

**HEMATOLOGIC VALUES OF THE BLACK SPIDER MONKEY  
(*ATELES FUSCICEPS*), RED SPIDER MONKEY (*ATELES  
GEOFFROYI*), WHITE FACE MONKEY (*CEBUS CAPUCINUS*),  
AND BLACK HOWLER MONKEY (*ALOUATTA VILLOSA*)<sup>1,2,3,4,5</sup>**

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**SUMMARY** • Hematologic values were determined from black spider monkeys (*Ateles fusciceps*), red spider monkeys (*Ateles geoffroyi*), white face monkeys (*Cebus capucinus*), and black howler monkeys (*Alouatta villosa*). Mean values, standard deviations, and minimal-maximal values were determined for erythrocyte counts, leukocyte counts, packed cell volumes, hemoglobin concentrations, differential leukocyte counts, mean cell volumes, mean cell hemoglobins, and mean cell hemoglobin concentrations. Calculations were presented separately for sexes, for immature and mature monkeys, and for arrival at laboratory, maintained in laboratory in 1967, and maintained in laboratory in 1968.

Hematologic parameters of Panamanian primates were desired as part of malarial studies at Gorgas Memorial Laboratory. Except for the report of Taliaferro and Kluver (5) on the "normal" erythrocyte and leukocyte counts determined from a few of these monkeys, no information could be found. To obtain information, we made hematologic determinations as time permitted. Data on the night monkey, *Aotus trivirgatus* (2), and the Panamanian marmoset, *Saguinus geoffroyi* (3), were presented elsewhere. Data from 4 other species, the black spider monkey, *Ateles fusciceps*, red spider monkey, *Ateles geoffroyi*, white face monkey, *Cebus capucinus*, and

black howler monkey, *Alouatta villosa*, are reported herein.

MATERIALS AND METHODS

Methods of blood collection and analysis (2) and of feeding and handling (1,4) were detailed previously. Most of the monkeys of the 4 species mentioned were immature (juvenile) because of difficulty in capturing adults. The spider monkeys and white face monkeys had generally been kept captive by Indians for a few weeks before arrival at the laboratory. Their arrival values, therefore, represent values consequent to being held captive by Indians rather than values in their natural state. The howler monkeys were generally brought to the laboratory within 48 hr after capture.

The original diet for the spider monkeys and white face monkeys consisted of a combination of rice, ground meat, and vegetables cooked daily and supplemented by seasonal fruits and vegetables. Beginning the latter part of 1967, Purina Monkey Chow

<sup>1</sup> From the Gorgas Memorial Laboratory, Panama, Republic of Panama.

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TABLE 1  
Hematologic determinations from immature Ateles fusciceps at Gorgas Memorial Laboratory

Determination	Females										Males											
	Arr		(1966-68)		(1967)		(1968)		Arr		(1966-68)		(1967)		Main		(1967)		Main		(1968)	
	No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	Main No	Mean $\pm$ SD*	No	Mean $\pm$ SD*		
Erythrocytes/cu mm (x105)	31	4.06 $\pm$ 0.99 (1.95-7.39)	12	3.66 $\pm$ 0.79 (1.96-4.91)	11	4.20 $\pm$ 0.57 (3.39-5.32)	12	3.54 $\pm$ 0.69 (1.97-4.22)	12	3.84 $\pm$ 0.69 (2.65-5.37)	17	3.84 $\pm$ 0.69 (2.65-5.37)	17	3.84 $\pm$ 0.69 (2.65-5.37)	17	4.27 $\pm$ 0.34 $^+$ (3.50-4.92)	17	4.27 $\pm$ 0.34 $^+$ (3.50-4.92)	17	4.27 $\pm$ 0.34 $^+$ (3.50-4.92)		
Leukocytes/cu mm (x103)	32	11.0 $\pm$ 4.2 (1.4-21.1)	12	26.3 $\pm$ 7.2 $^+$ (15.4-40.1)	11	19.9 $\pm$ 4.5 $^+$ (14.2-29.3)	13	12.8 $\pm$ 6.1 (4.3-28.5)	13	19.7 $\pm$ 7.6 (10.0-37.5)	17	19.7 $\pm$ 7.6 (10.0-37.5)	17	19.7 $\pm$ 7.6 (10.0-37.5)	17	22.3 $\pm$ 6.7 $^+$ (8.9-31.2)	17	22.3 $\pm$ 6.7 $^+$ (8.9-31.2)	17	22.3 $\pm$ 6.7 $^+$ (8.9-31.2)		
Packed cell volume (%)	55	39.2 $\pm$ 6.4 (19-50)	10	35.9 $\pm$ 8.0 (21-48)	10	41.9 $\pm$ 5.9 (35-55)	29	37.4 $\pm$ 7.5 (17-48)	29	37.7 $\pm$ 7.2 (27-50)	16	37.7 $\pm$ 7.2 (27-50)	16	37.7 $\pm$ 7.2 (27-50)	16	41.5 $\pm$ 3.1 (34-47)	16	41.5 $\pm$ 3.1 (34-47)	16	41.5 $\pm$ 3.1 (34-47)		
Hemoglobin (g/100 ml)	21	11.8 $\pm$ 2.6 (6.0-16.5)	10	11.4 $\pm$ 1.5 (8.2-13.8)	11	12.9 $\pm$ 1.6 (10.5-15.5)	8	9.9 $\pm$ 2.1 (5.0-12.5)	8	11.7 $\pm$ 1.6 (9.0-14.4)	17	11.7 $\pm$ 1.6 (9.0-14.4)	17	11.7 $\pm$ 1.6 (9.0-14.4)	17	12.6 $\pm$ 0.9 $^+$ (10.8-14.4)	17	12.6 $\pm$ 0.9 $^+$ (10.8-14.4)	17	12.6 $\pm$ 0.9 $^+$ (10.8-14.4)		
Neutrophils (%)	14	66.7 $\pm$ 12.1 (48-80)	0		11	64.9 $\pm$ 6.2 (54-72)	10	72.4 $\pm$ 10.7 (46-82)	10		0		15	56.1 $\pm$ 15.4 $^+$ (33-87)	15	56.1 $\pm$ 15.4 $^+$ (33-87)	15	56.1 $\pm$ 15.4 $^+$ (33-87)	15	56.1 $\pm$ 15.4 $^+$ (33-87)		
Lymphocytes (%)	14	30.7 $\pm$ 12.3 (15-51)	0		11	31.6 $\pm$ 6.1 (24-44)	10	26.6 $\pm$ 11.2 (13-54)	10		0		15	40.3 $\pm$ 14.8 (9-62)	15	40.3 $\pm$ 14.8 (9-62)	15	40.3 $\pm$ 14.8 (9-62)	15	40.3 $\pm$ 14.8 (9-62)		
Monocytes (%)	14	1.4 $\pm$ 1.0 (0-3)	0		11	1.9 $\pm$ 1.6 (0-5)	10	1.2 $\pm$ 1.1 (0-3)	10		0		15	1.7 $\pm$ 1.5 (0-4)	15	1.7 $\pm$ 1.5 (0-4)	15	1.7 $\pm$ 1.5 (0-4)	15	1.7 $\pm$ 1.5 (0-4)		
Eosinophils (%)	14	2.1 $\pm$ 1.7 (0-13)	0		11	1.8 $\pm$ 1.5 (0-4)	10	1.0 $\pm$ 1.3 (0-4)	10		0		15	1.7 $\pm$ 2.1 (0-8)	15	1.7 $\pm$ 2.1 (0-8)	15	1.7 $\pm$ 2.1 (0-8)	15	1.7 $\pm$ 2.1 (0-8)		
Basophils (%)	14	0.0	0		11	0.0	10	0.3 $\pm$ 0.7 (0-2)	10		0		15	0.0	15	0.0	15	0.0	15	0.0		
MCV (cj)	27	95.6 $\pm$ 8.7 (54.1-103.6)	10	99.4 $\pm$ 4.4 (93.8-107.1)	10	98.6 $\pm$ 4.0 (93.9-103.4)	11	96.3 $\pm$ 4.2 (86.2-100.0)	11	97.8 $\pm$ 4.5 (89.6-106.9)	16	97.8 $\pm$ 4.5 (89.6-106.9)	16	97.8 $\pm$ 4.5 (89.6-106.9)	16	96.0 $\pm$ 3.8 (93.9-97.8)	16	96.0 $\pm$ 3.8 (93.9-97.8)	16	96.0 $\pm$ 3.8 (93.9-97.8)		
MCH ( $\mu$ g)	19	28.8 $\pm$ 1.7 (22.3-30.7)	10	29.6 $\pm$ 0.6 (28.1-30.5)	11	29.9 $\pm$ 1.0 (29.0-30.0)	8	29.0 $\pm$ 1.7 (25.4-31.3)	8	29.5 $\pm$ 1.0 (26.8-31.3)	17	29.5 $\pm$ 1.0 (26.8-31.3)	17	29.5 $\pm$ 1.0 (26.8-31.3)	17	29.7 $\pm$ 0.4 (29.1-30.9)	17	29.7 $\pm$ 0.4 (29.1-30.9)	17	29.7 $\pm$ 0.4 (29.1-30.9)		
MCHC (%)	18	31.0 $\pm$ 2.8 (29.0-41.3)	8	30.2 $\pm$ 1.3 (28.1-31.8)	10	30.7 $\pm$ 1.3 (28.2-32.7)	7	30.6 $\pm$ 1.1 (29.0-32.7)	7	30.6 $\pm$ 1.7 (27.7-33.2)	16	30.6 $\pm$ 1.7 (27.7-33.2)	16	30.6 $\pm$ 1.7 (27.7-33.2)	16	30.9 $\pm$ 0.5 (30.3-31.8)	16	30.9 $\pm$ 0.5 (30.3-31.8)	16	30.9 $\pm$ 0.5 (30.3-31.8)		

Arr: Arrival at laboratory

Main: Maintained at laboratory

No: Number of determinations

Mean  $\pm$  SD $^+$ : Mean values  $\pm$  standard deviation; minimal maximal limits are shown in parentheses $^+$ : Differs from corresponding value for arrival,  $P < 0.01$

TABLE 2  
*Hematologic determinations from immature Ateles geoffroyi at Gorgas Memorial Laboratory*

Determination	Females						Males							
	Arr		Main		(1967)		Main		(1968)		(1967)		Main	
	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*	No	Mean $\pm$ SD*
Erythrocytes/cu mm (x106)	5	4.20 $\pm$ 0.58 (3.42-4.65)	5	4.70 $\pm$ 0.28 (4.26-4.95)	6	4.22 $\pm$ 0.58 (3.05-4.60)	3	4.85 $\pm$ 0.16 (4.68-4.98)	1	4.15	2	3.80 $\pm$ 0.07 $\pm$ (3.75-3.85)		
Leukocytes/cu mm (x103)	5	10.7 $\pm$ 2.4 (7.2-13.0)	5	19.9 $\pm$ 14.6 (2.8-41.6)	6	12.6 $\pm$ 4.5 (8.1-19.1)	3	9.9 $\pm$ 3.2 (7.3-13.5)	1	12.70	2	7.0 $\pm$ 2.8 (5.0-8.9)		
Packed cell volume (%)	8	39.3 $\pm$ 5.7 (29-47)	4	47.5 $\pm$ 3.0 (44-50)	6	40.5 $\pm$ 4.9 (31-44)	4	47.8 $\pm$ 2.6 (44-50)	1	40.0	2	36.5 $\pm$ 0.7 $\pm$ (36-37)		
Hemoglobin (g/100 ml)	1	13.7	5	13.7 $\pm$ 0.79 (12.5-14.4)	6	12.4 $\pm$ 1.7 (9.0-13.7)	3	14.0 $\pm$ 0.5 (13.5-14.4)	1	12.2	2	11.5 $\pm$ 0.1 $\pm$ (11.4-11.5)		
Neutrophils (%)	4	62.8 $\pm$ 9.3 (52-71)	0		4	38.8 $\pm$ 8.4 (27-47)	1	34.0	0		1	73.0		
Lymphocytes (%)	4	34.8 $\pm$ 8.1 (28-44)	0		4	59.7 $\pm$ 8.4 $\pm$ (51-71)	1	63.0	0		1	26.0		
Monocytes (%)	4	1.0 $\pm$ 0.8 (0-2)	0		4	1.0 $\pm$ 0.8 (0-2)	1	2.0	0		1	1.0		
Eosinophils (%)	4	1.0 $\pm$ 0	0		4	0.5 $\pm$ 0.6 (0-1)	1	1.0	0		1	0.0		
Basophils (%)	4	0.5 $\pm$ 1.0 (0-2)	0		4	0.0	1	0.0	0		1	0.0		
MCV (ccl)	5	98.9 $\pm$ 1.7 (97.3-101.1)	4	98.6 $\pm$ 3.3 (94.0-101.0)	6	97.0 $\pm$ 2.4 (95.2-101.6)	3	101.0 $\pm$ 5.0 (98.0-106.8)	1	96.4	2	96.1 $\pm$ 0.1 (96.0-96.1)		
MCH ( $\mu$ g)	1	29.5	5	29.2 $\pm$ 0.3 (28.9-29.7)	6	29.6 $\pm$ 0.4 (29.1-30.0)	3	29.0 $\pm$ 0.2 (28.8-29.2)	1	29.4	2	30.1 $\pm$ 0.4 (29.9-30.4)		
MCHC (%)	1	29.1	4	29.6 $\pm$ 1.3 (28.8-31.6)	6	30.5 $\pm$ 0.8 (29.0-31.2)	3	28.7 $\pm$ 1.5 (27.0-29.8)	1	30.5	2	31.4 $\pm$ 0.4 (31.1-31.7)		

Arr: Arrival at laboratory

Main: Maintained at laboratory

No: Number of determinations

Mean  $\pm$  SD\*: Mean values  $\pm$  standard deviation; minimal-maximal limits are shown in parentheses

†: Differs from corresponding value for arrival,  $P < 0.01$



25 (Ralston Purina Company, St. Louis, Mo.) was substituted for the cooked food.

Initially, howler monkeys died soon after arrival at the laboratory in spite of a variety of dietary, medicinal, and management regimens. Finally, efforts to provide a satisfactory substitute for their natural diet were abandoned. Among foods consumed by Panamanian howler monkeys in their natural state are the leaves and, in season, the fruits of the trumpet tree, *Cecropia mexicana*, the almond tree, *Terminalia catappa*, and the mango tree, *Mangifera indica*. Since these foods were provided to the monkeys, they have survived for lengthy period. Reported maintenance values were collected after the feeding of natural foods was started.

A problem initially encountered in spider monkeys was anemia due to pediculosis. The lack of a pollex hinders their grooming. Chlorinated hydrocarbons and organophosphates were forbidden at the laboratory because of insectary operations. Originally, spider monkeys were dipped in pine oil baths only when it was believed lousiness required treatment. In 1968, because the original regimen proved inadequate, weekly dippings in pine oil baths were instituted.

## RESULTS AND DISCUSSION

Table 1 shows higher mean values for erythrocyte counts, packed cell volume percentages, and hemoglobin determinations for both immature female and male black spider monkeys maintained in the laboratory in 1968 over the arrival group and the group maintained in 1967. The increased values may reflect either an improved louse control program or a change in diet, or both. Table 1 also shows an increase in leukocyte count for females and males for the maintained groups over the arrival groups. This is reflected in a numerical increase in both neutrophils and lymphocytes. Percentages for neutrophils indicate a numerical decrease for the 1968 group, quite the opposite of what

actually occurs. The increased leukocyte count may reflect an exposure to a more variable microbial population in the laboratory than encountered previously.

Table 2 gives hematologic data from red spider monkeys. Because of the limited number of determinations, no discussion will be given.

Table 3 gives determination from immature white face monkeys. As with black spider monkeys, an increase in leukocytes occurs in the maintained groups. The males show a decrease in erythrocyte counts, packed cell volume percentages, and hemoglobin determinations in the 1967 maintained group compared to the arrival group. This is followed by an increase in values for the 1968 group. This could reflect the change in diet. The same pattern is not seen with the females, but this apparent discrepancy may be due to an inadequate sampling of the female population.

Table 4 gives determinations from adult white face monkeys. Because of the few determinations from most groups, only the male group maintained in 1968 will be mentioned. This group shows significant differences from the 1968 immature male group listed in Table 3 in the mean values for erythrocyte counts, packed cell volume percentages, and hemoglobin determinations. Whether these differences are due to the immature monkeys being weaned too early, to their being unable or unwilling to obtain adequate food when confined with adults, to natural differences, or to some other reason is unknown.

Tables 5 and 6 present data obtained from black howler monkeys. Because of the few monkeys in the maintained groups, no discussions will be made.

The generally low hemoglobin values relative to the packed cell volume percentages may have been influenced by the method of hemoglobin determination. As noted in the previous publication that described the methodology (2), hemoglobin values were determined by the Sahli colorimetric method. This method, because of time, light

TABLE 3

Hematologic determinations from immature *Cebus capucinus* at Gorgas Memorial Laboratory

Determination	Males										
	Females					Males					
	Arr No	(1966-68) Mean $\pm$ SD*	Main No	(1967) Mean $\pm$ SD*	(1968) Mean $\pm$ SD*	Arr No	(1966-68) Mean $\pm$ SD*	Main No	(1967) Mean $\pm$ SD*	(1968) Mean $\pm$ SD*	
Erythrocytes/cu mm ( $\times 10^6$ )	7	4.25 $\pm$ 0.91 (2.58-5.34)	6	4.14 $\pm$ 0.69 (3.21-4.69)	4.03 $\pm$ 0.18 (3.85-4.30)	6	4.42 $\pm$ 0.61 (3.67-5.10)	15	3.75 $\pm$ 0.46 <sup>+</sup> (2.65-4.33)	23	4.10 $\pm$ 0.52 (3.15-4.90)
Leukocytes/cu mm ( $\times 10^3$ )	6	7.8 $\pm$ 2.1 (5.5-11.5)	6	10.5 $\pm$ 1.4 (9.0-13.0)	14.0 $\pm$ 2.74 <sup>+</sup> (10.6-16.5)	6	9.2 $\pm$ 4.1 (4.5-15.0)	15	19.5 $\pm$ 8.4 (10.5-34.0)	23	15.1 $\pm$ 6.0 (7.4-25.2)
Packed cell volume (%)	12	40.8 $\pm$ 5.6 (27-48)	6	40.6 $\pm$ 6.1 (32-46)	38.6 $\pm$ 1.5 (37-41)	8	37.5 $\pm$ 7.0 (26-42)	11	36.7 $\pm$ 3.5 (31-43)	22	39.3 $\pm$ 4.6 (30-48)
Hemoglobin (g/100 ml)	6	12.1 $\pm$ 2.2 (8.5-14.5)	3	10.6 $\pm$ 1.4 (9.5-12.2)	12.2 $\pm$ 0.8 (11.5-13.2)	4	13.1 $\pm$ 1.2 (11.5-14.3)	9	11.3 $\pm$ 0.5 <sup>+</sup> (8.0-13.0)	23	12.0 $\pm$ 1.8 (8.5-14.8)
Neutrophils (%)	3	57.7 $\pm$ 5.9 (51-62)	0		56.3 $\pm$ 10.1 (50-68)	4	55.8 $\pm$ 15.6 (43-78)	0		19	56.7 $\pm$ 11.6 (25-75)
Lymphocytes (%)	3	40.6 $\pm$ 6.4 (36-48)	0		42.3 $\pm$ 10.7 (30-49)	4	41.8 $\pm$ 17.2 (19-57)	0		19	39.5 $\pm$ 10.7 (23-64)
Monocytes (%)	3	0.3 $\pm$ 0.4 (0-1)	0		1.3 $\pm$ 0.6 (1-2)	4	0.8 $\pm$ 1.0 (0-3)	0		19	2.1 $\pm$ 1.1 (0-4)
Eosinophils (%)	3	0.0	0		0.0	4	1.3 $\pm$ 2.5 (0-5)	0		19	2.3 $\pm$ 2.3 (0-8)
Basophils (%)	3	1.3 $\pm$ 2.3 (0-4)	0		0.0	4	0.5 $\pm$ 1.0 (0-2)	0		19	0.0
MCV (c $\mu$ )	7	91.4 $\pm$ 15.5 (66.5-110.5)	6	98.6 $\pm$ 2.3 (96.0-102.6)	96.8 $\pm$ 1.3 (93.8-97.4)	4	98.6 $\pm$ 1.9 (96.1-100.8)	11	96.8 $\pm$ 2.5 (91.7-100.2)	22	95.9 $\pm$ 1.8 (93.2-101.4)
MCH ( $\mu$ g)	8	28.8 $\pm$ 2.1 (26.2-32.9)	3	29.7 $\pm$ 0.1 (29.6-29.8)	30.4 $\pm$ 1.5 (29.7-32.6)	4	28.1 $\pm$ 1.8 (25.5-29.3)	9	29.6 $\pm$ 0.8 (27.7-30.2)	23	29.2 $\pm$ 2.3 (22.7-34.0)
MCHC (%)	7	32.2 $\pm$ 4.4 (27.4-40.9)	3	29.7 $\pm$ 0.8 (28.9-30.5)	31.7 $\pm$ 1.3 (30.5-33.9)	2	30.0 $\pm$ 0.6 (29.6-30.4)	6	30.7 $\pm$ 0.8 (30.0-32.3)	22	30.5 $\pm$ 2.4 (24.3-35.9)

Arr: Arrival at laboratory

Main: Maintained at laboratory

No: Number of determinations

Mean  $\pm$  SD\*: Mean values  $\pm$  standard deviation; minimal-maximal limits are shown in parentheses+: Differs from corresponding value for arrival,  $P < 0.01$



TABLE 4

*Hematologic determinations from mature Cebus capucinus at Gorgas Memorial Laboratory*

Determination	Females				Males			
	Arr No	(1966-68) Mean $\pm$ SD*	Main No	(1968) Mean $\pm$ SD* (minimal-maximal limits)	Main No	(1967) Mean $\pm$ SD* (minimal-maximal limits)	Main No	(1968) Mean $\pm$ SD*
Erythrocytes/cu mm ( $\times 10^6$ )	1	4.90	4	4.61 $\pm$ 0.12 (4.50-4.77)	5	4.63 $\pm$ 0.16 (4.48-4.86)	14	4.92 $\pm$ 0.72 (4.15-6.68)
Leukocytes/cu mm ( $\times 10^3$ )	1	7.5	4	14.5 $\pm$ 5.3 (8.8-21.0)	5	23.5 $\pm$ 5.2 (15.7-30.0)	14	16.0 $\pm$ 8.4 (6.3-34.3)
Packed cell volume (%)	1	49.0	4	43.8 $\pm$ 1.3 (42-45)	5	44.8 $\pm$ 1.3 (44-47)	14	47.0 $\pm$ 6.7 (40-63)
Hemoglobin (g/100 ml)	1	14.5	4	13.4 $\pm$ 0.6 (12.5-14.0)	5	13.5 $\pm$ 0.5 (13.0-14.1)	14	14.4 $\pm$ 1.8 (12.4-19.8)
Neutrophils (%)	0		4	50.0 $\pm$ 6.7 (41-57)	0		11	55.6 $\pm$ 6.6 (47-70)
Lymphocytes (%)	0		4	47.5 $\pm$ 6.4 (43-55)	0		11	40.9 $\pm$ 6.7 (25-50)
Monocytes (%)	0		4	1.3 $\pm$ 0.6 (0-2)	0		11	1.8 $\pm$ 1.1 (0-4)
Eosinophils (%)	0		4	1.3 $\pm$ 0.6 (0-2)	0		11	1.6 $\pm$ 2.2 (0-5)
Basophils (%)	0		4	0.0	0		11	0.0
MCH ( $\mu$ g)	1	100.0	4	95.0 $\pm$ 2.3 (92.3-97.8)	5	96.9 $\pm$ 3.6 (90.5-99.4)	14	96.7 $\pm$ 1.8 (92.5-99.0)
MCH ( $\mu$ g)	1	29.6	4	29.0 $\pm$ 1.0 (27.5-29.8)	5	29.3 $\pm$ 0.5 (28.8-29.8)	14	29.7 $\pm$ 1.7 (26.6-34.3)
MCHC (%)	1	29.6	4	30.5 $\pm$ 0.6 (29.8-31.1)	5	30.2 $\pm$ 1.0 (29.3-31.8)	14	30.9 $\pm$ 2.2 (27.2-36.1)

Arr: Arrival at laboratory

Main: Maintained at laboratory

No.: Number of determinations

Mean  $\pm$  SD\*: Mean values  $\pm$  standard deviation; minimal-maximal limits are shown in parentheses

source, and human interpretive variables, leads to as much as a 10% error from the true mean. This could result in low hemoglobin values. In addition, because the hemoglobin values are used as the numerator in determining the mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) values, the MCH and MCHC values may also be low.

## REFERENCES

1. Kourany M, Porter JA Jr: A survey for enteropathogenic bacteria in Panamanian primates. *Lab Anim Care* 19: 336-341, 1969
2. Porter JA Jr: Hematology of the night monkey, *Aotus trivirgatus*. *Lab Anim Care* 19: 470-472, 1969
3. Porter JA Jr: Hematologic values of the Panamanian marmoset (*Saguinus Geoffroyi*). *Am J Vet Res* 31: 379-381, 1970
4. Porter JA Jr, Young MD: Susceptibility of Pana-

TABLE 5

*Hematological determinations from immature Alouatta villosa at Gorgas Memorial Laboratory*

Determination	Females				Males			
	Arr No	(1966-68) Mean $\pm$ SD* ( )	Main No	(1968) Mean $\pm$ SD* ( )	Arr No	(1966-68) Mean $\pm$ SD* ( )	Main No	(1968) Mean $\pm$ SD* ( )
Erythrocytes/cu mm ( $\times 10^6$ )	33	3.92 $\pm$ 0.68 (2.68-5.90)	4	4.37 $\pm$ 0.66 (3.75-5.03)	12	3.54 $\pm$ 0.81 (1.80-4.79)	5	4.45 $\pm$ 0.39 (4.14-5.07)
Leukocytes/cu mm ( $\times 10^3$ )	33	11.9 $\pm$ 5.5 (3.9-29.4)	4	13.2 $\pm$ 2.7 (10.4-16.5)	12	9.8 $\pm$ 2.9 (3.2-14.0)	5	13.7 $\pm$ 4.9 (8.2-20.4)
Packed cell volume (%)	25	36.8 $\pm$ 6.7 (20-48)	3	43.3 $\pm$ 6.7 (36-49)	10	35.0 $\pm$ 3.8 (29-40)	5	43.0 $\pm$ 4.6+ (39-51)
Hemoglobin (g/100 ml)	25	11.7 $\pm$ 1.8 (8.0-15.5)	4	12.9 $\pm$ 2.4 (11.4-14.5)	9	10.8 $\pm$ 2.3 (5.5-13.8)	5	13.1 $\pm$ 1.0 (12.3-14.7)
Neutrophils (%)	7	63.0 $\pm$ 18.9 (39-86)	3	67.3 $\pm$ 14.6 (57-84)	1	71.0	5	58.4 $\pm$ 8.9 (43-65)
Lymphocytes (%)	7	34.5 $\pm$ 19.3 (14-62)	3	30.3 $\pm$ 14.2 (14-40)	1	28.0	5	38.4 $\pm$ 8.4 (32-53)
Monocytes (%)	7	1.8 $\pm$ 1.3 (0-4)	3	2.0 $\pm$ 0.0	1	1.0	5	1.6 $\pm$ 1.3 (0-4)
Eosinophils (%)	7	0.1 $\pm$ 0.4 (0-1)	3	0.3 $\pm$ 0.5 (0-1)	1	0.0	5	1.6 $\pm$ 1.4 (0-4)
Basophils (%)	7	0.4 $\pm$ 0.5 (0-1)	3	0.0	1	0.0	5	0.0
MCV ( $\mu$ m)	25	97.7 $\pm$ 12.7 (55.7-123.1)	3	95.4 $\pm$ 2.4 (92.7-97.4)	8	111.0 $\pm$ 37.4 (80.9-200.0)	5	96.6 $\pm$ 3.8 (91.6-100.6)
MCH ( $\mu$ g)	25	29.7 $\pm$ 1.4 (26.3-33.6)	4	29.7 $\pm$ 0.7 (28.8-30.4)	9	28.2 $\pm$ 2.5 (22.3-30.6)	5	29.5 $\pm$ 0.3 (29.0-29.7)
MCHC (%)	21	31.4 $\pm$ 5.5 (25.6-52.5)	3	31.0 $\pm$ 1.2 (29.6-31.8)	6	27.0 $\pm$ 6.5 (15.3-33.3)	5	30.5 $\pm$ 1.4 (28.8-32.1)

Arr: Arrival at laboratory

Main: Maintained at laboratory

No.: Number of determinations

Mean  $\pm$  SD\*: Mean values  $\pm$  standard deviation; minimal-maximal limits are shown in parentheses

+: Differs from corresponding value for arrival; P &lt; 0.01

TABLE 6

*Hematologic determinations from mature Alouatta villosa at Gorgas Memorial Laboratory*

Determination	Females				Males			
	Arr No	(1966-67) Mean $\pm$ SD* (3.10-4.84)	Main No	(1968) Mean $\pm$ SD* (3.15-4.85)	Arr No	(1967) Mean $\pm$ SD* 4.05	Main No	(1968) Mean $\pm$ SD* (2.89-4.65)
Erythrocytes/cu mm ( $\times 10^6$ )	5	4.13 $\pm$ 0.68 (3.10-4.84)	5	3.76 $\pm$ 0.69 (3.15-4.85)	1	4.05	3	3.90 $\pm$ 0.91 (2.89-4.65)
Leukocytes/cu mm ( $\times 10^3$ )	5	9.6 $\pm$ 2.7 (7.1-13.1)	5	13.2 $\pm$ 5.0 (7.7-19.4)	1	15.2	3	15.7 $\pm$ 7.9 (7.2-22.9)
Packed cell volume (%)	4	36.2 $\pm$ 3.7 (32-41)	6	37.0 $\pm$ 5.8 (30-47)	0	0.0	3	37.3 $\pm$ 7.6 (29-44)
Hemoglobin (g/100 ml)	5	12.1 $\pm$ 1.6 (9.5-13.6)	5	11.2 $\pm$ 1.7 (9.5-14.4)	1	12.0	3	11.6 $\pm$ 2.7 (8.6-13.8)
Neutrophils (%)	3	77.7 $\pm$ 5.5 (74-84)	4	60.3 $\pm$ 6.4 (52-67)	0	0.0	3	59.0 $\pm$ 7.0 (51-64)
Lymphocytes (%)	3	18.0 $\pm$ 5.6 (13-24)	4	37.3 $\pm$ 6.1 (31-45)	0	0.0	3	38.7 $\pm$ 9.1 (32-49)
Monocytes (%)	3	2.0 $\pm$ 3.5 (0-6)	4	2.3 $\pm$ 1.0 (1-3)	0	0.0	3	1.3 $\pm$ 1.2 (0-3)
Eosinophils (%)	3	1.7 $\pm$ 0.6 (1-2)	4	0.3 $\pm$ 0.5 (0-1)	0	0.0	3	1.0 $\pm$ 0.7 (0-2)
Basophils (%)	3	0.7 $\pm$ 1.2 (0-2)	4	0.0	0	0.0	3	0.0
MCV ( $\mu$ m)	4	92.5 $\pm$ 7.9 (84.1-103.2)	5	97.6 $\pm$ 5.3 (92.5-106.5)	0	0.0	3	96.3 $\pm$ 3.5 (94.0-100.4)
MCH ( $\mu$ g)	5	29.3 $\pm$ 1.0 (18.2-34.2)	5	29.8 $\pm$ 0.9 (28.2-30.5)	1	29.6	3	29.8 $\pm$ 0.0 (29.7-29.9)
MCHC (%)	4	28.7 $\pm$ 7.2 (28.1-30.6)	5	30.5 $\pm$ 1.7 (28.6-32.7)	0	0.0	3	30.9 $\pm$ 1.1 (29.7-31.8)

Arr: Arrival at laboratory

Main: Maintained at laboratory

No: Number of determinations

Mean  $\pm$  SD\*: Mean values  $\pm$  standard deviation; minimal-maximal limits are shown in parentheses