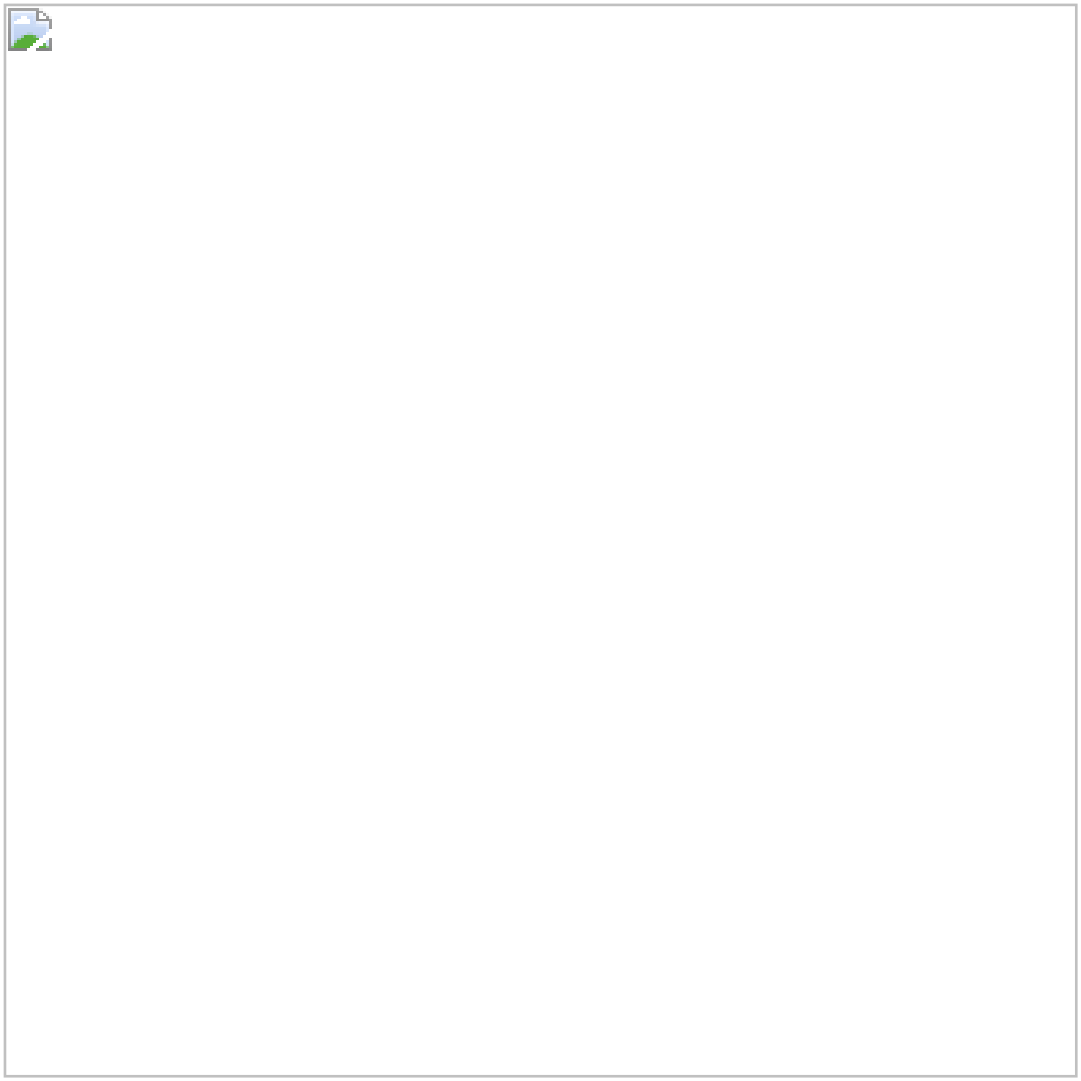

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HEMATOLOGIC AND SERUM CHEMISTRY VALUES OF CAPTIVE CANADIAN LYNX

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ABSTRACT: We present baseline values for 12 hematologic and 17 serum chemistry parameters collected from 22 captive lynx (*Felis lynx canadensis*) in December 1992, at Ronan, Montana (USA). There were no significant differences in hematologic parameters between yearlings and adults or between sexes. Lynx originally captured in the wild had significantly higher mean (±SE) counts of neutrophils ($7.7 \pm 0.37 \times 10^3$ versus $7.2 \pm 0.35 \times 10^3$) and lower counts of lymphocytes ($1.1 \pm 0.05 \times 10^3$ versus $1.6 \pm 0.08 \times 10^3$) compared to lynx born and raised in captivity. Yearling lynx had significantly higher values for alkaline phosphatase than adults (51.0 ± 6.0 IU/l versus 17.5 ± 0.8 IU/l.

Key words: captive Canadian lynx, *Felis lynx canadensis*, baseline hematology, baseline serum chemistry.

INTRODUCTION

Although blood analyses have been used to assess the health of several wildlife species including some felids (Hawkey and Hart, 1986), baseline characteristics of blood have not been published for Canadian lynx (*Felis lynx canadensis*). Reference values obtained from animals in captivity immobilized with drugs commonly used in field capture can facilitate the interpretation of blood parameters from wild-captured animals (Seal et al., 1975; Fuller et al., 1985). Our objective was to establish baseline values for hematology and serum chemistry of Canadian lynx.

MATERIALS AND METHODS

Blood samples were collected from 22 captive lynx at the Fraser Fur Farm in Ronan, Montana (USA) (47°32′N, 114°01′W; elevation 1,000 m), during 1 to 3 December, 1992, 3 mo prior to their breeding season (Tumlison, 1987). The five oldest lynx (two males, three females) were captured in the wild in Montana prior to 1985 and served as breeding stock. Their estimated (S. Fraser, pers. comm.) mean (±SE) age was 8.1 ± 0.9 yr. Six males and eleven females born and raised in captivity averaged 4.0 ± 0.4 yr. All animals were housed outdoors in 2 m × 3 m or larger kennels in ambient light and temperature. The lynx were fed 0.5 to 0.7 kg daily of a mixed ration containing beef and horse scraps, whole chicken, ocean fish, cereal grains, beef tripe, beef liver, and alfalfa meal. Water was provided *ad libitum*. All animals were fasted for 24 hr prior to blood collection.

We immobilized the lynx with a mixture containing a mean (±SE) dose of 17.8 ± 0.88 mg/kg of ketamine hydrochloride (Ketaset, Fort Dodge Laboratories, Fort Dodge, Iowa, USA) and 0.9 ± 0.04 mg/kg of xylazine (Rompun, Haver, Shawnee, Kansas, USA) administered intramuscularly with a blowpipe and pole syringe in succession. This dosage of ketamine falls within the range (11 to 20 mg/kg) commonly administered to lynx captured in the wild (Koehler, 1990). Time between initial injection and blood collection varied from 15 to 45 min which is comparable to field studies (Beltran et al., 1991). Yohimbine (Yobine, Lloyd Laboratories, Shenandoah, Iowa) was given intravenously at a high dosage of 0.9 ± 0.04 mg/kg (see Hsu and Lu, 1984).

Handling included weighing each lynx with a spring scale and drawing blood from the cephalic vein into untreated Vacutainer (Becton-Dickinson, Rutherford, New Jersey, USA) tubes for preparation of serum and into tubes coated with ethylenediamine tetraacetic acid (EDTA) for hematology. Each lynx was examined for clinical signs of disease. Temperature, pulse, and respiration were monitored. Heat packs (Safe and Warm, Boulder City, Nevada, USA) were used to facilitate the animal's thermoregulation. Penicillin (Durapen: Vedco, Overland Park, Kansas, USA) (22,000 U/kg) was administered intramuscularly to prevent infections.

Two fresh blood smears were prepared for differential counts of leukocytes, and serum was extracted from centrifuged samples at the end of each field day. Refrigerated blood samples were sent within 1 day by courier to Pathology

Associated Medical Laboratories, Coeur d'Alene, Idaho (USA), for analysis.

Values for the following hematological parameters were obtained using a Baker 9000 autoanalyzer with a Baker Haemoline II reagent (Serono-Baker Diagnostics, McGaw Park, Illinois, USA): leukocyte count (WBC), erythrocyte count (RBC), platelet estimate (PLT EST), and mean corpuscular volume (MCV). Hemoglobin (Hb) was determined by the cyanmethemoglobin procedure of Eilers (1967). Packed cell volume (PCV) and mean corpuscular hemoglobin concentration (MCHC) were calculated using the formulas of Meyer et al. (1992). Using Wright's stained blood films, we counted neutrophils (NEUT), lymphocytes (LYMPH), atypical lymphocytes (AT LYMPH), monocytes (MONO), eosinophils (EOS), basophils (BASO), and young neutrophils (BANDS).

Serum chemistry values were obtained with a DAX autoanalyzer and Technicon reagent at 37 C (Technicon, Inc., Tarrytown, New York, USA) for the following parameters: albumin (ALB), alkaline phosphatase (ALK PHOS), bilirubin (BILI), blood urea nitrogen (BUN), calcium (CA), cholesterol (CHOL), chloride (CL), creatinine (CREAT), gamma-glutamyl transpeptidase (GGT), glucose (GLU), potassium (K), sodium (NA), phosphorus (P), protein (PROT), aspartate aminotransferase (AST) (also known as serum glutamic-oxalacetic transaminase: SGOT), and alanine aminotransferase (ALT) (or serum glutamic-pyruvic transaminase: SGPT). Thyroxine (T4) was determined with the GammaCoat M competitive-binding RIA Kit (Incstar Corporation, Stillwater, Minnesota, USA) using Technicon set-point standards (Technicon, Inc., Tarrytown, New York).

We used Student's t-test for unpaired variates (Sokal and Rohlf, 1981) to test for significant (two-tailed, $P < 0.05$) differences between origin (wild versus captive), age classes, and sex.

RESULTS

We evaluated 12 hematology parameters for 22 lynx (Table 1) and 17 serum chemistry parameters for 16 lynx (Table 2). All reported individuals were clinically normal, except for moderate gingivitis in two of the older captive-raised animals.

There were no significant differences in hematologic parameters between yearlings and adults, or between sexes. Compared to lynx born and raised in captivity, lynx originally captured in the wild had significantly higher mean (±SE) NEUT ($7.7 \pm 0.37 \times 10^3$ versus $7.2 \pm 0.35 \times 10^3$, $P = 0.03$) and lower LYMPH ($1.1 \pm 0.05 \times 10^3$ versus $1.6 \pm 0.08 \times 10^3$, $P = 0.03$). Wild-captured lynx had significantly higher values than lynx born and raised in captivity for CREAT (2.9 ± 0.3 mg/dl versus 1.9 ± 0.1 mg/dl, $P < 0.001$) and PROT (7.2 ± 0.2 g/dl versus 6.8 ± 0.1 g/dl, $P = 0.04$). Yearling lynx had significantly higher ALK PHOS than adults (51.0 ± 6.0 IU/l versus 17.5 ± 0.8 IU/l, $P < 0.001$). The only significant difference between sexes was a higher average value for BUN in males.

DISCUSSION

The combination of higher NEUT and lower LYMPH in blood from lynx originally captured in the wild is a well-known phenomenon termed stress leukogram (Meyer et al., 1992) that also may be accompanied by elevated glucose. It is evidence that these animals, despite several years in captivity, were more sensitive to capture activity than lynx born and raised in captivity. Rich and Gates (1979) reported a similar response for wild coyotes (*Canis latrans*) in captivity compared to coyotes that were captive-born and raised. Fuller et al. (1985) recorded higher NEUT and GLU for bobcats (*Felis rufus*) captured in the wild compared to bobcats in captivity. Similar leukocytosis and neutrophilia in other carnivores have been attributed to capture stress (Kreeger et al., 1990). Values for AST and ALT from Iberian lynx (*F. lynx pardina*) (Beltran et al., 1991) and bobcats (Fuller et al., 1985) captured in the wild were higher than those recorded for captive Canadian lynx. Damage of muscle tissue from a trap, ensuing struggle, or an immobilizing dart may result in higher values for AST (Seal et al., 1975).

Two of the oldest animals captured in the wild accounted for the highest paired values of BUN and CREAT (46 mg/dl and 3.3 mg/dl for the male; 73 mg/dl and 3.8 mg/dl for the female). Such elevated values for these parameters in combination

TABLE 1. Descriptive statistics for 12 hematologic variables from 22 Canadian lynx in captivity at Ronan, Montana, December 1992.

Variable	Mean	SE	Range
Leukocytes ($\times 10^3$/ml)	9.1	0.44	5.0–12.2
Neutrophils ($\times 10^3$/ml)	7.3	0.35	70.0–88.0
Lymphocytes ($\times 10^3$/ml)	1.5	0.07	10.0–30.0
Monocytes ($\times 10^3$/ml)	0.2	0.01	0.0–5.0
Eosinophils ($\times 10^3$/ml)	<0.1	<0.01	0.0–2.0
Bands ($\times 10^3$/ml)	<0.1	<0.01	0.0–2.0
Erythrocytes ($\times 10^6$/ml)	6.4	0.17	4.3–7.8
Hemoglobin (g/dl)	11.5	0.27	8.4–14.0
Packed cell volume (%)	38.0	0.97	26.5–46.0
Mean corpuscular volume (fl)	59.4	0.38	56.0–62.0
Mean corpuscular hemoglobin concentration (g/dl)	30.3	0.15	29.0–31.8
Platelet estimate ($\times 10^3$/ml)	413.8	9.53	336.0–502.0

are evidence for subclinal renal dysfunction with advanced age (Seal et al., 1975; Meyer et al., 1992).

The higher values for ALK PHOS in yearlings was evidence that osteoblastic activity associated with growth was continuing (Meyer et al., 1992). Based upon morphological measurements, the yearlings had attained only 90% of adult size in length of head and of upper canine tooth (J. L. Weaver and M. R. Johnson, unpubl.). Higher ALK PHOS values for juveniles also have been recorded for Iberian lynx (Beltran et al., 1991) and coyotes (Smith and Rongstad, 1980). Seal and Hoskinson (1978) did not believe that ALK PHOS in pronghorns (*Antilocapra americana*) was affected by capture stress. Kreeger et al. (1990) found higher levels of ALK PHOS in trapped foxes (*Vulpes vulpes*) compared to controls, but Kreeger et al. (1990) did not account for age-related effects.

TABLE 2. Descriptive statistics for 17 serum chemistry variables from 16 Canadian lynx in captivity at Ronan, Montana, December 1992.

Variable	Mean	SE	Range
Albumin (g/dl)	3.6	0.04	3.3–3.9
Alkaline phosphatase (IU/l)	22.1	3.02	14.0–57.0
Bilirubin (mg/dl)	0.2	0.01	0.1–0.2
Blood urea nitrogen (mg/dl)	34.5	1.18	28.0–46.0
Calcium (mg/dl)	9.3	0.08	8.8–10.1
Cholesterol (mg/dl)	105.8	2.38	92.0–122.0
Chloride (mEq/l)	121.6	0.44	119.0–126.0
Creatinine (mg/dl)	2.1	0.13	1.5–3.3
Gamma-glutamyl transpeptidase (IU/l)	0.1	0.08	0.0–1.0
Glucose (mg/dl)	110.9	4.17	79.0–136.0
Potassium (mEq/l)	4.3	0.09	3.8–4.9
Sodium (mEq/l)	155.9	0.21	155.0–158.0
Phosphorus (mg/dl)	5.3	0.18	3.9–6.5
Protein (g/dl)	7.0	0.09	6.4–7.6
Aspartate aminotransferase (IU/l)	26.6	0.94	20.0–32.0
Alanine aminotransferase (IU/l)	35.7	1.85	23.0–46.0
Thyroxine (mcg/dl)	2.2	0.08	1.8–2.9

We believe that this blood profile of captive Canadian lynx can serve as a useful baseline. Although the furfarm diet was different in composition than the hare-based diet of wild lynx, the lynx attained nominal size and productivity at maturity and appeared clinically healthy. Also, the lynx were handled with drugs, dosages, and immobilization techniques similar to most field studies. Finally, the lynx were sampled at a time (early December) during the mid-range of circannual variation in blood values for other northern mammals. It appears that certain hematologic and serum chemistries can aid field researchers in ascertaining the subadult status of captured lynx (high ALK PHOS) as well as relative stress level (high NEUT/low LYMPH/high GLU) and tissue damage (high AST) associated with various types of capture techniques.

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