

<http://dx.doi.org/10.11646/zootaxa.3838.1.8>  
<http://zoobank.org/urn:lsid:zoobank.org:pub:E5B7BE11-CC19-440A-9152-AACE16B4F041>

## A new species and five new records of chewing lice (Insecta: Phthiraptera: Ischnocera) from an isolated population of the solitary tinamou *Tinamus solitarius* (Aves: Tinamiformes)

MICHEL P. VALIM<sup>1\*</sup> & LUÍS F. SILVEIRA<sup>2</sup>

<sup>1</sup>*Museu de Zoologia, Universidade de São Paulo, Av. Nazaré, 481, Ipiranga, São Paulo, SP 04263-000, Brazil*  
(mpvalim@hotmail.com)

<sup>2</sup>*Museu de Zoologia, Universidade de São Paulo, Av. Nazaré, 481, Ipiranga, São Paulo, SP 04263-000, Brazil*  
(lfs@usp.br)

\* Corresponding author

### Abstract

We report the first records of chewing lice from an isolated population of the solitary tinamou (formerly known as *Tinamus solitarius pernambucensis* Berla, 1946) in the Pernambuco Centre of Endemism (PCE), Brazil. All louse records previously published from the solitary tinamou came from the populations south of the São Francisco River, formerly known as *Tinamus solitarius solitarius* (Vieillot, 1819). Five known species of the family Heptapsogasteridae were identified from the northern population of this host: *Heptarthrogaster grandis* Carriker, 1936; *Ornicholax alienus* (Giebel, 1874); *Pterocotes solitarius* Guimarães & Lane, 1937; *Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866); and *Strongylotes wernecki* Guimarães & Lane, 1937. Also, the new species *Heptagoniodes guimaraesi* is described and illustrated from the northern population of this host, and a key for identification of all the species of *Heptagoniodes* Carriker, 1936 is included. The discovery of *H. guimaraesi* is the first Brazilian example of a bird ectoparasite represented by two different species of the same genus living on two distinct populations of the same host species. Records of eight louse species and 31 new localities from the southern population of the solitary tinamou in Brazil are given, and an updated list of all the chewing lice known from both host populations [subspecies] is included.

**Key words:** chewing lice, Phthiraptera, Heptapsogasteridae, *Heptagoniodes*, *Heptagoniodes guimaraesi*, new species, *Heptarthrogaster*, *Ornicholax*, *Pterocotes*, *Rhopaloceras*, *Strongylotes*, tinamous, *Tinamus solitarius solitarius*, *Tinamus solitarius pernambucensis*, Brazil, Pernambuco Centre of Endemism

### Introduction

The chewing louse family Heptapsogasteridae comprises a large group of species, all endemic to the Neotropical Region and restricted to the bird families Tinamidae (Tinamiformes) and Cariamidae (Gruiformes) (Carriker 1936, 1944). Many genera have been described to include the species from Tinamidae, and the only two species which occur on members of the non-related family Cariamidae are included in the genus *Heinrothiella* Eichler, 1942. Lice of this family appear to occupy the niche formed by the down feathers near the skin, the same niche occupied by species of Goniodidae parasitic on other basal group of neognathous birds (i.e. Galliformes) (Clay 1957: 155). Tinamou lice are of particular interest because a large number of species may be found co-infesting a single host species, with the most extreme examples of diversity being the brown tinamou, *Crypturellus obsoletus punensis* (Chubb, 1917), with 11 species belonging to 10 genera, and the solitary tinamou, *Tinamus solitarius* (Vieillot, 1819), with eight species in eight genera (Price *et al.* 2003: 384), but increased in this paper to 12 species in nine genera (see below). In both examples, the louse genera belong to three families from two suborders.

Although the last world checklist of chewing lice (Price *et al.* 2003, following Hellenthal *et al.* 2002) regarded the Heptapsogasteridae as a junior synonym of Philopteridae, here we follow the original proposal of Carriker (1936) for this odd morphological, ecological and geographical suprageneric taxon of ischnoceran lice parasitic on

tinamiform birds. This family classification also has morphological (Smith 2000, 2001) and molecular support (Johnson *et al.* 2001).

The genus *Heptarthrogaster* Carriker, 1936 was listed as a junior synonym of *Heptapsogaster* Carriker, 1936 by Hopkins & Clay (1952: 167) without any morphological justification, and this synonymy was adopted by Price *et al.* (2003: 189, 191) in their world checklist. Also, Hopkins & Clay (1952: 166) regarded *Heptagoniodes* Carriker, 1936 as a junior synonym of *Kelloggia* Carriker, 1903, a synonymy also adopted by Price *et al.* (2003: 189). However, it is possible to separate morphologically all the above genera (Guimarães & Lane 1937, Kéler 1939, Guimarães 1942a, Carriker 1944) and, therefore, we revert to the original generic classification proposed by Carriker (1936), recognizing *Heptarthrogaster* and *Heptagoniodes* as valid.

The solitary tinamou is the largest tinamou species outside Amazonia, represented by two subspecies, both living in humid, pristine Atlantic Forest: *Tinamus solitarius pernambucensis* Berla, 1946 occurs in the States of Pernambuco and Alagoas in a thin strip of Atlantic Forest known as the Pernambuco Centre of Endemism (PCE), and the nominate form recorded from the Brazilian state of Bahia in the north to Rio Grande do Sul, and also in south-east Paraguay and north-east Argentina (Dickinson 2003). However, due to a lack of diagnostic characters in the plumage and size, the northern subspecies *T. s. pernambucensis* was recently considered a junior synonym of the nominate, making *Tinamus solitarius* monotypic, with a severely threatened population (possibly extinct) on the PCE, and a vulnerable population in the south, both allopatric and separated by the São Francisco River (Silveira *et al.* 2003, Amaral & Silveira 2004) (Fig. 13).

Considering our scant knowledge of the chewing lice fauna from tinamous in the Atlantic Forest, in this paper we (1) name and describe a new species of *Heptagoniodes* from the northern population of *Tinamus solitarius*, (2) present a key to identify adult males of all *Heptagoniodes* species, (3) report new records of lice from both populations of *Tinamus solitarius*, (4) include a checklist of all lice known from both host populations, and (5) discuss the significance of these host-louse associations in view of our finding of different louse species of *Heptagoniodes* in each host population.

## Materials and methods

All the specimens studied are deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP), with a number associated as unique identifier (MZUSP #) from the SophiA® database for the Phthiraptera collection. One lot of chewing lice studied was taken from the holotype of the subspecies *T. solitarius pernambucensis* before it was made into a skin, which was later deposited in the Museu Nacional do Rio de Janeiro (MNRJ). The other two louse lots studied from this host subspecies have no host voucher. Additional louse specimens were collected from fresh birds and kept in alcohol until they were permanently slide-mounted in Canada balsam, following the technique in Palma (1978). Terminology of head chaetotaxy follows that employed by Clay (1951) and reinterpreted by Mey (1994), and that used for thoracic setae follows the latter author. The head dorsal sensilla placodea present in Heptapsogasteridae are here named as *s1–s6* (see Figs 4–6). Paynter & Traylor (1991) was used as a cross-reference to assign current provincial information and include geographic coordinates of localities. Common and scientific names of hosts follow Dickinson (2003).

Abbreviations for body measurements in the new species description are: HL, head length (at middle line); FW, frontal width (at preantennal level); POW, pre-ocular width (at level below the antennae); EW, emargination width (at narrowest level between the post-ocular emargination); TW, temporal width (at level of *mts1*); AnL, antennal length; PL, prothorax length; PW, prothorax width; PTL, pterothorax length; PTW, pterothorax width; AL, abdominal length (from anterior margin of tergo-pleurite III to body terminus); AW, abdominal width (at level of segment V); PrL, paramere length; MeL, mesosome length; TL, total length. All measurements are given in millimeters, with each range followed by the mean and standard deviation, the latter two values within parentheses.

## Systematics

**Phthiraptera Haeckel, 1896**

**Ischnocera Kellogg, 1896**

**Heptapsogasteridae Carriker, 1936**

### ***Heptagoniodes* Carriker, 1936**

*Heptagoniodes* Carriker, 1936: 166 (Type species: *H. mirabilis* Carriker, 1936, by original designation); Guimarães & Lane (1937: 7); Kéler (1938: 323); Guimarães (1942a: 16); Carriker (1944: 207).

*Kelloggia* (*Heptagoniodes*); Guimarães (1948: 163).

*Kelloggia* Carriker, 1903 (in part); Hopkins & Clay (1952: 166); Price *et al.* (2003: 189).

*Heptagoniodes* contains four known species, plus one described below as new; all of them are restricted to hosts of the genus *Tinamus*. Our study of specimens of *Heptagoniodes* of four species held in the MZUSP collection allowed us to give here an emendation of the generic diagnosis presented by Carriker (1936) and Guimarães (1942a, 1948), and a comparison with its morphologically close relatives.

*Heptagoniodes* is morphologically close to *Kelloggia* Carriker, 1903 and *Ornicholax* Carriker, 1903 having each side of the first visible tergo-pleurite (= I+II) entirely surrounded anteriorly by the metanotum and laterally by tergo-pleurites III. The first and second visible tergo-pleurites overlap those sclerites in segment III (Figs 1–2). Species of *Ornicholax* have well developed coni and the antennae are inserted at mid-point of the head lateral margins, whereas in *Heptagoniodes* and *Kelloggia* the coni are absent and the antennae are inserted near the front of the head lateral margins. Both sexes of *Heptagoniodes* can be promptly distinguished from *Kelloggia* by the absence of serration in the postero-lateral margin of the pterothorax (Fig. 7), which is quite conspicuous in the latter genus (Figs 6, 8). Species of *Heptagoniodes* have sexually dimorphic antennae (males have the scapus and pedicel swollen and the first flageromere with a dorsal finger-like projection) and a deep post-ocular emargination (Figs 3–4). The head of *Kelloggia* males is similar to those of the females (see Fig. 6). Another important character to distinguish both genera is head chaetotaxy: in both sexes of *Heptagoniodes*, the *pns* (postnodal seta) and *pts* (posttemporal seta) are developed into distinct setae (Figs 4–5), while in *Kelloggia* they are like sensilla (Fig. 6); in males of *Heptagoniodes* four (*s3–s6*) of the six head sensilla placodea are developed into well-formed setae, while in *Kelloggia* the *s1–s6* are sensilla in all species (Fig. 6). Furthermore, the shape of the mesosome in the male genitalia of both genera is different (compare Fig. 9 vs Figs 10–12).

The head sexual dimorphism of *Heptagoniodes* is phylogenetically informative as discussed by Guimarães (1948). The male head emargination is an important character to distinguish the genus *Heptagoniodes* into two main species groups (see Figs 3–4 and key below). The head shape in species of *Kelloggia* and *Heptagoniodes* implies different copulation strategies, and this feature alone supports their generic separation (Guimarães 1948: 163).

#### ***Heptagoniodes guimaraesi* Valim new species**

(Figs 1–2, 4–5, 7, 12–13)

Type host: *Tinamus solitarius pernambucensis* Berla, 1946.

Type locality: Mata do Othon, Barra de São Miguel, Alagoas, Brazil

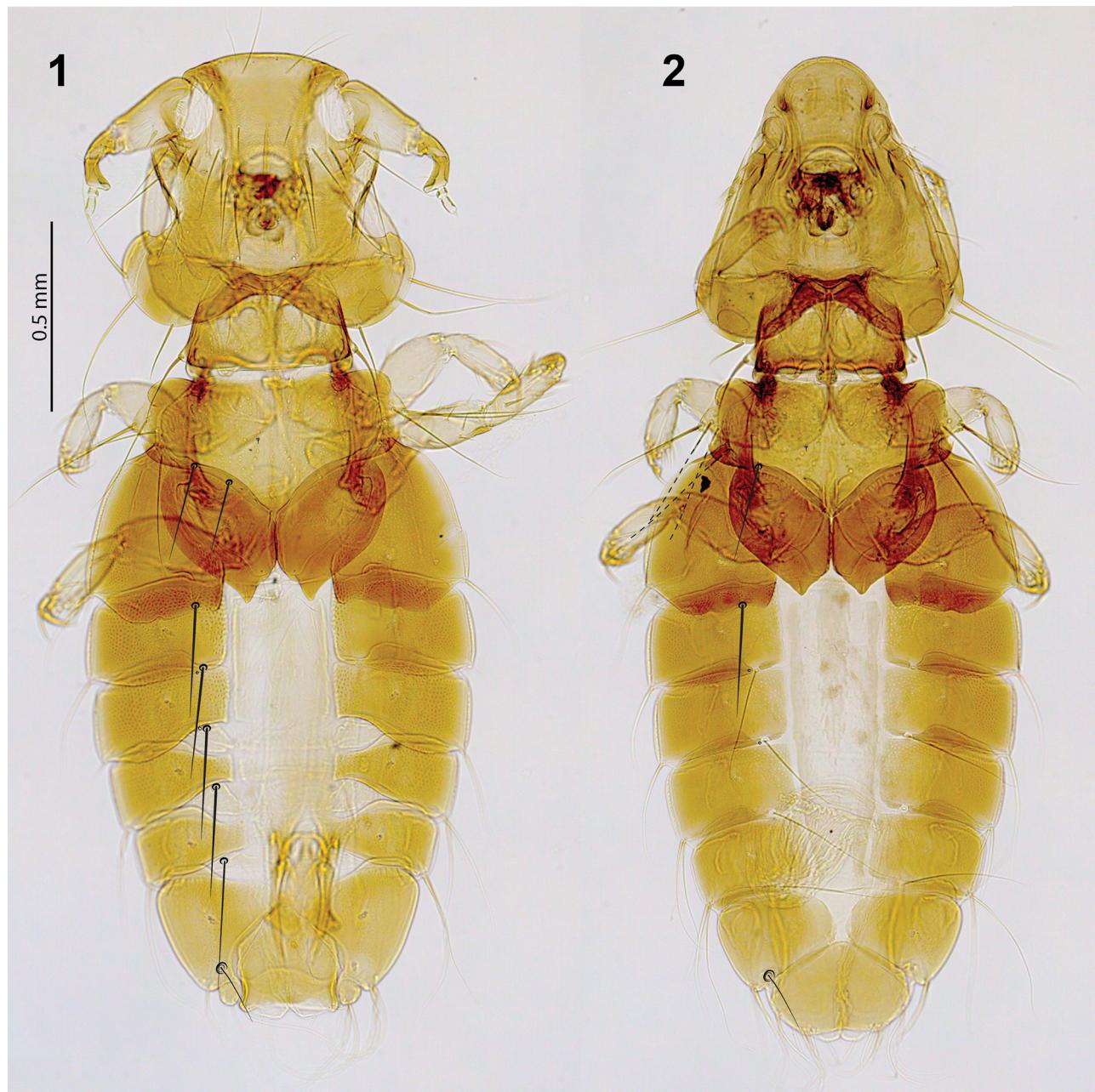
**Diagnosis:** The new species is morphologically close to *Heptagoniodes agonus* (Nitzsch [in Giebel], 1874) (ex *Tinamus tao tao* Temminck, 1815) and *H. dimorphus* Carriker, 1944 (ex *T. tao kleei* (Tschudi, 1843)) having the anterior margin of the temples sharply pointed (Fig. 4). However, it can be readily distinguished from these two species by the different shape of the mesosomal plate in the male genitalia, which is similar in both *H. dimorphus* and *H. agonus* (compare Fig. 12 against Fig. 10 and fig. 26b in Carriker 1944: 209).

**Description:** Dorsal habitus of male (Fig. 1) and of female (Fig. 2) fit the general morphology and chaetotaxy of the other four species placed in *Heptagoniodes*. Male head as in Fig. 4, with temples sharply pointed on their latero-anterior angles; head of female as in Fig. 5.

Thorax shape as in Figs 1–2, with chaetotaxy mostly as for the family. Pronotum with a pair of post-spiracular setae, each set on a postero-lateral projection (*pssp* in Figs 4–5), and three submarginal setae (*sensu* Mey 1994) each side, with the posterior seta longest and reaching the middle of prothorax (see *pms* in Figs 4–5). Pteronotum (from lateral to medial) with one latero-ventral spine-like seta, one latero-ventral trichoid seta, two postero-lateral, two postero-medial, plus one minute antero-medial seta. All thoracic sternites without setae.

Abdominal pattern of setae homogeneous, with few setae on both dorsal and ventral surfaces, similar to other

species in the genus. Dorsal chaetotaxy on each side: only two small atrophied setal alveoli (*asa*) one lateral and one medial on the anterior margin of tergite II (in males the medial seta is well developed); in the posterior margin one long and distinct seta in males, but in females this seta is an inconspicuous *asa*; a long post-spiracular setae present on tergites III–VII. Male tergite III large, with a small concavity on its posterior margin laterad to post-spiracular seta; tergite IV roughly rectangular; tergites V–VII with a postero-medial notch. In females tergites II–III as in males, IV–VII roughly rectangular. Tergite VIII with trichoid seta present on its postero-lateral angles,



**FIGURES 1–2.** *Heptagoniodes guimaraesi*: 1, male holotype. 2, female paratype (Some thoracic and abdominal setae missing in the original specimens were added on the left side only).

and the medial angle with an *asa* of the medial seta. Porotaxy: sensilla (Clay 1954) present on tergites IV–V (see Figs 1–2). Sternites IV–V with a small lateral plate, reticulated and oblong in shape, set on lateral sides of segments. Sternal chaetotaxy on each side: IV–V, one small lateral setae mediad to the small lateral sternites (rarely two in one side); VI, two small lateral setae mediad to the lateral sternites plus a very short setae (these setae are rarely present on V); VII, with two long and eight medium-long setae in females but absent in males. Pleural setae each side: III–V, 2 (1 long and 1 short setae); VI–VII, 3 (all long); VIII, 4 (all long).

Male genitalia distinctive, with a bell-shaped mesosome with lateral latero-posterior projections, one pair of sensilla on its mid-line and another pair on the base of each paramere; parameres long, slightly curved inwardly, with faint and finely pointed tips, and with one sub-apical sensillum and one apical small seta (Fig. 12).

Female vulvar margin with medial concavity, with 13–16 small anterior setae and 8–11 medium-long posterior setae each side.

**Measurements. Male** (N=18): HL 0.51–0.65 (0.62±0.030); FW 0.40–0.45 (0.43±0.011); POW 0.57–0.64 (0.60±0.019); EW 0.44–0.50 (0.47±0.013); TW 0.71–0.80 (0.75±0.025); AnL 0.50–0.60 (0.53±0.027); PL 0.22–0.27 (0.24±0.014); PW 0.46–0.50 (0.48±0.011); PTL 0.33–0.38 (0.36±0.013); PTW 0.68–0.76 (0.72±0.021); AL 1.46–1.61 (1.56±0.039); AW 0.88–1.08 (1.01±0.042); PrL 0.24–0.29 (0.26±0.012); MeL 0.24–0.31 (0.28±0.017); TL 2.40–2.67 (2.56±0.067).

**Female** (N=18): HL 0.62–0.69 (0.66±0.018); FW 0.32–0.42 (0.35±0.021); POW 0.41–0.52 (0.45±0.029); TW 0.67–0.79 (0.75±0.033); AnL 0.27–0.31 (0.29±0.012); PL 0.22–0.29 (0.25±0.014); PW 0.43–0.49 (0.47±0.017); PTL 0.34–0.39 (0.37±0.018); PTW 0.63–0.75 (0.71±0.030); AL 1.50–1.70 (1.60±0.056); AW 0.87–1.03 (0.97±0.040); TL 2.49–2.77 (2.65±0.082).

**Type material:** ex *Tinamus solitarius pernambucensis*. ♂ holotype (MZUSP #3208), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira coll. Paratypes: 20♂ and 19♀ (MZUSP #3209–3229), same data as the holotype.

**Additional non-type material:** ex *T. solitarius pernambucensis*. 6♂, 14♀, 5N (MZUSP #5769–5780), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.). 2N, same data as the holotype.

**Etymology:** The specific epithet is a noun in a genitive case honouring Lindolpho R. Guimarães (1908–1998), whose long-term studies on tinamous lice in Brazil earned him recognition as a world authority of this group of bird lice.

### Key to species of *Heptagoniodes* (adult males only)

(updated from Guimarães 1948)

1	Head with anterior margin of temples sharply pointed (Fig. 4); mesosomal plate with lateral projections (Figs 10, 12) . . . . .	2
-	Head with anterior margin of temples rounded (Fig. 3); mesosomal plate without lateral projections (Fig. 11). . . . .	4
2	Genitalia with mesosome as in Fig. 12 . . . . .	<i>H. guimaraesi</i> Valim n. sp.
-	Genitalia with mesosome as in Fig. 10 . . . . .	3
3	Total length < 2.50 mm; mesosomal plate short (0.18 mm) . . . . .	<i>H. dimorphus</i> Carriker, 1944
-	Total length > 2.60 mm; mesosomal plate long (0.30 mm) . . . . .	<i>H. agonus</i> (Nitzsch [in Giebel], 1866)
4	Post-ocular emargination very shallow, less pronounced; temples truncated. Mesosome as a sclerotized, tubular structure (see Plate XXX, figs 3, 3a, in Carriker, 1936) . . . . .	<i>H. mirabilis</i> Carriker, 1936
-	Post-ocular emargination deep, well pronounced (Fig. 3); temples nearly rounded (Fig. 3). Mesosome as a non-sclerotized, rugose, tubular structure (Fig. 11) . . . . .	<i>H. clayae</i> Guimarães & Lane, 1937

### Additional material examined

***Heptagoniodes clayae* ex *Tinamus solitarius solitarius*:** 1♀ (MZUSP #38), Alto da Serra (= Paranapiacaba) (23°47'S, 46°19'W), São Paulo, Brazil, Nov. 1906, H. Lüderwaldt coll. 3♂ (MZUSP #3189–3191), São Paulo, Brazil, no date, J.L. Lima coll.

***Heptagoniodes agonus* ex *T. tao tao*:** 2♂, 1♀ (MZUSP #114–116), Caxiticatuba (02°50'S, 55°08'W), Pará, Brazil, no date, L.R. Guimarães coll.

***Heptagoniodes dimorphus* ex *T. tao kleei*:** 1♀ paratype, (MZUSP #661), Palmar (17°06'S, 65°29'W, 800m), Cochabamba, Bolivia, 12 Jul. 1937, M.A. Carriker Jr coll.

***Kelloggia brevipes* Carriker, 1903** ex *T. major major*: 3♂, 2♀ (MZUSP #117–119), Igarapé Anibá, Amazonas, Brazil, no date, L.R. Guimarães coll.

## New records of louse species from *Tinamus solitarius pernambucensis*

### ***Strongylocotes* Taschenberg, 1882**

*Strongylocotes* Taschenberg, 1882: 54 (Type species: *Goniodes complanatus* Piaget, 1880, by subsequent designation).

This genus contains 22 species distributed on birds of the Tinamidae genera *Crypturellus* (15 species), *Nothura* (1), *Nothocercus* (2), *Rhynchotus* (1) and *Tinamus* (3).

### ***Strongylocotes wernecki* Guimarães & Lane, 1937**

*Strongylocotes wernecki* Guimarães & Lane (1937: 17, fig. 6).

*Strongylocotes latithorax* Kéler (1938: 313, figs 1, 6–7).

Material examined: 1♂, 1♀ (MZUSP #3198), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira coll.

**Remarks:** This species had been reported for Brazil from *Tinamus solitarius solitarius* only (see Guimarães & Lane 1937; Kéler 1938; Guimarães 1942b).

### ***Ornicholax* Carriker, 1903**

*Ornicholax* Carriker, 1903: 151 (Type species: *O. robustus* Carriker, 1903, by monotypy).

This genus contain seven species, all of them are restricted to birds of the genus *Tinamus*.

### ***Ornicholax alienus* (Giebel, 1874)**

*Goniocotes alienus* Giebel, 1874: 191.

*Ornicholax robustus taoi* Carriker (1936: 171, pl. 30, fig. 1).

*Ornicholax solitarius* Guimarães & Lane (1937: 3, fig. 1).

*Ornicholax alienus carrikeri* Guimarães (1948: 169, fig. 6).

*Ornicholax alienus* (Giebel, 1874); Hopkins & Clay (1952: 252).

Material examined: 1♂, 4♀ (MZUSP #3204–3207), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira coll. 1♀ (MZUSP #5768), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.)

**Remarks:** This species is commonly found on *T. solitarius solitarius* (see Guimarães & Lane 1937, Kéler 1938) and also occurs on *T. tao tao* (see Guimarães 1942b, 1948). The material listed above was identified by comparison with those mounted and determined by L.R. Guimarães, deposited in MZUSP collection, as well as with the redescription by Kéler (1938).

### ***Rhopaloceras* Taschenberg, 1882**

*Rhopaloceras* Taschenberg, 1882: 46 (Type species: *Goniodes aliceps* Nitzsch [in Giebel], 1874, by subsequent designation).

This genus contains 15 species, nine of them parasitic on birds of the genus *Crypturellus*, and three species on members of each of the genera *Tinamus* and *Nothocercus*.

### ***Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866)**

*Goniodes oniscus* Nitzsch [in Giebel], 1866: 388.

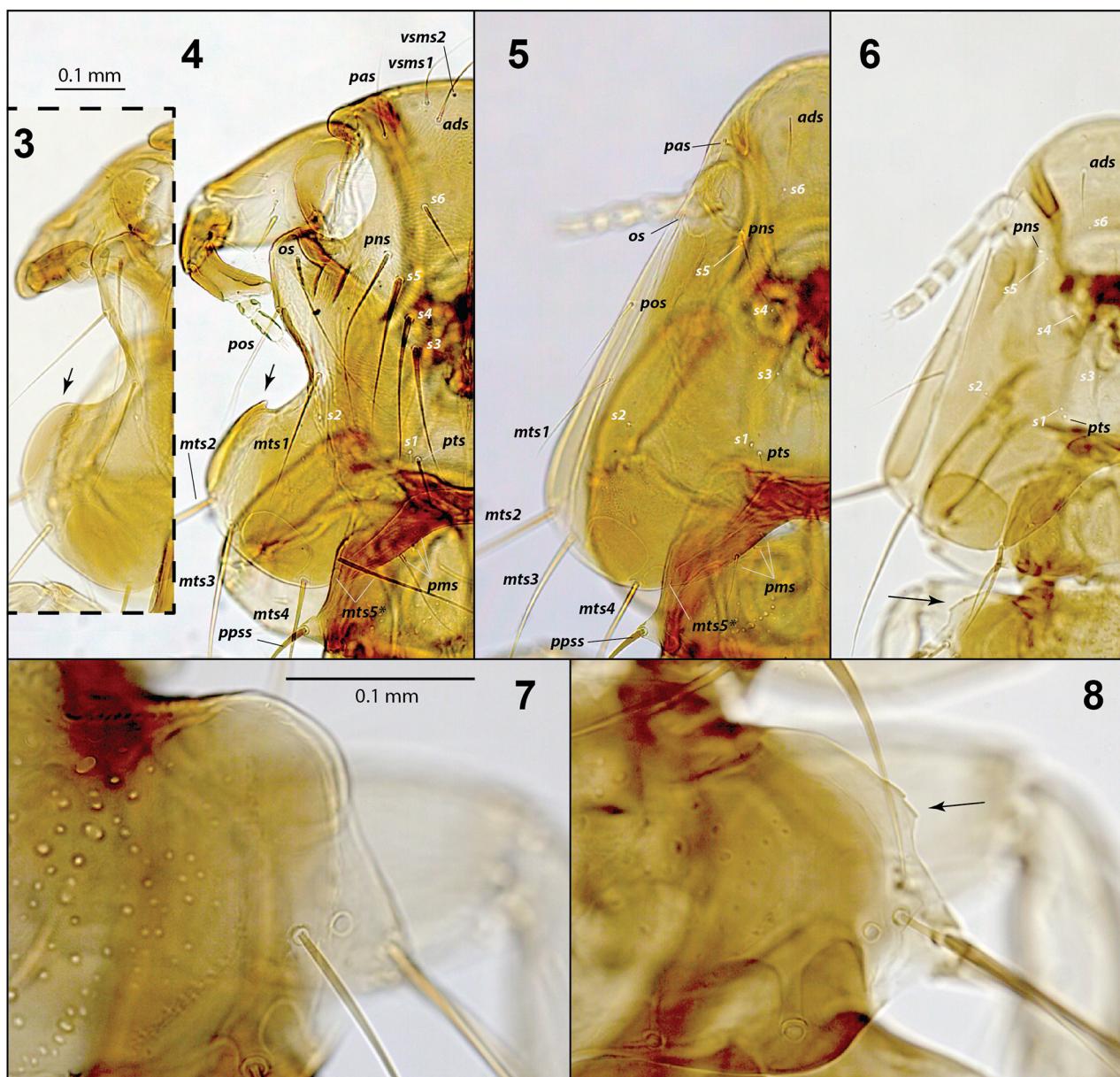
*Goniodes aliceps* Nitzsch [in Giebel] (1874: 204)

*Goniocotes longipes* Giebel (1874: 190).

*Rhopaloceras oniscus aliceps* Giebel [sic]; Eichler (1947: 170, fig. 7).

*Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866); Carriker (1936: 107, pl. 14, fig. 2); Guimarães & Lane (1937: 14); (Kéler (1939: 222, fig. 1).

Material examined: 6♀ (MZUSP #3192–3197), (host skin in MNRJ #24626), Igaraçu (07°50'S; 34°54'W), Usina São José, Pernambuco, Brazil, 20 Apr. 1945, H.F. Berla coll. 1♀ (MZUSP #3199), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira Coll. 1♀ MZUSP #5767), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.)



**FIGURES 3–8.** 3, *Heptagoniodes clayae* dorso-lateral view of male head. 4, *Heptagoniodes guimaraesi* dorsal view of male head. 5, *H. guimaraesi* dorsal view of female head. 6, *Kelloggia brevipes* Carriker, 1903, dorsal view of male head. 7, *Heptagoniodes guimaraesi* dorso-lateral angle of female pterothorax. 8, *Kelloggia brevipes* dorso-lateral angle of female pterothorax. **Abbreviations:** *ads*, anterior dorsal seta; *mts*, marginal temporal seta; *os*, ocular seta; *pas*, preantennal seta; *pos*, preocular seta; *pms*, marginal pronotal setae; *pns*, postnodal seta; *ppss*, postspiracular pronotal seta; *pts*, post-temporal seta; *vsms*, ventral submarginal seta; *s*, head sensilla (1–6) (Arrows in Figs 3–4 indicate anterior margin of temples. Arrows in Figs 6 and 8 indicate serration of postero-lateral margin of pterothorax).

**Remarks:** The only reliable records of this species from *T. solitarius solitarius* are those in Guimarães & Lane (1937) and Kéler (1939). The material listed above was identified by comparison with those deposited in MZUSP collection.

#### *Heptarthrogaster* Carriker, 1936

*Heptarthrogaster* Carriker, 1936: 134 (Type species: *Goniodes parvulus* Taschenberg, 1882, by original designation). This genus contains seven species of lice, all of which are restricted to species of the genus *Tinamus*.

## ***Heptarthrogaster grandis* Carriker, 1936**

*Heptarthrogaster grandis* Carriker, 1936: 136, pl. 20, fig. 3.

*Heptarthrogaster oliverioi* Guimarães & Lane (1937: 10, fig. 3).

*Heptapsogaster grandis* (Carriker, 1936); Price *et al.* (2003: 189).

*Heptapsogaster oliverioi* (Guimarães & Lane, 1937); Price *et al.* (2003: 190).

Material examined: 1♂, 1♀ (MZUSP #3200), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira coll.

**Remarks:** This species has been found as a regular ectoparasite of four species of *Tinamus*, of which *T. solitarius* is also included for Brazil (Guimarães & Lane 1937, Guimarães 1942a). Although Guimarães (1942a: 24) placed *H. oliverioi* as a junior synonym of *H. grandis*, and this opinion has been followed by Hopkins & Clay (1952: 169), the latest worldwide checklist of chewing lice inexplicably still considers the former name as valid (Price *et al.* 2003: 190).

## ***Pterocotes* Ewing, 1929**

*Pterocotes* Ewing, 1929: 113, 192 (Type species: *Goniodes aberrans* Carriker, 1903, by original designation).

This genus contains 11 species, distributed on birds of the genera *Crypturellus* (2), *Nothocercus* (6), and *Tinamus* (3).

## ***Pterocotes solitarius* Guimarães & Lane, 1937**

*Pterocotes aberrans solitarius* Guimarães & Lane, 1937: 15, fig. 5.

*Pterocotes solitarius* Guimarães & Lane, 1937; Guimarães (1943: 27, figs 7–12).

*Pterocotes aberrans mokak* Eichler (1947: 168, fig. 6); Guimarães (1950: 338).

Material examined: 3♂, 2♀ (MZUSP #3201–3203), Mata do Othon (09°50'S; 35°54'W), Barra de São Miguel, Alagoas, Brazil, 21 Feb. 1979, D.M. Teixeira coll.

**Remarks:** To date, this species has been recorded exclusively on *T. solitarius solitarius* by Guimarães & Lane (1937), Kéler (1939), and Guimarães (1943, 1950).

## **Louse records of doubtful provenance**

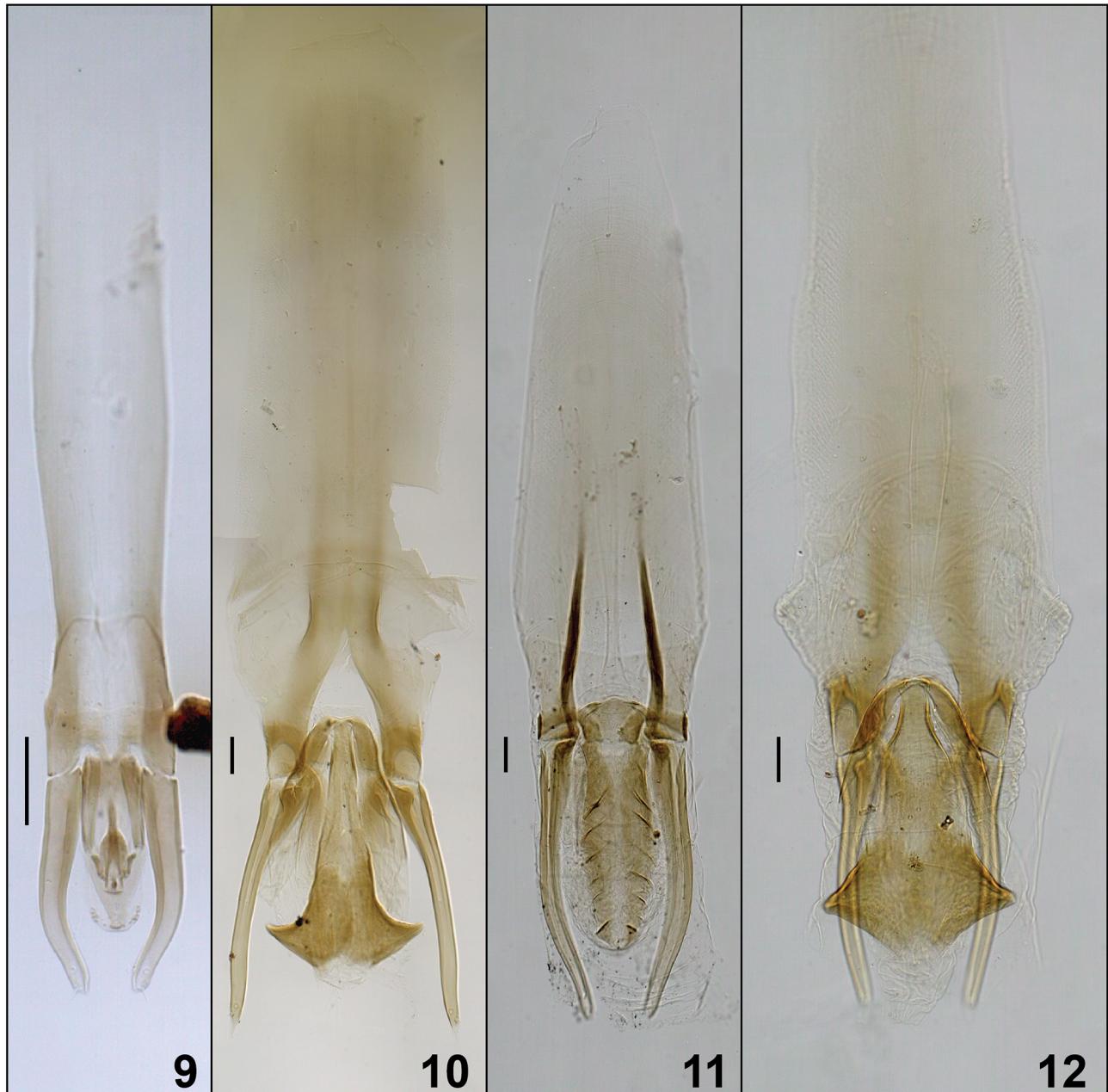
We studied one sample, collected by Pedro Mário Nardelli – a well-known tinamou breeder – from a captive *Tinamus solitarius pernambucensis*, containing three female lice. The identities of these lice did not match any species present in the samples we studied from the same host (see above). Therefore, their association with *T. solitarius pernambucensis* is doubtful until more specimens of the same species become available from this host.

## ***Megapeostus* sp.**

*Megapeostus* Carriker, 1936: 141 (Type species: *Megapeostus asymmetricus* Carriker, 1936, by original designation).

*Megapeostus* contains 13 species, eleven of them parasitic on birds of the genus *Crypturellus* and only two on *Tinamus* species.

Material examined: 1♀ (MZUSP #3232), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.).



**FIGURES 9–12.** Male genitalia (dissected): **9**, *Kelloggia brevipes* Carriker, 1903. **10**, *Heptagoniodes agonus*. **11**, *Heptagoniodes clayae* Guimarães & Lane, 1937. **12**, *Heptagoniodes guimaraesi*. Scale bars = 0.05 mm.

**Remarks:** This female was thoroughly compared with *Megapeostus asymmetricus* Carriker, 1936 and *M. fuscus* Clay, 1937. These two species and this female have 3–4 long spiniform setae on each side of the vulvar margin. However, this female differs from those species by the shape of its inner-ventral pleural setae on segments IV–VII being longer and thinner than in the two species, and by the outline of its vulvar margin being roughly convex and U-shaped, while it is W-shaped in the two mentioned species. This female may belong to an undescribed species, and *T. solitarius pernambucensis* maybe its true host, but more material from free living birds is essential to reach a definite conclusion about its identity.

## ***Rhopaloceras variegatus* Carriker, 1955**

*Rhopaloceras variegatus* Carriker, 1955: 8, figs 5a, 6a.

Material examined: 1♀ (MZUSP #3230), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.).

**Remarks:** This single specimen is here tentatively identified with the original description by Carriker (1955). Except for small differences between measurements, this female and the holotype are very similar. However, this identification should be taken with caution considering that we are comparing two single female specimens. *Rhopaloceras variegatus* is a natural ectoparasite of *Crypturellus variegatus* (Gmelin, 1789), which does not occur within the geographical range of *T. solitarius pernambucensis*. However, it is possible that both a specimen of *C. variegatus* and the host of the female louse studied here were living in the same enclosure, allowing for a transfer of lice between them. Regardless of its host association, this is the first record of *Rhopaloceras variegatus* for Brazil.

## ***Strongylocotes variegatus* Carriker, 1936**

*Strongylocotes complantus* [sic] *variegatus* Carriker, 1936: 86, pl. 7, fig. 3.

*Strongylocotes setifer* Hopkins, 1942: 116.

*Strongylocotes complanatus setifer* Hopkins, 1942; Carriker (1944: 109).

*Strongylocotes variegatus* Carriker, 1936; Hopkins & Clay (1952: 343).

Material examined: 1♀ (MZUSP #3231), Roteiro (09°50'S; 35°58'W), Alagoas, Brazil, Nov. 1978, P.M. Nardelli coll. (W.C.A. Bokermann leg.)

**Remarks:** *Strongylocotes variegatus* is also a natural ectoparasite of *Crypturellus variegatus*. The presence of a posterior projection on the marginal carina of the head and the head shape place this species in a *S. wernecki*. The single row of setae on the postero-lateral sides of the vulvar margin is distinctive for *S. variegatus*. As mentioned above under *Rhopaloceras variegatus*, the host record of this *S. variegatus* female may be the result of a louse transfer from *Crypturellus variegatus* to *T. solitarius pernambucensis*. Regardless of its host association, this is the first record of *Strongylocotes variegatus* for Brazil.

## **Additional records of louse species from *Tinamus solitarius solitarius* in Brazil**

### ***Heptagoniodes clayae* Guimarães & Lane, 1937**

*Heptagoniodes clayi* [sic] Guimarães & Lane, 1937: 7, fig. 2.

*Kelloggia clayae* (Guimarães & Lane, 1937); Price *et al.* (2003: 192).

*Heptagoniodes clayae* Guimarães & Lane, 1937; Valim (2009: 201).

Material examined: 2♀ (MZUSP #37–38), "Alto da Serra" (= Paranapiacaba, 23°47'S; 46°19'W), São Paulo, Brazil, Nov. 1906, H. Lüderwaldt coll. 2♂, 2♀ (MZUSP #112–113), Rio Paraná, São Paulo, Brazil, no date, J Lima coll. 18♂, 30♀, 42 N (MZUSP #173), São Paulo, Brazil, no date, J Lima coll. 1♂, 1♀ (MZUSP #392; voucher MZUSP #24459), Rio Doce, Minas Gerais, Brazil, 14 Sep. 1940, A.M. Ollala coll. 2♂, 2♀, 16N (MZUSP #478, 487), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'WS, 50m), Espírito Santo, Brazil, 22 Sep. 1942, B.M. Soares coll.

### ***Heptarthrogaster grandis* Carriker, 1936**

*Heptarthrogaster grandis* Carriker, 1936: 136, pl. 20, fig. 3.

Material examined: 4♂, 13♀ (MZUSP #147–149), São Paulo, Brazil, no date, J. Lima coll. 3♂, 3♀ (MZUSP #393,

MZUSP #24459), Rio Doce, Minas Gerais, Brazil, 14 Sep. 1940, A.M. Ollala coll. 2♂ (MZUSP #402), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'W, 50m), Espírito Santo, Brazil, 24 Sep. 1942, B.M. Soares coll. 1♂ (MZUSP #472), Rio Doce (right bank), Minas Gerais, Brazil, 04 Sep. 1940, A.M. Ollala coll.

### ***Heptarthrogaster keleri* Guimarães, 1942**

*Heptarthrogaster keleri* Guimarães, 1942a: 25, figs 26–31.

*Heptapsogaster keleri* (Guimarães, 1942a); Price et al. (2003: 189).

Material examined: 1♂, 1♀ (MZUSP #489, 481), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'W, 50m), Espírito Santo, Brazil, 22 Sep. 1942, B.M. Soares coll.

### ***Heptarthrogaster parvulus* (Taschenberg, 1882)**

*Goniodes parvulus* Taschenberg, 1882: 38, pl. 1, fig. 14.

*Heptarthrogaster parvulus* (Taschenberg, 1882); Carriker (1936: 134, pl. 20, fig. 1).

*Heptapsogaster parvulus* (Taschenberg, 1882); Price et al. (2003: 190).

Material examined: 15♂, 31♀ (MZUSP #160–162), São Paulo, Brazil, no date, J. Lima coll. 2♀ (MZUSP #394, MZUSP #24459), Rio Doce, Minas Gerais, Brazil, 14 Sep. 1940, A.M. Ollala coll. 1♂, 1♀ (MZUSP #473), Rio Doce (right bank), Minas Gerais, Brazil, 04 Sep. 1940, A.M. Ollala coll. 2♂, 1♀ (MZUSP #479), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'W, 50m), Espírito Santo, Brazil, 22 Sep. 1942, B.M. Soares coll. 1♂, 1♀ (MZUSP #488), same data as the latter but from another host individual.

### ***Ornicholax alienus* (Giebel, 1874)**

*Goniocotes alienus* Giebel, 1874: 191.

*Ornicholax alienus* (Giebel, 1874); Hopkins & Clay (1952: 252).

Material examined: 2♀ (MZUSP #41), Rio Paraná, São Paulo, Brazil, 1905, no collector. 1♂ (MZUSP #127–128), São Paulo, Brazil, no date, J. Lima coll. 2♀, 1N (MZUSP #391, MZUSP #24459), Rio Doce, Minas Gerais, Brazil, 14 Sep. 1940, A.M. Ollala coll. 1♂, 1♀ (MZUSP #397), São Paulo, Brazil, no date, F. Fonseca coll. 2♂, 5♀ (MZUSP #401), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'W, 50m), Espírito Santo, Brazil, 22 Sep. 1942, B.M. Soares coll.

### ***Pterocotes solitarius* Guimarães & Lane, 1937**

*Pterocotes aberrans solitarius* Guimarães & Lane, 1937: 15, fig. 5.

*Pterocotes solitarius* Guimarães & Lane, 1937; Guimarães (1943: 27, figs 7–12).

Material examined: 1♂ (MZUSP #131), São Paulo, Brazil, no date, J. Lima coll. 6♂ (MZUSP #395, MZUSP #24459), Rio Doce, Minas Gerais, Brazil, 14 Sep. 1940, A.M. Ollala coll.

### ***Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866)**

*Goniodes oniscus* Nitzsch [in Giebel], 1866: 388.

*Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866); Guimarães & Lane (1937: 14).

Material examined: 1♂, 1♀ (MZUSP #353–355), Barra do Cascalho, Porto Epitácio, Rio Paraná, São Paulo, Brazil, 15 Aug. 1935, J. Lima coll. 1♂, 2♀ (MZUSP #378), São Paulo, São Paulo, Brazil, no date, J. Lima coll. 1♂, 2♀, 1N (MZUSP #379), Batea, São Paulo, Brazil, Aug. 1940, F. Lane coll. 2♂, 3♀ (MZUSP #380), "Porto Epitácio" (= Presidente Epitácio, 21°46'S; 52°06'W), São Paulo, Brazil, Apr.–Jul. 1937, J. Lima coll. 2♂, 3♀, 1N (MZUSP #381), "Rio São José" (= Lagoa Juparanã, 19°10'S; 40°12'W, 50m), Espírito Santo, Brazil, 1945, B.M. Soares coll. 2♂, 1N (MZUSP #382), same data as previous record, except 22 Sep. 1942. 2♂, 2♀, 1N (MZUSP #383), Rio Doce (right bank), Minas Gerais, Brazil, 28 Jul. 1940, O. Pinto coll.

## ***Strongylocotes wernecki* Guimarães & Lane, 1937**

*Strongylocotes wernecki* Guimarães & Lane, 1937: 17, fig. 6

Material examined: 1♂, 7♀ (MZUSP #134–135, 174), São Paulo, Brazil, no date, J. Lima coll. 2♀, 1N (MZUSP #451, 458), São Paulo, Brazil, no date, F. Fonseca coll.

### **Checklist of Brazilian records of chewing lice from the solitary tinamou**

Acronyms for Brazilian states: AL, Alagoas; PE, Pernambuco (northeast region); ES, Espírito Santo; MG, Minas Gerais; SP, São Paulo (southeast region); SC, Santa Catarina (southern region).

Asterisk \*, denotes that the type host for the louse species is the solitary tinamou.

#### ***Tinamus solitarius solitarius* (Vieillot, 1819)**

*Menacanthus brachygaster* (Giebel, 1874) (Menoponidae); Kéler (1939: 250) SC.

*Microctenia tibialis* Kéler, 1939\* (Menoponidae); Kéler (1939: 251) SC.

*Pseudolipeurus taoi* Carriker, 1936 (Philopteridae); Kéler (1939: 247) SC (as *P. longipes* (Piaget), but see Guimarães 1942c: 274); Guimarães (1944: 212) ES.

*Heptagoniodes clayae* Guimarães & Lane, 1937\* (Heptapsogasteridae); Guimarães & Lane (1937: 7) SP; Guimarães (1948: 165) SP; Kéler (1938: 323) SC. Present study: ES and MG.

*Heptarthrogaster grandis* Carriker, 1936 (Heptapsogasteridae); Guimarães & Lane (1937: 10) SP; Kéler (1939: 233) SC. Present study: ES and MG.

*Heptarthrogaster parvulus* (Taschenberg, 1882) (Heptapsogasteridae); Kéler (1939: 235) SC. Present study: ES and MG.

*Heptarthrogaster keleri* Guimarães, 1942a (Heptapsogasteridae); Kéler (1939: 237) SC (as *H. minutus* Carriker, but see Guimarães 1942a: 25). Present study: ES.

*Ornicholax alienus* (Giebel, 1874) (Heptapsogasteridae); Guimarães & Lane (1937: 6) SP; Kéler (1938: 325) SC. Present study: ES and MG.

*Pterocotes solitarius* Guimarães & Lane, 1937\* (Heptapsogasteridae); Guimarães & Lane (1937: 17) SP; Kéler (1939: 227) SC; Guimarães (1943: 27) SP; Eichler (1947: 168), SC, but see Guimarães (1950: 339). Present study: MG.

*Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866) (Heptapsogasteridae); Guimarães & Lane (1937: 15) SP; Kéler (1939: 222) SC; Eichler (1947: 170) SC (see Guimarães 1950: 338). Present study: ES and MG.

*Strongylocotes wernecki* Guimarães & Lane, 1937\* (Heptapsogasteridae); Guimarães & Lane (1937: 19) SP; Kéler (1938: 313) SC. Present study: SP.

#### ***Tinamus solitarius pernambucensis* Berla, 1946**

*Heptagoniodes guimaraesi* Valim new species\* (Heptapsogasteridae). Present study, AL.

*Heptarthrogaster grandis* Carriker, 1936 (Heptapsogasteridae). Present study, AL.

*Ornicholax alienus* (Giebel, 1874) (Heptapsogasteridae). Present study, AL.

*Pterocotes solitarius* Guimarães & Lane, 1937 (Heptapsogasteridae). Present study, AL.

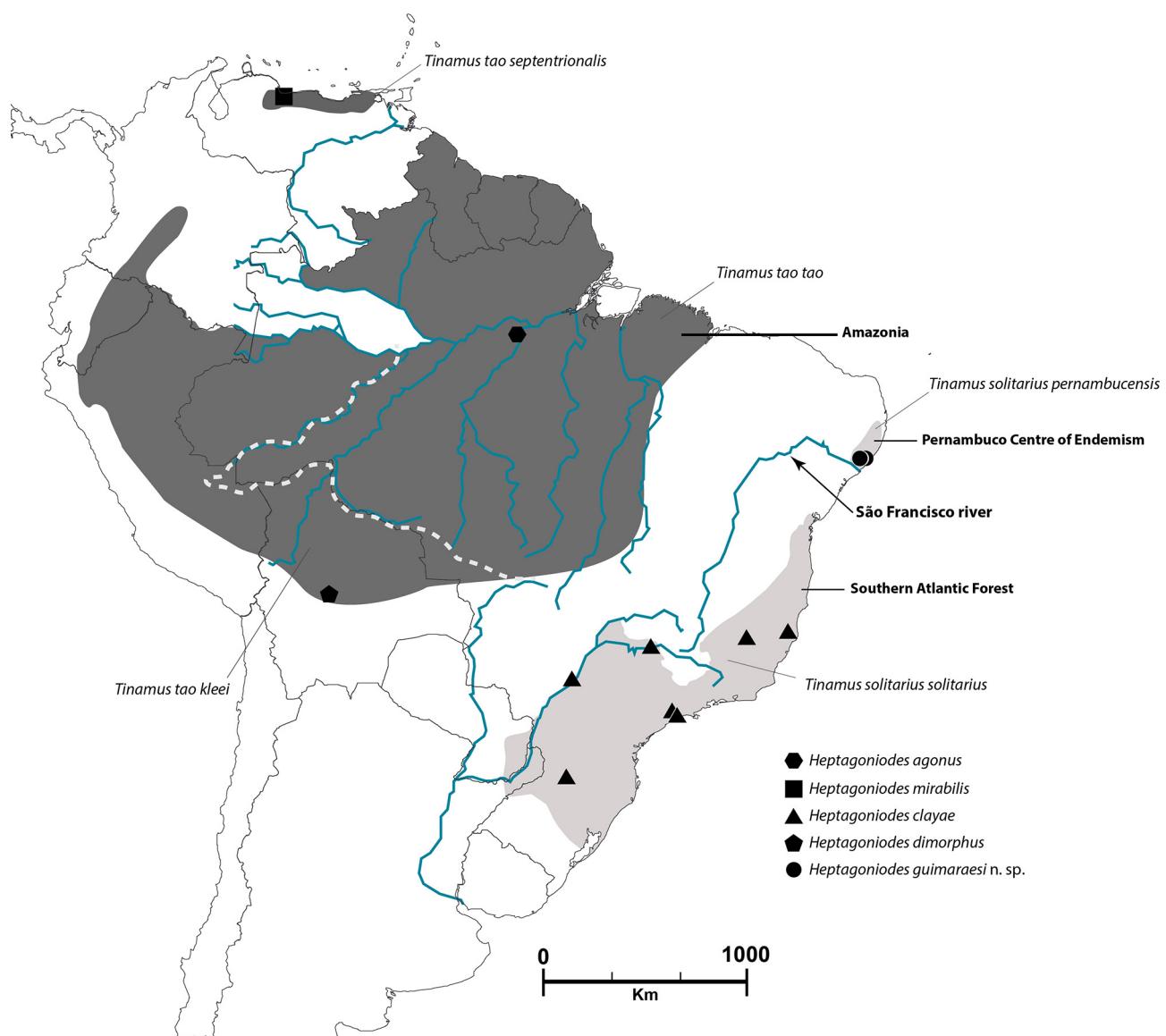
*Rhopaloceras oniscus* (Nitzsch [in Giebel], 1866) (Heptapsogasteridae). Present study, AL and PE.

*Strongylocotes wernecki* Guimarães & Lane, 1937 (Heptapsogasteridae). Present study, AL.

### **Discussion**

Among the six louse species found on the northern population of *Tinamus solitarius* from the PCE (regarded by some authors as *T. solitarius pernambucensis*), five are shared with the southern population (see Checklist above). Two of them are also shared with *T. tao tao* (see Price *et al.* 2003: 386), which is the Amazonian vicariant species for the solitary tinamou (Fig. 13). Regarding the louse fauna of the two populations of *T. solitarius*, the only species found on the northern population that is not found on the southern population of *T. solitarius* is *Heptagoniodes guimaraesi*, the new species described in this paper. In contrast, the southern population hosts *H. clayae*, which is not found on the northern population. These two species of *Heptagoniodes* are morphologically very distinct to each other, suggesting that they are not sister taxa.

*Heptagoniodes guimaraesi* is morphologically close to *H. agonus*, the species found on *T. tao tao*, indicating that an independent evolutionary history has taken place in the northern population of *T. solitarius* found in the PCE. The Pernambuco Centre of Endemism is a relatively small and thin strip of Atlantic Forest completely isolated from the southern Atlantic Forest by the São Francisco River, and from Amazonia by the Caatinga biome (Silveira *et al.* 2003) (Fig. 13). This biome has a singular bird fauna with endemic taxa related to those in both forest blocks, Amazonia and Atlantic Forest, suggesting a unique and complex history of old and recent invasions through forest corridors (Silveira *et al.* 2003). Usually, endemic taxa from the lowlands of the PCE are related to Amazonian taxa, while those from the mountains are related to their counterparts in the Atlantic Forest (see Silveira *et al.* 2004). This pattern could explain the morphological similarity between the new species *H. guimaraesi* from *T. solitarius pernambucensis* in the PCE, with the Amazonian species *H. agonus* parasitic on *T. tao tao*, instead of having its closest relative on *T. solitarius* from the southern Atlantic Forest. Some taxa found in the PCE are still poorly known, and this area is currently the most threatened area in Brazil, and even in South America. This area has many threatened taxa, and was home to Brazilian endemics that have recently gone extinct, including the bird species: *Glaucidium mooreorum* Silva, Coelho & Gonzaga, 2002 (Strigiformes: Strigidae), *Philydor novaesi* Teixeira & Gonzaga, 1983 (Passeriformes; Furnariidae), and *Pauxi mitu* (Linnaeus, 1766) (Galliformes: Cracidae), which is extinct in the wild (see Silveira *et al.* 2003; 2004).



**FIGURE 13.** Map of South America with geographical distributions of the species of *Heptagoniodes*, and those of their hosts (The dotted line indicates the separation of *Tinamus tao* subspecies).

Many taxa found in the isolated forests of PCE have their sister species outside that center of endemism. However, many others have not been critically reviewed and may prove to be simply varieties with no taxonomic significance. Amaral & Silveira (2004) reviewed the taxonomy of *Tinamus* from the Atlantic Forest and found no plumage or other morphological differences between *T. solitarius solitarius* and *T. s. pernambucensis*, making the latter name a junior synonym of the former. However, the geographical barrier of the São Francisco River has led to an unusual distribution pattern of *Heptagoniodes* lice parasitising *T. solitarius*. (Fig. 13). There are other known examples of chewing lice represented by different species on hosts of the same species, which are separated by geographical barriers (Clay 1964, 1976). The case of *H. guimaraesi* and *H. clayae* could be a Brazilian example of ectoparasite speciation caused by a geographic barrier separating its host populations and resulting in two allopatric louse species (Fig. 13). However, to accept this hypothesis the morphological similarity between *H. guimaraesi* and the Amazonian *H. agonus* has to be regarded as result of convergent evolution. Another, more likely scenario to explain that two species of *Heptagoniodes* parasitise two apparently identical but isolated host populations is that the northern population of *T. solitarius* was, at some point, in contact with the Amazonian host *T. tao tao* (Fig. 13). That contact would have allowed a successful host-switch of *Heptagoniodes* from *T. tao tao* onto *T. solitarius*, with a subsequent speciation and an extinction of the original *Heptagoniodes* population on the latter host. This is the most parsimonious hypothesis to explain the morphological similarity of *H. guimaraesi* with *H. agonus*, and not with *H. clayae* in the south of the São Francisco River.

The presence of *H. guimaraesi* only on the northern population of the solitary tinamou would corroborate the original hypothesis of Berla (1946), reopening the question about the validity of *T. s. pernambucensis*. Regardless the validity of this taxon, it is interesting that only one genus of lice, in a set of six, split into two species while the others remained exactly identical to those parasitic on the southern population of the host. Furthermore, it may be significant that *Heptagoniodes* is one of the “rarest” genera of chewing lice collected on *Tinamus* hosts (e.g. Carriker 1936, 1944; Guimarães & Lane 1937).

Judging from the geographic distribution of the specimens studied, *H. guimaraesi* does not appear to occur in any sample from southeastern or southern Brazil (Fig. 13). Considering that the small and restricted northern host population – of less than 100 individuals 40 years ago – is on the verge of extinction (Coimbra-Filho 1971; Silveira *et al.* 2003), it is likely that *H. guimaraesi* is also critically threatened, if not already extinct. Molecular studies of fresh samples of chewing lice may elucidate the true relationship among *H. guimaraesi*, *H. agonus* and *H. clayae*, perhaps showing if the morphological similarity is genetic or due to convergence. Unfortunately, all the material available for this study was stored in suboptimal conditions for an extended period of time, and DNA studies were not possible.

## Acknowledgements

We thank one anonymous referee and Ricardo L. Palma (Museum of New Zealand, Wellington, New Zealand) for their improvements to our first draft of this paper. We also thank Andrey J. Andrade for plotting the coordinates in the map. This study was supported by FAPESP – São Paulo Research Foundation, Brazil (MPV: 2011/11420-5 and 2012/06951-4). LFS acknowledges a grant received from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

## References

- Amaral, F.S.R. & Silveira, L.F. (2004) *Tinamus solitarius pernambucensis* Berla, 1946 é sinônimo de *Tinamus solitarius* (Vieillot, 1819). *Ararajuba*, 12 (1), 33–41.
- Berla, H.F. (1946) Lista das aves coletadas em Pernambuco, com descrição de uma subespécie N., de um alótípico fêmea e notas de campo. *Boletim do Museu Nacional do Rio de Janeiro*, 65, 1–35.
- Carriker, M.A. Jr. (1903) Mallophaga from birds of Costa Rica, Central America. *Nebraska University Studies*, 3 (2), 123–197, 9 pls.
- Carriker, M.A. Jr. (1936) Studies in Neotropical Mallophaga, Part I. – Lice of the tinamous. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 88, 45–186, 32 pls.
- Carriker, M.A. Jr. (1944) Studies in Neotropical Mallophaga (III) [Tinamidae N°. 2]. *Proceedings of the United States National Museum*, 95 (3180), 81–233.

- http://dx.doi.org/10.5479/si.00963801.95-3180.81
- Carriker, M.A. Jr. (1955) Studies in Neotropical Mallophaga XII (Part 4). Lice of the tinamous. *Boletín de Entomología Venezolana*, 11 (3–4), 97–131.
- Clay, T. (1937) Mallophaga from the Tinamidae. *Proceedings of the Zoological Society of London Series B*, 107, 133–159.
- Clay, T. (1951) An introduction to a classification of the avian Ischnocera (Mallophaga): Part I. *Transactions of the Royal Entomological Society of London*, 102, 171–195.
- Clay, T. (1954) The post-spiracular seta and sensillus in the Mallophaga (Insecta). *Annals and Magazine of Natural History*, Series 12, 7, 716–718.  
http://dx.doi.org/10.1080/00222935408651780
- Clay, T. (1957) The Mallophaga of birds. In: Baer, J.G. (Ed.), *Première symposium sur la spécificité parasitaire des parasites de vertébrés*. Institut de Zoologie, Université de Neuchâtel, Neuchâtel, pp. 120–158.
- Clay, T. (1964) Geographical distribution of the Mallophaga (Insecta). *Bulletin of the British Ornithologists' Club*, 84 (1), 14–16.
- Clay, T. (1976) Geographical distribution of the avian lice (Phthiraptera): a review. *Journal of the Bombay Natural History Society*, 71 (3), 536–547.
- Coimbra-Filho, A.F. (1971) Três formas da avifauna do nordeste do Brasil ameaçadas de extinção: *Tinamus solitarius pernambucensis* Berla, 1946, *Mitu mitu mitu* (Linnaeus, 1766) e *Procnias a. averano* (Hermann, 1783) (Aves – Tinamidae, Cracidae, Cotingidae). *Revista Brasileira de Biologia*, 31, 239–247.
- Dickinson, E.C. (Ed.) (2003) *The Howard and Moore complete checklist of the birds of the world. 3<sup>rd</sup> Edition*. Princeton University Press, New Jersey, 1039 pp.
- Eichler, W. (1942) Notulae Mallophagologicae. VIII. *Heinrothiella inexpectata* nov. gen. et spec. und einige andere z. T. neue Federlinge. *Zoologischer Anzeiger*, 139 (1–2), 27–31.
- Eichler, W. (1947) Notulae Mallophagologicae. XVIII. Ueber Einige Heptapsogastridae [sic]. *Revista de Entomologia*, 18 (1–2), 167–172.
- Giebel, C.G.A. (1874) *Insecta epizoa. Die auf Säugetieren und Vögeln schmarotzenden Insecten nach Chr. L. Nitzsch's Nachlass bearbeitet*. O. Wiegand, Leipzig, xvi + 308 pp., 20 pls.
- Guimarães, L.R. (1942a) Sobre alguns gêneros e espécies de Heptapsogastridae [sic] (Mallophaga). – I. *Papéis Avulsos de Zoologia, São Paulo*, 2 (2), 15–37.
- Guimarães, L.R. (1942b) Sobre alguns gêneros e espécies de Heptapsogastridae [sic] (Mallophaga). – II. *Papéis Avulsos de Zoologia*, 2 (12), 151–170.
- Guimarães, L.R. (1942c) Sobre as espécies do gênero *Pseudolipeurus* (Mallophaga-Philopteridae). *Papéis Avulsos de Zoologia*, 2 (20), 267–290.
- Guimarães, L.R. (1943) Sobre alguns gêneros e espécies de Heptapsogastridae [sic] (Mallophaga). – III. *Papéis Avulsos de Zoologia*, 3 (2), 19–37.
- Guimarães, L.R. (1948) Sobre algumas espécies de Malófagos encontrados em *Tinamus tao tao* Temminck e *Tinamus tao septentrionalis* Brabourne e Chubb. *Boletim do Museu Paraense (E. Goeldi) de Historia Natural e Ethnographia*, 10, 161–173.
- Guimarães, L.R. (1950) Pequenas notas sobre malofagos. II. *Papéis Avulsos de Zoologia*, 9 (21), 321–340.
- Guimarães, L.R. & Lane, F. (1937) Contribuições para o conhecimento das Mallophagas das aves do Brasil. VI – Novas espécies parasitas de Tinamiformes. *Revista do Museu Paulista*, 23, 1–21.
- Hellenthal, R.A., Price, R.D. & Timm, R.M. (2002) A review of the chewing louse genus *Tinamotaecola* (Phthiraptera: Philopteridae), with the description of three new species. *Journal of the Kansas Entomological Society*, 74 (3), 136–141.
- Hopkins, G.H.E. (1942) Stray notes on Mallophaga – V. *Annals and Magazine of Natural History*, Series 11, 9, 108–119.
- Hopkins, G.H.E. & Clay, T. (1952) *A check list of the genera & species of Mallophaga*. British Museum of Natural History, London, 362 pp.
- Johnson, K.P., Adams, R.J. & Clayton, D.H. (2001) Molecular systematics of Goniodidae (Insecta: Phthiraptera). *Journal of Parasitology*, 87 (4), 862–869.  
http://dx.doi.org/10.2307/3285146
- Kéler, S. von (1938) Über brasiliische Mallophagen. 1 Beitrag. *Arbeiten über Morphologische und Taxonomische Entomologie aus Berlin-Dahlem*, 5 (4), 305–326.
- Kéler, S. von (1939) Über brasiliische Mallophagen. 2 Beitrag. *Arbeiten über Morphologische und Taxonomische Entomologie*, 6 (3), 222–253.
- Mey, E. (1994) Beziehungen zwischen Larvemorphologie und Systematik der adulti bei den vogel - Ischnozeren (Insecta, Phthiraptera, Ischnocera). *Mitteilungen aus dem Zoologischen Museum in Berlin*, 70 (1), 3–84.
- Palma, R.L. (1978) Slide mounting of lice: a detailed description of the Canada Balsam technique. *New Zealand Entomologist*, 6 (4), 432–436.  
http://dx.doi.org/10.1080/00779962.1978.9722313
- Paynter, R.A.J. & Traylor, M.A. (1991) *Ornithological gazetteer of Brazil. Vol. 1. & 2*. Museum of Comparative Zoology, Cambridge, viii + 789 pp.
- Price, R.D., Hellenthal, R.A. & Palma, R.L. (2003) World checklist of chewing lice with host associations and keys to families and genera. In: Price, R.D., Hellenthal, R.A., Palma, R.L., Johnson, K.P. & Clayton, D.H. (Eds.), *The chewing lice. World*

- checklist and biological overview. Illinois Natural History Survey Special Publication*, 24 (Champaign), pp. 1–448.
- Silveira, L.F., Olmos, F. & Long, A.J. (2003) Birds in Atlantic Forest fragments in north-east Brazil. *Cotinga*, 20, 32–46.
- Silveira, L.F., Olmos, F. & Long, A.J. (2004) Taxonomy, history and status of Alagoas curassow *Mitu mitu* (Linnaeus, 1766), the world's most threatened cracid. *Ararajuba*, 12 (2), 125–132.
- Smith, V.S. (2000) Basal ischnoceran louse phylogeny (Phthiraptera: Ischnocera: Goniodidae and Heptapsogasteridae). *Systematic Entomology*, 25, 73–94.  
<http://dx.doi.org/10.1046/j.1365-3113.2000.00095.x>
- Smith, V.S. (2001) Avian louse phylogeny (Phthiraptera: Ischnocera): a cladistic study based morphology. *Zoological Journal of the Linnean Society*, 132, 81–144.  
<http://dx.doi.org/10.1111/j.1096-3642.2001.tb02272.x>
- Taschenberg, O. (1882) Die mallophagen mit besonderer Berücksichtigung der von Dr. Meyer gesammelten Arten systematisch bearbeitet. *Nova Acta der Kaiserlich Leopoldinisch-Carolinisch Deutschen Akademie der Naturforscher*, 44 (1), 1–244, 7 pls.
- Valim, M.P. (2009) Type specimens of lice (Insecta: Phthiraptera) held in the Museu de Zoologia da Universidade de São Paulo, Brazil. *Papéis Avulsos de Zoologia*, 49 (17), 197–219.  
<http://dx.doi.org/10.1590/s0031-10492009001700001>