DOI: 10.2478/s11686-010-0040-4
© W. Stefański Institute of Parasitology, PAS
Acta Parasitologica, 2010, 55(3), 270–275; ISSN 1230-2821

VERSITA

Redescription of *Lemuricola* (*Madoxyuris*) *bauchoti* (Nematoda, Oxyuridae) from *Lemur catta* in Madagascar

María del Rosario Robles[1]*, James E. Loudon[2], John M. Kinsella[3], Mandala Hunter-Ishikawa[4], David S. Miller[4], Michelle L. Sauther[2] and Frank P. Cuozzo[5]

[1]Centro de Estudios Parasitológicos y de Vectores CEPAVE (CCT-CONICET-La Plata) (UNLP), Calle 2 # 584 La Plata (1900), Buenos Aires, Argentina; [2]Department of Anthropology, University of Colorado, Boulder, CO 80309, USA; [3]HelmWest Laboratory, 2108 Hilda Avenue, Missoula, MT 59801, USA; [4]College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80524, USA; [5]Department of Anthropology, University of North Dakota, Grand Forks, ND 58202, USA

Abstract

Lemuricola (*Madoxyuris*) *bauchoti* Chabaud, Brygoo et Petter, 1965 is redescribed from material collected from the ring-tailed lemur, *Lemur catta*, from the Beza Mahafaly Special Reserve in Madagascar using the scanning electron microscope. This is a new host record and the first oxyurid reported from the ring-tailed lemur. Previously, records of each species of the subgenus *Madoxyuris* have been restricted to a single host species, but the close relationship between these nematodes and their Strepsirrhini hosts will only be proven when additional records fill in the gaps in their distribution.

Keywords

Lemuricola (*Madoxyuris*) *bauchoti*, Oxyuridae, ring-tailed lemur, *Lemur catta*, *Hapalemur*, Madagascar, SEM

Introduction

Species of Oxyuridae (Nematoda) can be found in most families and genera of the order Primates. The subfamily Enterobiinae was erected for oxyurids from primates (Hugot *et al*. 1996), and the monophyly of this subfamily was later confirmed by cladistic analysis (Hugot 1999). Primates of the suborder Strepsirrhini are parasitized by species of the genus *Lemuricola* Chabaud et Petter, 1959 (Enterobiinae).

Several authors have studied the possible coevolutionary relationships among groups of primates and their oxyurid parasites (e.g. Cameron 1929, Sandosham 1950, Inglis 1961, Brooks and Glen 1982, Hugot 1999). Among these, Hugot (1999) provides evidence supporting the existence of coevolution with cospeciation between hosts in Strepsirrhini and species of *Lemuricola*. Several occurrences of parasites specific to particular hosts were observed, and for this reason it is probable that the speciation of the parasites parallels very closely the speciation of the hosts (Hugot 1999). However, these studies are based on relatively few host species. To date, *Lemuricola* spp. have been recorded from only 10 of 88 host species of Strepsirrhini belonging to 7 of 23 genera and 4 of 7 families.

On the basis of cephalic and caudal papillae as well as characteristics of the lips, oesophagus and tip of the tail of males, three subgenera of *Lemuricola* have been defined (Chabaud and Petter 1959, Inglis 1961, Chabaud *et al*. 1965). To date, 9 species have been described: *L. nycticebi* (Baylis, 1928) and *L. malayensis* Inglis et Dunn, 1963 belong to the subgenus *Protenterobius* Inglis, 1961; *L. contagiosus* Chabaud et Petter, 1959 and *L. microcebi* Hugot, Morand et Gardner, 1995 belong to the subgenus *Lemuricola* Chabaud et Petter, 1965; and *L. lemuris* (Baer, 1935), *L. vauceli* Chabaud, Brygoo et Petter, 1965, *L. baltazardi* Chabaud, Brygoo et Petter, 1965, *L. bauchoti* Chabaud, Brygoo et Petter, 1965 and *L. daubentoniae* Petter, Chabaud, Delavenay et Brygoo, 1972 belong to the subgenus *Madoxyuris* Chabaud, Brygoo et Petter, 1965. Based on cladistic studies, Hugot and Baylac (2007) question the placement of *L. daubentoniae* in the subgenus *Madoxyuris*, suggesting that it is more closely related to the subgenus *Lemuricola*.

The males of each genus and subgenus of Enterobiinae have been observed to share a particular pattern of distribution of preanal and postanal papillae (Hugot and Baylac 2007). These caudal papillae as well as other features of the tail are very difficult to observe with light microscopy. Only two studies on Enterobiinae have studied these features with scanning electron microscopy (SEM) (Tenora *et al*. 1981, Baruš *et al*. 2007).

Lemuricola (*Madoxyuris*) *bauchoti* Chabaud, Brygoo et Petter, 1965 was described on the basis of specimens recov-

*Corresponding author: rosario@cepave.edu.ar

Table I. Main morphological features and measurements of *Lemuricola* (*Madoxyuris*) spp.

Species	***L.* (*M.*) *daubentoniae***	***L.* (*M.*) *lemuris***	***L.* (*M.*) *vauceli***	***L.* (*M.*) *baltazardi***	***L.* (*M.*) *bauchoti***	***L.* (*M.*) *bauchoti***
Author	Petter *et al*., 1972	(Baer, 1935)	Chabaud *et al*., 1965	Chabaud *et al*., 1965	Chabaud *et al*., 1965	Chabaud *et al*., 1965
Synonym		*Enterobius lemuris*				
Type host	*Dubentonia madagascariensis*	*Eulemur albifrons*	*Eulemur fulvus*	*Eulemur fulvus*	*Hapalemur* sp.	
Other hosts		*Eulemur macaco*	*Eulemur mongoz*			*Lemur catta*
Locality	Maroentsetra (Madagascar)	Berlin Museum	Ampijoroa (Madagascar)	Ampijoroa (Madagascar)	Ambavaniasy (Madagascar)	Beza Mahafaly (Madagascar)
References	Petter *et al*. 1972	Baer 1935	Chabaud *et al*. 1965	Chabaud *et al*. 1965	Chabaud *et al*. 1965	**this paper**
Male (n)		2	1?	3	3	10
total length	3.25	1.3–1.7	2.8	3.15	1.2	1.6–2.1
width	260	120-160	200	220	80–100**	150–210
nerve ring	120	–	160	160	70	80–120
oesophagus	–	328–440	790	390	255	220–280
bulb	–	54–72	120	110	50	50–80
total oesophagus	590	–	950	510	310	280–310
excretory pore	710	–	770	860	350	480–550
lateral alae	present	?	present	present	present	present
spicule	90	87–92	105	140	57	50–70
caudal alae length	270	?	present	present?		
tip of tail	absent	absent	absent	absent	absent	absent
Female (n)		2	1?	5	50	10
total length	4.6	5.0–6.0	5.3	5.3	2.24*–2.85	2.14–3.47
width	370	440–500	310	420	150*–200	150–280
nerve ring	100	216–235	200	200	130*–150	80–170
oesophagus	–	1000–1200	1250	585	350*–400	250–330
bulb	–	72–79	150	125	70–72*	70–90
total oesophagus	710	–	1450	730	440*–480	320–400
excretory pore	700	–	1100	1300	600*–620	350–550
lateral alae	present	?	present	present	present	present
vulva	1700	2400–3000	2400	2800	550*–1150	610–1300
tail	600	–	1250	800	550–578*	550–890
eggs	75 x 35	58–62 × 25–30	65 × 28	70 × 30	57 × 23	45–60 × 20–30

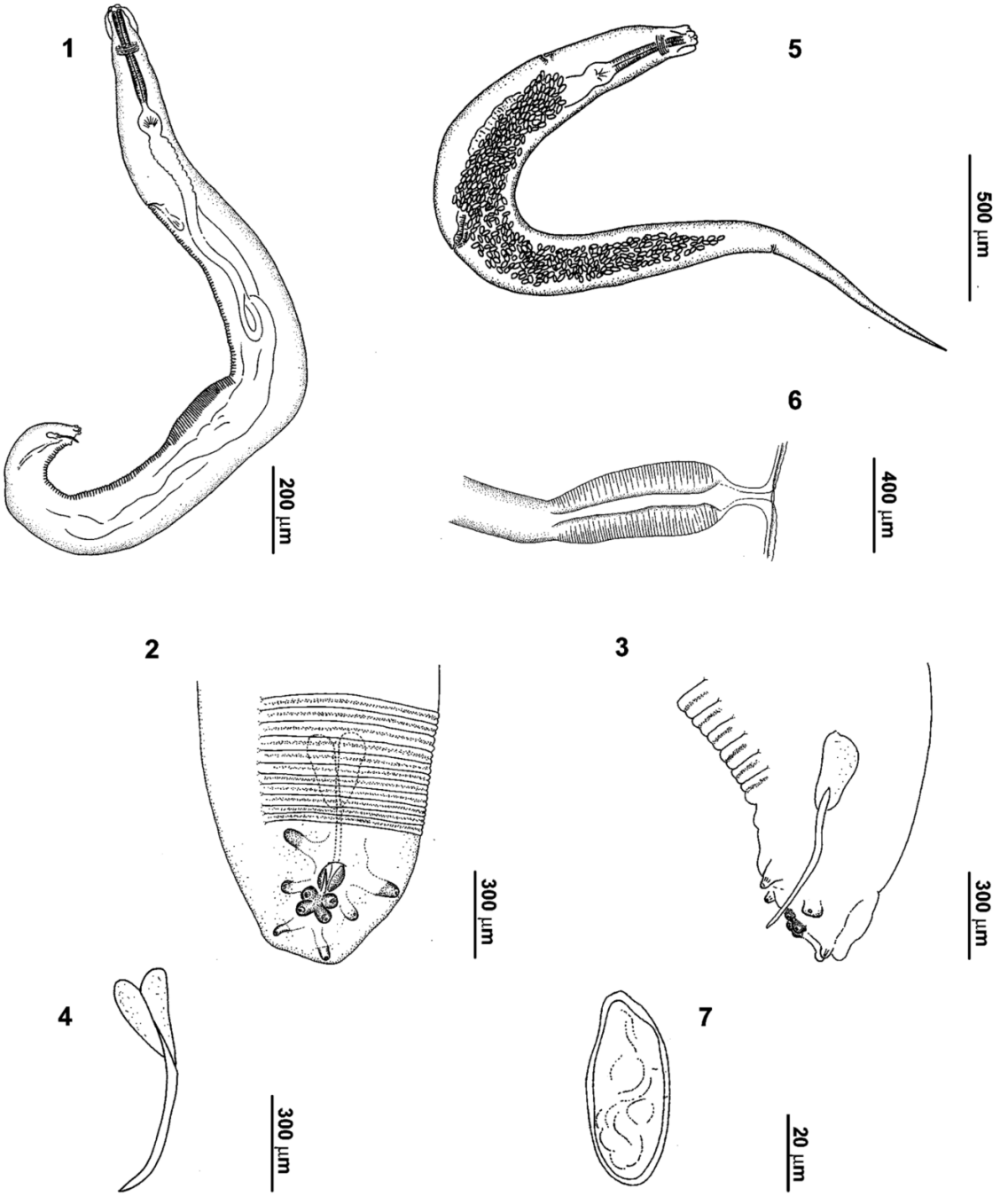
*Measurements obtained of allotype specimen; **measurements obtained of the drawing.

ered from *Hapalemur* spp. In this previous work, some characteristics were not mentioned, the drawings of the posterior end were not very clear and a correct differentiation from other species was not provided.

No species of Enterobiinae have been previously recorded from the ring-tailed lemur, *Lemur catta* Linneaus, 1758. The aim of this paper is to redescribe *Lemuricola* (*Madoxyuris*) *bauchoti* on the basis of new specimens recovered from this host from southwest Madagascar.

Materials and methods

The nematodes studied here were collected on 17 December 2005 from the feces of a ring-tailed lemur, *Lemur catta*, from the Beza Mahafaly Special Reserve in Madagascar (23°30´S, 44°40´E). The feces were collected immediately after observing the individual defecating during the morning hours (07–10 a.m.) and preserved in polyvinyl alcohol. Nematodes were studied in temporary mounts of lactophenol. Drawings were

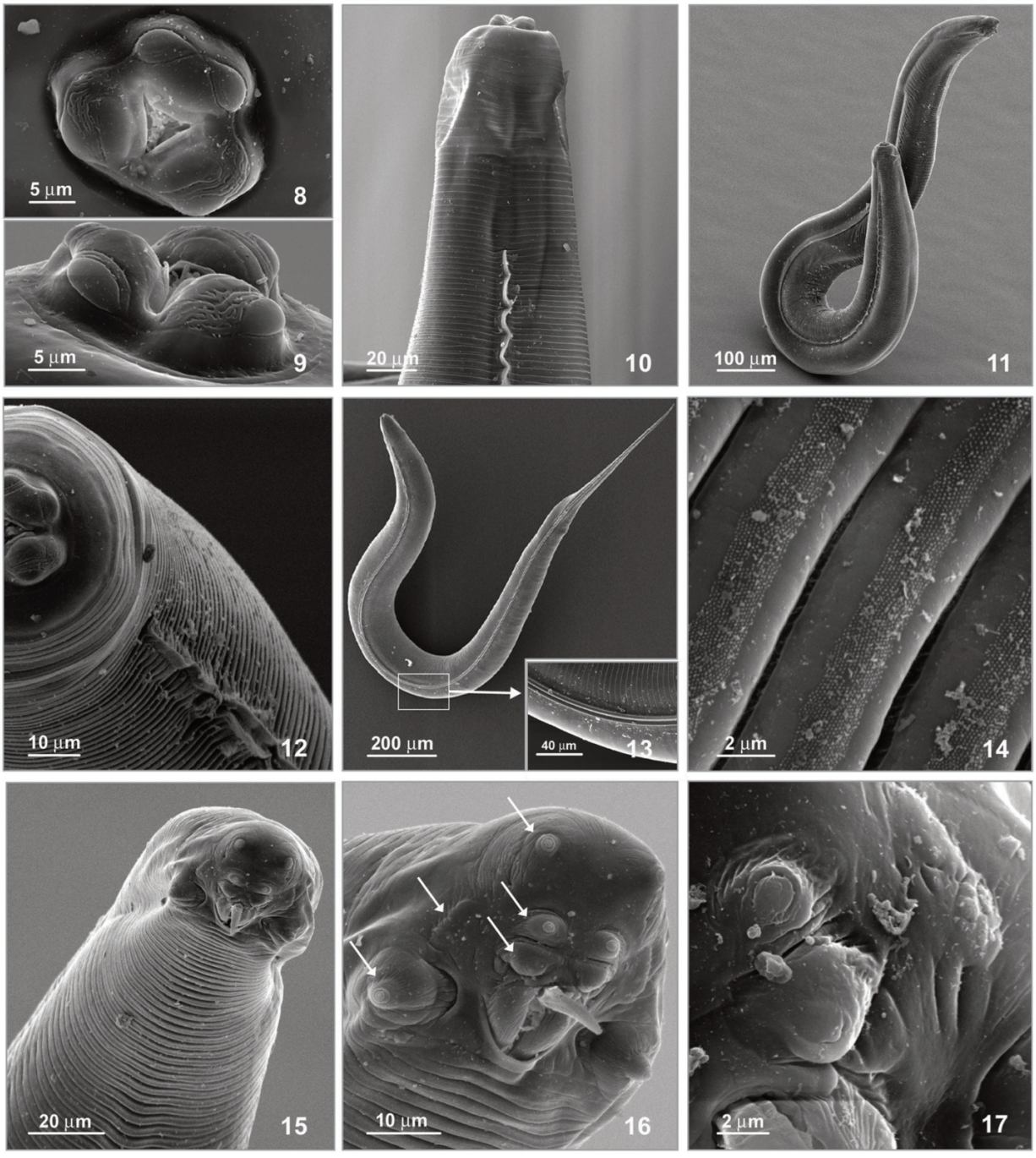


Figs 1–7. *Lemuricola* (*Madoxyuris*) *bauchoti*: **1 –** male, complete specimen; **2** – ventral view of posterior extremity, detail of caudal papillae, spicule and area rugosa; **3** – posterior extremity, lateral view; **4** –detail of spicule; **5 –** female, complete specimen; **6** – detail of vulva; **7 –** egg

made with the aid of a drawing tube. Some specimens were dried using the critical point method, examined under SEM (Jeol 6360 LV), and photographed.

All measurements are in micrometers unless otherwise stated (Table I).

The type specimen of *Lemuricola* (*Madoxyuris*) *bauchoti* from *Hapalemur* spp. was studied (1 female allotype, MNHN 634 F Muséum National d'Histoire Naturelle, Paris, France – this is the only type material existent of this species).



Figs 8–17. SEM micrographs of *Lemuricola* (*Madoxyuris*) *bauchoti*: **8** – female, buccal aperture surrounded by lips, four cephalic papillae and amphids, apical view; **9 –** female, lateral view of anterior extremity, detail of cephalic papillae and amphids; **10** – male, lateral view of anterior extremity, detail of lateral alae; **11** – male, complete specimen; **12** – female, lateral view of anterior extremity, detail of lateral alae; **13** – female, complete specimen, detail of lateral alae; **14** – male, detail of area rugosa; **15** – male, ventral view of posterior extremity and area rugosa; **16** – male, 2 pairs of pedunculate papillae, 2 pairs of sessile papillae, and 1 pair of amphids; **17** – male, detail of sessile papillae and amphids

Redescription

***Lemuricola* (*Madoxyuris*) *bauchoti* Chabaud, Brygoo et Petter, 1965** (Figs 1–17, Table I)

General: Buccal aperture surrounded by three lips. Lips defined, with cuticular edges around triangular opening (Figs 8 and 9). Four cephalic papillae visible and ventral papillae very close to the amphids (Figs 8 and 9). Lateral alae symmetrical and with sexual dimorphism. In males, the alae are single expansions (one crest) of the cuticle and extend from approximately 350–420 mm from the posterior end to approximately 3/4 of the body length (Figs 10 and 11); in females, the alae are double expansions (two crests) reaching the end of the body (Figs 12 and 13).

Male: Body length 1.2–2.1 mm. Body width 80–210. Total oesophagus 280–310 long, oesophageal bulb 50–80 long. Nerve-ring 70–120, and excretory pore 350–550 from anterior end (Fig. 1). Spicule 50–70 long (Figs 2–4). Tail spike absent (Figs 2 and 3).

Area rugosa present as a large round inflated cuticle posterior to the excretory pore, in the region between the second and third portion of body (Figs 1–3; 14 and 15).

Four pairs of caudal papillae: 1 preanal pedunculate pair, 2 postanal sessile pairs, and 1 large postanal pedunculate pair supporting the bursa (Figs 2 and 3, 15 and 16). The 2 sessile pairs are very close to each other and form a square cuticularized sheet connected with a small pitchfork ornamentation that longitudinally flanks the posterior edge of the cloaca (Figs 16 and 17). The phasmids are lateral to the first papillae and lie between the two pedunculate papillae (Fig. 17).

Female: Body length 2.14–3.47 mm. Body width 150–280. Total oesophagus 320–480 long, oesophageal bulb 70–90 long (Fig. 5). Nerve-ring 80–170, excretory pore 350–620, and vulva 550–1300 from anterior end (Figs 5 and 6). Tail relatively long, 550–890. Eggs elliptical and with large operculum, 45–60 × 20–30 (Fig. 7).

Type host: *Hapalemur* spp.

New host: *Lemur catta* Linnaeus, 1758 (Lemuridae).

Type locality: Ambavaniasy, east-central Madagascar.

New locality: Beza Mahafaly Special Reserve in Madagascar (23º30´S, 44º40´E).

Site of infection: Presumptively caecum. Found in feces.

Specimens deposited: Helminthological Collection of the Museo de La Plata CHMLP, no. is MLP 6146.

Remarks: The general morphology and measurements of the specimens of *L*. (*M*.) *bauchoti* from *L. catta* examined in the present study agree with specimens from *Hapalemur* spp. described by Chabaud *et al*. (1965) and the observations made here on the allotype specimen with a few exceptions. The minor discrepancies include small differences in the measurements of the excretory pore in both sexes and the total length of the oesophagus in the females (Table I).

The principal character which places these specimens in the subgenus *Madoxyuris* is the absence of a tail spike in the males. They can be differentiated from the other 4 species in the subgenus by their shorter oesophageal and spicule lengths. In addition, the males differ from *L.* (*M.*) *daubentoniae*, *L.* (*M.*) *vauceli*, and *L.* (*M.*) *baltazardi* by lacking caudal alae and by a more anterior excretory pore. The shorter distance from the vulva to the anterior end distinguishes the females from *L.* (*M.*) *lemuris*, *L.* (*M.*) *vauceli*, and *L.* (*M.*) *baltazardi*. Although the males are somewhat longer than the original description and there are other minor differences in measurements, we believe they most closely fit *L.* (*M.*) *bauchoti*.

Discussion

This is the first record of *Lemuricola* (*Madoxyuris*) *bauchoti* from *Lemur catta* and the first record of any oxyurid from this host. Structures such as the cephalic papillae, details and distribution of the caudal papillae and amphids, fine points of the cervical alae, and the area rugosa, poorly visualized under light microscopy, were observed here with the SEM for the first time.

Using light microscopy, Chabaud *et al*. (1965) described 3 pairs of pedunculate papillae, 2 pairs of sessile papillae, and 1 pair of amphids in *L.* (*M.*) *bauchoti* as well as *L.* (*M.*) *vauceli* and *L.* (*M.*) *baltazardi*. Only 2 pairs of pedunculate and 2 pairs of sessile papillae were observed here using SEM. There is no small pair of pedunculate papillae lateral to the anus as described by Chabaud *et al*., although there is a small ridge in this area (Fig. 15). Since the number of observed papillae in the Enterobiinae is constant, this feature should be re-examined in the species *L.* (*M.*) *vauceli* and *L.* (*M.*) *baltazardi*.

To date, all species in the subgenus *Madoxyuris* have been recorded from the family Lemuridae and each species has been described from a different species of host (Hugot and Baylac 2007). Chabaud *et al*. (1965) list the type host of *L. bauchoti* only as *Hapalemur* spp., but Hugot and Baylac (2007) give the type host as *Hapalemur simus* without any further explanation. In any case, ours is the first record of a species of *Lemuricola* from a host genus different from the original, which contradicts the coevolutionary theories of a number of authors (Cameron 1929, Sandosham 1950, Inglis 1961, Brooks and Glen 1982, Hugot 1999). However, a number of studies support a close phyletic affinity between *Lemur catta* and the genus *Hapalemur* (e.g. Crovella and Rumpler 1992, Macedonia and Stanger 1994, Yoder and Irwin 1999, Delpero *et al*. 2001), agreeing in part with the theories about a possible association by descent between *Lemuricola* and species of Strepsirrhini.

Future records of Enterobiinae in lemurs will reduce the gaps in their host distribution, and will prove or disprove the degree of correspondence between parasite and host phylogeny.

Acknowledgments. This research was supported by a grant from the National Science Foundation (BSC 0525109). We thank the follow-

ing people for supporting this research: Jeannin Ranaivonasy, Andry Randrianandrasana, Joel Ratsirarson, Jeannicq Randrianarisoa, and Youssouf Jacky Ibrahim. This research was supported by the Association Nationale pour la Gestion des Aires Protégées, the body governing research in Madagascar's protected areas, and the Département des Eaux et Forêts, Ecole Supérieure des Sciences Agronomiques. We thank Dana Whitelaw and members of the Beza Mahafaly Ecological Monitoring Team, especially Elahavelo and Enafa Efitroaromy. Special thanks to Jean Pierre Hugot for important suggestions on taxonomy. We also thank María Cristina Estivariz (CEPAVE-CCT-CONICET) for the drawings; and to Patricia Sarmiento (MLP-UNLP) for the SEM photographs.

References

Baer J.G.S. 1935. Etudes de quelques helminthes de lémuriens. *Revue Suisse de Zoologie*, 42, 275–292.

Baruš V., Foitová I., Koubková B., Hodová I., Šimková A., Nurcahyo W. 2007. A new nematode, *Pongobius hugoti* gen. et sp. n. from the orangutan, *Pongo abelii* (Primates: Hominidae). *Helminthologia*, 44, 162–169. DOI: 10.2478/s11687-007-0026-4.

Brooks D.R., Glen D.R. 1982. Pinworms and Primates: a case study in coevolution. *Proceedings of the Helminthological Society of Washington*, 49, 76–85.

Cameron T.W. 1929. The species of *Enterobius* Leach, in Primates. *Journal of Helminthology*, 7, 161–182. DOI: 10.1017/S0022149X00018770.

Chabaud A.G., Brygoo E.R., Petter A.J. 1965. Les nématodes parasites de lémuriens Malgaches. VI. Description de six espèces nouvelles et conclusion générales. *Annales de Parasitologie Humaine et Comparée*, 40, 181–214.

Chabaud A.G., Petter A.J. 1959. Les nématodes parasites de lémuriens Malgaches. II. Un nouvel Oxyure: *Lemuricola contagiosus*. *Mémoires de l'Institut Scientifique de Madagascar*, *Ser*. *A*, 13, 127–132.

Crovella S., Rumpler Y. 1992. Confirmation of the specific status of *Hapalemur aureus* (Primates: Strepsirrhini) by restriction genomic DNA banding patterns. *Human Evolution*, 7, 63–67.

Delpero M., Masters J.C., Cervella P., Crovella S., Ardito G., Rumpler Y. 2001. Phylogenetic relationships among the Malagasy lemuriforms (Primates: Strepsirrhini) as indicated by mitochondrial sequence data from the 12S rRNA gene. *Zoological Journal of the Linnean Society*, 132, 83–103. DOI: 10.1111/j.1096-3642.2001.tb00624.x.

Hugot J.P. 1999. Primates and their pinworm parasites: the Cameron hypothesis revisited. *Systematic Biology*, 48, 523–546. DOI: 10.1080/106351599260120.

Hugot J.P., Baylac M. 2007. Shape patterns of genital papillae in pinworms (Enterobiinae, Oxyurida, Nematoda) parasite of primates: A landmark analysis. *Infection*, *Genetics and Evolution*, 7, 168–179. DOI: 10.1016/j.meegid.2006.08.001.

Hugot J.P., Gardner S.L., Morand S. 1996. The Enterobiinae subfam. nov. (Nematoda, Oxyurida) pinworm parasites of primates and rodents. *International Journal for Parasitology*, 26, 147–159. DOI: 10.1016/0020-7519(95)00108-5.

Inglis W.G. 1961. The oxyurids parasites (Nematoda) of primates. *Proceedings of the Zoological Society of London*, 136, 103–122.

Macedonia J.M., Stanger K.F. 1994. Phylogeny of the Lemuridae revisited: Evidence from communication signals. *Folia Primatologica*, 63, 1–43. DOI: 10.1159/000156787.

Sandosham A.A. 1950. On *Enterobius vermicularis* (Linnaeus, 1758) and some related species from primates and rodents. *Journal of Helminthology*, 24, 171–204. DOI: 10.1017/S0022149X00019246.

Tenora F., Baruš V., Wiger R., Ryšavý B. 1981. Scanning electron microscopic studies on nematode species of the genera *Passalurus*, *Enterobius*, and *Lemuricola* (Oxyurida). *Acta Universitatis Agriculturae Facultas Agronomica,* 29, 327–339.

Yoder A.D., Irwin J.A. 1999. Phylogeny of the Lemuridae: Effects of character and taxon sampling on resolution of species relationships within *Eulemur*. *Cladistics*, 15, 351–361. DOI: 10.1111/j.1096-0031.1999.tb00271.x.

(Accepted May 14, 2010)