheat collected in September, 1975, was 59.4% digestible, while green material collected in February, 1976, was 89.4% digestible. The values determined for the Sepember collection were considered to be minimal digestibilities. These values compare favorably with those reported for Arizona chaparral browse species utilized by mule deer (Urness and McCulloch 1973). Furthermore, equines are able to utilize fibrous forage more efficiently than ruminants (Bell 1969; Wolter and Velandia 1970).

Conclusions

Green wooly Indianwheat appears to be an excellent forage, very rich in protein, phosphorus, and β-carotene, and is highly digestible. Its nutritive value decreases as it cures. Foothills paloverde and desertthorn may be sources of phosphorus and β-carotene in late summer and fall. White bursage appears to be intermediate, greater in nutrient value than the other browse species in the spring and less valuable than the others in the fall. Fecal analysis of feral burros in the Havasu Resource Area (Woodward and Ohmart 1976) has shown that wooly Indianwheat made up the bulk of feral burro diets from January through May. Foothills paloverde and desertthorn were used mostly in the fall, and white bursage was used primarily in the winter. Burros were dependent on the riparian habitat in the summer, and mesquite and arrowweed were major

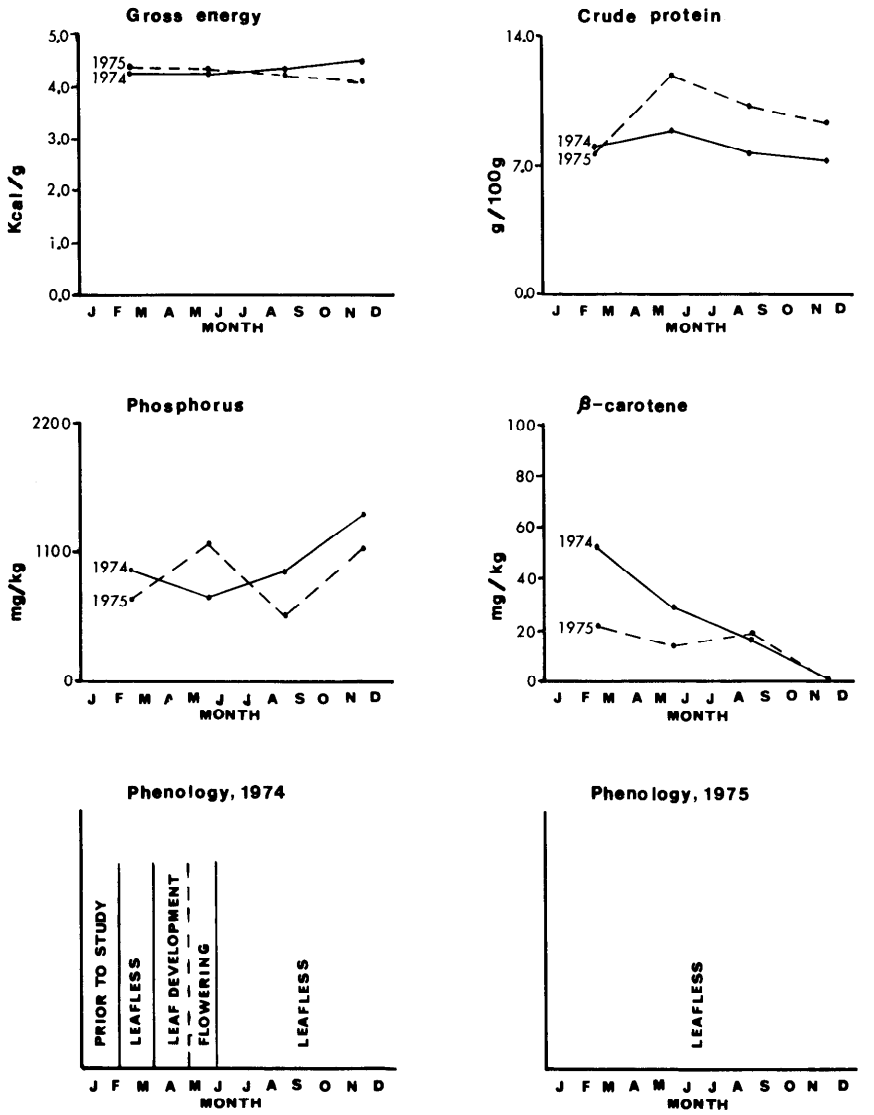

Fig. 4. *Seasonal fluctuations in nutritional quality and phenology of* Cercidium microphyllum *in lower Colorado River Valley, Arizona (1974-75).*

forage species at that time. Riparian vegetation was not investigated in the present study but is probably important in supplying carotene and possibly phosphorus in the summer months.

Protein and phosphorus are generally considered the critical nutrients in Arizona browse species (Swank 1956; Reynolds 1967; Urness 1969; Urness and McCulloch 1973). The forage species analyzed in the present study would be considered generally good to fair in protein content, poor in phosphorus content, and excellent to fair in digestibility, according to standards used by Urness and McCullock (1973) for Arizona deer forage.

Feral burros in the Havasu Resource Area appear to be in excellent health. Physical examination and analysis of blood samples from 90 immobilized burros and necropsies of three sacrificed burros have indicated no signs of malnutrition nor parasite infestations (R. D. Ohmart and E. Bicknell, personal communication). Woodward (1976) observed a burro population increase rate of 20 to 25% per 13- to 18-month period in a closely adjacent study area.

Although apparently adequate, nutrient quality of the desert forage species fluctuates seasonally, being greatest in late winter and spring, and lowest in fall and early winter. Riparian vegetation appears to be very important in the summer months, and its role in meeting the nutritional requirements of feral burros should be investigated.

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