Behavior and Weight Loss of Feeder Calves in a Railcar Modified for Feeding and Watering in Transit

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The behavior of 164kg Angus and Hereford calves was studied in a double deck 26m x 2.6m "jumbo" railcar equipped with feed and water. A 4,180 liter water tank positioned in the center of each deck divided the car into four compartments. Fifty head were loaded into the lower and upper forward compartment (252kg/m² floor space), each containing 675kg of hay in racks. The two rear compartments served as quarters for equipment and researchers. Two video cameras were mounted in the upper forward compartment containing calves. Behavior of the calves was monitored, with portions video taped during rail transport from Memphis, Tennessee to Amarillo, Texas (57 hr) in June, 1979. The calves commenced eating and drinking immediately after being loaded in the railcar. Up to 75% of the cattle could lie down while the car was not in motion (14.4 hr of trip). Calves stood at high speeds (80km/h) on unimproved track but continued to eat, drink and move about. Self and mutual grooming commonly occurred while traveling up to 40km/hr. Railcar temperature and relative humidity ranged from 17.8 to 41.1 °C and 54 to 99%, respectively, and was identical to outside. Weight loss for 50 similar calves shipped by truck was 10.6% while rail calves lost 4.5% during truck transport to the railcar (11.3 hr) and 2.1% during rail transport for a total of 6.6%. Average daily gain (ADG) from initial weight to 7 days postshipment was .45kg for rail and -.02kg for truck, but ADG became similar at 30 days indicating full recovery. One truck calf was dead on arrival and 8% of the truck and 5% of the rail calves were treated for shipping fever. Excluding feedcosts, rail transport at 252kg/m² floor space costs 30% less per calf than transport in fully loaded trucks.

Introduction

The United States' first federal animal welfare law was enacted in 1883 and was known as the "28-hour" law. It regulated, relatively ineffectively, the interstate transportation of livestock by railroad and ship. The present version of the "28-hour" law, (Public Law No. 340), was enacted in 1906 and has been very effective (the Animal and Plant Health Inspection Service, USDA, 1978). Public Law No. 340 states in part:

> *"That no railroad, ...or the owners or masters of steam, sailing, or other vessels carrying or transporting ...(animals) ...shall confine the same in cars, boats, or vessels of any description for a period longer than twenty-eight*

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consecutive hours without unloading the same in a humane manner, into properly equipped pens for rest, water, and feeding for a period of at least five consecutive hours, ..."

Section three states in part:

"That when animals are carried in cars, boats, or other vessels in which they can and do have proper food, water, space, and opportunity to rest the provisions in regard to their being unloaded shall not apply."

Motor transport was excluded because it had not come into general use in 1906. The "28-hour" law has never been amended to include animals moved interstate in trucks. Due to the increased mobility and speed of trucks and the added economic burden on the railroads of conforming to the "28-hour" law, essentially all livestock in the USA are now transported by truck.

Recent increases in the cost of energy are making transport of animals by rail, which has at least a four-to-one fuel efficiency advantage over trucks (Clark, 1979), more attractive. Most railroads in the United States refuse to transport livestock, citing the high costs of labor necessary to conform to the "28-hour" law, the switching required to unload cattle cars, and a lack of cattle handling facilities. There is also some evidence that rest stops can be more detrimental to the animals than shipping direct (Kilgour, 1978).

The purpose of this study was to monitor the behavior of calves shipped in a railcar equipped with feed and water. Density was planned to allow the cattle to lie down. These data would then be used to determine if this method of transport conformed to the intent of the "28-hour" law.

Procedure

Railcar

The double-deck 26m by 2.6m "jumbo" railcar had a 4,180 liter water tank placed against a side wall in the center of each deck. A door extended from the tank to the opposite wall, dividing each deck into two compartments. There was one drinking well on each side of the tank. Water level in the well was controlled by a self-filling vacuum system. A float board was used in each well to prevent splashing.

Inside height of the bottom deck was 1.7m and upper deck, 1.8m. The floor of the top deck consisted of alternating 14cm wide strips of flat steel and wood running across the car with the wood being beveled and extending 2cm above the steel. Excrement from the top deck could not drain onto the lower deck. The all wood bottom deck was similar in configuration.

Twelve temperature probes were placed in and around the cattle compartments. Fig. 1 shows location of the water tank, a television camera, and hay racks. The door connecting the two compartments is open. Hay racks, made of strips from automobile tires, were installed the length of the car. Each compartment held 675kg of hay in rectangular bales. The car was cleaned and bedded with fresh straw, and was positioned next to last on a 114-car train. Cattle were loaded in the forward half of both decks directly out of trucks. No loading or unloading facilities were required. The aft half of the cattle car served as living quarters for the researchers and housed the monitoring equipment.

Figure 1. Water tank, hayracks, television camera, and floodlights taken from the middle of the cattle compartment looking toward the compartment used for living quarters. The door dividing the two compartments at the water tank is open.

Behavioral observations

Video cameras were installed in the top forward compartment. Camera #1 was mounted on top of the water tank (Fig. 1). A convex mirror mounted on the ceiling and positioned to appear in the top of the video picture provided a view of the waterer directly beneath the camera. Camera #2 was mounted in the forward part of the car to monitor the activity of animals as they moved from one end of the car to the other. However, it was difficult to identify calves when they were midway between the cameras due to the low camera angle. Activity was continuously monitored during transport with portions recorded for later analysis at 18 hr/1 hr video tape using NEC VC-7505* ¾ inch cassette time lapse recorder. Minor frequency fluctuations in the electrical generator prevented use of slower time lapse speeds, *i.e.*, 36 or 72 hr tape.

Direct observations were also made through the door separating the compartments while traveling and through the sides of the car while stationary.

Experimental animals

One hundred and fifty Angus and Hereford steer and heifer calves averaging 164kg were obtained in Newport, Tennessee. They were fed a corn silage-based 16% crude protein conditioning ration in a feedlot for sixty days prior to transport. Fifty randomly selected calves were loaded into a conventional cattle truck and transported directly to the Texas Agricultural Experiment Station feedlot at Bushland, Texas. The calves were placed in compartments at the same density as if the truck had a "typical" full load. The remaining calves were transported by truck to Memphis, Tennessee where they were again weighed and immediately transferred to the railcar. Fifty head were loaded in the forward half of each deck (252kg/m^2 of floor space). This was 8.2kg/m^2 less than the load density recommended by Ashby and Landridge (1970) for export shipments of less than seventy-two hours duration. Large

*NEC America, Inc., Elk Grove Village, Illinois.

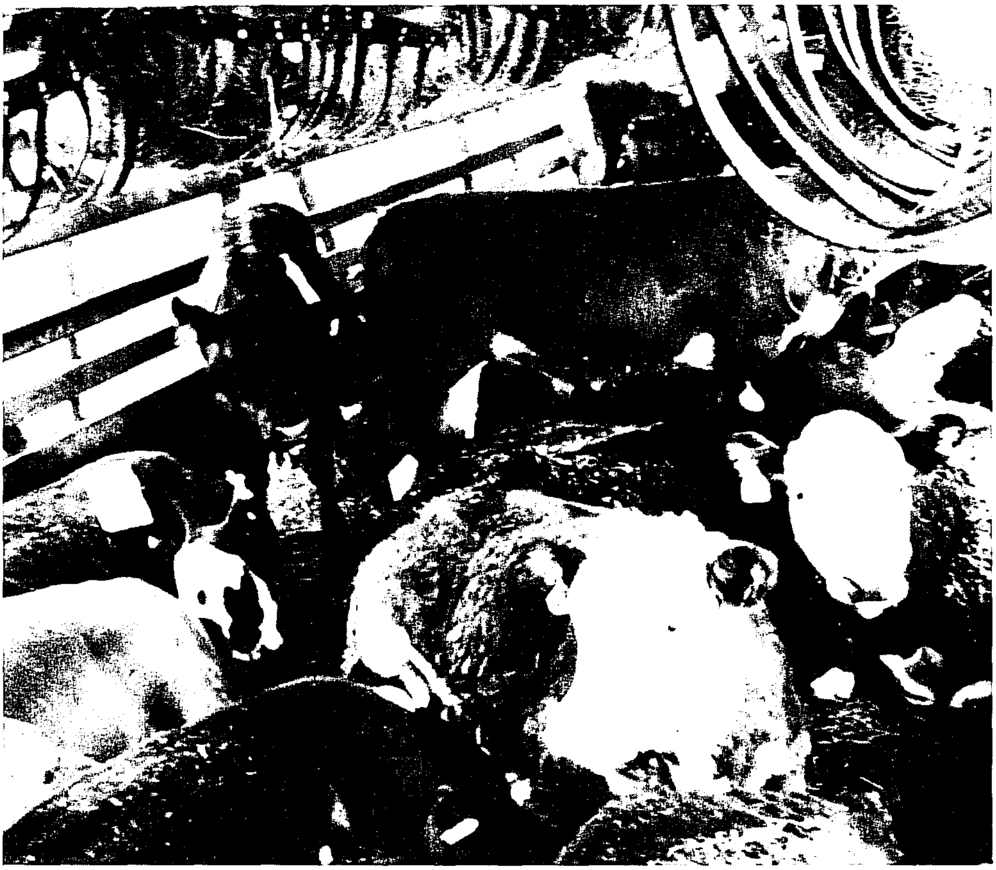

Figure 2. Cattle resting while train was stopped.

numbered tags were glued on the backs of ten randomly selected calves loaded on the top deck to serve as representative samples. The calves remained in the railcar until they reached Amarillo, Texas where they were trucked (.75 hr) to the feedlot at Bushland. The calves were weighed after 0, 7, 14, 28 and 48 days in the feedlot. Data were subjected to analysis of variance.

Results

The calves were in the railcar a total of fifty-seven hours. Time spent in transit, distance traveled and speed of the different phases of the shipment are summarized in Table I.

Calves were loaded in the railcar on June 26 at 1800 hours and immediately commenced eating hay and drinking water. Thirteen different calves drank during the first thirty minutes, reflecting the water deprivation during transport to the railcar. The calves remained highly active (exploratory behavior) for the first two hours after loading, with many animals moving from one end of the compartment to the other in less than fifteen minutes. The first animal was observed lying down at 2000 hrs. At 2233 hrs two-thirds of the calves on the bottom deck were lying down. None were lying down on the upper deck, but these were disturbed several times by personnel checking equipment.

Many of the cattle were lying down while the train was standing (~25% of the time in transit) or moving at slow speeds (30km/hr or less). Lying while the car was moving was a common occurrence from midnight of the first day on. If the ride was rough, almost all would stand. Those that remained lying were usually along a wall or in the blind area by the door separating the compartments (e.g., Fig. 6), perhaps to reduce the chance of being stepped on by calves attempting to maintain their balance.

The ride became extremely rough (pitch and sway) when the train was moving at high speeds (80km/hr) over unimproved sections of track. These periods rarely lasted more than one to two hours because the train was required to slow down when going through metropolitan areas. Since the car was pulled at the end of the train, occasional strong jolts were received during changes in speed due to the accordian action of the other cars. The train twice broke an air line and the automatic brake system caused an abrupt halt which threw the calves to the front of the car. Only once, however, was a calf observed to lose its footing during such a stop. Some calves appeared to be aided in maintaining balance by physical contact with others. Examination of video tapes showed that the calves positioned themselves in a random manner throughout the car regardless of speed and smoothness of ride. No tendency for them to maintain a head-to-head or head-to-tail orientation was observed. In concurrence with the observations of Kilgour and Mullord (1973), they avoided contact with the sides of the car when it was moving.

TABLE I. Distance Traveled, Average Speed, and Time Calves Spent on Trucks and Railcar

Carrier	Distance (km)	Average Speed (km/hr)	Time (hour)
Truck (Newport to Memphis)	750	66.5	11.3
Railcar (Memphis to Amarillo)	1226	21.4	57.2
Truck (Amarillo to Bushland)	24	32.0	.75
Overall	2000	28.6	69.2
Truck (Newport to Bushland)	1976	54.9	36.0

The calves continued to eat hay and drink regardless of the smoothness of the ride. Thirty-six different calves drank during an hour of the roughest ride experienced. When the car was standing still, hay and water consumption was greatly reduced as calves lay down to rest. Only one calf drank during the last 30 minutes of a 4 hr period, when the car was stopped. This occurred after 46 hrs in the railcar, and the highest temperatures were recorded during this stop. When the car started moving, the calves stood up and commenced eating and drinking. Apparent hay (5.1kg) and water (21 liters) consumption per head per day was normal (National Research Council, 1976). There was little wastage of hay, and the float board in the waterer was very effective in preventing splashing.

Five mounting attempts and frequent self and mutual grooming were observed. Social grooming occurred even while the train was moving at moderate speeds. Figs. 3, 4, 5 and 6 show the activity patterns of four calves under varying conditions. Calves traveled the full length of the compartment in as little as 12 minutes (Fig. 5). Animal density (.65m^2/head) permitted 75% of the animals to lie down at one time when the car was still, which accounted for 14.3 hours of the trip. Many calves continued to lie when the train was moving at slow to moderate speeds (15-50km/hr).

Ambient temperature and relative humidity ranged from 17.8 to 41.1 °C and 54 to 99%, respectively. Temperature inside the car was identical with outside temperature, due to the open sides of the car. The maximum temperature (41.1 °C) occurred when the car was stopped in a railyard. The calves showed no heat stress despite the presence of only a slight breeze.

Weight loss of calves shipped by truck was 10.6%, and was similar to that reported in other studies (Table II). The rail shipment had a weight loss rate which was 6.6% lower (P .01) than the truck shipment (4.5% during truck transport to the train, and 2.1% during rail transport and the truck ride to Bushland). Since the calves could not be weighed until after being trucked to Bushland, some of the 2.1% loss attributed to the railcar may have been caused by truck transport from Amarillo to Bushland. Four of fifty calves in the truck shipment and five of the 100 rail calves were treated for shipping fever after arrival at Bushland. One calf in the truck shipment was dead on arrival (pneumonia). The rail calves also had a significantly higher average daily gain at 7 and 14 days post-transit, but there was no difference after 28-48 days (Table III).

TABLE II. Typical Weight Loss (Shrink) of Cattle Transported by Truck

Source	Number of Animals	Distance Shipped (km)	Shrink %
Addis and Crenshaw (1969)	1,294	1,900	9.5
Self and Gay (1972)[1]	297	1,005	8.9
Embry *et al.* (1968)	80	1,450	7.8
Hale *et al.* (1967)	72	1,500	10.8
This study	50	2,000	10.6

[1]Cattle originating from sale yards, shipped during the summer.

TABLE III. Average Daily Gain From Preshipment Weight (Actual Pay Weight) for Calves Transported by Rail and Truck

	Average Daily Gain (kg)	
Period	Rail	Truck
Preshipment—7 days on feed[1]	.45 ± 1.47	-.02 ± 1.04
Preshipment—14 days on feed[2]	.79 ± .76	.58 ± .88
Preshipment—28 days on feed	.97 ± .50	.94 ± .43
Preshipment—48 days on feed	.96 ± .33	.99 ± .23

[1]Rail differed from truck, P<.05.
[2]Rail differed from truck, P<.04.

The railroad charged $1.02/km, while truck transport cost $.86/km. Assuming 200 calves were transported in the railcar at the density used in this study (50 calves in each compartment) and the trucks were carrying a "typical" full load of 164kg calves (100 head each), transport by rail would save 30% per km transported. When the cost of truck transport (39% of the distance moved was by truck) and all feed costs are included, there was an overall savings of 21% or $717 compared to shipment solely by truck.

Discussion

The calves appeared relatively uninhibited while in the railcar. They ate readily, each of the tagged animals drank several times a day, and self and mutual grooming occurred frequently. This indicates that the environment in the railcar was not overly stressful.

Optimal density in regard to behavioral factors should be determined. Density must be expressed on a weight basis rather than by number of animals to account for differences in animal size. There is also a strong possibility that the relationship between weight and space requirements may not be linear, especially for extremely light and heavy cattle. Excessive density would inhibit movement to the waterer and feeder and reduce or prevent lying. Cattle will resist lying as long as possible under crowded conditions. Animals are trampled when fatigue forces them to lie down and an excessive density does not leave them enough maneuvering room to get up. Our subjective observations indicate onset of fatigue after 14 hours. This would vary with the age and condition of the calves and the mode of transport. Kilgour and Mullord (1973) judged 13 hours of continuous travel to be the critical time for weaner calves in trucks, while Sutton *et al.* (1967) concluded that 24 hours was the maximum for 360kg oxen in railcars.

The calves were remarkably adept at maintaining their balance and conducting "normal" activity even when the ride was very rough. During severe jolts that occurred when the train's brakes locked, the cattle were thrown forward but received support from the other cattle due to the relatively high density. The animal that fell was at the waterer (rear most part of the compartment) and did not receive support from other calves.

Limiting group size is important to insure calves are not crushed by the combined force of herd mates during sudden jolts of the car or when loading and unloading. Ashby *et al.* (1977) found forty to be an acceptable group size for transport of sheep in aircraft, while sixty was too large. These authors concluded that group

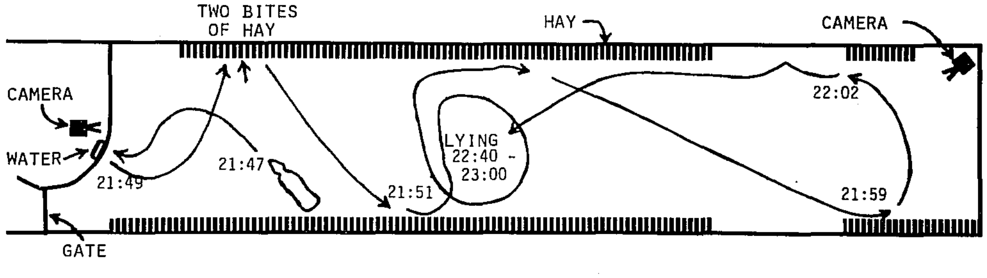

Figure 3. Activity of calf #5 from 2147-2300 hr on June 26. Calves were loaded on railcar on June 26 at 1800 hr. The train started moving slowly through the yard at 2300 hr.

size seemed more important than density. Bailey (1979) recommends group sizes of up to forty for cattle under 315kg and twenty for animals exceeding that weight, based on research with ocean shipments. The group size of fifty used in this study for 164kg animals was probably marginal; however, more research is needed in this area.

The lack of any special orientation of our calves is in contrast to two rail shipments of oxen observed by Sutton *et al.* (1967). A pronounced parallel orientation perpendicular to the direction of travel was observed while the train was moving. They did not, however, include data on density (though it was probably much greater than in this study), or where the car was placed on the train. An important consideration may be the amount of sway (caused by condition of the track) and the amount of slap occurring during changes in speed.

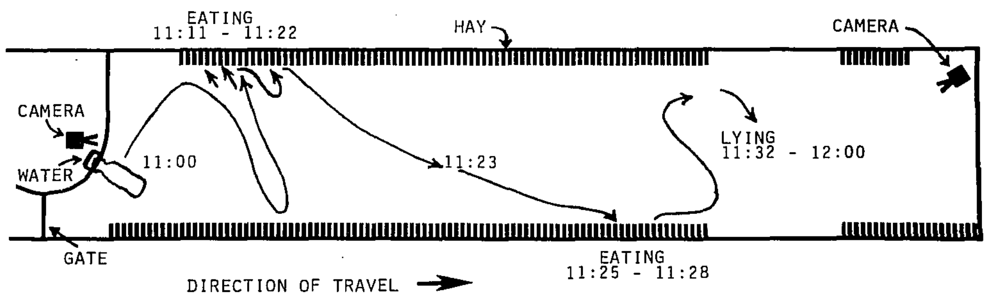

Figure 4. Activity of calf #9 from 1100-1200 on June 27. The train was moving at high speed (80km/hr) on poor track and slowed to 40km/hr at 1132 hr.

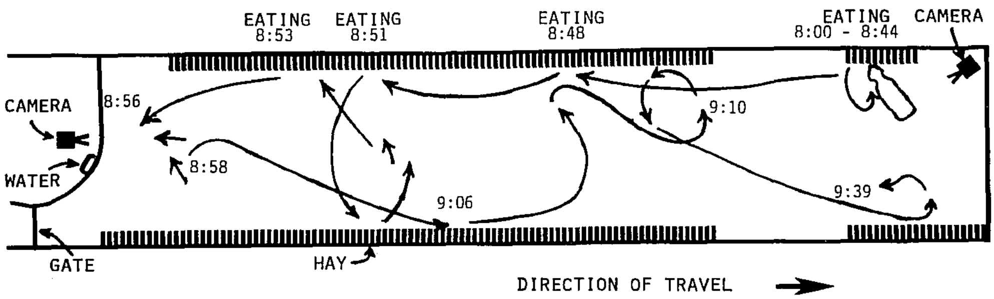

Figure 5. Activity of calf #2 from 0800-0939 on June 28. The train was stopped until 0820 hr when it started moving at 30km/hr.

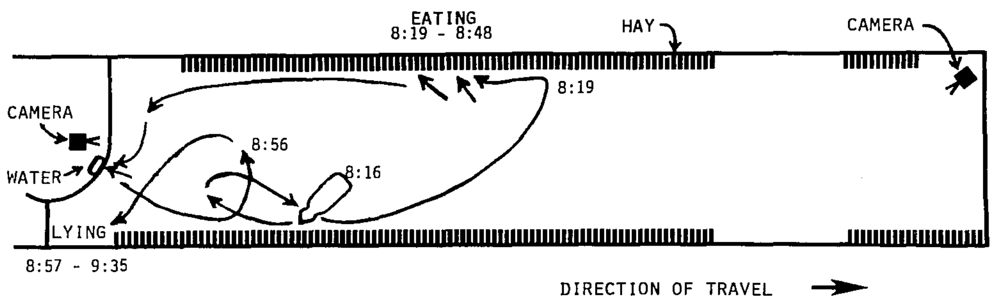

Figure 6. Activity of calf #7 from 0816-0935 hr on June 28. The train was stopped until 0820 hr when it started moving at 30km/hr.

Conclusions

Transport by rail in cars with feed and water with adequate space appears to have some advantage over transport by truck. The calves were transported at a savings in cost and reduced weight loss. The difference in weight loss, however, was only temporary. The truck calves fully compensated in approximately 30 days. A major problem with rail transport is the increased time in transit and the possibility of extended delays. The use of unit trains (composed entirely of cattle) would greatly reduce transit time. Cattle at the density and weight used in this study could have stayed on the car much longer without ill effect based on their appearance; however, hay and water would have had to be replenished.

Acknowledgements

Railcar modifications were by William Gentlemen and Sons, Amarillo, Texas.

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