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HEMATOLOGY AND SERUM BIOCHEMISTRY OF CAPTIVE SWIFT FOXES (*VULPES VELOX*)

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ABSTRACT: Blood samples were taken from 23 swift foxes (*Vulpes velox*) which were to be used in a reintroduction program. The foxes originated from two different captive breeding programs: one at the Calgary Zoo (CZ) and one at the Wildlife Reserve of Western Canada (WRWC). Several differences between swift fox and domestic canine hematology were seen, including an increased number of smaller red blood cells and lower absolute leukocyte counts in swift foxes. Serum glutamic pyruvic transaminase was higher than in the domestic canine normal range while serum creatinine values were lower. Hemoglobin, serum potassium, total protein, globulin in the two groups (CZ and WRWC) were statistically different as were male versus female mean corpuscular volume values.

Key words: Swift fox, *Vulpes velox*, hematology, serum biochemistry, captive breeding population.

INTRODUCTION

The swift fox (*Vulpes velox*) is a threatened carnivore species which was extirpated from the Canadian prairies in the late 1930's. Presently, efforts are underway to reintroduce this predator to its native habitat (Schroeder, 1982). All animals were 6-9 mo of age and had adult dentition and adult body weights (mean weight = 2.64 kg) at the time of handling. Prior to reintroduction each individual was handled for physical examinations, immunization, deworming and identification purposes. Blood samples were drawn from foxes to be released in 1985 and 1986. This study reports base-line hematological and serum biochemistry data in a captive population of this species.

MATERIALS AND METHODS

Swift foxes examined in this study came from the Calgary Zoo (CZ; Calgary, Alberta, Canada T2M 4R8) and the Wildlife Reserve of Western Canada (WRWC; Cochrane, Alberta, Canada T0L 0W0).

Calgary Zoo animals housed in outdoor pens and fed on a diet consisting mainly of commercial dog food (27% dry matter crude protein; Iams Company, Lewisburg, Ohio 45338, USA), supplemented with occasional whole animal prey. Fecal flotations done on several occasions were all negative. Foxes from WRWC also were housed in outdoor pens and their diet was pri-

marily day-old chicks and horsemeat supplemented with commercial dog food two or three times a week. These animals had occasional evidence of fleas, ticks and hookworm infections which was treated as soon as diagnosed.

Twenty-three swift foxes, 14 from CZ and nine from WRWC were sampled. No abnormalities were noted during their physical examination. During routine handling of the animals for examination and vaccination, blood samples were drawn from either cephalic or jugular veins. Calgary Zoo animals were anesthetized with isoflurane (Aerrane®, Anaquest, Pointe Claire, Quebec, Canada H9R 4V4) to facilitate identification tattooing. The WRWC animals were tattooed prior to arrival at the zoo and were manually restrained for sampling. The samples were collected into three vacutainer tubes; serum, EDTA and sodium fluoride (Becton Dickenson, Rutherford, New Jersey 07070, USA). The samples were submitted to a reference veterinary laboratory (Central Laboratory for Veterinarians Ltd., Langley, British Columbia, Canada V3A 1H9) for hematology and serum biochemistry determinations within 12 hr of collection. Hematology data were collected with the aid of a Coulter Model S (Coulter Electronics of Canada, Burlington, Ontario, Canada L7L 5J8); serum biochemistries were done by a centrifugal analyzer (C-Chem 500, Baker Instruments Corp., Allentown, Pennsylvania 18001, USA); and electrolytes were done with a Beckman E4A (Beckman Instruments Ltd., Mississauga, Ontario, Canada L5T 1W5).

The resulting hematological and serum biochemistry values are reported as means and standard errors. Also mean values for males, females, CZ animals and WRWC animals were

TABLE 1. Mean values for hematology and serum biochemistry of captive swift foxes from populations at the Calgary Zoo and the Wildlife Reserve of Western Canada.

Parameter	Units	Canine normals ^a	Swift fox population (n = 23)
White blood cell	$1 \times 10^3 \text{ mm}^3$	6-17	5.05 ± 1.354^b
Red blood cell	$1 \times 10^6 \text{ mm}^3$	5.5-8.5	9.46 ± 0.92
Hemoglobin	g/dl	12-18	17.95 ± 1.84
Hematocrit	%	37-55	51.15 ± 4.84
Mean corpuscular volume	fml	60-77	53.65 ± 2.33
Mean corpuscular hemoglobin	pg	19-25	18.57 ± 0.61
Mean corpuscular hemoglobin concentration	%	32-36	34.47 ± 1.19
Glucose	mg/dl	65-130	100.87 ± 48.61
Blood urea nitrogen	mg/dl	10-30	23.35 ± 6.77
Creatinine	mg/dl	1.0-2.0	0.79 ± 0.63
Sodium	meq/liter	140-158	148.78 ± 4.64
Potassium	meq/liter	4.0-5.7	5.0 ± 0.66
Calcium	mg/dl	8.5-11.5	11.57 ± 1.78
Phosphorus	mg/dl	3.0-7.0	5.69 ± 1.26
Total protein	g/dl	5.4-7.6	6.28 ± 0.63
Albumin	g/dl	2.3-4.0	2.83 ± 0.26
Globulin	g/dl	2.7-4.4	3.45 ± 0.68
Total bilirubin	mg/dl	0-0.5	0.17 ± 0.16
Serum alkaline phosphatase	IU/liter	10-84	53.43 ± 76.25
Serum glutamic pyruvic transaminase	IU/liter	5-65	88.35 ± 22.66

^a Central Lab for Veterinarians, Langley, British Columbia, Canada V3A 1H9.

^b Mean \pm standard error.

compared using a one-way analysis of variance. Statistical significance is reported at $P \leq 0.05$.

RESULTS

Several of the hematologic parameters of the swift foxes were notably different from domestic canine normal values established by the reference laboratory (Table 1). The white blood cell (WBC) count was lower than normal canine values while the red blood cell (RBC) count was higher. The mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) values were lower than normal canine values and the mean corpuscular hemoglobin concentration was within normal limits.

Serum creatinine values were lower than those for the normal dog range and serum calcium values were in the high normal range as compared to dog values. Serum glutamic pyruvic transaminase levels were higher than those of the domestic canine range. However, several samples were hemolyzed and this could have affected the results. Mean corpuscular volume val-

ues for males were significantly different from females while hemoglobin levels were significantly different between CZ and WRWC foxes (Table 2). Significant differences occurred also between the CZ and WRWC population in some of the serum chemistry parameters, specifically serum potassium, total protein and globulin (Table 2).

DISCUSSION

There is no information on the normal blood parameters of the swift fox. Hematologic and serum biochemistry values of other fox species are similar to those of the domestic canid (Dieterich, 1970). However, a study on the San Joaquin kit fox (*Vulpes macrotis mutica*) also shows increased numbers of smaller RBC's than for domestic dogs (McCue and O'Farrell, 1987). The data collected during this study show several differences between swift fox blood and that of the domestic canine. The lower MCV and MCH indicated a smaller RBC for this animal compared to the dog,

TABLE 2. Comparison with one-way ANOVA of hematologic and serum biochemistry mean values across sexes and localities for swift foxes from Alberta, Canada.

Parameter	Units	Sex				Locality			
		Male (n = 10)		Female (n = 13)		CZ (n = 14)		WRWC (n = 9)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
White blood cell	th/mm ³	5.57 ± 1.33*	4.65 ± 1.23*	3.65	>0.05	5.08 ± 1.15*	5.00 ± 1.61*	0.17	>0.05
Red blood cell	mil/mm ³	9.57 ± 0.88	9.38 ± 0.94	0.03	>0.05	9.18 ± 0.90	9.91 ± 0.76	3.18	>0.05
Hemoglobin	g/dl	17.92 ± 1.89	17.98 ± 1.79	0.13	>0.05	17.33 ± 1.93	18.92 ± 1.14	4.69	<0.05
Hematocrit	%	50.27 ± 4.99	51.83 ± 4.61	0.79	>0.05	50.12 ± 4.87	52.76 ± 4.34	2.08	>0.05
Mean corpuscular volume	fml	52.30 ± 2.28	54.69 ± 1.77	5.37	<0.05	54.00 ± 2.33	53.11 ± 2.23	0.18	>0.05
Mean corpuscular hemoglobin	pg	18.39 ± 0.46	18.72 ± 0.67	0.80	>0.05	18.69 ± 0.66	18.40 ± 0.46	0.65	>0.05
Mean corpuscular hemoglobin concentration	%	34.96 ± 1.21	34.09 ± 1.01	2.58	>0.05	34.35 ± 1.24	34.64 ± 1.08	0.06	>0.05
Glucose	mg/dl	103.10 ± 59.28	99.15 ± 38.34	0.36	>0.05	111.43 ± 46.36	84.44 ± 47.45	1.62	>0.05
Blood urea nitrogen	mg/dl	24.70 ± 7.62	22.31 ± 5.82	1.27	>0.05	24.43 ± 4.92	21.67 ± 8.64	1.13	>0.05
Creatinine	mg/dl	0.90 ± 0.78	0.70 ± 0.47	0.11	>0.05	0.65 ± 6.48	1.00 ± 0.77	1.19	>0.05
Sodium	meq/liter	150.80 ± 3.71	147.23 ± 4.69	1.94	>0.05	147.79 ± 5.51	150.33 ± 2.00	0.88	>0.05
Potassium	meq/liter	5.04 ± 0.62	4.96 ± 0.69	0.54	>0.05	4.59 ± 0.46	5.62 ± 0.36	27.42	<0.05
Calcium	mg/dl	12.06 ± 1.95	11.19 ± 1.53	0.73	>0.05	11.11 ± 1.41	12.28 ± 2.05	1.71	>0.05
Phosphorus	mg/dl	6.23 ± 0.86	5.27 ± 1.36	3.36	>0.05	5.71 ± 1.28	5.66 ± 1.23	0.2	>0.05
Total protein	g/dl	6.44 ± 0.69	6.15 ± 0.54	0.28	>0.05	5.96 ± 0.46	6.78 ± 0.51	12.03	<0.05
Albumin	g/dl	2.76 ± 0.18	2.88 ± 0.29	1.92	>0.05	2.79 ± 0.14	2.88 ± 0.36	0.88	>0.05
Globulin	g/dl	3.68 ± 0.72	3.28 ± 0.59	1.05	>0.05	3.16 ± 0.51	3.90 ± 0.68	6.32	<0.05
Total bilirubin	mg/dl	0.22 ± 0.19	0.13 ± 0.11	0.71	>0.05	0.11 ± 0.15	0.26 ± 0.13	3.56	>0.05
Serum alkaline phosphatase	IU/liter	80.60 ± 99.03	32.00 ± 41.42	1.51	>0.05	46.07 ± 80.29	64.11 ± 68.07	0.05	>0.05
Serum glutamic pyruvic transaminase	IU/liter	87.90 ± 14.18	88.69 ± 27.41	0.28	>0.05	95.64 ± 21.09	77.00 ± 20.23	3.79	>0.05

* Mean ± standard error.

although the concentration of hemoglobin in the cells was similar. Distributing hemoglobin in an increased number of smaller red blood cells will enhance gas exchange (Schalm, 1986). The female swift foxes had larger RBC's than the males. McCue and O'Farrell (1987) found no differences between male and female San Joaquin kit foxes.

Significant differences occurred between the CZ and WRWC populations. The management systems between these two facilities differed mainly in diet. Wildlife Reserve of Western Canada diets had a much higher protein level and this is reflected in the significantly higher serum total protein levels in the WRWC foxes. Isoflurane anesthesia has been found to cause a small decrease in serum potassium levels in dogs (Dobkin et al., 1976). This may explain the difference seen between the potassium levels in the CZ and WRWC populations in this study.

Herein we report for the first time hematologic and serum biochemistry data for captive populations of swift fox. Knowl-

edge of these "normal" values should prove to be of value in the evaluation of future disease problems that may arise in this threatened species.

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