

HEMATOLOGIC, SEROLOGIC VALUES, HISTOPATHOLOGIC AND FECAL EVALUATIONS OF BISON FROM YELLOWSTONE PARK

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ABSTRACT: Hematologic and blood chemistry parameters were measured in 149 free-ranging American bison (*Bison bison*) from Yellowstone National Park, Wyoming (USA). Additionally, histopathologic evaluations of lung, liver, spleen, kidney, and mesenteric and bronchial lymph nodes were made from ten animals. Forty-five fecal samples were screened for the presence of helminth ova. Leukopenia and markedly low blood urea nitrogen concentrations were the most notable differences observed from other bison populations. All tissues examined were essentially normal; there was evidence of moderate intestinal parasite burdens.

Key words: Bison, *Bison bison*, Yellowstone National Park, hematology, serum biochemistries, histopathology, internal parasites.

INTRODUCTION

The American bison (*Bison bison*) population within Yellowstone National Park, Wyoming (USA), is the only free-ranging, naturally regulated wild-stock bison population in the United States. Wildlife management policies within the park are dictated by the National Park Service natural regulation; thus handling of animals for collection of blood and tissue samples, or treatment of disease usually is not permitted. As a result, base-line physiologic and disease prevalence data in the approximately 3,000 head bison herd are unknown.

Our objectives were to determine blood values, internal parasite burdens, and conduct a histopathologic survey of selected tissues from apparently healthy Yellowstone bison.

MATERIALS AND METHODS

In 1991, the Montana (USA) State Department of Livestock and Department of Fish, Wildlife and Parks, Order of Destruction Number B-2 was passed in an effort to decrease the threat of disease transmission between domestic livestock and bison migrating out of Yellowstone National Park. From November 1991 through March 1992, at the direction of the Montana

Livestock Department, and in compliance with Order of Destruction Number B-2, 257 head of American bison were killed by rifle shot to the head as they exited the north boundary of the Park near Gardiner, Montana (45°3'N, 110°53'W). Teams of four or five National Park Service personnel obtained multiple blood and tissue samples from each animal within 10 min of death.

Whole blood was collected from lanced jugular veins into EDTA and serum vacuum glass tubes. Sections of lung, liver, spleen, kidney, mesenteric and bronchial lymph nodes and fecal samples were obtained and placed in individual, sterile plastic bags. All samples were placed in a cooler and sent chilled via over-night delivery to the University of Idaho, Caine Veterinary Teaching and Research Center, Caldwell, Idaho (USA).

After arrival at the laboratory, blood samples for serum biochemical tests were centrifuged at 500 × G for 5 min and the sera were decanted into individual, sterile plastic vials. Biochemical tests were conducted on sera ≤24 hr after arrival (≤48 hr after collection) by a commercial laboratory using a Technicon SMAC III (Technicon, Inc., Tarrytown, New York, USA). Sera were analyzed to determine concentrations of glucose, blood urea nitrogen (BUN), creatinine, uric acid, sodium, potassium, chloride, phosphorus, iron, total protein, albumin, globulin, total bilirubin, alkaline phosphatase, serum glutamic oxaloacetic transaminase (SGOT) [Aspartate transferase (AST)], lactic dehydrogenase

TABLE 1. Hematologic data for free-ranging American bison bulls, cows and calves (≤ 1 yr of age) from Yellowstone National Park, Wyoming, USA.

	Bison bulls (n = 49)		Bison cows (n = 45)		Bison calves (n = 18)	
	Range	Mean \pm SE	Range	Mean \pm SE	Range	Mean \pm SE
White blood cells ($10^6/\text{mm}^3$)	1.5-14.1	4.22 \pm 0.35	1.0-11.8	4.43 \pm 0.22	1.2-11.8	4.90 \pm 0.42
Red blood cells ($10^6/\text{mm}^3$)	5.23-10.88	8.62 \pm 0.19	5.47-11.13	8.29 \pm 0.14	5.86-11.38	9.27 \pm 0.23
Hemoglobin (g/dl)	8.3-20.7	15.91 \pm 0.37	8.2-21.2	15.41 \pm 0.25	9.9-20.9	16.34 \pm 0.42
Packed cell volume (%)	25-62	45.55 \pm 1.21	24-59	42.85 \pm 0.68	28-61	46.26 \pm 1.42
Neutrophils (%)	0-78	36.53 \pm 5.33	12-76	31.54 \pm 2.61	13-49	29.91 \pm 3.56
Lymphocytes (%)	11-86	44.44 \pm 4.45	8-86	48.61 \pm 3.83	34-81	54.55 \pm 4.14
Monocytes (%)	0-8	3.31 \pm 0.71	0-6	1.71 \pm 0.34	0-5	1.73 \pm 0.47
Eosinophils (%)	0-10	3.56 \pm 0.80	0-11	2.96 \pm 0.49	0-11	4.18 \pm 1.31
Basophils (%)	0	0	0-1	0.14 \pm 0.07	0-1	0.18 \pm 0.12
Band neutrophils (%)	0-24	4.50 \pm 1.63	0-6	0.82 \pm 0.31	0-1	0.09 \pm 0.09

(LDH), gamma-glutamyl transpeptidase (GGTP), triglyceride, and cholesterol. A Coulter Counter, Model ZF (Coulter Electronics, Inc., Hialeah, Florida, USA) was used for total leukocyte (WBC) and erythrocyte (RBC) counts. Hemoglobin concentrations were determined by a Hemoglobinometer, Model HGBR (Coulter Electronics, Inc.). Packed cell volume (PCV) was determined by micro-hematocrit centrifugation, and differential WBC counts were made viewing thin blood smears stained with Hema-3 stain (Curtin Matheson Scientific, Houston, Texas, USA), and examined at $1,000\times$ under oil immersion using standard counting techniques (Thrall, 1985). One hundred forty-nine blood and serum samples were identified as being from one of three groups: 54 bulls, 72 cows, and 23 calves ≤ 1 year of age. Several additional samples were received, but all hemolyzed or clotted samples were discarded. Data from each group were analyzed using descriptive statistics [means, standard error of the mean (SE), and minimum and maximum ranges] and were computed by the ABstat[®] computer program (Anderson-Bell, Parker, Colorado, USA).

Upon arrival at the laboratory, tissue samples submitted in plastic bags were visually examined grossly for signs of autolysis. Of those tissues in acceptable condition, ten representative sample sets were selected arbitrarily and fixed in 10% neutral buffered formalin. The fixed specimens were embedded in paraffin and sectioned at $5 \mu\text{m}$, mounted on glass microscope slides, stained with hematoxylin and eosin, and examined by light microscopy.

A total of 45 arbitrarily selected fecal samples (12 from bulls, 20 cows, and 13 calves) were evaluated. Helminth ova were concentrated via a sugar flotation method (Wade and Gaafar, 1985) and detected by light microscopy at $100\times$. All 45 fecal samples also were screened for the presence of trematode ova using the Fluke Finder[®] modified sedimentation procedure (Visual Difference, Moscow, Idaho). Ova were identified with the aid of Georgi (1974).

RESULTS

Leukopenia and markedly low BUN concentrations were the most notable abnormalities detected by hematologic and serologic evaluations of bison blood (Tables 1, 2).

Histologically, hemosiderin deposits were prominent in the red pulp of nine of ten spleen samples and in the medulla of all ten mesenteric lymph nodes sampled. Birefringent and non-birefringent spicular

TABLE 2. Serum biochemical data for free-ranging American bison bulls, cows and calves (≤ 1 yr of age) in Yellowstone National Park, Wyoming, USA.

Constituent	Bison Bulls			Bison Cows			Bison Calves (≤ 1 yr)		
	n	Range	Mean \pm SE	n	Range	Mean \pm SE	n	Range	Mean \pm SE
Glucose (mg/dl)	50	6-570	167.26 \pm 17.04	47	25-712	278.09 \pm 26.46	18	37-799	347.11 \pm 55.94
Blood urea nitrogen (mg/dl)	52	4-25	13.33 \pm 0.54	48	4-27	12.96 \pm 0.73	18	6-15	10.67 \pm 0.68
Creatinine (mg/dl)	54	1.60-4.50	3.44 \pm 0.08	48	2.1-3.9	3.03 \pm 0.05	18	2.3-4.1	3.29 \pm 0.12
Uric acid (mg/dl)	54	0.9-6.0	2.48 \pm 0.14	48	1.0-4.2	2.86 \pm 0.12	17	1.2-4.5	3.08 \pm 0.23
Sodium (mEq/L)	54	99-150	137.50 \pm 1.07	48	132-153	142.52 \pm 0.58	16	133-152	141.69 \pm 1.31
Potassium (mEq/L)	54	6.6-31.5	14.42 \pm 0.54	48	5.8-17.6	11.70 \pm 0.40	17	8.1-19.4	13.00 \pm 0.84
Chloride (mEq/L)	54	88-109	102.11 \pm 0.50	48	97-110	104.46 \pm 0.40	16	98-107	102.87 \pm 0.63
Calcium (mg/dl)	54	7.3-11.9	9.99 \pm 0.12	48	8.3-12.1	10.32 \pm 0.10	20	10.0-11.7	10.85 \pm 0.14
Phosphorus (mg/dl)	54	5.2-15.0	8.38 \pm 0.22	48	5.5-13.0	8.34 \pm 0.23	17	6.8-12.5	9.62 \pm 0.41
Iron (μ g/dl)	54	41-170	98.22 \pm 3.90	48	52-186	111.19 \pm 4.28	17	88-211	131.77 \pm 8.69
Total protein (g/dl)	54	5.4-9.7	8.08 \pm 0.12	48	6.1-9.3	8.07 \pm 0.13	18	6.3-9.0	7.60 \pm 0.15
Albumin (g/dl)	54	2.1-5.0	4.23 \pm 0.07	48	2.7-4.8	4.12 \pm 0.06	17	3.7-5.1	4.48 \pm 0.10
Globulin (g/dl)	54	1.8-6.0	3.85 \pm 0.10	48	2.2-5.3	3.97 \pm 0.12	18	2.2-4.4	3.22 \pm 0.13
Total bilirubin (mg/dl)	54	0.1-0.4	0.13 \pm 0.01	48	0.1-0.2	0.13 \pm 0.01	16	0.1-0.3	0.14 \pm 0.02
Alkaline phosphatase (U/L)	54	25-111	48.80 \pm 2.51	48	32-186	55.60 \pm 4.19	16	35-100	60.00 \pm 4.67
SGOT ^a (U/L)	54	68-191	112.74 \pm 3.94	47	67-328	113.85 \pm 7.11	16	64-176	120.06 \pm 7.04
Lactic dehydrogenase (U/L)	54	360-970	727.82 \pm 14.87	47	292-1,317	709.36 \pm 20.48	18	705-919	793.11 \pm 15.06
GCTP ^b (U/L)	49	5-52	17.67 \pm 1.32	47	10-69	25.09 \pm 1.84	14	17-49	28.64 \pm 2.48
Triglycerides (mg/dl)	54	1-79	25.50 \pm 2.49	45	10-169	40.38 \pm 3.64	14	21-81	38.71 \pm 4.10
Cholesterol (mg/dl)	54	41-159	89.30 \pm 3.19	48	49-202	83.96 \pm 3.53	14	59-238	107.79 \pm 11.18

^a Serum glutamic oxalacetic transaminase.

^b Gamma-glutamyl transpeptidase.

and granular deposits were focal in the cortex of seven of ten bronchial lymph nodes sampled. Occasional focal minimal lymphocytic accumulations were present in the liver and renal cortex of several samples. Scattered mineral concretions among tubules of the renal medulla were present in most kidney sections. Severe hepatic lipidosis was seen in one case. One liver had scattered foci of several necrotic hepatocytes attended by a few neutrophils.

Some mesenteric lymph nodes had prominent populations of plasmacytes in medullary cords. In several bronchial lymph nodes there were relatively prominent populations of eosinophils.

Of the 12 fecal samples from bison bulls, all but one contained ova tentatively identified as *Strongylus* spp.; two samples held cestode ova. No evidence of *Trichuris* spp. ova was found. Six of the 20 fecal samples from bison cows had no detected parasite ova. *Strongylus* spp. ova were found in 14 of the 20 samples; two samples had ova tentatively identified as *Trichuris* spp.; and four samples contained cestode ova. Of the 13 fecal samples from bison calves, 11 contained *Strongylus* spp. ova (range: 1–25; mean: 8.6 ± 4.9); three samples yielded a total of five *Trichuris* ova; only one sample contained cestode ova, and it contained 200+ ova.

DISCUSSION

Probable momentary stress generated by a fatal gun shot wound to the head and the time that sera remained on the clots before harvesting would be expected to result in increased biochemical values of glucose, BUN, creatinine, potassium, and phosphorus (Benjamin, 1978). Compared with previously published bison data (Marler, 1975; Mehrer, 1976; Keith et al., 1978; Clemens et al., 1987; Miller et al., 1989; Sikarskie et al., 1990), the Yellowstone bison had elevated values of glucose, potassium, and phosphorus, as expected. However, BUN concentrations were substantially lower in Yellowstone samples compared with bison from other studies.

The BUN values reported by Keith et al. (1978) from bison on low protein diets were much more comparable. Such a finding would be compatible with low protein forage probably available to Yellowstone bison during late autumn and early winter. Yellowstone bison had elevated concentrations of uric acid and LDH, and decreased concentrations of total bilirubin compared to the other cited studies. All other biochemical values were essentially the same as those reported in the other studies. The Yellowstone bison values for glucose, creatinine, uric acid, potassium, phosphorus, total protein, albumin, and SGOT were higher than those reported for cattle (Maas, 1983). Blood urea nitrogen values were, however, lower than the normal values reported for cattle.

The only study known to us reporting hematologic data from some killed bison (Mehrer, 1976) failed to state the number killed, or describe the method used. Further, no distinction was made between data obtained from blood collected from live animals or from those killed. With the exception of differences in WBC counts, values reported by Keith et al. (1978), involving blood obtained during the month of December in Colorado (USA) from bison on a low protein diet, closely resembled those reported here. The Yellowstone bison WBC values were less than half of those reported from bison in other localities. The reason for this apparent leukopenia is unknown. While unlikely, there may have been some leukocyte sequestration in the capillary beds. The shock of an acute fatal wound probably would not account for such an apparent leukopenia, and no evidence of viral or bacterial infections were noted.

The hemosiderin noted in splenic red pulp and medulla of mesenteric lymph nodes undoubtedly was related to normal processing of effete red blood cells. Birefringent and non-birefringent spicular and granular deposits foci in the cortex of bronchial lymph nodes were collections of particles which were inhaled, captured by

phagocytes in the lung and subsequently transported via lymph vessels to local nodes. The bison undoubtedly had inhaled a lot of dusty air.

The prominent populations of plasmacytes in some mesenteric lymph node medullary cords may have been associated with antibody production in response to some antigenic stimulation. The eosinophil responses as seen in several bronchial lymph nodes often are thought to be associated with parasitism.

Base line data, in the areas evaluated, have now been established on Yellowstone bison. It would appear that the method of securing tissue samples from the bison had little effect on altering the parameters evaluated. With few exceptions, the data obtained from the Yellowstone bison fall within the ranges of bison values reported from other sources, but are different from those of domestic cattle.

LITERATURE CITED

- BENJAMIN, M. M. 1978. Outline of veterinary clinical pathology. The Iowa State University Press, Ames, Iowa, 351 pp.
- CLEMENS, E. T., K. L. MEYER, M. P. CARLSON, AND N. R. SCHNEIDER. 1987. Hematology, blood chemistry and selenium values of captive pronghorn antelope, white-tailed deer and American bison. *Comparative Biochemistry and Physiology* 87C: 167-170.
- GEORGI, J. R. 1974. Parasitology for veterinarians, 2nd ed. W. B. Saunders Co., Philadelphia, Pennsylvania, 386 pp.
- KEITH, E. O., J. E. ELLIS, R. W. PHILLIPS, AND M. M. BENJAMIN. 1978. Serologic and hematologic values of bison in Colorado. *Journal of Wildlife Diseases* 14: 493-500.
- MAAS, J. 1983. Interpreting serum chemistry screens in cattle. *Modern Veterinary Practice* 64: 963-967.
- MARLER, R. J. 1975. Some hematologic and blood chemistry values in two herds of American bison in Kansas. *Journal of Wildlife Diseases* 11: 97-100.
- MEHRER, C. F. 1976. Some hematologic values of bison from five areas of the United States. *Journal of Wildlife Diseases* 12: 7-13.
- MILLER, L. D., C. O. THOEN, K. J. THROLSON, E. M. HIMES, AND R. L. MORGAN. 1989. Serum biochemical and hematologic values of normal and *Mycobacterium bovis*-infected American bison. *Journal of Veterinary Diagnostic Investigations* 1: 219-222.
- SIKARSKIE, J. G., T. W. SCHILLHORN VAN VEEN, G. VAN SELM, AND M. D. KOCK. 1990. Comparative blood characteristics of ranched and free-ranging American bison (*Bison bison*). *American Journal of Veterinary Research* 51: 955-957.
- THRALL, M. A. 1985. Hematology. In *Laboratory procedures for animal health technicians*, P. W. Pratt (ed.). American Veterinary Publications, Inc., Santa Barbara, California, pp. 39-88.
- WADE, W. F., AND S. M. GAAFAR. 1985. Internal parasites. In *Laboratory procedures for animal health technicians*, P. W. Pratt (ed.). American Veterinary Publications, Inc., Santa Barbara, California, pp. 271-331.

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