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SPONTANEOUS TOXOPLASMOSIS IN THE WHITEFACE MONKEY, *CEBUS CAPUCINUS*, IN PANAMA

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Spontaneous toxoplasmosis in primates other than man was first reported by Thezé (1916) in a monkey, *Stentor seniculus*. Later Levaditi and Schoen (1933) described a natural infection in *Cynocephalus babuin* and Kopciowska and Nicolau (1938) in a chimpanzee. This work has been ably reviewed by Cowen and Wolf (1945). In the present communication spontaneous toxoplasmosis in a Panama whiteface monkey, *Cebus capucinus*, is described. The strain of organism was isolated in white Swiss mice and has been maintained to date by continuous passage in this rodent.

An infant whiteface monkey was brought into the laboratory in a moribund condition in August of 1953 by a local dealer who requested us to examine it for possible yellow fever. This dealer purchased large numbers of monkeys for export and maintained them for variable periods of time in screened enclosures on the outskirts of the city. He complained of heavy losses among the animals recently. The *Cebus* brought in had received one injection of penicillin the previous day.

The monkey, an emaciated infant, was sacrificed. No gross pathological changes were observed except for a small pneumonic focus in the right upper lobe of the lung. Parasites were not observed in an ordinary thick film of the blood nor in fecal suspensions. Blood cultures yielded growth of *Pseudomonas aeruginosa*. Six mice were inoculated intracerebrally with the serum of this monkey and six, also intracerebrally, with a suspension of pooled sections of the cerebral cortex and cerebellum.

In one histological section of the cerebral cortex stained with hematoxylin and eosin a small toxoplasmic pseudocyst was found. The mice were kept under daily observation. Three weeks after inoculation the group receiving brain tissue all showed irritability, ruffling of the fur and light tremors. Four of these six animals were sacrificed during the following week. Enlargement of the spleen was observed in all four, congestion of the lung in two. Small numbers of *Toxoplasma* were identified in lung and brain tissue. Sections of brain, spleen and liver were emulsified for further passage in mice. One of the 6 mice inoculated intracerebrally with serum was observed 10 weeks later to carry the head tilted to one side and to move in circles. It was sacrificed and showed small numbers of *Toxoplasma* in smears of the brain.

This strain has been maintained for 24 continuous passages to date in mice. The first passages were made by the combined intracerebral and intraperitoneal injection of tissue suspensions (brain, liver, spleen and lung). A chronic type of infection with a minimum incubation period of 2 weeks was produced in these earlier passages. The spleen was greatly enlarged and the lungs showed moderate to severe involvement. Toxoplasmas were found with greatest frequency in lung

and brain tissue. In brain tissue they usually appeared in the pseudocyst form. In later passages inoculations have been performed only by the intraperitoneal route, using peritoneal fluid or washings as the inoculum. The majority of mice now sicken within 4 to 5 days and die within 7 days. An occasional mouse has survived for a month or longer presenting the chronic form of the infection. The peritoneal fluid ordinarily contains great numbers of toxoplasmas in the early acute phase.

The organisms isolated from this monkey show the same morphological characteristics as other strains of *Toxoplasma* (Sabin, 1943; Jacobs, 1953). In fresh wet preparations no active motility has been observed. They are small crescent-shaped organisms, usually pointed at one extremity and more rounded at the other, about 4 to 7 micra in length by 2 to 4 micra in width. Actively dividing forms are much wider than resting forms and are frequently oval in shape. In Giemsa-stained smears the cytoplasm is blue and the nucleus, usually located nearer to one extremity, is red or purple. We found no evidence to indicate reproduction by any other process than binary fission. The protozoons were found free or intracellularly placed, singly, in small intracellular clusters or in pseudocysts of various sizes. In the pseudocysts there was no sharp demarcation between the cytoplasm of the various individuals. In histological sections the parasites are smaller, less crescentic and less readily identifiable than in Giemsa-stained smears. No growth was obtained in ordinary bacterial culture media or in Sabouraud's, Cleveland and Collier, or NNN media.

In order further to establish the identity of the organisms isolated in mice, their pathogenicity in a variety of other animals was studied. As is well known, *Toxoplasma* is unique among parasites in its very wide range of experimental hosts. Four hamsters, two young rabbits and two guinea pigs were inoculated, all by the intracerebral route. The hamsters developed an acute meningoencephalitis with death in 4 to 5 days after inoculation. The two rabbits died in 12 and 21 days respectively and one of the 2 guinea pigs in 15 days. *Toxoplasma* were observed in the meninges and cerebral cortex in each instance. The other guinea pig survived during a ten-week period when it was accidentally destroyed. Of especial interest is the high pathogenicity of this strain for two species of small Panamanian monkeys, the marmoset, *Marikina geoffroyi*, and the night monkey, *Aotus zonalis*, in which it produces an acute uniformly fatal infection (Rodaniche, 1954). The *Toxoplasma* also grow in the chick embryo and its membranes, especially the chorioallantoic.

The immunological relationship between this and other strains of *Toxoplasma* has not yet been determined. This phase of the work must await receipt of suitable control sera for serological tests and a control strain of the parasite for cross-immunity tests.

DISCUSSION

Spontaneous toxoplasmosis has been described previously on the Isthmus of Panama in man by Kean and Grocott (1947, 1948) and Mantz and co-workers (1949), in the pigeon by Johnson (1944), in the guinea pig by Rodaniche and Pinzon (1949) and in the dog by Grocott (1950). It is now described for the

first time in the whiteface monkey. Unfortunately, we have no information as to the source of the infection—whether it was contracted in the jungle or in captivity. The strain of *Toxoplasma* here described corresponds closely in morphology and animal pathogenicity with those studied by other authors. It shows no progressive motility in fresh wet preparations and fails to grow in artificial culture media. Although it gives the same types of serological reactions as other strains of *Toxoplasma*, the establishment of its immunological identity with these strains must depend on the acquisition of suitable control material. The exact relationship of the *Toxoplasma* to cause of death in this infant monkey was not ascertained. The animal was very poorly nourished. Sections of the previously mentioned focus of interstitial pneumonia in the lung and of apparently normal liver tissue stained with hematoxylin and eosin failed to reveal structures that could be interpreted with certainty as *Toxoplasma*. One pseudocyst was encountered in a section of cerebral cortex. Other tissues and organs were not preserved. There was invasion of the blood stream as indicated by the positive result obtained in a mouse injected with the blood of this monkey.

CONCLUSIONS

Spontaneous toxoplasmosis in an infant whiteface monkey, *Cebus capucinus*, in Panama is described. This is the first report of natural infection in this species of primate.

REFERENCES

Cowen, D., and Wolf, A., 1945. Toxoplasmosis in the monkey. Acute fatal infection experimentally produced in a young Macaca mulatta, *J. Infec. Dis.* **77**: 144–157.

Grocott, R. G., 1950. A case of canine toxoplasmosis in the Canal Zone, *Am. J. Trop. Med.* **30**: 669–675.

Jacobs, L., 1953. The biology of toxoplasma, *Am. J. Trop. Med. and Hyg.* **2**: 365–389.

Johnson, C. M., 1944. Annual Report of the Gorgas Memorial Laboratory, 1943, pp. 15–17.

Kean, B. H., and Grocott, R. G., 1947. Asymptomatic toxoplasmosis, *Am. J. Trop. Med.* **27**: 745–748.

Kean, B. H., and Grocott, R. G., 1948. Congenital toxoplasmosis, *J.A.M.A.* **136**: 104–108.

Kopciowska, L., and Nicolau, S., 1938. Toxoplasme spontanée du chimpanzé, *Compt. rend. Soc. Biol.* **129**: 179–181.

Levaditi, C., and Schoen, R., 1933. Présence d'un toxoplasme dans l'encéphale du Cynocéphalus babuin, *Bull. Soc. Path. Exot.* **26**: 402–405.

Mantz, F. A., Dailey, H. R., and Grocott, R. G., 1949. Toxoplasmosis in Panama. Report of two additional cases, *Am. J. Trop. Med.* **29**: 895–908.

Rodaniche, E. de, and Pinzon, T. de, 1949. Spontaneous toxoplasmosis in the guinea-pig in Panama, *J. Parasitol.* **35**: 152–154.

Rodaniche, E. de, 1954. Susceptibility of the marmoset, *Marikina geoffroyi*, and the night monkey, *Aotus zonalis*, to experimental infection with *Toxoplasma*, Am. J. Trop. Med. & Hyg. **3**: 1026–1032.

Sabin, A. B., 1943. Toxoplasmosis, Brennemans *Practice of Pediatrics IV:* 43–54.

Sabin, A. B., and Feldman, H. A., 1948. Dyes as microchemical indicators of a new immunity phenomenon affecting a protozoan parasite (*Toxoplasma*), *Science*, **108**: 660–663.

Sabin, A. B., and Olitzky, P. K., 1937. Toxoplasma and obligate intracellular parasitism, *Science* **85**: 336–338.

Thézé, J., 1916. Rapport sur les travaux de l'Institut d'Hygiene et de Bacteriologie, *Bull. Soc. Path. Exot.* **9**: 449–469.