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# Dietary Quality, Fecal Nitrogen and 2,6 Diaminopimelic Acid in Black-Tailed Deer in Northern California

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Range managers need easily measured indices of dietary quality to ensure high quality forage for deer. Levels of fecal nitrogen and fecal 2,6 diaminopimelic acid, which have been suggested as such indices, were monitored for two herds of black-tailed deer *(Odocoileus hemionus columbianus)* in northern California. Both values were highest in summer collections, suggesting high quality summer diets, and were lowest in winter collections. Nitrogen levels appeared to differ between herds, but the cause could not be determined. DAPA levels did not appear to differ between herds.

*Retrieval terms: Odocoileus hemionus columbianus,* black-tailed deer, fecal nitrogen, diaminopimelic acid

Deer are a valuable wildlife resource. For this reason, wildlife and range managers are concerned with the quality of forage available for deer. Because determining dietary quality for ruminants can be complex and expensive, managers need indices of dietary quality that are relatively easy to obtain.

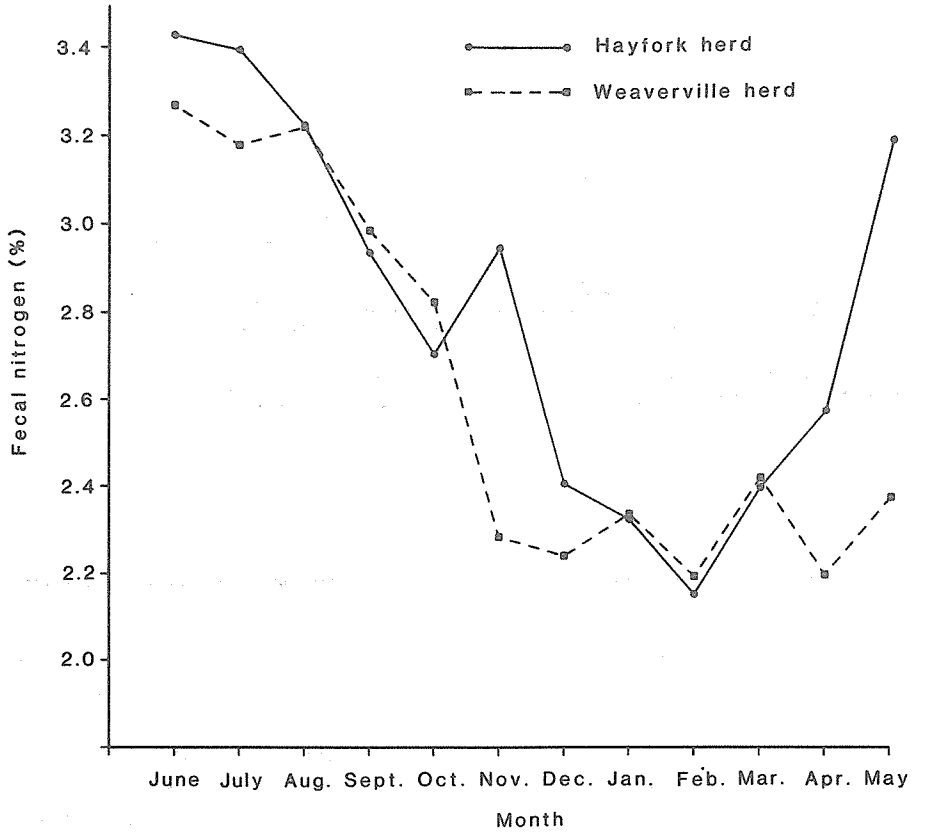
Nitrogen content of ruminant feces has been suggested as a measure of forage protein content and digestibility.[1] High fecal nitrogen content indicates high quality forage. However, fecal nitrogen concentration can be affected by interactions of various factors, including intake of dry matter[2] and phenolic compounds.[3]

A large proportion of the digestible energy used by ruminants results from the action of rumen bacteria on ingested matter and the production of volatile fatty acids; and most rumen bacteria contain 2,6 diaminopimelic acid (DAPA). Because concentrations of DAPA in rumen bacteria remain relatively constant, and because high populations of bacteria would be expected with high intake of digestible energy, Nelson and others suggested fecal DAPA as an index of digestible energy and forage quality.[4,5] However, variation in DAPA concentrations among strains of bacteria may limit its usefulness as an indicator.[6]

Few 12-month profiles of fecal nitrogen and none for fecal DAPA were found in the literature for deer. We, therefore, monitored fecal nitrogen and DAPA for two herds of migratory black-tailed deer *(Odocoileus hemionus columbianus)* in northern California. Nitrogen and DAPA were highest in summer during peak forage conditions and lowest in winter. DAPA levels did not differ between herds. Lower nitrogen levels for the Weaverville herd in early and late winter may reflect a poorer quality diet than that of the Hayfork herd. Further study is needed to relate fecal nitrogen and DAPA to seasonal range use, food habits, and forage quality.

## STUDY AREA AND METHODS

Sample pellet groups were collected on the seasonal ranges occupied by the Weaverville and Hayfork herds of black-tailed deer in Trinity County, California. Maps of the study area and descriptions of deer habitat are available elsewhere.[7] Monthly sampling began in June 1982 and concluded in May 1983. Each month, for each herd, three samples were collected from those seasonal ranges with the highest concentrations of deer. Each sample consisted of 3 pellets from each of 15 arbitrarily chosen fresh pellet groups, for a total of 45 pellets. Pellets were sent to Wildlife Habitat Management Services at Washington State University, Pullman, where they were analyzed for nitrogen and DAPA.[8]



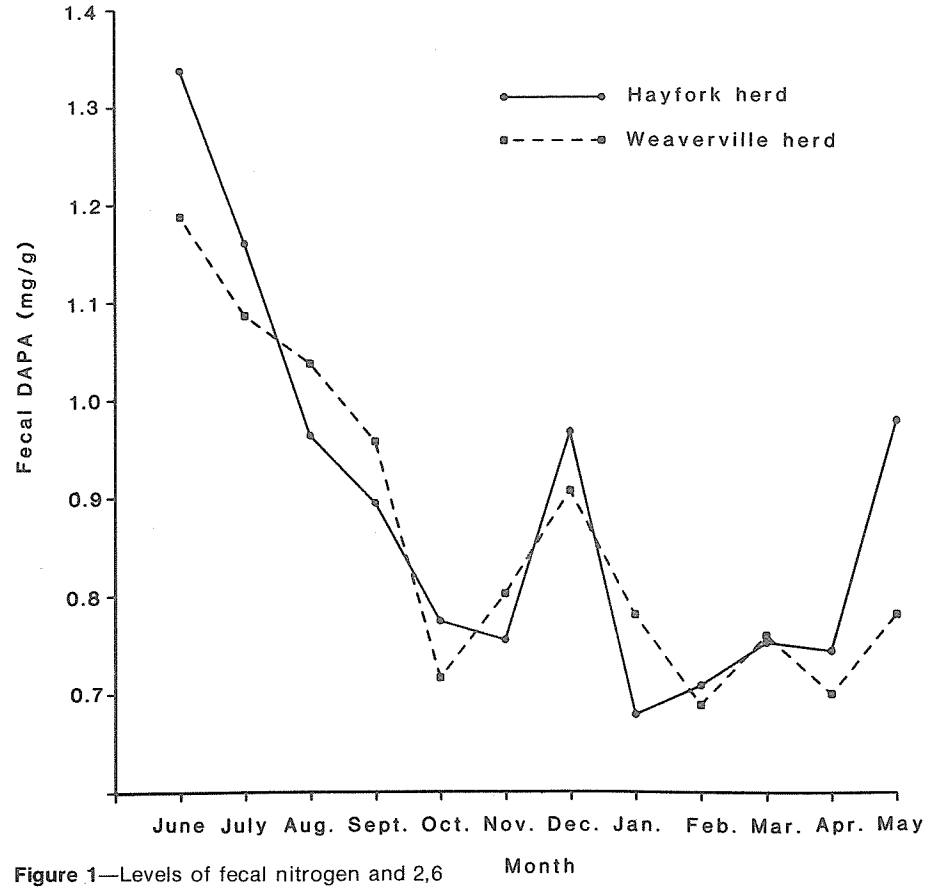




**Figure 1**—Levels of fecal nitrogen and 2,6 diaminopimelic acid (DAPA) were highest in summer when forage conditions were best.

## RESULTS AND DISCUSSION

### Nitrogen

Fecal nitrogen showed distinct monthly variations over the 12-month sampling period *(fig.1)*. Nitrogen levels were highest during summer, declined during fall, and reached a minimum in winter. Few differences were noted between herds; however, mean values appeared lower for samples collected on the summer range of the Weaverville herd in June and July 1982 and again in April and May 1983, compared with those from the Hayfork herd. Furthermore, fecal nitrogen levels appeared to reach a minimum earlier in winter for Weaverville deer and stay low longer into spring than did those for Hayfork deer.

Two hypotheses can be generated from these data.

- The lower fecal nitrogen values for Weaverville deer may reflect a poorer quality diet at some seasons of the year, particularly early and late winter. Deer collected from the Weaverville herd during winter 1979-80 were in poorer condition than were deer from the Hayfork herd,[9] and food habits differed between the herds.[10] Hayfork deer may consume higher quality forage in early winter and early spring either because of a greater availability of more nutritious forage on the winter range, or because they are able to spend more time on migratory ranges.

- Higher values for fecal nitrogen among Hayfork deer during some months may be the result of diets high in secondary plant compounds such as phenolics.[3] Hayfork deer diets in winter consisted of a higher proportion of Douglas-fir *(Pseudostuga menziesii)* and white fir *(Abies concolor)* than did Weaverville deer diets.[10] Douglas-fir needles are known to contain numerous secondary compounds that inhibit the action of rumen bacteria.[11]

Additional information is needed to confirm or reject these hypotheses.

### Diaminopimelic Acid

Fecal DAPA showed distinct monthly variations similar to fecal nitrogen *(fig. 1)*. DAPA levels were also highest during summer and lowest during late winter and early spring. No distinct differences in DAPA levels were noted between herds. An apparent secondary peak in DAPA during December, for both Weaverville and Hayfork deer, may have resulted from the consumption of acorns. Harlow and others[12] found that hand-composited white-tailed deer diets that included acorns were twice as high in digestible energy as were diets without acorns. Elsewhere in California, black oaks *(Quercus kelloggii)* and blue oaks *(Q. douglasii)* drop most of their acorns in October and November.[13,14] Although samples from deer rumens in late December-early January 1979-80 contained no acorns,[10] acorn drop can be highly synchronous,[13] and exact dates may vary from year to year. Furthermore, deer and other wildlife may consume most of the acorn drop over a period of only a few weeks.[13]

## CONCLUSIONS

Although nitrogen levels appeared to vary between herds and DAPA did not, levels of both were highest in summer—when forage conditions are at a peak—and may indicate high dietary quality. Further study is needed to relate seasonal range use, and food habits in particular, to fecal nitrogen and DAPA.

## NOTES

[1] Lancaster, R. J. *Estimation of digestibility of grazed pasture from faeces nitrogen.* Nature 163:330-331; 1949 February 26.

[2] Hutchinson, K. J. *Factors governing faecal nitrogen wastage in sheep.* Austr. J. Agric. Res. 9:508-520; 1958.

[3] Mould, Eric D.; Robbins, Charles T. *Nitrogen metabolism in elk.* J. Wildl. Manage. 45(2):323-334; 1981 April.

[4] Hutton, K.; Bailey, F. J.; Annison, E. F. *Measurement of the bacterial nitrogen entering the duodenum of the ruminant using diaminopimelic acid as a marker.* Brit. J. Nutr. 25:165-173; 1971.

[5] Nelson, Jack R.; Koes, Richard M.; Miller, William H.; Davitt, Bruce B. *Big game habitat management on a nutritional basis—a new approach.* 1982. Unpublished draft supplied by authors. (Presented at Western Elk Workshop, 1982 February 22-23, Flagstaff, AZ)

[6] Van Soest, Peter J. *Nutritional ecology of the ruminant.* Corvallis, OR: O & B Books, Inc.; 1982. 374 p.

[7] Kie, John G.; Burton, Timothy S.; Menke, John W. *Deer populations and reservoir construction in Trinity County, California.* Calif. Fish and Game 68(2):109-117; 1982.

[8] Czerkawski, Julian W. *Methods for determining 2,6-diaminopimelic acid and 2-aminoethylphosphonic acid in gut contents.* J. Sci. Food Agric. 25:45-55; 1974.

[9] Kie, John G.; Burton, Timothy S.; Menke, John W. *Comparative condition of black-tailed deer,* Odocoileus hemionus columbianus, *in two herds in Trinity County, California.* Calif. Fish and Game 70(2); 1984 April. In press.

[10] Kie, John G.; Burton, Timothy S.; Menke, John W.; Grenfell, William E., Jr. *Food habits of black-tailed deer,* Odocoileus hemionus columbianus, *in Trinity County, California.* Calif. Fish and Game 70(3); 1984 July. In press.

[11] Oh, Hi Kon; Sakai, T.; Jones, M. B.; Longhurst, W. M. *Effects of various essential oils isolated from Douglas fir needles upon sheep and deer rumen microbial activity.* Appl. Microbiol. 15(4):777-784; 1967 July.

[12] Harlow, Richard F.; Whelan, James B.; Crawford, Hewlette S.; Skeen, John E. *Deer foods during years of oak mast abundance and scarcity.* J. Wildl. Manage. 39:330-336; 1975.

[13] Bowyer, R. Terry; Bleich, Vernon C. *Ecological relationships between southern mule deer and California black oak.* In: Plumb, Timothy R., tech. coord. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1980:292-296.

[14] Menke, John W.; Fry, Michael E. *Trends in oak utilization—fuelwood, mast production, animal use.* In: Plumb, Timothy R., tech. coord. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1980: 297-305.

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