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SUSCEPTIBILITY OF *ATELES FUSCICEPS*, *ATELES GEOFFROYI* AND *CEBUS CAPUCINUS* MONKEYS TO *PLASMODIUM VIVAX*

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Previously we reported that *Plasmodium vivax* could be grown in the Panamanian night monkey, *Aotus trivirgatus* (YOUNG, PORTER and JOHNSON, 1966), and in the Panamanian marmoset, *Saguinus geoffroyi*, (PORTER and YOUNG, 1966). GEIMAN and MEAGHER (1967) confirmed our results in *Aotus*.

3 additional Panamanian primates have been infected with *P. vivax*—the black spider monkey, *Ateles fusciceps;* the red spider monkey, *A. geoffroyi;* and the white-faced monkey, *Cebus capucinus*.

The methods for handling primates and experimental infections were detailed previously (YOUNG et al., 1966; PORTER and YOUNG, 1966). In general, infected blood was injected intraperitoneally. Most of the animals had been splenectomized. They were given the immunosuppressant drug azathioprine (Imuran) orally at the rate of 5 mg. per kg. body weight at the time of the inoculation of infected blood.

Attempts were made to infect the *Ateles* and *Cebus* monkeys and also the black howler monkeys, *Alouatta villosa*, with blood infected with *P. vivax* from man and experimentally infected monkeys. All human donors of infected blood resided in the Republic of Panama.

None of 11 *A. fusciceps*, 1 *A. geoffroyi*, 6 *Cebus*, or 2 *Alouatta* became infected after inoculation with *P. vivax* blood from man (Table I). However, after the *P. vivax* from man had been established in *Aotus*, the infections were passed successfully from this primate to the *Ateles* and *Cebus;* 11 of 21 *A. fusciceps*, 4 of 6 *A. geoffroyi*, and 2 of 18 *Cebus* developed parasitaemias. The single *Alouatta* was not infected.

All monkeys developing malaria had been splenectomized and all except one had received azathioprine.

In the two *Ateles* species the parasitaemia persisted on the average for 25 and 38 days respectively and reached very high levels in some animals. The parasitaemia in the *Cebus* was of a low grade and of short duration.

The monkey to monkey passages of *P. vivax* distributed by donors and recipients are shown in Table II. After *P. vivax* from human donors was established in *Aotus*, subinoculations produced infections in *A. fusciceps* and *Cebus*. Inoculations from *A. fusciceps* infected other *A. fusciceps* and also *A. geoffroyi*. Conversely, parasites from *A. geoffroyi* infected other *A. geoffroyi* and *A. fusciceps*.

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TABLE I. Transfer of *Plasmodium vivax* to monkeys.
(January 1, 1965–March 31, 1968)

Species of primate	Man to monkey	Inoculum	Prepatent period	Patent period	Parasitaemia maximum	
	S*/A	Range (10^6)	Average (days)	Average (days)	per c.mm.	Day of patency
Ateles fusciceps	0/11	<1–58	0	0	0	0
Ateles geoffroyi	0/1	?	0	0	0	0
Cebus capucinus	0/6	2–64	0	0	0	0
Alouatta villosa	0/2	?–12	0	0	0	0
	Monkey to monkey					
Ateles fusciceps	11/21	1–300	13	25	106,920	13
Ateles geoffroyi	4/6	1–52	8	38	24,350	29
Cebus capucinus	2/18	1–600	1	5	10	4
Alouatta villosa	0/1	28	0	0	0	0

S/A Success/Attempts

* Demonstrable parasitaemia for at least 3 successive days.

Plasmodium vivax of human origin has been maintained by serial blood passages in the *Aotus trivirgatus* (night monkey) for over 2 years. This parasite has also been grown in the *Saguinus geoffroyi* (marmoset) and transferred in serial passages.

With the *Aotus* monkeys as donors, the induced infections grew well in the *Ateles* but did not persist as long or attain parasitaemia as high as in the *Aotus* or *Saguinus*. Once established in the *Ateles*, subinoculations to other *Ateles* were usually successful. Several consecutive serial passages have been made from *Ateles* to *Ateles*.

Attempts to infect the *Ateles* from human sources of *P. vivax* parasites were not successful. However, as *P. vivax* of human origin induced into *Aotus* monkeys did infect the *Ateles* upon subinoculation, it seems that it might be possible to transfer human parasites directly to these animals under favourable conditions.

Discussion

The present report brings to a total of 5 the number of Panama monkeys susceptible to human *P. vivax*. Of these, the infections in 3—*Aotus trivirgatus*, *Saguinus geoffroyi* and *Ateles fusciceps*—became well established. A fourth species, *A. geoffroyi*, was slightly less susceptible but has not been tried as extensively as the other 3. These 4 species appear to be good models in which to study induced *P. vivax* of human origin.

So far, *Cebus capucinus* appears to have only a slight susceptibility to *P. vivax*.

Alouatta villosa was not infected in 5 attempts. However, as the number of trials was small, it is too early to draw conclusions as to its susceptibility.

TABLE II. Monkey to monkey passages of *Plasmodium vivax* distributed by donor and recipient.
(February 25, 1966–March 31, 1968)

Recipients	Donors							
	Aotus trivirgatus		*Saguinus geoffroyi*		*Ateles fusciceps*		*Ateles geoffroyi*	
	S*/A	AMP/c.mm.	S*/A	AMP/c.mm.	S*/A	AMP/c.mm.	S*/A	AMP/c.mm.
Ateles fusciceps	4/11	14,000	0/1	0	6/7	35,000	1/2	<10
Ateles geoffroyi	0/1	0	—	—	1/1	5,000	3/4	15,000
Cebus capucinus	2/14	5	0/2	0	—	—	0/2	0

S/A Successes/Attempts.

AMP/c.mm. Average maximum parasites/c.mm.

* Demonstrable parasitaemia for at least 3 successive days.

— No attempts.

Summary

Plasmodium vivax infected Panamanian monkeys *Ateles fusciceps*, *A. geoffroyi*, and *Cebus capucinus*. The parasites were from *Aotus trivirgatus* donors which had been infected originally from human sources. The resultant parasitaemia was relatively high in the *Ateles*, but low in the *Cebus*.

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