4. G. M. Edelman, B. Benacerraf, Z. Ovary, M. D. Poulik, *Proc. Natl. Acad. Sci. U.S.* **47**, 1751 (1961).
5. J. B. Fleischman, R. R. Porter, E. M. Press. *Biochem. J.*, in press.
6. S. Utsumi and F. Karush. Paper presented at the meeting of the American Association of Immunologists, Atlantic City, April 1963.
7. F. S. Farah, M. Kern, H. N. Eisen, *J. Exptl. Med.* **112**, 1195 (1960).
8. S. F. Velick, C. W. Parker, H. N. Eisen, *Proc. Natl. Acad. Sci. U. S.*, **46**, 1470 (1960).
9. The spectra of free and antibody-bound DNP lysine differ in 1*M* propionic acid in a manner similar to that in phosphate-NaCl buffer, *p*H 7.4 (L. Wofsy, Ph.D. thesis, Yale University, 1961). The absorption maximum of the free hapten in the propionic acid at 362 m$\mu$ is shifted to 378 m$\mu$ on binding to anti-DNP and $E_{max}$ decreases from 1.44 $\times$ $10^4$ to 1.04 $\times$ $10^4$. Extinction coefficients for the bound hapten were obtained by direct titration of a solution of anti-DNP in propionic acid with DNP lysine in antibody excess.
10. H. Metzger, L. Wofsy, S. J. Singer, in preparation.
11. ———, *Biochemistry* **2 (1963)**, 979 (1963).
12. ———, *ibid.* **1 (1962)**, 1031 (1962).
13. O. Rohult and D. Pressman, personal communication.
14. Studies by F. Franek and R. S. Nezlin, *Folia Microbiol.* **8**, 128 (1963), appear to suggest a specific association of B and A chains of horse antibody globulin. However, the results are inconclusive, since the amount of activity recovered after separation of the chains was only about 2 percent of the original.
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## Quartan-Type Malaria Parasite of New World Monkeys Transmissible to Man

The first recognized natural transmission of a simian malaria to man occurred accidentally in 1960 with the vivax-like *Plasmodium cynomolgi bastianellii* as reported by Eyles, Coatney and Getz (*1*). In 1961 Coatney *et al.* (*2*) and Schmidt *et al.* (*3*) showed that an old laboratory strain of *P. cynomolgi* could also be transmitted to man by mosquito bite.

Recently we have been able to transmit to a man a second species of simian malaria, *Plasmodium brasilianum*. This was accomplished by the bites of infected *Anopheles freeborni* mosquitoes which had been allowed to feed on a spider monkey, *Ateles geoffroyi geoffroyi*, with an infection acquired naturally in Panama. This quartan parasite of New World monkeys was originally described by Gonder and von Berenberg-Gossler (*4*) from the white or bald oukari, *Brachyurus calvus*. Clark (*5*) and Clark and Dunn (*6*) reported it as a natural parasite of *Ateles sp.*, *Cebus sp.*, and *Alouatta sp.* Clark and Dunn were unable to infect man with this parasite either by the inoculation of parasitized blood from the monkey or by the bites of infected *Anopheles albimanus* mosquitoes.

Our transmission of *Plasmodium brasilianum* to man by mosquito bite was possible because nine individuals (seven Caucasians and two Negroes) volunteered to participate. They were bitten by 8 to 15 infected mosquitoes. Five of the volunteers (three Caucasians and two Negroes) developed patent infections. The prepatent periods ranged from 29 to 64 days, with a mean and a median of 43 days. The parasitemias were of low order, less than 50 parasites per microliter of blood, and the durations of patent parasitemia ranged from 4 to 19 days, during which time gametocytes were occasionally observed. Fever was present in only one volunteer who exhibited a true quartan fever pattern with a maximum temperature of 39.5°C. This same volunteer experienced a fever of 38.3°C 2 days preceding the onset of patent parasitemia. Symptomatology was minimal, consisting only of headache and loss of appetite.

The infection in man has been blood-passaged back to the monkey and to additional human volunteers. Thus the identity and infectivity of the parasite have been confirmed.

It is of interest to note that *Plasmodium brasilianum*, the quartan simian parasite of New World monkeys was transmitted with ease to both Caucasians and Negroes, whereas the vivax-like parasite of Old World monkeys, *P. cynomolgi* and *P. cynomolgi bastianellii*, was transmissible only to Caucasians (*2, 7*). This finding parallels the situation as found with *P. malariae* and *P. vivax* in man.

The fact that humans can be experimentally infected by the bites of mosquitoes infected with *P. brasilianum* constitutes a second example of a zoonotic malaria. This situation is of special interest because of the possible importance of these zoonoses to worldwide eradication.

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**References and Notes**

1. D. E. Eyles, G. R. Goatney, M. E. Getz, *Science* **131**, 1812 (1960).
2. G. R. Coatney, H. A. Elder, P. G. Contacos, M. E. Getz, R. Greenland, R. W. Rossan, L. H. Schmidt, *Am. J. Trop. Med. Hyg.* **10**, 673 (1961).
3. L. H. Schmidt, R. Greenland, C. S. Genther, *ibid.* **10**, 679 (1961).
4. R. Gonder and von Berenberg-Gossler, *Malaria Internat. Arch.* (Lpz.) **1**, 47 (1908).
5. H. C. Clark, *Am. J. Trop. Med.* **11**, 11 (1931).
6. ——— and L. H. Dunn, *ibid.* **11**, 1 (1931).
7. H. K. Beye, M. E. Getz, G. R. Coatney, H. A. Elder and D. E. Eyles, *Am. J. Trop. Med. Hyg.* **10**, 311 (1961).
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## Hepatomas in Rainbow Trout: Descriptive and Experimental Epidemiology

Abstract. *Four ingredients of a dry diet, Santa Monica, and a special food supplement, were tested for their effects on the occurrence of hepatomas in* Salmo gairdnerii. *When cottonseed meal was omitted from the diet, no hepatomas developed in the experimental fish. When the same diet with its usual cottonseed meal component was fed, 48 percent of the fish developed hepatomas.*

Hepatomas were reported among rainbow trout (*Salmo gairdnerii*) by Haddow and Blake (*1*) in the British Isles, Cudkowicz and Scolari (*2*) in Italy, and Nigrelli (*3*), Wales (*4*), and Ellis (*5*) in the United States, prior to 1960. The discovery of hepatomas in hatchery-reared rainbow trout in 1960 was described by Rucker *et al.* (*6*); this outbreak, which proved to be nationwide in distribution, was exceptionally high in incidence among some groups of trout. Wood and Larson (*7*) mention a 50 percent occurrence of gross tumors among 250,000 adult rainbow trout.

Hepatoma lesions vary greatly among rainbow trout. Their histopathology has been studied and described by Rucker *et al.* (*6*), Wood and Larson (*7*), and others (*2, 8*). Metastases have been reported in the kidney and spleen (*6–8*), and the heart, stomach, and pyloric cecae (*2*).

In 1960, after the initial discovery of hepatoma in California in a shipment of Idaho trout and, subsequently, among dry-fed fish at a number of State hatcheries, we decided to survey the entire fish population in State hatch-