

Behavior of Fistulated Steers on a Desert Grassland¹

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Highlight

Behavior of four ruminal fistulated steers was studied for a 60-day period in mid-summer on mesquite and mesquite-free desert grassland pastures near Tucson, Arizona. Steers consistently grazed during four definite daylight grazing periods and two nighttime periods throughout the study. The four steers were remarkably similar in their activities and differed only in salting time; their activities did not appear to differ from those of intact cattle. Activities were similar on mesquite and mesquite-free pastures. As the grazing season advanced and forage matured, rumination time increased and frequency of urination declined. Other behavioral activities of the steers were unaffected by sources of variation studied.

Traditionally, animal behavior studies have been conducted to help in solving range and livestock management problems, in designing grazing systems and in achieving more efficient range use. This study on grazing behavior was conducted primarily for the purpose of determining if behavioral characteristics of fistulated steers differ from those of intact cattle.

Use of esophageal and ruminal fistulated animals, a technique which has come into common use only in the last 15 years, has allowed significant improvement in range nutrition research. This technique offers many advantages for study of botanical composition and nutritional characteristics of diet, and forage intake (Van Dyne, 1964). Despite the obvious advantages of using fistulated animals for such studies, there is doubtless some question concerning extrapolation of data from fistulated animals to non-fistulated (intact) animals. Presumably there should be close correspondence in behavior of the two if wide application is to be made of research results from fistulated animals.

In 1964 Galt (Galt et al. 1968, 1969) initiated a series of studies at the Santa Rita Experimental Range near Tucson, Arizona using ruminal fistulated steers to measure forage intake, digestibility

and botanical composition of diets for cattle grazing on desert grassland. We planned this companion study to compare behavior of fistulated with intact animals under the experimental conditions of Galt's study and thereby to determine the constraints if any on extrapolation of Galt's findings to intact animals. Although it was not possible to compare intact with fistulated steers in this particular study because of severe time restrictions on the senior author and temporary unavailability of intact animals, comparisons might be made with data in the literature or with data from future studies involving intact animals.

Study Area and Experimental Procedure

The study was conducted during the summer of 1967 on an 80-acre tract of desert grassland on the Santa Rita Experimental Range, near Tucson. Velvet mesquite (*Prosopis juliflora* var. *velutina* (Woot.) Sarg.) was completely eradicated from the north half of the tract in 1955. The pasture has been under good range management since treatment. The mesquite in the south half of the tract has not been disturbed and at present covers almost twice as much area as it did in 1900 (Martin, 1966). The mesquite-infested and mesquite-free portions (each 40 acres) were fenced into two pastures in 1966 to facilitate Galt's study.

The pastures are located on a gently sloping alluvial fan dissected by a few shallow dry washes (Fig. 1). Elevation is about 4200 feet. Sixty percent of the annual rainfall (14 to 16 inches) is received from late June through September; most of the remainder falls from December through early April (Martin, 1966). During the summer the maximum daily temperature ranges from 80 to 100 F and the minimum temperature ranges from 60 to 70 F.

Because this study was conducted simultaneously with Galt's study, using the same pastures and animals, certain restrictions were imposed on the conduct of our study. A change-over design (Patterson and Lucas, 1962) was employed to test the following sources of variation: pasture (mesquite and mesquite-free), trials, periods, pairs of steers and among steers. Four fistulated steers were observed during three of Galt's grazing trials of 20 days each between June 27 and September 9 (Fig. 2). At the beginning of the first trial, two steers (A & B) were placed in the mesquite pasture and two (C & D) in the mesquite-free pasture for a 10-day period. For the second 10-day period of the trial the pairs of steers switched pastures. This switch-back procedure was carried on through the second and third trials for the duration of the experiment. Within each period a restricted random procedure determined the sequence for observing each animal on each of two days. The selected animal was followed and observed for a complete day. Thus, within each trial (two periods) each of the four steers was observed for two days in each of the two pastures.

Observation on a particular steer for any given day began when he arose in the morning and continued until he

¹ Arizona Agricultural Experiment Station Journal Article No. 1474. Received April 14, 1969; accepted for publication July 10, 1969.

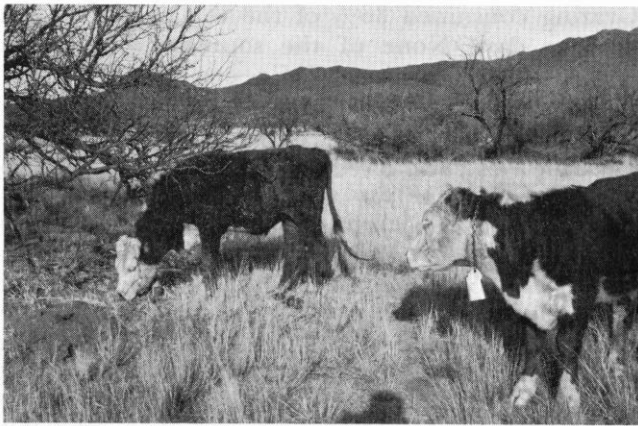


FIG. 1. Fistulated steers grazing desert grassland at the Santa Rita Experimental Range.

ceased grazing with the approach of darkness. The period from rising in the morning until bedding at night is referred to as an animal-day.

Behavioral activities observed were grazing, lying-ruminating, standing-ruminating, walking, standing-idle, lying-idle, drinking, salting, and mastication of a cud. Frequencies of drinking, salting, urinating, defecating and mastication of a cud were also recorded. The time of day at which a change in activity occurred and the amount of time spent in various activities were recorded to the nearest minute.

Once during every 10-day period a pair of steers was observed for a complete night. This was easily accomplished since both steers on the same pasture spent the night together. During dark nights bells which hung from the steers' necks and a flashlight aided the observations. Use of the light affected activity of the steers noticeably; its use was avoided as much as possible. This made it difficult to collect accurately the activity data at nighttime. For this reason nighttime observations are of questionable accuracy.

Galt evacuated the steers on ten days during the course of our study. Because a significant portion of the day was required for the activities involving evacuation, no observations were made on days scheduled for rumen evacuation. Observations were resumed on the day following evacuation. During the third period Galt harnessed the steers with bags for collection of feces. Our study was interrupted

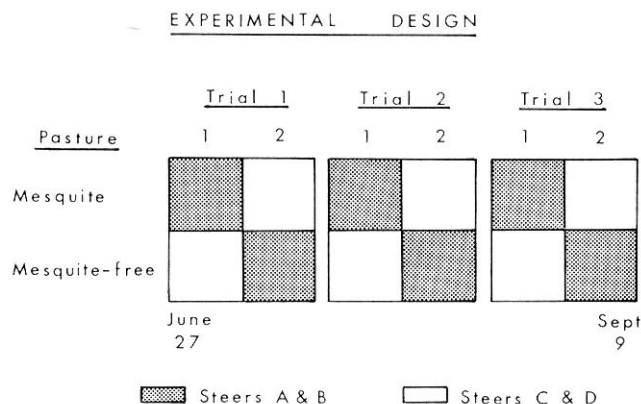


FIG. 2. Schematic diagram of the change-over experimental design.

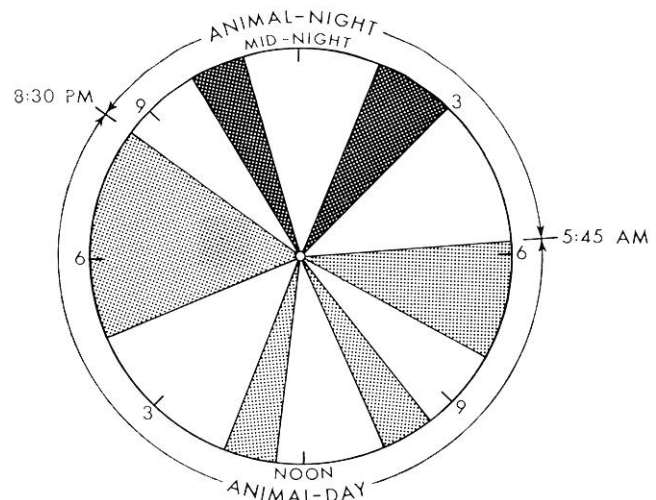


FIG. 3. The steers grazed in four distinct grazing periods (shaded) during the 14.4 hour animal-day; the animal-night was 9.6 hours in duration and involved two grazing periods.

for four days so the steers could become adjusted to the bags. Observations were resumed when the effect of harnessing on animal behavior had diminished.

Results

The 24-hour day was divided into an animal-day and animal-night. The animal-day is the time from rising—about daybreak—until the animal lies down late in the evening. The animal-day was usually the time between 5:45 AM and 8:30 PM and averaged 14.4 hours for the four steers (Fig. 3); it coincided closely with the daylight period. This is less than 15.3 hours reported by Dwyer (1961) for intact Hereford cows, but longer than 13.6 hours reported by Cory (1927) for intact Hereford cows and bulls. The time between 8:30 PM and 5:45 AM represented the animal-night and averaged 9.6 hours. Analysis of variance showed that length of animal-day was unrelated to the sources of variation tested.

Grazing.—Grazing time is the time animals spent grazing and the short time in walking while selecting forage. The steers grazed in a characteristic daily pattern throughout the study. Each animal-day was composed of two major and two minor grazing periods. Major periods occurred in the early morning and late evening; the two minor periods occurred around mid-day (Fig. 3). The first major period began with rising about 5:45 AM and lasted until 8:00 AM. The next grazing period was a minor one; it began at 9:30 AM and lasted until 10:30 AM. The second minor grazing period occurred between 12:30 and 1:30 PM. The last daylight period was the one of greatest activity; it began about 4:30 PM and lasted until 8:30 PM. There was no difference between groups of steers or pastures in total grazing time; the steers foraged

Table 1. Duration of various behavioral activities of fistulated steers during the animal-day, animal-night, and 24-hour day.

Activity	Animal-day		Animal-night		24-hour day	
	Hours	% of period	Hours	% of period	Hours	% of period
Grazing	6.7	46	2.0	21	8.7	36
Ruminating	4.4	31	2.4	25	6.8	28
Lying	2.8	20	2.1	22	4.9	20
Standing	1.6	11	0.3	3	1.9	8
Idling	2.2	15	3.9	41	6.1	25
Lying	1.2	8	3.7	39	4.9	20
Standing	1.0	7	0.2	2	1.2	5
Walking	0.39	2.7	—	—	—	—
Drinking	0.09	0.6	—	—	—	—
Salting	0.61	4.2	—	—	—	—

for 6.7 hours per animal-day. This is a longer time than 6.0 hours reported by Cory (1927) but similar to 6.5 hours described by Lampkin et al. (1958). Culley (1934) reported 7 to 8 hours of grazing per day for intact cattle under diverse summer grazing situations on the Santa Rita Experimental Range. He mentioned only two grazing periods each day, early morning and late afternoon. The early morning grazing period for our study involved 28% of the daylight grazing time, compared to 44% for the major period in the evening. The minor grazing periods of the forenoon and afternoon averaged 12 and 13% of the daylight grazing time, respectively.

During the two major grazing periods, steers consumed many bites of forage within a single step. During the two minor grazing periods, the steers grazed more leisurely; they usually walked several steps between bites. When grazing a particular plant, a steer would observe the plant, walk toward it, and sniff it before either eating or rejecting the plant part. The steers repeated this throughout the grazing period. The time taken to complete the cycle was very brief and difficult to determine.

The animals grazed during two distinct periods at nighttime. The first period was usually between 10:00 and 11:00 PM; the second was between 1:30 and 3:00 AM (Fig. 3). The steers averaged 2.0 hours of grazing per animal-night (Table 1). Although Dwyer (1961) also reported two hours of nighttime grazing for intact Hereford cows in an Oklahoma study, most authorities have found that cattle seldom spend this much time in nighttime grazing (Hancock, 1953). Culley (1934) reported that cattle frequently grazed until 11:00 PM in the spring, but made no other reference to nighttime grazing.

The steers grazed 8.7 hours during a 24-hour day; 77% of this grazing time occurred during the animal-day and 23% during the animal-night.

Grazing consumed 36% of the total activity in a 24-hour day. None of the sources of variation tested had a significant influence on total daily grazing time.

The effect of several extraneous factors on grazing time was considered. Temperature seemed to have some effect. On very hot days (when temperatures reached 90–100 F) the steers preferred to lie down under a shrub or small tree until temperatures receded, than to graze in the mid-day heat. On very hot days the steers grazed until late evening, i.e., until about 9:00 or 9:30 PM. On some days animals were observed during heavy rainfall. The steers stopped grazing as the rain began and stood at the spot where they were last grazing. They often ruminated during periods of rainfall and resumed grazing as the rainfall stopped. Thus, rainfall, if intense, seems to limit grazing time.

Amount of moonlight has been suspected by some researchers as an influence on nighttime grazing. In our study duration of nighttime grazing was not influenced by presence or absence of moonlight—nor were other nighttime activities. This result is in accord with most studies on intact animals (Hancock, 1953).

Ruminating.—The second most time-consuming animal activity, next to grazing, was rumination. Rumination time as defined by Hancock (1953) is the total time spent in regurgitation, mastication and swallowing of ruminal ingesta, and the short intervals between boluses. The steers ruminated while either standing or lying down, and in rare cases, while walking slowly.

Rumination time averaged 4.4 hours per animal-day. Of this, steers ruminated 1.6 hours while standing and 2.8 hours while lying down (Table 1). Total ruminating time per steer was about the same as that reported for Hereford cows by Dwyer (1961). Ruminating time differed significantly among trials. Steers ruminated for an average of 3.8, 4.3 and 5.1 hours per animal-day during the first, second and third trials, respectively. The first trial coincided with the stage of rapid growth for most herbaceous species. By the end of the third trial, plants had matured and lost their green color. Difference in ruminating time among trials appears to be related to changes which normally occur in maturing forage. Ruminating time did not vary with other sources of variation.

Determination of ruminating time at night was the most difficult of all observations. Use of a flashlight disturbed the steers; they either stopped ruminating and stared at the observer or they walked away. This difficulty undoubtedly introduced errors in the results. During the animal-night, the steers ruminated an average of 2.4 hours; 2.1 hours occurred while lying down and 0.3 hours

occurred while standing. Thus, during darkness steers definitely preferred to ruminate while lying, whereas during the daylight this preference was less apparent.

The steers ruminated for 6.8 hours in each 24-hour day, the same as reported by Hughes and Reid (1951) for intact Hereford steers. The steers ruminated 1.9 hours while standing and 4.9 hours while lying down. Total ruminating time comprised about 28% of the 24-hour activity, with 65% of the rumination done during the day. Based on a sample of one hundred boluses for each animal, the average number of mastications was 45 per bolus. This is less than 53 found by Hancock (1954) but higher than 39 found by Wagnon (1963) for intact cattle. The average time required to masticate each bolus was 41 seconds; about the same as 44 seconds reported by Dwyer (1961).

Idling.—Idling time is the time an animal spends in lying and standing positions while not engaged in either grazing, ruminating or walking. The steers idled for 6.1 hours or 25% of their time per 24-hour period (Table 1). This is somewhat less than 7.1 hours reported by Hughes and Reid (1951) but more than 4.6 hours reported by Nelson and Furr (1966). The steers idled 2.2 hours per animal-day and 3.9 hours per animal-night. None of the sources of variation significantly influenced idling time.

The steers idled-standing an average of 1.0 hours per animal-day, but only 0.2 hours at night for a total of only 5% of the 24-hour activity. They spent much less time standing idle than animals reported in the literature (Hancock, 1953). The steers idled-lying 1.2 hours per animal-day and 3.7 hours per animal-night, or a total of 4.9 hours in each 24-hour day. This is higher than 2.0 hours reported by Nelson and Furr (1966) but similar to 4.2 hours reported by Lampkin et al. (1958). Lying-idle time represented 20% of the animals 24-hour activity.

At the beginning of the animal day, the steers usually stood idle for a short time before grazing. Upon rising they completed rumination (which they normally performed before rising), stretched themselves, licked their bodies and then walked to a nearby tree to scratch. During grazing periods the steers commonly ceased grazing for some time to stand idle, to observe other animals or automobiles passing along a nearby road. The animals largely or altogether ceased grazing activities at times and looked for protection from the sun. On the warmer days they spent their idle time by standing more than lying, and on very hot days they alternated periods of lying-idle with standing-idle. In some cases the steers seemed to tire of lying idle and rose to rest standing. In most cases they sniffed the ground before lying down. When

lying, they tended to lie on their left side more than their right. This may have been because of the fistula which was located on their left side.

Walking.—Walking time is that time spent walking or running from one place to another exclusive of the short steps taken while grazing. Most of the walking time was spent going to and coming from water and salt. The steers walked 0.4 hours per animal-day. This comprised only 2.7% of the animal-day activity and a much shorter period of time than 96 minutes reported by Wilson (1961) but higher than 14 minutes reported by Hughes and Reid (1951). None of the sources of variation tested affected walking time.

Drinking.—Drinking habits varied widely during the course of study but were not significantly related to sources of variation tested, probably because of high error variance. The average frequency of drinking was 2.7 times per animal-day, a figure which is a little higher than most observations reported in the literature (Hancock, 1953). The high frequency might have been caused by loss of moisture through the fistula or perhaps because of the rumen evacuations conducted by Galt. Culley (1934) inferred that intact animals grazing this same experimental range, but obviously in much larger pastures, watered only once daily, usually in the morning. However, some cattle varied from this habit by watering every other day or in the afternoon. Culley mentioned no variation in watering frequency because of time of year.

The steers commonly drank twice daily, but on occasion drank as many as four times. The first trip to water occurred between 7 and 8 AM, after which grazing was resumed. The steers returned to water about noon. After this watering they sought the shade of a tree. Air temperature, wetness of plants and rainfall seemed to influence the frequency of drinking. On especially hot days, the steers drank three or four times a day. The third trip to water usually occurred about 4:30 PM and the fourth without any apparent pattern. On days when plants were wet either from rainfall or heavy dew, the animals drank only once or twice daily. During the twelve nights of observation, the steers drank on only two nights and then they made one trip for water. Average duration of drinking time was 5.2 minutes per day.

Salting.—Whenever the animals drank water, they also licked salt from the single block of plain salt located about 30 feet from water in each pasture. The animals never licked salt without drinking and they did not lick salt at night. Thus, the average frequency of salting was the same as for drinking, 2.7 times daily. Whether the frequency of drinking and salting would have been as highly correlated, had the salt been located at some distance to water is problematical.

The steers licked salt an average of 37 minutes per day or 4.2% of the daily activity (Table 1). This is much higher than 7.6 minutes reported by Cory (1927) or 15 minutes by Culley (1934). There was a highly significant difference among the four steers in the time spent on salt. The average time ranged from 32 to 48 minutes per day.

In most cases the animals licked salt after drinking water. Frequently a steer alternated drinking and licking several times during one visit. Thus, a steer walked directly from the pasture to water; after drinking, the steer walked to the salt and licked for several minutes, then returned to the water and back to the salt. This cycle was repeated as many as five times. Finally, they went directly from salt—not water—to perform other activities such as grazing, ruminating or idling. Culley (1934) noted that "... while some cattle did alternate between water and salt, there were equally as many that drank only once, then ate salt, or vice versa, and left."

Defecations and Urinations.—Steers defecated an average of 7.9 times per animal-day and 4.3 times per animal-night. The total of 12.2 defecations per 24-hour period is identical to the figure reported by Dwyer (1961) for intact Hereford cows. The steers urinated an average of 5.5 times per animal-day, somewhat higher than 4.6 times recorded by Dwyer (1961). The decrease in frequency of urination from 8.0 per animal-day in the first trial to 6.5 and 4.4 times in the second and third trials was highly significant. This was associated with increasing plant maturity and dryness as the growing season progressed. Thus, the significant difference among trials was likely caused by changes in moisture content of the plants.

Discussion and Conclusions

The fistulated steers followed a systematic behavioral pattern throughout the study period. They grazed during six distinct periods each 24 hours, four during daylight and two at night. The first and last daylight periods involved concentrated, methodical grazing. Forenoon and early afternoon grazing periods were brief, interrupted, and more leisurely. Grazing was the dominant daylight activity and involved 49% of the activity. The steers spent 32% of the daylight hours ruminating and 19% idling. The steers were not reluctant to graze at night; they spent 21% of the animal-night grazing, a figure which is considerably higher than most reported in the literature (Hancock, 1953). The steers ruminated 25% and idled 41% of the animal-night. For the entire study period, the ratio of grazing time to rumination time to idling time on a 24-hour basis was 1.4:1.1:1.0.

In most instances, the fistulated steers responded in similar fashion to intact animals as reported in the literature. It seems probable that differences

noted may be attributable to differences in experimental conditions such as climate, forage conditions, size of experimental units, and location of water and salt within pastures, rather than innate differences between fistulated and intact animals.

The sources of variation used in this study had little impact on behavioral activity. Presence or absence of mesquite in the pastures had no significant effect on activity of the animals. Rumination time and frequency of urination were each affected by season; rumination time increased with maturity of forage, and frequency of urination decreased as forage moisture content decreased.

The four steers were very similar in the performance of various activities; they differed from one another only in daily salting time. Steers always licked salt when they drank water, but in the watering-salting sequence the steers always completed the sequence with salting and went directly from salt to resume grazing, ruminating or idling activities. These observations do not provide answers to the controversy on salt placement, but they suggest that experiments to test animal behavior as a function of salt placement may yield some answers.

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