“usual” range for *M. moniliformis*. These observations confirm the wide range of morphological variations reported for moniliformid acanthocephalans. These size variations could be a cause of some of the confusion on the taxonomic status of *M. clarki* and *M. moniliformis* in North America. Populations of these 2 acanthocephalan species exhibit considerable variability, depending on host and geographical distribution; see Chandler (1921, 1941), Van Cleave (1924, 1953), Petrochenko (1958), and Buckner and Nickol (1975a, b). This is the first morphological study of *M. clarki* from *G. bursarius missouriensis*.

Specimens: Three male and 4 female *M. clarki* on 7 slides in the University of Nebraska State Museum, Harold W. Manter Laboratory Coll. 38227.

Hosts: Skulls in the Museum of High Plains, Fort Hays, Kansas Coll. nos. 31075, 31077, 31108, 31122, 31126, 31135, 31141 (one gopher was not infected).

**Literature Cited**


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**Research Note**

**The Raccoon as Intermediate Host of Three Sarcocystis Species in Europe**

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**Abstract:** One out of 12 raccoons from German Zoos was found to possess musculature infected by sarcocysts of 2 distinct Sarcocystis species (S. sp. 1 and S. sp. 2). The cyst wall of S. sp. 1 had fingerlike, and that of S. sp. 2 hairlike, villar protrusions. Two out of 45 raccoons from a free-ranging population in Germany showed infection of the muscle by a third Sarcocystis species (S. cf. sebeki, without villar protrusions of the cyst wall). None of the 3 species is identical with *Sarcocystis kirkpatricki*, described from raccoons in North America.

**Key Words:** raccoon, *Procyon lotor*, *Sarcocystis*.

Free-ranging raccoons, *Procyon lotor* L., in North America are known as intermediate hosts of *Sarcocystis kirkpatricki* Snyder et al., 1990. In Europe raccoons occur not only in zoos but also free in certain areas. Since we are unaware of reports of *Sarcocystis* spp. in raccoons in Europe, we decided to investigate whether the raccoons in North America and Europe are parasitized by the same or different *Sarcocystis* species.

Seven raccoons originated from the Leipzig
Figures 1–3. *Sarcocystis* sp. 1 from a zoo raccoon. Arrowheads point to the wall protrusions. 1. Light microscope photomicrograph of the sarcocyst in longitudinal section. Bar = 10 μm. 2, 3. Transmission electron micrographs of the cyst wall and/or its villar protrusions. 2. Bar = 1.1 μm. 3. Bar = 0.4 μm.
Zoo, 5 from other East German zoos, and 45 animals were taken from a free-ranging population of the Buckow region (east of Berlin). For the history of this population see Grummt (1965), and for the integration into a parasitological research project see Lux and Priemer (1995). Muscle tissues were removed from esophagus and loin of the zoo animals and from tongue, esophagus, heart, chest, ribs, diaphragm, and thigh of the wild animals, and examined for the presence of sarcocysts by picking them to small pieces by means of fine needles and forceps under a dissecting microscope at 6.3-fold magnification. For histological examination, infected tissues were fixed in 4% formaldehyde, sectioned at 3 to 5 \( \mu m \), and stained with hematoxylin and eosin. The length of the bradyzoites was determined by measuring the more or less bent median line step by step from pole to pole, and the width was measured at the widest diameter. For transmission electron microscopy (TEM), portions of muscle from the single infected wild animal were fixed according to Pospischil and von Bomhard (1979). In the material from the zoo animal, a second Sarcocystis species was detected during the histological investigation, this species could only be prepared for TEM investigation according to the re-embedding method described by Bergmann and Kinder (1987). For this purpose, the position of the sarcocyst within the musculature was marked on the back of the slide and the cover glass was removed. The section was first dipped into absolute ethanol, then into a mixture of ethanol and propylene oxide. The section was then covered with a mixture of glycid ether and propylene oxide, and a gelatin case filled with glycid ether was put on the marked place. After polymerization for 30 min at 105° C, the case was broken off and trimmed. Ultrathin sections were cut and stained with uranyl acetate and lead citrate. All measurements are in micrometers unless stated otherwise. Abbreviations: \( \bar{x} = \) mean value, SD = standard deviation, \( N = \) number of elements measured.

Of the 12 raccoons from zoos, only one was found to be infected with 2 Sarcocystis species, and only 2 of 45 free-ranging raccoons were infected by a third species.

**Sarcocystis sp. 1**  
(Figs. 1–3)

**ORIGIN:** Procyon lotor, Leipzig Zoo, born in the zoo.
**LOCALIZATION:** Loin musculature.
**DESCRIPTION:** A single sarcocyst detected in histological sections, 99.5 wide by light microscopy; cyst wall thick, palisadelike, 4.6–6.9 wide (\( \bar{x} = 5.9, SD = 0.5, N = 50 \)) by light microscopy; ground substance plus primary cyst wall 0.48–0.78 wide (\( \bar{x} = 0.62, SD = 0.09, N = 20 \)) by electron microscopy, 0.46–1.20 (\( \bar{x} = 0.74, SD = 0.23, N = 50 \)) with light microscopy. Fingerlike villar protrusions arise from cyst wall, closely packed, 5.8–7.4 long (\( \bar{x} = 6.1, SD = 0.4, N = 50 \)) by light microscopy, with basal width of 1.12–1.38 (\( \bar{x} = 1.23, SD = 0.10, N = 5 \)) in ultrathin sections; core of villar protrusions interwoven with microfilaments; surface of protrusions with small invaginations at short distances; invaginations 0.054–0.072 wide (\( \bar{x} = 0.059, SD = 0.005, N = 10 \)) by electron microscopy; diameter of the compartments (created by septal invaginations) near cyst wall 9.2–19.9 (\( \bar{x} = 14.5, SD = 3.0, N = 20 \)) at light microscopic level; depth in direction of center of sarcocyst 12.2–41.3 (\( \bar{x} = 27.2, SD = 6.9, N = 20 \)).

**Sarcocystis sp. 2**  
(Figs. 4, 5)

**ORIGIN:** Procyon lotor, Leipzig Zoo, born in the zoo.
**LOCALIZATION:** Wall of the esophagus, loin musculature.
**DESCRIPTION:** Two sarcocysts found, 1.8 and 1.9 mm long, 118–132 wide in the fresh state, extracted from muscle fibers; cyst wall thin with light microscopy; ground substance plus primary cyst wall 0.30–0.54 wide (\( \bar{x} = 0.38, SD = 0.06, N = 20 \)) in ultrathin sections; numerous, predominantly diagonal and cross-cuts of hairlike

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Figures 4, 5. Sarcocystis sp. 2 from a zoo raccoon. Transmission electron micrographs of the cyst wall. G = ground substance. Arrowheads point to the cuts of the hairlike villar protrusions. 4. Protrusions cut mainly crosswise. Bar = 0.4 \( \mu m \). 5. Protrusions cut mainly diagonally. Bar = 0.6 \( \mu m \).

Figures 6, 7. Sarcocystis cf. sebeki from a free-ranging raccoon. Transmission electron micrographs. 6. Section of the interior of a sarcocyst with bradyzoites and a septum (arrowhead). Bar = 1.7 \( \mu m \). 7. Section of the cyst wall consisting of the ground substance (G) and the membrane of the parasitophorous vacuole plus underlying osmiophilic layer with small invaginations (arrowhead). Bar = 0.4 \( \mu m \).
villar protrusions of cyst wall visible by electron microscopy; layer of these cut villar protrusions 0.50–1.26 wide (\( \bar{x} = 0.89, SD = 0.25, N = 20 \)); villar protrusions 0.18–0.50 in diameter (\( \bar{x} = 0.35, SD = 0.08, N = 85 \)), about 0.6 at bases; fine granulation visible in the interior of villar protrusions by electron microscopy; surface of cyst wall with small invaginations at short distances, 0.090–0.108 deep (\( \bar{x} = 0.101, SD = 0.011, N = 10 \)) and 0.06–0.12 wide (\( \bar{x} = 0.088, SD = 0.019, N = 10 \)) by electron microscopy; compartments 21.4–51.8 (\( \bar{x} = 29.9, SD = 9.5, N = 10 \)) wide near cyst wall by light microscopy, depth in direction of center 19.5–48.8 (\( \bar{x} = 33.7, SD = 8.8, N = 10 \)); bradyzoites 14.0–17.1 long (\( \bar{x} = 15, SD = 0.9, N = 30 \)) and 3.4–3.9 wide (\( \bar{x} = 3.6, SD = 0.19, N = 30 \)) by light microscopy, squashed out of extracted sarcocyst.

**Sarcocystis cf. sebeki**

*(Tadros and Laarman, 1976)*

(Figs. 6, 7)

**ORIGIN:** *Procyon lotor,* from the free-ranging population in the area of Buckow (east of Berlin).

**LOCALIZATION:** Muscle of loin, ribs, thorax, thighs, tongue, diaphragm, and wall of the esophagus.

**DESCRIPTION:** Sarcocysts 4–18 mm long and 27.5–112 (in histological sections 60.4–95.5) wide in the fresh state, extracted from muscle fibers; cyst wall thin and smooth at the light microscopic level, with no villar protrusions by electron microscopy, 1.06–1.71 wide (\( \bar{x} = 1.3, SD = 0.17, N = 30 \)); surface of cyst wall with shortly spaced small invaginations, 0.072–0.126 deep (\( \bar{x} = 0.094, SD = 0.016, N = 20 \)) and 0.060–0.126 wide (\( \bar{x} = 0.088, SD = 0.017, N = 20 \)) by electron microscopy; compartments 6.9–16.2 wide near cyst wall (\( \bar{x} = 10.6, SD = 2.9, N = 10 \)) and 8.5–14.6 (\( \bar{x} = 10.4, SD = 2.2, N = 10 \)) deep in direction of center with light microscopy; bradyzoites 6.6–8.5 long (\( \bar{x} = 7.4, SD = 0.3, N = 50 \)) and 1.3–1.8 wide (\( \bar{x} = 1.5, SD = 0.2, N = 50 \)) by light microscopy, squashed out of extracted sarcocyst.

**Sarcocystis kirkpatricki** is the only known *Sarcocystis* species from raccoons in the U.S.A. (Seneviratna et al., 1975; Kirkpatrick et al., 1987). Its cyst wall is similar to type 11 (or lies between types 9 and 11) of the classification by Dubey et al. (1989) and differs distinctly in form and structure from all 3 species found by us in European raccoons.

The cyst wall of our *Sarcocystis* sp. 1 is similar to type 10 of the classification by Dubey et al. (1989). Some features are recognizable (fingerlike outline of the villar protrusions and microfilaments in the core), although the TEM pictures are not optimal because of the re-embedding method applied. Thus it appears that the re-embedding method of Bergmann and Kinder (1987) allows a specific follow-up check of a paraffin section by means of TEM and allows ultrastructural characterization of the cyst wall at least in some cases. It is possible to get diagnostically usable ultrathin sections by means of this method that, however, cannot be compared with the sarcocysts embedded especially for TEM investigation in regard to the shrinkage and preservation state of the tissue (Figs. 2, 3). *Sarcocystis* sp. 1 is similar to *Sarcocystis* cf. *hofmanni,* a species occurring frequently in roe deer (*Capreolus capreolus*) in central Europe (see Sedlacek and Wesemeier, 1995), which is morphologically indistinguishable from *Sarcocystis* *hofmanni* Odening, Stolte, Walter, and Bockhardt, 1994, found in the European badger (*Meles meles,* Mustelidae) in Germany. Therefore, it is possible that the species usually occurring in roe deer sporadically infects badger and also raccoon.

*Sarcocystis* sp. 2 is morphologically indistinguishable from other species with hairlike villar protrusions of the cyst wall (type 7 of the classification by Dubey et al., 1989). From the zoo area and its environment, the following species would be in consideration: *Sarcocystis* *capreolicanis* (roe deer, see Sedlacek and Wesemeier, 1995), *S. cruzi* (cattle), *S. arieticanis* (sheep), and *S. hircicanis* (goats) (see Dubey et al., 1989). It is interesting that again a species from roe deer comes into question among them.

*Sarcocystis sebeki* was described from the musculature of *Apodemus sylvaticus* and *Mus musculus.* The definitive host is the tawny owl. Tadros and Laarman (1979) found similar sarcocysts in a European weasel and fed them to a tawny owl, in which a weak infection was obtained. Odening et al. (1994) described similar sarcocysts in European badgers (also mustelids), designating them as “*S. cf. sebeki.*” Because the sarcocysts found in wild European raccoons are morphologically indistinguishable from those of weasel and badger, we use the same designation “*S. cf. sebeki.*”

The occurrence of specific *Sarcocystis* species in the raccoon introduced into Europe is scarcely imaginable, because stable predator–prey relationships would not last with the raccoon as a
prey item in the absence of a predator regularly eating it. Thus it is possible that all 3 species found by us in European raccoons refer to “letters delivered to wrong address” which normally occur in other mammals. Voucher specimens are available from Institute of Zoo Biology and Wildlife Research, PF 1103, D-10252 Berlin, Germany: Collection of Protozoa, No. kT 68/60-W 1115/92 (histological sections of loin with S. sp. 1), and No. kT 66/57-W 24 (histological sections of tongue with S. cf. sebeki).

**Literature Cited**


**Research Note**

**Helminths of Cetaceans on the Southeastern Coast of Brazil**

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**ABSTRACT:** Seventy cetaceans accidentally captured in fishing nets in Rio de Janeiro State (Brazil) were dissected for parasites. Sotalia fluviatilis (Delphinidae) harbored Braunina cordiformis, Halocercus brasiliensis, and Anisakis typica. Tursiops truncatus (Delphinidae) was parasitized by Nastirema sp. and B. cordiformis. Steno bredanensis (Delphinidae) had only B. cordiformis. Sotalia fluviatilis represents a new host record for Braunina cordiformis that is reported for the first time from Brazil. In an attempt to correlate these cetaceans’ parasite infections with their food habits, a survey was made on fish of 20 species and Loligo sanpauliensis (Cephalopoda) from the same area. Only, Bagre bagre, Macrodon ancyllodon, and Nebris microps contained Anisakis sp. larvae, a parasite species infecting cetaceans. Lack of parasites in 42 Pontoporia blainvillei (Pontoporiidae) within our study area was probably related to the age of the hosts and differences in food habits between young and adults.

**KEY WORDS:** marine mammals, Cetacea, parasites, Brazil, Braunina cordiformis, Anisakis typica, Halocercus brasiliensis, Nastirema.

Despite the long Brazilian coastline (about 8,700 km), the parasite fauna of marine mammals in this part of the Neotropical region is largely unknown. Previous studies in Brazil are restricted to only 2 reports: Halocercus bras-