Kasetsart J. (Nat. Sci.) 45 : 1020 - 1027 (2011)

A Redescription of *Felicola (Paradoxuroecus) bengalensis* (Werneck, 1948) (Phthiraptera: Trichodectidae) from a Common Palm Civet (*Paradoxurus hermaphroditus*) in Thailand

Tanasak Changbunjong*, Pirom Prompiram, Thekhawet Weluwanarak and Ruangrat Buddhirongawatr

ABSTRACT

The chewing louse species, *Felicola (Paradoxuroecus) bengalensis* (Werneck, 1948) (Phthiraptera: Trichodectidae) has been previously described based on the morphology of the head, abdomen, genitalia and the shape and the presence of abdominal tergites. However, such studies lack detailed biometrical data. In this study, chewing lice from a common palm civet, *Paradoxurus hermaphroditus* Pallas, 1777 (Carnivora: Viverridae), captured from the reserved forest in Western Thailand, is redescribed and illustrated using three male and three female specimens. Detailed morphological data were gathered on these louse species, which strongly supplements previous descriptions and can also be used for monitoring the health status of the common palm civet population.

Keywords: chewing lice, *Felicola (Paradoxuroecus) bengalensis*, *Paradoxurus hermaphroditus*, phthiraptera, trichodectidae

INTRODUCTION

The family Trichodectidae (Insecta: Phthiraptera: Ischnocera) includes over 380 taxa (species and subspecies), all of which parasitize mammals (Lyal, 1985; Price *et al*., 2003). The morphology of Trichodectidae shows a combination of characters that distinguishes it from other ischnoceran families by the presence of three segmented antennae and tarsi with a single claw (Perez-Jimenez *et al*., 1990).

The same morphology is present in the genus *Felicola* and the subgenera into which it is subdivided. There are 55 species in the genus *Felicola*, which is divided into four subgenera—namely, *Felicola*, *Suricatoecus*, *Lorisicola* and *Paradoxuroecus*—with 18, 11, 13 and 13 species, respectively. From these 55 species, 48 species are from hosts belonging to the families Felidae, Herpestidae and Viverridae, whereas 6 species are from Canidae, and only 1 species is from Lorisidae (Primates) (Timm and Price, 1994).

The subgenus *Paradoxuroecus* had been debated by several authors including Werneck (1948) who considered the subgenus to be a synonym of *Felicola* and accordingly placed it as a subgenus of *Lorisicola*. Conversely, Hopkins (1949) considered *Neofelicola* and *Parafelicola* to be subgenera of *Felicola.* Lyal (1985) divided the genus *Felicola* into two subgenera (*Felicola* and *Suricatoecus*) and the genus *Lorisicola* into two subgenera (*Lorisicola* and *Paradoxuroecus*).

The Monitoring and Surveillance Center for Zoonotic Diseases in Wildlife and Exotic Animals, Faculty of Veterinary Science, Mahidol University, Nakorn Pathom 73170, Thailand.

* Corresponding author, e-mail: g4837556@hotmail.com

Received date : 31/05/11 Accepted date : 28/07/11

However, Timm and Price (1994) demonstrated that the characteristics used to separate *Felicola* and *Lorisicola* were not sufficient for the differentiation of genera and considered all four subgenera within the single genus *Felicola*.

The original description of female chewing lice, *Felicola* (*Paradoxuroecus*) *bengalensis*, was described in the genus *Neofelicola* (Werneck, 1948). These lice were collected in Thailand from *Paradoxurus hermaphroditus canus* Miller, a subspecies of the common palm civet, a mammal from the family Viverridae and native to Southeast Asia and Southern China (Emerson, 1965). This mammal is a solitary nocturnal omnivore that forages on fruits, leaves, arthropods, worms and mollusks and has the flexibility to live in dense forests, agricultural areas or even alongside humans (Francis, 2008). The female lice collected from this host corresponded to the descriptions of *N. bengalensis* made by Werneck (1948) and thus were originally classified as such. In addition, Emerson (1965) also classified male chewing lice collected from the same host species and in the same country as *N. bengalensis*.

Although previous studies of Werneck (1948) and Emerson (1965) have already described *Felicola (P.) bengalensis* in Thailand, they lacked biometrical data on the species. Therefore, this paper presents a detailed description of *Felicola (P.) bengalensis* including biometric data and illustrations.

MATERIALS AND METHODS

In June 2009, an adult common palm civet (*Paradoxurus hermaphroditus*) was trapped in the Srinakarin dam reserved forest, Kanchanaburi province, Western Thailand. It was anesthetized with tiletamine hydrochloride (Zoletil®) before being examined for ectoparasites. A fine-toothed comb was used to dislodge any ectoparasites in the fur of the animal. Collected lice specimens were preserved in 70% alcohol and taken to the laboratory. They were mounted in Hoyer's medium (Krantz, 1978). Mounted slides were then incubated at 45 °C for a week and cover-slips were ringed with paint to prevent desiccation of the medium during storage.

A systematic classification was made following Timm and Price (1994), while the terminology adopted for the description of male and female specimens was based on Lyal (1985).

RESULTS

Lice were the only ectoparasites detected in this study. A total of six adult lice, comprising three males and three females were collected from the host. All lice specimens were found on the dorsal zone, especially on the back and abdominal regions.

Redescription of *Felicola (Paradoxuroecus) bengalensis*

Male and female morphology are shown in Figure 1 and Figure 3, respectively. The head is rather large, and its width is greater than its length in both sexes (Table 1). Its maximum width is located at the level of the temples and sparse scattered dorsal setae. The length of the preantennal region is approximately the same as the postantennal region. The anterior part of the head presents an osculum (median indentation of the anterior margin of the head). Along the margin between the osculum and antennae is a "clypeal marginal carina" that is broadly convex and sclerotised, with a lightly sclerotised posterior to the osculum. Mandibles are asymmetrically large and sclerotised. Antennae are filiform in both sexes with three antennomeres divided into the scape, pedicel and flagellum. In males, the scape is broader than the other antennomeres with a longitudinal setal row. Only the male flagellum bears two basally articulated teeth. The temples margin is round and its occipital region has a characteristic sinuous shape (Figure 1).

The thorax is wider than long (Table 1). The prothorax has a short lateral seta and a long median submarginal seta on each side. The pterothorax has a row of setae including two short and two long setae placed laterally. A single tarsal claw is presented at the terminal of each leg.

The abdomen is oval-shaped in both sexes comprising two short setae on tergum I and a single row of short setae on tergum and sternum II–VIII. Segments III–VI bear abdominal spiracles. Only on the anterior of males are tergites found on tergum III–VI, while sternite plates divided into anterior and posterior are found at segment VI of the sternum. In females, tergite plates can be seen on tergum III–IX, while posterior tergites are absent.

The male genitalia comprise sternites VI, VII and VIII and are fused to the lateral rod of the subgenital plate (Figure 2). Basal apodeme lateral struts are straight and parallel to a large spinous sac. Parameres are short and basally closely associated. Mesomeres are extended basally between basal apodeme lateral struts and fused apically with median extension. The measurements of male genitalia are shown in Table 2.

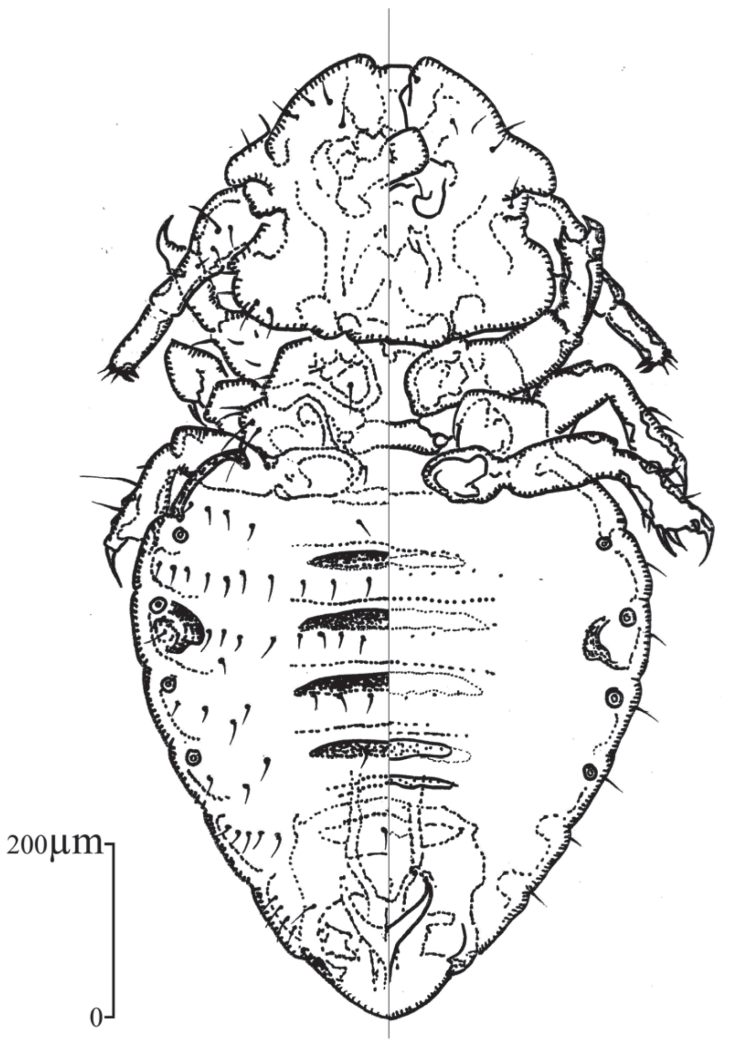

Figure 1 *Felicola (Paradoxuroecus) bengalensis*. Male: dorsal (left) and ventral (right) views.

Table 1 Measurements (μm) of *Felicola* (*Paradoxuroecus*) *bengalensis*.

Characteristic	Male (n=3)				Female (n=3)			
	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD
CL	343	350	346	4.13	382	387	384	2.98
CW	388	392	390	2.03	421	442	429	11.48
CI	0.88	0.89	0.89	0.01	0.88	0.91	0.89	0.02
TL	182	184	183	0.1	194	246	212	29.42
TW	323	333	328	5.27	418	419	419	0.47
AL	603	638	624	18.84	762	770	767	4.3
AW	601	608	606	4.46	714	778	740	33.66
ToL	1,135	1,155	1,145	10	1,343	1,399	1,364	30.08
CoI	1.88	1.9	1.89	0.01	1.8	1.88	1.84	0.04

CL = Cephalic length; CW = Cephalic width; CI = Cephalic index (CL/CW); TL = Thoracic length; TW = Thoracic width; AL = Abdominal length; AW = Abdominal width; ToL = Total length; CoI = Corporal index (ToL/AW); SD = Standard deviation.

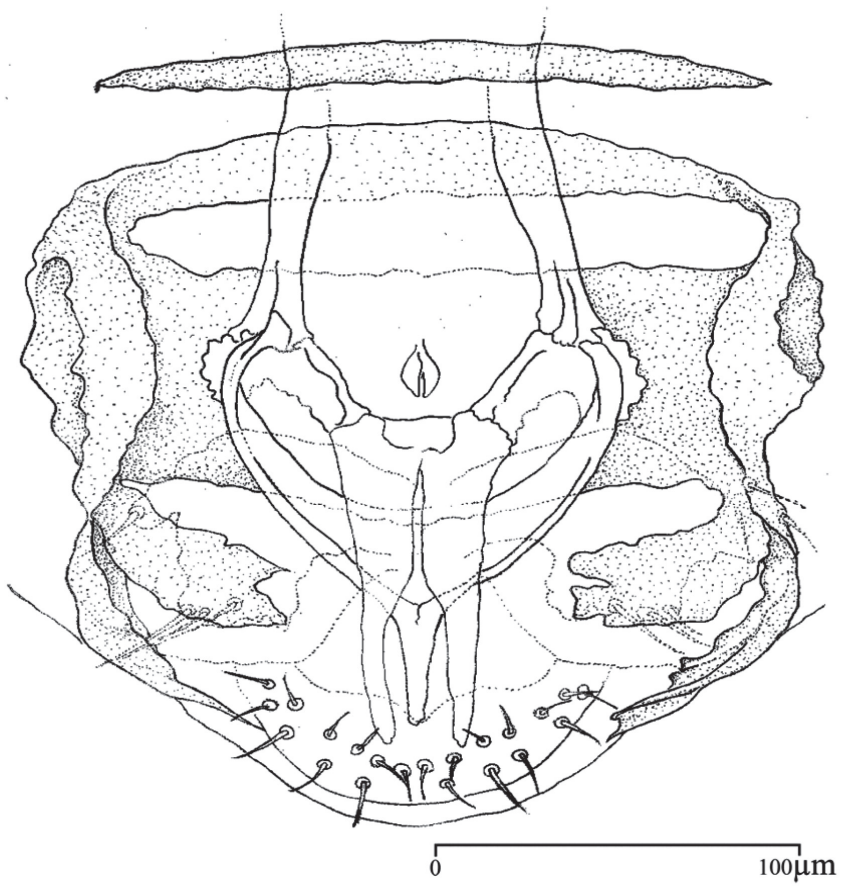

Figure 2 *Felicola (Paradoxuroecus) bengalensis*. Male genitalia.

Table 2 Measurements (μm) of the male genitalia of *Felicola* (*Paradoxuroecus*) *bengalensis*.

Characteristic	Minimum	Maximum	Mean	SD
BpL	165	183	174	9
BpW	116	119	118	1.73
PaL	110	111	111	0.58
PaW	39	43	41	2

BpL = Basal plate length; BpW = Basal width; PaL = Paramere length; PaW = Paramere width; SD = Standard deviation.

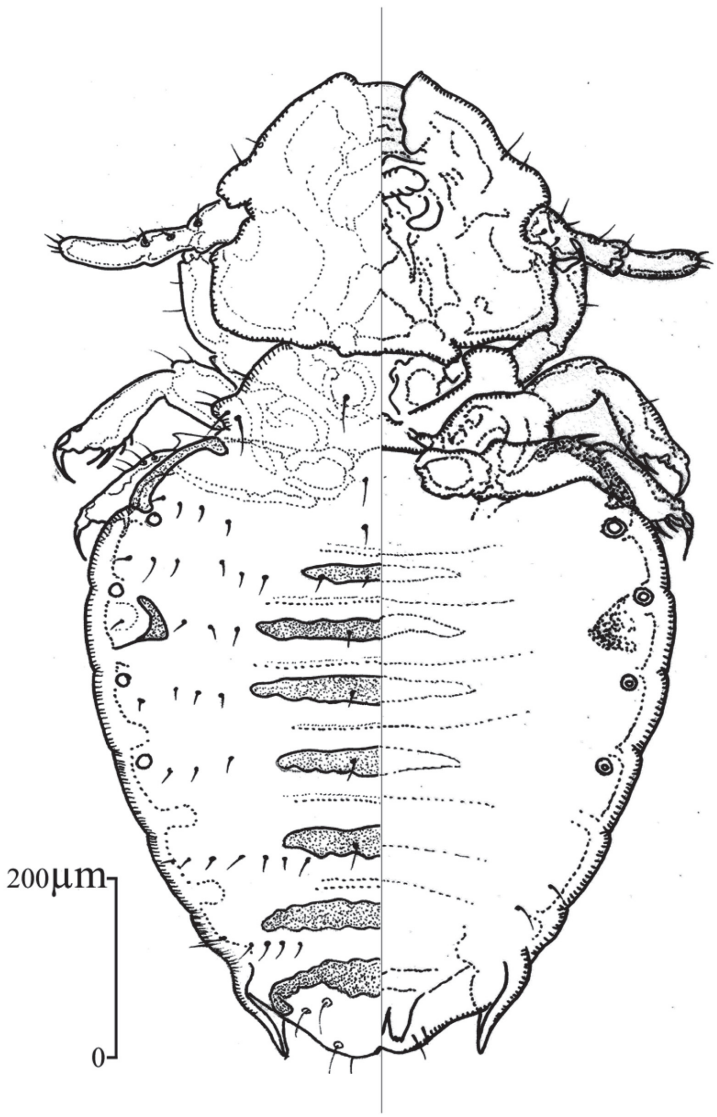

Figure 3 *Felicola (Paradoxuroecus) bengalensis*. Female: dorsal (left) and ventral (right) views.

The female genitalia region has a characteristic chaetotaxy (Figure 4). The subgenital lobe is divided into a bilobe with overlapping scales. Each gonapophysis presents a lobe and often bears four setae.

DISCUSSION

The male and female lice studied were clearly classified in the genus *Felicola* based on the morphology of their heads and genitalia. In addition, the study lice can be placed within the subgenus *Paradoxuroecus* (Lyal, 1985) by the presence of: 1) four pairs of abdominal spiracles, 2) a median extension on a mesomeral arch (mesomeres), 3) a male gonopore surrounded by a spicular patch and 4) a female subgenital lobe with overlapping scales.

Felicola (P.) bengalensis can be distinguished from other species within the subgenus by the shape of the male genitalia, the shape and the presence of abdominal tergites and the shape of the abdomen. Furthermore, biometrical data of this louse species are critical to evaluate differences between species. For instance, the corporal index (CoI) of both male and female lice of *Felicola (P.) bengalensis* in the present study was smaller than in *Felicola (P.) genettae*, while other biometrical data including total length (ToL) and cephalic index (CI) were similar (Perez, 1990).

The morphology, including general size, shape and chaetotaxy, of *Felicola (P.) bengalensis* is very similar to *Felicola (P.) philippinensis* (Emerson, 1965). However, Emerson (1965) demonstrated that *Felicola (P.) bengalensis* can

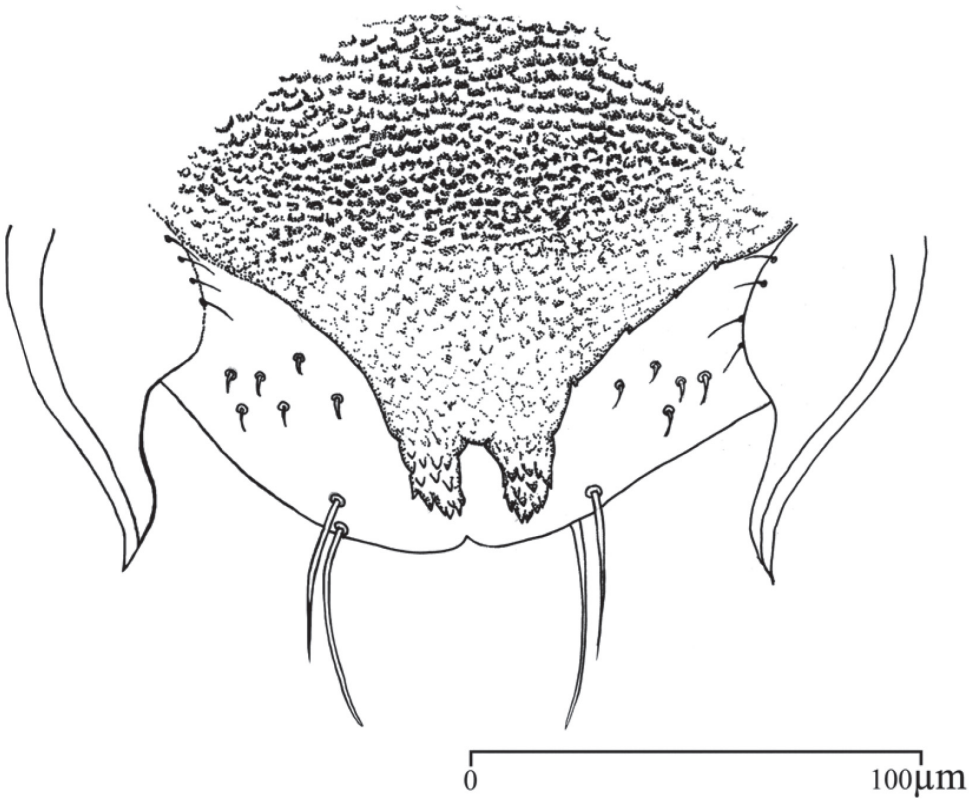

Figure 4 *Felicola (Paradoxuroecus) bengalensis*. Female genitalia.

be separated from *Felicola (P.) philippinensis* by the row of setae on the abdominal tergite and sternite in both sexes, as more setae are found in *Felicola (P.) philippinensis* than in *Felicola (P.) bengalensis*. The male genitalia of the two species are also very different. In the female, the vulva of *Felicola (P.) philippinensis* has more marginal setae than in *Felicola (P.) bengalensis* (Emerson, 1965). The later study indicated that the characteristics of the genitalia, tergal and sternal setae in males and the valval setal number in females were not sufficient to distinguish between *Felicola (P.) bengalensis* and *Felicola (P.) philippinensis*. *Felicola (P.) philippinensis* has been consequently provisionally synonymised with *Felicola (P.) bengalensis* (Lyal, 1985).

Lice (Phthiraptera) are typically host specific with most species parasitizing a single host species or a few closely related species (Durden, 2001). They are obligate parasites that spend their entire life cycle on the hosts (Emerson and Price, 1985). The infestation of lice on mammalian hosts can cause anemia, dermatitis, pruritis, skin sensitization and other allergic reactions, intense grooming, fur matting and alopecia, inflamed or scaly skin, unthriftiness, decreased growth rate, secondary infection at bite sites and the transmission of parasites and pathogens (Nelson *et al*., 1975). In addition, Nelson *et al.* (1975) also reported a large number of lice infestations on wild mammals that can be the cause of serious pathological conditions. Because lice are known to cause health problems in various species of wild mammals, treatment programs are recommended (Durden, 2001). Ticks, like lice, are ectoparasites which have also been reported on the common palm civet in Thailand (Aroon *et al*., 2009). However, the present results confirm that there is host specificity between lice, specifically, between *Felicola (P.) bengalensis* and their host, *Paradoxurus hermaphroditus*.

In summary, this study obtained new and valuable data on the morphology of *Felicola (P.) bengalensis* from the common palm civet that will be helpful for further studies on ectoparasites and their hosts. The findings are also important for monitoring the health of the wildlife population, especially for species that are endangered or near extinction.

ACKNOWLEDGEMENTS

This work was supported by the Plant Genetic Conservation Project under the Royal Initiation of Her Royal Highness Princess Maha Chakri Sirindhorn (RSPG). The authors would like to thank the staff of the Monitoring and Surveillance Center for Zoonotic Diseases in Wildlife and Exotic Animals (MoZWE) for specimen collection and study suggestions.

LITERATURE CITED

Aroon, S., T. Artchawakom, J.G. Hill, S. Kupittayanant and N. Thanee. 2009. Ectoparasites of the common palm civet (*Paradoxurus hermaphroditus*) at Sakaerat Environmental Research Station, Thailand. **Suranaree J. Sci. Technol.** 16: 277–281.

Durden, L.A. 2001. Lice (Phthiraptera), pp 3–17. *In* W.M. Samuel, (ed.). **Parasitic Diseases of Wild Mammals.** Iowa State University Press. Ames, IA, USA.

Emerson, K.C. and R.D. Price. 1985. Evolution of Mallophaga on mammals, pp. 233–255. *In* K.C. Kim, (ed.). **Coevolution of Parasitic Arthropods and Mammals.** John Wiley and Sons. New York.

Emerson, K.C. 1965. A new species of Mallophaga from the Philippine Islands. **J. Kans. Entomol. Soc.** 38: 68–69.

Francis, C.M. 2008. **A Field Guide to the Mammals of Thailand and South-East Asia.** Asia Books. Bangkok. 392 pp.

Hopkins, G.H.E. 1949. The host-associations of the lice of mammals. **Proceedings of**

the Zoological Society of London. 119: 387–604.

Krantz, G.W. 1978. **A Manual of Acarology.** 2nd ed. Oregon State University Bookstores. Corvallis, OR, USA. 509 pp.

Lyal, C.H.C. 1985. A cladistic analysis and classification of trichodectid mammal lice (Phthiraptera: Ischnocera). **Bull. Br. Mus. (Nat. Hist.) Entomol.** 51: 187–346.

Nelson, W.A., J.E. Bell, C.M. Clifford and J.E. Keirans. 1975. Host-ectoparasites relationships. **J. Med. Entomol.** 12: 143–166.

Perez, J.M., M.D. Soler-Cruz, R. Benítez-Rodríguez, I. Ruiz-Martínez, M. Díaz-López, F. Palomares-Fernández and M.D. Castro. 1990. Phthiraptera from some wild carnivores in Spain. **Sys. Parasitol.** 15: 107–117

Price, R.D., R.A. Hellenthal, R.L. Palma, K.P. Johnson and D.H. Clayton. 2003. **The Chewing Lice: World Checklist and Biological Overview.** Natural History Survey. Illinois Special Publication 24. 501 pp.

Timm, R.M. and R.D. Price. 1994. A new species of *Felicola* (Phthiraptera: Trichodectidae) from a Costa Rican jaguar, *Panthera onca* (Carnivora: Felidae). **Proceedings of the Biological Society of Washington.** 107: 114–118.

Werneck, F.L. 1948. **Os malofagos de mamiferos, Parte I: Amblycera e Ischnocera (Philopteridae e parte de Trichodectidae)** (in Portuguese). Revista Brasileira de Biologia. Rio de Janeiro. 243 pp.