

## Experimental *Cryptosporidium parvum* Infections in Opossums (*Didelphis virginiana*)

David S. Lindsay,<sup>1,2</sup> Charles M. Hendrix,<sup>1</sup> and Byron L. Blagburn,<sup>1</sup> <sup>1</sup> Department of Pathology and Parasitology, College of Veterinary Medicine, Auburn University, Alabama 36849, USA. <sup>2</sup> Present address: U.S. Department of Agriculture, Agricultural Research Service, Animal Parasitology Institute, BARC-East, Beltsville, Maryland 20705, USA

**ABSTRACT:** Five nursing opossums (*Didelphis virginiana*) were each inoculated with  $5 \times 10^6$  *Cryptosporidium parvum* oocysts of calf origin. Following inoculation, endogenous stages of *C. parvum* were observed in the ileum, cecum, and colon of these opossums. Two of three noninoculated pouch mates acquired infections during the study based on examinations of feces and tissue sections of all eight opossums. Mild diarrhea was observed in four of seven opossums harboring *C. parvum*, although none died as a result of the infection. Under the conditions of this study, *C. parvum* appeared to be only mildly pathogenic for opossums.

**Key words:** *Cryptosporidium parvum*, *Cryptosporidium* sp., coccidia, opossum, *Didelphis virginiana*, experimental infection, neonates.

Several authors have reviewed the literature on the coccidian genus *Cryptosporidium* (Levine, 1984; Navin and Juranek, 1984; Current, 1985; O'Donoghue, 1985; Tzipori, 1985; Fayer and Ungar, 1986). There is little information on cryptosporidial infections in marsupials; only O'Donoghue (1985) mentioned infection of a marsupial (the marsupial mouse, *Antechinus* sp.) with *Cryptosporidium* sp. Other data were not presented. Therefore, it is not known whether the species infecting the marsupial mouse was *C. parvum* or *C. muris*, the two valid species of *Cryptosporidium* found in mammals (Upton and Current, 1985; Anderson, 1987). The present study was undertaken to determine if nursing opossums (*Didelphis virginiana*) were susceptible to infection following oral inoculation with *C. parvum* oocysts.

A female opossum was captured in Lee County, Alabama (32°36'N, 85°36'W), and transported to the Laboratory Animal Care Facility (College of Veterinary Medicine, Auburn University, Alabama 36849, USA). The opossum was housed in a stainless steel

dog cage and given commercial dry cat food (Purina Cat Chow, Ralston Purina Company, St. Louis, Missouri 63164, USA) and water, ad libitum. After 22 days in captivity, the opossum was observed to have nursing pouch young. Thirty-six days after the female opossum was captured, the pouch young were inoculated with *C. parvum* oocysts. Fecal examinations using Sheather's sugar solution (Ernst and Benz, 1981) on samples collected from the mother opossum were negative for *C. parvum* oocysts 1 wk and at 1 day before the pouch young were inoculated with *C. parvum* oocysts. Based on the report of Jurgelski and Porter (1974), we estimated that the opossums were approximately 75 days old when inoculated.

Oocysts of *C. parvum* used in this study were isolated originally from the feces of a naturally infected dairy calf (Lindsay et al., 1987), and maintained in our laboratory by periodic passage in 2- to 3-day-old calves. Oocysts were separated from fecal debris by flotation in Sheather's sugar solution and stored in Hanks' balanced salt solution (HBSS) containing 100 IU/ml penicillin and 100 µg/ml streptomycin (GIBCO, Grand Island, New York 14072, USA) at 4 C. Oocysts had been stored for <2 mo prior to these experimental inoculations.

Five nursing opossums were each inoculated orally with 0.5 ml of HBSS containing  $5 \times 10^6$  oocysts using an 18 ga animal feeding needle. They were then weighed and returned to their dam. Their mean weight at the time of inoculation was  $46.7 \pm 0.8$  g. Although we initially observed only these five nursing opossums, three other pouch mates were observed when opossums were being removed from

the dam for examination at necropsy. Because the opossums were not identified at the time of inoculation, we were not able to differentiate between inoculated and noninoculated opossums. Therefore, only general conclusions can be drawn from the results of our examinations. One nursing opossum each was examined at necropsy 6, 7, and 8 days postinoculation (PI), two were examined 9 days PI, and three were examined 10 days PI. The following tissues were fixed in 10% neutral-buffered formalin, embedded in paraffin, sectioned at 8  $\mu$ m, and stained with hematoxylin and eosin for light microscopic examinations: lung, liver, kidney, spleen, pancreas, stomach, duodenum, jejunum, ileum, cecum, and colon. Feces from the colon of each opossum were divided and a portion was stained with Kinyoun's carbol fuchsin (Heine, 1982) and the remaining portion examined by flotation using Sheather's sugar solution (Ernst and Benz, 1981).

None of the opossums died as a result of infection with *C. parvum*. The only observed clinical sign was semi-formed, dark brown fecal material in the colons and rectums of four of seven opossums harboring cryptosporidia. All opossums continued to nurse, as evidenced by milk in their stomachs at necropsy, and weight gains during the study. Their mean weight at necropsy was  $86.5 \pm 4.3$  g.

Only one of the eight opossums remained *C. parvum* free during the course of this study. Five of seven infected opossums had developmental stages of *C. parvum* in the ileum, cecum, and colon, whereas two had stages only in the cecum and colon. Mild villous atrophy was observed in the ilea of opossums examined 7 and 8 days PI. Developmental stages of *C. parvum* and microscopic lesions were not observed in the other tissues of these or the other opossums examined. Oocysts of *C. parvum* were observed in the feces of six of the eight opossums examined. However, one of the opossums negative for fecal oocysts had developmental stages of *C. parvum* in the cecum and colon.

Results of this study indicate that pouch young opossums are susceptible to oocyst-induced infections with *C. parvum*. However, because of the lack of severe clinical disease and minimal microscopic lesions following inoculation of  $5 \times 10^6$  oocysts, *C. parvum* appears to be only mildly pathogenic for opossums. Two of the three opossums initially overlooked and not inoculated developed *C. parvum* infections during the course of the study. It is possible that they were infected by ingesting oocysts of *C. parvum* that passed, unexcysted, through the digestive system of the inoculated pouch mates.

We thank Natalie Hickox and Joy Vaughan for technical assistance. This paper is College of Veterinary Medicine publication 1934, and Alabama Agricultural Experiment Station Journal Number 5-871300.

#### LITERATURE CITED

- ANDERSON, B. C. 1987. Abomasal cryptosporidiosis in cattle. *Veterinary Pathology* 24: 235-238.
- CURRENT, W. L. 1985. Cryptosporidiosis. *Journal of the American Veterinary Medical Association* 187: 1334-1338.
- ERNST, J. V., AND G. W. BENZ. 1981. Coccidiosis. *In Diseases of cattle in the tropics*, M. Ristic and I. McIntyre (eds.). Martinus Nijhoff, The Hague, The Netherlands, pp. 337-392.
- FAYER, R., AND B. P. L. UNGAR. 1986. *Cryptosporidium* spp. and cryptosporidiosis. *Microbiological Reviews* 50: 458-483.
- HEINE, J. 1982. Eine einfache Nachweismethode für Kryptosporidien im Kot. *Zentralblatt für Veterinärmedizin Reihe B* 29: 324-327.
- JURGELSKI, W., JR., AND M. E. PORTER. 1974. The opossum (*Didelphis virginiana* Kerr) as a biomedical model. III. Breeding the opossum in captivity: Methods. *Laboratory Animal Science* 24: 412-425.
- LEVINE, N. D. 1984. Taxonomy and review of the coccidian genus *Cryptosporidium* (Protozoa, Apicomplexa). *Journal of Protozoology* 31: 94-98.
- LINDSAY, D. S., B. L. BLAGBURN, AND J. A. ERNEST. 1987. Experimental *Cryptosporidium parvum* infections in chickens. *The Journal of Parasitology* 73: 242-244.
- NAVIN, T. R., AND D. D. JURANEK. 1984. Cryptosporidiosis clinical, epidemiologic, and parasitologic review. *Reviews of Infectious Diseases* 6: 313-327.

- O'DONOGHUE, P. J. 1985. *Cryptosporidium* infections in man, animals, birds and fish. Australian Veterinary Journal 62: 253-258.
- TZIPORI, S. 1985. *Cryptosporidium*: Notes on epidemiology and pathogenesis. Parasitology Today 1: 159-165.
- UPTON, S. J., AND W. L. CURRENT. 1985. The species of *Cryptosporidium* (Apicomplexa: Cryptosporidiidae) infecting mammals. The Journal of Parasitology 71: 625-629.

*Received for publication 18 June 1987.*