

EXOERYTHROCYTIC STAGES OF *PLASMODIUM VIVAX* IN *ATELES* MONKEYS*

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Abstract. Seven and 10-day exoerythrocytic forms of *Plasmodium vivax* have been experimentally produced in hepatic tissues of *Ateles* (spider monkeys); patent infections developed in the recipients. These monkeys represent a new test system.

In 1969, for the first time, exoerythrocytic schizonts of a human malaria (*Plasmodium falciparum*) were demonstrated in a New World monkey (*Aotus trivirgatus*).¹ Later, in two brief reports,^{2,3} it was stated that these forms of *P. vivax* also had been seen in experimentally infected *Aotus* monkeys. A detailed description of 6-, 7-, and 8-day bodies in the vivax-*Aotus* model has since been published.⁴

Subsequent to the transmission of vivax malaria to *Ateles fusciceps* (black spider monkeys),⁵ we have found 7- and 10-day exoerythrocytic stages of the parasite in this second host system. The present communication will record our preliminary observations.

MATERIALS AND METHODS

Sporozoites of the Achiote line of *P. vivax* were derived from *Anopheles albimanus* after infective feedings on *Aotus* donors. Mosquito thoraces were triturated in chilled 10% homologous, heat inactivated serum saline (0.85%) and sporozoites obtained by centrifugation. Three *A. fusciceps* served as recipients; each had been splenectomized and was free of naturally acquired malaria. Hepatic inoculation of sporozoites and biopsies on each monkey were performed via laparotomy. The liver tissue was fixed in Carnoy's solution, and processed by routine histological procedures. Specimens were embedded in

paraffin, and serially sectioned at 5 μ . Colophonium-Giemsa was used for staining.⁶

RESULTS AND DISCUSSION

Exoerythrocytic stages were recorded for each animal (Table 1). In the biopsy material from 328D, a single 7-day form was identified, whereas for 488D, 9 schizonts have been observed. In the latter case, examination of the tissue is continuing. No 10-day forms were found in these two monkeys, though patent infections did appear 2 and 12 days, respectively, after the second biopsy. In the third subject, 5833, two exoerythrocytic forms were seen on day 10, the first day of parasite patency. The second biopsy from this monkey on day 15, was negative for parasites.

The 7-day bodies were circular or ovoid in appearance, ranging in maximum diameter from 15.0 μ to 25.0 μ (mean = 20.1 μ). The number of nuclei at this stage of development was variable, 4 to 30 per section. The nuclei were deeply stained, and in most cases were of uniform size, discrete and rounded. The cytoplasm was slightly granular, compact, with several small, clear vacuoles in approximately half of the parasites. Shrinkage from the host cell was noted in a few instances. Compression of the host cell nucleus occurred, and there was no apparent tissue reaction in the surrounding area.

The 10-day exoerythrocytic stages were lobed, with longest diameters measuring 63.8 μ and 67.5 μ . A section of an unlobed portion of one of these forms is shown in Figure 1. Nuclei were finely divided, irregularly-shaped and not clearly defined. The cytoplasm was extremely granular and diffuse; beginning cleft formation was apparent. One of the bodies was more heavily stained on one side. Small vacuoles also were present in one body. There was moderate shrink-

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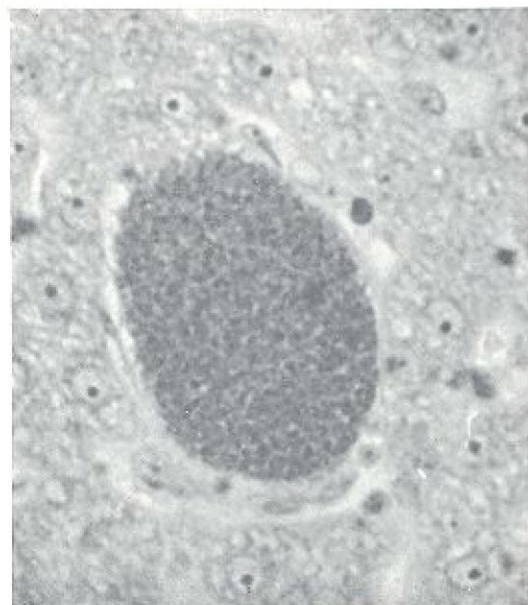


FIGURE 1. Section of a 10-day exoerythrocytic stage of *Plasmodium vivax* in *Ateles fusciceps*. $\times 678$.

age of the parasite from the host cell and no evidence of reaction in the surrounding tissue.

The 7-day exoerythrocytic forms in *A. fusciceps* had diameters of approximately half those of the same age in man,⁶ whereas at 10 days they corresponded to the late (8-day) development described for the chimpanzee.⁷ The above indicates that these stages of *P. vivax* grow more slowly in *Ateles* than in man or the chimpanzee, which may be related to the longer prepatent periods in the *Ateles*. The average maximum diameter of the 7-day body from *Ateles* (20.1μ) was smaller than 7 and 6-day stages in *Aotus* (31.4μ and 26.0μ);⁴ however, morphology in both hosts was similar. The 10-day forms were considerably larger than those at 8 days in *Aotus*, and were close to maturity; their appearance at this biopsy was consistent with the concurrent onset of patency.

In a recent extension of similar studies to another species of *Ateles*, *A. geoffroyi* (red spider

TABLE 1
Sporozoite inoculation of Plasmodium vivax and results of hepatic biopsy in Ateles fusciceps

Data	Monkey no.		
	328D	488D	5833
Inoculation route*	iv + ih	iv + ih	ih
Biopsy day/result	7/pos. 10/neg.	7/pos. 10/neg.	10/pos. 15/neg.
Prepatent period-days	12	22	10

* iv, intravenous; ih, intrahepatic.

monkey), we have found numerous, large 7-day exoerythrocytic schizonts after direct hepatic inoculation. Details will be summarized in a subsequent report.

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