LETTER

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Hematology and Serum Biochemistry Values of Healthy Free-ranging Panamanian White-faced Capuchins (*Cebus imitator*) in Costa Rica

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ABSTRACT: We describe the hematology and serum biochemistry values for 26 free-ranging Panamanian white-faced capuchins (*Cebus imitator*) in Costa Rica. Howell-Jolly bodies and microfilariae were observed in some animals. This baseline information is a tool for health assessment and species conservation.

The Panamanian white-faced capuchin (*Cebus imitator*) is a neotropical nonhuman primate that is distributed from Honduras to Panama (Mittermeier et al. 2013). In Costa Rica, it can be found near the Caribbean and Pacific coasts and is under threat of extinction due to habitat loss, hunting, and the pet trade (Wainwright 2007). Due to their diet and generalist behavior, Panamanian white-faced capuchins contribute significantly to habitat regeneration (Wainwright 2007).

A lack of information regarding health and diseases of wild Panamanian white-faced capuchins is likely due to the difficulty of capture of the animal and the high costs of research (Crofoot et al. 2009). Hematology and serum biochemistry values of the genus *Cebus* and the Cebidae family have been reported in Latin America and the US, in captive animals (Larsson et al. 1999; ZIMS 2018), and in wild *Cebus* spp. (Flaiban et al. 2008; Crofoot et al. 2009). There are no data for wild Costa Rican Panamanian white-faced capuchins and only a single study of 15 captive animals (Meneses and Bouza-Mora 2014).

Our objective was to describe the hematology and serum biochemistry values for clinically healthy wild Panamanian white-faced capuchins in Costa Rica. These baseline studies are useful and reliable tools that allow professionals to generate health and management protocols for conservation strategies (Thoisy et al. 2001; Crofoot 2009).

The research was conducted between May 2010 and September 2012. We captured 26 wild monkeys in seven protected and nonprotected natural areas within Costa Rica: six animals from the central and south Caribbean side and 20 from the north, central, and south Pacific coasts. The study followed the ethical guidelines of the Animal Welfare Commission of the Universidad Nacional and Costa Rican legislation, as well as guidelines of the American Society of Primatologists.

The individuals were captured using darts (1 cc, Type P, PneuDart Inc., Williamsport, PA, USA) with ketamine 10% (10–20 mg/kg) and xylazine 2% (0.5–2 mg/kg), fired with a compressed gas rifle (PneuDart Inc., Model X-Caliber Gauged CO_2) or a blowgun depending on the distance, targeting the femoral quadriceps and biceps muscles (Olberg 2007). Sampling was carried out during 0500–1100 and 1400–1800 hours, avoiding heavy precipitation or environmental temperatures higher than 35 C.

Each primate underwent a clinical examination, and, upon determining good health, blood samples (2–4 mL) were taken from the femoral or cephalic vein (Sasseville et al. 2012). Blood with ethylenediaminetetraacetic acid anticoagulant was used to perform hematologic analysis. For biochemistry, blood was collected into vials without anticoagulant and serum separated by centrifugation within 24 h (Thrall et al. 2012). Throughout the entire process, the monkeys were kept under veterinary supervision until they were released at the capture site. The samples were kept at 4 C and processed maximum 5 d after their collection (Thrall et al. 2012), and nohemolyzed samples were used.

Hematocrit was quantified using a microhematocrit centrifuge (Hematokrit Hettich

TABLE 1. Hematology values for wild white-faced capuchin monkeys (*Cebus imitator*, Cebidae) in Costa Rica, 2010–12.

	All individuals					Males (n=19; 16 adults, 3 juveniles)					Females (n=7; 6 adults, 1 juvenile)				
Analytes[a]	*N*	Mean	SD	Minimum	Maximum	*N*	Mean	SD	Minimum	Maximum	N	Mean	SD	Minimum	Maximum
Hematocrit (%)	25	39.9	4.6	33.0	50.0	19	40.7	4.8	33.0	50.0	6	37.5	3.6	34.0	42.0
Hemoglobin (g/dl)	25	12.0	2.1	8.3	16.2	19	12.7	1.8	9.5	16.2	6	10.5	1.7	8.0	13.2
MCHC (%)	25	31.0	2.7	27.0	36.0	19	31.2	2.8	27.0	36.0	6	28.6	4.5	20.8	33.0
WBC/μL	25	10,382	4,456	3,200	19,400	19	11,850	3,845	5,650	19,400	6	5,733	2,821	3,200	10,750
Band. Neutrophils (%)	24	0.4	0.6	0	2.0	19	0.3	0.7	0	2.0	5	0.6	0.6	0	1.0
Band. Neutrophils/μL	24	30.7	55.7	0	165	18	23.7	55	0	165	6	51.5	57.2	0	136
Segmented. Neutrophils (%)	24	42.7	16.4	19.0	76.0	18	43.0	17.7	19.0	76.0	5	41.7	13.1	30.0	62
Segmented. Neutrophils/μL	24	4,595.8	3,280	1,024	12,351	18	5,343.9	3,435.6	1,074	12,351	6	2,352	1,141	1,024	3,870
Eosinophils (%)	24	4.9	4.2	0	14.0	18	4.9	3.8	0	13.0	5	5.0	5.9	0	14.0
Eosinophils/μL	25	503	412	0	1,505	19	525.2	363.9	0	1,242	6	432	572.9	0	1,505
Basophils (%)	23	0.6	0.8	0	2.0	17	0.6	0.8	0	2.0	6	0.7	0.8	0	2.0
Basophils/μL	25	75.9	89.9	0	286	19	89.1	97.8	0	286	6	34.2	44.5	0	108
Lymphocytes (%)	24	49.2	15.8	20.0	77.0	18	49.8	17.2	20.0	77.0	6	47.5	11.7	33.0	68.0
Lymphocytes/μL	24	4,698	1,973	1,440	8,320	18	5,352	1,676	2260	8,320	6	2,737	1,484	1,440	4,622
Monocytes (%)	23	0.8	0.7	0	2.0	18	0.7	0.8	0	2.0	5	1.0	0.7	0	2.0
Monocytes/μL	24	93.1	105	0	387	19	106	115	0	387	5	44.5	35.1	0	91.0

[a] MCHC = mean corpuscular hemoglobin concentration; WBC = white blood cells.

TABLE 2. Biochemical values for wild white-faced capuchin monkeys (*Cebus imitator*, Cebidae) in Costa Rica, 2010–12.

	All individuals					Males					Females				
Analytes [a]	*n*	Mean	SD	Minimum	Maximum	*N*	Mean	SD	Minimum	Maximum	*n*	Mean	SD	Minimum	Maximum
Total proteins (g/L)	25	72.1	10.2	51.0	89.0	18	72.7	10.2	51.0	89.0	7	70.6	10.9	58.0	88.0
Albumin (g/L)	24	38.3	3.8	29.0	47.0	17	38.6	3.5	33.0	47.0	7	37.3	48.0	29.0	43.0
Globulin (g/L)	24	35.0	7.3	18.0	47.0	17	35.9	6.8	24.0	47.0	7	33.3	8.7	18.0	45.0
A/G ratio	23	1.0	0.1	0.9	1.4	17	1.1	0.2	0.9	1.4	6	1.0	0.1	0.9	1.2
Urea nitrogen (mmol/L)	24	6.0	2.4	1.4	10.7	18	5.5	2.2	1.4	10.2	6	7.4	2.2	4.6	10.7
Creatinine (μmol/L)	22	83.1	17.5	53.4	122.0	15	86.2	16.8	61,0	122.0	7	76.3	18.3	53.4	106.8
Calcium (mmol/L)	21	2.1	0.2	1.6	2.4	15	2.1	0.2	1.6	2.4	6	2.1	0.1	2.0	2.3
Phosphorous (mmol/L)	21	1.9	0.9	0.6	3.4	16	1.8	0.8	0.8	3.0	6	2.4	1.3	0.6	3.4
Ca/P ratio	22	1.5	0.8	0.6	3.5	16	1.5	0.7	0.7	2.8	6	1.4	1.1	0.6	3.5
ALT (U/L)	25	31.3	25.3	9.0	98.0	18	31.5	25.6	13.0	98.0	7	30.7	26.6	9.0	88.4

[a] A/G = albumin-globulin ratio; ALT = alanine aminotransferase; Ca/P = calcium-phosphorous ratio.

210, Andreas Hettich, Tuttlingen, Germany); hemoglobin was determined by the cyanomethemoglobin reaction, and the concentration of mean corpuscular hemoglobin was calculated. The white blood cell count was made using Neubauer's camera, and the leukocyte differential was determined by examination of a blood smear, stained with May-Grünwald Giemsa (Thrall et al. 2012).

The analysis of total protein, albumin (A), globulins (G), urea nitrogen, creatinine, alanine aminotransferase, calcium (Ca), and phosphorus (P) was made by automatic colorimetric and kinetic methods, using an automatic analyzer (Selectra Junior, Ecokit Electronic, Medellin, Antioquia, Colombia) and a semiautomatic analyzer (Metrolab 1600®, Weimerlab.Group, Riobamba, Rosario, Argentina). The A/G and Ca/P ratios were calculated.

The data from the blood variables was analyzed using the statistical program InfoStat® (Agricultural College, National University, Córdoba, Argentina). The extreme values for each variable obtained by box plot were eliminated in order to calculate the mean and the measures of data dispersion (SD, minimum, and maximum values: National Committee for Clinical Laboratory Standards 2000). Statistical comparisons between sexes or ages were not possible because of insufficient numbers in each group.

The hematology values showed higher dispersion, especially the leucogram (Table 1), than did the serum biochemistry analytes (Table 2). These characteristics have been previously reported, because leukocytes are more responsive to proximate conditions than are erythrocytes (Sasseville et al. 2012) and metabolites that were studied. The variations that we found are likely related to individual differences of animals captured in the wild, biological factors like sex and age (Flaiban et al. 2008; Ray et al. 2008), ecological factors, nutritional and metabolic conditions, habitat quality, and physiological responses to anesthetic drugs and capture stress (Larsson et al. 1999; Thoisy et al. 2001; Flaiban et al. 2008; Sasseville et al. 2012). Also, preanalytical condition like the sample storage time could

increase variability, especially in the CBC, but not before 72 h of storage (Meneses-Guevara et al. 2010).

No cell morphology changes were observed, but 35% (9/26) of the monkeys had Howell-Jolly bodies in their erythrocytes, a common finding in nonhuman primates, especially *Cebidae* and *Prosimii* (Sasseville et al. 2012). Microfilariae were present in four animals, without clinical symptoms, possibly from common nematodes like *Filariopsis barretoi* or *Dipetalonema gracile* (Chinchilla et al. 2007; Parr et al. 2013).

This report for apparently healthy, wild Panamanian white-faced capuchin in Costa Rica included the largest number of wild individuals of this species examined to date. The hematology and serum biochemistry results were within the ranges reported for *Cebus* spp. (Gallego and Roldán 2007; Meneses and Jiménez 2007; Flaiban et al. 2008; Crofoot et al. 2009; ZIMS 2018). These analytes represent the normal physiological values for free-ranging Panamanian white-faced capuchins, under similar circumstances of capture and handling.

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