TECHNIQUES FOR REARING MOOSE CALVES WITH RESULTING WEIGHT GAINS AND SURVIVAL

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Abstract: Neonatal moose (Alces alces) were hand-reared for experimental studies on parasites. Forty-four of 54 calves were successfully weaned using a formula of 1:1 whole bovine milk:evaporated milk to which colostrum was added. Thirty of 36 calves survived from weaning to January 1. Milk formula and volume, cleanliness of facility, detailed observations and data recording, and prompt medical attention were considered most important for success.

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Raising neonatal, wild ungulates by hand is one of the only ways to ensure tractable animals for use in wildlife studies. However, the process is difficult, time consuming, and can be unrewarding. Techniques for raising moose (Alces alces) calves have been reported by Dodds (1959), Markgren (1966), Landowski (1969), Regelin et al. (1979), Lautenschlager and Crawford (1983), and Addison et al. (1983). Only Addison et al. (1983) report rearing several groups of moose under different conditions and during different years. Their success was variable.

This paper summarizes our experiences raising moose calves and presents data on survival and weight gains of 44 moose calves successfully raised to weaning at the University of Alberta from 1980 to 1984.

MATERIALS AND METHODS

Rearing Facilities

Since 1974, many neonatal moose, mule deer (Odocoileus hemionus), and white-tailed deer (Odocoileus virginianus) have been reared at the University of Alberta, Biomedical Animal Centre, Ellerslie. Facilities there include a small barn (220 m^2) with adjoining runways and two small (0.25 ha) and one larger (0.5 ha) grassy paddocks. Within the barn are 12 concrete-floored pens (3m x 3.5m) separated by 2.5 cm mesh wire. Each pen is equipped with an automatic watering bowl and adjoins an outside, concrete runway (3m x 9m). A central corridor provides access from each pen to a closed-stall scale located within the barn. The

barn is heated during cold weather and well ventilated at all times, maintaining a temperature of 10°C to 25°C.

Acquisition and Early Care

From mid-May to mid-June, orphaned (or non-orphaned) moose calves were collected (or captured) from various parts of Alberta and brought to our facility. Most calves were less than one-week old but two older animals arrived in August. Fifteen calves were received in 1980, 11 in 1981, 16 in 1982, and 12 in 1984. These numbers exclude a few animals brought to the facility after suffering various serious accidents; these calves died or were killed soon after arrival for humane reasons.

Upon entry to the facility, all animals were thoroughly examined for wounds and other signs of trauma. A detailed history, compiled for each animal included date and location of capture, feedings previous to arrival, and notes on behavior. Calves received after 10 June were isolated for three to five days and observed for infectious diseases. Feces were examined for eggs or larvae of internal helminths.

Feeding Procedures

All calves were bottle-fed a milk formula of one part whole, unpasteurized bovine milk to one part evaporated milk. At each feeding, 68-136 ml (2-4 oz) of bovine colostrum was added to the formula. Feeding schedules varied between years (Table 1).

Table 1. Approximate feeding schedules for calves reared at the University of Alberta, 1980-1984.

Week since arrival	1980		1981		1982		1984	
	l/d*	Times/ day**	l/d	Times/ day	l/d	Times/ day	l/d	Times/ day
1	2.84	6	2.48	6	2.13	6	2.13	6
2	3.25	6	2.84	6	2.13	6	2.48	6
3	3.55	6	3.25	5	2.48	6	2.48	6
4	3.84	5	3.55	5	2.66	5	2.84	6
5	3.79	4	4.02	4	2.96	5	2.66	5
6	3.19	3	3.19	3	3.08	4	2.37	4
7	3.19	3	3.19	3	3.55	4	2.37	4
8	2.84	3	2.84	3	2.48	3	1.78	3
9	2.66	3	2.66	3	2.13	3	1.18	2
10	2.25	2	2.25	2	1.77	2	1.18	2
11	2.25	2	2.25	2	1.42	2	0.71	2
12	1.12	1	1.12	1	0.89	1	--	-

* Liters of milk formula per day
** Number of feedings per day

Varying development between individuals demanded some flexibility in these schedules. Advances in the feeding schedule were based on animal health, weight gains, and amount of formula consumed. Milk was warmed before each feeding.

Soil and water were available throughout the pre-weaning period. Alfalfa/timothy hay and fresh aspen (Populus tremuloides) and willow (Salix sp.) browse were offered daily after one to four weeks of ago. In 1980, Dolomite pills and bone meal were given as a calcium supplement. In 1981 and 1982, a powdered vitamin supplement (Pervinal, 8 in 1 Pet Products, St. Aubrey, N.Y.) was occasionally mixed into the formula. No vitamin supplements were used in 1984 because moose seemed to be quite healthy.

Detailed records of the amount of formula consumed, defecation, urination, activities, and general condition were recorded for each animal after each feeding. In 1980, 1981, and 1982, all calves were weighed twice weekly until weaning and once weekly thereafter. In 1984, calves were weighed daily until weaning, and weekly thereafter.

Two to 5 calves were housed together in each indoor pen throughout the summer. Access to the outside runways was permitted in dry weather after the first few weeks. Calves were put into the grassy paddocks during the day after 4 to 5 weeks. After weaning, moose were permanently housed outside in cement-floored pens or the larger paddocks.

Cleanliness was stressed. All bottles and nipples were rinsed immediately after each feeding. Bottles were sterilized in the steam cycle of a dishwasher and nipples were immersed and stored in a disinfectant bath (Enz-all, R and M Chemicals, Nisku, Alberta) between feedings. Each week, the straw lining the pens was replaced and feed troughs and watering bowls were cleaned. All personnel entering the animal pens wore coveralls and rubber boots. A creosote foot bath was used immediately upon entering the barn from outside or from the outside paddocks. Separate coveralls and rubber boots were used for handling sick animals.

Weaning Procedures

Techniques for weaning calves onto solid food evolved considerably over the four years. In general, the transition from a milk formula to a solid diet was accomplished by gradually reducing the frequency of

feedings after 2-4 weeks, and by reducing daily volumes after 5-7 weeks. Solid foods were made more available as milk volume was reduced. The greatest changes in our weaning techniques have been in the amount and types of solid foods offered during the weaning period.

In 1980, the animals were to be weaned onto a modified Moose Research Center "special" ratio (see Schwartz et al. 1980) containing 25% aspen sawdust (13.1% protein, 17.8% fiber). In order to accustom the animals to eating aspen sawdust, sawdust was initially mixed with soil starting at week four. Over time, the proportion of sawdust to soil was increased until there were two separate containers in each pen, one with sawdust and one with soil. Finally, a pelleted deer ration (17.9% protein, 14.9% fiber) was gradually mixed with the sawdust until, at week 10, a mix of approximately 25% sawdust, 75% deer pellets was obtained. This mixture was later replaced with the Moose Research Center ration.

In 1981, a similar routine was followed, however, instead of sawdust, an increasing proportion of rolled oats was mixed into the soil and the procedure was begun earlier, in week two. Beginning in the sixth week, the rolled oats were gradually replaced with an increasing proportion of the Moose Research Center pelleted ration.

In 1982, a commercially available, 18% crude protein, dairy creep ration was used instead of the rolled oats and the Research Center ration was replaced with a custom-prepared, pelleted moose ration (12.8% protein, 19.3% fiber). In December 1982, this ration was replaced with the 1980 pelleted, deer ration used at the facility.

In 1984, a simpler weaning procedure was followed. Pelleted deer ration and Calf Manna (Carnation, Milling Division, Los Angeles, CA) were offered ad libitum after 10 June. After another week, the Calf Manna was removed because the moose were feeding eagerly and exclusively on the deer pellets. No calf starter or rolled oats was mixed into the soil boxes.

Mean number of days until weaning were: 83 ± 10, 106 ± 19, 100 ± 12, and 79 ± 17, for 1980, 1981, 1982 and 1984, respectively.

Treatment of Illnesses

Illness was usually first noted as listlessness or refusal to feed. Rectal temperatures of listless animals or animals off feed were taken immediately after we attempted to feed them. (Normal body temperature for calves was 37-38°C). Animals were moved to an isolated pen if their temperature was higher than 39.2°C. Sick calves remained isolated until they recovered or died.

Temperatures over 39.4°C were treated with intramuscular injections of one of three antibiotics: penicillin G (Ethacillin, Rogar/STB, London, Ont.), chloramphenicol (Austicol 200, Austin Laboratories, Joliette, P.Q.), and oxytetracycline hydrochloride (Liquamycin, Rogar/STB, London, Ont.).

Bloat was occasionally encountered after feeding and was treated with diocotyl sodium sulfosuccinate (Bloat-go, Animal Health Supplies, LTD, Regina, Sask.) administered at each feeding and/or a bismuth subsalicylate suspension (Pepto-bismol, Norwich-Eaton, Paris, Ont.) given in 10-20 ml doses every two hours. Milk volumes were reduced by

1/2 for the first two to three feedings after the animal bloated and, in severe cases, were replaced with electrolytes (Calf Electrolytes, Salsbury Laboratories, LTD, Kitchener, Ont.). Occasionally, calves with severe bloat were stomach-tubed and the sour milk and other rumen contents removed. All animals with bloat were walked as often as possible.

Diarrhea was the most frequent, persistent, and difficult problem to treat. Treatment usually consisted of immediately decreasing the milk volume by one half for two to three feedings and giving neomycin sulfate and methscopolamine bromide (Biosol-M, Tuco Products Co., Orangeville, Ont.) orally after each feeding or by mixing it into the milk formula. In persistent or severe cases, milk was partially or completely replaced with either electrolytes and glucose or an oral nutrient powder mix (Life-guard, Norden Co., Calgary, Alta.). A variety of oral suspensions was tried to control diarrhea: 1) bismuth subsalicylate, kaolin and pectin; 2) Streptomycin, sulfamethazine, kaolin, pectin, and aluminum oxide (Sul-Dyo-Strep, Pfizer Co. LTD., Montreal, P.Q.), 3) dihydrostreptomycin, sulfamethazine, kaolin, pectin, salts and hydroxide (Hibitane, Ayerst Laboratories, Montreal, P.Q.); 4) opium, kaolin and pectin (Donnegal-PG, A.H. Robbins Co., Montreal, P.Q.); and 5) boluses of chlorohexidine, hydrochloride, dihydrostreptomycin, kaolin, and sulphamethazaine salts (Polyansyne, Ayerst Laboratories, Montreal, P.Q.).

Extensive intravenous feedings and treatments were used during a prolonged period of endotoxemic shock in two calves in 1982. Continuous drip feedings of 10% glucose and saline and treatments with large doses

of prednisolone sodium succinate (Solu-Delta-Cortef 100, Tuco Products, Co., Orangeville, Ont.) and chloramphenicol were used for 2 to 3 days, twice on one calf and four times on the other.

Superficial cuts, wounds, and scrapes were treated by cleaning with hydrogen peroxide and applying a topical disinfectant containing chlorohexidine acetate (Hibitane, Ayerst Laboratories, Montreal, P.Q.)

Two calves in 1984 suffered broken legs. Both fractures were at the distal end of the canon bone of the hind leg. Each animal was immobilized with xylazine (Rompun, Haver-Lockart, Bayvet Division, Mississauga, Ont.) while the bone was set and a fiberglas cast (Cutter Cast, Cutter Biomedical, San Diego, CA) applied. Rapid growth of the leg necessitated bi-weekly changing of the casts. Mildly infected pressure sores at the joints beneath the cast were treated with a topical disinfectant when the cast was changed. Penicillin injections were given for three days after discovering the sores. After 6 weeks, the casts were removed and a support bandage was employed for an additional week.

RESULTS

Pre-weaning survival of moose calves ranged from 45% in 1981 to 100% in 1984) (Table 2). Survival of weaned moose to 7 months of age was more consistent, ranging from 79% in 1980 to 92% in 1984. In 1981, mean weights of moose on arrival to our facility were higher ($P < .05$) than in any of the other years (Table 3). Mean weights at weaning were lower in 1984 ($P < .05$) than in 1980 or 1981. Weight gains in 1982 were lower ($P < .05$) than those in any other year.

Table 2. Survival of moose calves, 1980-1984.

Year	Survival to weaning No. weaned/No. received	Survival from weaning to January 1 No. alive January 1/No. weaned
1980	14/15 (.93)	11/14 (.79)*
1981	5/11 (.45)	4/5 (.80)
1982	13/16 (.81)	4/5 (.80)**
1984	12/12 (1.00)	11/12 (.92)*
Totals	44/54 (.81)	30/36 (.83)

* Includes one calf each year that died by accident (= fractured skull and broken leg).
** Excludes eight calves sacrificed at weaning for scientific study.

Table 3. Weights and weight changes of moose calves surviving to weaning.

	1980 n=14	1981* 4	1982 13	1984 12
Mean weight at arrival (kg)	19.8±5.9	27.5±4.4	19.2±6.3	17.3±6.0
Mean weight at weaning (kg)	82.0±12.1	97.7±24.1	68.2±16.2	71.7±6.9
Weight gain (kg) per day	0.75±0.15	0.65±0.15	0.49±0.12	0.71±0.13
Weight gain (kg) per liter milk consumed	0.28±0.06	0.30±0.08	0.21±0.06	0.37±0.06

* excludes one calf received 6 August.

Weights at arrival of moose that survived to weaning and those that died before weaning were similar ($P = .23$). Weights at weaning of moose that died prior to 7 months and those that survived were similar ($P = .10$).

DISCUSSION

Moose calves have been successfully reared on a variety of milk formulas: 1) milk replacer (Regelin et al. 1979); 2) human baby formula (Addison et al. 1983); 3) evaporated milk and pig replacer (Addison et al. 1983); 4) raw bovine milk (Lautenschlager and Crawford 1983), and 5) whole bovine milk and evaporated milk mixed 2:1 (Addison et al. 1983) and 1:1 (this study). No experiments have been conducted to compare the effectiveness of each of these formulas under controlled conditions, hence, definitive conclusions are inappropriate. Based on our 81% weaning success over four years and on the 100% success reported by Addison et al. (1983), we suggest that some mix of evaporated milk and whole milk is a satisfactory formula for raising moose calves.

Healthy moose calves willingly consume large quantities of milk. Attempting to satiate this hunger is not advisable. Addison et al. (1983) recommend that feeding more than 2.5 liter/day is unnecessary and may cause diarrhea. We agree.

Our feeding schedules differed considerably among years (Fig. 1). In 1984, daily volumes of milk consumed were significantly ($P < .05$) lower than those of other years, but weight gains were good (Fig. 2). Scouring was a minimal problem (6 cases in 89 days) in 1984; feces were usually firm and pelleted until the animals were allowed to feed on fresh grass in outside paddocks. In 1980, 1981, and 1982, similar feeding schedules were followed but daily volumes were much higher. Diarrhea was common in 1980 and 1981, and was a severe problem in 1982. Even when the animals were not afflicted with diarrhea, their feces were seldom firm. We recommend that daily volumes of milk formula be

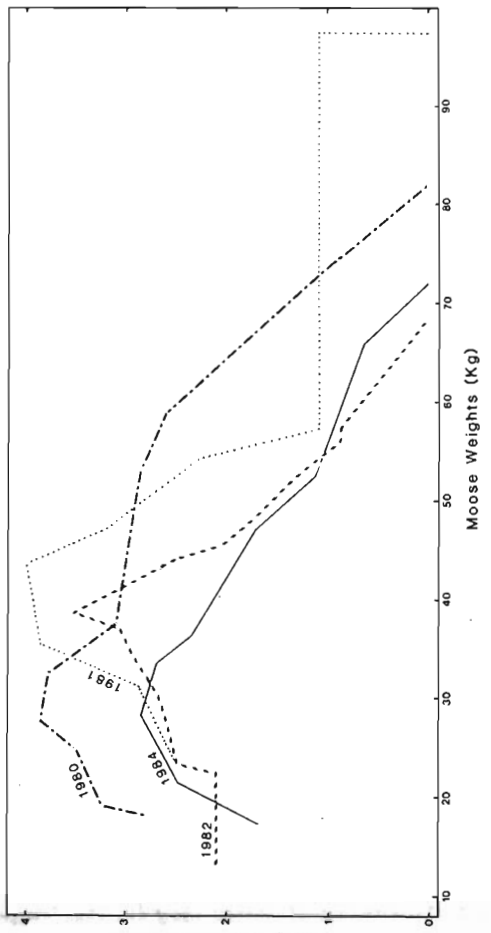

Figure 1. Mean daily volumes of milk formula consumed by moose calves, 1980 to 1984.

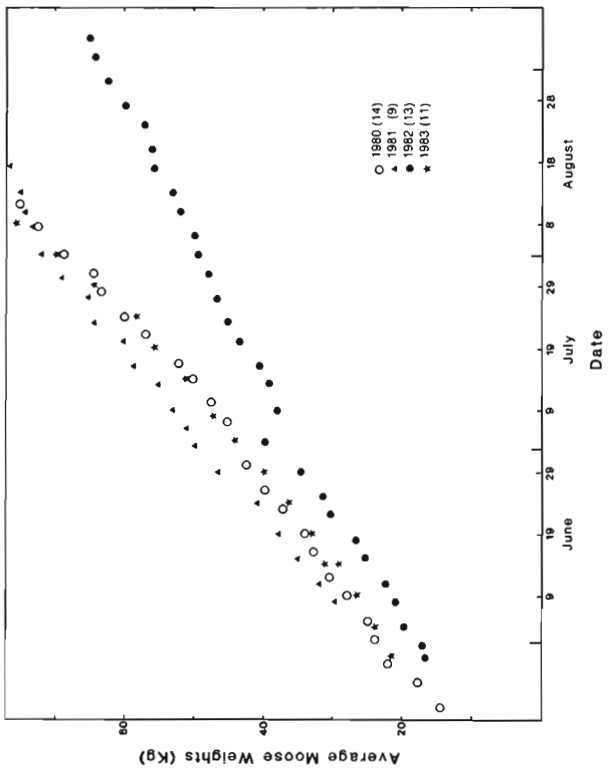

Figure 2. Mean weights of moose calves reared at the University of Alberta, 1980 to 1984.

increased gradually until, at about 25 kg, each calf is receiving about 2.5 liters/day. Then, as recommended by Addison et al. (1983), restrict daily milk volumes to 2.5 liters until weaning begins.

Penicillin G was usually effective for combatting infections; calf body temperatures usually returned to normal in 2-3 days. Treatment of bloat was less successful. Administration of "Bloat-go" and frequent walking relieved most cases. Although no single remedy for diarrhea was consistently successful, early detection and decreased milk volumes generally resulted in recovery.

The success of a weaning program is measured by the survival and health of the animals during the few months following weaning. If accidental deaths are excluded, the survival of our weaned calves until 7 months old was over 80%. Therefore, we must conclude that any of the weaning methods presented are satisfactory. However, the weaning program followed in 1984 was most convenient. It is similar to the program employed by Addison et al. (1983) in 1980, and by Regelin et al. (1979).

Weights of moose calves at capture did not seem to influence calf survival. There was no difference between the arrival weights of 44 animals that survived to weaning and 10 that did not. Nor was there a difference between the arrival weights of 30 moose that survived past 7 months and 16 that did not. Although larger calves may survive the first stressful days of captivity better than small ones (Addison et al. 1983), the additional stress incurred upon an older calf at capture may negate the benefit of larger size.

Weights of moose throughtout the pre-weaning period were quite similar in 1980, 1981, and 1984 (Fig. 2). A serious outbreak of diarrhea in 1982 retarded animal growth in early July. Although the diarrhea problem was cleared up by mid-July, weight gains never returned to those of other years. There was no difference between the weight gain performances of 1980 and 1984 calves even though the total milk volumes offered these calves differed.

RECOMMENDATIONS

1. Feed moose a bottle of mix of whole bovine milk and evaporated milk mixed 1:1 or 2:1.
2. Start moose calves at ~2.0 liters of formula daily and feed six times/day (i.e., every four hours).
3. Feed calves no more than 2.5 liters/day regardless of their appetite.
4. Provide pelleted ration ad libitum throughout the weaning period.
5. Provide large amounts of natural browse (we used willow and aspen).
6. Given that a particular facility can conveniently house only so many neonates, avoid overcrowding.
7. Have as few people as possible involved in direct care/feeding of the calves.
8. Have personnel on duty at all times, particularly in June and most of July, for early detection of illness and other problems.
9. Act promptly on medical decisions.

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