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HEMATOLOGY AND BLOOD CHEMISTRY IN THE SEA OTTER (*ENHYDRA LUTRIS*)

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ABSTRACT: Hematology and blood chemistry studies were undertaken on 41 sea otters during a 3-yr period. The results are compared to corresponding values for other mustelids and diving marine mammals. Results showed the otters apparent adaptation to its marine environment by having values that were similar to those of pinnipeds and cetaceans.

INTRODUCTION

A knowledge of hematology and blood chemistry of the sea otter is essential in order to provide adequate medical care. Information on normal blood values in the sea otter is limited.

Stullken and Kirkpatrick (1955) described the red blood cells (RBC), white blood cells (WBC), eosinophils, hemoglobin, and blood sugar of 12 sea otters. Williams (1978) presented preliminary blood findings on 21 sea otters from Alaska and California. The present report is an attempt to provide more complete baseline data on hematology and blood chemistry of sea otters.

MATERIALS AND METHODS

Forty-one adult wild sea otters were captured in a diver-held capture device in California by personnel of the California Department of Fish and Game from 1977 through 1979. Otters were restrained with an intramuscular injection of M99 (D-M Pharmaceuticals, Inc., Rockville, Maryland 20850, USA) at a dosage level of 0.04 mg/kg and diazepam (Pittman Moore, Inc., Washington Crossing, New Jersey 08560, USA) at 0.07 mg/kg, or fentanyl (Pittman Moore, Inc., Washington Crossing, New Jersey 08560, USA) at 0.05 mg/kg and azaperone (Roche Laboratories, Division of Hoffman-LaRoche Inc., Nutley, New Jersey 07110, USA) at 0.20 mg/kg, and blood was collected (Williams, 1978; Williams and Kocher, 1978; Williams et al., 1981).

The site of venipuncture was usually the proximal aspect of the femoral vein. On four occasions the jugular vein was used. A 2.5-cm 20-gauge needle, attached to a 20-ml eccentric tip disposable syringe, was used for venipuncture. A total of 20 ml of blood was collected.

Immediately after collection, the blood was transfered into evacuated tubes containing ethylenediaminetetraacetic acid (EDTA) for hematology determinations, plain evacuated tubes for clinical chemistry determinations, and evacuated tubes containing sodium fluoride for glucose determinations.

Coulter model-S cell counters calibrated with Coulter 4C hematology reference control (Coulter Electronics, Inc., Hialeah, Florida 33010, USA) were used for the following hematological determinations: white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin (HGB), hematocrit (HCT), and mean corpuscular hemoglobin concentration (MCHC). Differential cell counts were determined on Wright-Giemsa stained blood smears counting at least 100 nucleated cells.

The following clinical chemistry tests were performed on Technicon SMA-12/60 and Technicon AA-2 Autoanalyzers (Technicon Corporation, Tarrytown, New York 10591, USA) using standard methods: albumin, alkaline phosphatase, blood urea nitrogen (BUN), calcium, cholesterol, creatinine, glucose, serum glutamic oxaloacetic transaminase (SGOT), also known as aspartate amino transferase (AST), serum glutamic pyruvic transaminase (SGPT) also known as alanine amino transferase (ALT), lactic dehydrogenase (LDH), phosphorus, total bilirubin, total protein, and uric acid. Chloride and carbon dioxide (CO_2) values were determined by the Oxford titration method (Oxford Laboratories, Foster City, California 94404, USA), creatine phosphokinase (CPK) by the SpinChem Kinetic enzyme method (Smith Kline Instruments, Inc., Sunnyvale, California 94088, USA), amylase by the starch iodine method, and lipase using the olive oil substrate method. Sodium and potassium values were determined on a Beckman Kline flame photometer (Beckman Instruments, Inc., Fullerton, California 92634, USA) or a Technicon SMA 12/60 autoanalyzer. Radioimmunoassay method (Clinical Assay Division, Travenol Laboratories, Inc., Cambridge, Massachusetts 02134, USA) was used for T_3 and T_4 determinations. Globulin values were calculated by subtracting albumin from total protein.

RESULTS AND DISCUSSION

The results of the hematological studies are presented in Table 1. Blood chemistry results are presented in Table 2. The animals used in this study, by their general appearance and lack of recognizable signs of disease, were judged to be clinically healthy. The mean presented here is intended to provide a baseline for recognition

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TABLE 1. Hematologic values from 41 normal adult sea otters.

Value	Mean	SD[a]	Min[b]	Median	Max[c]
WBC (/μl)	8,660.00	2,650.00	3,700.00	8,600.00	14,600.00
RBC (× 10^6/μl)	5.11	0.74	3.64	5.09	6.99
HGB (g/dl)	17.92	2.77	9.80	18.50	22.00
HCT (%)	55.36	7.87	36.10	56.30	68.10
MCV (fl)	110.20	7.87	84.00	110.00	126.00
MCH (pg)	36.11	2.82	28.00	36.70	40.20
MCHC (g/dl)	32.72	1.73	29.20	33.10	37.80
NRBC (/100 WBC)	0.12	0.64	0.00	0.00	4.00
Band neutrophils (/μl)	8.66	25.98	0.00	0.00	86.60
Neutrophils (/μl)	4,862.59	1,469.60	2,078.40	4,763.00	7,794.00
Lymphocytes (/μl)	2,790.25	1,184.69	433.00	2,944.00	5,542.40
Monocytes (/μl)	336.00	234.69	0.00	346.00	1,039.20
Eosinophils (/μl)	639.97	649.50	0.00	433.00	2,251.60
Basophils (/μl)	1.73	13.86	0.00	0.00	86.60

[a] SD = Standard deviation.
[b] Min = Lowest value.
[c] Max = Highest value.

and analysis of significantly abnormal blood chemistry and hematology. Wide ranges were observed for some values which may be normal or could indicate disease conditions not detected during the brief period in which blood samples and other measurements were obtained. The effect of capture and administration of tranquilizing drugs on these values was not determined.

The results show the sea otter's apparent adaptation to its marine environment since most of the values are more similar to those of unrelated marine mammals than to those of other members of the family Mustelidae (Kennedy, 1935; Medway and Moldovan, 1966; Vallyathan et al., 1969; Greenwood et al., 1971; Lane et al., 1972; Geraci and Medway, 1974; MacNeill, 1975; Seal, pers. comm.).

TABLE 2. Clinical chemistry values from 41 normal adult sea otters.

Value	n[a]	Mean	SD[b]	Min[c]	Median	Max[d]
Total protein (g/dl)	41	7.0	1.0	4.3	7.0	9.7
Albumin (g/dl)	41	2.9	0.6	1.4	3.0	3.7
Globulin (g/dl)	41	4.1	1.0	1.7	4.0	6.6
BUN (mg/dl)	41	67.0	25.3	32.0	60.0	147.0
Creatinine (mg/dl)	37	1.1	0.4	0.5	1.0	2.2
Glucose (mg/dl)	41	108.0	34.1	51.0	105.0	182.0
Total bilirubin (mg/dl)	41	0.3	0.2	0.1	0.3	0.9
Cholesterol (mg/dl)	41	198.0	62.5	80.0	200.0	330.0
Calcium (mg/dl)	41	8.9	1.2	5.3	8.9	10.8
Phosphorus (mg/dl)	41	5.4	1.9	2.0	5.0	9.4
Sodium (mEq/liter)	37	151.0	4.3	142.0	151.0	167.0
Potassium (mEq/liter)	37	4.6	1.2	3.5	4.4	11.3
Chloride (mEq/liter)	34	114.0	6.1	100.0	114.0	134.0
CO_2 (mEq/liter)	34	23.0	3.6	14.0	23.0	30.0
Alkaline phosphatase (IU/liter)	41	59.0	33.9	16.0	54.0	154.0
SGPT (IU/liter)	33	91.0	38.5	36.0	80.0	195.0
SGOT (IU/liter)	10	299.0	212.0	60.0	249.0	711.0
LDH (IU/liter)	10	257.0	162.3	83.0	225.0	485.0
CPK (IU/liter)	33	330.0	160.2	63.0	256.0	967.0
Amylase (IU/liter)	33	248.0	119.3	24.0	218.0	610.0
Lipase (IU/liter)	33	44.0	22.8	10.0	44.0	133.0
Uric acid (mg/dl)	8	2.0	1.5	0.0	1.8	4.5
T_3 (ng/dl)	29	63.2	12.7	20.0	62.0	100.0
T_4 (μg/dl)	29	2.1	1.1	0.1	2.3	4.1

[a] N = Number of animals tested.
[b] SD = Standard deviation.
[c] Min = Lowest value.
[d] Max = Highest value.

The mean hemoglobin (HGB) value of 17.92 g/dl and hematocrit (HCT) of 55.36% were similar to the average values for pinnipeds and cetaceans and higher than those of other mustelids, including the closely related river otter (*Lutra canadensis*) (Kennedy, 1935; Ridgway, 1971; MacNeill, 1975). The mean RBC count of $5.11 \times 10^6/\mu l$ was much lower than the $11.6 \times 10^6/\mu l$ RBC count found in river otters, but corresponds closely to the range for pinnipeds and cetaceans. The blood of marine mammals contains fewer erythrocytes per cubic millimeter than most other mammals, but their mean corpuscular volume (MCV) is generally larger (Vallyathan et al., 1969; Greenwood et al., 1971; Ridgway, 1971; Geraci and Medway, 1974; MacNeill, 1975).

In the white blood cell differential the only remarkable finding was the high percentage of eosinophils. This may have been a result of numbers of parasites, mainly the acanthocephalans, *Corynosoma* and *Falsifilicollis*, commonly found in the sea otter intertinal tract (Hennessy, 1972). High percentages of eosinophils have been reported in other marine mammals (Ridgway, 1971).

The mean blood urea nitrogen (BUN) value in the sea otter is high (67.0 mg/dl) when compared to the river otter (27.2 mg/dl) and skunk (28.0 mg/dl). Similar high values are found in other marine mammals, particularly cetaceans. This may be related to their high protein diet, energy conservation, and high metabolic rate and does not reflect a pathological state (Medway and Moldovan, 1966; Ridgway, 1971). The mean level of lactic dehydrogenase in the sea otter is 257.0 IU/liter. This is higher than levels reported in the river otter (118.6 IU/liter) and skunk (146.5 IU/liter), but not as high as lactic dehydrogenase values in cetaceans and pinnipeds (Vallyathan et al., 1969; Greenwood et al., 1971; Ridgway, 1971; MacNeill, 1975; Seal, pers. comm.). In diving mammals, wide variations in lactic dehydrogenase levels are possible in an individual animal due to leakage of this intracellular enzyme from the skeletal muscle as a result of muscle exertion during a dive (Vallyathan et al., 1969).

The mean serum glutamic oxaloacetic transaminase (SGOT) value of 299.0 IU/liter in the sea otter is three times higher than the SGOT value reported in other mustelids and is much higher than the normal range of values for cetaceans (Vallyathan et al., 1969; Greenwood et al., 1971; MacNeill, 1975). In several animals in this study the SGOT was much above the mean, perhaps the result of muscle exertion. SGOT is widely distributed in the tissues and is probably not useful as an indicator of liver disease in the sea otter. The serum glutamic pyruvic transaminase (SGPT) mean value is 91.0 IU/liter in the sea otter. SGPT is an enzyme that when elevated specifically indicates hepatocellular damage in some species. The major sources of SGPT are hepatocytes in the liver with very low concentrations found in other tissues.

The alkaline phosphatase mean value was 59.0 IU/liter in the sea otter, compared to 17.6 IU/liter in the skunk, 11.2 IU/liter in pinnipeds, and a range of 21–42 IU/liter in cetaceans (Vallyathan et al., 1969; Greenwood et al., 1971; Ridgway, 1971; MacNeill, 1975; Seal, pers. comm.). The explanation for this higher mean value in the sea otter is not known.

The mean potassium value in the sea otter was 4.6 mEq/liter. An occasional high potassium level may be the result of severe physical exertion or possibly hemolysis of the blood sample.

Muscle exertion or possibly muscle damage in an individual animal during capture may be responsible for the variation between minimum and maximum creatine phosphokinase values in the sea otter (63.0 to 967 IU/liter).

The hematology and blood chemistry values not specifically mentioned here were all closely related to the values found in other mustelids, cetaceans and pinnipeds. It is likely, with no evidence to the contrary, that sea otters will respond hematologically to disease as predictably as do most domestic animals.

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BOOK REVIEW . . .

Recent Advances in the Study of Raptor Diseases, J. E. Cooper and A. G. Greenwood, eds. Chiron Publications Ltd., P.O. Box 25, Keighley, West Yorkshire, England. 1981. 176 pp. Price: U.K. and Europe—11.00 English pounds; Overseas, U.S.A. and Canada—12.00 English pounds.

This publication contains the majority of the papers presented at the First International Symposium on Diseases of Birds of Prey held in London, July 1–3, 1980, and covers subjects as diverse as microbiology, surgery, anesthesia, toxicology, and behavior. The Symposium provided a forum for discussion of raptor medicine and pathology and was the first international meeting devoted to this theme. Speakers at the conference came from Britain, Canada, the United States, Germany, Holland, Sweden and Romania and included many of the world's authorities and specialists in the field of raptor diseases.

The proceedings consist of an "Opening Address" by Kai Curry-Lindahl, followed by three sections: Part I: Pathology and Microbiology (seven papers); Part II: Surgery and Anaesthesia (eight papers); and Part III: Medicine and Therapeutics (seven papers). In addition, five papers on captive breeding and four papers on mortality factors in wild populations are presented. Most papers include, as you would expect, a list of references which provide additional sources of related information. Photographs and drawings contribute greatly to the text describing orthopedic surgical procedures, but are of limited value in other papers.

The proceedings consist of contributions from 45 authors and co-authors. As with any conference, there is considerable variation in depth of discussion, in the quality of the research and of the presentation, and in the overall merit of the work. In many cases, the degree of coverage is consistent with the amount of study on the topic and expertise of the researcher, whereas in a few papers, too little information was provided to be of significant value. In view of these differences, the editors have done a fine job in putting together these papers representing current knowledge on various aspects of raptor medicine and disease into a well-organized, concise proceeding.

In summary, this volume contains much useful information on selected topics pertaining to raptors, and is a good review of many of the latest developments in the field. It is a valuable addition to the literature and should contribute greatly to further research in this emerging field. And, as stated by the editors, it will have appeal to the veterinarian, wildlife biologist, ornithologist, falconer and aviculturist.

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