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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

CYSTACANTHS OF *GIGANTORHYNCHUS ECHINODISCUS* (ACANTHOCEPHALA, GIGANTORHYNCHIDAE), IN NEOTROPICAL TERMITES (ISOPTERA, TERMITIDAE)

CISTACANTOS DE *GIGANTORHYNCHUS ECHINODISCUS* (ACANTHOCEPHALA, GIGANTORHYNCHIDAE), EN TERMITAS NEOTROPICALES (ISOPTERA, TERMITIDAE)

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Abstract

Specimens of *Labiotermes emersoni* (Araujo, 1954) and *Orthognathotermes heberi* Raw & Egler, 1985, were collected at Parque Nacional da Serra da Canastra, State of Minas Gerais, Brazil. Soldiers of the two species were suspected to carry larval acanthocephalan parasites due to different sizes and shape of their heads and because some specimens had a conspicuous, cylindrical, whitish 'body' in the hemocoel, around the digestive tract in the abdomen. The termites showed shape alteration and light pigmentation dystrophy of the heads induced by the larval acanthocephalans. These alterations were documented photographically and the cystacanths described. The encysted juveniles removed from the hemocoel of infected soldier termites and processed accordingly, were determined as *Gigantorhynchus echinodiscus* (Diesing, 1851). The proboscis had the typical cylindrical shape and the characteristic two distal circles of large hooks (6+12), covered with small, almost rootless spines, and a very short neck. This is the first record from Brazil of any species of termites infected with acanthocephalans of the genus *Gigantorhynchus* Hamann, 1892 and the first record of *G. echinodiscus* cystacanths infecting the intermediate host.

Keywords: Anteaters - *Cornitermes* - *Gigantorhynchus lutzi* - intermediate hosts - life cycles - *Labiotermes* - morphology alteration - *Orthognathotermes.*

Resumen

Los especímenes de *Labiotermes emersoni* (Araujo, 1954) y *Orthognathotermes heberi* Raw & Egler, 1985, se colectaron en el Parque Nacional de Serra da Canastra, Estado de Minas Gerais, Brasil. Se sospechaba que soldados de las dos especies eran portadores de larvas de acantocéfalos parásitos debido a diferentes tamaños y formas de la cabeza, además de un "cuerpo" blanquecino, cilíndrico visible en el hemocele de algunos ejemplares, alrededor del tubo digestivo en el abdomen. Los termitas mostraron alteración de forma y leve distrofia de pigmentación en sus cabezas inducidas por los acantocéfalos larvales. Estas alteraciones se documentaron fotográficamente y se describen los cistacantos. Las formas juveniles enquistadas retiradas del hemocele de soldados infectados se identificaron como *Gigantorhynchus echinodiscus* (Diesing, 1851). Los probóscides tenían la típica forma cilíndrica y los característicos dos círculos distales de grandes ganchos (6+12), cubiertos de pequenas espinas, casi sin raíces y un cuello muy corto. Este es el primer registro de dos especies de termitas infectadas por acantocéfalos del género *Gigantorhynchus* Hamann, 1892 y el primero registro de cistacantos de *G. echinodiscus* infectando el hospedero intermediário,

Palabras clave: oso-hormiguero – *Cornitermes* – *Gigantorhynchus lutzi* – hospedero intermediário – ciclos de vida – *Labiotermes* – alteración morfológica – *Orthognathotermes*.

INTRODUCTION

Pigmentation alteration induced by larval acanthocephalans, known as "color dichromatism", "depigmentation", "non-pigmentation", or more properly, "pigmentation dystrophy", as suggested by Oetinger & Nickol (1981), is an uncommon phenomenon. It has been documented for North America in species of the aquatic isopod genus *Asellus* Geoffroy, 1764 (Seidenberg, 1973, Camp & Huizinga, 1979, Oetinger & Nickol, 1981, 1982). The same phenomenon was recorded for the first time in Brazil by Amato *et al.* (2003), in the terrestrial isopod genus *Atlantoscia* (van Name, 1940).

Termites seldom have been confirmed as intermediate hosts for acanthocephalans, much less were recorded with morphological and/or behavioral alterations induced by these parasites. Until recently, there have been only two instances in which these isopterans have been associated indirectly with acanthocephalans (Reichensperger, 1922; Smales, 1997) and only one in which these insects have been proved to be the real intermediate hosts and the subject of serious studies about the effects of these helminths on them.

Acanthocephalus aenigma Reichensperger, 1922, was described as a new species from the hemocoel of specimens of two termite species from the locality of Encano Alto, State of Santa Catarina, southern Brazil (Reichensperger 1922), while Smales (1997) made a suggestion that termites were the intermediate hosts for *Multisentis myrmecobius* Smales, 1997, because the type host, *Myrmecobius fasciatus* Waterhouse, 1836, a marsupial anteater from Australia, feeds mainly on them.

The Caribbean termite, *Nasutitermes acajutlae* (Holmgren, 1910), has been the subject of acanthocephalan (Oligacanthorhynchidae) parasitism studies (behavior, color and shape changes, and predation risk) (Fuller *et al.*, 2003) and its implications for reproductive success (Fuller & Jeyasingh, 2004), in the U. S. Virgin Islands. Later, Nickol *et al.* (2006) described the cystacanths obtained from worker hemocoels of *N. acajutlae*, subcutaneous tissues of lizards, greater omentum of mongooses, and mesenteries of birds from these Caribbean islands, identifying them as *Oncicola venezuelensis* Marteau, 1977. Later yet, Fuller &

Nickol (2011) described mature specimens of *O. venezuelensis* from a road-killed feral house cat found dead in the islands.

Adults of two of the six species of *Gigantorhynchus* Hamann, 1892, considered valid by Yamaguti (1963) and Amin [in Crompton & Nickol (1985)] have been collected by several authors (Table I) from their final hosts in several regions of Brazil: 1. *Gigantorhynchus echinodiscus* (Diesing, 1851) from the giant anteater ('tamanduá-bandeira') *Myrmecophaga tridactyla* Linnaeus, 1758, commonly known in Brazil as: 'iurumi', 'jurumim', 'tamanduá-açú', 'tamanduá-cavalo', 'papa-formigas-gigante', and 'urso-formigueiro-gigante', and *Tamandua tetradactyla* (Linnaeus, 1766), known as 'tamanduá-mirim'; and 2. *Gigantorhynchus lutzi* Machado Filho, 1941, from the didelphid marsupial *Caluromys philander* Linnaeus, 1758, commonly known in Brazil as 'cuíca' or 'bare-tailed woolly opossum' in the United States (Machado Filho, 1941).

In Brazil, eggs attributed to *G. echinodiscus* have been recorded in coprolites from archaeological sites (Ferreira *et al.*, 1989) and the first notice about the modification of morphology of termite soldiers by acanthocephalans was made by Cancello (1991).

The present paper describes the cystacanths found in the hemocoels of soldiers of *Labiotermes emersoni* (Araujo, 1954) (Figs 1 and 2) and *Orthognathotermes heberi* Raw & Egler, 1985, and documents photographically, the phenomena of shape alteration and pigmentation dystrophy induced by larval acanthocephalans in termites from Parque Nacional da Serra da Canastra (P. N. Serra da Canastra), State of Minas Gerais, Brazil, as intermediate hosts for *G. echinodiscus.*

MATERIAL AND METHODS

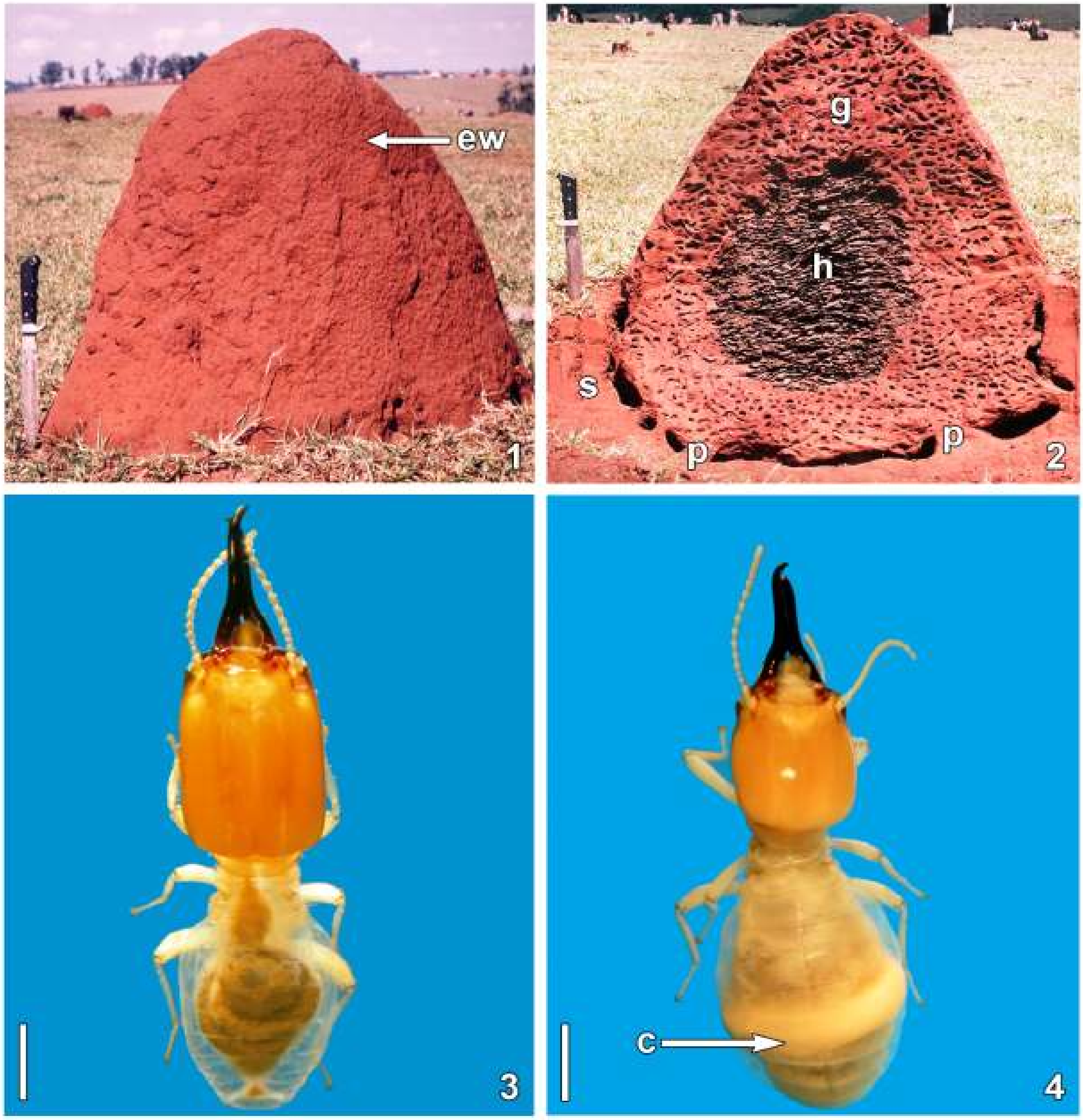
The colony of *L. emersoni* was sampled in an abandoned nest of *Cornitermes cumulans* (Kollar *in* Pohl, 1832) (Figs 1 and 2), while the colony of *O. heberi* was found in a nearby area, in its own nest. All soldier samples from the *Labiotermes* colony were infected by acanthocephalans, while in the *Orthognathotermes* colony a fewer proportion of the soldiers had a cystacanth. The termite samples were obtained by authorized personnel, following the Brazilian policies and guidelines to be applied to the collection of invertebrates. The infected individuals showed heads with strong shape and size alteration, as well as a whitish abdomen, perceptible to the naked eye. Termites, together with chunks of the nests, were collected at the P. N. Serra da Canastra (-20.249 S, -46.563 W), State of Minas Gerais, Brazil and transported to the Laboratory of Isoptera, Museu de Zoologia, Universidade de São Paulo (MZUSP). Cystacanths were removed from the abdomen of termites and released from their envelopes and kept in distilled water to die and evaginate the proboscis. Immediately, helminths were fixed in A. F. A. (Ethanol, Formalin, Glacial Acetic Acid) and later stained in Delafield´s hematoxylin (Amato & Amato, 2010). Two specimens were processed for Scanning Electron Microscopy (SEM) at the 'Centro de Microscopia Eletrônica (CME) – Universidade Federal do Rio Grande do Sul - UFRGS'. Measurements are in micrometers, unless otherwise indicated; widths were measured at the widest point. Proboscis hooks from the first two circles were measured in full profile, lengths are the straight-line between the tip of the hook to the junction with the root; lateral hook-like spines were measured to the tallest point; ranges are followed by the mean in parentheses. Voucher specimens were deposited in the 'Coleção Helmintológica do Instituto Oswaldo Cruz', Rio de Janeiro, RJ, Brazil (CHIOC Catalog Nº: 37956a-o) and 'Coleção de Invertebrados do Museu de Zoologia' Universidade de São Paulo, SP, Brazil (MZUSP Catalog Nº - 21.965).

RESULTS

Gigantorhynchus echinodiscus (Diesing, 1851) (Figs 5 - 16)

Cystacanths from termite intermediary host.

Description. Based on 35 specimens (17 males and 18 females) mounted in Canada balsam and 2 specimens mounted on stubs for SEM. Trunk widest at middle of anterior half (Fig. 5), 2.20 mm–2.94 mm (2.58 mm) long by 515–686 (596) wide. Proboscis cylindrical (Figs 5 and 6, and 11), 784–955 (822) long by 368–686 (471) wide; first distal circle of 6 hooks (Figs 7 and 9 - arrows), largest, robust, 51–83 (66) long; second distal circle of 12 hooks (Figs 7 and 9 - asterisks), smaller than those in first circular row, 24–39 (36) long, arranged in pairs among the 6 hooks of

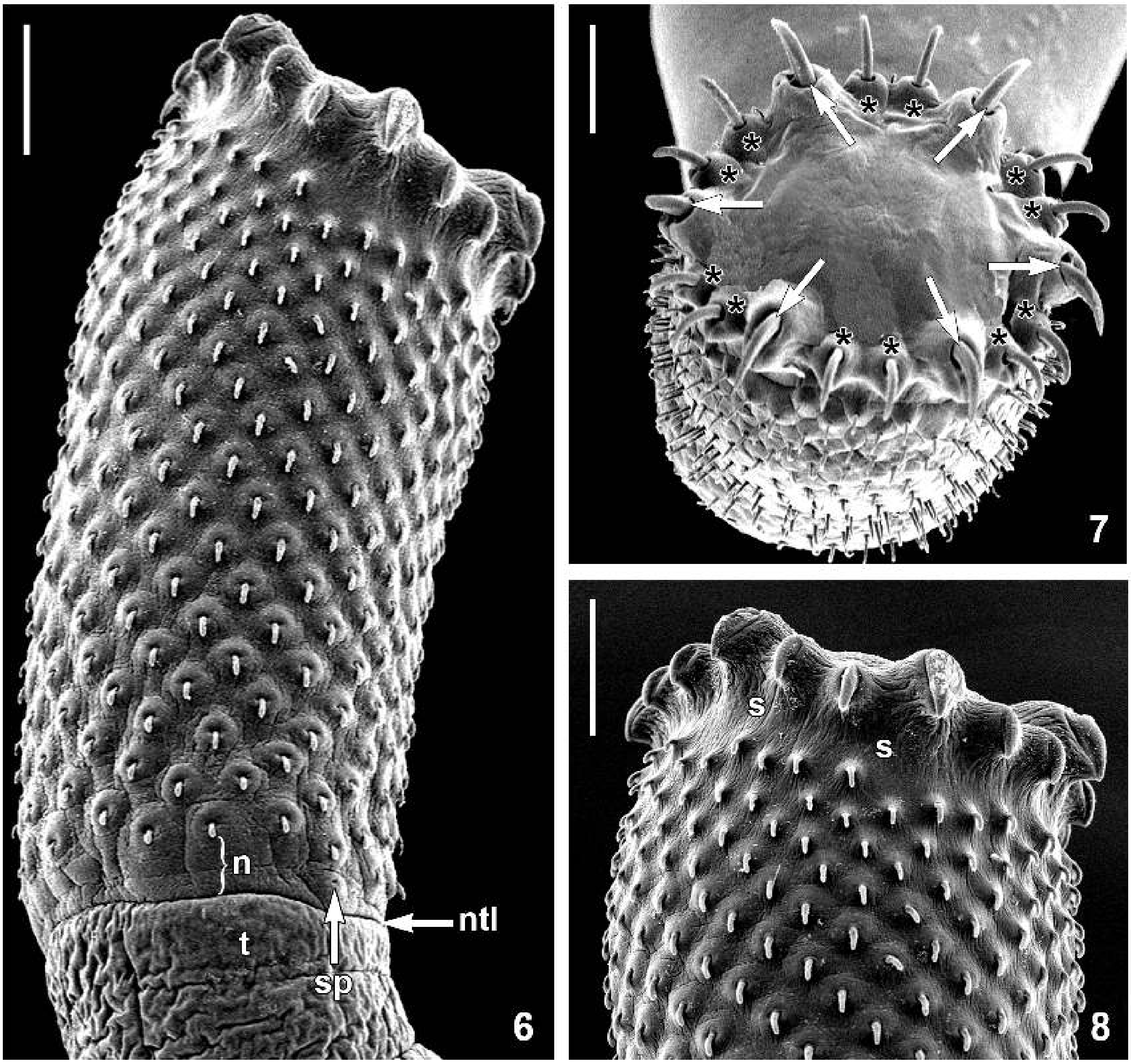


Figures 1-2. Nests of *Cornitermes cumulans*, re-colonized by *Labiotermes emersoni*. 1. Medium size (stage 2), entire nest, external wall (ew). 2. Vertical section of the nest galleries (g), hive (h), pillars (p), soil (s). **Figures 3-4.** *Orthognathotermes heberi*. 3. uninfected specimen, bar = 1 mm; and 4. infected specimen, with cystacanth of *Gigantorhynchus echinodiscus* (arrow - c), bar = 1 mm.

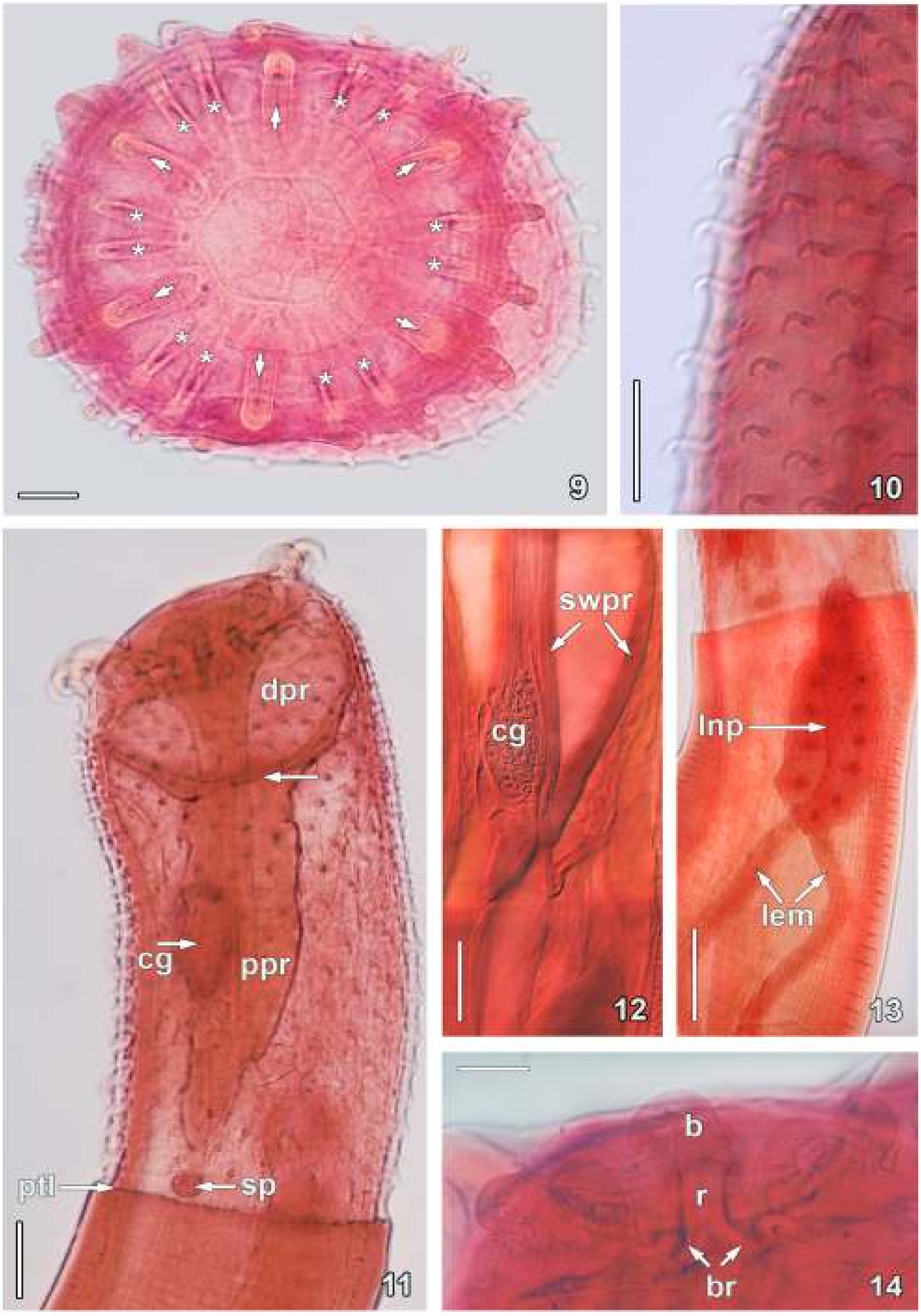
the first distal circle, roots appearing bifid from front view (Fig. 14 - br); both rows separated by a slight depression space (Figs 6 and 8 - s) from the 28 longitudinal rows of almost rootless spines, each longitudinal row with 11–13 spines; each spine 24–31 (25) long. Neck quite short (Fig. 6 - n), 45–75 (55) long by 340-460 (401) wide, with two lateral sensory pits (Fig. 11 - sp), 25-45 (34) long by 30-45 (38) wide. Proboscis receptacle divided in two portions (Fig. 11), proximal portion (Fig. 11 - ppr) much longer and narrower than distal portion, 442-602 (514) long, distal portion (Fig. 11 - dpr) wider, 150-225 (171) long by 265-400 (349) wide, single walled (Fig. 12 – swpr). Cerebral ganglion (Figs 11 and 12 - cg), 120-185 (157) long by 50-85 (68) wide, along ventral wall of proboscis receptacle. Lemnisci ribbon-like (Fig. 13 - lem) 0,9mm-3.21mm (1.81mm) long, sometimes looped, sometimes reaching posterior region of trunk, multinucleated; characteristically wider proximally, where developing nuclei are located before moving posteriad as lemnisci grow, this region 0.35mm-1.00mm (0.52mm) long (Fig. 13 - lnp). Reproductive system primordial. Testes 2, same size (Fig. 15), tandem, in posterior portion of trunk, partially superposed, anterior testis (Fig. 15 – at) 165-275 (206) long by 55-165 (106) wide. Developing cement glands 8 (Fig. 15 - cg), each with a single, large central nucleus, juxtaposed to testes. Saefttigen's pouch (Fig. 15 – Sp), 80-158 (113) long; bursa retracted in all male specimens (Fig. 15 – rb). Uterine bell (Fig. 16 - ub) 49-85 (62) long; uterus (Fig. 16 - u) 182-253 (220) long; vagina (Fig. 16 - v) surrounded by strong, muscular sphincter (Fig. 16 - vs), 194-243 (218) long; muscular sphincter 97-105 (98) long. Protonephridia not observed. Genital pore terminal, in males (Fig. 15 - mgp) and in females (Fig. 16 - fgp).

Figure 5. *Gigantorhynchus echinodiscus*, unencysted cystacanth, from *Labiotermes emersoni*, bar = 0.5mm.

Taxonomic summary.
Intermediate host: Brazilian termites, *Labiotermes emersoni* (Araujo, 1954) and *Orthognathotermes heberi* Raw & Egler, 1985.
Locality: P.N. Serra da Canastra (-20.249 S, -46.563 W), State of Minas Gerais, Brazil.
Site of infection: hemocoel of soldier termites.
Prevalence: *Labiotermes emersoni* – 100% of the soldiers; *Orthognathotermes heberi* – 5-15% of the soldiers.
Intensity: 1 worm/host.
Specimens deposited: Cystacanths, voucher specimens from *L. emersoni* (CHIOC – 37.956a-o); cystacanths, voucher specimens from *L. emersoni* (MZUSP – 21.965).
Specimens examined: Adult specimens of *G. echinodiscus* and *G. lutzi* borrowed from the CHIOC: *G. echinodiscus* – 10.574a, d, e, and f;



Figures 6-8. *Gigantorhynchus echinodiscus*, unencysted cystacanth, from *Labiotermes emersoni*, processed for SEM. 6. entire proboscis, neck (n), trunk (t), lateral sensory pit (white arrow – sp), and distal trunk portion (arrow showing the proboscis - trunk limit – ntl), bar = 100 µm; 7. *en face* view of proboscis, first circle of 6 larger hooks (white arrows) and second circle of 12 hooks, smaller and placed, in pairs, between the large hooks of the first circle (asterisks), bar = 100 µm; 8. lateral view of proboscis showing the space (s) between the first two circles of large hooks and the remainder, almost rootless spines, bar = 100 µm.



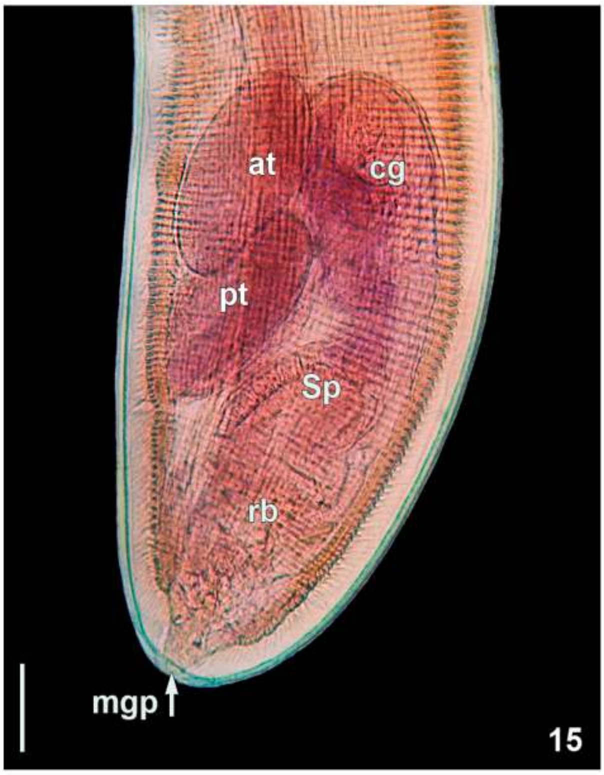
Figures 9-14. *Gigantorhynchus echinodiscus*, unencysted cystacanth, from *Labiotermes emersoni*. 9. *en face* view of proboscis, first circle of 6 larger hooks (white arrows) and second circle of 12 hooks, smaller and placed in pairs between the large hooks of the first circle (asterisks), bar = 50 µm; 10. lateral view of proboscis, showing almost rootless spines, bar = 100 µm; 11. lateral view of entire proboscis, showing the characteristic proboscis receptacle divided into two portions; a distal portion (dpr), a proximal portion (ppr), and the limit between these portions (white arrow). – ptl); the ventral cerebral ganglion (cg), one of the lateral sensorial pit (sp), just anterior to the limit between the trunk and the neck (ptl), bar = 100 µm; 12. the proximal portion of the single wall proboscis receptacle (swpr) and the contiguous, ventral cerebral ganglion (cg), bar = 50 µm; 13. anterior end of trunk, showing the proximal, enlarged, nucleated portion (lnp) of the lemnisci (lem), bar = 200 µm; 14. lateral view of apical portion of the proboscis, and the bifid root (br), root (r), and blade of one of the large hooks, bar = 50 µm.

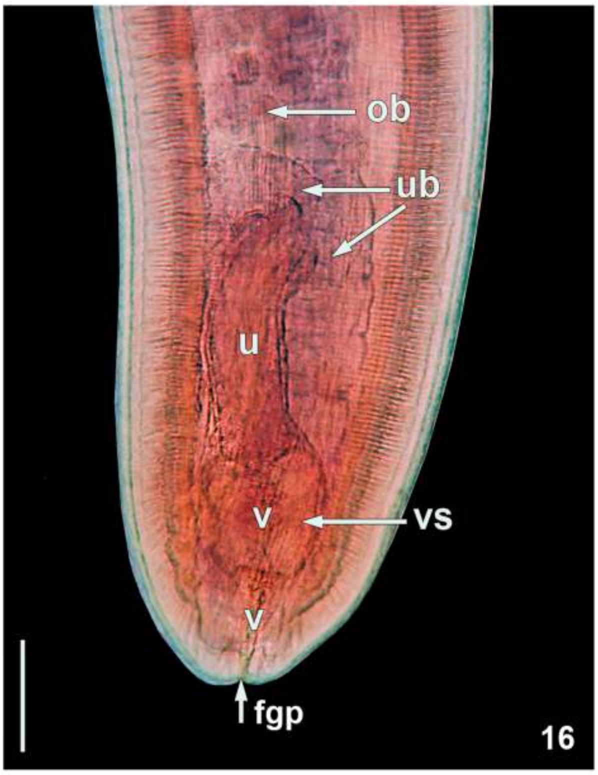
G. lutzi – 15.408c, e, and f (Table I).

Remarks

All Brazilian termites examined showing alterations induced by the acanthocephalan parasites where soldiers, which are always fed by the workers, although workers have not yet been found infected.

When male and female cystacanths are compared it is not possible to detect differences in size or oncotaxy in the proboscis. The lemnisci have a proximal portion wider, showing several nuclei close together (Fig. 13 – lnp). As the lemnisci grow the nuclei move from the proximal portion and get distributed along their length. The testes are always partly superposed and located in the posterior region of the trunk, condition observed in the adult male specimens borrowed from the CHIOC. Due to the fact that anteaters feed directly on termites, it is not surprising that the life cycle of *G. echinodiscus* does not include paratenic hosts.





Figures 15-16. *Gigantorhynchus echinodiscus*, unencysted cystacanth, from *Labiotermes emersoni*. 15. posterior portion of the trunk, showing the male reproductive system: anterior testis (at) and posterior testis (pt) of same size, tandem, and partially superposed, as was observed in the male adult specimen examined from the CHIOC (10.574c); the incipient cement glands (cg), the Saefftigen´s pouch (Sp), the retracted copulatory bursa (rb), and the terminal, male genital pore (mgp), bar = 100 µm; 16. posterior portion of the trunk showing the female reproductive system: incipient ovarian balls (ob), the uterine bell (ub), the uterus (u), the vagina (v), surrounded by the vaginal sphincter (vs), and terminal, female genital pore (fgp), bar = 100 µm.

Table 1. List of records of *Gigantorhynchus echinodiscus* and *G. lutzi* in the COLEÇÃO HELMINTOLÓGICA DO INSTITUTO OSWALDO CRUZ (CHIOC), Rio de Janeiro.

CHIOC Nº	Slide Nº	Specific name	Host[1]	Conservation medium	Provenience[2]	Colected by	Date	Determined by	Date	Observations
308		*echinodiscus*	?	Glycerin	?	?	?	?	?	-
310		*echinodiscus*	*Tamandua tetradactyla*	ETOH 70% - Glycerin	Angra dos Reis, RJ	L. Travassos	01 Nov 1913	L. Travassos	29 Sep 1952	-
1393		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	Feb 1917	-
1397		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	O. Dreher	?	?	?	-
1398		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	Feb 1917	-
1400		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	?	-
1401		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	Feb 1917	-
1402		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	01 Feb 1915	-
1403		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	A. Lutz	?	L. Travassos	Feb 1917	-
1404		*echinodiscus*	*Myrmecophaga sp.*	Formalin 5%	Instituto de Bacteriologia, SP	?	?	?	?	-
1435		*echinodiscus*	*Myrmecophaga tetradactyla*	ETOH 70%	Museu Paulista, Franca, SP	?	?	A. Porta	22 Mar 1905	-
1436		*echinodiscus*	*Myrmecophaga tetradactyla*	Canada balsam	Museu Paulista, Franca, SP	?	?	A. Porta	22 Mar 1905	-
1459		*echinodiscus*	*Myrmecophaga tetradactyla*	ETOH 70%	Museu Paulista, Franca, SP	O. Dreher	23 Dec 1902	A. Porta	?	-
1460		*echinodiscus*	*Myrmecophaga tetradactyla*	Canada balsam	Museu Paulista, Franca, SP	O. Dreher	?	?	?	-
1464		*echinodiscus*	*Myrmecophaga tetradactyla*	ETOH 70%	Museu Paulista, Franca, SP	O. Dreher	?	L. Travassos	?	-
1525	a-h	*echinodiscus*	*Tamandua tetradactyla*	Canada balsam	Museu Paulista, Franca, SP	O. Dreher	23 Dec 1902	A. Porta	?	-
1526	a-c	*echinodiscus*	*Tamandua tetradactyla*	Canada balsam	Museu Paulista, SP	O. Dreher	23 Dec 1902	A. Porta	?	-

Table I. List of records of *Gigantorhynchus echinodiscus* and *G. lutzi* in the COLEÇÃO HELMINTOLÓGICA DO INSTITUTO OSWALDO CRUZ (CHIOC), Rio de Janeiro (cont.).

CHIOC Nº	Slide Nº	Specific name	Host[1]	Conservation medium	Provenience[2]	Colected by	Date	Determined by	Date	Observations
3979		*echinodiscus*	*Tamandua tetradactyla*	Formalin 5%	São João, MT	L. Travassos	04 Jul 1922	L. Travassos	01 Nov 1922	-
3980		*echinodiscus*	*Tamandua tetradactyla*	Formalin 5%	São João, MT	L. Travassos	04 Jul 1922	L. Travassos	01 Nov 1922	-
6270		*echinodiscus*	*“Tamandua tetradactylus”*	ETOH 70% - Glycerin	Instituto Pasteur, SP	A. Carini & J. Maciel	17 Aug 1915	L. Travassos	01 Sep 1915	-
9190		*echinodiscus*	*Myrmecophaga jubata*	ETOH 70% - Glycerin	Instituto Pasteur, SP	A. Carini	27 Mar 1905	L. Travassos	?	-
9320	a-b	*echinodiscus*	?	Canada balsam	?	J. G. de Faria	?	L. Travassos	29 Mar 1905	-
9391	a-c	*echinodiscus*	*Myrmecophaga jubata*	Canada balsam	Instituto Pasteur, SP	A. Carini	29 Mar 1905	L. Travassos	29 Mar 1905	-
9749		*echinodiscus*	*Tamandua tetradactyla*	Acetic formalin	Abaeté, PA	E. Chagas	04 Jun 1937	L. Travassos	01 Aug 1937	-
9750		*echinodiscus*	*Tamandua tetradactyla*	Acetic formalin	Abaeté, PA	E. Chagas	04 Jun 1937	L. Travassos	01 Aug 1937	-
9914		*echinodiscus*	*Tamandua tetradactyla*	Acetic formalin	Belém, PA	H. Lent	19 Aug 1936	J. F.T. Freitas & H. Lent	1938	-
10574	a-f	*echinodiscus*	*Tamandua tetradactyla*	Canada balsam	Belém, PA	H. Lent	19 Aug 1936	J. F.T. Freitas & H. Lent	1938	-
10587		*echinodiscus*	*Tamandua tetradactyla*	Canada balsam	Belém, PA	H. Lent	19 Aug 1936	J. F.T. Freitas & H. Lent	1938	-
13104		*lutzi*	*Caluromys philander*[3]	Acetic formalin	Aurá, Belém, PA	G. Jansen	11 Nov 1940	D. A. Machado Filho	01 May 1941	Holotype & Alotype not designated
13105		*lutzi*	*Caluromys philander*[3]	Acetic formalin	Aurá, Belém, PA	G. Jansen	11 Nov 1940	D. A. Machado Filho	01 May 1941	Paratypes
15408	a-f	*lutzi*	*Caluromys philander*[3]	Canada balsam	Aurá, Belém, PA	G. Jansen	11 Nov 1940	D. A. Machado Filho	01 May 1941	Paratypes
16184		*echinodiscus*	*Tamandua tetradactyla*	Acetic formalin	Salobra, MS	L. Travassos & J. F.T. de Freitas	29 May 1942	D. A. Machado Filho	1946	-
17541		*echinodiscus*	*“Tamandua tetradactyla tetradactyla”*	Acetic formalin	Linhares (Cupido Farm), ES	L. Travassos, J. F. T. de Freitas & H. Travassos	02 Mar 1948	D. A. Machado Filho	01 Mar 1949	-
20039		*echinodiscus*	*“Tamandua bandeira”*	Acetic formalin	State of Mato Grosso	L. Travassos	29 Sep 1952	L. Travassos	29 Sep 1952	-

DISCUSSION

The effects induced by acanthocephalans on their intermediate hosts were discussed by various authors and range from increased conspicuousness, either by the larvae acquiring pigmentation or by pigmentation dystrophy of the host, which results from the interference of the acanthocephalan with the metabolic pathway for ommochrome pigmentation in the isopod hosts (Oetinger & Nickol, 1982).

This was not the case in the Caribbean termite, *N. acajutlae*. In the U. S. Virgin Islands Fuller *et al.* (2003), Fuller & Jeyasingh (2004), and Nickol *et al.* (2006) found only workers infected. It is not clear why the workers of the Brazilian species of termites, known to feed the soldiers, do not get infected themselves, as only the workers feed directly on the feces of the final hosts, anteaters and didelphid marsupials, although this behavior has not been observed directly. Another interesting aspect is that in the life cycle of *G. echinodiscus* there are no paratenic hosts involved, as there are in the life cycle *of N. acajutlae* in the Caribbean.

Reichensperger (1922) described *Acanthocephalus aenigma* Reichensperger, 1922, as a new species based on cystacanths from the hemocoel of specimens of two termite species from the locality of Encano Alto, State of Santa Catarina, Southern Brazil. One of them was *Cornitermes cumulans*, the same species that built the nests lately recolonized by *Labiotermes emersoni* (Araujo, 1954) in the P.N. Serra da Canastra (Figs 1 and 2), and found infected by the cystacanths of *G. echinodiscus* reported in the present work. According to Nickol *et al.* (2006) "Nothing further is known about this species, and usually it is considered to be unrecognizable. Meyer (1932) assigned it to *Oligacanthorhynchus* Travassos, 1915, as an appendix. Possession of 30 proboscis hooks instead of 36 distinguishes it from *O. venezuelensis* and suggests that *A. aenigma* properly should be assigned to *Neoncicola* Schmidt, 1972". In the cystacanths' description, Reichensperger (*op. cit.*) mentioned that the testes were located in the mid-trunk, unlike the position found in the cystacanths described in the present work. So, there is a possibility that the acanthocephalan found as cystacanths in the termites from Santa Catarina, might be yet another species. This confirms that Meyer (*op. cit.*) was correct assigning the species to Oligacanthorhynchidae, as the testes in this family are post equatorial, but not in the posterior region of the trunk.

Specimens of *O. heberi* were originally described showing an unprecedented dimorphism in soldiers (called by the authors "major soldiers" and "minor soldiers", respectively) — a case of parasitism by acanthocephalans not perceived by Raw & Egler (1985). In 1991, Cancello published a short note on the presence of acanthocephalan larvae in the hemocoel of termite soldiers [*Cornitermes cumulans*, *Orthognathotermes* sp., and *Paracornitermes* sp. (today *Labiotermes*). Since then, other species of termites have been recorded with the same kind of parasites: *Termes* spp., *Amitermes amifer*, *Embiratermes neotemicus*, and *Spinitermes* sp.]. But, unhappily, because the acanthocephalan larvae found in these species, the true identity of these larvae will have to wait to be determined.

In 2003, one of us (JFRA) received specimens of termites fixed in ethanol from the junior authors (normal and parasitized soldiers of *O. heberi* - Figs 3 and 4 of the present paper). Rocha & Cancello (2009, pg. 8), in the revision of *Orthognathotermes* stated: "The minor soldiers described by Raw & Egler (1985) are individuals infested by an undetermined species of Acanthocephala. The soldier caste is monomorphic, contrary to the original description".

Six species of *Gigantorhynchus* were considered valid by Yamaguti (1963) and Amin (*in* Crompton & Nickol, 1985), two of which were the first to be described to Science and from Brazil: *G. echinodiscus* found in myrmecophagids and *G. lutzi* found in didelphid marsupials (*Caluromys philander* (Linnaeus, 1758). Besides having different final hosts, the Brazilian species differ by the number of hooks present in the first two circles of hooks of the proboscis - *G. echinodiscus* (Figs 6-8) with the formula (6+12) (first circle with six large hooks, intercalated by a second circle of 12, smaller hooks arranged in pairs among the larger hooks of the first circle with roots appearing 'bifid' (Fig. 14) and *G. lutzi* with the formula 6+6 (first circle with six large hooks also intercalated by a second circle of six, slightly smaller, hooks. *Gigantorhynchus ortizi* Sarmiento, 1954, from Peruvian marsupials [*Metachirus nudicaudatus* (Desmarest, 1817) known as 'cuíca-de-quatro-olhos'] and for having the same large hook formula (6+6) in the proboscis, is similar to *G. lutzi* (Sarmiento 1954).

Gigantorhynchus lopezneyrai Días-Ungría, 1958 and *Gigantorhynchus ungriai* Antonio, 1958 were described from Venezuela, both from myrmecophagids. The former species with the large hook formula (4+8) (hooks in the first and second circle, respectively), appears to be an incorrect observation and needs to be revisited, and the later with the same type of large hook formula (6+12) as is found in *G. echinodiscus*. Even though Días-Ungría (1958) recorded a smaller number of large hooks in the first two circles of the proboscis in *G. lopezneirai* (the author did not show an unquestionable 'en face' drawing of the proboscis). Antonio (1958), did not show good illustrations of the new species, including the proboscis, and did not present an 'en face' drawing of the proboscis, which in this case, for having the same large hook formula as *G. echinodiscus*, would have been of utmost importance. Although the author has pointed out specific differences in the pseudo segmentation of the trunk, he left serious doubts about the validity of this species. The last species to be described for *Gigantorhynchus* was *Gigantorhynchus pesteri* Tadros, 1966, from a Baboon of Rhodesia, Africa. The species described by Tadros (1966) was based only on two immature females which had not evaginated the proboscis. The author reported an unusual large hook formula — a single crown of 4 large hooks at the summit of the proboscis. Certainly this species needs to be revisited.

As the present paper is the first to show the unquestionable structure of the proboscis through SEM images (Figs 6-8), it would be important to look for infected termites in Venezuela, above all, in the ranges occupied by myrmecophagids and/or recover adults from the intestine of 'oso melero' to process for SEM images which could be compared with those of the present paper.

The CHIOC does not hold any cystacanth of any species of *Gigantorhynchus* from any intermediate host. This information has been confirmed by the examination of all 31 records of *G. echinodiscus* from myrmecophagids and 1 record of *G. lutzi* annotated in three index cards (CHIOC Nºs 13.104 and 13.105 in AFA, and 15.408 mounted in Canada balsam), but found on a single host from Aurá, in the greater Belém, State of Pará (Table 1). The oldest record of specimens of *Gigantorhynchus* spp. deposited in the CHIOC is dated of 1902 and the latest has been recorded 1952 (Table 1). Due to the poor condition in which the deposited specimens of *G. lutzi* are, it is very important that new efforts be made to find didelphids infected in Aurá, Belém, PA. New efforts should also be made to find anteaters which are near death, for any reason, or which were recently road-killed to be examined by helminthologists or immediately frozen for a later necropsy by specialists, who could collect and prepare these acanthocephalans following modern and recommended techniques. Only then, the two species known from Brazil could be revisited using quality specimens.

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