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Authors: WILLIAMS, J. I., and TRAINER, D. O.

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A HEMATOLOGICAL STUDY OF SNOW, BLUE, AND CANADA GEESE*

J. I. WILLIAMS and D. O. TRAINER,**
Department of Veterinary Science, University of Wisconsin, Madison, Wisconsin 53706

Abstract: Hematological values, including erythrocyte counts, hematocrit and hemoglobin values, and total and differential leucocyte counts, were measured at approximately 30-day intervals during a calendar year in adult snow *(Chen caerulescens)*, blue *(Chen caerulescens)* and Canada geese *(Branta canadesis interior)*. Blood samples from approximately 10 birds (range 3-14) of each type of goose were examined at each bleeding period. Erythrocyte counts for snow and blue geese were very similar and slightly higher than those recorded for Canada geese. Seasonal trends were evident for erythrocyte, hematocrit, and hemoglobin measurements. The highest erythrocyte counts occurred during the winter and spring; the lowest during the summer. Hematocrit and hemoglobin values were highest in the winter and early spring and at their lowest level in the fall. Total and differential leucocyte counts revealed no obvious species or seasonal variations. There were no hematological differences detected between males and females. This is the first report of a detailed hematological study of snow, blue, and Canada geese.

Wild geese constitute a significant segment of wild waterfowl populations in North America. If these populations are to be successfully managed, basic knowledge of the bird including its physiology is important. Although considerable information is available concerning certain aspects of the wild goose, little is recorded on its physiological parameters, such as hematology.

Although hematological data for several anseriform species are available in the literature,[1,3,9,10] they are generally lacking for wild geese. Contributions by Dukes and Schwarte,[4] Hanson,[5] and Lucas and Jamroz[6] provide the only available hematological information on the Canada goose, and a literature review failed to reveal any hematological data on the snow or blue goose. Most ornithologists consider the blue and snow goose to be color phases of a single species.[7] In this study, however, they are referred to as distinct species to simplify the reporting and discussion of data.

This study was undertaken to provide baseline hematological data for three species of wild geese during a calendar year, and to determine if hematological differences existed between species, sexes, or seasons of the year.

MATERIALS AND METHODS

Sixty wild adult snow, blue, and Canada geese were obtained from the Sand Lake National Wildlife Refuge, Colombia, South Dakota, through the cooperation of R. A. Hunt, Wisconsin Department of Natural Resources, Research Bureau. Twenty birds of each species (10 of each sex) were banded, wing clipped and sexed prior to release in a 5-acre, fenced pen at the Wilkie Brothers Foundation in southeastern Wisconsin. The geese had access to a small pond, were free to graze on available vegetation, and were provided ad libitum a diet of corn and commercial duck ration throughout the course of the study.

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** Present address is Wisconsin State University, Stevens Point, Wisconsin 54481.

Beginning in May 1969, approximately 10 birds of each species were bled at monthly intervals for 1 year. The actual number of blood samples tested per month varied from 3-14 due to difficulty in capture, breakage of tubes, etc. Due to losses resulting from predation and escape, the number of Canada geese was substantially reduced during the second half of the study. In an attempt to keep the number of blood samples per species similar, Canada geese *(Branta canadessis interior)* held at the Charmany Research Center, University of Wisconsin, Madison, were bled and specimens substituted for the last five bleeding periods. All blood samples were collected from the brachial vein during the late morning (10-11:00 AM). Blood smears were immediately prepared from each sample for total and differential leucocyte counts, and blood to be used for other measurements was mixed with ethylenediamine tetraacetic acid (EDTA).

Within 5 hours of collection, laboratory determinations of the hematological values were carried out at the Wisconsin Alumni Research Foundation, Madison, Wisconsin, using the following methods:

Erythrocytes

An electronic Coulter counter* was used to determine erythrocyte counts.[2] Two-fold dilutions, starting with 20 lambda of blood in 10 ml of Isoton*, were prepared. The number of erythrocytes in the second dilution was read directly on the counter.

Hematocrit

Microhematocrit methods, employing 75 mm microhematocrit tubes, were used to determine hematocrit percentages. Each tube was centrifuged for 5 to 7 minutes after which a direct reading of sediment (PCV) was taken from the column.[2]

Hemoglobin

Hemoglobin concentrations were determined by cyanomethemoglobin methods, utilizing a Coleman spectrophotometer.[15] Twenty lambda of blood was added to 6 ml of Drabkin solution and the optical density of the solution was then recorded on the spectrophotometer at a wavelength of 540 m μ. This value was then multiplied by a factor of 31.6 to convert the value of hemoglobin to grams/100 ml.

Total leucocytes

The number of leucocytes in each sample was measured by an indirect method described by Coles.[2] Acidophilic cells in each sample were stained with a 1:200 dilution of phloxine stain and then counted directly on a hemocytometer. The total percent of eosinophils and heterophils were counted from the blood smear. These values were then incorporated into a formula to determine the total number of leucocytes present in the sample.

Differential leucocytes

Blood smears stained with Wright's stain were used to determine differential leucocyte counts.[2] A total of 100 cells/slide were examined to determine the percent of heterophils, eoxinophils, lymphocytes and basophils.

RESULTS

A summary of the hematological data for the snow, blue, and Canada geese in this study is presented in Table 1. Based on erythrocyte counts, species differences were significant ($P < 0.05$) when tested by analysis of variance.[13] Erythrocyte values for Canada geese were significantly lower than those for either snow or blue geese; however, snow and blue geese values were similar to each other. This apparent species difference was not detected when comparing other hematologic parameters in this study.

Based on the results of the hematological measurements in this study there were no differences in sex-specific hematologic values within a given species of goose (Table 1).

*Coulter Electronics Co., Hialeah, Florida.

All three species of geese had similar leucocyte values; therefore, to eliminate the presentation of duplicate data only leucocyte data for the blue geese were recorded (Table 3).

In all three species of geese, erythrocyte, hematocrit, and hemoglobin measurements varied with the season of the year (Table 2). These seasonal tendencies did not exist for total or differential leucocyte counts. An increase in the number of erythrocytes in each species occurred during the winter, peaked in March, and declined during the summer with the lowest values recorded in September (Fig. 1a). Hematocrit (Fig. 1b) and hemoglobin values (Fig. 1c) had similar seasonal patterns with the highest values recorded in the spring and the lowest in the fall.

The least variability in values was recorded for hematocrit and hemoglobin measurements, while basophil, eosinophil, and monocyte counts had the largest coefficients of variability.

DISCUSSION

Some of the apparent differences in hematological values recorded in this study are of interest and may be related to other physiological changes of the geese. As noted above, seasonal patterns in erythrocyte counts were recorded for snow, blue, and Canada geese. Similar seasonal tendencies have been reported in other avian species such as doves, pigeons, chickens and canaries.[8,11,12,16] The high erythrocyte counts observed during the spring may have been due to increased metabolic processes and hormone levels associated with reproductive behavior and migratory activity. It has been reported that hormones such as thyroxin,

TABLE 1. A summary of grand mean hematological data, including average values for both sexes and the range of monthly means for snow, blue, and Canada geese.

Measurement	Species		
	Snow	Blue	Canada
Erythrocytes (10^6/mm^3)			
Grand mean	2.24	2.25	2.01
Male	2.24	2.26	1.98
Female	2.25	2.24	2.06
Hematocrit (percent)			
Grand mean	45.7	46.0	45.4
Male	45.6	46.6	45.1
Female	46.1	45.8	46.0
Hemoglobin (gm/100 ml)			
Grand mean	14.5	14.0	14.3
Male	14.2	14.7	14.1
Female	14.6	13.8	14.4
Total Leucocyte (10^3/mm^3)			
Grand mean	20.1	19.3	20.8
Male	19.7	18.8	20.4
Female	21.0	20.7	21.8

TABLE 2. A summary of monthly mean erythrocyte, hematocrit and hemoglobin values of snow, blue, and Canada geese.

Species	Measure*	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Snow	RBC (10 mm)	2.26 (.15)**	2.41 (.02)	2.69 (.07)	2.52 (.05)	2.41 (.04)	2.17 (.06)	2.14 (.06)	1.99 (.05)	1.78 (.06)	2.52 (.19)	1.81 (.09)
	PCV (percent)	44.2 (1.3)	48.3 (2.5)	46.8 (2.2)	53.7 (.91)	53.8 (.26)	46.4 (.39)	44.9 (.23)	41.1 (.55)	43.7 (.65)	42.0 (.65)	41.0 (.32)
	Number	6	3	4	10	10	8	8	5	7	7	5
Blue	RBC	2.49 (.08)	2.38 (.08)	2.91 (.08)	2.63 (.08)	2.42 (.04)	2.72 (.06)	2.22 (.06)	2.11 (.06)	1.77 (.04)	2.26 (.06)	1.88 (.06)
	PCV	45.8 (1.2)	46.1 (1.3)	48.8 (1.6)	52.8 (.91)	54.8 (.91)	48.2 (1.4)	43.9 (1.0)	42.4 (.65)	42.4 (.73)	40.5 (.75)	38.9 (1.8)
	Hb	15.0 (.45)	16.6 (.48)	15.1 (.45)	14.0 (.41)	16.6 (.41)	14.8 (.43)	14.3 (.17)	12.6 (.27)	13.4 (.24)	13.5 (.26)	14.2 (.93)
	Number	11	11	5	10	10	12	10	14	11	10	9
Canada	RBC	2.31 (.06)	2.51 (.08)	2.63 (.15)	2.32 (.06)	2.03 (.07)	1.70 (.05)	2.04 (.06)	1.78 (.07)	1.78 (.02)	2.60 (.09)	1.62 (.04)
	PCV	43.0 (1.1)	52.0 (2.4)	50.0 (.94)	56.0 (5.2)	58.1 (.87)	44.2 (.55)	45.5 (.81)	44.3 (.73)	44.0 (1.0)	38.0 (.61)	38.0 (1.3)
	Hb	16.7 (.24)	18.9 (.42)	16.1 (.32)	14.7 (.42)	18.2 (.31)	13.6 (.27)	14.3 (.44)	12.5 (.27)	13.5 (.42)	12.7 (.35)	12.4 (1.32)
	Number	3	7	5	10	10	11	10	14	4	7	8

** ( ) = one standard error.

* RBC = erythrocytes, PCV = hematocrit, and HB = hemoglobin.

TABLE 3. A summary of monthly means for total and differential leucocyte counts of blue geese.

Measure*	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Total Leucocyte	27.4	18.3	17.1	25.4	11.8	15.8	22.3	18.0	18.4	21.1	25.4
	(2.4)**	(1.3)	(1.8)	(3.4)	(1.1)	(1.5)	(1.2)	(1.2)	(1.5)	(1.3)	(2.7)
Heterophils	23	25	39	25	30	42	53	48	35	32	32
	(1.6)	(2.2)	(3.4)	(3.0)	(2.3)	(2.5)	(2.1)	(2.8)	(3.8)	(2.6)	(2.2)
Eosinophils	.82	.91	.40	.60	.40	.70	1.31	.41	.45	.82	.33
	(.38)	(.37)	(.25)	(.26)	(.16)	(.30)	(.59)	(.20)	(.25)	(.29)	(.47)
Lymphocytes	73	70	56	72	66	56	43	49	61	62	63
	(2.0)	(2.2)	(3.9)	(3.0)	(2.6)	(2.5)	(2.3)	(2.8)	(4.0)	(3.4)	(2.8)
Monocytes	.9	.9	.8	.5	1.3	.7	.7	.6	.8	.9	1.0
	(.25)	(.21)	(.20)	(.22)	(.53)	(.14)	(.21)	(.20)	(.23)	(.28)	(.29)
Basophils	1.7	3.0	3.0	2.0	3.1	.67	1.7	2.5	3.3	3.5	2.6
	(.33)	(.39)	(.73)	(.72)	(.78)	(.22)	(.30)	(.45)	(.73)	(.78)	(.63)
Number	11	11	5	10	10	12	10	14	11	10	9

* WBC = $10^3/mm^3$; differential counts = percent.

** ( ) = one standard error.

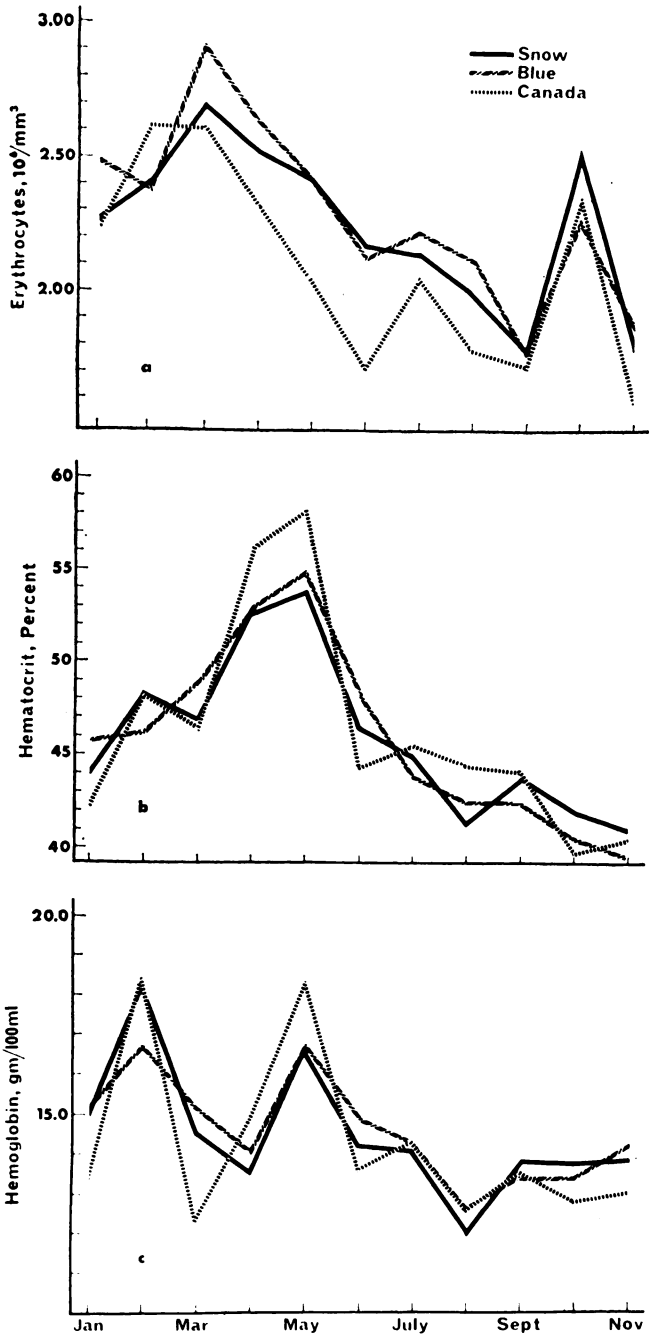

FIGURE 1. Seasonal variations of erythrocyte (a), hematocrit (b), and hemoglobin (c) values of snow, blue, and Canada Geese.

estrogen, and androgens influence hematological measurements.[1] The second increase in the number of erythrocytes in all three species that occurred during October, may be the result of changes in the physiological state of the geese associated with fall migratory behavior.

In general, the hematological measurements recorded in this study for all three species were similar; although, Canada geese had a significantly lower mean erythrocyte value than either snow or blue geese. This relationship was the same for the Canada geese held at the Wilkie Brothers Foundation and for the substituted Canada geese kept at the Charmany Research Center. Since larger species normally have larger erythrocytes,[11] it is conceivable that Canada geese have larger cells than snow or blue geese, thus accounting for the higher hematocrit and hemoglobin values recorded for Canada geese.

Based on a number of anatomical and behavioral characteristics, most ornithologists consider the blue and snow goose to be color phases of a single species.[7] The hematological results of this study support this single species contention.

Although it is commonly reported in other avian species that males have higher erythrocyte counts than females,[10,11,14] there were no obvious sex differences detected in this study. A partial explanation for this lack of sexual dimorphism may involve diurnal erythrocyte cycles. Such a cycle exists in chickens and males have lower values at noon than at any other time of the day.[3] The geese in this study were bled in the late morning, a time when males may have had the lowest numbers of circulating erythrocytes, possibly resulting in low counts.

The hematological values recorded for Canada geese in this study are comparable to limited data available. Hemoglobin concentrations are similar to those reported for several Canada geese by Dukes and Schwarte.[4] Heterophil and basophil percentages are comparable with those of Lucas and Jamroz,[8] while lymphocyte counts were approximately 30 percent higher and eosinophil and monocyte values are nearly 80 percent lower. Hematological data for snow and blue geese were not available for comparison.

The limitations of this hematological study both in sample size and environmental conditions are appreciated, but the results do provide valuable baseline physiological data which adds to our basic knowledge of the snow, blue, and Canada goose.

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