PHYSIOLOGIC AND MORPHOMETRIC MEASUREMENTS IN NEONATAL MOOSE AND THEIR COWS IN ALASKA

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Abstract: Blood chemistry, hematology and morphometric measurements from moose (*Alces alces gigas*) calves and their post-parturient mothers from the Kenai Peninsula, Nelchina Basin, and Susitna Basin, Alaska are presented. Comparison of blood parameters among neonates were generally uniform and differences detected were negligible. The post-parturient cows were at a physiological low when compared to non post-parturient cows. The calves also reflected low levels of critical blood values. The physiologic and morphometric measurements provide base-line data for future comparisons of post-parturient cows and neonatal calves.

Blood chemical and hematological values have been reported for most North American ungulates. Assessment and application is not possible until adequate sampling of a species over time and under various conditions permits standardization and interpretation of variation in these parameters. Blood studies of Alaskan moose (*Alces alces gigas*) were the first in which sampling of key sex and age classes under varying environmental circumstances provided the bases for using these parameters to assess condition of moose (Franzmann and LeResche 1978). Nevertheless, two categories of moose remained unmeasured, namely neonatal moose calves and post-parturient cows, and this study provides the background on these animals.

Weights and measurements of North American moose (*Alces alces*) have been reported (Blood et al 1967, Breckenridge 1946, Denniston 1956, Franzmann et al. 1978, Karns 1976, Kellum 1941, Murie 1934, Peek 1962, Peterson 1955, Timmermann 1972), but until this report, data for neonates were lacking.

Moose calf mortality studies in Alaska (Ballard et al. 1980, Franzmann et al. 1980) afforded the opportunity to collect physiologic and morphometric data from neonates and their mothers. This paper reports the results of these data from different regions of Alaska, 1977-1979. Comparisons and assessment of differences were made primarily using the blood parameters which best reflected condition of moose (Franzmann and LeResche 1978).

METHODS

Moose calves were sampled from the Kenai Peninsula, Nelchina Basin, and Susitna Basin during late May and early June in 1977, 1978, and 1979. The Kenai area was described by Oldemeyer et al. (1977), and the Nelchina and Susitna Basin study areas by Ballard and Taylor (1978).

Calf capturing methods were described by Ballard et al. (1979). Blood collecting and analysis were done as outlined by Franzmann and LeResche (1978) and measurements were obtained as defined by Franzmann et al. (1978). During the 2 years of the Kenai Peninsula study, blood samples were obtained from 24 post-parturient cows, but none were obtained from the Nelchina and Susitna studies.

Means and standard deviations of sorted data were calculated. Comparison and evaluation of data were by t-test programs. All differences cited are at $P<0.01$ unless otherwise indicated. The 1977 Kenai Peninsula sample was sorted into June and May calf samples. The June calves were approximately 1 week old at capture, and all other calves were from 1-to-3 days old.

Packed cell volume (PCV), hemoglobin (Hb), calcium (Ca), phosphorus (P), glucose, total protein (TP), albumin, and beta globulin were measured and used in assessment as described by Franzmann and LeResche (1978). The remaining blood parameters were combined and presented as base-line data and include; cholesterol, triglyceride, lactic dehydrogenase (LDH), glutamic oxalacetic transaminase (GOT), alkaline phosphotase, sodium

(Na^+), potassium (K^+), chloride (Cl^-),carbon dioxide (CO_2), iron, blood urea nitrogen (BUN), creatanine, bilirubin, uric acid, globulin, alpha 1 globulin, alpha 2 globulin, and gamma globulin. The calf measurement data were sorted by year and population.

RESULTS

Table 1 lists the combined means, standard deviations and sample sizes of all blood and measurement parameters from neonatal calves. They comprise the base-line standards for neonatal moose calves in Alaska. The calf blood data were sorted by location and year (also month for Kenai 1977) for condition related blood parameters (PCV, HB, Ca, P, glucose, TP, albumin, and beta globulin--Franzmann and LeResche 1978) and are presented in Table 2 with mean condition related blood parameters from post-parturient Kenai cows and late winter adult moose (Franzmann and LeResche 1978).

The Nelchina 1977 calves PCV (35.4%) was higher than all other calf populations except Susitna-1977 (34.0%) and Kenai 1977 June (32.8%) (Table 2). No other PCV differences were detected. Hemoglobin differences were limited to the Kenai 1977 May mean (10.6 g/dL) being lower than the Nelchina 1978 (11.7 g/dL) and the Susitna 1977 (12.4 g/dL) means. No differences were detected among Ca levels, but P differences were detected with the Nelchina 1977 mean (7.1 gm/dL) less than the Susitna 1978 (9.7 gm/dL), Sustina 1979 (9.8 gm/dL), and Kenai 1977 May (8.6 gm/dL) means.

Table 1. Neonatal Alaskan moose calf unsorted blood values and measurements from 1977, 1978, and 1979 on the Kenai Peninsula, Nelchina Basin and Susitna Basin.

Parameters measured	Unit	Sample size	Mean	Standard deviation
Glucose	mg/dL	97	141.7	41.2
Cholesterol	mg/dL	97	96.9	20.8
Triglyceride	mg/dL	84	132.8	102.8
LDH	U/L	96	604.0	172.6
SGOT	U/L	97	90.1	87.0
SGPT	U/L	86	82.6	98.0
Alkaline phosphotase	U/L	97	622.2	201.0
Phosphorus	mg/dL	97	8.5	1.9
Calcium	mg/dL	97	11.6	0.9
Ca/P	ratio	97	1.4	
Sodium	mEg/L	86	136.1	5.5
Potassium	mEg/L	86	5.8	1.0
Chloride	mEg/L	86	92.3	4.7
Carbondioxide	mEg/L	85	14.4	4.9
BUN	mg/dL	97	15.4	5.9
Creatanine	mg/dL	87	1.1	0.4
Bilirubin	mg/dL	95	0.5	0.3
Uric acid	mg/dL	93	0.5	0.3
Total protein	g/dL	97	5.28	0.62
Albumin	g/dL	97	2.54	0.40
Globulin	g/dL	97	2.74	0.32
Alpha 1 globulin	g/dL	97	0.47	0.16
Alpha 2 globulin	g/dL	97	0.46	0.18
Beta globulin	g/dL	97	0.91	0.43
Gamma globulin	g/dL	97	0.90	0.52
A/G	ratio	97	0.93	
Iron	mg/dL	47	199.8	158.0
Menoglobin	g/dL	104	11.4	1.6
Packed cell volume	%	103	30.7	4.6
Total Body Length	Cm	102	99.2	8.3
Hind Foot Length	Cm	106	45.0	2.2
Chest Girth	Cm	106	61.2	5.8
Neck Circumference	Cm	103	29.7	3.0
Weight	kg	109	18.0	4.5

The Nelchina 1978 P level (7.9 gm/dL) was also significantly lower than the Susitna 1979 mean (9.8 gm/dL). Glucose differences were characterized by Susitna 1978 mean (78 mg/dL) being lower than all except the Nelchina 1978 mean (128 mg/dL) and Kenai 1977 June mean (207 mg/dL) being higher than all but the Kenai 1978 (154 mg/dL), Susitna 1977 (161 mg/dL) and Kenai 1977 May (154 mg/dL). The only differences among TP means were that the Nelchina 1978 mean (5.01 g/dL) was significantly lower than the Kenai 1978 (5.78 g/dL) and Nelchina 1977 (5.58 g/dL) means. Albumin differences were characterized by Nelchina 1977 (2.32 g/dL) and the Nelchina 1978 (2.24 g/dL) means being lower than most Susitna and Kenai populations except the Kenai 1977 May (2.62 g/dL) and Susitna 1977 (2.40 g/dL) populations. The beta-globulins showed sporadic differences among populations, but there was no pattern. The Kenai 1977 June beta globulin mean (1.17 g/dL) was highest and the Kenai 1978 mean (0.61 g/dL) was lowest.

The Kenai samples afforded opportunity to compare the blood of neonatal calves with that of their post-parturient mothers (Table 2). We combined data from the Kenai neonatal calves (Kenai 1977 May, Kenai 1977 June, and Kenai 1978) and compared both the condition-related and the other blood parameters with those of the cows (Table 3). Neonatal calf levels were significantly higher than the cows' for cholesterol, LDH, alkaline phosphotase, P, Ca, BUN, bilirubin, globulin, alpha 1 globulin, and beta globulin. However, the cows had higher CO_2, creatanine, TP, albumin, hemoglobin and PCV levels.

Table 2. Condition related blood parameters from Alaskan neonatal moose calves, post-parturient Kenai cows, and adult moose sampled in late winter (Feb.-May).

Population and year	Blood parameters																							
	PCV			Hb			Ca			P			Glucose			TP			Albumin			Beta Globulin		
	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
Nelchina 1977	35.4	4.5	14	11.6	1.3	14	12.4	0.6	13	7.1	1.6	13	136	40	13	5.58	0.6	13	2.32	0.27	13	1.12	0.35	13
Nelchina 1978	30.0	3.0	25	11.7	1.2	24	11.1	0.5	19	7.9	1.6	19	128	35	19	5.01	0.51	19	2.24	0.39	19	0.69	0.18	19
Susitna 1977	34.0	4.9	8	12.4	1.6	8	12.0	0.8	8	7.3	2.8	8	161	30	8	5.47	0.82	9	2.40	0.36	9	1.2	1.0	9
Susitna 1978	30.1	2.9	8	10.3	1.4	8	11.6	0.7	7	9.7	0.7	7	78	39	7	5.11	0.43	7	2.71	0.24	7	0.75	0.17	7
Susitna 1979	28.2	5.8	13	11.9	2.5	14	11.5	1.0	14	9.8	1.9	14	144	31	14	5.23	0.61	14	2.78	0.39	14	0.69	0.15	14
Kenai 1977 May	29.2	4.2	19	10.6	1.2	19	11.7	0.8	21	8.6	1.4	21	154	42	21	5.17	0.55	21	2.62	0.53	21	0.89	0.29	21
Kenai 1977 June	32.8	3.3	6	11.5	0.8	6	11.4	2.0	6	10.2	3.0	6	207	43	6	5.15	0.87	6	2.91	0.53	6	1.17	0.21	6
Kenai 1978	29.8	4.1	10	10.5	1.7	10	11.6	0.4	10	8.7	1.5	10	154	30	10	5.78	0.74	10	2.76	0.28	10	0.61	0.21	10
Post-parturient 1977-78 cows (Kenai)	38.3	5.6	23	14.2	2.3	23	10.6	0.9	24	4.2	1.5	24	141	31	24	6.60	0.81	23	4.25	0.63	23	0.63	0.16	23
Adult moose 1977-78[a] late winter	45.6	5.7	184	18.2	1.8	187	10.4	0.8	273	4.5	1.2	273	120	29	273	7.01	0.61	277	4.12	0.68	277	0.69	0.27	277

a From Franzmann and LeResche (1978).

When we compared condition related blood parameters of post-parturient cows with adult moose sampled during last winter (Table 2), we detected significant differences. Late winter adult moose had significantly higher levels of PCV, Hb, and T.P. and had lower levels of glucose than did post-parturient cows.

Barrett and Chalmers (1979) analyzed blood from neonatal pronghorns (*Antilocapra americana*) and we compared our values from neonatal moose with theirs (Table 4). We also included glucose, Hb, and PCV data from white-tailed deer (*Odocoileus virginianus*) (Johnson et al. 1978) and black-tailed deer (*Odocoileus hemionus columbianus*) (Bandy et al. 1957, Cowan and Bandy 1969).

Differences in weights and measurements between neonatal moose calves were detected only in comparisons between the Kenai 1977 June population and others. This population (n=6) was 1 week old, and all others were generally 1-to-3 days old and this difference would be expected. The mean weights and measurements listed in Table 1 exclude the weights and measurements from the Kenai 1977 June group and thereby represent calves 1-to-3 days old.

DISCUSSION

Comparison of blood parameters among neonatal moose calf populations lacked a pattern that could be used to quantify relative condition based on criteria established for adult moose (Franzmann and LeResche 1978). Blood values from the calves generally indicate a uniformity among the populations, particularly when the older Kenai 1977 June population is excluded.

Table 3. Physiologic measurements from neonatal moose calves and post-parturient cows sampled during spring of 1977 and 1978 on the Kenai Peninsula, Alaska.

Parameter measured	Unit	Neonatal calves			Post-parturient cows		
		N	$\bar{x}$	SD	N	$\bar{x}$	SD
Glucose	mg/dL	36	163.4	42.3	24	140.6	31.3
Cholesterol	mg/dL	36	101.1*	13.7	24	74.5	16.4
Triglycerides	mg/dL	23	108.6	86.9	--	--	--
LDH	U/L	36	544.1*	143.2	24	319.0	93.3
SGOT	U/L	36	71.8	22.5	24	75.3	29.2
SGPT	U/L	26	45.0	32.9	14	38.7	11.2
Alkaline phosphotase	U/L	36	479.9*	133.8	24	112.0	137.0
Phosphorous	mg/dL	36	8.9*	1.8	24	4.2	1.5
Calcium	mg/dL	36	11.5*	0.9	24	10.6	0.9
Ca/P	ratio	36	1.3		24	2.5	
Sodium	mEq/L	26	135.6	8.4	15	133.5	3.4
Potassium	mEq/L	26	5.3	0.7	15	5.0	0.6
Chloride	mEq/L	25	92.2	6.6	14	95.2	6.4
Carbon dioxide	mEq/L	26	10.3*	4.7	14	18.8	4.3
BUN	mg/dL	36	16.5*	5.2	24	10.3	6.8
Creataine	mg/dL	26	1.03*	0.41	15	1.93	0.46
Bilirubin	mg/dL	36	0.47*	0.29	24	0.26	0.17
Uric acid	mg/dL	34	0.32	0.18	23	0.42	0.22
Total protein	g/dL	36	5.38*	0.67	23	6.60	0.81
Albumin	g/dL	36	2.67*	0.54	23	4.25	0.63
Globulin	g/dL	36	2.71*	0.33	23	2.35	0.60
Alpha 1 globulin	g/dL	36	0.48*	0.17	23	0.27	0.15
Alpha 2 globulin	g/dL	36	0.34	0.16	23	0.45	0.20
Beta globulin	g/dL	36	1.10*	0.26	23	0.63	0.16

Continued

Table 3 (cont.)

Parameter measured	Unit	Neonatal calves N	$\bar{x}$	SD	Post-parturient cows N	$\bar{x}$	SD
Gamma globulin	g/dL	36	0.79	0.40	23	1.03	0.35
A/G	ratio	36	0.99		23	1.81	
Iron	mg/dL	26	233.8*	212.4	14	131.5	67.3
Hemoglobin	g/dL	35	10.7*	1.3	23	14.2	2.3
Packed cell volume	%	35	29.9*	4.2	23	38.3	5.6
MCHC	%	35	35.8	4.0	23	37.1	3.9

* Significantly ($P<0.01$) different than mean for post-parturient cows.

The differences between post-parturient cows and their calves (Table 3) do reflect a pattern. Calf blood levels were significantly higher or the same as the cows for all parameters except PCV, HB, TP, albumin, CO_2 and creatanine. Both hematologic values (PCV and Hb) were higher in cows, and this reflects their more developed hemopoietic systems. Barrett and Chalmers (1979) when compairing neonate and adult pronghorns reported that Ca, P, cholesterol, and alkaline phosphotase, were significantly higher in neonates than adults, and we found the same for moose (Table 3). Pronghorn adults had significantly higher PCV, Hb, TP, and albumin levels than neonates, as we found for moose (Table 3). The only difference in neonate-adult patterns between the two species was that pronghorn fawns had higher magnesium, sodium and glucose values than adults, while this was not the case in moose, and in moose there were no differences between sodium and glucose between neonates and adults, but there were in pronghorns.

The adult moose sampled in this study had given birth to calves within 1-to-3 days prior to sampling. The cows were in poor condition according to the criteria of Franzmann et al. (1976). of those which were graded by us, ten were ranked at "6", seven at "5" and three at "4". The stresses of pregnancy, calving, and lactation appeared to be reflected in their physical condition. Blood values of post-parturient cows reflected poor condition compared to adult moose described by Franzmann and LeResche (1978) sampled in late winter and early spring (February to May). Levels of PCV, Hb, and TP (all condition-related parameters) were significantly higher in adult moose than post-parturient cows. Glucose was higher in post-parturient cows which likely reflected the stress of

capture (Franzmann and LeResche 1978, Franzmann et al. 1975). Packed cell volume, Hb, and TP were determined not to be influenced by excitability (Franzmann and LeResche 1978).

It is apparent that the Kenai Peninsula post-parturient cows are at a definite physiological low. There were no other moose data from post-parturient cows for comparison, and the values determined may be normal for moose that have experienced the stress of pregnancy, parturition, and lactation at a critical time of year. What is of equal concern and interest is the low status of some critical neonatal blood values in relation to the already depressed post-parturient cows (PCV, Hb, TP, and albumin). The pattern of low blood values in neonates was also detected in pronghorn fawns (Barrett and Chalmers 1979) and in general closely resembles moose neonates (Table 4). Moose neonates have lower PCV, Hb, Ca, and P levels, but higher protein fractions except gamma globulin. Alkaline phosphotase moose mean (622.2 U/L) was extremely higher than for pronghorns (296.4 U/L). Alkaline phosphatase levels are associated with active skeletal development (Coles 1974), and perhaps the larger skeletal structure of the moose calf results in higher levels. Values from other neonate ungulates are limited, but glucose, Hb, and PCV values from white-tailed deer and black-tailed deer (Table 4) are also relatively low and generally similar to pronghorns and moose.

Additional sampling of postparturient moose from other populations will be necessary to determine if this is a normal pattern. These base-line physiologic parameters may serve as comparative data for future sampling.

Table 4. Comparisons of blood parameter means of neonatal moose, pronghorns, white-tailed deer, and black-tailed deer.

Parameter measured	Unit	Moose[a]	Pronghorn[b]	White-tailed deer[c]	Black-tailed deer
Glucose	mg/dL	141.7(97)	203.5(60)	119.7(5)	90.2(7)[d]
Cholesterol	mg/dL	96.9(97)	67.4(89)		
SGOT	U/dL	90.1(97)	106.5(92)		
Alkaline phosphotase	U/dL	622.2(97)	296.4(74)		
Phosphorus	mg/dL	8.5(97)	10.0(83)		
Calcium	mg/dL	11.6(97)	12.4(85)		
Ca/P	ratio	1.40	1.24		
Sodium	mEq/L	136.1(86)	145.2(85)		
Potassium	mEq/L	5.8(86)	6.2(85)		
BUN	mg/dL	15.4(97)	21.3(63)		
Creatanine	mg/dL	1.1(87)	2.4(11)		
Total protein	g/dL	5.28(97)	4.78(46)		
Albumin	g/dL	2.54(97)	2.36(46)		
Globulin	g/dL	2.74(97)	2.42(46)		
Alpha globulin	g/dL	0.93(97)	0.59(46)		
Beta globulin	g/dL	0.91(97)	0.70(46)		
Gamma globulin	g/dL	0.90(97)	1.13(46)		
A/G	ratio	0.93(97)	1.01(46)		
Hemoglobin	g/dL	11.4(104)	14.6(116)	8.4(5)	10.3(26)[e]
Packed cell volume	%	30.7(103)	39.7(110)	30.9(5)	33.8(26)[e]

a This study
b Barrett and Chalmers (1979)
c Johnson et al. (1978)
d Bandy et al. (1957)
e Cowan and Bandy (1969)

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