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VARIATION IN SELECTED HEMATOLOGICAL PARAMETERS OF CAPTIVE RED-TAILED HAWKS[1]

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Abstract: Diurnal and winter variations of four hematological parameters were examined in 10 red-tailed hawks *(Buteo jamaicensis).* The mean values obtained were: 39.4% packed cell volume (PCV); 2.45×10^6 erythrocytes (RBC) per mm^3 of blood; 5.73 mg of calcium and 1.44 mg of magnesium per 100 ml of plasma. Only the PCV and RBC count showed significant diurnal variation. When the birds were sampled at a set time of day, from November through to February, no significant changes were detected in any of the four parameters. Variation among the birds in RBC count, PCV and calcium concentration was significant on a diurnal basis but over the four month period only the PCV varied significantly.

INTRODUCTION

Routine procedures in the diagnosis and treatment of many animal diseases include the determination of packed cell volume (PCV), and erythrocyte (RBC) counts. For domestic fowl, normal values of these two parameters have been extensively documented, as well as values associated with specific diseases.[2] However, few data have been collected on PCV and RBC counts for other avian species, especially for raptors. Of those hematological reports for birds of prey,[1,6,8,9,11,17,20,22] only a few[16,23] use sample sizes large enough to statistically detemine variations due to the individual birds, and sampling periods long enough to determine temporal variations.

With the increase in the number of programs designed to rehabilitate individual raptors, to breed and release endangered raptor species, and to use raptors in laboratory research, knowledge of raptor PCV and RBC counts could be a valuable health monitoring tool. Thus winter and daily levels of these two parameters in captive red-tailed hawks *(Buteo jamaicensis)* are reported in this paper.

Diurnal and winter variations in total plasma calcium and magnesium concentrations are also included. Although these two elements have been well studied in several avian species[14,15,21] and are known to be important in maintaining the health and normal reproduction of birds, calcium metabolism is not yet fully understood in raptors[10] and magnesium has yet to be examined.

MATERIALS AND METHODS

Ten red-tailed hawks of undetermined sex and at least four years of age were housed in pairs in $6.5 \times 3.5 \times 2.5$ m (L×W×H) pens described elsewhere.[4] They were kept under natural photoperiod and fed ad libitum a daily diet of 90% laboratory rat and 10% chicken with no water provided.

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Blood samples were taken from each bird on 19 November, 19 December, 23 December and 26 February of 1975 to 1976, between 0900 and 1000 h. Three of the pairs were sampled additionally at 1400 and 1900 h on 26 February. Ambient temperatures on these days were 0, -30, -10 and -3 C respectively.

At each sampling, 2.8 ml of blood was removed from the brachial vein using a 25 gauge needle attached to a 5 ml syringe containing 0.2 ml of saturated sodium citrate solution as anticoagulant. Once collected, the blood was immediately transferred to a test tube and placed on ice. The PCV was measured with microhematocrit tubes on a microhematocrit reader. Ten μl of the blood was diluted (1:200) in a Unopette (Becton-Dickinson, New Jersey) and the RBC count determined using a Neubauer hemacytometer. Blood remaining in the test tube was centrifuged and the plasma frozen. Total plasma calcium and magnesium concentrations were determined with a Perkin-Elmer Atomic Absorption Spectrophotometer, Model 360, according to standard procedures.[18] All analyses were adjusted for plasma dilution by the anticoagulant and, except for the PCV determination, were performed in duplicate.

Analysis of variance and Duncan's New Multiple-Range Test[24] were used to detect significant variations in PCV, RBC counts and calcium and magnesium concentrations between the four sampling days, between the three sampling times on 26 February, and between the individual birds.

RESULTS

The overall average values obtained for each of the four hematological parameters were: 39.4% PCV; 2.45×10^6 RBC per mm^3 of blood; 5.73 mg of calcium and 1.44 mg of magnesium per 100 ml of plasma. Means and standard errors for these parameters on the four sampling days are summarized in Table 1, and at the three sampling times on 26 February in Table 2. The results of Duncan's New Multiple-Range Test are indicated on both these tables.

Analysis of variance indicated that PCV and RBC count showed significant diurnal variation, decreasing throughout the day. PCV, RBC count and plasma calcium concentration varied significantly among the birds at each sampling time on 26 February.

None of the four parameters showed significant variation between months but PCV did vary significantly between birds at each monthly sampling.

DISCUSSION

The average PCV of 39.4% is in the range of 30-50% considered normal for avian blood[26] and concurs with the 40% postulated by Redig[20] to be a normal value for raptors in general. Since our average PCV value is only 0.2% lower than the Falconiformes' average deter-

TABLE 1. Mean ± S.E. of 4 Hematological Parameters Determined for 10 Captive Red-Tailed Hawks on 4 Sampling Days.

	Date Sample Taken			
Parameter	19 Nov.	19 Dec.	23 Dec.	26 Feb.
PCV (%)	$38.6 \pm 3.28^{a*}$	39.4 ± 3.96^{a}	38.1 ± 3.20^{a}	40.7 ± 4.17^{a}
RBC ($10^6/mm^3$)	2.25 ± 0.59^{a}	2.63 ± 0.25^{a}	2.73 ± 0.40^{a}	2.43 ± 0.28^{a}
Ca (mg/100 ml)	5.14 ± 0.38^{a}	5.34 ± 0.21^{a}	5.09 ± 0.28^{a}	5.78 ± 1.44^{a}
Mg (mg/100 ml)	1.41 ± 0.12^{a}	1.44 ± 0.80^{a}	1.39 ± 0.11^{a}	1.51 ± 0.20^{a}

*Numbers with different superscripts within a parameter are significantly different from each other at $p < 0.01$.

TABLE 2. Mean ± S.E. of 4 Hematological Parameters Determined for 6 Captive Red-Tailed Hawks at 3 Sampling Times on 26 February.

Parameter	Time Sample Taken (h.)		
	0900	1400	2100
PCV (%)	$42.2 \pm 4.71^{a*}$	39.0 ± 3.77^{ab}	37.7 ± 4.78^{b}
RBC (10^6/mm^3)	2.51 ± 0.28^{a}	2.43 ± 0.25^{a}	2.22 ± 0.31^{b}
Ca (mg/100 ml)	6.10 ± 1.81^{a}	6.22 ± 2.12^{a}	6.04 ± 2.06^{a}
Mg (mg/100 ml)	1.55 ± 0.21^{a}	1.40 ± 0.08^{a}	1.38 ± 0.08^{a}

*Numbers with different superscripts within a parameter are significantly different from each other at $p < 0.01$.

mined by Balasch *et al.*,[1] our data also substantiate the theory that Falconiformes have lower PCV values than most other avian orders.[1] However, 39.4% was somewhat lower than the average PCV of 43% reported by Bond and Gilbert[6] for four immature red-tailed hawks. This difference raises several questions. The methodology of the PCV determinations would not apper to be a source of discrepancy because our average RBC count of 2.45×10^6 cells per mm^3 of blood was also lower than the 3.2×10^6 reported by Bond and Gilbert.[6] They may have sampled in the morning which we found gave significantly higher values than in the evening. Indeed, at 0900 h our average PCV was 42.4%, only 0.8% lower than Bond and Gilbert's value. This is within the 1% error expected for PCV determinations.[7]

Age also may affect raptor PCV. Immature red-tailed hawks may have higher PCV values than adults, as has been demonstrated in domestic poultry.[25]

The significant difference found between the PCVs of individual birds when sampled throughout one day and winter requires further investigation. This variation could indicate an influence of such factors as age, sex and/or health on PCV. Although the PCV varies with sex in poultry,[12] and quail and geese,[13] no sexual differences in PCV have been found in white-crowned sparrows *(Zonotrichia leucophrys gambelii),*[15] European kestrels *(Falco tinnunculus),*[16] or American kestrels *(Falco sparverius).*[23]

The significant decrease in PCV and RBC count from 0900 to 1900 h on 26 February may be due to hemodilution caused by repeated sampling. The average RBC count of 2.45×10^6 cells per mm^3 of blood falls in the range for birds in general ($1.9\text{-}5.0 \times 10^6$) and for raptors ($2.08\text{-}2.90 \times 10^6$).[20]

The plasma total calcium concentration of 5.73 mg per 100 ml is just below the normal range of 7-15 mg reported by Cooper[10] for Falconiformes and Strigiformes. Raptors appear to have much lower plasma calcium concentrations than that reported for other avian species. Total calcium concentrations of 15-19 mg per 100 ml of plasma have been found in chickens,[21] 10 mg in Japanese quail *(Coturnix coturnix japonica)*[5] and 16-28 mg in white-crowned sparrows.[15]

Significant differences in calcium concentrations between our sampled birds could be due to age, sex and time of last feeding.[25] Since it is possible to detect large differences in blood calcium due to shell formation,[21] the female that laid an egg on 19 March probably contributed to the significant difference between birds on 26 February.

The average total plasma magnesium concentration of 1.44 mg per 100 ml is close to the 2 mg reported for Japanese quail.[5] Further knowledge of plasma magnesium concentrations in raptors

may assist in the diagnosis of raptor diseases. Magnesium is involved in basic bodily functions and activates many important enzymes such as phosphatases, ATPases, carboxylases in the heart and the pyruvic acid oxidase system in the brain.[19] Neuromuscular disorders, convulsions and cardiovascular abnormalities can all result from a magnesium imbalance.[19]

In summary, many significant variations in the four hematological parameters examined were revealed. If parameters such as these are to be useful indicators of health in birds of prey, it becomes evident that one must first take into consideration the influence of natural phenomena on these parameters, such as the time of the day, season, age and sex.

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