

## PROGRESS IN THE SURVEY FOR BLOOD PARASITES OF THE WILD MONKEYS OF PANAMA

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A brief report (1) on this subject was published some months ago. It was confined largely to three species of monkeys captured in the province of Chiriqui, Republic of Panama in the month of July, 1929. Since that time it has been possible to revisit that general region. The camp was located this time on the Rio La Vaca in the area known as the Coto. It is a large uninhabited area that contains abundant animal life. This expedition was made in the dry season (February) 1930. Another expedition was recently made (August, 1930) to the mid-basin of the Tuira river in the province of Darien. One of our objectives on this trip was to secure some specimens of *Ateles dariensis* Goldman. We were not successful in securing this species for they have been either killed off by the indians for food or frightened into more remote parts of the river basin. It will be necessary to make a more extended trip into the headwaters of the basin during the dry season. It is impossible to find any part of this river basin totally uninhabited since it is a fertile area with many scattered indian villages. In order to take the black spider monkey in a region reasonably free of human habitations we will be forced to hunt the mountain boundary line between the Tuira river of Panama and the Atrato river of Columbia.

During the year a certain number of local monkeys have been purchased from hunters who have held the animals in captivity from a few days to a few months, the time necessary to bring them to Panama city and to find a sale for them.

This report will consolidate the results of our three expeditions in which wild monkeys were killed or caught and examined in the camp. These animals were as remote from native and indian

villages (human contact) as it is possible to be in this era of the Republic of Panama.

A second part of the report will consist of the findings in purchased captive wild monkeys, in other words, monkeys that have lived a brief period of time in captivity in some rural village and later in Panama city. Our studies on the two groups of monkeys thus permits a report on one or more specimens from eight species of local monkeys. Goldman (2) considers these the chief species or subspecies found in Panama with the exception of a subspecies of the Chiriqui titi and the Coiba island howling monkey.

The monkeys are listed according to Goldman (2) as follows:

1. *Saimiri orstedii orstedii* (Reinhardt). The titi monkey of Chiriqui, Panama.
2. *Aotus zonalis* Goldman. The night monkey of eastern Panama.
3. *Leontocebus geoffroyi* (Pucheran). Squirrel monkey or mono titi.
4. *Alouatta palliata inconsonans* Goldman. Panama howling monkey, mono negro.
5. *Cebus capucinus capucinus* (Linnaeus). Colombian white-throated capuchin.
6. *Cebus capucinus imitator* Thomas. Panama white-throated capuchin.
7. *Ateles geoffroyi* Kuhl. Geoffroy's spider monkey, mono colorado. Red spider monkey.
8. *Ateles dariensis* Goldman. Darien black spider monkey.

#### METHODS OF EXAMINATION

Blood films and crushed tissue films were prepared and stained in the camp. The thick-blood-films were thoroughly dried and then laked and stained in an aqueous solution of Giemsa's stain for a period of one hour using 1 cc. of stock solution of Giemsa's stain to 30 cc. of water that had a reaction closely approximating that of fresh rain water or fresh distilled water. Wright's stain was used on the other films and then counterstained with Giemsa if the animal had been dead for more than an hour or two. These prepared slides from autopsied monkeys and blood films from the few we could capture in an unharmed condition were brought

back to Panama for detailed microscopic examination. Eight infant and juvenile monkeys were brought back for laboratory observation. The results are tabulated by species.

*Saimiri örstedii örstedii* (Reinhardt), (table 1)

The adults of this species average about 2 pounds but ranged from  $1\frac{1}{2}$  to  $2\frac{1}{4}$  pounds in body weight. They showed the presence of microfilaria in 83.3 per cent yet in no instance could adult

TABLE 1

*Saimiri örstedii örstedii* (Reinhardt). The titi monkey of Chiriqui province.  
Examined in the wild state

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
Infants.....	1	0	0	0	0
Juveniles.....	3	0	0	1	0
Adults.....	56	0	16	52	0
Total.....	60	0	16	53	0

TABLE 2

*Aotus zonalis* Goldman. The night monkey of Panama  
(Captive wild animals)

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
Infants.....	0	0	0	0	0
Juveniles.....	0	0	0	0	0
Adults.....	4	0	1	1	0
Total.....	4	0	1	1	0

filaria be found in any of the serous cavities. Trypanosomes were present in 26.6 per cent. Malaria was not found in any of the 60 specimens nor was the spleen pigmented or enlarged. The spleen in this species weighs about 1 gram for every pound of body weight.

*Aotus zonalis* Goldman, (table 2)

These appear to be young adults. They range in weight from 530 to 565 grams. They weigh less than their appearance indi-

cates. The spleen weight average on three of these monkeys was 1.3 grams. The ratio of this weight to the body weight is, therefore, about the same as in the Chiriqui titi. No malarial pigment found in the three examined at autopsy.

*Leontocebus geoffroyi* (Pucheran), (table 3)

The adults of this species weigh from 1 to 1½ pounds. Spleens weigh from 1 to 2 grams and never have shown pigment suggestive of malaria. The species reveals about the same rate

TABLE 3  
*Leontocebus geoffroyi* (Pucheran). Squirrel monkey or mono titi

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
(Tuira River wild animals)					
Infants.....	0	0	0	0	0
Juveniles.....	1	0	1	1	0
Adults.....	21	0	18	18	2
Total.....	22	0	19	19	2
(Captive wild animals)					
Infants.....	5	0	1	0	0
Juveniles.....	14	0	1	2	1
Adults.....	9	0	6	7	0
Total.....	28	0	8	9	1

for filariasis and trypanosomiasis as other monkeys. No adult filarial worms were found in the serous cavities.

It shows a marked variation from all the other species in its ability to act as a host for spirochetes. Two wild monkeys and one captive wild monkey showed a spirochete resembling *Treponema recurrentis* Lebert (3).

*Alouatta palliata inconsonans* Goldman, (table 4)

Adults of this species range from 16 to 19¼ pounds. The spleen weight in the animal weighing 19¼ pounds, an old male, was 48 grams or about 2.5 grams of spleen weight to 1 pound of

body weight. The spleen was pigmented and revealed some malarial parasites. No adult filarial worms were found in the serous cavities.

TABLE 4

*Alouatta palliata inconnans* Goldman. Panama howling monkey, mono negro

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
(Chiriqui and Darien wild animals)					
Infants.....	0	0	0	0	0
Juveniles.....	0	0	0	0	0
Adults.....	6	1	5	0	0
Total.....	6	1	5	0	0
(Captive wild animals—locality unknown)					
Infant.....	1	0	0	0	0
Juvenile.....	1	1	0	0	0
Adult.....	0	0	0	0	0
Total.....	2	1	0	0	0

TABLE 5

*Cebus capucinus capucinus* (Linnaeus). The Columbian white-throated capuchin, commonly known as white faced monkey

(Chargres and Tuira Rivers wild animals)

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
Infants.....	1	0	1	0	0
Juveniles.....	2	1	1	0	0
Adults.....	8	0	1	5	0
Total.....	11	1	3	5	0

*Cebus capucinus capucinus* (Linnaeus), (table 5)

These adults range from 5½ to 8½ pounds. These spleens weigh 10 to 14 grams or about 2 grams to each pound of body weight.

Many adult filarial worms are found in the abdominal cavity and infrequently in the pleural, pericardial and scrotal sacs. The splenic pulp not infrequently shows pigmentation.

*Cebus capucinus imitatur*, (table 6)

The body weight for adults averages 5 to 6 pounds while the spleen weight average is about 10 to 12 grams or 2 grams to 1 pound of body weight.

TABLE 6

*Cebus capucinus imitatur*, white throated capuchin of Chiriqui, commonly known, also, as white faced monkey

(La Vacca and Rio Blanco Rivers)

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
Infant.....	1	0	1	0	0
Juvenile.....	5	5	2	0	0
Adult.....	32	1	15	32	0
Total.....	38	6	18	32	0

TABLE 7

AGE	NUMBER EXAMINED	MALARIA PARASITES	TRYPANOSOMES	MICROFILARIA	SPIROCHETES
Cebus monkeys. (Captive wild monkeys—locality unknown)					
Infants.....	3	0	1	0	0
Juveniles.....	3	2	1	1	0
Adults.....	0	0	0	0	0
Total.....	6	2	2	1	0

*Ateles geoffroyi* Kuhl. Geoffroy's spider monkey, mono colorado. Red spider monkey. Wild animals—La Vacca and Blanco Rivers, Chiriqui)

Infants.....	8	8	0	0	0
Juveniles.....	6	6	1	2	0
Adults.....	52	11	6	54	0
Total.....	66	25	7	56	0

All adults had filarial worms in peritoneal cavity and sometimes in other serous cavities. Many animals, young ones in particular, show pigmentation of the spleen.

*Cebus monkeys*, (table 7)

The adult weight ranged from 11 to 21 pounds, the average being 16 to 17 pounds. The spleen ratio in infant and juveniles

was about 10 grams to 1 pound of body weight and about 2 or 3 grams to the pound in old adults. Splenic enlargement associated with pigmentation was very common. A vast number of adult filarial worms were found in the peritoneal cavity of this species in adult animals but seldom found in juveniles and not at all in infants. These parasites were occasionally found in the other serous cavities.

TABLE 8

SPECIES OF MONKEY	NUMBER EXAMINED	POSITIVE MALARIA	POSITIVE TRYPANOSOMES	POSITIVE MICROFILARIA	POSITIVE SPIROCHETES
<i>Saimiri orstedii orstedii</i> (Reinhardt). (The Chiriqui titi monkey).....	60	0	16	53	0
<i>Aotus zonalis</i> Goldman. (The night monkey).....	4	0	1	1	0
<i>Leontocebus geoffroyi</i> (Pucheran). (Squirrel monkey-mono titi).....	50	0	27	28	3
<i>Alouatta palliata inconsonans</i> Goldman. (Panama Howling monkey. Mono negro).....	8	2	5	0	0
<i>Cebus capucinus capucinus</i> (Linnaeus) and <i>C. c. imitator</i> . White throated monkey.....	55	9	23	38	0
<i>Ateles geoffroyi</i> , Kuhl. Red spider monkey. Mono colorado.....	75	34	8	56	0
<i>Ateles dariensis</i> Goldman. Darien black spider monkey*.....	1	1	0	0	0
Total.....	253	46	80	176	3

\* This animal was given its malaria by direct inoculation of blood from a red spider monkey that had malaria.

In addition to these animals there were 6 juvenile and 1 infant red spider monkey brought back alive and in good condition. All of them were positive for malaria and one juvenile showed a few trypanosomes. We have purchased two juvenile red spider monkeys in Panama city that came from Chiriqui and these also are positive for malaria.

*Ateles dariensis* Goldman. The Darien black spider monkey. No capture and examination in the jungle has yet been made by us but we

have purchased one juvenile that was negative for all blood parasites although it died of malaria in forty-eight days after being inoculated with malarial blood from a red spider monkey. Its body weight was 5½ pounds and the spleen weighed 19 grams, or 3.4 grams of spleen to 1 pound of body weight.

A composite table of all monkeys whether examined in the wild state or conducted on purchased animals recently made captives is given (table 8).

The gross and microscopic pathology, intestinal parasites, etc. can not be detailed in this report. It may be stated, however, that malaria, filariasis and spirochetosis play important rôles in certain species and that the trypanosomes apparently cause little or no harm to the monkeys nor to guinea pigs and *M. rhesus* monkeys when injected into them.

#### SUMMARY

1. During the past eighteen months 210 native wild monkeys and 43 native captive monkeys have been examined for parasites of the blood stream. The only difference the two groups show is a decrease in the intensity of the infections in most of the captive animals rather than any difference in parasite species.

2. *Monkey malaria.* The present state of our knowledge indicates that many infant monkeys of the prehensile tail species, especially the *Ateles* and *Cebus* species, die of this disease. We have observed four such deaths. Those that survive this period are moderately good carriers of the disease through the juvenile period of life. During adult life other diseases and particularly late stage pregnancy seem to provoke a recrudescence in some animals. In these species of monkeys the spleen weight shows a ratio of 2.5 to 4 grams to each pound of body weight while in those species in which malaria was not found the spleen rate was 1 gram to each pound of body weight. Malarial pigmentation of the spleen is common in the prehensile tailed species and not yet found by us in the other species. The malarial parasites found closely resemble human quartan and tertian malaria. Nothing that resembles *P. falciparum* has been found here.

3. *Monkey trypanosomiasis*. All species thus far examined by us show this parasite except *Ateles dariensis*. We have seen but one specimen of this monkey, a juvenile raised in captivity. Adults examined in the wild state will almost certainly show some individuals harboring this parasite. The infection appears to offer little injury to the animals and does not take in the ordinary laboratory animals into which it has been inoculated. Morphological studies will be reported at a later date.

4. *Monkey filariasis*. This is an important monkey disease, particularly in the *Cebus* and *Ateles* species. We have not yet examined a satisfactory number of the howling monkeys (*Alouatta palliata inconsonans* Goldman). There is a marked proliferative peritonitis present and in some cases a sero-purulent fluid is found. Vast numbers of adult-parasites are found in the omentum and also free in the cavity. Omental adhesions are common and occasionally pleural and pericardial adhesions also are present. Further studies are in progress and a report pending.

Filariasis in the titi species and the night monkey are of a different order. No adult parasites have been found by us in the cavities of the two titi monkeys although their blood films are positive in almost every case.

5. Malaria is a disease of infant and juvenile life while trypanosomiasis and filariasis are chiefly noted among the adults.

6. *Monkey spirochetosis*. This has not been found spontaneously in any but the titi monkey commonly known as the squirrel monkey *Leontocebus geoffroyi* (Pucheran). It is fatal in most instances to infant and juvenile members of this species in captivity while an adult recovers spontaneously in a very few days. The rate of demonstrable infection in the wild is very low for adults. We have not been able to examine enough juveniles and infants in the wild to learn the incidence in them.

7. Our chief interest surrounds the possibilities of transfers of these infections to man or domestic animals and our efforts have been used in this direction rather than to complete the protozoological and pathological studies or to enter the equally interesting study of the parasites to be found in the alimentary tract.

The old monkeys (in the wild) have much of interest in diseases of bones and joints and the genito-urinary system.

8. *Ectoparasites*. These are found but with great difficulty on the animal, although we have seen one severe louse infestation in the *Atelzs* species. It is our belief that the ticks, lice and fleas common to these monkeys are more apt to be found at night while the animal is at rest in its favorite shelter. This of course confronts one with some major problems in observation yet it may be possible to study the dens of night monkeys, *Aotus zonalis* Goldman, since their habits are quite similar to those of squirrels.

Mosquito studies are in progress in relation to monkey malaria, and tick observations are under way in regard to possible transfers of the monkey spirochete.

#### REFERENCES

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