

A PRELIMINARY REPORT ON SOME PARASITES IN THE BLOOD OF WILD MONKEYS OF PANAMA

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The recent works of Wenyon (1), Hegner (2) and others have collected the records concerning the parasites of monkeys in a very concise manner. A large part of these records refer to monkeys belonging to the eastern hemisphere, chiefly Africa and Borneo. Gonder and Gossler (3) in 1908 described *Plasmodium brasilianum* in a monkey (*Brachyurus calvus*) which had been imported to Hamburg from the Amazon district of South America. Seidelin (4) in 1912 described a parasite, probably a plasmodium, in a monkey (*Ateles* sp.) of Yucatan. These reports stimulated my interest in the parasites of monkeys. My field observations have been largely confined to a search for plasmodia in local species of monkeys that were not living in captivity. I found a quartan-like plasmodium in a wild monkey (5) (*Cebus capucinus capucinus*) that was captured in an uninhabited part of the Chagres river basin (Rio Boqueron) in February, 1917. The same monkey revealed a trypanosome of large size. No descriptive record was made of these parasites at that time and two subsequent trips to the same area failed to acquire any further evidence of these infections.

During the month of July, 1929, an opportunity presented itself to make a survey of some wild monkeys in an uninhabited region of Panama during the early part of the "rainy season." Our party interested itself in a number of problems but this report will be confined to a preliminary statement of the parasites of the blood stream.

LOCATION OF THE SURVEY

Our camp was located at approximately 8° 24' 30" North Latitude and 82° 55' 00" West Longitude and at a point, in

an air line, 7.5 miles from the Pacific coast. The elevation of the camp site was 75.5 feet and the area surveyed was more or less a flat coastal plain.

All of the monkeys captured were taken from July 11 to July 23 inclusive except for one specimen of white face monkey and four howling monkeys which were taken about a mile from the coast a day or two later. Table 1 will show the meteorological

TABLE 1
Meteorological record

DATE	TEMPERATURE			RELATIVE HUMIDITY				RAIN	TIME OF RAIN	HOURS OF SUNSHINE
	Maximum	Minimum	Mean	7 a.m.	1 p.m.	5 p.m.	Mean			
								<i>inches</i>		
July 11	88	71	79	97	88	94	93	0.28	4 p.m.	4.5
July 12	90	73	82	97	80	96	91	0.27	4 p.m.	1.5
July 13	91	70	81	97	83	88	89	0.10	9 p.m.	2.0
July 14	89	72	81	98	78	94	90	0.09	8 p.m.	1.7
July 15	89	70	80	99	63	85	82			5.5
July 16	91	72	82	99	72	79	83			
July 17	90	69	80	99	68	95	87	0.02	7 p.m.	5.3
July 18	91	71	81	99	73	97	90	0.27	5 p.m.	6.4
July 19	90	70	80.0	99	78	96	91.1	0.88	5 p.m.	6.1
July 20	90	68	79.0	97	65	82	81.3	0.17	5 p.m.	3.8
July 21	90	69	79.5	98	70	78	82.0	0.01	4 p.m.	6.4
July 22	90	71	80.5	99	72	90	87.0	0.05	8 p.m.	6.9
July 23	88	72	80.0	99	91	87	92.3	0.16	12 m.d.	0.0
July 24	88	72	80.0	100	74	74	82.7			4.3
July 25	89	72	80.5	100	80	85	88.3	0.01	5 p.m.	1.5

report from a pioneer station of the Chiriqui Land Company a half day's walk to the south of our camp.

METHOD OF EXAMINATION

a. It was only possible to prepare ante mortem blood films from two monkeys, otherwise all investigations were post mortem. The post mortem period ranged from one to five hours, in most cases being about three hours.

b. A blood film (thin) was made in the usual manner and Wright's stain was used.

c. A thick blood film, using about five times the amount of blood contained in a thin film, was made and thoroughly dried in a circular patch about half an inch in diameter. This film was laked and stained in an aqueous solution of Giemsa's stain for a period of one hour, using 1 cc. of the stock solution of Giemsa's stain to 30 cc. of water that had a reaction closely approximating that of freshly distilled water.

d. Crushed tissue films were made from the following organs: gray matter of the brain, rib marrow, spleen pulp and inguinal

TABLE 2
Stained blood and tissue films

MONKEY SPECIES	NUMBER OF EXAMINATIONS	POSITIVE MALARIA PARASITES		POSITIVE MALARIA PIGMENT		POSITIVE FOR TRY-PANOSOME		POSITIVE FOR MICROFILARIA	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
<i>Ateles geoffroyi</i> (red spider monkey).....	24	7	29.1	15	62.5	0	0	22	91.6
<i>Cebus capucinus imitator</i> (Panama white-throated monkey)...	31	3	9.7	12	38.7	13	41.9	27	87.1
<i>Saimiri orstedii orstedii</i> (Titi monkey).....	54	0	0	0	0	14	25.9	49	90.7
<i>Alouatta palliata inconsonans</i> * (Panama howling monkey).....	4	0	0	0	0	4	100.0	0	0
Totals.....	113	10	8.8	27	23.9	31	27.4	98	86.7

* No deep tissue films examined.

lymph node. These films were dried and stained in the same manner as the thin blood film.

e. Blood was aspirated from the heart of the monkeys and defibrinated. Subcutaneous inoculations were then made into guinea pigs, from the pooled blood of each day's collection of monkeys, and into a large female monkey (*Macacus rhesus*). This monkey had lived in the outdoor cages of the Board of Health Laboratory at Ancon, Canal Zone, for almost ten years and had been used in experiments concerning relapsing fever when she first arrived on the Canal Zone.

f. Sets of tissue specimens were taken from each monkey for histopathological study. The examination of these specimens is incomplete at present and will not be included in this preliminary report.

All of the blood and tissue films have been searched for any form of parasite that might be revealed by these methods and the results are given in table 2.

None of the inoculated guinea pigs nor the inoculated monkey (*Macacus rhesus*) have shown any of the parasites found in these wild monkeys in their daily blood films up to the end of August, a period of a month and a half following the first inoculations. The guinea pigs were the only available animals for use in attempting to secure trypanosome strains. The Old World monkey seemed a likely host for New World monkey parasites but it may have acquired similar infections in early life and established a relative degree of immunity. Furthermore, it is possible that the post mortem state of the blood from the wild monkeys defeated our efforts.

A juvenile white face monkey (*Cebus capucinus imitator*) was brought back in good condition. It has shown daily a light trypanosome infection and a direct transfer of its blood to the *Macacus rhesus* again produced a refractory result.

A complete study of the parasites found in these monkeys will necessarily require the capture of live monkeys possessing these infections. It is highly probable that all the parasites found are specific for the monkeys and some of them probably for certain species of monkeys. Nevertheless, it is desirable to attempt transfers to man and certain domestic animals.

The monkey malaria appears to be somewhat different in character in the red spider and white throated monkeys. The red spider monkey shows parasites that closely resemble *P. vivax*. The rings are rather large and have but one dot of chromatin. The old trophozoites are irregular in shape and the red blood cell is enlarged and pale. The gametocytes are large round, oval or pear shaped. Segmentation occurs in the peripheral blood and deep tissues, however, the merozoites range from 10 to 14 in number and this is about half the number found in *P. vivax* in man. No Schüffner's dots were found.

The white throated monkey showed parasites that more closely resembled *P. malariae*. That is, the pigment was more abundant, the old trophozoites were inclined to be band-like and the red cells were not increased in size nor decolorized to the extent noted in the other species of monkey. The adult asexual parasites did not fill the red cells. The merozoites numbered 6 to 12, usually 6, 7 or 8. It will be necessary to learn more about the complete cycles before attempting definite statements as to the species of these parasites.

The red spider monkeys, as a general rule, showed marked splenic enlargement and deep pigmentation of the viscera.

The white throated monkey, in some instances, revealed the same.

The Titi monkey failed to show pigmentation or splenic enlargement.

No opportunity was afforded to examine the organs of the black howler monkeys.

SUMMARY

1. Goldman (6) lists ten monkeys for the Republic of Panama. Four of these are included in this survey.

2. *Ateles geoffroyi*, the red spider monkey, revealed tertian-like malaria parasites and microfilaria but none of the 24 monkeys showed a trypanosome.

3. *Cebus capucinus imitator*, the Panama white-throated monkey of Chiriqui, revealed quartan-like malaria parasites, a large trypanosome and microfilaria.

4. *Saimiri orstedii orstedii*, the Titi monkey of Chiriqui, revealed no malaria parasites but did show a large trypanosome and microfilaria.

5. *Alouatta palliata inconsonans*, the black howling monkey, revealed trypanosomes but no other blood parasites in the 4 specimens examined.

6. The autopsy examination of these monkeys (Howling monkey not subjected to this examination) revealed adult filaria in large numbers in the abdominal cavity of the red spider and white throated species but no adults were found in any of the cavities of the Titi monkeys.

7. *Macacus rhesus*, an adult female monkey was inoculated with a total of 5.75 cc. of defibrinated blood from 60 monkeys, 7 red spider monkeys contained malaria parasites and 8 additional ones revealed phagocytosed pigment, 3 white throated monkeys contained malaria parasites and 6 additional ones showed phagocytosed pigment. This monkey (*M. rhesus*) has shown no sign of illness, no elevation of temperature and no parasites in the period of six weeks following her inoculations. No trypanosomes have been seen in her blood films although she was inoculated with positive blood from three species: red spider, white throated and Titi monkeys.

8. Nearly all the monkeys showing malaria parasites in the blood or spleen films were infants, juveniles or adult females that were pregnant. No severe infections were found. The thick blood film and films from the spleen and rib marrow were the most valuable films used in this survey. Such films were not used in the Chagres River surveys and this, no doubt, accounts for the failure to find light infections in the adult monkeys.

9. Guinea pigs inoculated with blood from the same three species of monkeys also failed to show a trypanosome infection during the six weeks following the inoculations.

10. The hunters encountered the white throated monkeys 9 times, the red spider monkeys 7 times, the Titi monkeys 5 times and the black howling monkeys 2 times. Whether this represents as many separate colonies of monkeys one can not say, but the monkeys found positive for malaria, trypanosomes and microfilaria were not confined to the captures of any one or two days.

11. The monkey should afford a better animal for research work in malaria than the bird since it supplies a larger volume of blood than the bird, a type of blood cell more closely resembling man and species of plasmodia that are difficult to distinguish from the benign species found in man.

12. Some experiments in the transfer of monkey malaria to man have proven refractory in the Eastern hemisphere yet it would seem proper to repeat this work in our region if an infant monkey with an acute initial infection can be taken alive.

Similar efforts with the trypanosomes should be made against the horse.

REFERENCES

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- (6) GOLDMAN, EDWARD A. 1920 Mammals of Panama. Smithsonian Miscellaneous Collections, vol. 69, no. 5.

PLATE 1

PARASITES FOUND IN THE THIN BLOOD FILM FROM RED SPIDER MONKEY 27

Wright's stain was employed. The young and old trophozoites resemble *P. vivax* and three of the parasites in the lower row resemble tertian gametocytes.

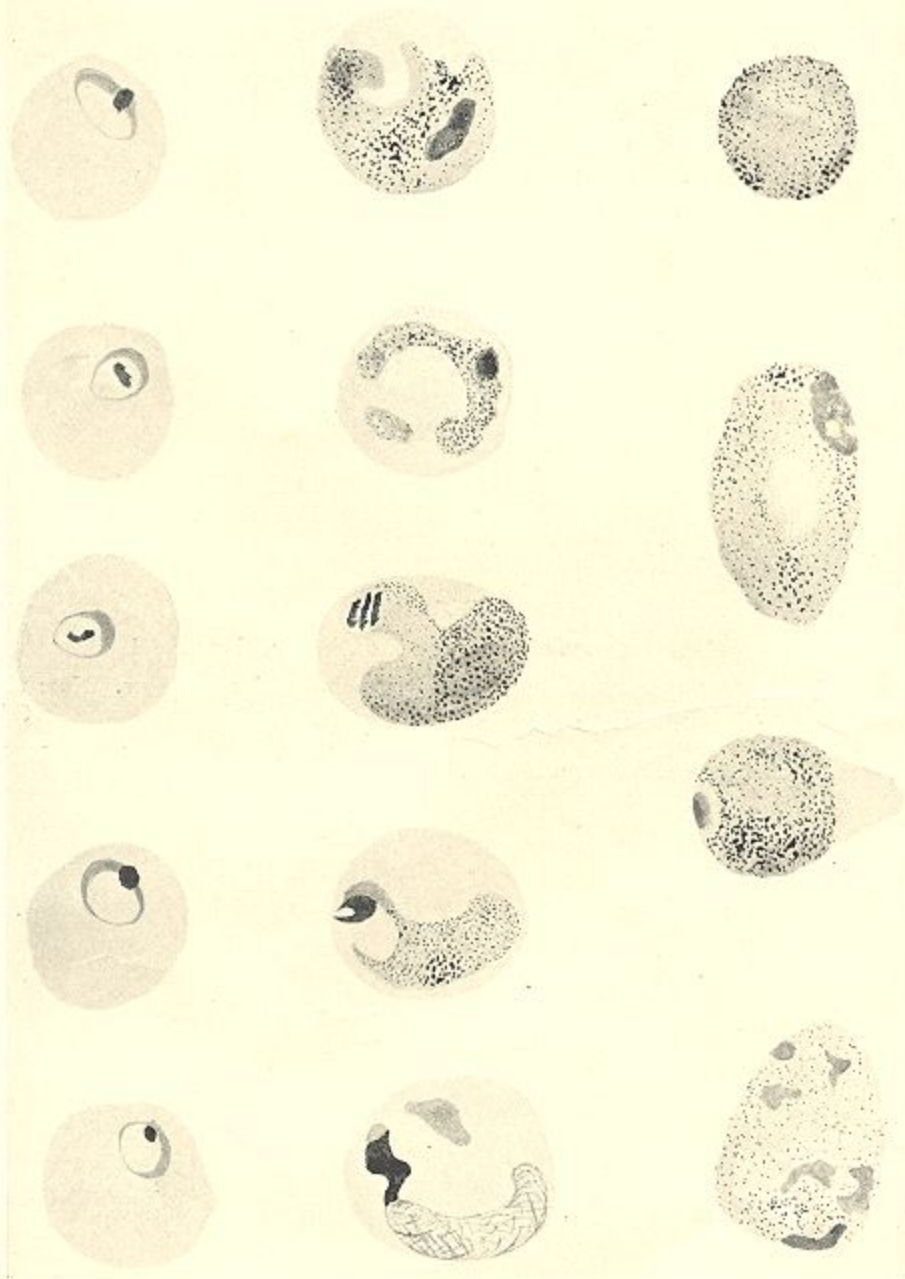


PLATE 2

A THICK BLOOD FILM FROM RED SPIDER MONKEY 27

An aqueous solution of Giemsa stain was applied for one hour. Note the difference in appearance of the young trophozoites in the thick film treated in this manner. The segmenting parasites divide into 10 to 14 merozoites. The lower row probably represent gametocytes.

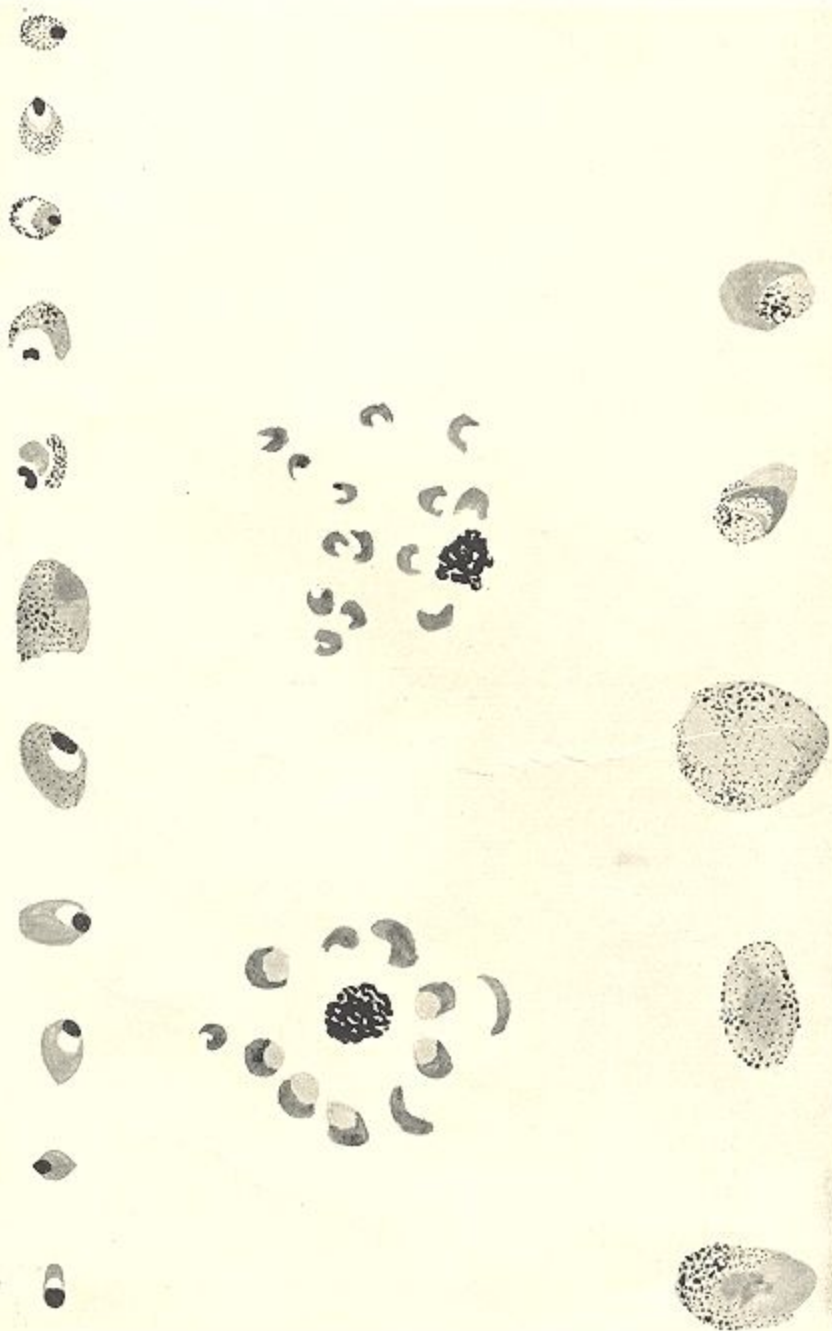


PLATE 3

This group of parasites were found in the spleen films from red spider monkeys 9 and 27. Wright's stain was employed. The top row shows enlarged red cells containing segmenting parasites dividing into 9 to 14 merozoites. The cell in the lower right corner represents a spleen cell loaded with pigment. The other parasites probably represent young and old gametocytes.

NO. 27



NO. 46



NO. 46



NO. 46



NO. 9



NO. 9



NO. 9



NO. 9



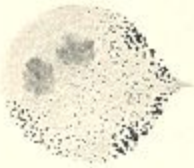
NO. 9



NO. 9



NO. 9



NO. 9



PLATE 4

A THICK BLOOD FILM FROM WHITE THROATED MONKEY 89

This film was stained for one hour in an aqueous solution of Giemsa's stain. Note the trophozoites in the top row which contain abundant coarse pigment, and the band-like forms in middle row. The segmenting forms show 6 and 8 merozoites. This species resembles *P. malariae*.

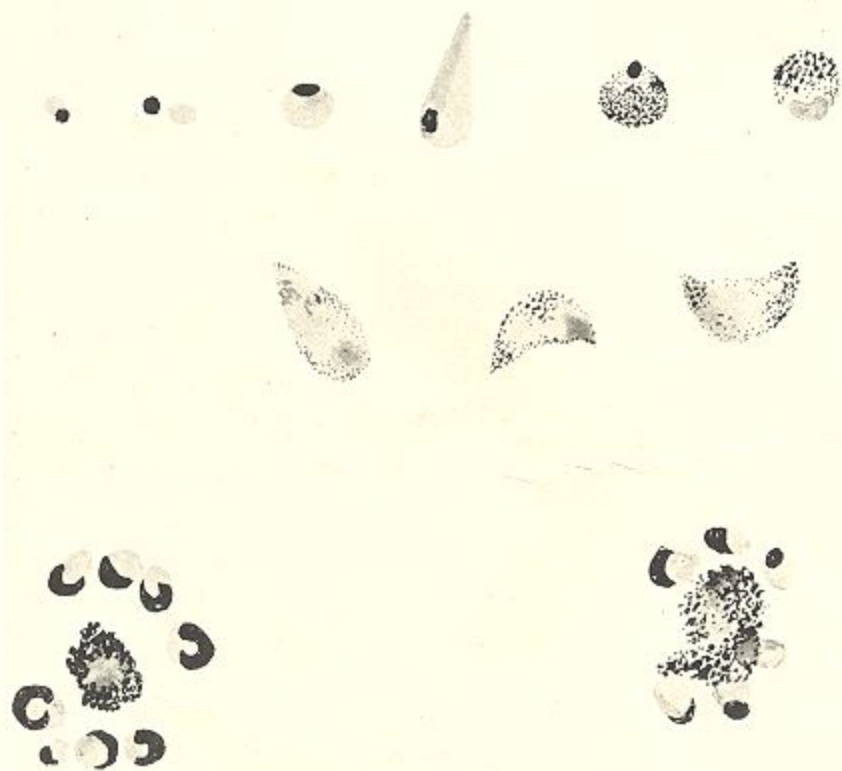


PLATE 5

This plate shows rib marrow and spleen films from white throated monkey 89. The cell in the lower right corner is a pigmented cell from the spleen. Wright's stain.

SPLEEN



RIB MARROW



SPLEEN



SPLEEN

