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Clinical Pathology of Nestling Marabou Storks in Uganda

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ABSTRACT: Packed cell volumes (PCV) and plasma chemistry parameters were measured in 20 nestling marabou storks (*Leptoptilos crumeniferus*) in January 2003 that were a part of a colony located in the center of the city of Kampala, Uganda. There were no significant differences ($P \geq 0.05$) in plasma chemistry values or PCV between sexes with the exception of globulin and total plasma protein values, which were higher in females. There were significant differences ($P \leq 0.05$) in blood glucose, creatine kinase, and globulin levels between birds of different body weight. Total plasma protein, uric acid, phosphorous, and creatine kinase were generally higher relative to published data on other avian species, including nestling white storks (*Ciconia ciconia*).

Key words: *Leptoptilos crumeniferus,* marabou stork, packed cell volume, plasma chemistry, Uganda.

The objective of this study was to determine plasma chemistry and packed cell volume (PCV) values for nestling marabou storks (*Leptoptilos crumeniferus*). The marabou stork is indigenous to tropical Africa, where it is common to abundant in most parts of its range (Hancock et al., 1992). Despite its ubiquity, no plasma chemistry or hematologic parameters have been reported for free-ranging marabou storks. The biology of the marabou stork in Uganda has been well described by Pomeroy (1977, 1978). Adult marabous weigh between 5 and 8 kg, and the diet of the birds in Kampala (Uganda) probably includes almost anything organic, such as garbage, fish remains, abattoir refuse, and a large amount of vegetable matter (Hancock et al., 1992). Marabou storks undertake short migrations, mainly between the north and south of Uganda, coinciding with rainfall seasonality (Pomeroy, 1977, 1978). Marabous are colonial nesters, building multiple nests in particular tree types, such as mvule (*Melicia excelsa*). Incubation period is 30.3 days, and average clutch size is 2–3 eggs. Marabous have an extremely long period from hatching to fledging, being about 135 days, with first flights out of the nest at 110–115 days. Marabous first breed at 6–7 yr of age and can live up to 25 yr in captivity (Hancock et al., 1992).

The marabou stork has responded to increasing urbanization of human populations by adopting a scavenging lifestyle and cosmopolitan diet in urban areas. Populations have increased in Kampala, and breeding colonies can be found in the city center (Hancock et al., 1992). The use of birds as monitors of the potential effects of chemicals in the environment is well documented (Burger and Peakall, 1995). Spatial and temporal variation in clinical pathology data between and within wildlife populations has been used as a nonspecific indication of changes within their environment (Bowerman et al., 2000; Hanni et al., 2003; Uhart et al., 2003). The purpose of this report is to add to the physiologic information available on free-ranging marabou storks.

Packed cell volumes, plasma chemistry parameters, and body weights were recorded in 11 male and 9 female nestling marabou storks in January 2003 (Table 1). Marabou nestlings were part of a colony located along Nile Avenue in central Kampala, Uganda (0°19′N, 35°25′E). Marabou stork nestlings were sampled from 12 nests, in six white cedar trees (*Tabebuia*

TABLE 1. Body weight, packed cell volume, and plasma chemistry values for nestling marabou storks (*Leptoptilos crumeniferus*) from Kampala, Uganda (n=20).[a]

Parameter	Mean	SD	Median	Q1	Q3	Min	Max
Weight (kg)	4.1	1.6	3.8	3.1	4.9	1.6	7.6
Packed cell volume (%)	34	4	33	31	37	28	40
Total plasma protein R (g/l)[b]	46	4	47	43	49	40	52
Total plasma protein C (g/l)[c]	41	5	42	39	45	30	50
Glucose (mmol/l)[d]	11.7	2.1	12.2	10.4	13.2	7.5	15.1
Aspartate transaminase (U/l)	135	28	143	115	155	84	178
Calcium (mmol/l, n=18)[e]	2.70	0.17	2.74	2.68	2.82	2.35	2.95
Phosphorous (mmol/l)	2.84	0.87	2.53	2.15	3.53	1.74	4.49
Creatine kinase (U/l, n=16)	1,422	575	1,320	988	1,854	584	2,705
Uric acid (mmol/l)	0.873	0.355	0.806	0.643	1.100	0.357	1.422
Albumin (g/l)	17.1	2.3	17.0	16.0	19.0	12.0	20.0
Globulin (g/l)	24.2	3.5	25.0	22.0	26.0	18.0	30.0
Sodium mmol/l, n=16)[e]	149	2	149	148	151	143	153
Potassium (mmol/l)	4.2	1.3	3.9	2.9	5.3	2.7	6.5
Chloride (mmol/l, n=18)[e]	107	5	107	105	111	96	115
Cholesterol (mmol/l)	4.97	1.27	5.10	3.86	5.98	3.08	7.28

[a] Q1 = 25th percentile of the sample; Q3 = 75th percentile of the sample; Min = minimum; Max = maximum.
[b] Plasma protein determined by refractometry.
[c] Plasma protein determined by colorimetry.
[d] Determined on whole blood.
[e] Indicates outlying values have been removed and the sample size adjusted accordingly.

pentaphylla), in one colony, on 1 day between 7:00 AM and 6:00 PM. Marabou stork nestlings were temporarily captured for sample collection with professional tree climbing techniques (US Department of Agriculture Forest Service, 1996). Parents never left the nest (and vigorously defended the chicks) or remained close to the nest and returned on retreat of the climber. Marabou stork nestlings were placed singly into a ventilated nylon bag (The Taku Tailor, Juneau, Alaska, USA) and lowered to the ground for sampling. Blood (12 ml) was collected from the medial metatarsal vein via a butterfly catheter (23 gauge × 1.9 cm, Surflo Winged Infusion Set, Terumo, Elkton, Maryland, USA) connected to a 3-ml syringe. Blood (8 ml) was immediately transferred to a 10-ml vacutainer tube containing lithium heparin anticoagulant, and the remainder was transferred to a 5-ml vacutainer tube containing calcium ethylenediaminetetraacetic acid anticoagulant (Becton Dickinson, Franklin Lakes, New Jersey, USA). Fresh whole blood was also used to determine blood glucose levels with a hand-held glucometer (Medisense 2® Card Glucometer with Precision Plus Sensors®, Medisense Inc., Bedford, Massachusetts, USA). A drop of whole blood was placed on a commercially prepared paper sample card to be used for sex determination. Physical examination included scoring body condition (on the basis of pectoral muscle mass and feather condition), morphologic measurements, determination of whether the crop was empty or full, and visual evaluation of abnormalities. Finally, birds were placed in a cotton sack, and body weight was recorded by a spring balance (Homs model 20, Douglas Homs Corp., Belmont, California, USA). Average time for removal from the nest until return was 14.5 min (range 7–22 min). Sample transport, storage, and analysis were as described by Hollamby et al. (2004a, b) in this volume. Analyses were performed 2 wk after sampling.

Birds were sexed by polymerase chain reaction amplification of homologous sections of chromo-helicase-DNA binding genes (Avian Biotech International, Tallahassee, Florida, USA) located on the avian sex chromosome (Griffiths et al., 1998). Controls were obtained from marabou storks of known sex.

Analysis of variance (ANOVA) was conducted to assess association between sex, body weight, and plasma chemistry parameters (SAS PROC ANOVA for categorical risk factors, and SAS PROC GLM for continuous risk factors; SAS Inc., Cary, North Carolina, USA). Univariate and multivariate analyses were conducted. The level of significance (type 1 [α] error) was set at 0.05 (Table 2).

All birds were in good body condition as assessed by pectoral muscle mass, and no abnormalities were detected on physical examination. Mean weight of the nestlings was 4.1±1.6 kg (range 1.65–7.60 kg). Six birds had full crops. Eight samples had slight, two moderate, and five severe hemolysis. Female nestlings had significantly higher plasma globulin levels ($P \leq 0.05$) and total plasma protein (TPP) than males ($P \leq 0.05$), as measured by refractometry and colorimetric methods. Weight of nestling was not significant ($P \geq 0.05$) when assessed simultaneously with sex for its association with TPP. A strong positive correlation ($r^2 = 0.78$) existed between TPP values determined by a temperature-compensated refractometer in the field and the colorimetric method in the laboratory. Mean TPP values for nestlings were 5 g/l higher when measured by refractometry.

Most plasma chemistry parameters and PCVs reported in this study for marabou stork nestlings were similar to those recorded for other species of free-ranging and caged bird nestlings, including bald eagles (*Haliaetus leucocephalus*), Spanish imperial eagles (*Aquila adalberti*), and a variety of psittacines, including *Ara, Cacatua,* and *Eclectus* spp. (Clubb et al., 1991; Redig, 1993; Bowerman et al., 2000; Hoefle et al., 2000). However, TPP, phosphorous, potassium, and creatine kinase

TABLE 2. Results of analysis of variance of plasma chemistry values in nestling marabou storks (*Leptoptilos crumeniferus*) ($n=19$) from Kampala, Uganda.

Plasma chemistry parameters	Body weight		Sex		Overall	
	F	*P*	*F*	*P*	*F*	*P*
Aspartate transaminase	0.12	0.73	1.42	0.25	0.77	0.48
Creatine kinase	10.45	0.01	0.08	0.79	5.6	0.02
Cholesterol	0.22	0.64	3.42	0.08	1.82	0.19
Globulin	6.47	0.02	5.98	0.03	6.22	0.01
Potassium	0.06	0.81	0.12	0.74	0.09	0.91
Phosphorous	0.01	0.93	0.16	0.69	0.09	0.92
Total plasma protein R[b]	2.74	0.12	9.53	0.01	6.14	0.01
Uric acid	0.08	0.78	0.01	0.93	0.04	0.96
Albumin	1.20	0.29	2.69	0.12	1.95	0.18
Calcium	0.25	0.63	0.75	0.40	0.50	0.62
Chloride	0.13	0.73	1.95	0.18	1.04	0.38
Glucose[a]	10.41	0.01	0.93	0.35	5.67	0.01
Sodium	1.34	0.26	2.23	0.16	1.78	0.20
Packed cell volume	2.16	0.16	1.39	0.25	1.78	0.20
Total plasma protein C[c]	3.99	0.06	4.82	0.04	4.41	0.03

[a] Determined on whole blood.
[b] Plasma protein determined by refractometry.
[c] Plasma protein determined by colorimetry.

(CK) were higher and aspartate transaminase (AST) values lower compared with nestlings of other species recorded in the above studies. These same increases were apparent when compared with nestling white stork (*Ciconia ciconia*) plasma chemistry parameters (Montesinos et al., 1997), with the exception of phosphorous and potassium, which were similar to values recorded for nestling white storks.

Elevations in plasma potassium and phosphorous values, relative to the studies cited above, were most likely artifactual and caused by hemolysis (Fudge, 2000). Elevated CK values, compared with the above studies, were most likely a combination of sample hemolysis and struggling during handling. A possible explanation for elevated TPP levels in nestlings compared to other species could be increased sources of protein available in an urban environment. In Kampala, this included abattoirs and an abundance of refuse associated with inadequate waste disposal services (Matagi, 2002). Plasma chemistry samples from breeding, nonbreeding, rural, and urban colonies would be necessary to validate this explanation.

The strong correlation between TPP measurements made by refractometry and the colorimetric method suggests that refractometric measurements of TPP provide single readings that are consistent, when compared with colorimetric readings, but not precise. Thus, refractometry should be used only as an approximation, rather than an absolute indicator of TPP. Lumeij and Maclean (1996) demonstrated poor reproducibility of refractometry to determine avian plasma protein values.

Differences in AST and calcium levels between sexes have been recorded in avian species (Gee et al., 1981), but this has not been a consistent finding and was not found in this study. Apart from a small sample size, no conclusions can be drawn from the higher globulin and TPP values found for females. However, results of multivariate ANOVA suggest that variation in TPP between sexes was not due to variation in body weight, which could be viewed as an approximate indicator of age during the long fledging period in this species.

There is a paucity of physiologic data on many common African avian species with-

in their natural habitat. Spatial and temporal changes in hematologic and plasma chemistry parameters between and within marabou stork populations might prove useful in assessing the health of these populations and their environment.

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