Redescription of *Pterygodermatites (Mesopectines) nycticebi* (Mönnig, 1920) (Nematoda: Rictulariidae), a parasite of slow loris *Nycticebus coucang* (Mammalia: Primates)

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Key words: Nematoda, Rictulariidae, taxonomy, morphology

Abstract. *Pterygodermatites (Mesopectines) nycticebi* (Mönnig, 1920) (Nematoda: Spirurida: Rictulariidae) is redescribed based on immature and mature adults collected from the stomach and small intestine at autopsy of a slow loris, *Nycticebus coucang* (Boddaert, 1785) (Mammalia: Primates), in a zoological garden in Japan. It is first demonstrated that male possesses a minute telamon and a left lateral pore in the preanal part of body. The cause of death of the slow loris is strongly surmised to be related to the nematode infection, which was apparently acquired under captivity in the zoological garden.

Pterygodermatites nycticebi (Mönnig, 1920) (Nematoda: Rictulariidae) was first described by Mönnig (1920) based on only females collected from slow loris, *Nycticebus coucang* (Boddaert, 1785), of Indonesian origin which died in the Amsterdam Zoological Garden. It was later classified in the subgenus *Mesopectines* Quentin, 1969 by Quentin (1969). More later, it was redescribed based on only 1 male and 2 non-gravid females collected from slow loris in Malaysia (Quentin and Krishnasamy 1979). Morphological remarks have also been made on specimens found from primates of both Old World and New World origins that were reared in the zoological gardens in the United States (Yue et al. 1980, Montali et al. 1983, Tuggle and Beehler 1984, Gardiner and Imes 1987). However, our knowledge of its morphology is not sufficient. We recently had an opportunity to observe many male and female adults of *P. (M.) nycticebi* collected at necropsy of a slow loris in a zoological garden in Japan. They were at various growth stages and showed some important morpho-logical characteristics that have not been known as described herein.

MATERIALS AND METHODS

The host was an adult male slow loris that was introduced to a zoological garden in Hyogo Prefecture, Japan, on 14 April 1985, from an animal dealer in Japan, and died on 18 September 1985. The animal was supposed to be wild caught, but detailed records on the place of capture and the period of previous rearing were unknown. At the zoo, the animal was kept in a cage with size of 2 m (width) × 3 m (depth) × 2.5 m (height), and fed mainly with fruits. Significant abnormality was not noticed until the day before its death. Necropsy was performed by one of us (K.M.) 8 hr after the death. The body

was emaciated, 460 g in weight. No food material but instead numerous nematodes were found in the stomach and small intestine. The worms were fixed in a 10% formalin solution and preserved. They were submitted to the Department of Infectious Diseases, Oita Medical University, for detailed examination in 2000. For microscopical observation, they were cleared in a glycerol-alcohol solution by evaporating alcohol. Drawings were made with the aid of a drawing tube. Range and mean of the measurements, in micrometres unless otherwise stated, are given. For scanning electron microscopy (SEM), the samples were dehydrated in a graded t-butanol series, dried with a VFD-21 t-butanol freeze dryer (Vacuum Device, Ibaragi, Japan), coated with gold, and observed under a S-800 scanning electron microscope (Hitachi Science Systems, Tokyo, Japan).

RESULTS

Pterygodermatites (Mesopectines) nycticebi

(Mönnig, 1920) Quentin, 1969 Figs. 1–20

Redescription. Nematoda: Spirurida: Rictularioidea: Rictulariidae. Stout worms with 2 subventral rows of combs commencing immediately behind the buccal cavity (Figs. 1, 4, 13, 19). Buccal aperture inclined dorsally, hemicircular: dorsal rim with teeth, ventral rim with large cutting plate; 8 cephalic papillae forming 4 groups and 6 small inner papillae present; amphidial pores and lateral inner papillae on prominent conical elevations; 3 buccal teeth prominent (Figs. 2–4, 11–13). Oesophagus divided into short anterior muscular and long posterior glandular portions. Nerve ring at posterior 1/3 of muscular oesophagus; excretory pore slightly anterior to nerve ring; deirids spike-like, on spherical swellings (Figs. 1, 14).

Figs. 1–10. Male of *Pterygodermatites (Mesopectines) nycticebi* (Mönnig, 1920) collected from slow loris, *Nycticebus coucang*. **Fig. 1.** Anterior end, right lateral view. **Figs. 2–4.** Cephalic extremity, apical (2), dorsal (3) and right lateral (4) views. **Fig. 5.** Posterior end, left lateral view. **Fig. 6.** Posterior end with three fan-shaped preanal protrusions, right lateral view. **Fig. 7.** Spicules and telamon, dorsal view. **Fig. 8.** Telamon, dorsal view. **Figs. 9, 10.** Posterior extremity, ventral (9) and left lateral (10) views.

Figs. 11–18. Female of *Pterygodermatites* (*Mesoplectines*) *nycticebi* (Mönnig, 1920) collected from slow loris, *Nycticebus coucang*. **Figs. 11–13.** Cephalic extremity, apical (11), dorsal (12) and right lateral (13) views. **Fig. 14.** Deirid and subvental combs, dorsal view. **Fig. 15.** Ovejector, excised, left lateral view. **Figs. 16, 17.** Posterior extremity, ventral (16) and right lateral (17) views. **Fig. 18.** Egg.

Figs. 19, 20. Scanning electron microscopy of male *Pterygodermatites (Mesopectines) nycticebi* (Mönnig, 1920) collected from slow loris, *Nycticebus coucang*. **Fig. 19.** Cephalic extremity, subdorsal view (arrows indicate amphidial pores; d – dorsal side; v – ventral side). **Fig. 20.** Posterior extremity, left lateral view, showing a unilateral pore (arrow) and its magnified view (inset).

Male (17 worms): Posterior end bent ventrally. Length 3.5–15 (9.2) mm, width 122–730 (434). Subventral combs, 54–70 (67) pairs in number, terminating anterior to cloacal aperture (Figs. 5, 6, 20). Buccal cavity 26–70 (46) in depth. Nerve ring 156–408 (307), excretory pore 196–544 (407) and deirids 263–920 (589) from cephalic extremity. Muscular and glandular portions of oesophagus 170–552 (394) and 0.99–3.45 (2.25) mm, respectively, in length. Midventral area posterior to excretory pore often tuberculated. Preanal median ornamentation, 1–5 in number, of which posterior 1 to 3 fan-shaped (Figs. 5, 6, 9, 10, 20). Posterior end of preanal ornamentation 66–221 (146) from anus. Spermatozoa spherical, seen in seminal vesicle in all individuals (Fig. 5). Spicules equal, slightly curved ventrally, with dull distal tips, 79–90 (85) long by 6–8 (6.5) wide (Figs. 5, 7, 10). Gubernaculum absent. Telamon 3-pronged distally (Figs. 7, 8). Perianal region with area rugosa (Figs. 5, 6, 9, 10). Caudal papillae 10 pairs: 2 preanal, 1 adanal, 7 postanal, arranged grossly in 2 lines, but adanal pairs slightly lateral; 1st to 4th postanal pairs grouped, 5th and 6th pairs located closer, 7th pair apical (Figs. 5, 6, 9, 10). Preanal median unpaired papilla indistinct. Large unpaired pore containing several minute projections in left side of body at level of preanal fan (Figs. 5, 6, 9, 10, 20); neither duct nor ampulla connected seen. Phasmidial pores minute, in front of 7th pair of postanal papillae (Fig. 9). Tail conical, 102–263 (194) long.

Female (7 gravid and 4 non-gravid worms): Gravid individual stout. Subventral combs becoming spike-like at about 50th pairs, terminating at level of anus (Figs. 16, 17). Longitudinal cuticular thickenings with markings present in midtail laterally (Figs. 16, 17). Vulva near level of oesophago-intestinal junction, at 30th–42nd pairs of combs. Ovejector directed posteriorly, split into 2 branches (Fig. 15). Tail conical, sharply pointed distally (Figs. 16, 17). Eggs found in worms with body length of 12.1 mm or more, short-ellipsoidal, 32–40 (36.3) by 22–30 (26.0), thick-shelled, containing larva at deposition (Fig. 18). Measurements of gravid females: length 12.1–32 (24.5) mm, width 0.34–1 (0.73) mm; number of subventral comb pairs 68–94 (90); buccal cavity depth 42–84 (58); nerve ring 332–512 (398), excretory pore 496–680 (561), deirids 560–896 (729), vulva 2.56–4.95 (3.69) mm from cephalic extremity; muscular portion of oesophagus 464–624 (523) long, glandular portion of oesophagus 2.14–4.94 (3.7) mm long; tail 192–392 (277) long. Measurements of non-gravid females: length 4.51–9.77 (6.82) mm, width 0.2–0.32 (0.24) mm; number of subventral comb pairs 91–93 (92); buccal cavity depth 32–40 (36); nerve ring 204–256 (220), excretory pore 240–374 (300), deirids 340–456 (382), vulva 1.56–2.07 (1.83) mm from cephalic extremity; muscular portion of oesophagus 264–344 (304) long, glandular portion of oesophagus 1.56–2.07 (1.83) mm long; tail 92–120 (110) long.

Host: Slow loris *Nycticebus coucang* (Boddaert, 1785) (Primates: Lorisidae).

Sites of infection: Stomach and intestine.

Locality: Zoological garden, Hyogo, Japan (34°42'21"N, 135°14'2"E); origin unknown.

Date of collection: 18 September 1985.

Specimens deposited: National Science Museum, Tokyo, NSMT-As 3020.

Remarks: The morphological characteristics of the present worms are generally identical with those of *P. (M.) nycticebi* described by Quentin and Krishnasamy (1979). Although Quentin and Krishnasamy (1979) found only 1 preanal fan in the male, Tuggle and Beehler (1984) observed 3 preanal fans. The peculiar unpaired pore on the left lateral side in posterior body and the telamon have not been described. The position of vulva was recorded to be anterior to the oesophago-intestinal junction by Mönnig (1920) and Tuggle and Beehler (1984), but posterior to it by Quentin and Krishnasamy (1979). The present females show that the vulva is situated posterior to the oesophago-intestinal junction in immature worms but tends to be shifted anteriorly in gravid worms. By SEM observation, Gardiner and Imes (1987) found prominent dorsal cuticular ridges just posterior to the oral aperture. However, such ridges were not observed in the present material (Fig. 19). Irregularly reticulated nature of the ridges suggests that they were artifacts due to inappropriate dehydration procedure for SEM observation.

DISCUSSION

The slow loris seems to be the natural definitive host of *P. (M.) nycticebi* because it has been recorded from this primate in its natural habitats (Quentin and Krishnasamy 1979). Yue et al. (1986) demonstrated that the German cockroach, *Blattella germanica*, and the golden hamster, *Mesocricetus auratus*, could serve as intermediate and paratenic hosts, respectively. The presence of immature adults besides fully-grown worms in the present host, which had been reared in the zoological garden for more than 5 months, strongly suggests that the infection was acquired during this period by ingesting some intermediate hosts. Presumably, the Japanese cockroach, *Periplaneta japonica*, which was sometimes found in the cage, served as the source of infection. Similar infection of primates with *P. (M.) nycticebi* acquired under captivity in the zoological gardens has also been reported previously (Montali et al. 1983).

It has been known that rictulariids cause a severe, sometimes fatal, disease in primates. Lubimov (1933) recovered about 1,700 individuals of *Pterygodermatites (Mesoplectines) alphi* Lubimov, 1933 from 1 capuchin monkey, *Cebus apella*, which died in the Moscow Zoo. Lindquist et al. (1980) considered that the cause of death of a white-handed gibbon, *Hylobates lar lar*, was intestinal intussusception and chronic parasitism with *Pterygodermatites* sp. In the golden tamarins, *Leontopithecus rosalia rosalia*, *P. (M.) nycticebi* was also proved to associate with high morbidity and mortality (Montali et al. 1983). Tuggle and Beehler (1984) observed thickened intestinal wall, haemorrhagic foci and mononuclear leukocyte infiltration due to *P. (M.) nycticebi* infection in a slow loris although the cause of death was considered as septicaemia and possible lupus erythematodes. In the present case, the cause of death is also strongly surmised to be related to the nematode infection. An unusual case of rictulariid infection of human was also reported (Kenny et al. 1975).

The peculiar unilateral pore anterior to the anus in male of *P. (M.) nycticebi* is of special interest. Similar left lateral ornamentation has been figured for male of *Pterygodermatites (Multipectines) affinis* (Jägerskiöld, 1904) by Seurat (1915), although it resembles a pedunculate papilla. Lichtenfels et al. (1995) described bilateral perivulvar pores on the cuticle in the trichostrongylid nematodes and suggested their secretory nature because they were connected with ampullae under the cuticle. Differing from the perivulvar pores, the present ornamentation is unilateral, lacking a connecting duct, and found in males. Presumably, this pore may be of sensory nature because similar structure has been demonstrated for the somatic sensory organs of free-living nematodes (cf. Malakhov 1994). The function of this left lateral pore is unclear, but may be related to the copulatory behaviour, probably playing a role to find the proper position on the vulvar site. More observation on many other rictulariid species is necessary to elucidate the functional and systematic significance of this structure.

Acknowledgements. We should express our sincere thanks to Dr. J.-L. Justine, Muséum National d'Histoire Naturelle, Paris, and Mr. J. Araki, Meguro Parasitological Museum, for their kindness in providing valuable information on relevant literature, and to Mr. H. Kawazato and Ms. A. Yasuda, Oita Medical University, for their technical assistance on SEM observation. This study was partly supported by JSPS grant No. 12640684.

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Received 28 May 2002

Accepted 21 August 2002