Laboratory Animal Science

Pterygodermatites nycticebi (Nematoda: Spirurida) in Golden Lion Tamarins[1,2,3,4]

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Summary | *Pterygodermatites nycticebi* (syn *Rictularia nycticebi*), a spirurid nematode first described in the slow loris *(Nycticebus coucang)*, recently has been associated with morbidity and mortality in the golden lion tamarin *(Leontopithecus rosalia rosalia)* collection at the National Zoological Park. Adult worms were found in the lumen of the small intestine with their anterior ends embedded in the mucosa. Larvae, when present, were deeper in the submucosa. A few heavily infected animals developed profound weakness, anemia, and hypoproteinemia. Infective larvae of *Pterygodermatites nycticebi* developed in laboratory-reared German cockroaches *(Blatella germanica)* that were fed tamarin feces containing eggs of *Pterygodermatites nycticebi*. Wild-caught German cockroaches also were found to harbor these infective larvae which implicates this ubiquitous pest as an intermediate host. Effective control of *Pterygodermatites nycticebi* has been achieved by regular fecal screening of all callitrichids for spirurid eggs and biannual prophylaxis with mebendazole at 40 mg/kg, as well as a rigorous cockroach extermination program.

Key Words | Intestinal parasitism — Spiruridae — Callitrichidae

Pterygodermatites nycticebi (Manning, 1920; Quentin, 1969) is a spirurid nematode that was first reported in the slow loris *(Nycticebus coucang)* (**1**). Infections with this parasite previously were reported in the Callitrichidae collection at the National Zoological Park (**2,3**), but referred to as *Rictularia* sp. Similar spirurids have been reported in golden lion tamarins *(Leontopithecus rosalia rosalia)*, *Saguinus* sp, and *Hylobates* sp at several other zoos (**4–6**). Deaths were attributed to the parasites in several of these animals.

Spirurid eggs have been found intermittently for several years in many members of our golden lion tamarin colony. The mode by which these animals became infected was unknown, but it was postulated that cockroaches or crickets which they frequently ingest may serve as intermediate hosts. Previous dissection of numerous cockroaches, both at our zoo (**3**) and at the Oklahoma City Zoo (**5**), however, revealed no larval spirurids and thus the role of these insects in the transmission of the parasite was uncertain.

Recently, heavy *P nycticebi* infections occurred in two golden lion tamarins. These cases provided an opportunity to determine the modes of infection and to characterize further the clinical and pathological aspects of the disease.

History

The Callitrichidae collection at the National Zoo consisted of a colony of 25 golden lion tamarins housed at a research facility, a separate group of seven to 10 animals that were used primarily for exhibit purposes, and another group of 12 kept at Front Royal, Virginia. A small colony of five brown-headed tamarins *(Saguinus fuscicollis)*, kept in the exhibit area of the zoo, has since been disbanded.

Pterygodermatites nycticebi (reported as *Rictularia sp*) were first recovered at the National Zoological Park from a brown-headed tamarin that was acquired in 1977 and died of severe parasitism several months later. The monkey had been introduced as a breeding male, but had numerous fighting encounters and underwent periods of extensive stress. Several months later, a 6-month-old golden lion tamarin that had a diaphragmatic hernia was found to have a heavy infection with *P nycticebi* at necropsy (**2,3**).

The most recent cases include a 5-month-old female that was born in our colony in March 1981. She appeared healthy until August 1981, at which time she was found on the floor of her cage in a weakened condition. Her feces contained a bolus of roundworms identified as *P nycticebi*. At that time, her total serum protein was 3.9 g/dl, but her hemogram was within normal limits (**7**). She was treated supportively with fluids, steroids, and antibiotics for 2 days and then dosed with 40 mg/kg of

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mebandazole[5] daily for 2 days. Her condition improved, and she was returned to the colony 1 week after the deworming with no evidence of spirurid egg passage. Two months later, her total serum protein was 6.4 g/dl, and although she had an eosinophilia with 3,300 eosinophils/μl (30%), she appeared alert and ate well. By the end of another month, no spirurid eggs were evident after three consecutive daily fecal flotation examinations, but because she was due to be sent to another zoo, she was treated prophylactically with mebendazole at 40 mg/kg for 3 more days. No further problems with *Pterygodermatites* were reported after she left our facility.

Another case was a 3-year-old male that was acquired from the Pretoria Zoo in South Africa in February 1981 as a breeding prospect to expand our genetic pool. He was placed in our quarantine facility for 1 month. Three consecutive daily fecal flotations were negative for parasite eggs shortly after his arrival, and he was tuberculin-negative. A hemogram indicated a moderate degree of anemia with a hematocrit of 27.0% and a hemoglobin of 9.7 g/dl. He was treated with 25 mg of iron dextran, and within 2 weeks the hemogram returned to a normal range, with a hematocrit of 37%, hemoglobin of 11.2 g/dl, and erythrocytes of 4.9 million/μl. At that time, the total serum protein was 6.4 g/dl. After another negative tuberculin test, the animal was released into the colony 1 month after his arrival. He was then paired with a female from the colony, and both were isolated from the other tamarins to enhance breeding activities.

In August 1981, about the same time that the young female became ill due to *Pterygodermatites*, the Pretoria male was admitted to the hospital moribund, hypothermic, and with a hematocrit of 27.5%, a hemoglobin of 8.5 g/dl, and total erythrocyte count of 3.8 million/μl. He was also leukopenic and hypoproteinemic, with a total leukocyte count of 2,300 μl, and a total serum protein of 2.0 g/dl. The monkey was passing watery feces with numerous nematodes identified as *P nycticebi*. He was treated for shock with intravenous fluids, steroids, and antibiotics. After his condition became somewhat stabilized, he was given mebendazole at 40 mg/kg for 2 consecutive days. During that time, he continued to pass numerous worms, but his condition worsened, and he died 3 days after the onset of his illness.

A complete necropsy revealed a thin animal with depleted fat stores and masses of nematodes identified as *P nycticebi* throughout the gastrointestinal tract (Figure 1). In addition to the parasites eliminated just before the monkey died, approximately 300 adult and 100 larvae were recovered from the digestive tract. The majority of the worms were in the small intestine and colon, with a few in the stomach, cecum, and rectum. The largest were free in the lumen, but the smaller forms, particularly in the upper portion of the small intestine, were attached to the mucosa. Approximately 80% of the worms were still alive less than 3 hours after the animal

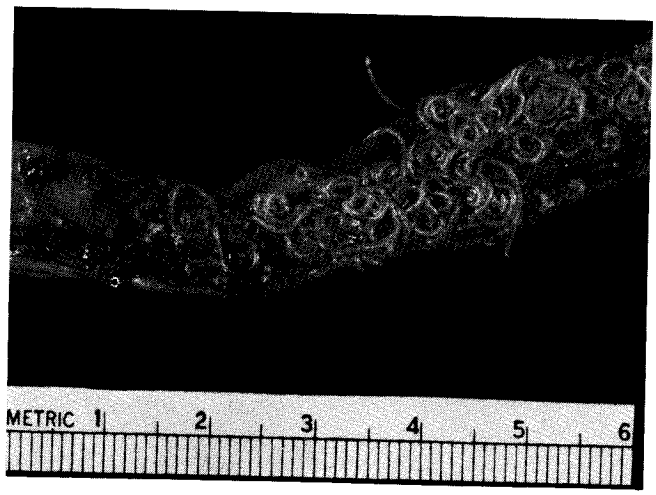

Figure 1
Opened small intestine from golden lion tamarin with numerous *Pterygodermatites nycticebi*. Necrotic mucosa to left (AFIP Neg 81-17425).

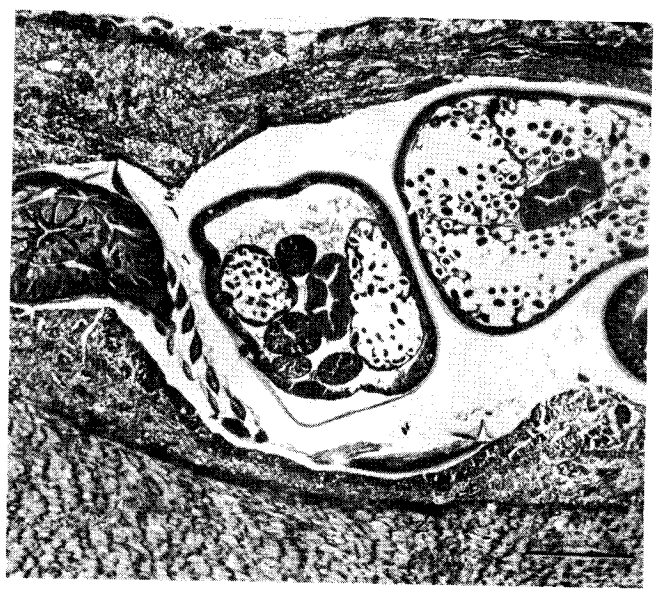

Figure 2
Pterygodermatites nycticebi embedded in small intestine. Hematoxylin and eosin stain. Line = 1 mm (AFIP Neg 81-17416).

died. The maximum dimensions of adult worms were: female, 30 x 1 mm; male: 8.5 x 0.5 mm.

Microscopically, the worms had their anterior ends embedded in the submucosa of the tamarin's small intestine (Figures 2, 3), although in a few instances, worms were found in the tunica muscularis and the pancreatic ducts. The small intestine showed marked clubbing of villi, and in some areas there was a necrotic pseudomembrane containing spirurid eggs, numerous yeasts, and pseudohyphae compatible with *Candida* sp. There also were numerous bacteria in the luminal contents. Incidental findings included moderate aortic atherosclerosis, mild cholelithiasis with a cystic common duct, and membranous glomerulonephritis.

[5]Telmin Paste. Pitman-Moore, Washington Crossing, NJ.

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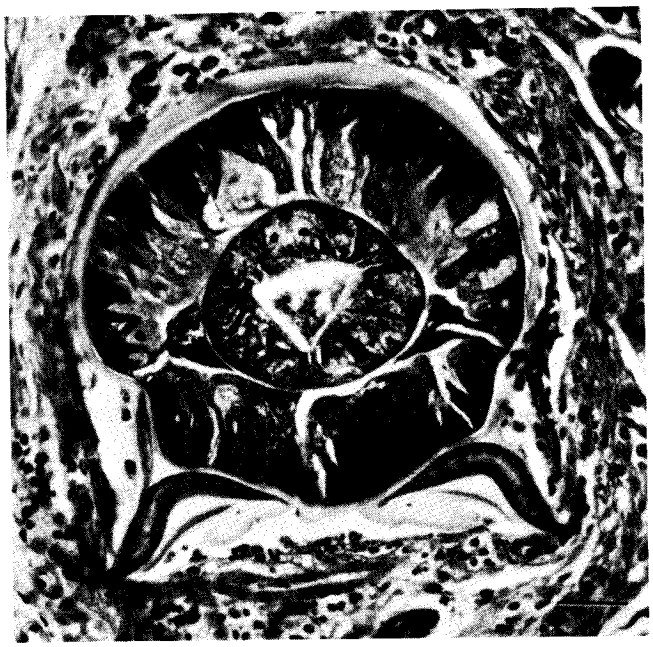

Figure 3
Histological section of anterior end. Note coelomyarian musculature and subventral combs. Hematoxylin and eosin stain. Line = 125 μm (AFIP Neg 81-17424).

An experiment with material from these two cases was performed to determine whether cockroaches played a role in the transmission of *P nycticebi.*

Materials and Methods

Forty laboratory-reared German cockroaches *(Blattella germanica)* were divided into two groups of 20 each and housed in large plastic containers covered with nylon mesh. One group was given water and a commercial rabbit diet[6] *ad libidum.* In the other group, feces from golden lion tamarins with *Pterygodermatites* eggs were substituted for rabbit diet. After 19 days, cockroaches were stunned by hypothermia, the head and tip of the abdomens were snipped from the body with scissors, and the intestines were removed with forceps. These were placed in buffered saline (0.88% NaCl) and examined for the presence of spirurid larvae. Several cockroaches from each group also were fixed in 10% neutral buffered formalin and processed for histopathology. The experimental cockroaches were isolated from any possible exposure to wild roaches at the facility. In addition, approximately 50 wild German cockroaches were captured in the vicinity of the dead tamarin's (Pretoria male) cage, and processed similarly.

Results

Fifteen of the 20 experimental cockroaches fed the affected tamarin's feces were found to be infected with larval stages of *P nycticebi.* Larvae were coiled in and associated with hypertrophy of the columnar epithelial cells of the cockroaches' intestines. Most larvae were third stage, although there were a few second-stage larvae. Measurements of 20 third-stage larvae teased from the intestine were as follows: length: 820 μm (range, 770 to 924 μm); maximum width: 46 μm (range, 45 to 47 μm); buccal cavity: 10 μm (range, 9 to 11 μm); muscular esophagus: 103 μm (range, 90 to 112 μm); glandular esophagus: 276 μm (range, 272 to 281 μm); intestine: 383 μm (range, 353 to 427 μm); tail: 52 μm (range, 47 to 56 μm). None of the control cockroaches was found to harbor larval spirurids.

In the wild-caught cockroaches, the intestines teased from the first five insects yielded 170 infective spirurid larvae with the same morphologic characteristics as determined for *P nycticebi* larvae obtained from the experimentally infected cockroaches. Histological sections revealed numerous larvae in intestinal cells and in the body cavities of the cockroaches.

Discussion

Pterygodermatites nycticebi appears to represent a relatively new parasite problem, particularly in members of Callitrichidae. A closely related spirurid, *Rictularia* sp, also has been reported in guenons (*Cercopithecus* sp), capuchins (*Cebus* sp), and tamarins in Russia (**8,9**). Some confusion in the nomenclature, however, may exist between *Pterygodermatites* and *Rictularia,* as prior to 1969 both were classified as *Rictularia,* but later the genus was subdivided into *Rictularia* and *Pterygodermatites* sp. The former has one single buccal tooth, and the latter has three buccal teeth. They are also distinguished by other morphologic differences of the oral cavity (**10,11**). Distinguishing features of these Rictularidae in tissue sections are two rows of subventral combs and intestinal cells with basally located nuclei (**12**). Eggs are thick-shelled and embryonated, characteristic of spirurid eggs, and measure 39 to 45 x 26 to 36 μm; however, identification of the specific type of spirurid is best made on the worms themselves.

The source of *P nycticebi* at the National Zoo is not known at this time. The primate collection did have five slow lorises in the early 1960's, the last one having died in 1977. While spirurids were not mentioned in any of the necropsy reports, these prosimians may have established the parasite in the collection and perpetuated it via the cockroach population.

The high morbidity associated with *Pterygodermatites* in our collection was most likely due to its life cycle involving the cockroach and the cockroach-eating habits of many of the tamarins. Passage of intact worms has only been observed in individuals with heavy infections that either had no previously known exposures or were otherwise stressed by intercurrent disease (**3**). Of the two additional cases reported here, one of the golden lion tamarins was only 5 months of age at the time her heavy infection was detected; the other (Pretoria male) had entered the collection just 5 months prior to succumbing to the *Pterygodermatites* infection. This animal was clearly fecal-negative for spirurid eggs at the beginning and end

[6]Purina Rabbit Chow. Ralston Purina Co, St Louis, MO.

of his month's quarantine, and it is unlikely that he entered the collection with this parasite.

The search for *P nycticebi* larvae in cockroaches was based upon the fact that these insects serve as intermediate hosts for other spirurids including *Physaloptera* sp, a common parasite of nonhuman primates (**13**), and the more closely related members of the family *Rictularidae* that occur in carnivores and rodents (**14**). Experimentally determining that the German cockroach will support second and third stage larvae provided the impetus to continue to dissect wild cockroaches. The subsequent finding of larval forms of *P nycticebi* in wild German cockroaches strongly implicates this insect as the intermediate host, although naturally infected cockroaches were not fed to tamarins to fulfill Koch's postulates.

Although clinical cases have occurred sporadically, the current regimen with mebendazole at 40 mg/kg seems to have controlled any major build-up of *P nycticebi* in the callitrichid collection, which is tested for parasites and treated with anthelmintic on a regular basis. The prepatent period of this worm is not known, but estimates from previous clinical cases indicate that it requires from 3 to 5 months before the parasite becomes deleterious to the host. Taking this into consideration, tamarins from the time of weaning up to 1 year of age are treated for 2 days of each month and adults for 2 days, three to four times yearly. The mebendazole paste is placed on a piece of banana which is readily consumed by the animals. Any animals that subsequently have eggs in their feces are treated for 3 days, and their feces are then checked for eggs for 3 to 5 consecutive days. Tamarins destined for other zoos are tested and treated rigorously prior to departure. Therapeutic trials in heavily infected animals have been limited. The mebendazole treatment appeared to be effective in the young female but not in the Pretoria male. This animal had not received earlier prophylaxis with mebendazole, and the failure was felt to be dose-related based on the numbers of worms found at necropsy.

Ultimately, eradication of the cockroach would be the most effective means of eliminating *P nycticebi*. Although complete extermination of cockroaches is difficult, continual efforts to control this pest should reduce exposure of tamarins to larvae.

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