To the Graduate Council:

I am submitting herewith a thesis written by Diane Keiser Beeman entitled "Serum and Whole Blood Parameters of Black Bears in the Great Smoky Mountains National Park." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Ecology.

Michael R. Pelton, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

SERUM AND WHOLE BLOOD PARAMETERS OF BLACK BEARS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Diane Keiser Beeman

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ABSTRACT

During the summers of 1974, 1975, and 1976, blood samples were taken from 124 black bears (Ursus americanus) captured in the Great Smoky Mountains National Park. Hematological data were collected on 96 individual bears and serum parameters on 124 bears.

Counts of red cells, white cells, and platelets were performed on whole blood as well as determinations of hemoglobin concentration and hematocrits. Corrected white cell counts, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were calculated. Serum samples were analyzed for glucose, blood urea nitrogen (BUN), creatinine, sodium, potassium, chloride, carbon dioxide, uric acid, calcium, inorganic phosphorus, total protein, albumin, serum iron, cholesterol, triglyceride, alkaline phosphatase, lactic dehydrogenase (LDH), serum glutamic-oxalacetic transaminase (SGOT), creatine phosphokinase CPK), and total bilirubin. Statistical analysis in the form of least squares analysis of variance for unequal subclass size was performed on the data ($P<0.05$).

Hematocrit, levels of white blood cells and percentage of neutrophils were higher in bears caught in snares while percentage of lymphocytes and eosinophils were lower; the variability seen in these parameters is attributed to the stress of the method of capture. MCHC levels were lower in yearling bears and reflect a dietary deficiency associated with a lack of vitamin B_{12} or, more generally, with a lack of animal matter. Counts of white blood cells, MCHC and percentage of neutrophils were higher in 1975 than 1976, while percentage of

lymphocytes were lower. These variations may be related to dietary differences between trapping years and a possible higher incidence of disease in 1975. Monocyte levels were significantly lower in bears immobilized with Sernylan; no specific reason is noted for the difference.

Creatinine levels were higher in males than females and in adults than subadults. Such a relationship exists because the rate of production of creatinine depends on total muscle mass. Potassium, inorganic phosphorus, cholesterol, and alkaline phosphatase were higher in subadults than adults. Variation seen in potassium, uric acid and cholesterol depends on probable differences in food preferences. Fluctuation with age in inorganic phosphorus and alkaline phosphatase is related to the rapid bone growth in subadults. Glucose levels were elevated in bears captured in snares and are related to stress. BUN, uric acid, and glucose levels were higher in bears immobilized with M-99 while chloride and alpha globulin are elevated in bears captured with Sernylan. The fluctuations seen in chloride levels are related to the effects of the drug on the pH of the blood. The variations associated with BUN and uric acid are related in part to changes in kidney function associated with the drug type. The reasons for the changes in alpha globulin are not known. Reasons for the alterations of glucose levels are not known. Phosphorus, total bilirubin and carbon dioxide all were higher in 1974 than in 1975 or 1976, while chloride and sodium and potassium were lower. It is suggested that these differences are the result of differences in handling and storage techniques between the first year and the second two years. Glucose was higher in 1974 than in 1975 and 1976. Total protein, cholesterol, electrophoretic albumin and beta globulin were higher in 1975 than in 1974 and 1976, while albumin, alpha globulin and uric acid were highest in 1976. Changes in these parameters reflect dietary differences between years. SGOT and CPK levels were higher in 1974 than in 1975 and reflect a tendency by one clinical laboratory to report those values that were out of range as true maximum values instead of eliminating them as unusable. Alkaline phosphatase levels were higher in 1976, but no reason is postulated for this variation.

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CHAPTER I

INTRODUCTION

A baseline blood profile is useful in monitoring the response of species to disease, nutritional deficiencies, and stress. Blood has long been used as a diagnostic tool by veterinarians; yet only recently have wildlife biologists begun to utilize blood parameters. The delay in use of blood as a monitoring agent has been due in part to the difficulties associated with sampling sufficient numbers of animals to establish baseline values. With the advent of safe and efficient immobilizing drugs this difficulty has been partially alleviated. However, there is still the problem of whether blood profiles from sedated animals can be considered valid baseline data. The only alternative at the present time is to assume that these values are valid while accepting the limitations imposed by the effects of the immobilizing agent used (Hawkey, 1975). Further study may be able to isolate particular effects of drugs or of stress from capture and hence allow adjustment for those values altered by either.

Wild mammal species whose blood parameters have previously been studied range from elephants, *Elephas maximus* (Lewis, 1974) and *Loxodonta africana* (Debbie and Clausen, 1975) to gray squirrels, *Sciurus carolinensis* (Guthrie et al., 1966; Hoff et al., 1976). Big game species are the most prominent group of large mammals studied: white-tailed deer, *Odocoileus virginianus* (Johnson et al., 1968; Seal and Erickson, 1969), mule deer, *Odocoileus hemionus* (Anderson et al., 1970; Anderson et al., 1972), moose, *Alces alces* (Franzmann and Le Resche, 1978), elk, Cervus canadensis (Vaughnet al., 1973; Pedersen and Pedersen, 1975), pronghorn, Antilocapra americana (Barrett and Chalmers, 1977), and bighorn sheep, Ovis canadensis (Franzmann, 1972).

Very few studies of hematology and serum chemistries of brown bears (Ursus arctos) were found in the literature. Aside from limited data published by Seal et al. (1967), the only other available information on the hematology and blood chemistries of this species was that of Pearson and Holloran (1972) and Holloran and Pearson (1972).

Hematology of captive polar bears, Ursus maritimus, was reported by Seal et al. (1967) and serum electrolytes were reported on polar bears by Manery et al. (1966). Lee et al. (1977) reported seven whole blood parameters and 15 serum parameters on 21 adults and 12 immature wild polar bears.

Information concerning hematology of black bears (Ursus americanus) was reported by Svihla et al. (1955), Musacchia et al. (1955), Jacobs (1957), Youatt and Erickson (1958), King et al. (1960), Erickson and Youatt (1961), Hock (1966), Seal et al. (1967) and Dieterich (1970). Similarly, reports on values for blood chemistries in black bear were found in Svihla et al. (1955), Youatt and Erickson (1958), King et al. (1960), Erickson and Youatt (1961), Hock (1966), Brown et al. (1971), Nelson et al. (1973), Poelker and Hartwell (1973), Eubanks et al. (1976), and Matula (1976).

Erickson and Youatt (1961) reported seasonal changes in hematology that might be related to winter dormancy. Halikas and Bowers (1972) measured the blood viscosity of black bears during autumn, winter, and spring. Poelker and Hartwell (1973) compared the levels of magnesium, sodium, calcium, potassium, and copper in black bears from an area in which these animals had extensively damaged trees with those parameters from an area suffering no such damage. Matula (1976) examined 30 blood parameters of bears in northeastern Pennsylvania and analyzed them for the influence of sex, season, and age. In the present study area Eubanks et al. (1976) reported 18 serum parameters and analyzed them with respect to age, weight, and data of collection.

The objective of this study was to establish baseline values for whole blood and serum parameters for the population of black bears in the Great Smoky Mountains National Park (GSMNP) and to examine the effects of sex, age, year, trap type and drug used on the various parameters measured. These data, hopefully, will contribute to establishing norms for the species as a whole. Moreover, comparisons with data from similar studies in other areas should elucidate differences and similarities for black bears in various parts of their range.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

The Great Smoky Mountains National Park, comprised of 2072 km^2 (207,382 ha.), is situated on the common border of Tennessee and North Carolina. The land contained in the Park includes portions of Blount, Sevier, and Cocke counties in Tennessee and Swain and Haywood counties in North Carolina. U. S. Highway 441, from Gatlinburg, Tennessee, to Cherokee, North Carolina, bisects the acreage. A second major highway, State Route 73, runs parallel to the north boundary from Gatlinburg to Townsend.

The study area comprises the northwest quarter of the Park (150,607 ha.). It is bounded by the Transmountain Road on the east and the Tennessee-North Carolina border on the south.

Topography

The mountains in the Park extend from the northeast to the southwest and are characterized by deep V-shaped valleys, steep slopes, and narrow ridges. The elevation ranges from 271 m above sea level where Abrams Creek meets the Little Tennessee River at Chilhowee Lake to 2025 m at Clingman's Dome. Approximately 960 km of mountain streams drain the area (Marcum, 1974).

Climate

The average annual temperature at elevations below 450 m is 14° C, while the average annual temperature at elevations above 1900 m is 6° C.

With each 1000 m increase in elevation the temperature decreases approximately 4°C. Monthly temperatures usually peak in July and are at a low in February. At low elevations precipitation averages 140 cm per year, while at the highest elevations precipitation may exceed 200 cm. Precipitation is usually at a maximum in July and at a minimum in September and October (Eagle and Pelton, In Press).

Flora

The vegetation within the Park is diverse because of the many microhabitats found therein. Elevational increases approximate a movement northward with respect to vegetational changes. There are 1300 species of flowering plants, approximately 350 species of mosses and liverworts, 250 species of lichens, and more than 2000 species of fungi within the area (Stupka, 1960).

Vertebrate Fauna

Numerous species of fishes, amphibians, reptiles, and birds occur within the Park. The National Park Service (1969) reports that there are more than 200 species of birds, 23 species of snakes, and 72 species of fish. In addition, according to the National Park Service (1969) the area contains one of the richest arrays of salamanders in the world. Mammals, however, are not as abundant. Linzey and Linzey (1971) report that 59 species of mammals reside within the Park. Of these, 25 species belong to the family Rodentia. The white-tailed deer and the European wild hog (*Sus scrofa*) are the only large mammals present other than the black bear. More detailed descriptions of the study area, natural history, topography, climate, flora and vertebrate fauna can be found in Marcum (1974) and Beeman (1975).

CHAPTER III

METHODS AND MATERIALS

During the summers of 1974, 1975, and 1976, 124 black bears were captured in the study area; 114 were captured using Aldrich spring-activated snares and 10 using culvert traps or free-ranging techniques. Samples from bears captured in 1974 were considered as a preliminary study to the present work (Eubanks et al., 1976).

Bears were immobilized with either Sernylan (Phencyclidine hydrochloride, Parke Davis and Co., Morris Plains, N. J.) (n=65) or M-99 (Etorphine hydrochloride, American Cyanamide Co., Wayne, N. J.) (n=59). Basic biological data were recorded for each animal (Eagar, 1977).

Blood samples were collected from the femoral vein into vacuum tubes fitted with a 20 ga, 3.81 cm (1.5 in) needle and a Vacutainer Luer adapter (Becton-Dickinson, Rutherford, N. J.). Whole blood was collected in 7 ml vacuum tubes (Becton-Dickinson) containing 0.09 ml of EDTA(K_3) to prevent clotting and inverted gently three to five times to insure proper mixing. During the second summer a smaller vacuum tube (3 ml) was evaluated; it appears that the smaller tube allows for better maintenance of cellular integrity. Blood smears were made on precleaned microscope slides within 15-30 min. after blood collection and later stained with Giemsa (2%). The high lipid content in many of the blood samples made it difficult to obtain a suitable smear. Serum samples were obtained by collecting whole blood in 20 ml vacuum tubes (Becton-Dickinson) containing no additive. Samples were refrigerated (4.5^{o}C) immediately on return from the field (three to six hours). The samples were not chilled in the field because of the difficulty in transporting additional equipment while backpacking in to check traps. The blood in the 20 ml vacuum tube was allowed to clot overnight. The serum was then withdrawn and spun at 3300 rpm for 20 min. in a clinical centrifuge (IEC, Clinical Centrifuge, Head 211) to remove any extraneous red cells. The serum was transferred to plastic vials, and stored at -75°C for later study.

Hematology data were collected on 96 individual bears. A bear was considered a distinct individual if it was a new capture or a recepture from a previous trapping year. The whole blood samples were analyzed within 24-48 hrs. after collection. Whole blood analyses included counts of red cells, white cells, and platelets as well as determinations of hemoglobin concentration and hematocrits. Red cells, white cells, and platelets were diluted in an appropriate Unopette (Becton-Dickinson) and hand-mixed for five minutes. Each of these samples was then manually counted using a hemacytometer (Davidshon and Nelson, 1974: 117, 124, 126).

Hematocrits were measured by the microhematocrit method (Brown, 1976: 74) using capillary tubes, a microhematocrit centrifuge (IEC, Microhematocrit Centrifuge, Model B) and a card reader. The average of four determinations is given as the mean hematocrit for each sample.

Hemoglobin was measured with a Spencer Hemoglobinmeter (American Optical, South Bridge, Mass.) following the methodology found in Cartwright (1968: 92). The reported value is the average of two samples.

Differential white cell counts were performed on the Giemsa stained blood smears. One hundred cells, under oil immersion, were counted on each slide.

Values for mean cellular volume (MCU), mean cellular hemoglobin (MCH), and mean cellular hemoglobin concentration (MCHC) were calculated as described previously (Simmons, 1976: 78). A corrected count of white cells was calculated for each sample which had yielded a suitable smear.

Serum samples from those bears trapped in 1975 were taken to the Clinical Laboratory at The University of Tennessee Memorial Research Hospital where they were chemically analyzed by a SMA 12/60 and a SMA 6/60 (Technicon, Inc., Tarrytown, N. Y.). The SMA 12/60 profile included the following parameters: total protein, albumin, calcium, phosphorus, cholesterol, uric acid, creatinine, bilirubin, alkaline phosphatase, creatine phosphokinase (CPK), lactate dehydrogenase (LDH) and serum glutamic-oxalacetic transaminase (SGOT). The SMA 6/60 analyses included chloride, carbon dioxide, sodium, potassium, blood urea nitrogen (BUN), and glucose. Concentrations of albumin and the alpha, beta, and gamma globulin fractions of serum proteins were measured electrophoretically using a Mircozone instrument (Beckman Instrument Co., Inc., Fullerton, Calif.).

Serum samples from bears caught in 1976 were analyzed using a SMAC (Technicon Inc., Tarrytown, N. Y.) with the cooperation of Fort Sanders Presbyterian Hospital. This instrument is superior to that used in the prior year because it requires less serum and measures two more parametsrs: serum iron and triglycerides.

Initial analysis of the data included calculation of means, standard deviation, range and standard error. Data were then statistically examined by least squares analysis of variance for unequal subclass size (SAS 1972 PROC GLM) (Barr et al., 1976). Each parameter was examined for the influence of year, sex, age, trap type and drug used. If $P<0.05$, then the parameter varied significantly with the variable being tested.

CHAPTER IV

RESULTS AND DISCUSSION

General Comments

The results of whole blood studies, serum analyses, and serum electrophoresis on black bears captured during the summers of 1974, 1975, and 1976 are summarized in Tables 1, 2, and 3. Tables presenting the data summarized by sex, age, year of capture and trap type can be found in Tables 7-18 (p. 47) in the Appendix. Tables 4, 5, and 6 present those parameters that are significantly affected by sex, age, year samples, trap type, or drug used. Tables 19-24 (p. 76) in the Appendix summarize by variable the data where more than one variable is significant.

There were no significant differences in whole blood parameters with regard to sex. MCHC levels were significantly lower in bears one year old. Monocyte levels were significantly lower in bears immobilized with Sernylan. Hematocrit levels, levels of white blood cells and percentage of neutrophils were higher in bears caught in snares while percentage of lymphocytes and eosonophils were lower. Counts of white blood cells, MCHC and percentage of neutrophils were higher in 1975 than in 1976, while percentage of lymphocytes were lower (Table 4).

Calcium, serum iron, and triglycerides were the only three parameters measured on serum that exhibited no significant variation with year, sex, age, trap type or drug used. Carbon dioxide bilirubin, SGOT, phosphorus, glucose and CPK were higher in 1974 than in 1975 or

TABLE 1. Whole Blood Parameters of Black Bears Captured During the Summers of 1975 and 1976, GSMNP.

Determination	N	Mean	Standard Deviation	Range
Red Blood Cells ($10^6/mm^3$)	96	7.10	1.07	4.49 - 9.54
White Blood Cells ($10^3/mm^3$)	96	16.05	5.33	6.72 - 35.68
Platelets ($10^6/mm^3$)	95	0.53	0.14	0.16 - 0.89
Hematocrit (%)	96	42.93	4.21	32.00 - 55.00
Hemoglobin (gm)	95	14.54	1.49	10.70 - 18.80
MCH (uug)	95	20.70	2.98	16.00 - 32.20
MCV (u^3)	96	61.16	7.92	46.10 - 86.60
MCHC (%)	95	33.91	1.42	29.70 - 40.00
Neutrophils (%)	78	81.50	10.65	37.00 - 97.00
Lymphocytes (%)	78	12.50	7.62	2.00 - 43.00
Monocyte (%)	78	1.62	1.66	0.00 - 8.00
Eosinophil (%)	78	3.62	4.33	0.00 - 41.00
Basophil (%)	78	0.73	1.06	0.00 - 4.00
NRBC (%)	78	0.65	1.50	0.00 - 10.00
CWBC ($10^3/mm^3$)	73	15.74	5.52	6.58 - 35.68

TABLE 2. Serum Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976, GSMNP.

Determination	N	Mean	Standard Deviation	Range
Sodium (mEq/L)	123	142.64	5.56	131.00 - 160.00
Chloride (mEq/L)	124	101.99	7.32	88.00 - 125.00
Potassium (mEq/L)	124	4.81	0.72	3.20 - 7.50
Calcium (mg/dl)	124	7.98	1.01	5.80 - 12.50
Inorganic phosphorus (mg/dl)	122	5.45	1.32	2.40 - 9.60
Serum iron (mcg/dl)	51	164.70	79.99	60.00 - 378.00
BUN (mg/dl)	124	12.35	7.98	0.00 - 44.00
Creatinine (mg/dl)	124	1.57	0.34	0.90 - 3.00
Uric acid (mg/dl)	124	2.32	0.51	1.40 - 4.40
Total bilirubin (mg/dl)	122	0.18	0.14	0.00 - 1.50
CO2 (mEq/l)	74	18.99	3.94	11.00 - 33.00
Glucose (mg/dl)	124	99.60	51.63	7.00 - 285.00
Cholesterol (mg/dl)	124	252.04	44.72	125.00 - 475.00
Triglycerides (mg/dl)	51	229.67	71.08	63.00 - 409.00
Total protein (g/dl)	124	7.18	0.60	5.60 - 10.00
Albumin (g/dl)	72	3.97	0.34	1.10 - 5.70
Alkaline phosphatase (U/L)	124	56.17	25.11	15.00 - 187.00
LDH (U/L)		Not reported--values out of instrumentation range		
SGOT (U/L)	46	185.63	59.10	57.00 - 358.00
CPK (U/L)	51	641.24	288.91	45.00 - 1200.00

TABLE 3. Serum Electrophoresis of Black Bears Captured During the Summers of 1974, 1975, and 1976, GSMNP.

Determination	N	Mean	Standard Deviation	Range
Albumin (g/dl)	120	3.66	0.49	1.89 - 4.84
Alpha globulin (g/dl)	120	0.99	0.27	0.50 - 2.60
Beta globulin (g/dl)	120	1.30	0.26	0.68 - 2.36
Gamma globulin (g/dl)	120	1.23	0.70	0.51 - 7.71

TABLE 4. The Effects of Year, Age, Sex, Trap Type, and Drug Type on Parameters of Whole Blood of Black Bears (* = significant, - = not significant, P<0.05).

Determination	Year	Age	Sex	Trap Type	Drug
Red blood cells	-	-	-	-	-
White blood cells	*	-	-	*	-
Platelets	-	-	-	-	-
Hematocrit	-	-	-	*	-
Hemoglobin	-	-	-	-	-
MCH	-	-	-	-	-
MCV	-	-	-	-	-
MCHC	*	*	-	-	-
Neutrophils	*	-	-	*	-
Lymphocytes	*	-	-	*	-
Monocytes	-	-	-	-	*
Eosinophils	-	-	-	*	-
Basophils	-	-	-	-	-

TABLE 5. The Effects of Year, Age, Sex, Trap Type, and Drug Type on Serum Parameters of Black Bears (* = significant, - = not significant, P<0.05).

Determination	Year	Age	Sex	Trap Type	Drug
Sodium	*	-	-	-	-
Chloride	*	-	-	-	*
Potassium	*	*	-	-	-
Calcium	-	-	-	-	-
Inorganic phosphorus	*	*	-	-	-
Serum iron	-	-	-	-	-
BUN	-	-	-	-	*
Creatinine	-	*	*	-	-
Uric acid	*	*	-	-	*
Total bilirubin	*	-	-	-	-
Carbon dioxide	*	-	-	-	-
Glucose	*	-	-	*	*
Cholesterol	*	*	-	-	-
Triglycerides	-	-	-	-	-
Total protein	*	-	-	-	-
Albumin	*	-	-	-	-
Alkaline phosphatase	*	*	-	-	-
LDH		Not reported--values out of instrumentation range			
SGOT	*	-	-	-	-
CPK	*	-	-	-	-

TABLE 6. The Effects of Year, Age, Sex, Trap Type, and Drug Type on Serum Electrophoretic Values of Black Bears (* = significant, - = not significant, P<0.05).

Determination	Year	Age	Sex	Trap Type	Drug
Albumin	*	-	-	-	-
Alpha globulin	*	-	-	-	*
Beta globulin	*	-	-	-	-
Gamma globulin	-	-	-	-	-

1976, while sodium, chloride and potassium levels were lower. Total protein and cholesterol were significantly higher in 1975 than in 1974 and 1976, while albumin, uric acid and alkaline phosphatase were significantly higher in 1976. Potassium, phosphorus, cholesterol, alkaline phosphatase, and uric acid were significantly higher in subadults. Creatinine was higher in adults and in males. Glucose was higher in those bears captured in snares. Uric acid, BUN, and glucose were higher in those bears immobilized with M-99, while chloride levels were higher in bears immobilized with Sernylan (Table 5).

Albumin and beta globulin were higher in 1975 than in 1974 and 1976, while alpha globulins were higher in 1976 than in 1974 and 1975. Alpha globulins were also higher in bears immobilized with Serynlan (Table 6).

Whole Blood Parameters

Counts of red cells, hematocrit, and concentrations of hemoglobin for black bears in this study were within the range of those values reported by Matula (1976), Pearson and Halloran (1972), Dieterich (1970), Seal et al. (1967), Hock (1966), Erickson and Youatt (1961), Youatt and Erickson (1958), and Svihla et al. (Table 1, p. 12). Values for counts of red cells, hematocrits, and concentration of hemoglobin were higher than those reported for brown bears (Pearson and Halloran, 1972; Seal et al., 1967) and polar bears (Lee et al., 1977; Seal et al., 1967).

There were no differences in counts of red cells, hematocrits, and concentrations of hemoglogin attributable to sex, age, year or drug used (Table 4). Matula (1976) reported higher red cell counts in his female bears and he postulated that this elevation arose as compensatory for reduced hemoglobin, reflected in lower MCH and MCHC values. He attributed this to iron deficiency in females during pregnancy and lactation. The six lactating bears (Table 7, Appendix) showed no trend toward lower hemoglobin or higher counts of red cells. The change that might have occurred in these parameters with implantation would not show up here because implantation occurred after the trapping year had ceased. Pearson and Halloran (1972), in the brown bear, and Lee et al. (1977), in the polar bear, found no variation in red cell parameters associated with sex.

Bears trapped in snares had significantly higher hematocrits than those captured while free ranging or in culvert traps (Figure 1). Although the differences were not significant, the concentration of hemoglobin and the counts of red cells were also elevated in bears trapped in snares. The combination of elevated hematocrit, hemoglobin, and the counts of red cells characterize a geberal response to stressful situations. A splenic concentration releasing a pool of red cells is seen in certain excitable breeds of dogs such as the poodle (Schalm et al., 1975: 88). The effects of stress on whole blood and serum parameters of bears have been discussed by many authors (Lee et al., 1977; Eubanks et al., 1976; Matula, 1976; and Pearson and Halloran, 1972); however, this study is the first to clearly show the response of the red blood cell and its related parameters to the stress of the method of capture. This is further substantiated in this study by the alterations seen in the numbers and kinds of white blood cells (p. 24).

MCV, MCH, and MCHC values for black bears (Table 1, p. 12) compare favorably with those reported by Matula (1976), but were higher than those given by Dieterich (1970) and Hock (1966). MCV values in the

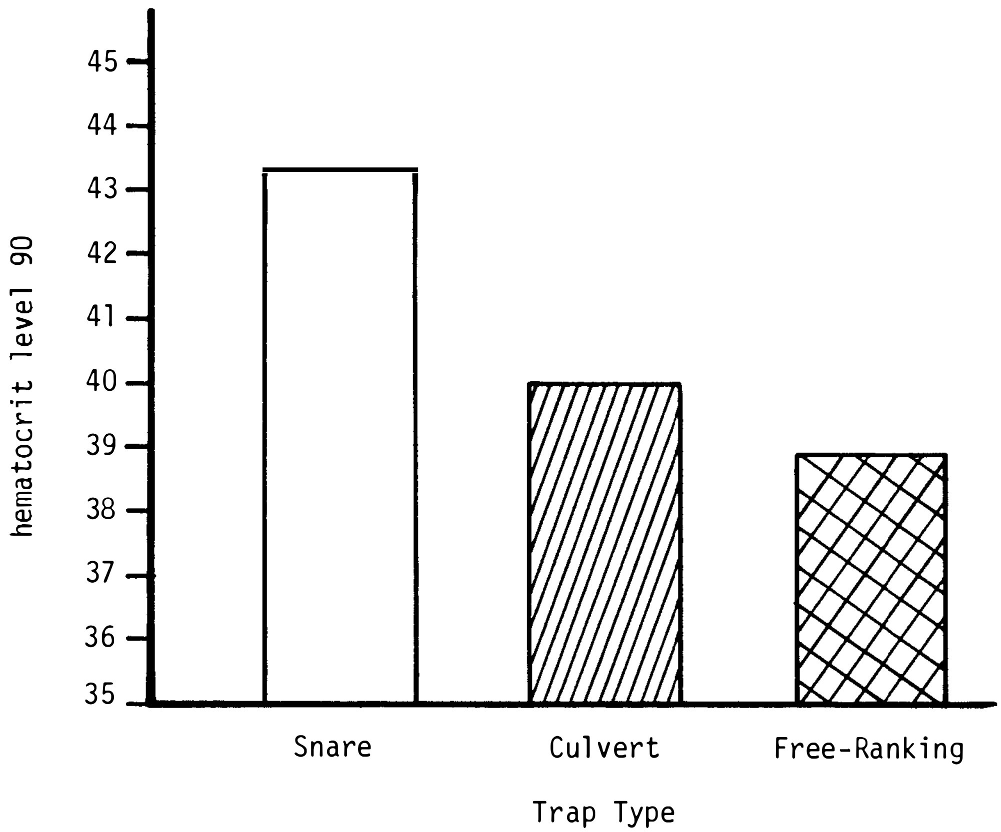

Figure 1. Hematocrit levels of black bears with respect to trap type, GSMNP.

present study were lower than those reported by Pearson and Halloran (1972) and Seal et al. (1967); however, MCH and MCHC values were similar. Values for MCV and MCH in this study were higher than those from brown bears (Pearson and Halloran, 1972) and polar bears (Lee et al., 1977), but MCHC values were lower.

No significant differences were noted in MCV, MCH and MCHC values for sex, trap type or drug type. MCH and MCV levels were not significant for the influence of age and year sampled; however, MCHC values were significant for the influence of both (Table 4, p. 15).

The MCHC was significantly lower for the yearling bears than for any other age class. To interpret these findings it is necessary to view the trends in counts of red cells, hematocrit, concentration of hemoglobin, MCV, and MCH (Figure 2). Numbers of red blood cells and the concentration of hemoglobin were lower in one and two year old bears. Hematocrit levels were reduced in two year old bears, although they approached the mean of all age classes in the yearlings. MCV levels were higher in bears of the first two age classes. MCH values were elevated in two year old bears.

These variations in numbers of red blood cells, hematocrit, concentration of hemoglobin, MCH, MCV and MCHC are not inconsistent with data previously reported in the literature. Seal et al. (1967) stated that cubs and yearlings had fewer red blood cells, lower hematocrits, and lower hemoglobin concentrations than adults. They also reported that newborn cubs of the genus ursus had a 50% higher MCV than adults. Matula (1976) found a significant increase in MCH levels with age; although not significant, similar trends were found for MCHC values

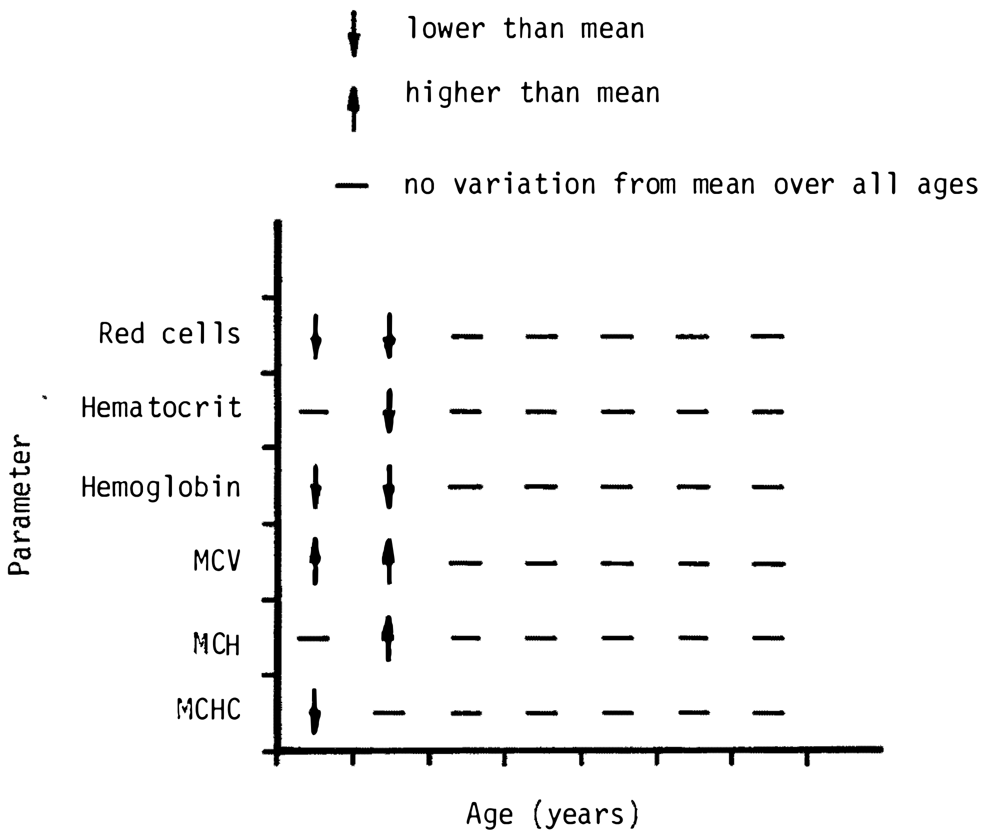

Figure 2. Variation in red cell parameters of black bears with respect to age, GSMNP.

and hemoglobin concentrations. He reported, however, that younger bears had a lower MCV.

Matula (1976) and Seal et al. (1967) felt that younger bears might exhibit hypochromic microcytic anemia. In the present study younger bears had cells which were macrocytic and normochromic, a condition which paralleled that seen when there is a lack of vitamin B_{12} or folic acid (Schalm, 1961: 242). Seal et al. (1975) suggested such a dietary deficiency for wolf pups. This deficiency could be a major factor in mortality in the very young bears. Similarly the differences noted in MCHC values between the years (1975 and 1976) reflect a difference in animal matter consumed, although previous food habit studies suggest that the levels of animal matter consumed is relatively consistent over time (Beeman and Pelton, In-Press; Eagle and Pelton, In-Press).

Values reported for counts of white blood cells for black bears (Table 1, p. 12) were higher than those values reported by Matula (1976), Pearson and Halloran (1972), Dieterich (1970), Seal et al. (1967), King et al. (1960), Jacobs (1957), and Svihla et al. (1955), but were lower than those reported by Youatt and Erickson (1958). Calculating the corrected white blood cell count for those bears yielding a suitable smear altered the baseline values very little. The average values, expressed as percentages, for the number of neutrophils, lymphocytes, monocytes, eosinophils, and baseophils from black bears in this study were similar to those reported by Matula (1976), Pearson and Halloran (1972), Jacobs (1957), and Musacchia et al. (1955).

Counts of white blood cells, percentage of neutrophils and lymphocytes exhibited no significant variation with sex, age and drug type. Monocytes displayed no significant difference with sex, age, trap type and year while eosinophils exhibited no significant fluctuation with sex, age, drug type and year. Basephils displayed no significant variation with sex, age, drug type, trap type and year (Table 4, p. 15). Values for counts of white cells were significantly elevated in bears captured by snares (Figure 3). These same bears had elevated levels of neutrophils and depressed levels of lymphocytes and eosinophils. Lee et al. (1977) reported an elevation in the counts of white blood cells of polar bears captured with snares, although they did not include data on the kinds of cells and their respective numbers. It is, however, now accepted that under conditions of stress the adrenal cortical secretions depress the number of circulating eosinophils and lymphocytes and leads to an elevation of circulating neutrophils (Schalm, 1961: 270). These results coupled with those seen for red cell parameters certainly indicate the high level of stress associated with the capture of bears by snares.

White blood cells were significantly elevated in bears captured during the 1975 trapping season. Neutrophils were significantly higher in these same bears while the lymphocyte levels were depressed. These results are more difficult to explain than the differences in trap type, but they may reflect a combination of factors such as possible dietary differences and perhaps a higher incidence of diseases such as leptospirosis or parasites such as Dirofilaria ursi (Cook and Pelton, 1979).

Platelet levels reported for black bears (Table 1, p. 12) are comparable to those reported by Jacobs (1957) and Egdahl and Richards (1955). No significant differences in counts of platelets were noted

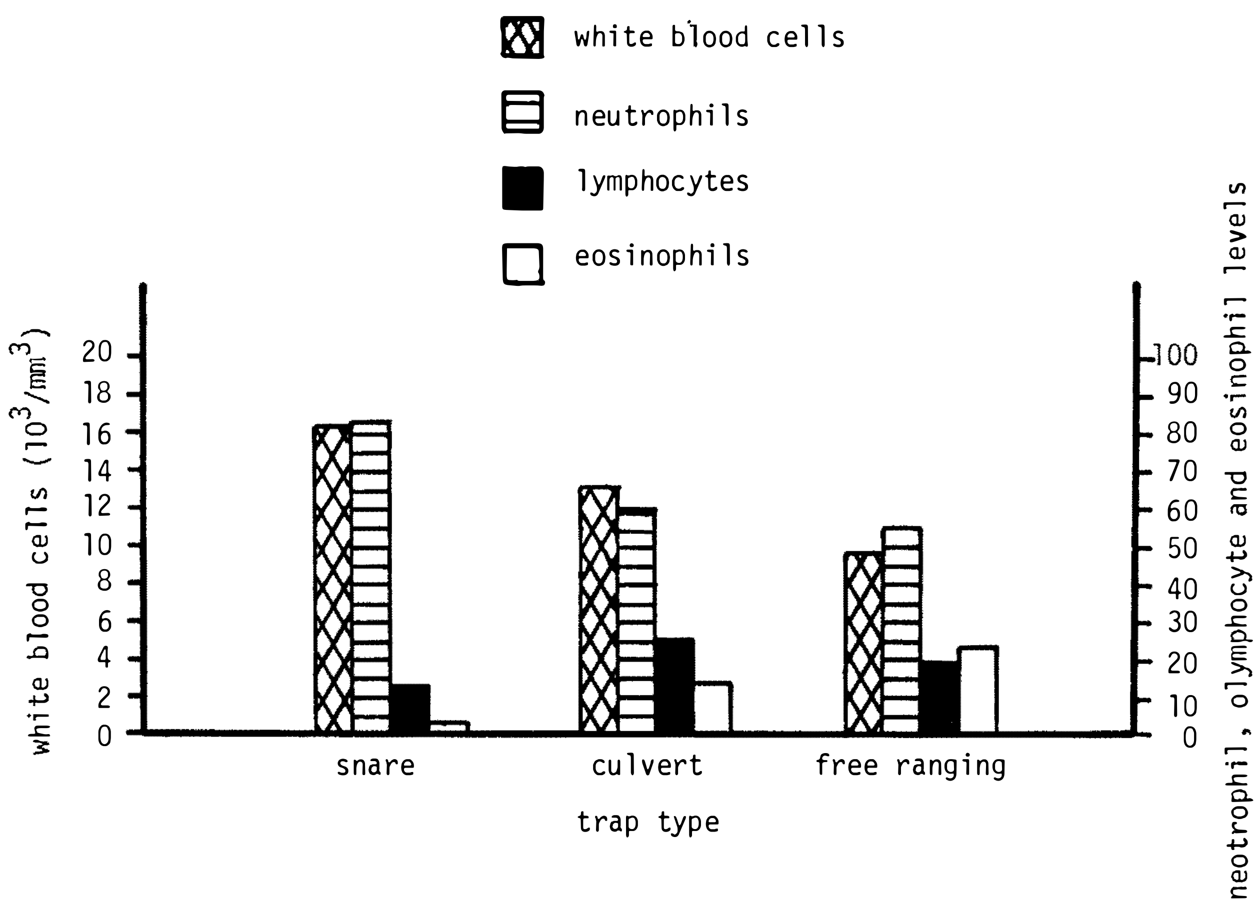

Figure 3. Variation in white cell parameters of black bears with respect to trap type, GSMNP.

for the influence of sex, year, age, trap type, or drug type (Table 4, p. 15).

Serum and Serum Electrophoretic Parameters

In general, the values reported for sodium, chloride, potassium, calcium, inorganic phosphorus, serum iron, and triglycerides fall within the range of previously reported values for black bears (Matula, 1976; Eubanks et al., 1976; Poelker and Hartwell, 1973; Halloran and Pearson, 1972) (Table 2, p. 13). No significant variation in calcium, serum iron and triglycerides values were found for the influence of sex, age, trap type, year, or drug type (Table 5, p. 16).

Matula (1976) and Eubanks et al. (1976) reported higher levels of calcium in male bears. Although Eubanks et al. (1976) gave no suggestions, Matula (1976) attributed lower levels in females to physiological changes in pregnant and lactating females. The six lactating bears in this study (Table 11, Appendix) exhibited no significant difference from the mean of all bears. It might be predicted that there would be changes in calcium during the final stages of gestation.

Sodium, chloride and potassium levels were significantly lower in 1974 than in 1975 and 1976; phosphorus levels were significantly higher. The only realistic factor that might explain the variation is a difference in handling and storage techniques in 1974 (Eubanks et al., 1976). The major discrepancies between the handling of the samples of 1974 and those of 1975 and 1976 were the length of time between the initial separation of the sera and its final storage and the final storage temperatures. During 1974 the sera was often stored for up to a week at -7°C before transfer to -20°C. Samples from 1975 and 1976 were immediately frozen at -75°C after sera separation.

Potassium and phosphorus levels were elevated in young bears. Anderson et al. (1972) reported similar findings for young male mule deer. Elevated phosphorus levels were also reported for young polar bears (Lee et al., 1977), wolf pups (Seal et al., 1975) and humans (Tietz, 1976: 1222) and may reflect the rapid bone growth occurring in these animals. Elevated levels of potassium were also found in newborn humans (Tietz, 1976: 1222) and may be related to an increased requirement for potassium in the rapidly growing animal.

Serum chloride levels are related to the pH of the blood. Chloride levels are increased during respiratory alkalosis and are decreased during respiratory acidosis (Cohn and Kaplan, 1966: 292-293). Animals immobilized with Sernylan have a tendency toward hyperventilation. Therefore, the higher chloride levels in the bears immobilized with Sernylan may be due to respiratory alkalosis and the accompanying retention of chloride by the kidney. Depression of the respiratory centers and the resultant respiratory acidosis can be caused by M-99. Excess chloride is excreted in the urine during respiratory acidosis. Therefore, the lower levels found in animals immobilized with M-99 might be explained in this manner, or the significance between the two values could result from a combination of slight respiratory alkalosis in the animals immobilized with Sernylan and slight respiratory acidosis in animals immobilized with M-99 (Beeman and Pelton, 1979).

BUN, creatinine, uric acid, bilirubin, and carbon dioxide levels compared favorably to values reported by other authors (Matula, 1976; Eubanks et al., 1976; Halloran and Pearson, 1972) (Table 2, p. 13). Levels of BUN and uric acid varied with the drug type; higher levels were observed from animals immobilized with M-99 (Table 5, p. 16). Elevated levels were due in part to drug altered kidney function associated with the physiological effects of M-99 (Beeman and Pelton, 1979). Values for bilirubin, carbon dioxide, and uric acid were significantly affected by year sampled (Table 5, p. 16). Carbon dioxide is sensitive to the amount of handling and the means of storage (Tietz, 1976: 851). Values of carbon dioxide for 1975 were not forwarded to the author by the hospital because of the unreliability associated with the prolonged handling and storage of the samples. Results from 1974 and 1976 suffered from this variability and their reliability was questionable, although the lower levels seen in 1976 probably relate to more rapid handling of the samples. Bilirubin is sensitive to sunlight and hemolysis. Values for bilirubin were higher in 1974 than in 1975 and 1976. Once again this may reflect a difference in handling and storage techniques. Uric acid levels were higher in 1976 than in 1975. The higher levels may be associated with a higher intake of protein. Seal et al. (1975) reported higher uric acid levels in wolf pups that ingested more animal food.

Values for creatinine and uric acid were also significantly affected by age and creatinine by sex (Table 5, p. 16). Creatinine levels were significantly higher in adults than subadults and in males than in females. The higher creatinine levels that were seen in adults and males result from the fact that creatinine production is proportional to total muscle mass (Mazur and Harrow, 1971: 459). A similar trend was reported for humans; male creatinine levels were higher than those for females (Tietz, 1976: 1211). Uric acid levels were highest in subadults; this is opposite to the trend observed in humans (Tietz, 1976: 1225). Higher uric acid levels in subadults may reflect food preferences or a change in basal metabolism. Seal et al. (1975) found higher BUN, uric acid, and cholesterol levels in one group of wolf pups due to a diet higher in animal flesh and protein.

Serum glucose levels in this study were lower than those reported by Matula (1976) and Eubanks et al. (1976) but were similar to those reported by Halloran and Pearson (1972) (Table 2, p. 13). Serum glucose levels were higher than those reported for whole blood glucose levels by other authors (Erickson and Youatt, 1961; Youatt and Erickson, 1958; and Svihla et al., 1955). Higher serum glucose levels were to be expected as normal true glucose concentration in the blood is lower than that found in serum (Caraway, 1976: 242). Levels reported here for black bears were comparable to those reported for brown bears (Halloran and Pearson, 1972) and polar bears (Lee et al., 1977).

Glucose levels were consistent with respect to age and sex, but they were significantly affected by the year sample, the trap type, and the drug type (Table 5, p. 16). Since the same methods of trapping and collection were used in all seasons, it is likely that the yearly differences observed in glucose levels reflect a dietary effect (Figure 4). Perhaps bears in 1974 and 1976 had more recent access to more high energy foods. Glucose is very sensitive to recent ingestion of foods (Caraway, 1976: 241) and could account for these differences.

The significantly higher levels of glucose observed in black bears captured in snares is likely a reaction to the stress of the method of capture. Both Matula (1976) and Seal et al. (1975) suggest that the stress of capture was responsible for elevated glucose levels in

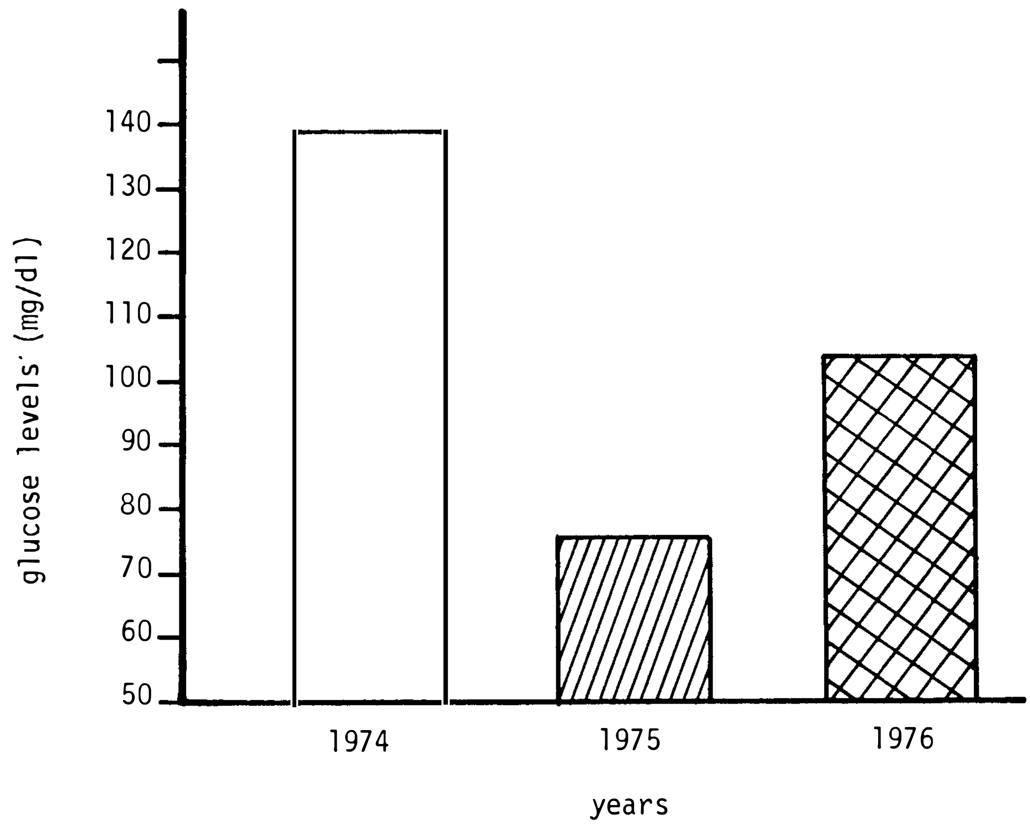

Figure 4. Levels of glucose of black bears with respect to year, GSMNP.

black bears and wolves, respectively. Differences observed between the drug types cannot be explained.

Values for cholesterol in this study were lower than those found by Matula (1976), Nelson et al. (1973), and Svihla et al. (1955) but were comparable to those reported by Eubanks et al. (1976) and Halloran and Pearson (1972) (Table 2, p. 13). Levels were also similar to those reported by Halloran and Pearson (1972) for brown bears but were lower than those reported for polar bears (Lee et al., 1977).

Levels of cholesterol were not significantly influenced by sex, trap type, or drug type but were significantly influenced by age and year sampled (Table 5, p. 16). Cholesterol levels were highest in subadult bears, a condition exactly the opposite of that found in humans (Tietz, 1976: 1209). Since diets high in fats encourage the accumulation of cholesterol (Effelson and Caraway, 1976: 459), this may reflect the different dietary preferences of subadults. Marler (1975) found higher levels of cholesterol for subadults in the American bison (<u>Bison bison</u>). Levels of cholesterol for 1975 were significantly higher than those for 1974 or 1976. Elevated levels of cholesterol in 1975 correspond with the general observation during that period of a large lipid layer when whole blood samples were allowed to sit overnight. The elevated levels of cholesterol observed in 1975 probably reflected a difference in diets among the seasons.

Levels of triglycerides were similar to those reported by Nelson et al. (1973) for their bears just prior to winter sleep (Table 2, p. 13). Values in this study were not significantly influenced by sex, age, year, trap type, or drug type (Table 5, p. 16).

Levels of total serum protein reported here for black bears were comparable to those reported by others (Matula, 1976; Eubanks et al., 1976; Halloran and Pearson, 1972), but they were lower than those reported by Hock (1966), Erickson and Youatt (1961), and Riedesel and Folk (1957) (Table 2, p. 13). Levels of total serum protein for black bears were also similar to those reported for brown bears by Halloran and Pearson (1972) and polar bears (Lee et al., 1977). Total serum proteins were not significantly influenced by sex, age, trap type, or drug type but were significantly affected by year sampled (Table 5, p. 16).

When examining serum protein levels, it is essential not only to consider total protein levels, but also the ratios of the individual fractions. Levels of albumin in this study were measured in two different manners using the techniques of electrophoresis and the techniques of a quantative dye-binding reaction (Eubanks et al., 1976) (Table 2, p. 13). Although the measurement of albumin utilizing this dye-binding reaction is supposed to be insensitive to non-human albumin, the results were very similar to those reported for electrophoretic fractionization.

Albumin values reported here for black bears were comparable to those reported by Eubanks et al. (1976) and Halloran and Pearson (1972) but were higher than those reported by Matula (1976) (Table 3, p. 14). These values were also within the range reported for brown bears (Halloran and Pearson, 1972). Albumin levels, like total serum protein levels, were significant for year sampled.

Alpha, beta, and gamma globulins in this study were similar to those reported by Eubanks et al. (1976) (Table 3, p. 14). Levels of alpha globulins were only significantly affected by year and drug type and beta globulin levels only by year. Total serum protein was significantly higher in 1974 and 1975 than in 1976 (Figure 5). Similarly, albumin and beta globulin levels were higher while alpha globulin levels were lower. The probable differences observed in the plasma protein profile resulted from dietary differences between the years samples. Dimopoullos (1970: 108) reported that plasma proteins were sensitive to nutritional influences such as vitamins, growth factors and other related substances. The drug-related differences seen in the alpha globulin fraction are not explained here. Further study is necessary before any drug related response can be explained.

Alkaline phosphatase levels reported here for black bears were comparable to those reported by Eubanks et al. (1976), were lower than those reported by Matula (1976) and were higher than those reported by Halloran and Pearson (1976) (Table 2, p. 13). Values reported in this study were higher than those reported for brown bears (Halloran and Pearson, 1972) and polar bears (Lee et al., 1977).

Levels of alkaline phosphatase were consistent for sex, trap type, and drug type, but significant variation occurred with age and year (Table 5, p. 16). Levels of alkaline phosphatase were significantly elevated in subadult bears (Figure 6). Matula (1976) reported a similar trend in black bears, Lee et al. (1977) in polar bears and Tietz (1976: 1221) in humans. High levels of serum alkalins phosphatase in subadults probably reflects the rapid bone growth that occurs in young animals. Alkaline phosphatase levels in 1974 and 1975 were significantly lower than those found in 1976; however, no obvious reason for this variation is known.

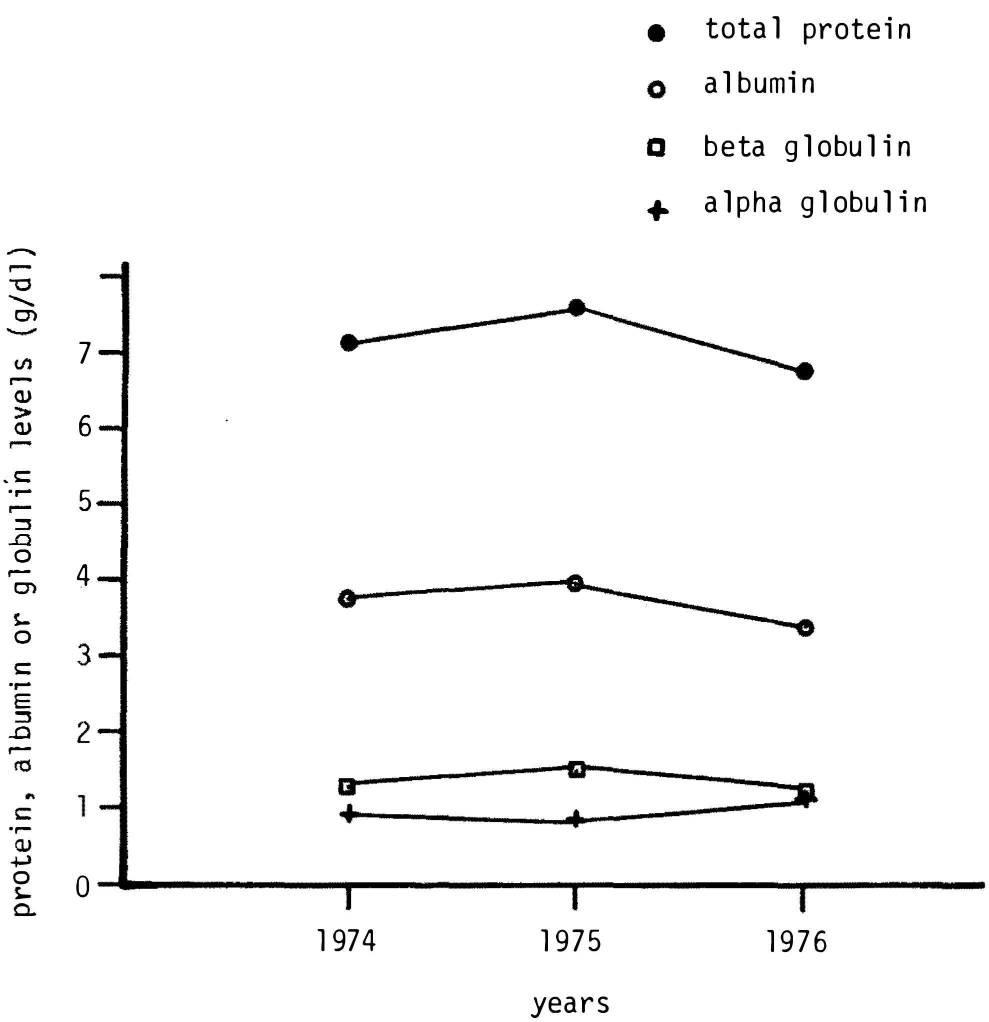

Figure 5. Total protein, albumin, alpha and beta globulins of black bears with respect to year, GSMNP.

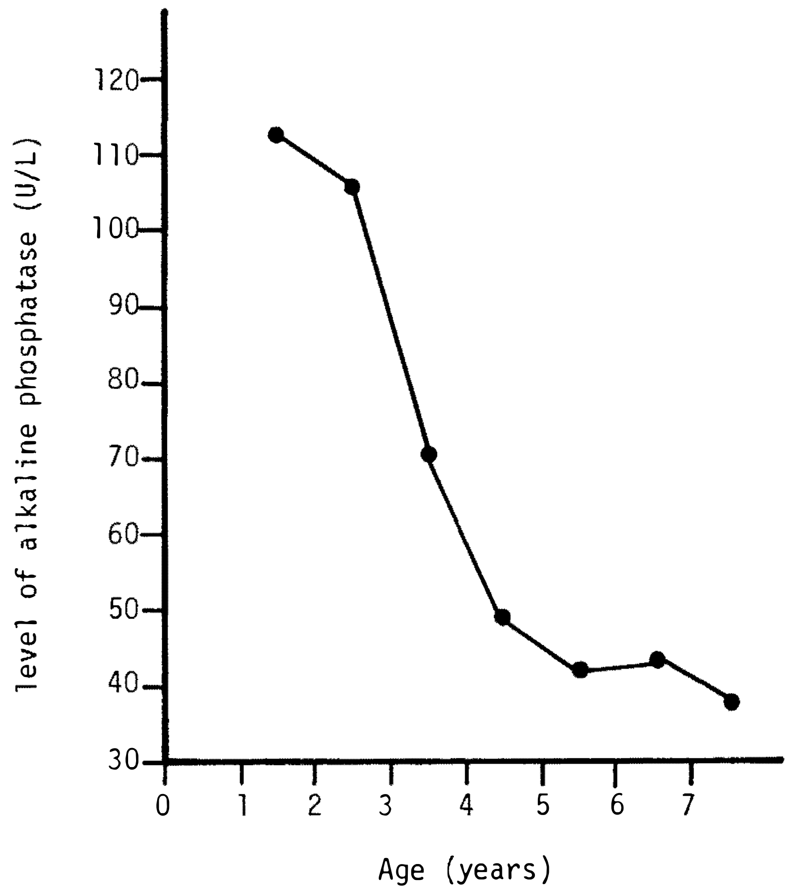

Figure 6. Levels of alkaline phosphatase of black bears with respect to age, GSMNP.

SGOT levels reported for black bears in this study were higher than those reported by Matula (1976) but were lower than those reported by Halloran and Pearson (1972) (Table 2, p. 13). SGOT levels were also lower than those reported for brown bears (Halloran and Pearson, 1972) but were higher than those reported for polar bears (Lee et al., 1977).

Levels for SGOT, CPK, and LDH were all affected by tissue trauma which results in the dumping of enzyme content of the cell into the serum (Kachmar and Moss, 1976); elevated levels of these parameters in this study reflect this effect. Seal et al. (1972) found elevated levels of SGOT, CPK, and LDH in white-tailed deer after restraint. Similarly, Lee et al. (1977) found significantly higher SGOT and LDH levels in snared polar bears. The present study illustrates that the stress-related effect on LDH was so intense that levels exceeded the maximum sensitivity of the instrumentation.

Both SGOT and CPK levels were only significantly affected by the year sampled. The higher levels in 1974 probably reflect a tendency of the hospital to report the maximum value as the true reading instead of culling that reading for being out of instrumentation range.

CHAPTER V

SUMMARY

1. Thirteen parameters of whole blood, 20 serum chemistries and four parameters of serum electrophoresis were measured in black bears. Although variability occurred, most levels were within the range of those reported in other studies.

2. Hematocrit, levels of white blood cells, percentage of neutrophils and eosinophils all varied with trap type. This variability was associated with the stress of the method of capture.

3. MCHC levels changed with age and reflected a deficiency of vitamin B_{12}.

4. Counts of white cells, MCHC and percentage of neutrophils and lymphocytes fluctuated with the year sampled. These differences were related to probable dietary differences between trapping seasons.

5. Percentages of monocytes differed with the drug used. No specific reason was noted for the difference.

6. Creatinine levels differed in the two sexes and the difference existed since the rate of production of creatinine depends on muscle mass.

7. Potassium, inorganic phosphorus, creatinine, uric acid, cholesterol and alkaline phosphatase all differed with age. The variation seen in potassium, uric acid and cholesterol depended on probable food preferences; inorganic phosphorus and alkaline phosphatase variations were related to the rapid bone growth in subadults and creatinine levels were associated with a smaller total muscle mass in subadults.

8. Glucose levels varied with trap type and were related to stress.

9. Chloride, BUN, uric acid, glucose and alpha globulin levels differed with the drug type. The variations seen in chloride levels are related to the effects of the drug type on the pH of the blood. The variations associated with BUN and uric acid were related in part to changes in kidney function associated with drug type. The reasons for changes in alpha globulins are unknown. The reasons for glucose level alterations is unknown.

10. Sodium, chloride, phosphorus, potassium, total bilirubin and carbon dioxide all changed with year sampled. It is suggested that these differences were the result of different handling and storage techniques in the first year and the second two years.

11. Uric acid, glucose, cholesterol, total protein, albumin alpha and beta globulin levels fluctuated with the year sampled. Changes in these parameters probably reflected dietary differences between years.

12. SGOT and CPK levels varied with year and reflected a tendency by one clinical laboratory to report those values that were out of range as true maximum values instead of culling the values as unusable.

13. These analyses illustrate how sensitive bears are to the method of capture, how sensitive the animals are to the available food supply and how blood parameters vary depending on drug type used.

CHAPTER VI

RECOMMENDATIONS

During the course of this study several events occurred which limit the usefulness of the data. If this research is to be pursued, it is believed that the following recommendations would lead to a more accurate evaluation of the normal hematological picture of black bears:

1. Serum samples should be handled as rapidly as possible and immediately stored at -75^{o}C.

2. The same immobilizing drug should be utilized.

3. The same hospital should analyze all the serum chemistries.

Further research needs to be conducted on the basis nutritional requirements of black bears. Research should also be conducted relating blood parameters to the disease process in black bears. Likewise, it would be beneficial if more research would be done on stress as it relates to the method of capture.

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APPENDIX

TABLE 7. Whole Blood Parameters of Black Bears Captured During the Summers of 1975 and 1976 by Sex, GSMNP.

Determination	M/F	Male			Female			
		Mean	S.D.	Range	Mean	(Lact)	S.D.	Range
Red blood cells ($10^6/mm^3$)	59/37	7.03	0.97	4.63 - 9.42	7.21	(7.31)	1.16	4.49 - 9.54
White blood cells ($10^3/mm^3$)	59/37	15.73	5.45	6.72 - 35.68	16.57		6.13	7.84 - 29.76
Platelets ($10^6/mm^3$)	59/36	0.52	0.12	0.28 - 0.76	0.55		0.18	0.16 - 0.89
Hematocrit (%)	59/37	42.76	4.32	32.00 - 55.00	43.19	(43.00)	4.22	34.00 - 50.00
Hemoglobin (gm)	58/37	14.52	1.53	10.70 - 18.80	14.56	(14.30)	1.42	11.80 - 17.20
MCH (uug)	58/37	20.86	2.71	16.70 - 32.20	20.58		3.28	46.10 - 86.60
MCV (u^3)	59/37	61.25	7.16	48.70 - 78.80	61.01		9.22	16.00 - 30.70
MCHC (%)	58/37	34.02	1.61	29.70 - 40.00	33.75		1.57	31.00 - 38.80
Neutrophils (%)	49/29	80.96	14.13	37.00 - 97.00	82.41		11.00	51.00 - 94.00
Lymphocytes (%)	49/29	12.78	8.87	2.00 - 43.00	12.03		7.89	4.00 - 39.00
Monocytes (%)	49/29	1.53	1.57	0.00 - 8.00	1.76		1.81	0.00 - 7.00
Eosinophils (%)	49/29	3.94	6.86	0.00 - 41.00	3.10		5.47	0.00 - 21.00
Basophils (%)	49/29	0.73	1.06	0.00 - 4.00	0.72		1.03	0.00 - 3.00
NRBC (%)	49/29	0.67	1.38	0.00 - 7.00	0.62		1.90	0.00 - 10.00
CWBC ($10^3/mm^3$)	47/26	15.01	5.31	6.59 - 35.68	17.03		6.07	8.43 - 28.20

TABLE 8. Whole Blood Parameters of Black Bears Captured During the Summers of 1975 and 1976 by Age, GSMNP.

Determination	Age	N	Mean	S.D.	Range
Red blood cells ($10^6/mm^3$)	1.5	11	6.98	0.97	4.63 - 7.98
	2.5	5	6.08	0.84	5.18 - 7.20
	3.5	9	7.28	0.81	6.07 - 8.60
	4.5	21	7.15	1.05	5.35 - 9.32
	5.5	24	7.20	1.32	4.49 - 9.54
	6.5	15	7.16	0.71	6.38 - 9.02
	7.5	11	7.14	1.08	5.49 - 8.62
White blood cells ($10^3/mm^3$)	1.5	11	15.86	5.90	7.84 - 26.16
	2.5	5	17.35	9.94	9.28 - 28.60
	3.5	9	16.93	3.68	13.48 - 24.96
	4.5	21	18.29	6.49	9.32 - 35.68
	5.5	24	15.00	4.64	7.92 - 29.76
	6.5	15	15.70	6.11	10.52 - 28.20
	7.5	11	13.64	3.97	6.72 - 18.32
Platelets ($10^6/mm^3$)	1.5	11	0.55	0.10	0.37 - 0.68
	2.5	5	0.60	0.19	0.40 - 0.89
	3.5	9	0.60	0.07	0.46 - 0.66
	4.5	21	0.55	0.13	0.32 - 0.76
	5.5	24	0.52	0.17	0.24 - 0.89
	6.5	15	0.50	0.16	0.16 - 0.73
	7.5	11	0.45	0.16	0.28 - 0.81
Hematocrit (%)	1.5	11	42.91	3.94	36.00 - 48.00
	2.5	5	41.20	1.48	39.00 - 43.00
	3.5	9	43.33	4.21	35.00 - 48.00
	4.5	21	42.86	4.19	37.00 - 55.00
	5.5	24	42.46	5.38	32.00 - 54.00
	6.5	15	43.13	4.03	38.00 - 48.00
	7.5	11	42.27	3.69	38.00 - 50.00

TABLE 8 (continued)

Determination	Age	N	Mean	S.D.	Range
Hemoglobin (gm)	1.5	11	13.93	1.52	10.70 - 15.60
	2.5	5	14.04	0.65	13.20 - 15.00
	3.5	9	14.67	1.01	12.80 - 15.90
	4.5	21	14.59	1.66	11.80 - 18.80
	5.5	24	14.52	1.75	11.50 - 18.20
	6.5	15	14.76	1.20	12.20 - 16.10
	7.5	11	14.94	1.41	13.00 - 16.60
MCH (uug)	1.5	11	20.08	1.76	17.80 - 23.10
	2.5	5	23.38	3.13	19.70 - 26.60
	3.5	9	20.30	2.15	17.70 - 24.70
	4.5	21	20.76	1.42	16.40 - 32.20
	5.5	24	20.56	3.14	17.40 - 30.70
	6.5	14	20.50	1.81	17.20 - 23.70
	7.5	11	21.28	3.14	16.00 - 26.90
MCV (u^3)	1.5	11	62.07	6.11	54.20 - 77.80
	2.5	5	68.66	8.99	58.30 - 79.20
	3.5	9	60.92	7.69	49.80 - 73.20
	4.5	21	59.79	8.87	46.10 - 80.10
	5.5	24	60.09	9.15	48.70 - 86.60
	6.5	14	60.40	4.25	53.20 - 67.70
	7.5	11	63.02	8.43	48.70 - 78.80
MCHC (%)	1.5	11	32.41	1.29	29.70 - 34.80
	2.5	5	34.04	0.51	33.60 - 34.90
	3.5	9	33.93	1.51	31.80 - 36.60
	4.5	21	33.99	1.42	31.00 - 36.30
	5.5	24	34.52	1.82	31.90 - 40.00
	6.5	14	34.04	1.61	31.30 - 37.40
	7.5	11	33.73	1.30	31.00 - 35.90

TABLE 8 (continued)

Determination	Age	N	Mean	S.D.	Range
Neutrophils (%)	1.3	11	78.50	15.28	52.00 - 93.00
	2.5	5	84.75	12.66	67.00 - 97.00
	3.5	9	85.75	7.59	75.00 - 96.00
	4.5	21	85.13	8.16	67.00 - 97.00
	5.5	24	77.75	16.86	37.00 - 95.00
	6.5	15	80.67	13.36	51.00 - 94.00
	7.5	11	81.22	14.14	51.00 - 92.00
Lymphocytes (%)	1.5	11	15.40	11.76	5.00 - 39.00
	2.5	5	7.00	5.60	2.00 - 15.00
	3.5	9	10.75	6.71	3.00 - 21.00
	4.5	21	9.94	4.88	2.00 - 19.00
	5.5	24	13.69	10.24	3.00 - 43.00
	6.5	14	14.27	9.38	4.00 - 30.00
	7.5	11	12.78	6.24	7.00 - 25.00
Monocytes (%)	1.5	11	1.60	1.07	0.00 - 3.00
	2.5	5	2.75	1.26	1.00 - 4.00
	3.5	9	1.00	0.93	0.00 - 2.00
	4.5	21	1.69	2.09	0.00 - 7.00
	5.5	24	1.69	1.89	0.00 - 8.00
	6.5	14	2.67	1.75	0.00 - 6.00
	7.5	11	1.22	1.48	0.00 - 4.00
Eosinophils (%)	1.5	11	3.80	5.37	0.00 - 17.00
	2.5	5	4.00	5.66	0.00 - 12.00
	3.5	9	1.00	1.60	0.00 - 4.00
	4.5	21	3.19	5.19	0.00 - 21.00
	5.5	24	5.56	9.95	0.00 - 41.00
	6.5	14	1.73	1.75	0.00 - 16.00
	7.5	11	4.56	6.82	0.00 - 19.00

TABLE 8 (continued)

Determination	Age	N	Mean	S.D.	Range
Basophils (%)	1.5	10	0.70	0.82	0.00 - 2.00
	2.5	4	1.50	1.73	0.00 - 3.00
	3.5	8	1.13	1.36	0.00 - 4.00
	4.5	16	0.69	1.08	0.00 - 3.00
	5.5	16	0.75	1.06	0.00 - 4.00
	6.5	15	0.67	0.90	0.00 - 3.00
	7.5	9	0.22	0.67	0.00 - 2.00
NRBC (%)	1.5	10	0.90	1.60	0.00 - 5.00
	2.5	4	3.25	4.57	0.00 - 10.00
	3.5	8	0.50	0.93	0.00 - 2.00
	4.5	16	0.81	1.87	0.00 - 7.00
	5.5	16	0.25	0.58	0.00 - 2.00
	6.5	15	0.20	0.41	0.00 - 1.00
	7.5	9	0.56	0.88	0.00 - 2.00
CWBC ($10^3/mm^3$)	1.5	9	15.96	5.51	8.48 - 26.16
	2.5	4	14.21	8.95	8.44 - 27.56
	3.5	8	16.61	3.89	14.48 - 24.96
	4.5	16	17.51	7.30	9.32 - 35.68
	5.5	15	14.51	3.03	9.84 - 21.24
	6.5	13	16.26	6.39	10.52 - 28.20
	7.5	8	13.27	4.45	6.59 - 18.24

TABLE 9. Whole Blood Parameters of Black Bears Captured During the Summers of 1975 and 1976 by Trap Type, GSMNP.

Determination	Trap Type	N	Mean	S.D.	Range
Red blood cells ($10^6/mm^3$)	1 snare	87	7.11	1.07	4.49 - 5.54
	2 free ranging	5	6.91	0.68	5.97 - 7.75
	3 culvert	4	6.98	1.19	5.90 - 8.62
White blood cells ($10^6/mm^3$)	1 snare	87	16.56	5.70	6.72 - 35.68
	2 free ranging	5	9.66	2.33	7.84 - 13.20
	3 culvert	4	13.12	2.22	10.52 - 15.76
Platelets ($10^6/mm^3$)	1 snare	86	0.54	0.15	0.16 - 0.89
	2 free ranging	5	0.54	0.17	0.36 - 0.75
	3 culvert	4	0.42	0.05	0.34 - 0.46
Hematocrit (%)	1 snare	87	43.30	4.16	34.00 - 55.00
	2 free ranging	5	38.80	4.09	32.00 - 42.00
	3 culvert	4	40.00	3.65	36.00 - 44.00
Hemoglobin (gm)	1 snare	86	14.65	1.46	10.70 - 18.80
	2 free ranging	5	13.12	0.98	11.50 - 13.80
	3 culvert	4	13.95	1.56	12.00 - 15.40
MCH (uug)	1 snare	86	20.88	3.02	16.00 - 32.20
	2 free ranging	5	19.02	0.74	17.80 - 19.80
	3 culvert	4	20.15	1.95	17.40 - 21.90
MCV (u^3)	1 snare	87	61.59	8.14	46.10 - 86.60
	2 free ranging	5	56.14	2.96	53.60 - 59.80
	3 culvert	4	57.98	6.30	48.70 - 62.60

TABLE 9 (continued)

Determination	Trap Type	N	Mean	S.D.	Range
MCHC	1 snare	86	33.87	1.62	29.70 - 40.00
(%)	2 free ranging	5	33.90	1.50	32.60 - 35.90
	3 culvert	4	34.83	1.06	33.30 - 35.70
Neutrophils	1 snare	71	83.76	10.67	41.00 - 97.00
(%)	2 free ranging	4	57.50	16.46	37.00 - 74.00
	3 culvert	3	60.00	10.82	51.00 - 72.00
Lymphocytes	1 snare	71	11.54	8.04	2.00 - 43.00
(%)	2 free ranging	4	19.75	6.90	14.00 - 29.00
	3 culvert	3	25.67	5.86	19.00 - 30.00
Monocytes	1 snare	71	1.55	1.57	0.00 - 8.00
(%)	2 free ranging	4	3.00	2.94	0.00 - 7.00
	3 culvert	3	1.33	1.53	0.00 - 3.00
Eosinophils	1 snare	71	2.27	3.48	0.00 - 19.00
(%)	2 free ranging	4	21.75	13.94	8.00 - 41.00
	3 culvert	3	11.67	4.51	7.00 - 16.00
Basophils	1 snare	71	0.72	1.04	0.00 - 4.00
(%)	2 free ranging	4	0.50	0.58	0.00 - 1.00
	3 culvert	3	1.33	1.53	0.00 - 3.00
NRBC	1 snare	71	0.65	1.56	0.00 - 10.00
(%)	2 free ranging	4	1.25	2.50	0.00 - 5.00
	3 culvert	3	0.00	0.00	0.00 - 0.00

TABLE 9 (continued)

Determination	Trap Type	N	Mean	S.D.	Range
CWBC ($10^3/mm^3$)	1 snare	67	16.11	5.71	6.59 - 35.68
	2 free ranging	4	10.85	2.36	8.48 - 13.20
	3 culvert	3	12.24	1.66	10.52 - 13.84

TABLE 10. Whole Blood Parameters of Black Bears Captured During the Summers of 1975 and 1976 by Year, GSMNP.

Determination	Year	N	Mean	Standard Deviation	Range
Red blood cells	75	45	7.16	1.12	4.49 - 9.54
($10^6/mm^3$)	76	51	7.05	0.99	4.63 - 9.42
White blood cells	75	45	17.43	6.37	7.84 - 35.68
($10^3/mm^3$)	76	51	14.84	4.80	6.72 - 28.20
Platelets	75	44	0.54	0.14	0.24 - 0.89
($10^6/mm^3$)	76	51	0.52	0.15	0.16 - 0.89
Hematocrit	75	45	42.07	4.05	32.00 - 49.00
(%)	76	51	43.69	4.34	36.00 - 55.00
Hemoglobin	75	44	14.53	1.33	11.50 - 17.20
(gm)	76	51	14.55	1.61	10.70 - 18.80
MCH	75	44	20.57	2.96	16.00 - 30.70
(uug)	76	51	20.90	2.93	16.70 - 32.50
MCV	75	45	59.73	8.59	46.10 - 86.60
(u^3)	76	51	62.40	7.23	48.70 - 80.10
MCHC	75	44	34.50	1.40	31.30 - 38.80
(%)	76	51	33.39	1.57	29.70 - 40.00
Neutrophils	75	31	84.60	13.13	37.00 - 97.00
(%)	76	47	79.45	12.68	41.00 - 95.00

TABLE 10 (continued)

Determination	Year	N	Mean	Standard Deviation	Range
Lymphocytes (%)	75	31	9.13	6.24	2.00 - 29.00
	76	47	14.72	9.06	4.00 - 43.00
Monocytes (%)	75	31	1.45	1.48	0.00 - 7.00
	76	47	1.72	1.77	0.00 - 8.00
Eosinophils (%)	75	31	4.23	8.49	0.00 - 41.00
	76	47	3.23	4.49	0.00 - 19.00
Basophils (%)	75	31	0.65	1.11	0.00 - 4.00
	76	47	0.79	1.00	0.00 - 3.00
NRBC (%)	75	31	0.45	1.06	0.00 - 5.00
	76	47	0.79	1.84	0.00 - 10.00
CWBC ($10^3/mm^3$)	75	27	16.78	6.77	8.48 - 35.68
	76	46	15.13	4.83	6.59 - 28.70

TABLE 11. Serum Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Sex, GSMNP.

Determination	M/F	Male			Female			
		Mean	S.D.	Range	Mean	Lact	S.D.	Range
Sodium (mEq/L)	74/49	142.47	5.98	131.00 - 160.00	142.90		5.86	131.00 - 156.00
Chloride (mEq/L)	75/49	101.91	8.31	80.00 - 125.00	102.12		7.60	86.00 - 122.00
Potassium (mEq/L)	75/49	4.89	0.96	3.30 - 7.00	4.70		0.85	3.20 - 7.50
Calcium (mg/dl)	75/49	7.96	0.96	5.80 - 11.80	8.02	7.55	1.11	6.90 - 12.50
Inorganic phosphorus (mg/dl)	73/49	5.68	1.30	2.40 - 9.50	5.00		1.17	2.50 - 9.60
Serum iron (mcg/dl)	31/20	170.45	88.27	60.00 - 378.00	155.85		74.35	67.00 347.00
BUN (mg/dl)	75/49	12.57	8.70	0.00 - 44.00	12.02		7.05	0.00 - 37.00
Creatinine (mg/dl)	75/49	1.63	0.41	0.90 - 3.00	1.48		0.27	1.00 - 2.10
Uric acid (mg/dl)	75/49	2.29	0.57	1.40 - 4.40	2.36		0.56	1.50 - 3.80
Total bilirubin (mg/dl)	74/48	0.18	0.12	0.00 - 0.60	0.18		0.21	0.00 - 1.50
CO_2 (mEq/L)	46/28	19.20	4.43	13.00 - 33.00	18.65		4.02	11.00 - 29.00
Glucose (mg/dl)	75/49	99.03	51.51	15.00 - 285.00	100.47		63.21	7.00 - 280.00
Cholesterol (mg/dl)	75/49	253.48	58.31	125.00 - 475.00	249.84		36.28	170.00 - 335.00
Triglycerides (mg/dl)	31/20	223.94	72.36	63.00 - 398.00	238.55		74.20	92.00 - 409.00
Total protein (g/dl)	75/49	7.23	0.77	5.60 - 10.00	7.11		0.59	6.00 - 8.60
Albumin (g/dl)	44/28	3.88	1.41	1.60 - 5.70	4.11		1.47	1.10 - 5.60
Alkaline phosphatase (u/L)	75/49	59.53	38.30	16.00 - 187.00	51.02		27.01	15.00 - 152.00
LDH (u/L)		Not reported--values out of instrumentation range						
SGOT (u/L)	31/15	181.68	72.12	57.00 - 252.00	193.80		76.71	93.00 - 358.00
CPK (u/L)	32/19	685.91	493.75	45.00 -1200.00	566.00		396.83	68.00 -1200.00

TABLE 12. Serum Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Age, GSMNP.

Determination	Age	N	Mean	Standard Deviation	Range
Sodium (mEq/L)	1.5	12	142.50	4.89	135.00 - 150.00
	2.5	4	149.25	8.46	142.00 - 160.00
	3.5	15	142.80	6.96	131.00 - 154.00
	4.5	26	141.42	4.88	131.00 - 152.00
	5.5	31	143.13	6.54	132.00 - 159.00
	6.5	19	142.37	6.39	132.00 - 156.00
	7.5	16	142.31	4.29	135.00 - 150.00
Chloride (mEq/L)	1.5	12	108.08	6.60	92.00 - 111.00
	2.5	5	112.00	11.73	96.00 - 125.00
	3.5	15	100.27	11.36	80.00 - 113.00
	4.5	26	100.46	6.03	86.00 - 110.00
	5.5	31	101.45	8.12	83.00 - 118.00
	6.5	19	102.11	7.90	88.00 - 122.00
	7.5	16	103.06	5.12	96.00 - 115.00
Potassium (mEq/L)	1.5	12	6.30	0.62	5.40 - 7.50
	2.5	5	5.26	0.88	4.30 - 6.70
	3.5	15	4.43	0.79	3.30 - 6.00
	4.5	26	4.65	0.86	3.50 - 6.70
	5.5	31	4.65	0.69	3.50 - 6.80
	6.5	19	4.82	0.70	3.70 - 6.20
	7.5	16	4.50	0.94	3.20 - 6.90

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
Calcium (mg/dl)	1.5	12	8.50	1.14	6.40 - 9.50
	2.5	5	8.96	2.04	7.60 - 12.50
	3.5	15	7.88	0.81	5.80 - 9.10
	4.5	26	7.86	0.64	6.10 - 9.10
	5.5	31	8.24	1.16	6.60 - 11.80
	6.5	19	7.68	0.99	6.70 - 10.90
	7.5	16	7.80	0.80	6.30 - 9.30
Inorganic phosphorus (mg/dl)	1.5	11	6.99	1.31	4.90 - 9.40
	2.5	4	6.08	2.53	3.60 - 9.60
	3.5	15	6.11	1.30	4.30 - 9.50
	4.5	26	5.02	1.44	2.40 - 8.10
	5.5	31	5.47	1.23	2.70 - 7.70
	6.5	19	5.05	1.36	3.00 - 7.50
	7.5	16	4.78	1.66	2.50 - 8.50
Serum iron (mcg/dl)	1.5	7	123.71	337.56	88.00 - 201.00
	2.5	2	109.00	18.38	96.00 - 122.00
	3.5	3	171.00	71.30	72.00 - 242.00
	4.5	7	135.29	45.83	74.00 - 185.00
	5.5	12	179.58	99.22	76.00 - 347.00
	6.5	11	166.55	84.99	67.00 - 369.00
	7.5	8	212.38	106.33	60.00 - 378.00

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
BUN (mg/dl)	1.5	12	13.17	10.79	1.00 - 38.00
	2.5	5	14.20	7.69	8.00 - 24.00
	3.5	15	16.33	9.98	1.00 - 37.00
	4.5	26	12.15	9.30	0.00 - 44.00
	5.5	31	11.32	6.02	0.00 - 26.00
	6.5	19	11.16	6.12	1.00 - 24.00
	7.5	16	11.19	7.37	1.00 - 28.00
Creatinine (mg/dl)	1.5	12	1.26	0.34	0.90 - 1.90
	2.5	5	1.52	0.40	1.10 - 2.10
	3.5	15	1.51	0.19	1.20 - 1.80
	4.5	26	1.61	0.40	1.00 - 2.60
	5.5	31	1.58	0.34	1.10 - 2.40
	6.5	19	1.59	0.28	1.20 - 2.10
	7.5	16	1.78	0.47	1.30 - 3.00
Uric acid (mg/dl)	1.5	12	2.61	0.58	1.50 - 3.50
	2.5	5	2.54	0.26	2.40 - 3.00
	3.5	15	2.45	0.35	1.80 - 2.90
	4.5	26	2.37	0.62	1.50 - 4.40
	5.5	31	2.09	0.49	1.40 - 3.80
	6.5	19	2.41	0.73	1.40 - 3.80
	7.5	16	2.16	0.47	1.50 - 3.00

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
Total bilirubin (mg/dl)	1.5	11	0.11	0.05	0.00 - 0.20
	2.5	5	0.18	0.13	0.10 - 0.40
	3.5	15	0.19	0.14	0.00 - 0.50
	4.5	26	0.19	0.13	0.00 - 0.60
	5.5	31	0.20	0.26	0.00 - 1.50
	6.5	18	0.16	0.10	0.00 - 0.40
	7.5	16	0.17	0.12	0.00 - 0.50
CO^2 (mEq/L)	1.5	7	16.42	1.90	14.00 - 19.00
	2.5	2	15.50	2.12	13.00 - 17.00
	3.5	10	20.30	4.74	13.00 - 31.00
	4.5	12	18.83	5.24	13.00 - 33.00
	5.5	18	20.11	4.44	13.00 - 29.00
	6.5	13	18.31	4.94	11.00 - 29.00
	7.5	12	19.17	2.12	16.00 - 23.00
Glucose (mg/dl)	1.5	12	85.92	51.32	20.00 - 168.00
	2.5	5	85.20	34.36	25.00 - 108.00
	3.5	15	109.53	63.12	33.00 - 285.00
	4.5	26	86.62	54.20	10.00 - 230.00
	5.5	31	99.65	54.64	7.00 - 280.00
	6.5	19	102.47	62.68	9.00 - 216.00
	7.5	16	122.63	56.08	45.00 - 209.00

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
Cholesterol (mg/dl)	1.5	12	304.67	65.89	218.00 - 475.00
	2.5	5	298.60	47.95	242.00 - 375.00
	3.5	15	260.87	32.38	210.00 - 324.00
	4.5	26	238.58	50.36	152.00 - 3370.00
	5.5	31	245.97	49.17	125.00 - 339.00
	6.5	19	238.79	38.37	150.00 - 295.00
	7.5	16	239.13	39.32	173.00 - 290.00
Triglycerides (mg/dl)	1.5	7	170.29	64.23	63.00 - 245.00
	2.5	2	239.50	10.61	232.00 - 247.00
	3.5	4	270.00	85.33	227.00 - 398.00
	4.5	7	223.00	56.46	137.00 - 301.00
	5.5	12	235.17	72.17	118.00 - 358.00
	6.5	11	261.64	83.48	152.00 - 409.00
	7.5	8	212.63	60.74	92.00 - 289.00
Total protein (g/dl)	1.5	12	6.93	1.07	5.80 - 10.00
	2.5	3	6.78	0.97	5.60 - 7.80
	3.5	15	7.15	0.57	6.30 - 8.30
	4.5	26	7.33	0.80	6.30 - 9.70
	5.5	31	7.22	0.61	5.90 - 8.10
	6.5	19	7.28	0.67	6.40 - 8.60
	7.5	17	7.09	0.42	6.50 - 8.00

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
Albumin (g/dl)	1.5	7	4.97	0.22	4.60 - 5.20
	2.5	2	4.45	0.21	4.30 - 4.60
	3.5	10	3.01	1.74	1.10 - 5.60
	4.5	11	3.54	1.32	2.00 - 5.20
	5.5	17	3.98	1.53	1.80 - 5.70
	6.5	13	4.62	1.17	2.00 - 5.40
	7.5	12	3.75	1.41	1.60 - 5.10
Alkaline phosphatase (U/L)	1.5	12	112.67	44.87	31.00 - 187.00
	2.5	5	105.80	50.28	45.00 - 184.00
	3.5	15	70.87	34.33	25.00 - 145.00
	4.5	26	49.31	21.21	18.00 - 95.00
	5.5	31	42.19	19.21	15.00 - 97.00
	6.5	19	43.32	15.07	19.00 - 73.00
	7.5	16	38.00	8.19	20.00 - 54.00
LDH (U/L)		Values not reported--out of instrumentation range			
SGOT (U/L)	1.5	2	125.50	6.36	121.00 - 130.00
	2.5	0			
	3.5	7	214.00	40.24	158.00 - 250.00
	4.5	9	197.33	65.43	104.00 - 250.00
	5.5	11	165.18	75.87	57.00 - 250.00
	6.5	8	199.13	90.90	68.00 - 358.00
	7.5	9	178.22	86.49	66.00 - 252.00

TABLE 12 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
CPK (U/L)	1.5	3	452.33	121.88	319.00 - 558.00
	2.5	1	277.00		277.00 - 277.00
	3.5	7	981.57	321.74	348.00 - 1200.00
	4.5	9	832.78	472.62	133.00 - 1200.00
	5.5	13	551.85	488.12	51.00 - 1200.00
	6.5	7	574.14	444.73	45.00 - 1200.00
	7.5	11	500.91	484.47	68.00 - 1200.00

TABLE 13. Serum Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Trap Type, GSMNP.

Determination	Trap Type	N	Mean	Standard Deviation	Range
Sodium (mEq/L)	1 snare	113	142.81	6.13	131.00 - 160.00
	2 free ranging	6	139.67	1.03	138.00 - 141.00
	3 culvert	4	142.25	0.96	141.00 - 143.00
Chloride (mEq/L)	1 snare	114	102.24	8.19	80.00 - 125.00
	2 free ranging	6	96.70	4.18	92.00 - 103.00
	3 culvert	4	103.00	3.74	99.00 - 108.00
Potassium (mEq/L)	1 snare	114	4.77	0.92	3.20 - 7.50
	2 free ranging	6	5.65	0.79	4.30 - 6.50
	3 culvert	4	4.90	0.36	4.60 - 5.30
Calcium (mg/dl)	1 snare	114	7.98	1.02	5.80 - 12.50
	2 free ranging	6	8.17	1.23	6.40 - 9.50
	3 culvert	4	7.83	0.75	7.00 - 8.80
Inorganic phosphorus (mg/dl)	1 snare	112	5.37	1.53	2.40 - 9.60
	2 free ranging	6	6.60	0.97	5.40 - 7.90
	3 culvert	4	6.05	1.53	4.20 - 7.50
Serum iron (mcg/dl)	1 snare	46	156.15	75.76	57.00 - 358.00
	2 free ranging	1	220.00		220.00 - 220.00
	3 culvert	4	249.50	126.37	124.00 - 369.00
BUN (mg/dl)	1 snare	114	12.36	8.24	0.00 - 44.00
	2 free ranging	6	9.30	4.68	4.00 - 17.00
	3 culvert	4	16.50	5.45	11.00 - 24.00

TABLE 13 (continued)

Determination	Trap Type	N	Mean	Standard Deviation	Range
Creatinine (mg/dl)	1 snare	114	1.58	0.36	0.90 - 3.00
	2 free ranging	6	1.30	0.28	0.90 - 1.60
	3 culvert	4	1.65	0.48	1.10 - 2.10
Uric Acid (mg/dl)	1 snare	114	2.35	0.56	1.40 - 4.40
	2 free ranging	6	2.10	0.46	1.40 - 2.80
	3 culvert	4	1.68	0.22	1.40 - 1.90
Total bilirubin (mg/dl)	1 snare	113	0.18	0.17	0.00 - 1.50
	2 free ranging	5	0.14	0.05	0.10 - 0.20
	3 culvert	4	0.13	0.05	0.10 - 0.20
CO^2 (mEq/L)	1 snare	69	18.88	4.38	11.00 - 33.00
	2 free ranging	1	19.00		19.00 - 19.00
	3 culvert	4	20.75	1.50	19.00 - 22.00
Glucose (mg/dl)	1 snare	114	103.89	56.05	9.00 - 285.00
	2 free ranging	6	50.50	23.95	20.00 - 90.00
	3 culvert	4	51.00	37.83	7.00 - 98.00
Cholesterol (mg/dl)	1 snare	114	249.15	46.75	125.00 - 375.00
	2 free ranging	6	307.50	88.76	235.00 - 475.00
	3 culvert	4	251.00	59.01	213.00 - 339.00
Triglycerides (mg/dl)	1 snare	46	232.00	73.55	63.00 - 409.00
	2 free ranging	1	163.00		163.00 - 163.00
	3 culvert	4	219.25	72.27	152.00 - 321.00

TABLE 13 (continued)

Determination	Trap Type	N	Mean	Standard Deviation	Range
Total protein (g/dl)	1 snare	114	7.17	0.67	5.60 - 9.70
	2 free ranging	6	7.60	1.28	6.60 - 10.00
	3 culvert	4	7.00	0.64	6.30 - 7.80
Albumin (g/dl)	1 snare	68	3.89	0.67	1.10 - 5.70
	2 free ranging	1	5.60		5.60 - 5.60
	3 culvert	3	5.13	0.20	4.90 - 5.30
Alkaline phosphatase (U/L)	1 snare	114	56.50	33.72	15.00 - 187.00
	2 free ranging	6	64.84	51.67	16.00 - 135.00
	3 culvert	4	33.75	21.53	19.00 - 65.00
LDH (U/L)	1 snare	Not reported--values out of instrument range			
	2 free ranging				
	3 culvert				
SGOT (U/L)	1 snare	43	190.98	72.12	57.00 - 358.00
	2 free ranging	1	123.00		123.00 - 123.00
	3 culvert	2	102.00	48.08	68.00 - 136.00
CPK (U/L)	1 snare	47	681.00	456.31	51.00 - 1200.00
	2 free ranging	1	276.00		276.00 - 276.00
	3 culvert	3	140.00	109.00	45.00 - 259.00

TABLE 14. Serum Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Year, GSMNP.

Determination	Year	N	Mean	Standard Deviation	Range
Sodium (mEq/L)	74	23	138.87	5.42	131.00 - 148.00
	75	50	144.58	5.36	134.00 - 160.00
	76	50	142.44	5.88	131.00 - 157.00
Chloride (mEq/L)	74	23	95.83	9.06	80.00 - 109.00
	75	50	102.26	6.45	92.00 - 118.00
	76	51	104.51	7.53	88.00 - 125.00
Potassium (mEq/L)	74	23	4.01	0.70	3.20 - 6.50
	75	50	4.84	0.78	3.70 - 6.50
	76	51	5.16	0.91	3.80 - 7.50
Calcium (mg/dl)	74	23	8.16	0.70	6.90 - 9.40
	75	50	8.07	1.23	6.10 - 12.50
	76	51	7.82	0.91	5.80 - 10.90
Inorganic phosphorus (mg/dl)	74	23	6.11	1.41	2.90 - 9.50
	75	50	4.95	1.25	2.50 - 7.90
	76	49	5.65	1.69	2.40 - 9.60
Serum iron (mcg/dl)	74	-	164.73		-
	75	-			-
	76	51	164.73	82.63	60.00 - 378.00
BUN (mg/dl)	74	23	11.57	11.31	0.00 - 44.00
	75	50	13.94	7.07	4.00 - 34.00
	76	51	11.16	7.10	0.00 - 38.00

TABLE 14 (continued)

Determination	Year	N	Mean	Standard Deviation	Range
Creatinine (mg/dl)	74	23	1.70	0.41	1.20 - 3.00
	75	50	1.50	0.33	0.90 - 2.30
	76	51	1.59	0.37	0.90 - 2.60
Uric acid (mg/dl)	74	23	2.22	0.59	1.50 - 4.40
	75	50	2.18	0.38	1.40 - 3.10
	76	51	2.50	0.66	1.40 - 3.80
Total bilirubin (mg/dl)	74	23	0.37	0.27	0.20 - 1.50
	75	48	0.14	0.10	0.00 - 0.50
	76	51	0.13	0.05	0.10 - 0.30
CO^2 (mEq/L)	74	23	21.82	4.82	13.00 - 33.00
	75	-	-	-	- - -
	76	51	17.71	3.30	11.00 - 24.00
Glucose (mg/dl)	74	23	138.78	66.94	15.00 - 285.00
	75	50	76.50	28.79	10.00 - 135.00
	76	51	104.57	60.95	7.00 - 230.00
Cholesterol (mg/dl)	74	23	248.87	30.06	190.00 - 312.00
	75	50	268.50	58.10	125.00 - 475.00
	76	51	237.33	45.66	148.00 - 339.00
Triglycerides (mg/dl)	74	-	-	-	- -
	75	-	-	-	- -
	76	51	229.67	72.70	63.00 - 409.00

TABLE 14 (continued)

Determination	Year	N	Mean	Standard Deviation	Range
Total protein (g/dl)	74	23	7.13	0.71	6.20 - 9.70
	75	50	7.60	0.63	6.60 - 10.00
	76	51	6.79	0.53	5.60 - 8.00
Albumin (g/dl)	74	23	1.95	0.29	1.10 - 2.40
	75	-	-	-	-
	76	49	4.91	0.39	4.30 - 5.70
Alkaline phosphatase (U/L)	74	23	55.96	25.82	20.00 - 112.00
	75	50	50.84	31.44	15.00 - 145.00
	76	51	61.49	39.94	19.00 - 187.00
LDH (U/L)		Not reported--out of instrumentation range			
SGOT (U/L)	74	74	230.00	40.60	95.00 - 250.00
	75	75	-	-	-
	76	76	141.17	71.58	57.00 - 358.00
CPK (U/L)	74	74	1040.35	316.84	300.00 - 1200.00
	75	75	-	-	-
	76	76	313.39	249.57	45.00 - 863.00

TABLE 15. Serum Electrophoresis of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Sex, GSMNP.

Determination	M/F	Mean	S.D.	Range	Mean	S.D.	Range
Albumin (g/dl)	72/48	3.64	0.55	2.65 - 4.84	3.69	0.52	1.89 - 4.75
Alpha globulin (g/dl)	72/48	0.98	0.28	0.50 - 1.69	1.02	0.35	0.50 - 2.60
Beta globulin (g/dl)	72/48	1.28	0.26	0.68 - 2.20	1.32	0.37	0.82 - 2.36
Gamma globulin (g/dl)	72/48	1.29	0.86	0.51 - 7.71	1.13	0.40	0.62 - 3.12

TABLE 16. Serum Electrophoresis of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Age, GSMNP.

Determination	Age	N	Mean	Standard Deviation	Range
Albumin (g/dl)	1.5	11	3.45	0.30	3.20 - 4.27
	2.5	5	3.88	0.78	2.85 - 4.75
	3.5	14	3.44	0.65	1.89 - 4.49
	4.5	25	3.81	0.57	2.65 - 4.69
	5.5	30	3.69	0.55	2.44 - 4.84
	6.5	19	3.61	0.33	2.78 - 4.04
	7.5	16	3.70	0.56	2.96 - 4.58
Alpha globulin (g/dl)	1.5	11	1.09	0.25	0.76 - 1.48
	2.5	5	1.01	0.22	0.79 - 1.31
	3.5	14	0.99	0.35	0.50 - 1.69
	4.5	25	0.92	0.27	0.50 - 1.42
	5.5	30	1.00	0.26	0.54 - 1.57
	6.5	19	1.11	0.46	0.67 - 2.60
	7.5	16	0.89	0.20	0.51 - 1.31
Beta globulin (g/dl)	1.5	11	1.20	0.27	0.80 - 1.68
	2.5	5	1.10	0.28	0.68 - 1.42
	3.5	14	1.32	0.25	0.84 - 1.73
	4.5	25	1.34	0.30	0.84 - 2.02
	5.5	30	1.35	0.38	0.82 - 2.36
	6.5	19	1.31	0.36	0.82 - 2.18
	7.5	16	1.20	0.18	0.85 - 1.56

TABLE 16 (continued)

Determination	Age	N	Mean	Standard Deviation	Range
Gamma globulin (g/dl)	1.5	11	0.92	0.25	0.56 - 1.41
	2.5	5	1.04	0.28	0.77 - 1.50
	3.5	14	1.36	0.59	0.70 - 3.12
	4.5	25	1.26	0.47	0.68 - 3.05
	5.5	30	1.13	0.27	0.63 - 1.70
	6.5	19	1.16	0.31	0.62 - 1.96
	7.5	16	1.61	1.67	0.51 - 7.71

TABLE 17. Serum Electrophoresis of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Trap Type, GSMNP.

Determination	Trap Type	N	Mean	Standard Deviation	Range
Albumin (g/dl)	1 snare	111	3.66	0.54	1.89 - 4.84
	2 free ranging	5	3.76	0.38	3.30 - 4.34
	3 culvert	4	3.38	0.63	2.44 - 3.71
Alpha globulin (g/dl)	1 snare	111	0.99	0.31	0.50 - 2.60
	2 free ranging	5	0.87	0.16	0.73 - 1.11
	3 culvert	4	1.15	0.22	0.94 - 1.43
Beta globulin (g/dl)	1 snare	111	1.30	0.32	0.68 - 2.36
	2 free ranging	5	1.21	0.16	1.05 - 1.46
	3 culvert	4	1.17	0.14	0.98 - 1.30
Gamma globulin (g/dl)	1 snare	111	1.24	0.74	0.51 - 7.71
	2 free ranging	5	1.26	0.09	1.13 - 1.35
	3 culvert	4	1.00	0.30	0.71 - 1.27

TABLE 18. Serum Electrophoresis of Black Bears Captured During the Summers of 1974, 1975, and 1976 by Year, GSMNP.

Determination	Year	N	Mean	Standard Deviation	Range
Albumin (g/dl)	74	20	3.75	0.56	1.89 - 4.54
	75	49	3.91	0.44	3.28 - 4.84
	76	51	3.39	0.49	2.44 - 4.66
Alpha globulin (g/dl)	74	20	0.90	0.28	0.50 - 1.51
	75	49	0.85	0.18	0.50 - 1.31
	76	51	1.17	0.33	0.54 - 2.60
Beta globulin (g/dl)	74	20	1.28	0.34	0.50 - 1.51
	75	49	1.48	0.30	1.04 - 2.36
	76	51	1.21	0.19	0.68 - 1.51
Gamma globulin (g/dl)	74	20	1.50	1.61	0.63 - 7.71
	75	49	1.29	0.26	0.68 - 1.96
	76	51	1.07	0.32	0.51 - 1.83

TABLE 19. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975 and 1976 that were Significant for Year and Age, GSMNP.

	Age	N	Mean	Standard Deviation	Range
			MCHC (%)		
1974	1.5	0			
	2.5	0			
	3.5	0			
	4.5	0			
	5.5	0			
	6.5	0			
	7.5	0			
1975	1.5	4	33.38	0.99	32.60 - 34.80
	2.5	3	34.27	0.57	33.80 - 34.90
	3.5	5	34.76	1.47	32.60 - 36.60
	4.5	13	34.70	1.15	32.10 - 36.30
	5.5	12	34.97	1.49	33.30 - 38.80
	6.5	4	34.05	2.54	31.30 - 37.40
	7.5	3	33.90	0.96	32.80 - 34.60
1976	1.5	7	31.86	1.13	29.70 - 33.20
	2.5	2	33.70	0.14	33.60 - 33.80
	3.5	4	32.90	0.79	31.80 - 33.70
	4.5	8	32.61	0.98	31.00 - 34.20
	5.5	12	34.14	2.01	32.70 - 40.00
	6.5	10	33.90	1.37	31.90 - 36.00
	7.5	7	33.66	1.46	31.00 - 34.70
			Potassium (mEq/L)		
1974	1.5	0			
	2.5	0			
	3.5	6	3.75	0.34	3.30 - 4.20
	4.5	5	4.52	1.18	3.50 - 6.50
	5.5	6	4.03	0.37	3.50 - 4.60
	6.5	2	4.40	0.90	3.70 - 5.10
	7.5	4	3.53	0.22	3.20 - 3.70
1975	1.5	5	6.14	0.53	5.40 - 6.70
	2.5	3	4.83	0.46	4.30 - 5.10
	3.5	5	4.86	0.70	4.20 - 6.00
	4.5	14	4.68	0.83	3.70 - 6.70
	5.5	13	4.55	0.57	3.90 - 6.10
	6.5	6	4.93	0.75	5.30 - 6.20
	7.5	4	4.45	0.45	3.90 - 5.00

TABLE 19 (continued)

	Age	N	Mean	Standard Deviation	Range
1976	1.5	7	6.41	0.70	5.60 - 7.50
	2.5	2	5.90	1.13	5.10 - 6.70
	3.5	4	4.93	0.70	4.30 - 5.90
	4.5	8	4.66	0.75	3.90 - 5.60
	5.5	12	5.10	0.76	4.30 - 6.80
	6.5	11	4.76	0.67	3.80 - 6.00
	7.5	8	4.98	1.09	4.00 - 6.90
			Inorganic phosphorus (mg/dl)		
1974	1.5	0			
	2.5	0			
	3.5	6	6.73	1.48	5.10 - 9.50
	4.5	5	6.42	1.37	4.30 - 8.10
	5.5	6	6.32	0.45	5.80 - 6.90
	6.5	2	5.20	2.69	3.30 - 7.10
	7.5	4	4.95	1.54	2.90 - 6.40
1975	1.5	5	6.94	0.72	6.10 - 7.90
	2.5	3	4.90	1.15	3.60 - 5.80
	3.5	5	5.32	1.15	4.30 - 6.80
	4.5	14	4.84	1.10	2.60 - 6.40
	5.5	13	4.61	0.99	2.70 - 6.00
	6.5	6	5.03	1.04	3.30 - 6.10
	7.5	4	3.43	0.76	2.50 - 4.10
1976	1.5	6	7.03	1.74	4.90 - 9.40
	2.5	1	9.60		
	3.5	4	6.18	0.80	5.40 - 7.20
	4.5	7	4.34	1.58	2.40 - 8.40
	5.5	12	6.14	1.21	4.20 - 7.70
	6.5	11	4.80	1.21	3.00 - 7.50
	7.5	8	5.70	1.75	2.90 - 8.50
			Cholesterol (mg/dl)		
1974	1.5	0			
	2.5	0			
	3.5	6	252.00	39.42	210.00 - 312.00
	4.5	5	238.00	38.44	190.00 - 297.00
	5.5	6	243.00	24.21	205.00 - 280.00
	6.5	2	257.50	17.68	245.00 - 270.00
	7.5	4	261.25	21.75	240.00 - 290.00

TABLE 19 (continued)

	Age	N	Mean	Standard Deviation	Range
1975	1.5	5	350.00	70.71	325.00 - 475.00
	2.5	3	318.33	49.07	290.00 - 375.00
	3.5	5	262.00	24.14	240.00 - 300.00
	4.5	14	252.14	54.23	170.00 - 370.00
	5.5	13	255.38	60.15	125.00 - 335.00
	6.5	6	249.17	38.00	200.00 - 295.00
	7.5	4	261.25	34.73	210.00 - 285.00
1976	1.5	7	272.29	41.12	218.00 - 331.00
	2.5	2	269.00	38.18	242.00 - 296.00
	3.5	4	272.75	34.33	252.00 - 324.00
	4.5	7	231.57	45.79	175.00 - 300.00
	5.5	12	234.00	47.48	148.00 - 339.00
	6.5	11	231.45	42.88	150.00 - 287.00
	7.5	8	217.00	38.40	175.00 - 277.00
			Alkaline phosphatase (U/L)		
1974	1.5	0			
	2.5	0			
	3.5	6	68.33	28.14	40.00 - 112.00
	4.5	5	51.20	28.80	20.00 - 93.00
	5.5	6	62.50	29.78	25.00 - 97.00
	6.5	2	49.50	7.79	44.00 - 55.00
	7.5	1	36.75	3.95	32.00 - 40.00
1975	1.5	5	103.00	41.05	35.00 - 135.00
	2.5	3	78.33	29.30	45.00 - 100.00
	3.5	5	65.00	47.83	25.00 - 145.00
	4.5	14	53.36	31.02	18.00 - 136.00
	5.5	13	34.69	12.72	15.00 - 55.00
	6.5	6	41.00	11.21	28.00 - 60.00
	7.5	4	30.75	8.69	20.00 - 40.00
1976	1.5	7	119.57	49.33	31.00 - 187.00
	2.5	2	103.44	56.49	110.00 - 184.00
	3.5	4	82.00	29.90	38.00 - 103.00
	4.5	8	54.14	19.79	35.00 - 89.00
	5.5	11	40.75	11.27	20.00 - 65.00
	6.5	11	42.82	18.36	19.00 - 73.00
	7.5	7	42.38	7.21	33.00 - 54.00

TABLE 20. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975 and 1976 that were Significant for Sex and Age, GSMNP.

	Creatinine (mg/dl)				
	Age	N	Mean	Standard Deviation	Range
Male	1.5	9	1.26	0.38	0.90 - 1.90
	2.5	4	1.37	0.31	1.10 - 1.70
	3.5	13	1.55	0.19	1.20 - 1.80
	4.5	19	1.59	0.56	0.20 - 2.60
	5.5	17	1.66	0.36	0.10 - 2.40
	6.5	6	1.77	0.24	1.40 - 2.10
	7.5	7	2.00	0.58	1.30 - 3.00
Female	1.5	3	1.27	0.31	1.00 - 1.60
	2.5	1	1.75	0.50	1.40 - 2.10
	3.5	2	1.30	0.14	1.20 - 1.40
	4.5	4	1.43	0.18	1.10 - 1.60
	5.5	14	1.48	0.28	1.10 - 2.00
	6.5	13	1.48	0.26	1.20 - 1.90
	7.5	10	1.61	0.30	1.30 - 2.10

TABLE 21. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 that were Significant for Year and Trap Type, GSMNP.

Year	Trap Type	N	Mean	Standard Deviation	Range
		White Blood Cells ($10^3/mm^3$)			
1975	Snare	41	18.11	6.16	9.84 - 35.68
	Free ranging	4	10.10	2.45	7.84 - 13.20
	Culvert	0			
1976	Snare	46	15.14	4.88	7.72 - 28.20
	Free ranging	1	7.92		
	Culvert	4	13.17	2.30	54.00 -123.00
		Lymphocytes (%)			
1975	Snare	27	7.55	4.42	2.00 - 21.00
	Free ranging	4	19.75	6.89	14.00 - 29.00
	Culvert	0			
1976	Snare	44	14.15	8.79	5.00 - 43.00
	Free ranging	0			
	Culvert	3	25.67	5.86	19.00 - 28.00
		Neutrophils (%)			
1975	Snare	27	88.63	6.14	72.00 - 97.00
	Free ranging	4	57.00	16.10	37.00 - 74.00
	Culvert	0			
1976	Snare	44	80.30	11.61	41.00 - 95.00
	Free ranging	0			
	Culvert	3	60.00	10.82	51.00 - 72.00

TABLE 22. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975 and 1976 that were Significant for Year and Drug Type, GSMNP.

	Drug Type	N	Mean	Standard Deviation	Range
			Chloride (mEq/L)		
1974	M-99	23	95.83	9.06	80.00 - 109.00
	Sernylan	0			
1975	M-99	0			
	Sernylan	50	102.26	6.45	92.00 - 118.00
1976	M-99	42	103.85	7.56	99.00 - 125.00
	Sernylan	9	107.55	7.02	99.00 - 122.00
			Alpha Globulin (g/dl)		
1974	M-99	23	0.90	0.28	0.50 - 1.51
	Sernylan	0			
1975	M-99	0			
	Sernylan	49	0.85	0.18	0.51 - 1.31
1976	M-99	42	1.12	0.49	0.98 - 2.60
	Sernylan	9	1.36	0.27	0.54 - 1.69

TABLE 23. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975, and 1976 That Were Significant for Year, Drug and Trap Type, GSMNP.

	Drug Type	Trap Type	N	Mean	Standard Deviation	Range
			Glucose (mg/dl)			
1974	M-99	Snare	23	138.78	66.94	15.00 - 285.00
		Free ranging	0			
		Culvert	0			
	Sernylan	Snare	0			
		Free ranging	0			
		Culvert	0			
1975	M-99	Snare	0			
		Free ranging	0			
		Culvert	0			
	Sernylan	Snare	45	79.11	28.15	10.00 - 120.00
		Free ranging	5		25.88	20.00 - 90.00
		Culvert	0			
1976	M-99	Snare	41	118.63	58.76	9.00 230.00
		Free ranging	0			
		Culvert	1	98.00		
	Sernylan	Snare	5	44.60	22.41	16.00 - 75.00
		Free ranging	1	38.00	25.97	7.00 - 58.00
		Culvert	3	35.33		

TABLE 24. Blood Parameters of Black Bears Captured During the Summers of 1974, 1975 and 1976 that were Significant For Year, Age and Drug Type, GSMNP.

	Drug Type	Age	N	Mean	Standard Deviation	Range
			Uric Acid (mg/dl)			
1974	M-99	1.5	1	2.00		
		2.5	0			
		3.5	6	2.37	0.24	2.10 - 2.70
		4.5	5	2.54	1.80	1.50 - 4.40
		5.5	5	2.06	0.29	1.70 - 2.30
		6.5	2	2.15	0.21	2.00 - 2.30
		7.5	4	1.90	0.16	1.70 - 2.10
	Sernylan	1.5	0			
		2.5	0			
		3.5	0			
		4.5	0			
		5.5	0			
		6.5	0			
		7.5	0			
1975	M-99	1.5	0			
		2.5	0			
		3.5	0			
		4.5	0			
		5.5	0			
		6.5	0			
		7.5	0			
	Sernylan	1.5	5	2.48	0.45	2.00 - 3.10
		2.5	3	2.33	0.20	2.10 - 2.50
		3.5	6	2.25	0.58	1.40 - 2.80
		4.5	15	2.15	0.28	1.80 - 2.70
		5.5	13	1.96	0.41	1.40 - 2.60
		6.5	6	2.13	0.29	1.80 - 2.50
		7.5	5	2.14	0.33	1.90 - 2.70
1976	M-99	1.5	7	2.71	0.67	1.50 - 3.50
		2.5	2	2.70	0.42	2.40 - 3.00
		3.5	3	2.63	0.46	2.10 - 2.90
		4.5	7	2.57	0.57	2.20 - 3.70
		5.5	8	2.42	0.77	1.40 - 3.80
		6.5	8	2.75	0.93	1.60 - 3.80
		7.5	7	2.57	0.39	2.10 - 3.00
		1.5	0			
		2.5	0			
		3.5	1	1.50		
		4.5	1	2.70		
		5.5	3	1.93	0.15	1.80 - 2.10
		6.5	2	1.80	0.57	1.40 - 2.20
		7.5	2	1.55	0.71	1.50 - 1.60

VITA

Diane Keiser Beeman was born in Rochester, New York on December 19, 1945. She attended elementary schools in that city and was graduated from Greece Olympia High School in June 1963. In September 1963 she entered Monroe Community College, and in June 1965 she received an Associate of Arts degree. In September 1965 she entered the University of Rochester and received her Bachelor of Science degree in General Studies in June 1971. In the fall of 1974 she was accepted to the Graduate School of The University of Tennessee. She began study toward a Master of Science degree in Ecology and received this degree in March 1981.

Ms. Beeman is presently employed by the National Institute of Environmental Health Sciences as a biologist and is married to William A. Beeman.