



## **Intestinal Coccidia of Raccoons (*Procyon lotor*) from Key Largo, Florida, U.S.A**

Authors: Foster, Garry W., McCleery, Robert A., and Forrester, Donald J.

Source: *Comparative Parasitology*, 71(2) : 175-177

Published By: The Helminthological Society of Washington

URL: <https://doi.org/10.1654/4106>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## Intestinal Coccidia of Raccoons (*Procyon lotor*) from Key Largo, Florida, U.S.A.

GARRY W. FOSTER,<sup>1,3</sup> ROBERT A. McCLEERY,<sup>2</sup> AND DONALD J. FORRESTER<sup>1</sup>

<sup>1</sup> Department of Pathobiology, College of Veterinary Medicine, University of Florida, P.O. Box 110880, Gainesville, Florida 32611-0880, U.S.A. (e-mail: fosterg@mail.vetmed.ufl.edu) and

<sup>2</sup> Department of Wildlife and Fisheries Sciences, Texas A&M University, 210 Nagle Hall, College Station, Texas 77843, U.S.A. (e-mail: bmcc@neo.tamu.edu)

**ABSTRACT:** Fecal samples were collected from 61 adult raccoons (*Procyon lotor*) livetrapped on Key Largo, Florida, U.S.A. (25°15'N; 80°15'W), between April and November 2002 and analyzed for intestinal coccidia. *Eimeria procyonis* (84%), *Eimeria nuttalli* (10%), 1 unidentified species of *Eimeria* (3%), and an unidentified species of *Sarcocystis* (3%) were found. No oocyst of *Cryptosporidium* was found on a fecal smear stained with Kinyoun carbol-fuchsin acid-fast stain.

**KEY WORDS:** *Procyon lotor*, raccoon, *Eimeria procyonis*, *Eimeria nuttalli*, *Sarcocystis*, *Cryptosporidium*, Florida, Key Largo.

Little information has been published on the intestinal coccidia of raccoons, *Procyon lotor* (Linnaeus, 1758), in Florida, U.S.A. The only report we could find was that of Forrester (1992), who analyzed 45 raccoon fecal samples from central and southern Florida (Collier, Indian River, and mainland Monroe counties) and reported 2 species of *Eimeria* (*Eimeria procyonis* Inabnit, Chobotar, and Ernst, 1972, and *Eimeria nuttalli* Yakimoff and Matikaschwili, 1932) and 1 unidentified *Sarcocystis*. We collected raccoon fecal samples from Key Largo, the northernmost island of the Florida Keys chain. A large portion of the upper part of Key Largo is unsettled and protected land, including the Crocodile Lake National Wildlife Refuge, a 2,674-ha hardwood hammock.

This project was undertaken to assess some of the parasitic protozoa fauna found in the raccoon population inhabiting Key Largo.

### MATERIALS AND METHODS

Fecal samples were collected from 61 raccoons on Key Largo (25°15'N; 80°15'W), Monroe County, Florida, U.S.A., between 30 April and 26 November 2002. Raccoons were livetrapped in an ca. 900-ha area within and adjacent to the Crocodile Lake National Wildlife Refuge and the Key Largo Botanical State Park, both located at the northern end of Key Largo. The raccoons were captured using Tomahawk 106 and 108 livetraps (Tomahawk Live Trap Co., Tomahawk, WI, U.S.A.), marked with blue or orange PVC cement, and released after a fecal sample was obtained. The ages and genders of the raccoons were not recorded.

Fecal samples collected in the field were placed individually into plastic freezer bags and refrigerated up to 1 mo before arriving at the laboratory for analysis. About 3 g

of each sample was then placed in a 16-ml glass snap-cap vial containing approximately 12 ml of 2% (w/v) aqueous solution of potassium dichromate and allowed to aerate for 10–14 d uncapped at room temperature (24°C) to allow coccidian oocysts to sporulate. Fresh 2% potassium dichromate solution was added to the vials as needed. A routine fecal flotation using a modified Sheather's sugar solution was conducted according to the techniques of Duszynski and Wilber (1997). Photovouchers were deposited in the U.S. National Parasite Collection (USNPC, Beltsville, Maryland, U.S.A.).

Fecal samples were analyzed for *Cryptosporidium* using a Kinyoun carbol-fuchsin acid-fast staining technique (BBL TB Kinyoun Stain Kit, Becton Dickinson Microbiology Systems, Sparks, Maryland, U.S.A.). Stained smears were scanned at ×400 and ×1,000.

*Eimeria* prevalences were evaluated statistically using either chi-square or Fisher's exact test, with regard to collection sites, using SigmaStat® for Windows (version 2.03, SPSS, Inc., Chicago, Illinois). Significance was indicated by  $P \leq 0.05$ .

### *Procyon lotor* (Linnaeus, 1758) (Syn. *Ursus lotor* Linnaeus, 1758)

#### *Eimeria procyonis* Inabnit, Chobotar, and Ernst, 1972

**Prevalence:** Hosts infected, 51 of 61 (83.6%).

**Site of infection:** Unknown. Oocysts collected from feces.

**Type host:** Raccoon, *P. lotor*.

**Locality records:** U.S.A.: Alabama, Georgia, and Michigan (Inabnit et al., 1972); Florida (Forrester, 1992); Illinois (Adams et al., 1981); Ohio (Dubey, 1982); and Washington (Dubey et al., 2000).

**Specimens deposited:** USNPC 93689; photovoucher.

**Other known specimens:** USNPC 86352; phototype.

<sup>3</sup> Corresponding author.

*Remarks:* Inabnit et al. (1972) did not indicate from which state infected samples were found. Dubey (1982) reported meronts, gamonts, and oocysts of *E. procyonis* in epithelial cells at the tips of the villi of the small intestine, histologically. Dubey et al. (2000) reported *E. procyonis* from both captive and wild-caught juvenile raccoons housed at a wildlife center in the state of Washington, U.S.A. The prevalence for *E. procyonis* in raccoons from Key Largo was similar to those reported by Inabnit et al. (1972) ( $P = 0.067$ ) and Dubey et al. (2000) ( $P = 1.000$ ) but significantly higher than those reported by Adams et al. (1981) ( $P < 0.001$ ) and Forrester (1992) ( $P = 0.021$ ).

### ***Eimeria nuttalli***

#### **Yakimoff and Matikaschwili, 1932**

*Prevalence:* Hosts infected, 6 of 61 (9.8%).

*Site of infection:* Unknown. Oocysts collected from feces.

*Type host:* Raccoon, *P. lotor*.

*Locality records:* U.S.A.: Alabama, Georgia, and Michigan (Inabnit et al., 1972); Florida (Forrester, 1992); Illinois (Adams et al., 1981); and Iowa (Morgan and Waller, 1940). Russia: Leningrad (Yakimoff and Matikaschwili, 1932). U.K.: England, London (Mackinnon and Dibb, 1938).

*Remarks:* Yakimoff and Matikaschwili (1932) sampled raccoons that were imported from North America. Mackinnon and Dibb (1938) reported finding "... oocysts with undivided contents ..." and postulated that "they were probably eimeriid, and may be referable to *Eimeria nuttalli* Yakimoff and Matikaschwili, 1932." They reported that the unsporulated oocysts measured  $16.5\text{--}21 \times 12\text{--}17 \mu\text{m}$ , stating that "the majority were  $18 \times 15 \mu\text{m}$ ," but they gave no reference to the oocyst wall. The raccoons Mackinnon and Dibb (1938) sampled were being housed at the sanatorium of the London Zoological Gardens, where the majority of the animals there were quarantined on first arrival, so these raccoons were most likely imported from North America to become zoo residents. The prevalence for *E. nuttalli* in raccoons from Key Largo was similar to that reported by Inabnit et al. (1972) ( $P = 0.181$ ) but was significantly lower than those reported by Adams et al. (1981) ( $P = 0.006$ ) and Forrester (1992) in both Collier and Monroe counties ( $P < 0.001$ ).

### ***Eimeria* sp.**

*Prevalence:* Hosts infected, 2 of 61 (3.3%).

*Site of infection:* Unknown. Oocysts collected from feces.

*Specimens deposited:* USNPC 93690; photovoucher.

*Remarks:* Oocysts were ellipsoidal,  $28\text{--}31 \times 14\text{--}17 \mu\text{m}$  (mean  $29.2 \times 15.7 \mu\text{m}$ ;  $n = 22$ ), with a smooth, 2-layered wall about  $1 \mu\text{m}$  thick, inner layer brownish and outer layer colorless, without micropyle, and without residuum or polar granule. Sporocysts were ellipsoidal,  $10\text{--}11 \times 6\text{--}8 \mu\text{m}$  (mean  $10.1 \times 7.7 \mu\text{m}$ ;  $n = 30$ ), without stieda body, no sporocyst residuum was seen. These oocysts were much larger and the sporocysts morphologically different from those of *E. nuttalli*. This may be a spurious coccidium originating from a food item passing through the raccoon's gastrointestinal tract.

### ***Sarcocystis* sp.**

*Prevalence:* Hosts infected, 2 of 61 (3.3%).

*Site of infection:* Unknown. Sarcocysts collected from feces.

*Remarks:* *Sarcocystis* sp. sporocysts were elliptical,  $12\text{--}14 \times 7.2\text{--}9.6 \mu\text{m}$  (mean  $13.2 \times 8.5 \mu\text{m}$ ;  $n = 10$ ). Forrester (1992) reported *Sarcocystis* sp. in 1 of 34 (2.9%) raccoon fecal samples from Collier County, Florida, U.S.A., but did not give details of the sporocysts. The prevalence of the *Sarcocystis* sp. we found was similar to that reported by Forrester (1992). Intestinal *Sarcocystis* sp. sporocysts have been reported previously in raccoons by Robel et al. (1989) from Kansas (5 of 128, 3.9%) and by Adams et al. (1981) from Illinois (2 of 48, 4.2%).

### ***Cryptosporidium* sp.**

No oocyst of *Cryptosporidium* was seen.

## **DISCUSSION**

The partial descriptions of the unknown species of *Eimeria* and the *Sarcocystis* sporocysts are given here merely as a reference for future investigators and not to describe a new species.

Forrester (1992) reported *E. nuttalli* in raccoons from Collier (33 of 34, 97%), Indian River (1 of 1), and mainland Monroe (7 of 10, 70%) counties and *E. procyonis* from Collier (19 of 34, 56%) and Indian River (1 of 1) counties in Florida. We found 6 of 61 raccoons (9.8%) on Key Largo infected with *E. nuttalli* and 51 of 61 (83.6%) infected with *E. procyonis*. The lower prevalence of *E. nuttalli* in our samples may be due to the fact that there were many

unsporulated coccidia oocysts in our samples, which we could not positively identify, and also to small sample sizes from 2 of the counties. It is likely that more of the oocysts would have sporulated if we had followed the recommendations of Duszynski and Conder (1977) and placed the fecal–dichromate samples in petri dishes to sporulate. Considering the relatively small sample sizes for this and the other surveys, drawing any conclusions from the statistical analysis presented here may not be warranted.

Robel et al. (1989) reported that “unsporulated coccidian oocysts (*Eimeria* spp.) were found in the rectal contents ...” in 26% of the raccoons they sampled in Kansas. The authors gave no details about the oocysts.

Snyder (1988) reported that 13 of 100 (13%) fecal samples collected from raccoons in Illinois tested positive for *Cryptosporidium parvum* using an indirect immunofluorescent technique. He also reported that all the positive samples were from juvenile raccoons. Although we did not determine the age of the raccoons trapped in this study, the samples we tested for *Cryptosporidium* came, for the most part, from what appeared to be full-sized adults. This may be one reason for our negative *Cryptosporidium* results.

This is the first report of *E. procyonis*, *E. nuttalli*, and *Sarcocystis* sp. in raccoons from any of the Florida Keys.

Key Largo is not an isolated island ecosystem. Road access from Dade County, on the Florida mainland, to Key Largo is on a built-up levy, which would allow easy passage for raccoons and other animal migrants. To further investigate these intestinal coccidia, juvenile as well as adult raccoons on other islands in the Florida Keys chain and in southern Dade County should be sampled.

#### ACKNOWLEDGMENTS

The authors thank Qi-Yun Zeng for helping with the *Cryptosporidium* analysis. We thank also Ellis Greiner for reading an earlier draft of the manuscript and making helpful suggestion for improvement and

for commenting on oocyst morphology. This research was supported by the Florida Agricultural Experiment Station and approved for publication as Journal Series No. R-09334.

#### LITERATURE CITED

- Adams, J. H., N. D. Levine, and K. S. Todd Jr. 1981. *Eimeria* and *Sarcocystis* in raccoons in Illinois. *Journal of Protozoology* 28:221–222.
- Dubey, J. P. 1982. *Baylisascaris procyonis* and eimerian infections in raccoons. *Journal of the American Veterinary Medical Association* 181:1292–1294.
- Dubey, J. P., M. M. Garner, B. M. Rosenthal, and D. DeGhetto. 2000. Clinical coccidiosis in raccoons (*Procyon lotor*). *Journal of Parasitology* 86:1299–1303.
- Duszynski, D. W., and G. A. Conder. 1977. External factors and self-regulating mechanisms which may influence the sporulation of oocysts of the rat coccidium, *Eimeria nieschulzi*. *International Journal of Parasitology* 7:83–88.
- Duszynski, D. W., and P. G. Wilber. 1997. A guideline for the preparation of species descriptions in the Eimeriidae. *Journal of Parasitology* 83:333–336.
- Forrester, D. J. 1992. Parasites and Diseases of Wild Mammals in Florida. University Press of Florida, Gainesville, Florida. 459 pp.
- Inabnit, R., B. Chobotar, and J. V. Ernst. 1972. *Eimeria procyonis* sp. n., an *Isospora* sp., and a redescription of *E. nuttalli* Yackimoff and Matikaschwili, 1932 (Protozoa: Eimeriidae) from the American raccoon (*Procyon lotor*). *Journal of Protozoology* 19:244–247.
- Mackinnon, D. L., and M. J. Dibb. 1938. Intestinal protozoa. *Proceedings of the Zoological Society of London, Series B* 108:323–345.
- Morgan, B. B., and E. F. Waller. 1940. Severe parasitism in a raccoon. *Transactions of the American Microscopical Society* 59:523–527.
- Robel, R. J., N. A. Barnes, and S. J. Upton. 1989. Gastrointestinal helminths and protozoa from two raccoon populations in Kansas. *Journal of Parasitology* 75:1000–1003.
- Snyder, D. E. 1988. Indirect immunofluorescent detection of oocysts of *Cryptosporidium parvum* in the feces of naturally infected raccoons (*Procyon lotor*). *Journal of Parasitology* 74:1050–1052.
- Yakimoff, W. L., and I. L. Matikaschwili. 1932. Coccidiosis in raccoons; *Eimeria nuttalli* n. sp., parasite of *Procyon lotor*. *Parasitology* 24:574–575.