Technical Report No. 13

PROGRESS REPORT

IBP ANTELOPE PROJECT

PAWNEE SITE

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GRASSLANDS BIOME

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INTRODUCTION

This report covers activities mainly during the period between January 1969 and September 1969. Some activities and data collections, however, occurred before the above period. It was felt that, while building up an experimental herd of antelope and gaining experience with handling the animals, certain trials such as energy flux and water turnover rate studies should be initiated. It is important to know the basic energy requirements of the pronghorn under laboratory-controlled conditions before field trials can be conducted on available energy and nutrients in antelope food. Antelope, having evolved in an arid environment, may have special adaptations to regulate water metabolism. The investigation of this physiological phenomenon was another part of our study.

METHODS AND MATERIALS

Facilties

A 40' x 30' x 8' high woven wire enclosure with a runway and shelter was built adjacent to the Metabolic Laboratory at Colorado State University. The enclosure is separated into two parts. The purpose of this enclosure is to raise young animals and to keep animals awaiting trials close to the Metabolic Laboratory. Another large enclosure (100' x 100') has been built for antelope at the deer pens of the Wildlife Biology Department of Colorado State University. Animals not on trial are kept in this enclosure where we can conduct simple training of animals for travel and for grazing studies. A horse trailer has been purchased and converted for hauling the animals.

Acquiring and Raising Animals

Seven fawns (two to three days of age) were captured in June 1969. They were raised on whole, pasteurized cow's milk and had free access to our deer concentrate ration, alfalfa hay and, for most of the summer, natural vegetation in and outside of the large enclosure. These animals were trained to enter, ride and leave the horse trailer, to spend time in metabolic cages and, while grazing, to be followed by an observer. Because of our previous experience with *Clostridium perfringens* outbreak (Nagy et al. 1969) all animals received anti-toxin type B, C, D preventive shots subcutaneously.

Water Kinetics and Energy Flow

Two male and female animals, captured in June 1968, raised and trained as previously described, were placed in metabolic cages (4' x 4' x 3') at room temperature. During the trials, which lasted 160-240 hours, food and water were available ad libitum. Energy flow and water kinetic data were collected simultaneously. Consumption of dry matter was measured. Urine and feces were collected and sampled for determination of dry matter. Periodically the cages were sealed with plexiglas and respiration was recorded for three hours to measure heat production by indirect calorimetry (Kleiber 1961). This procedure was repeated often enough to allow each animal 15 hours of respiratory measurement time including three additional hours under fasting conditions. In addition, respiration was recorded for one animal at 24-hour increments for 72 hours of fasting.

The isotope dilution technique of Foy and Schieden (1960) was used to study water kinetics of pronghorn antelope. Animals were injected with 2 ml of tritiated water (specific activity 200.9 μc/ml) and immediately placed in metabolic cages. Urine samples were collected in early morning and late afternoon. The time for excretion of each sample was estimated as the mid-point ($\bar{x}$) between each two collection periods and recorded as hours post injection. A 20 ml aliquot was taken from each urine sample, refluxed with activated charcoal and filtered to provide a clear filtrate for determining specific activity. A 0.05 ml aliquot of the filtrate from each sample was pipetted into dioxane-based scintillation solution, and its activity was determined using a Packard Tricarb-scintillation Spectometer. The specific activity of each sample (expressed as $\mu c/ml \times 10^{-4}$) was plotted against time of excretion on semilogrithmic coordinates, and the best-fitting straight line was calculated by the method of least squares.

The water kinetic relationships involved are illustrated in the formula $Y = ae^{b\overline{x}}$ where Y is the specific activity of any sample. The specific activity at time zero is represented by "*a*"; "*b*" is the slope of the line (the constant rate of water intake), and "*e*" is the $\log_e$ function.

Other calculations include total body water or pool (P), determined by dividing the specific activity of the isotope injected by the specific activity of the urine sample at time zero. The water turnover rate was calculated as Ln2/b. The water flux (amount of water leaving the pool per unit time per unit of metabolic size) is equal to $P \frac{b}{kg^{3/4}}$.

During the summer and early fall of 1969, additional energy flux and water kinetic trials were conducted, but the analyses for these trials have not been completed.

To determine the effect of the environmental stress (temperature, etc.) on the water kinetics of pronghorn, one group of three animals was maintained inside the laboratory at 21°C and relatively stable humidity, while a second group of four animals was enclosed in a pen outside. These trials were conducted in early July and October.

The effects of temperature on both energy flux and water kinetics under controlled conditions were determined. Trials of 21° and 32°C were conducted, using six females enclosed in metabolic cages. At the present time, two metabolic cages are being refrigerated to allow expansion of the controlled temperatures down to approximately -12°C.

RESULTS AND DISCUSSION

General Notes on Raising Animals

Data on monthly weights of the animals captured in June 1969 as well as their monthly feeding regime are presented in Table 1. By October 1, 1969 the average weight of the animals (18 kg) was somewhat under the average weight of five antelope fawns killed by hunters during the last week of September. This somewhat lower weight could be attributed to the cautious feeding of the animals during their first month of life to prevent possible repetition of the enterotoxemia which occurred a year ago.

The behavior of captive antelope is markedly different from that of mule deer. Although all animals were obtained at a very early age (two to three days old), they never seem to trust humans as do deer. Pronghorn seem to have a more inquisitive mind than deer; they will approach humans to investigate. But the slightest movement will frighten them. In general, our attempts failed to halter-break them for the purpose of walking them on a leash. Those animals which showed some promise on-leash would never engage in feeding activity while thus restricted. When approximately three to four months old, antelope will object to the slightest restrictions, such as being picked up or weighed. They will, however, become accustomed to the presence of humans while free grazing, and observers who are known to them can walk within two or three feet of them. Pronghorn fawns when released on a range will run and play for 15 to 20 minutes before engaging in feeding activity. During this time, when frightened, they will seek security in the proximity of their caretakers, by running back to them. Because of the extreme weather conditions this fall, we could not gather food habit data with the fawns. The animals, however, were exercised weekly in the range, approximately one mile from the enclosures.

Of the five surviving animals captured in 1968, two died of neck injuries when frightened by cattle and humans, one probably died of arthritis developed during the clostridium enterotoxemia, and one died of unknown causes during the early summer of 1969. Of the seven fawns captured in June 1969, one died of neck injury in October 1969, when cattled walked close to the enclosure. All animals seem to be healthy and growing normally. They will enter and ride in a horse trailer, they seem to be calm in metabolic cages, and they will graze in the close proximity of observers.

Energy Flow

A primary problem in interpreting the results of this experiment is the age of the antelope. Any comparison with other ruminants requires cognizance of the possible age differences.

The digestible, metabolizable and net energy values calculated for antelope do not differ much from values given for young cattle (Table 2). Net energy values are slightly higher for antelope on mixed concentrate than for cattle on similar diets. This may be explained partially by the age factor, since younger animals possess higher metabolic rates (Blaxter 1962).

Ritzman and Benedict (1930) showed that fasting metabolic rates of lambs and sheep decreased rapidly with age until the animals were four to six months old. After one year, their fasting metabolic rates seemed relatively stable. Ritzman and Colovos (1943) found that growing young cattle reached a relatively stable plane of basal metabolism after approximately eight months. The fasting heat production of antelope ranged from 61 to 100 kcal/kg$^{3/4}$/day (Table 3). Considering variation that exists among species (Table 4) and even within species (Blaxter 1962), this is not unusual. Some discrepancies could occur when comparing the results of various experiments, depending on the length of fast. One male antelope was fasted for 72 hours and respiration was recorded at 24-hour intervals. The results indicate that a 48-hour fast will produce a reliable fasting metabolic rate (Table 5). Silver et al. (1969) found this true with adult white-tailed deer.

Compared to dry cows fed twice their maintenance requirements (Table 6), the pronghorn showed a lower percent energy loss through feces, urine, and methane. The low methane loss was due probably to the ages of the antelope. The lowered fecal loss may represent a species difference, since age does not seem to affect apparent digestible energy (Blaxter 1962). The increased metabolic rate of young animals could account for the high total heat production found in the pronghorn (Table 6).

There seems to be a direct relationship between age and heat increment for the four animals. In addition there is some evidence that an inverse relationship of age with net energy for maintenance exists (Table 3). At this time these phenomena are unexplained.

Water Kinetics

Validity of the isotope dilution technique requires the assumption that body water pool of the animals remains constant throughout the trial. This was probably true, as evidenced by the exponential decrease in specific activity of the samples with time (Fig. 1). Measurements made by Till and Downes (1962) with sheep also support this assumption.

Differences between water turnover rates of male and female antelope were prominent. A coefficient of determination (r^2) was calculated for all lines. The values showed that 96% of the total variation of y was associated with x for all lines. The two males revealed similar rates, as did the two females (Fig. 1). Similar results were found by Chapman and Black (1967) in a study of effects of sex on water metabolism in chickens. Data on antelope indicate that females have a higher percent body water and flux than the males (Table 7). For the males, the average body water was 75% of the body weight, the average biological half-life of water was 5.9 days, and the average flux was 192 ml per day/$kg^{3/4}$. Comparable values for females were 81, 4.5 and 262, respectively. Exempting body water, these values are similar to values for mule deer (Knox et al. 1969). The one-tailed t-test for unpaired data was applied to the flux values for the male vs. female antelope. A significant difference existed at the 5% level of probability. Prentice et al. (1952) showed that water content of the body varies inversely with fat. Edeleman and Leibman (1959) stated that younger animals tend to have a higher percent body water than older animals. These factors may account for the higher values found in pronghorn. The biological half-life of water in antelope also was similar to that of sheep (Anand and Parker 1966). Since T 1/2 value is a function of body size, these results seem reasonable (Foy

1964). The amounts of water consumed were 84 and 107 ml per day/kg body weight for the two females, while these values for the two males were 64 and 52.

SUMMARY

Energy flow trials with four pronghorn antelope produced results similar to those described for other ruminants, with the possible exception of total heat production and fasting metabolic rate. The increased heat production may have been due to the higher metabolism of young animals. The fasting metabolic rates were higher than the interspecific mean of 70 kcal/kg$^{3/4}$/day (Kleiber 1961); similar results occurred with other wild ruminants.

Results obtained on water kinetics of antelope show a higher percent body water and flux in females than in males. Data also indicate that pronghorn antelope, under the conditions tested, have a slightly higher body water content than other species examined in other studies. Since pronghorns probably have a lower body fat content than domestic animals, body water content probably would be higher. Water flux in antelope is similar to that in sheep or deer.

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Table 1. Average weights and food intakes of seven antelope fawns (June - October 1969)

Age	Average Weights (kg)	Average Food Intake Per Animal Per Day		
		Milk (ml/day)	Times Daily	Concentrate (gr)
Few days old	3.6	40 1/	5 x	None
1 Month	4.5	185 2/	4 x	Some
2 Months	7.2	185	3 x	200
3 Months	12.6	185	2 x	350
4 Months	18.0	185	2 x	950
5 Months	24.0	185	1 x	1,000

1/ Cow's colostrum for 72 hours after capture

2/ From here on, 52 liquid oz. (4 cans) of whole evaporated milk was added to whole milk to make one gallon.

Table 2. Percent of gross energy available to young dairy calves, Hereford steers and young pronghorn antelope

	Digestible Energy	Metabolizable Energy	Net Energy
*Young Dairy Calves (4) (hay, grain, beet pulp)	70	61	45
**Young Hereford Steers (4) (timothy hay, ground corn, cottonseed meal)	68	58	42
Young Pronghorn Antelope (4) (mixed concentrate - mainly rolled barley and milo, corn, and protein supplement)	78	73	57

* Ritzman, E. G. and N. F. Colovos 1943.

** Mitchell, H. H. and T. S. Hamilton 1940.

Table 3. Energy flux in pronghorn antelope (percent of gross intake)

Antelope	Age (days)	Digestible Energy	Metabolizable Energy	Total Heat Production	Heat Increment	Net Energy (Maintenance)	Net Energy (Production)	Fasting Metabolism (kcal/kg$^{0.75}$)
Male 1	108	77	71	55	4	51	16	106
Female 1	122	72	68	62	14	49	6	92
Female 2	143	80	75	48	16	32	27	110
Male 2	182	79	74	56	30	26	18	61

Table 4. Average fasting metabolism of certain domestic and wild ruminants in kcal/24 hr per unit of metabolic size, either $kg^{.73}$ (*) or $kg^{.75}$.

Animal	Fasting Metabolism
Sheep[1]	52 *
Steer[1]	86 *
Non-pregnant cows[1]	79 *
Goat[2]	38
White-tailed deer[3]	
Summer coat	144
Winter coat	97
African cattle[4]	82 *
Eland[4]	111 *
Wildebeest[4]	104 *
Red deer[5]	90
Pronghorn	92

1 Blaxter 1962

2 Silver et al. 1959

3 Silver et al. 1969

4 Rogerson 1968

5 Brockway and Maloiy 1968

Table 5. Oxygen consumption, carbon dioxide production (liters per hr) and respiratory quotients of pronghorn antelope under fed and fasting conditions

		Full Fed	24-hour Fast	48-hour Fast	72-hour Fast
Male 1	CO_2	11.9	5.4	4.5	4.3
	O_2	13.1	7.1	6.0	5.9
	R.Q.	0.91	0.76	0.74	0.72
Male 2	CO_2	7.6		6.3	
	O_2	8.9		8.3	
	R.Q.	0.85		.76	
Female 1	CO_2	12.7		6.6	
	O_2	13.2		9.0	
	R.Q.	0.96		0.73	
Female 2	CO_2	8.1	5.6	5.2	
	O_2	8.8	7.1	7.2	
	R.Q.	0.91	0.79	0.72	

Table 6. Average energy flux values of dry dairy cows fed various diets and pronghorn fed mixed concentrate

Dry Cows * (Twice Maintenance)	Gross Energy Intake (kcal/day)	(Percent of Gross Energy Intake)				
		Feces	Urine	Methane	Total H.P.	Energy Balance
100% Alfalfa	47,630	38	6	6	41	9
75% Alfalfa and 25% Concentrate	45,950	33	6	7	42	12
50% Alfalfa and 50% Concentrate	36,820	27	7	7	44	15
Antelope (ad libitum)						
Mixed Concentrate	2,340	23	3	.2	56	17

* From Flatt et al. 1965.

Table 7. Water kinetic characteristics of pronghorn antelope as determined by isotope dilution

Antelope Number	Sex	Age (days)	Percent body water	Turnover (Percent/day)	Biological half-life (days)	Flux $\left(\frac{\text{ml per day}}{\text{kg}^{.075}}\right)$
1	M	108	77	11	6.3	178
2	M	182	73	12	5.6	205
3	F	143	82	15	4.5	264
4	F	122	80	16	4.4	261

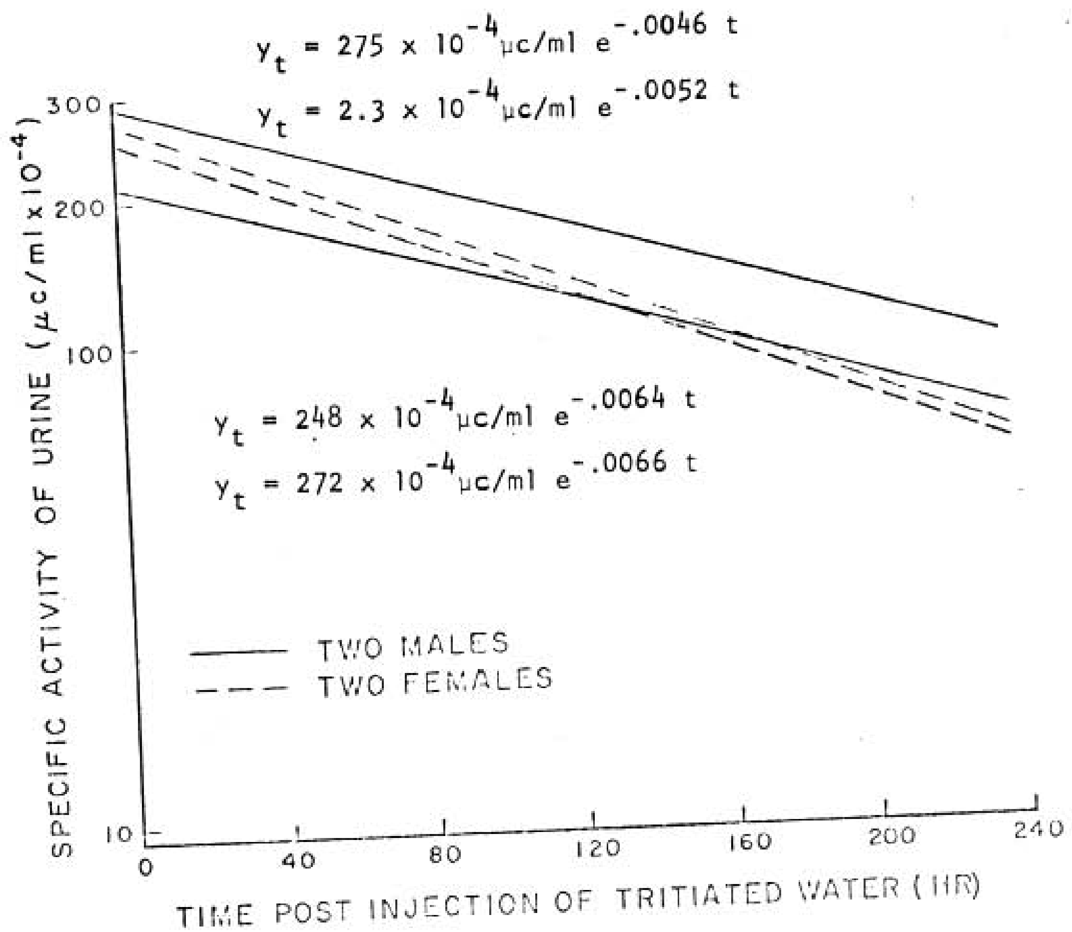
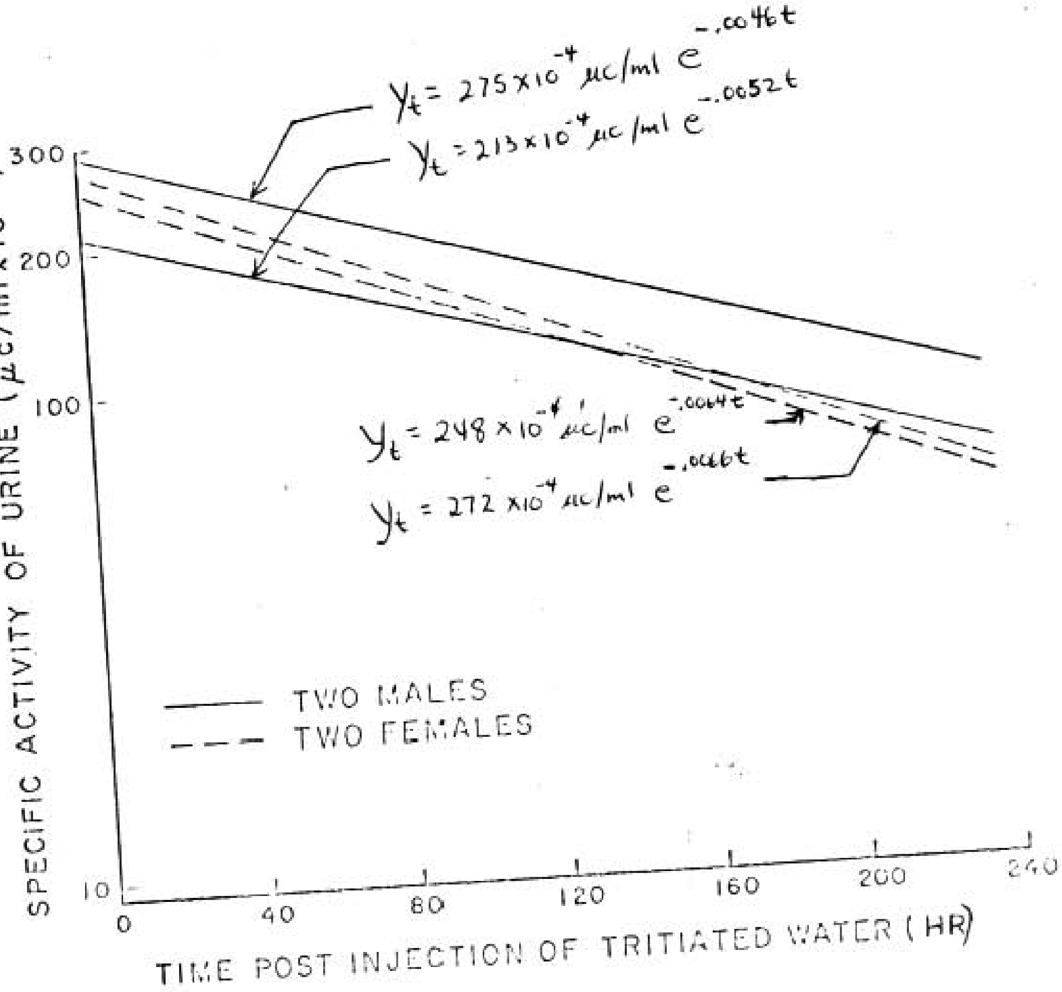


Fig. 1. Comparison of the water turnover rates between male and female pronghorn antelope



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