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Diet and Nutrition of the Pronghorn Antelope

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DIET AND NUTRITION OF THE PRONGHORN ANTELOPE

by

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

Pronghorn antelope (Antilocapra americana) in northwestern South Dakota consumed at least 32 different plants species. Major forage plants were big sagebrush (Artemisia tridentata), silver sage (A. cana), yellow sweet clover (Melilotus officinalis), gold aster (Chrysopsis villosa), and blue grama (Bouteloua gracilis). Cultivated small grain crops were not a major food source of pronghorn. Differences in diet composition, plant groups, plant groups and time of use and plant group, area, month interaction were significant.

Average in vitro digestion of 31 food plants was 51 percent. Mean digestion of grasses was 57 percent, forbs 42 percent, and shrubs 55 percent. Yearling male pronghorn needed 85.91 g/kg water and 123.17 kcal/kg to maintain themselves for one day.

The pronghorn antelope (Antilocapra americana Ord) is found only in North America from south central Canada south to northern Mexico (Burt and Grossinheider 1964). The historic range of the pronghorn included the Great Plains and the high sagebrush plateaus of the western United States (Yoakum 1968). Prior to 1800, there were 35 to 40 million antelope. Unrestricted hunting and habitat reduction reduced the population to between 13 and 20 thousand by 1900.

Pronghorn are a unique wildlife species which has been noted for keen eye sight and speed (Stone and Cram 1905, Cahalane 1961). They are the only surviving member of a large fossil group of pronghorn antelope type animals. All genera except Antilocapra have become extinct since the Pleistocene epoch. The genus has changed little in the last million years, and has no close relatives. Similar fossil forms have been found only in North America.

The objectives of my study were to determine what plant species antelope consumed, the digestibility of plants normally consumed, and the energy and water needs of yearling male pronghorn.

STUDY AREA

Harding County is located in northwestern South Dakota. The area is predominantly treeless, rolling, semi-arid plain with an average elevation of 1036 m. Forested buttes are found in the north central eastern, and southern parts of the county. Many smaller treeless buttes are scattered throughout the area (Visher 1914).

The county is well drained with no natural lakes. Standing water is limited to artificial stock dams and shallow ephemeral ponds. The county is drained by the Little Missouri, Grand, and Moreau Rivers. Rainfall averages 30 cm per year. Vegetation is primarily short grasses and herbs. Groves of cottonwoods (Populus occidentalis) occur along streams. The larger buttes are covered with Ponderosa pine (Pinus ponderosia).

METHODS

Food Habits Study

Fresh fecal material was collected from free ranging antelope in Harding County. Thirteen adjoining townships, ranges 5, 6, and 7 north, townships 17, 18, 19, and 20 east, plus township 16 north range 6 east, comprised the study area. The study area was homogenous in topography and plant cover with portions of the six northern townships planted to small grains, mainly wheat (Triticum aestivum).

Fecal collections were taken monthly between July 1976 and June 1977. Individual or groups of pronghorn were approached on foot by one or two observers. Field personnel kept the antelope under observation until one or more animals defecated; age, either juvenile or adult, and sex (Taber 1971) of each animal from which pellets were retrieved was recorded along with distance to the nearest small grain field.

Successful collections were made when field personnel were as close as 3 m or as far as 700 m from the antelope under observation. Identification of individual pellet groups was difficult between November 1977 and February 1978, when pronghorn were in groups. When confusion was possible, sex and age were listed as unknown. Sample size varied from 18 pellet groups in July to 34 in March (Table 1).

Searches for individual or groups of antelope were carried out in a systematic manner in strata based on distance from the nearest small grain crop, measured or estimated in whole statute miles

Table 1. Monthly sample sizes of fecal collections used in food habits study by sex and age.

	June	July	August	September	October	November	December	January	February	March	April	May	Total
Adult Males	2	6	6	4	1	0	2	1	5	6	3	15	52
Adult Females	4	15	12	6	4	3	2	4	13	25	22	9	119
Juveniles	0	7	10	2	1	0	1	0	7	1	0	1	30
Unknown	11	2	2	3	22	27	25	25	9	0	1	0	127
Total	18	30	30	15	28	30	30	30	34	32	26	25	328

(1.61 km). Collections were made in no section (1.61 km^2 area) more often than once each day. Ideally, observations and collections from pronghorn groups should have been made at different distances from small grain crops varying from 1 to 10 miles (1.6 to 16.1 km) during each sample period. It was not always possible to locate antelope in 10 unique strata each month. Samples from July were taken from 4 different strata while April samples included 7 strata (Table 2). The number of samples within each stratum varied from 2 pellet groups taken at 9 miles (14.49 km) to 31 at 1 mile (Table 3).

Observations were made during daylight hours. Most successful collections were made within 1 hour after sunrise or within 1 hour before sunset. During these two periods, antelope were usually feeding and more easily approached.

Fecal samples were examined by microanalysis (Hansen 1971). Pellet groups were air dried and ground over a 40 mesh screen in a Wiley laboratory mill. Five microscope slides were prepared from each pellet group; 20 random microscope fields were observed per slide. All slides were prepared so that each microscope field had 3 to 6 plant fragments. Plant fragments in the fecal samples were compared to a type collection of similarly prepared plants of known species collected in Harding County. Specific and common names were in accordance with Van Bruggen (1976). Plants in the type collection are listed in Appendix A. Plant fragments were classified as grasses, forbs or shrubs according to criteria described by Hansen (1971). Whenever possible, fragments were classified to species by comparing

Table 2. Distance of fecal collection sites from the nearest small grain field, numbers indicate the number of pellet groups collected at each strata.

	June	July	August	September	O tober	November	De ember	January	February	Mar h	April	May	Totai
Miles													
1	4	14	12	6	10	9	7	6	3	9	8	6	94
2	0	7	3	0	2	4	3	7	6	7	1	1	41
3	0	2	2	2	0	0	6	0	6	3	0	2	23
4	3	0	5	0	0	0	0	1	5	3	2	2	21
5	3	1	0	1	4	4	6	0	0	4	4	0	27
6	0	0	5	0	0	0	0	5	9	2	4	10	35
7	0	2	0	0	0	0	0	0	0	0	0	3	5
8	0	0	3	1	4	0	0	0	0	0	2	0	10
9	0	0	0	0	0	0	0	5	0	4	0	0	9
10	8	4	0	5	8	13	8	6	5	0	5	1	63
Total	18	30	30	15	28	30	30	30	34	32	26	25	328

Table 3. Number of different locations in each stratum from which fecal samples were taken.

Miles	June	July	August	September	October	November	December	January	February	March	April	May	Total
1	2	5	4	2	3	3	2	2	1	2	3	2	31
2	0	1	1	0	1	1	1	3	3	2	1	1	15
3	0	1	1	1	0	0	1	0	1	1	0	1	7
4	1	0	4	0	0	0	0	1	2	1	1	1	11
5	1	1	0	1	1	1	2	0	0	2	2	0	11
6	0	0	2	0	0	0	0	1	2	1	1	2	9
7	0	1	0	0	0	0	0	0	0	0	0	1	2
8	0	0	2	1	1	0	0	0	0	0	1	0	5
9	0	0	0	0	0	0	0	1	0	1	0	0	2
10	2	4	0	3	2	3	3	3	1	0	1	1	23
Total	6	13	14	8	8	8	9	11	10	10	10	9	116

them to the type collection. Photomicrographs of each type species were also taken and cataloged for reference. Occurrence of a specific plant was recorded when an identifiable fragment of that species was present in the pellet group.

There is a one to one relationship between relative density of plant fragments and the dry weight of each component of a plant fragment mixture (Hansen 1971). Hansen et al. (1973) and Todd and Hansen (1973) found no significant differences between food habits studies using fecal samples and those using rumen contents of bighorn sheep (Ovis canadensis), domestic sheep (Ovis aries), cattle (Bos tauras), or bison (Bison bison). I assumed that fecal samples would give an unbiased estimate of pronghorn food habits.

In Vivo Digestion Trials

Four yearling male antelope were selected as trial animals and held in metabolism stalls similar to one described by Maynard and Loosli (1965). The pronghorn had been dehorned at approximately 10 months of age for safer handling.

From one week prior to the first digestion trial until the end of the study, these 4 animals received 2000 grams of alfalfa (Medicago sativa) pellets per day in addition to water and trace mineral salt ad libitum. Alfalfa is eaten by Harding County pronghorn in the spring and fall. I selected alfalfa pellets as the total ration for the digestion trial because antelope eat them readily. In addition, they are inexpensive, readily available, can be accurately

weighed, and easily separated from fecal material. Food was withheld 24 hours before and after each trial period. Mineral salt was not provided during the trial periods.

A measured amount of water was provided at the beginning of each trial period and resupplied twice daily. Water remaining at the end of each trial period was also measured. A similar water container was placed out of the reach of the pronghorn to determine loss to evaporation. At no time was less than 1ℓ of water available to any study animal. No allowance was made for spillage since it was a small amount of that which was provided.

Two-thousand grams of alfalfa pellets were provided each day. Refused food was removed daily, stored in a freezer and later oven dried at 60 C for 24 hours and weighed. No study antelope consumed all 2000 grams of the available alfalfa pellets in one day. All feces were removed once each day and stored in a freezer. Later they were oven drived at 60 C for 24 hours to a constant weight.

Data were collected from 4 study animals during 3 periods of 5 days each for a total of 60 animal days. Seven days elapsed between the first and second trial period, 8 days between the second and third. Food consumption was measured on days 1 through 4 of each trial period; fecal production was measured on days 2 through 5. Food consumption and fecal production were each recorded for a total of 48 animal days. Samples of feces and samples of food as fed were ground over a 40 mesh screen in a Wiley laboratory mill and sent to Iowa Testing Laboratories, Inc. (Eagle Grove, Iowa) for proximate analysis (Horwitz 1975).

Water was checked twice each day; food was given and feces removed once daily during the trial period. At other times disturbance was held to a minimum. Animals spent most of their time while in the stalls lying down. Pronghorn injury was limited to minor hair loss and swelling of the tarsus.

In Vitro Digestion Trials

Food plants important to pronghorn in northwestern South Dakota were digested in vitro (Tilley and Terry 1963, Pearson 1970). Thirty-one plant species were collected from various locations within the Harding County study area during August 1977. The samples were air dried and apical non-woody portions were separated and ground over a 40 mesh screen in a Wiley laboratory mill. Ground samples were oven dried to a constant weight at 60 C for 24 hours. Triplicate 0.5 g samples of each plant species were digested in vitro (Pearson 1970). One blank tube was run for every 2 sample tubes. Eight samples of ground alfalfa pellets were also digested in a separate trail. Losses from each of the triplicate natural forage samples and 8 alfalfa pellet samples were used to determine in vitro digestibility for each food species tested.

Permanent Rumen Fistula

Fistulation of two pronghorn was performed by a veterinarian (R. N. Masson, D.V.M., Brookings, South Dakota). Fistulation techniques described by Johnson (1966) were generally followed except

that the pronghorn were in right lateral recumbency during both stages of the operation. The rumen cannula was designed for use with domestic sheep by the Kansas State University, Department of Animal Science (Manhattan, Kansas).

Both animals were used as a source of inocula for the in vitro digestion of the naturally selected forage species. Animal number 104 was the sole source of inocula for the alfalfa pellet in vitro digestion. One animal, number 104, required physical restraint while rumen contents were collected. Animal number 205 was passive during collections. One ℓ of rumen contents was collected from each animal for the naturally selected plants trial; 200 ml were drawn for the alfalfa trial. Normal rumen contractions propelled the rumen contents into a clean glass beaker.

RESULTS AND DISCUSSION

Food Habits Study

Importance of Three Plant Groups

Findings of my study were based on 328 fresh antelope fecal samples collected at monthly intervals. A 3 x 11 x 9 factorial arrangement (Steel and Torrie 1960:132-160) of an analysis of variance was used to test shifts in diet preference. May and June samples were treated as a single group in the analysis as were the 8 and 9 mile strata for all months. These combinations allowed computation of the analysis using the least-square method (Steel and Torrie 1960:256).

The analysis showed significant differences (0.05 level) between the diet preferences of pronghorn for different plant groups. The interaction between plant groups and the month in which they were selected, the interaction between plant groups and the strata from which they were selected, and the interaction between plant group, month and stratum were also significant (0.05 level). Differences between months and differences between strata were not significant (Table 4).

Grasses were not a major component of pronghorn diet. They were the smallest fraction of the winter diet (Table 5). Summer use ranged from 41 percent in July to 13 percent in September (Table 5). In April, forbs were 2 percent of the diet (Table 5). In May and June, forbs increased to over 50 percent and remained the major diet item until early fall. Forbs were consumed at their highest rate in the summer, decreasing through fall and reached their low point of

Table 4. Analysis of variance of pronghorn food habits.

Source of Variation	Degrees of Freedom	Mean Square	F
Plant Group	2	993.90	855.99**
Month	10	0.18	0.16
Strata	8	0.05	0.44
Plant Group X Month	20	286.10	246.41**
Plant Group X Strata	16	7.20	6.20**
Month X Strata	44	0.05	0.04
Month X Strata X Plant Group	88	7.30	6.28**
Error	745	1.16	

** $P<0.01$ significance

Table 5. Monthly mean percent grasses, forbs, and shrubs found in pronghorn fecal samples.

Mean Percent	June	July	August	September	October	November	December	January	February	March	April	May
Grasses	41	32	13	23	18	Tr.	Tr.	Tr.	Tr.	3	9	11
Forbs	44	62	68	32	13	4	3	4	4	2	55	52
Shrubs	15	6	19	45	69	95	97	96	96	95	36	36

Tr. is less than 1 percent observed.

4 percent in winter (Table 6). Shrubs were the major component of winter diet. Shrub use was greatest (97 percent) in February and lowest (6 percent) in August (Table 5). Shrubs were the major food source of pronghorn in Harding County in fall, winter, and spring (Table 6).

The proximity of small grain crops affected pronghorn food habits (Table 4). Grass occurrence in pronghorn diet in the 1 mile stratum was greater than other strata except during April, May, June, July, and August, when strata more remote from small grain fields had more grass. Mean percent forbs was highest in the 1 mile stratum except in April, May and August (Table 7).

In April, the use of shrubs showed a strong relationship ($r = -0.99$) to the proximity of small grain crops. Pronghorn which fed close to small grain crops used more shrubs than pronghorn which fed in areas remote from such crops.

Dirschl (1963) reported the monthly variation of four different plant groups in antelope diet in Saskatchewan. He found that evergreen browse was important as a winter food and was replaced by grasses in the spring. Grasses were replaced by forbs and deciduous browse as summer and fall food sources. Similar trends were reported by Schwartz and Nagy (1973) and Cole and Wilkins (1958) in Colorado, and by Smith and Malechek (1974) in Utah. In Montana, winter diet of pronghorn averaged 93 percent shrubs, 6 percent forbs, and 1 percent grasses (Bayless 1969).

Table 6. Seasonal mean percent grasses, forbs and shrubs found in pronghorn fecal samples.

Mean Percent	Summer (July-September)	Fall (October-December)	Winter (January-March)	Spring (April-June)
Grasses	29	24	Tr.	8
Forbs	58	16	4	36
Shrubs	13	70	96	56

Tr. is less than 1 percent observed.

Table 7. Monthly mean percent grasses, forbs and shrubs found in pronghorn fecal samples collected from various stratum based on distance from small grain crops.

Stratum in Miles	June	July	August	September	O tober	November	De ember	January	February	Mar h	Aprii	May
Percent Grasses in Strata												
1	32	30	11	49	49	Tr.	Tr.	Tr.	Tr.	2	12	9
2	X	26	16	X	1	0	Tr.	Tr.	Tr.	3	3	4
3	X	32	6	1	X	X	Tr.	X	0	1	X	7
4	36	X	13	X	X	X	X	0	Tr.	7	9	X
5	46	54	X	1	1	Tr.	Tr.	X	X	4	19	X
6	X	X	10	X	X	X	X	0	Tr.	2	4	13
7	X	18	X	X	X	X	X	X	X	X	X	14
8	X	X	32	4	1	X	X	X	X	X	1	X
9	X	X	X	X	X	X	X	Tr.	X	4	X	X
10	44	43	X	1	Tr.	Tr.	Tr.	Tr.	0	X	X	10

Table 7. Continued.

Stratum in Miles	June	July	August	September	October	November	December	January	February	March	April	May
Percent Forbs in Strata												
1	52	67	73	40	19	3	3	7	7	1	37	72
2	X	64	61	X	15	3	1	5	4	3	73	51
3	X	62	82	32	X	X	3	X	2	3	X	57
4	49	X	65	X	X	X	X	7	3	1	65	X
5	47	37	X	10	6	3	2	X	X	2	37	X
6	X	X	77	X	X	X	X	2	7	3	68	45
7	X	70	X	X	X	X	X	X	X	X	X	30
8	X	X	35	43	15	X	X	X	X	X	78	X
9	X	X	X	X	X	X	X	2	X	2	X	X
10	37	52	X	31	8	5	5	3	4	X	X	70

Table 7. Continued.

Stratum in Miles	June	July	August	September	October	November	December	January	February	March	April	May
Percent Shrubs in Strata												
1	13	3	16	11	32	97	97	92	93	96	51	19
2	X	8	22	X	84	97	98	95	96	94	24	45
3	X	15	13	68	X	X	97	X	98	96	X	36
4	15	X	22	X	X	X	X	94	96	93	26	X
5	7	9	X	89	93	97	98	X	X	94	15	X
6	X	X	13	X	X	X	X	98	X	96	28	42
7	X	6	X	X	X	X	X	X	93	X	X	56
8	X	X	32	53	84	X	X	X	X	X	21	X
9	X	X	X	X	X	X	X	98	X	94	X	X
10	19	4	X	68	92	94	95	97	96	X	X	20

Tr. is less than 1 percent observed.

X is no sample collected.

O is sample collected but no plant fragment of that group observed.

Season of Occurrence of Various Plant Species

Big sagebrush (Artemisia tridentata) was the most commonly used forage plant during all months of the year except April when fringed sagewort (Artemisia frigida) occurred in more fecal samples (Table 8). Big sagebrush was the only plant species eaten during every month of the study and was found in 253 pronghorn fecal samples. Fringed sagewort occurred in all months except July. Silver sage (Artemisia cana) was observed during 8 months of the year (November of June) in 150 samples. It received heavier late winter use than fringed sagewort. White sage (Artemisia ludoviciana) was found during the summer (28 pellet groups) and early fall (2 pellet groups), and again in late winter (11 pellet groups).

Yellow sweet clover (Melilotus officinalis) and gold aster (Chrysopsis villosa), the most commonly used forbs, occurred in 116 and 73 fecal samples, respectively (Table 8). Yellow sweet clover occurred every month except August and September. Gold aster was important from fall to mid-winter and in June. Alfalfa was used during fall and early winter (11 pellet groups) and again in April (3 pellet groups).

Grass species were in the minority at all times. Blue grama (Bouteloua gracilis) was identified in fecal samples collected in spring, and was the most commonly used grass, occurring in 32 pellet groups. Sandreed (Calamovilfa longifolia) became important in late summer and again in late winter along with smooth brome (Bromus enermus). Crested wheatgrass (Agropyron cristatum) was used during

Table 8. Number of fecal samples containing important food plants.

Plant Species	June	July	August	September	October	November	December	January	February	March	April	May	Total
Artemicia tridentata	5	14	20	13	22	29	29	26	29	24	23	19	253
A. frigida	0	5	7	8	9	23	19	16	24	31	14	19	175
A. cana	0	0	0	10	13	21	25	24	28	21	13	5	150
Melilotus officinalis	1	0	0	2	5	10	20	23	12	27	9	7	116
Chrysopsis villosa	0	0	6	4	13	10	4	2	0	0	23	11	73
Artemisia ludoviciana	1	3	18	2	0	0	0	8	3	7	0	6	48
Sphaeralcea coccinea	3	11	17	0	0	0	0	0	0	5	3	0	39
Opuntia fragilis	0	0	0	0	0	0	0	11	16	11	0	0	38
Opuntia sp.	0	0	0	0	0	0	11	16	11	0	0	0	38
Bouteloua gracilis	0	0	0	0	0	2	0	0	0	8	8	14	32
Small grain crops	0	0	0	6	12	0	0	0	0	5	3	0	26
Calamovilfa longifolia	1	4	5	0	0	0	0	0	0	11	4	0	25
Oxytropis sp.	1	0	0	5	4	0	0	3	6	0	0	0	19
Aristida sp.	0	0	0	0	0	0	0	4	7	7	0	0	18
Artemisia dracunculus	0	0	0	2	0	2	4	10	0	0	0	0	18

Table 8. Continued

Plant Species	June	July	August	September	October	November	December	January	February	March	April	May	Total
Medicago sativa	0	0	0	6	2	3	0	0	0	3	0	0	14
Bromus inermis	2	6	3	0	0	0	0	0	0	0	3	0	14
Agropyron cristatum	1	4	7	0	2	0	0	0	0	0	0	0	12
Ratibida columifera	0	0	4	0	0	1	0	0	0	0	0	6	11
Oryzopsis hymenoides	0	0	0	4	4	2	0	0	0	0	0	0	10
Psoralea agrophylla	0	0	0	0	1	0	0	0	0	0	9	0	9
Buchloe dactyloides	3	5	0	0	0	0	0	0	0	0	0	0	8
Bromus tectorum	0	7	0	0	0	0	0	0	0	0	0	0	7
Muhlenbergia cuspidata	0	0	5	0	0	0	0	0	0	0	0	0	5
Ambrosia psilostachya	0	0	0	0	0	0	0	0	5	0	0	0	5
Agropyron smithii	0	0	0	0	0	0	0	0	0	5	0	0	5
Phlox sp.	0	0	0	0	0	3	0	2	0	0	0	0	5
Ambrosia sp.	0	0	0	0	0	0	0	0	5	0	0	0	5
Dalea enneandra	0	0	0	0	0	0	0	4	0	0	0	0	4
Secale cereale	0	3	0	0	0	0	0	0	0	0	0	0	3
Distichlis spicata	0	2	0	0	0	0	0	0	0	0	0	0	2
Poa arida	1	0	0	0	0	0	0	0	0	0	0	0	1

the summer (12 pellet groups), while indian ricegrass (Oryzopsis hymenoides) was limited to fall and early winter. Buffalo grass (Buchloe dactyloides) was used during July (3 pellet groups) and August (5 pellet groups), while cheat grass (Bromus tectorum) was found in 7 pellet groups during July. Prickly pear (Opuntia sp.) was used only between January and April. Opuntia fragilis and Opuntia sp. each occurred in 38 fecal samples during that period (Table 8).

Forbs such as yellow sweet clover, gold aster and scarlet mallow (Sphaeralcea coccinea), and grasses including blue grama, sandreed, and crested wheatgrass, made up the bulk of the pronghorn summer diet. In the fall, grasses were less commonly used and were replaced by forbs such as alfalfa, locoweed (Oxytropis sp.), white sage and silky wormwood (Artemisia dracunculus). Shrubs of the genus Artemisia dominated antelope winter diet. Sage was supplemented with small amounts of yellow sweet clover, prickly pear, scarlet mallow and indian ricegrass. As spring progressed, pronghorn added blue grama and threeawn (Artistida sp.) to their diet and increased forb use. Sagebrush use decreased at this time.

Small grains including oats (Avena sativa), wheat and barley (Hordeum vulgare), were found in October (6 pellet groups), November (12 pellet groups), April (5 pellet groups), and May (3 pellet groups). No small grains were found in fecal samples collected further than 1 mile (1.61 km) from grain fields. Typically, pellet groups which had small grains were collected from pronghorn as they stood in stubble fields. When fecal samples which contained small grains were

compared to fecal samples which had no small grains, there was no significant difference (0.05 level) between the percent grass in the two different types (Students t = 0.95 81 degrees of freedom).

Bever (1947) reported that silver sage was the most important winter food of 87 antelope. Other plants found to be important in that study included big sagebrush, prickly pear, rabbitbrush (Chrysothamnus sp.) and greasewood (Sarcobatus vermiculatus). Bever lumped most forbs into one group and all grasses into another.

Cole and Wilkins (1958) found that 41 Colorado pronghorn used 45 different species of plants. Shadscale saltbrush (Atriplex confertifotia), silver sage, western snowberry (Symphoricarpos occidentalis) and common comandra (Comandra pallida) composed the bulk of the diet during all seasons. Of the other 40 plants, none contributed more than 10 percent of the diet.

Dirschl (1963) examined the rumens of 42 pronghorn taken during the fall in Saskatchewan and found that silver sage and creeping juniper (Juniperus horizontalis) made up 59 percent of the stomach contents and western snowberry 17 percent. Eight other plant groups composed the remaining 24 percent of the rumen contents.

Hlavachich (1968) observed feeding habits of pronghorn in Kansas. He found they spent 16 percent of their eating time consuming sagewort (Artemisia kansana) and 40 percent eating cactus (Opuntia macrorhiza).

From studies on Wyoming's Red Desert, Severson et al. (1968) reported that big sagebrush made up 73 percent of the summer, fall,

and winter diet of 34 pronghorn. The other major component, Douglas rabbitbrush (Chrysothamnus pumilis) averaged 17 percent.

While studying pronghorn in Montana, Bayless (1969) found that big sagebrush was the most commonly used plant and together with silver sagebrush and rubber rabbitbrush (Chrysothamus nauseosus) made up 93 percent of the winter diet. Fringed sagewort, hoary aster (Aster canescens) and Canada bluegrass (Poa compressa) made up the balance of the winter diet. This information was based on 9,345 minutes of pronghorn observation.

Schwartz and Nagy (1973) observed tame grazing pronghorn and found that fringed sagewort and blue grama were important in winter, brome grass in early spring, and scarlet globemallow (Sphaeralcea coccinea) and thelesperma (Thelesperma trifidum) in summer. This Colorado study was based on bite counts of 8 pronghorn during 7 trial periods.

In Vivo Digestion Trials

Very little is known about the nutritional requirements of antelope (Smith and Malechek 1974). Jacobs (1973 Job Completion Report, Project No. FW-3-R-20, Wyoming Game and Fish Department, Laramie) used digestion by difference to determine the digestion coefficients of big sagebrush for pronghorn. He found it to be of high digestibility when fed in combination with yellow sweet clover. Digestion by difference cannot be used to measure energy used by antelope because sagebrush contains substances which inhibit rumen

organisms (Oh et al. 1968) thus biasing digestiblity figures for yellow sweet clover and consequently, that for sagebrush.

I used 48 animal days of food intake and fecal production to determine daily energy requirements of yearling male pronghorn. Estimates of daily energy use were made using values of 4.15 kcal/g for carbohydrates, 9.40 kcal/g for fat, and 4.65 kcal/g for protein (Maynard and Loosli 1965). Energy from food sources was gross food energy minus fecal energy. Energy from metabolism of body tissues was assumed to be 9.40 kcal/g, the caloric value of fat. Energy gain due to weight loss was added to energy income to compute gross energy use. The food energy which was converted to body tissue resulting in a weight gain was substracted from energy income when computing gross energy use. Energy from food sources ranged from 87.19 to 101.98 kcal/kg and averaged 88.76 kcal/kg/day. Energy from metabolism of body tissues averaged 38.55 kcal/kg/day. Total gross energy use averaged 123.17 kcal/kg/day (Table 9).

Digestion coefficients of dry matter were calculated using the formula:

$$\text{Digestion Coefficient} = \text{Digested} \times 100/\text{Consumed} \qquad (1)$$

"Digested" is the mean dry matter; "consumed" is the mean of 12 days consumption for each animal. Dry matter digestibility of alfalfa pellets by yearling male pronghorn varied from 50 to 52 percent and averaged 51 percent. Average body weight change for each 5-day trial period varied from a 1.35 kg loss to a 0.15 kg gain (Table 10). Water use for all antelope during the trial averaged 85.91 g/kg/day (Table 11).

Table 9. Energy sources of yearling male pronghorn (kcal/kg) from food and body tissues.

Animal Number	Energy From Food Sources			Total Food	Body Tissue Energy	Gross Energy Use
	Protein	Fats	Carbohydrates			
209	21.72	3.01	62.46	87.19	+73.08	160.27
212	25.11	3.29	73.58	101.98	+9.57	111.55
214	22.11	3.20	62.17	87.78	-9.29	79.49
220	21.16	3.20	52.74	78.10	+63.27	141.37
Mean	22.60	3.17	62.99	81.76	38.55	123.17
Standard Deviation	1.75	0.12	8.14	9.86	34.44	35.36

Table 10. Change in body weight (kg) of yearling pronghorn during *in vivo* digestion trials.

Animal Number	Trial I	Trial II	Trial III	Trial Weight Change $\bar{X}$	Trial Weight Change $S\bar{x}$	Daily Weight Change $\bar{X}$	Daily Weight Change $S\bar{x}$
209:							
Beginning	35.82	33.09	34.47				
End	34.02	32.66	32.66	-1.35	0.80	-0.27	0.16
212:							
Beginning	29.48	29.03	29.94				
End	29.48	29.03	29.48	-1.15	0.26	-0.03	0.05
214:							
Beginning	34.47	33.11	34.37				
End	34.02	34.02	34.47	+0.15	0.69	+0.03	0.14
220:							
Beginning	34.47	33.57	34.47				
End	34.02	31.11	34.02	-0.45	0.07×10^5	-0.23	0.23
Overall Mean:				-0.45	0.65	-0.12	0.14

Table 11. Daily water consumption (g/kg) of yearling pronghorn fed alfalfa pellets.

Trial Period	Animal Number 209	212	214	220	Mean	Standard Deviation
I	64.66	89.98	85.66	67.68	77.00	12.68
II	90.37	91.73	90.12	101.46	93.42	5.41
III	87.32	89.75	83.35	88.80	87.31	2.82
Mean	80.78	90.49	86.38	85.98		
Standard Deviation	14.05	1.08	3.44	17.07		

Overall mean 85.91, standard deviation 10.12

Data from my study showed a 35 kg yearling male pronghorn needed 3000 ml water and 2861 kcal of gross energy to hold itself at slightly below maintenance. Weight loss which averaged 0.12 kg/day could be offset by consumption of an additional energy income of 32.23 kcal/kg/day.

According to Kleiber (1961) basal metabolic rate may be expressed as:

$$BM = 70\ w^{0.75} \qquad (2)$$

Where BM is the basal metabolism in kcal of heat produced and w is the body weight in kg. A 35 kg pronghorn required 1007 kcal daily to produce this heat. Assuming resting metabolic rate (RMR) to be 1.25 times BM (Kleiber 1961:308), 1289 kcal/day would be needed to maintain a yearling male pronghorn in a resting state. Data from my study indicated that a resting non-fasting 35 kg pronghorn needed 4310 kcal to hold body weight constant. This is 3.42 times RMR.

Wesley et al. (1973) used indirect calorimetry to determine basal metabolic requirements and found a fasting 37.8 kg pronghorn required 80 ± 1 kcal/kg$^{0.75}$/day. A 35 kg pronghorn would require 1151 kcal/day. I found that a resting non-fasting pronghorn consumed 2.49 times its daily basal energy need and still lost 0.12 kg/day. To maintain body weight a 35 kg yearling male pronghorn must consume 3.74 times its basal energy requirements. Pronghorn used 30 percent of their gross energy for basal metabolic functions if formula (2) is used, and 27 percent if Wesley et al. (1973) figures are used. Losses due to heat of fermentation, gaseous products of digestion, heat increment, urinary energy, and stress of trial conditions contributed to this inefficiency.

In Vitro Digestion Trials

Ground samples of important pronghorn food plants were digested using in vitro techniques described by Pearson (1970). Mean digestion of grasses collected from Harding County during August was 57.10 percent (Table 12). Indian ricegrass was the most digestible at 86.27 percent, while tame rye (Secale cereal) (18.80 percent) was least. Blue grama, the most commonly consumed grass, had a digestibility of 57.20 percent. Forbs collected in the summer averaged 41.61 percent digestibility. Dalea (Dalea enneandra) had the highest digestibility (81.99 percent). Yellow sweet clover had a very low digestibility of 20.60 percent (Table 13). Shrub digestibility was slightly lower than grasses. White sage was highest, 63.29 percent, while silky wormwood was lowest, 41.10 percent (Table 14).

The most commonly used food plant in August, big sagebrush, was less digestible than either fringed sagewort or white sage, both of which were less often used. Cheat grass, the third most commonly used food plant in August, was only 78 percent as digestible as sandreed and only 75 percent as indian ricegrass, neither of which were important food sources during August. Factors other than rumen digestibility seem to influence pronghorn food selection.

To compare in vivo and in vitro digestion in the pronghorn, eight samples of alfalfa pellets, as fed during the in vivo digestion trial, were digested to vitro. Mean digestion of the 8 samples was 42 percent. Overall dry matter digestibility in the in vivo trial was 51 percent.

Table 12. Mean digestion of 3 grass samples during in vitro digestion.

Species	Percent	Standard Deviation
Agropyron cristatum	32.34	2.93
A. smithii	40.82	3.22
Aristida sp.	41.90	3.59
Bouteloua gracilis	57.20	2.44
Bromus inermis	60.86	1.60
B. tectorum	62.44	4.67
Buchloe dactyloides	71.14	12.00
Calamovilfa longifolia	80.11	5.13
Distichlis spicata	70.15	6.45
Muhlenbergia cuspidata	54.28	3.44
Oryzopsis hymenoides	86.27	3.30
Phalaris arundinacea	70.21	3.12
Poa arida	52.86	1.45
Secale cereal	18.80	2.31
Mean (all grasses)	57.10	
Standard Deviation	18.74	

Table 13. Mean digestion of 3 forb samples during in vitro digestion.

Species	Percent	Standard Deviation
Ambrosia psilostachya	26.08	11.05
Aster sp.	36.47	7.04
Chrysopsis villosa	61.31	7.81
Dalea enneandra	81.99	6.57
Helianthus ridiidus	59.71	4.25
Medicago sativa	17.17	1.05
Melilotus officianlis	20.60	5.26
Opuntia fragilis	10.82	14.56
Opuntia sp.	23.82	11.46
Phlox sp.	44.10	6.80
Psoralea argophylla	41.12	4.48
Ratibida columnifera	55.39	12.16
Mean (all forbs)	41.61	
Standard Deviation	19.51	

Table 14. Mean digestion of 3 shrub samples during in vitro digestion.

Species	Percent	Standard Deviation
Artemisia dracunculus	44.10	5.73
A. cana	53.62	3.42
A. frigida	61.15	6.61
A. ludoviciana	63.29	1.42
A. tridentata	54.87	5.81
Mean (all shrubs)	55.41	
Standard Deviation	7.52	

Pronghorn-Livestock Competition for Energy Sources

Several studies have shown that antelope fed on a large number of individual plants in widely scattered areas while livestock tended to graze intensively in more limited areas.

Schwartz et al. (1976) studied foraging behavior of pronghorn and cattle and found that both favored lowland flats and plateaus which had higher plant production than surrounding ridges and hillsides. Pronghorn could meet their energy requirement while grazing low production areas or by selecting only high quality plants from high production areas, cattle use was more intensive while pronghorn use was selective.

The wide variety of plant species consumed by South Dakota antelope provided an adequate buffer to livestock-antelope competition between May and October. In November, the number of plant species which pronghorn fed on decreased. Diversity of food sources used continued to decrease until mid-winter when 97 percent (Table 5) of pronghorn diet was composed of 3 species of Artemisia (Table 8).

During the winter, pronghorn were in competition for a narrow range of food sources. If the biomass of the three species of Artemisia were large enough for all herbivores present, then competition would not occur. If ranges were managed to limit Artemisia, small mobile herbivores such as pronghorn would have the advantage over larger more intensive grazers such as cattle. The advantage is of the same nature as that described by Ellis and Travis (1975) for widely scattered plants of high quality. They indicated that cattle

fed intensively and as a group while pronghorn fed independently in a sporadic manner with frequent changes from grazing to resting. The manner in which a large or small ruminant (pronghorn vs. cattle) spends its foraging time depends on the quality and quantity of the available forage. Sites with large amounts of low quality forage would allow the large ruminant (such as a 454 kg cow) which grazes intensively to meet its daily energy requirements sooner than a small ruminant (such as a 45 kg pronghorn) which grazes sporadically. If the site had a sparce covering of high quality forage, the smaller more mobile ruminant would have the advantage of less time spent eating (Schwartz et al. 1976). Review of these studies shows that pronghorn behavior would give them an advantage over cattle on ranges managed to exclude Artemisia. The advantage of the pronghorn would rapidly reach a point of diminishing returns as more Artemisia was removed from the range.

Severson et al. (1968) observed sheep-pronghorn competition in Wyoming. They found basic differences in the feeding habits of the two species. Pronghorn tended to be less gregarious, fed for longer periods, and moved greater distances than sheep during equal time periods. In that study, competition for food plants was expressed as percent overlap for each species. When all forage species were considered, there was an 8.2 percent overlap. When only favored food plants of the two ungulates was considered, the diet overlap dropped to 3.2 percent. These studies indicated that even when large numbers of pronghorn were present on average condition range, there was little pronghorn-livestock competition for food.

Effects of Diet Modification Due to Small Grain Crops

Land in Harding County is rapidly being converted from range to crop land. Soil Conservation Service figures show that during 1974-1975 land devoted to cultivated crops increased by 20,235 ha (U.S.D.A. Soil Conservation Service 1975). United States Department of Agriculture, Agricultural Stabilization and Conservation Service figures for Harding County show total tilled area increased by 42,898 ha between 1974 and 1976. Range favorable to pronghorn management in Harding County is shrinking. Increases in cultivated areas increase livestock-pronghorn competition if livestock numbers are maintained.

Ellis (1970) developed a systems model for pronghorn based on vegetation data collected in California. He found that fawn survival was related to the structure of the plant communities. Fawn survival increased as an exponential function of the part of the ground covered by non-browse species. On Great Basin summer range, cattle biomass was 20 to 30 times that of pronghorn. He concluded that in early spring, cattle and other herbivores would rapidly deplete the limited supply of emerging forbs and grasses, forcing pregnant pronghorn does to use browse in their diet at a time when they would normally select non-browse species. This competition for desired energy sources resulted in lowered doe condition and was a primary component of fawn survival.

The presence of small grain crops in Harding County has modified antelope diets. The percent of diet composed of shrubs in April was

highly correlated (r = -0.99) to the proximity of small grain crops. Pronghorn which fed close to small grain crops were forced to substitute larger amounts of Artemisia for grass-forb combinations than pronghorn which fed remote from such crops. Does in their last trimester of pregnancy were forced to compete with other herbivores for a smaller amount of forbs and grasses due to grain farming. Competition for emerging forbs and grasses of the type described by Ellis (1970) was taking place.

South Dakota pronghorn were benefited by grain farming during times when sprouted grains provided a food source. This food source was of limited importance during two short periods. Pronghorn were negatively affected when cultivation of range removed the wide variety of plants needed for spring, summer, and early fall energy sources.

Ability of Habitat to Support Pronghorn

This and other studies have shown that pronghorn use a wide variety of forbs, grasses and shrubs as energy sources. Every study has shown seasonal shifts in preference among and within plant groups. Pronghorn need a mixture of plant species from which energy can be secured. Any practice which limits the number of different plant species available, including cultivation, fencing and removal of Artemisia, can be considered detrimental to pronghorn.

SUMMARY AND CONCLUSIONS

Examination of fresh fecal samples from 328 free ranging antelope over a 12 month period in South Dakota showed that 96 percent of the winter diet was shrubs while summer diet was 87 percent grass and forbs. Important food plants included big sagebrush, silver sage, yellow sweet clover, blue grama and sandreed. Four yearling male pronghorn consumed 85.91 g/kg/day water. Energy requirements were 123.17 kcal/kg/day. Dry matter digestibility averaged 51 percent. Thirty-one important food plants were digested by in vitro techniques using pronghorn rumen fluid. These plants averaged 51 percent digestibility. Alfalfa pellets averaged 42 percent digestibility.

No pronghorn-livestock competition was apparent in Harding County. The diverse nature of pronghorn diet and their mobile feeding habits provide natural buffers to competition. There was no evidence that pronghorn used more sprouted small grains than other grasses. Pronghorn in Harding County do not travel more than 1 mile to eat sprouted small grains. If diversity of plant types is maintained, antelope can meet their energy and nutritional needs.

LITERATURE CITED

Autenrieth, R. E., and E. Ficher. 1975. On the behavior and socialization of pronghorn fawns. Wildl. Monogr. 42. 109 pp.

Bayless, S. 1969. Winter food habits, range use, and home range of antelope in Montana. J. Wildl. Manage. 38(3):538-551.

Bever, W. 1947. Food habits of antelope in northwestern South Dakota. Wild. Dept. Libr. S. Dakota State Univ., Brookings, S. Dakota. 9 pp.

Burt, W. H., and R. P. Grossinheider. 1964. A field guide to the mammals. Houghton Mifflin Company, Boston. 284 pp.

Cahalane, V. H. 1961. Mammals of North America. The MacMillian Company, New York. 682 pp.

Cole, G. F., and B. T. Wilkins. 1958. The pronghorn antelope. Its range use and food habits in central Montana with special reference to wheat. Montana Fish and Game Dept. Tech. Bull. 2. 37 pp.

Dirschl, H. J. 1963. Food habits of the pronghorn in Saskatchewan. J. Wildl. Manage. 27(1):81-93.

Ellis, J. E. 1970. A computer analysis of fawn survival in the pronghorn antelope. Ph.D. Thesis. Univ. of Calif., Davis. 70 pp.

_____, and M. Travis. 1975. Comparative aspects of foraging behavior of pronghorn antelope and cattle. J. Appl. Ecol. 12(2):411-420.

Hansen, R. M. 1971. Drawings of tissues of plants found in herbivore diets in the litter of grasslands. Range Science Dept., Colo. State Univ., Fort Collins. Biome Tech. Rept. 70. 69 pp.

_____, D. G. Peden, and R. W. Rice. 1973. Discerned fragments in feces indicates diet overlap. J. Range Manage. 26(2):103-105.

Hlavachick, B. D. 1968. Foods of Kansas antelope related to choice of stocking sites. J. Wildl. Manage. 32(2):349-401.

Horwitz, W. ed. 1975. Official methods of analysis. 12 ed., Association of Official Agricultural Chemists, Washington D.C. 755 pp.

Johnson, R. R. 1966. Techniques and procedures for in vitro and in vivo rumen studies. J. Anim. Sci. 25:855-875.

Kitchen, D. W. 1974. Social behavior and ecology of the pronghorn. Wildl. Monogr. 38. 96 pp.

Kleiber, M. 1961. The fire of life. John Wiley and Sons, Inc. New York. 454 pp.

Maynard, L. A. and J. K. Loosli. 1969. Animal nutrition. 6th ed. McGraw-Hill Book Company, New York. 613 pp.

Oh, K. H., M. B. Jones, and W. M. Longhurst. 1968. Comparison of rumen microbile inhibition resulting from various essential oil isolated from relatively unpalatable plant species. Appl. Microbiol. 16(1):39-44.

Pearson, H. A. 1970. Digestibility trials: in vitro technique. U.S.D.A. Misc. Pub. 1147. 85-92 pp.

Schwartz, C. C., S. Mathews, and J. G. Nagy. 1976. Foraging behavior of pronghorn and cattle on a shortgrass prairie in Colorado. Antelope States Workshop, Twin Falls, Idaho. 7:79-99.

_____, and J. G. Nagy. 1973. Pronghorn food habit studies. U. S. I. B. P. Dept. of Wildl. Bio. Colo. State Univ., Fort Collins Tech. Rep. 70. 25 pp.

Severson, K., M. Maz, and W. Hepworth. 1968. Food preferences, carrying capacities, and forage competition between antelope and domestic sheep in Wyoming's Red Desert. Sci. Monogr. 10. Agric. Exp. Stn. Univ. of Wyoming, Laramie. 55 pp.

Smith, A. D. and J. C. Malechek. 1974. Nutritional quality of summer diets of pronghorn antelope in Utah. J. Wildl. Manage. 38(40):792-798.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Company, Inc., New York. 481 pp.

Stone, W., and W. E. Cram. 1905. American animals. Doubleday, Page and Company, New York. 318 pp.

Taber, R. D. 1971. Criteria of sex and age. Pages 325-402 in R. H. Giles (ed.), Wildlife Management Techniques. The Wildlife Society, Washington, D.C.

Todd, J. W., and R. M. Hansen. 1973. Plant fragments in the feces of bighorns as indicators of food habits. J. Wildl. Manage. 37(3):363-365.

Tilley, J. M. A., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassland Soc. 11(1):104-111.

U.S.D.A. Soil Conservation Service. 1975. 1975 update of county land use estimates: Harding County. U.S.D.A., S.C.S., Huron, S. Dakota. 1 pp.

Van Bruggen, T. 1976. The vascular plants of South Dakota. Iowa Univ. Press, Ames. 538 pp.

Visher, S. S. 1914. The biology of Harding County northwestern South Dakota. South Dakota Geological Survey, Bull. 6. 127 pp.

Wesley, D. E., K. L. Knox, and J. G. Nagy. 1973. Energy metabolism of pronghorn antelope. J. Wildl. Manage. 37(4):563-573.

Yoakum, J. 1968. A review of the distribution and abundance of American pronghorn antelope. Antelope States Workshop Proceedings, Alturas, Calif. 3:4-14.

APPENDIX A. Plants in type collection used during examination of pronghorn fecal samples (Van Bruggen 1976).

Specific Name	Common Name
Plants grouped as grasses:	
Agropyron cristatum	Crested wheatgrass
A. smithii	Western wheatgrass
Andropogon scoparius	Little bluestem
Artistida sp.	Threeawn
Boutelous gracilis	Blue grama
Bromus inermis	Smooth brome
B. tectorum	Cheat grass
Buchloe dactyloides	Buffalo grass
Calamovilfa longifola	Prairie sandreed
Carex filifolia	Carex
Distichlis spicata	Inland saltgrass
Elymus virginicus	Virginia wild rye
Hordeium jubatum	Foxtail barley
Koeleria cristata	Junegrass
Muhlenbergia cuspidata	Plains muhly
Oryzopsis hymenoides	Indian ricegrass
Convolvulus arvensis	Field bindweed
Conyza ramosissima	Horseweed
Coryphantha vivipara	Pincushion cactus
Dalea enneandra	Dalea

APPENDIX A. Continued

Specific Name	Common Name
Dyssodia papposa	Dogweed
Echinacea angustifolia	Purple cone-flower
Glycyrrhiza lepidota	Licorice
Helianthus rigidus	Rigid sunflower
Lactua oblongifolia	Wild lettuce
Medicago sativa	Alfalfa
Melilotus officinalis	Yellow sweet clover
Opuntia fragilis	Prickley pear
Orthocarpus luteua	Owl's clover
Oxytropis sp.	Locoweed
Petalostemon purpureum	Purple prairie clover
Phlox sp.	Phlox
Psoralea argophylla	Silverlead scarfpen
Ratibida columnifera	Coneflower
Rumex venosus	Sour greens
Phalaris arundinaceu	Reed canary grass
Poa arida	Plains bluegrass
Secale cereal	Tame rye
Setaria glauca	Yellow foxtail
Spartina pectinata	Prairie cordgrass

APPENDIX A. Continued.

Specific Name	Common Name
Stipa comata	Needle and thread grass
S. viridula	Green needle grass
Plants grouped as forbs:	
Amaranthus albus	Tumbleweed
A. graecizans	Prostrate pigweed
Ambrosia psilostachya	Small ragweed
Allium textile	Wild onion
Aster ericoides	White aster
Astragalus ceramicus	Astragalus
Campanula rotundifolia	Blue bell
Cleome serrulata	Common bee plant
Chrysopsis villosa	Gold aster
Cirsium vulgare	Bull thistle
Solidago missouriensis	Prairie goldenrod
Sphaeralcea coccinea	Scarlet mallow
Taraxacum officinale	Gray-seeded dandelion
Plants grouped as shrubs:	
Artemisia cana	Silver sage
A. dracanculus	Silky wormwood
A. frigida	Pasture sage-brush
A. ludoviciana	White sage
A. tridentata	Sagebrush

APPENDIX A. Continued.

Specific Name	Common Name
Lupinus argenteua	Lupine
Prunus americana	Wild plum
P. virginiana	Choke Cherry
Rhus aromatica	Skunk-bush sumac
Ribes missouriense	Gooseberry
Rosa woodsii	Wild rose
Shepherdia argentea	Buffalo berry
Symphoricarpus occidentalis	Wolf berry

APPENDIX B. Pronghorn reaction to sedative drugs.

Xylazine (Rompun, Haver-Lockhart Lab., Shawee, Kansas) and Entropine (M-99, D-M Pharmaceuticals, Inc., Rockville, Maryland) were used as immobilization and analgesic agents during pronghorn fistulation. Xylazine, a sedative commonly used in domestic livestock, was used singly at dosage levels up to 11 mg/kg (body weight) without achieving the desired effect. Horses (Equas caballus) need only 2.2 mg/kg for complete sedation. Entrophine, an analgesic and immobilizing agent widely used on wildlife species, was used to anesthetize the pronghorn for fistulation. Entrophine was given at the rate of 0.30 mg/kg, intramuscularly, in several doses along with 1 mg/kg Xylazine, intramuscularly, in a single dosage. Diprenorphine (M 50-50, D-M Pharmaceuticals, Inc., Rockville, Maryland), given intravenously at the rate of 2 mg/animal, rapidly reversed the state of narcosis produced by Entrophine. Individual antelope reactions to sedation and immobilization varied. Pronghorn reactions are listed as field notes.

APPENDIX B. Individual pronghorn reactions to M99 and Rompun.

Animal Number	Sex	Weight kg	Relative Time (Minutes)	Field notes:
103	Male	33	0	Given 5.0 ml M99 intramuscularly.
			2	Respiration rate 120 per minute.
			3.5	Acting nervous.
			4	Pant with mouth open.
			4.5	Grunting, jumping on hind legs.
			5	Respiration rate 132 per minute.
			7	Staggering, lies down, up again, respiration 132 per minute.
			8	Struggling to get up.
			9	Held down by handler, still struggling.
			12	Less reactive to stimulus.
			23	Given 1.0 ml M99 intramuscularly.
			28	Given 0.2 ml Rompun intramuscularly.
			31	Eyes unreactive.
			34.5	Little response to handler, animal quiet. Surgical plain.
			39	Respiration 204 per minute, quiet. Surgical plain.
			55	Respiration 144 per minute, quiet. Surgical plain.
			65	Given 2.0 ml M50-50 intravenously.
			73	Animal up.
			76	Respiration rate 240 per minute.

APPENDIX B. Continued.

Animal Number	Sex	Weight kg	Relative Time (Minutes)	Field notes:
104	Female	34	0	Given 5.3 ml M99 intramuscularly.
			0.5	Lying down.
			1	Stands up. Walking around.
			1.5	Mouth open, panting.
			3.5	Agitated. Down panting and grunting.
			4.5	Standing up, lying down.
			13	Given 1.0 ml M99 intramuscularly.
			16	Down, 1.0 ml Rompun, held down by handler.
			18	In surgical plain. Poor muscle relaxation.
			20	Moving around some. Surgical plain.
			32	Given 0.5 ml M99. Surgical plain.
			50	Given 1.0 ml M99. Surgical plain.
			64	Given 0.5 ml M99. Surgical plain.
			86	Given 2.2 ml Rompun. Surgical plain.
			90	Given 2.0 ml M50-50 intravenously. Surgical plain.
			93	Animal up, breathing rapidly.

APPENDIX B. Continued.

Animal Number	Sex	Weight kg	Relative Time (Minutes)	Field notes:
205	Male	33	0	Given 6.0 ml M99 intramuscularly.
			3	Staggering, mouth open.
			6.5	Down. Held down by handler.
			9	Given 1.0 ml M99.
			11	Given 0.2 ml Rompun, 1.5 cc M99.
			16	Given 1.5 cc M99. Surgical plain.
			25	Given 1.0 cc M99. Surgical plain.
			31	Given 1.0 cc M99. Surgical plain
			46	Given 2.0 cc M50-50. Surgical plain.
			48	Animal up. Breathing rapidly.

APPENDIX C. Pronghorn training.

A total of 12 pronghorn were trained for use in my study. All antelope were captured on the first or second day after birth in western South Dakota. Four were from the spring 1975 fawn crop, 8 from the 1976 crop.

The 1975 group, (2 males 2 females) had been trained for other laboratory uses, been declared unusable and maintained without training from age 9 to 13 months. At this time daily training was reinstituted. Food intake was closely controlled and I carried out all feeding, maintenance, and training.

Food was offered once each day. I would enter the pen and place hay on the ground, retreat 1 m, sit down and remain motionless. The females would approach, sniff the hay and myself, and move away. After several repeats of this activity, I removed all but 1.5 kg of hay until the next day. The females rapidly came to recognize me and accept my presence. Within 1 week they began to play (Kitchen 1974, Autenrieth and Ficher 1975) at my approach and follow me. Molasses covered grain was hand fed and within 2 weeks either female would take this hand fed grain as a reward. Within 1 month the females would accept close approach by myself and confinement in a small pen.

The most difficult gap to bridge with the 1975 males was to establish my dominance without instilling too much fear in the animals. Training was carried out in the same manner as for the females, except that I never sat in the presence of the males. I

permitted no aggressive behavior toward myself. 1 found that dominance could be established over these 2 pronghorn with a level stare and 1 or 2 steps toward the animal. In 2 weeks the males began to anticipate my arrival and within 1 month would accept close approach and confinement. The 1976 group was successfully trained for other purposes and easily adapted to my studies.

All pronghorn were trained to accept grain from my hand. I found that pronghorn could be easily restrained if I held only the lower jaw of the animal. If other parts were held the pronghorn became very perturbed and hard to handle. While being held in this manner the pronghorn stood quietly.

Pronghorn can be trained to accept close contact with humans and confinement. It should be remembered that these are highly stressful conditions for pronghorn. Typical responses to this stress are: running blindly into walls and fences, hair eating, anorexia, pneumonia and death.

A pronghorn which is startled will typically run blindly away from the direction of the stimulus. The animal will continue to try to escape as long as the stimulus persists. The threshold of the stimulus can be raised with age and training. The degree of reactions to stimulus, however, seems to be indeperdent of either of these two factors.