

## Key to the soldiers of *Angularitermes* Emerson with a new species from Brazilian Amazonia (Isoptera: Termitidae: Nasutitermitinae)

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### Abstract

An identification key based on characters of the soldier caste is provided for species of *Angularitermes*. Soldiers of previously described species in the genus, *A. clypeatus*, *A. nasutissimus*, *A. orestes*, *A. pinocchio* and *A. tiguassu*, are illustrated along with a new species, *Angularitermes coninasus*, **n. sp.**, that is described and illustrated from soldier and worker castes. Samples of the new species were collected from epigeal nests at the Brazilian Amazon rainforest. The soldier of *A. coninasus*, **n. sp.** is distinguished from its congeners by having a short conical frontal tube, much wider at its base.

**Key words:** termites, taxonomy, Neotropical region, identification key

### Introduction

The Nasutitermitinae genus *Angularitermes* was described by Emerson (1925) as a new subgenus of *Nasutitermes* Dudley, based on imago and soldier castes from the rain forest of Kartabo, Guyana (South America). Later, Snyder (1949) raised *Angularitermes* to generic level and Mathews (1977) considered it as a senior synonym of *Tintermes* Araujo.

*Angularitermes* is a well defined genus, whose soldiers are characterized by bilobed postclypeus, the intricate microsculpture on the frontal tube base (Cancello *et al.* 1996) and the relatively large mandible “points”, while workers have mandibles with reduced marginal teeth. The genus ranges from Trinidad to southeastern Brazil (Constantino, 1998).

Five species were included in *Angularitermes* until now. *A. nasutissimus* Emerson 1925, the type-species, is known from Amazonia and Trinidad. Emerson (1925) did not mention the microhabitat of the type material. One sample from the Museu de Zoologia da Universidade de São Paulo (MZUSP) from Amapá, Brazil, has an observation made by the collector as “in rotten wood”.

*A. clypeatus* Mathews 1977 was described from Mato Grosso State and was found as an inquiline in nests of *Cornitermes silvestrii*. *A. orestes* (Araujo 1970) shows a distribution in the Cerrado vegetation in central Brazil, and was found by Araujo (1970) as an inquiline of nests of *Armitermes euamignathus* and by Mathews (1977) in nest of *Embiratermes neotenicus*. *A. pinocchio* Cancello & Brandão 1996 is known from the Cerrado region in the State of Goiás (Brazil), and also from the Atlantic Forest (Reis & Cancello, 2007); this species was found by D. Brandão (Cancello *et al.* 1996) as an inquiline in nests of *C. silvestrii*. Finally, *A. tiguassu* Cancello & Brandão 1996 is known only from the State of Goiás, and was collected in the soil drawn up by the raised roots of a fallen tree, in a semi-deciduous tropical forest (Cancello *et al.* 1996) and also found as an inquiline in nests of *Cornitermes cumulans* by Costa *et al.* (2009).

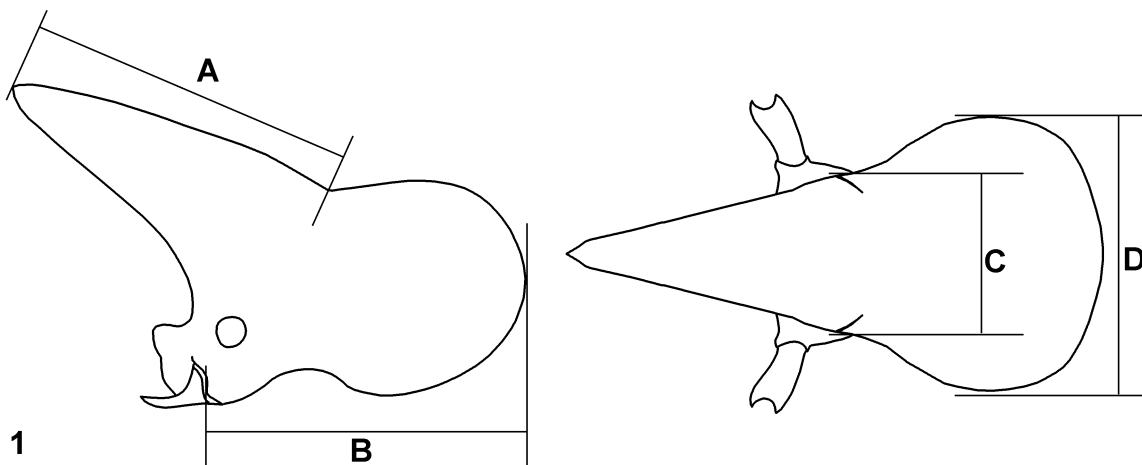
Herein, *Angularitermes coninasus*, **n. sp.**, from Brazilian Amazonia, is described and illustrated, based on characters of soldier and worker castes. Also, for the first time an epigeal nest is characterized for a species of *Angularitermes*. A key for the identification of the soldiers of the six species of *Angularitermes* is provided.

## Material and methods

The examined material is deposited in the Isoptera collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP) and comprises the following samples of each species: *A. nasutissimus*: 3460, paratype (Guyana, Kartabo; A.E. Emerson coll.; 11.viii.1920), and 9433 (Brazil, Amapá, Macapá; R. Constantino coll.; 28.x.1989); *A. clypeatus*: 7388, holotype (Brazil, Mato Grosso, 12°49'S 51°46'W; A.G.A. Mathews coll.; 11.i.1968); *A. orestes*: 4708, holotype (Brazil, Minas Gerais, Serra do Curral; R.L. Araujo coll.; 2.xii.1956); *A. pinocchio*: 10040, holotype (Brazil, Goiás, Goiânia; D. Brandão coll.; x.1987); *A. tiguassu*: 10041, holotype (Brazil, Goiás, Goiânia; D. Brandão coll.; x.1987) and two samples of the new species described herein (9425 and 13445, detailed below).

The morphometric characters used in this paper and their correspondence with Roonwal's system (Roonwal 1970) are indicated in parentheses when possible, as follows: LT, length of hind tibia (85); maximum width of head (17, Fig. 1D), LN, length of frontal tube (figure 1A); LH, length of head to lateral base of mandibles (5, Fig. 1B); WN, maximum width of frontal tube (Fig. 1C); and LN/WN, LN/LH, and LH/LT indices. All measurements, provided in millimeters, were taken with a micrometric reticule adapted to a binocular stereomicroscope. The number of specimens measured for each caste of *Angularitermes coninasus* **n. sp.** is provide in descriptions; also three soldiers of *A. nasutissimus*, three of *A. tiguassu* and the type of *A. clypeatus* had the LN/WN index measured to be used into the key.

Line drawings were prepared with a *camera lucida* coupled to a stereomicroscope and then scanned. Photographs of soldiers were taken with a digital camera adapted to a stereomicroscope at different focal points of each individual and then combined using *Combine ZP* software (Hadley 2010). The worker enteric valve was mounted on a microscope slide with alcohol gel and photographed under an optic microscope Axio Imager A1 and digital camera ICc 1, Zeiss.



**FIGURE 1.** Morphometric characters of soldier head. In lateral view (left) and in dorsal view (right): A, length of frontal tube; B, length of head to lateral base of mandibles; C, maximum width of frontal tube; and D, maximum width of head.

The terms used for pilosity are comparative: “thick bristles” are erect hairs with well-marked bases and thicker than the “bristles”; bristles are thinner than the first (see the differences between them comparing the bristles in the soldier head: figures 2A—*A. coninasus* **n. sp.** with 2D—*A. tiguassu*); “hairs” are shorter than bristles, less rigid and with inconspicuous bases; “microscopic hairs” are very short and only visible under high magnification, usually 50× or more. The term epicranial suture is used as explained by Grassé (1982, p. 7). The terminology adopted for the worker mandibles follows Fontes (1987), and the terminology for the digestive tube is after Noirot (2001).

Key to species of *Angularitermes*

- 1. Frontal tube very conical with a wide base, almost half of the length of frontal tube (Fig. 2A) ..... *A. coninasus* Carrijo & Rocha, n. sp.
- Frontal tube longer, not as conical as above, width of base much shorter than half of the length of frontal tube (Figs. 2B–F) .. 2
- 2. Short hairs on frontal tube, when present, only in the first basal third ..... 3
- Short hairs along the length of frontal tube ..... 4
- 3. Postclypeus very large and projected forward; length of frontal tube proportionally longer compared to cephalic capsule size (Fig. 2E) ..... *A. pinocchio* Canello & Brandão
- Postclypeus smaller; length of frontal tube proportionally shorter compared to cephalic capsule size (Fig. 2C) ..... *A. orestes* (Araujo)
- 4. Antennae with 14 articles; ratio LN/WH more than 1.85 (Figs. 2B and 2F) ..... 5
- Antennae with 15 articles; ratio LN/WH less than 1.55; (Figs. 2D) ..... *A. tiguassu* Canello & Brandão
- 5. Postclypeus very prominent and upward oriented (Fig. 2F) ..... *A. clypeatus* Mathews
- Postclypeus short (Fig. 2B) ..... *A. nasutissimus* Emerson

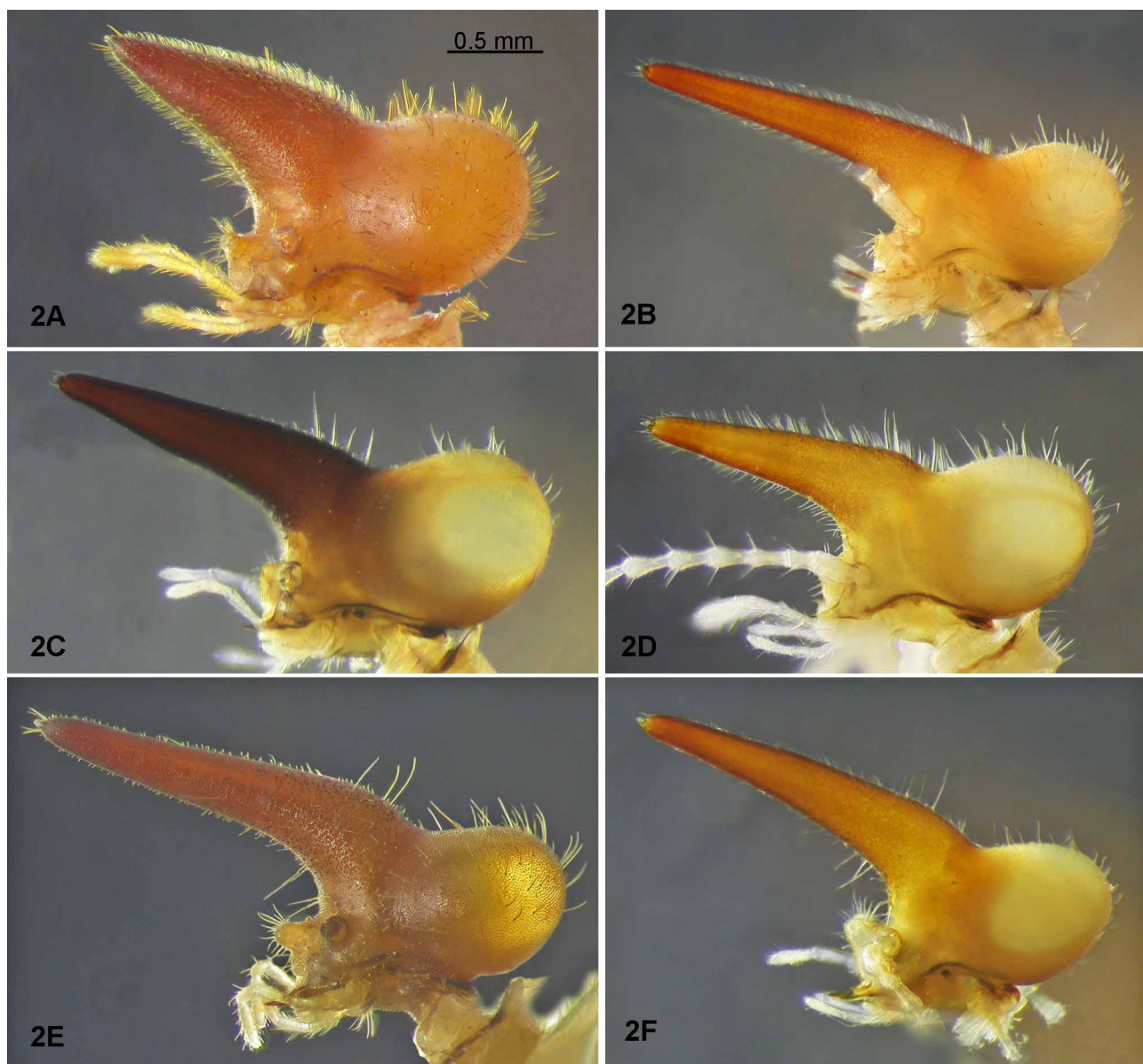


FIGURE 2. *Angularitermes* soldier head, in profile: A, *A. coninasus* n. sp. (paratype); B, *A. nasutissimus*; C, *A. orestes* (paratype); D, *A. tiguassu* (holotype); E, *A. pinocchio* (paratype); and F, *A. clypeatus* (holotype).

*Angularitermes coninasus* Carrijo & Rocha, new species

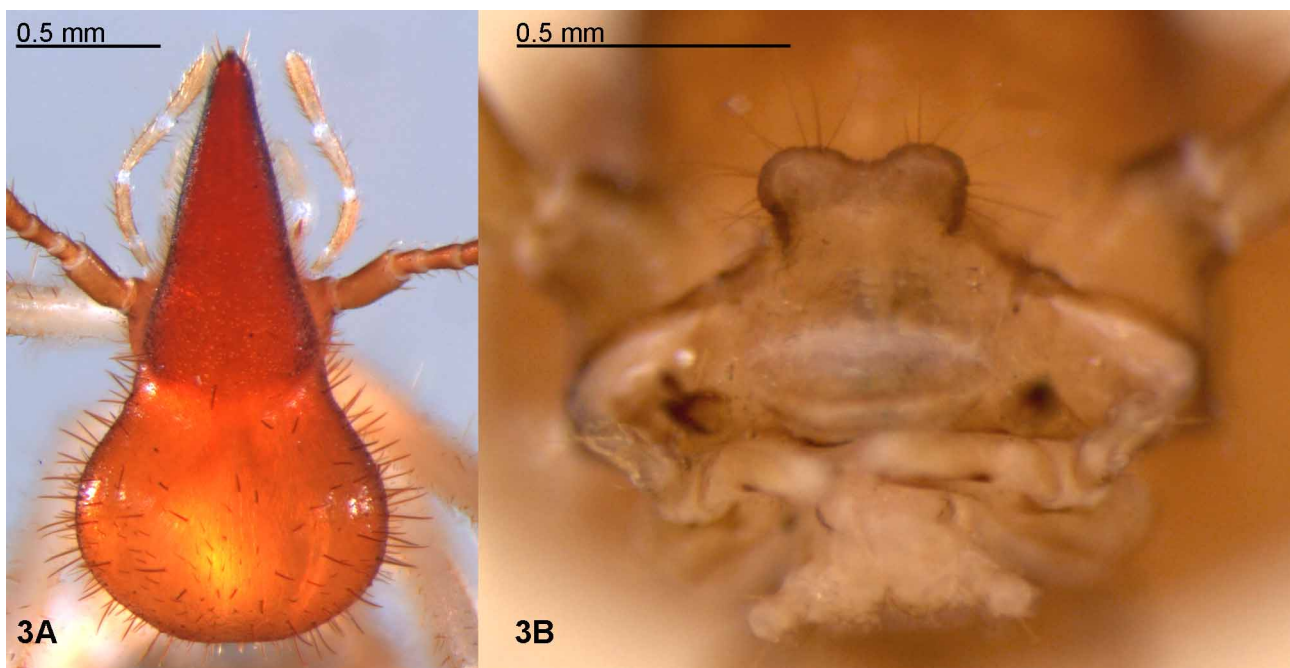
**Holotype.** Soldier, part of lot MZUSP 13445, Brasil, Rondônia, Porto Velho, Jaci-Paraná, Ilha da Pedra module from the Fauna Monitoring Program of Santo Antônio UHE, transect two, 3850 meters, 09°09'S 64°35'W; T. F. Carrijo & R. G. Santos coll.; 14.ix.2010.

**Paratypes.** The remain specimens from holotype's sample (workes and soldiers) and Brazil, Amazonas, Humaitá, 13.ix.1990, R. Constantino coll. (MZUSP 9425), part of the sample from the Museu Paraense Emílio Goeldi, (MPEG 3680).

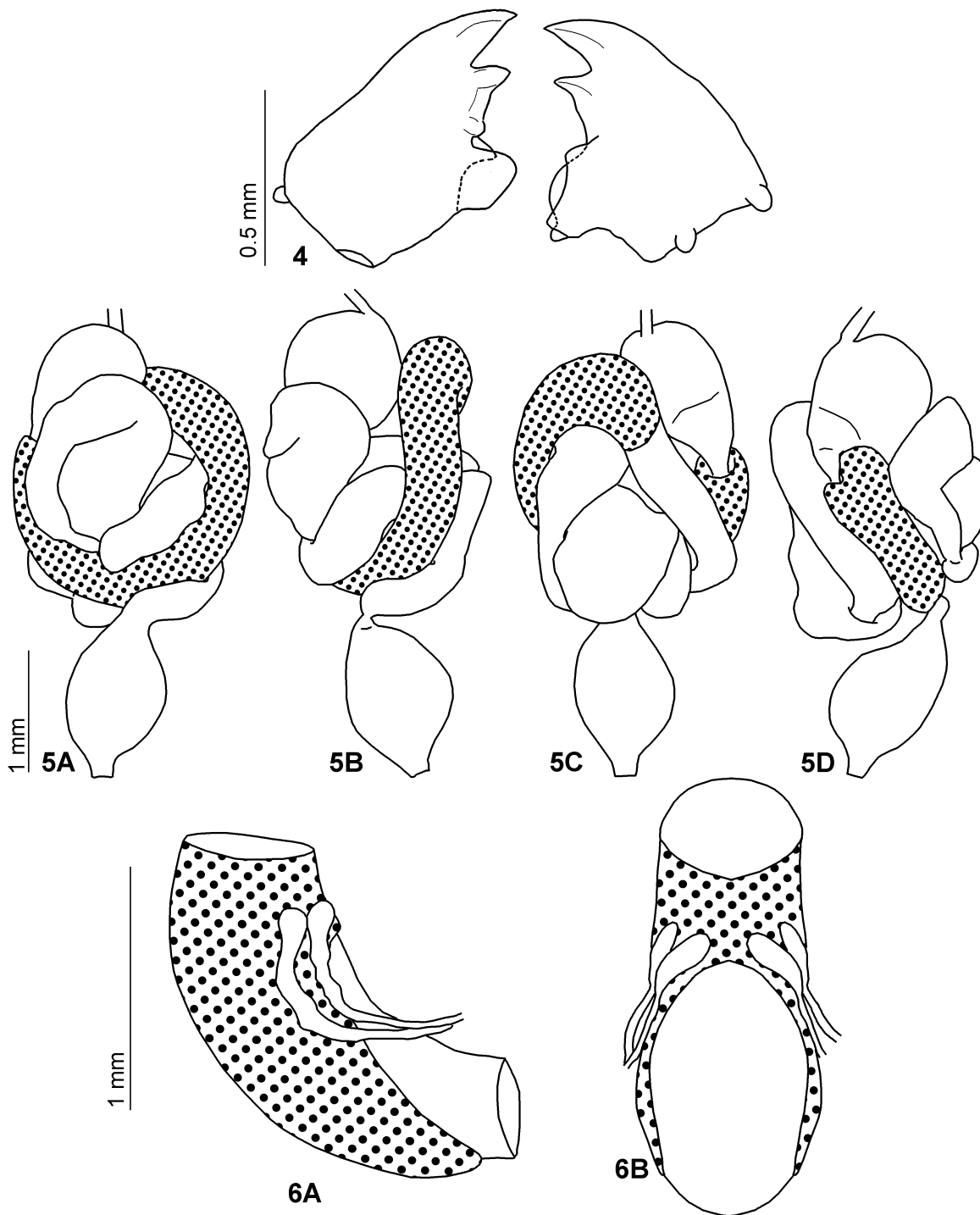
**Etymology.** The specific epithet *coninasus* is a combination of the Latin term *conus* (meaning cone) and frontal tube as a reference to the conical shape of the soldier frontal tube.

**Description.** Imago. Unknown.

Soldier (Figs. 2A and 3). Monomorphic. Head capsule pyriform in dorsal view. frontal tube conical, with a slight to strong constriction at the base (Fig. 3A), pointing upward in profile. Postclypeus well-developed; projected upward and forward (Fig. 3B). Mandibular blade reduced to conspicuous "points". Labrum shorter than wider; anterior margin of labrum rounded. Antennae with 14 articles; 1<sup>st</sup> article is the largest with at least twice the length of 2<sup>nd</sup>; 3<sup>rd</sup> longer than 2<sup>nd</sup>; from 4<sup>th</sup> to 7<sup>th</sup> or 8<sup>th</sup> slightly longer than the anterior; from the 8<sup>th</sup> to the last, one shorter than the next, the last is as long as the 2<sup>nd</sup>. Anterior lobe of pronotum trapezoidal, almost rectangular, with anterior margin slightly emarginated. Legs very long; tibiae longer than head capsule length. Frontal tube with a microsculpturing of irregular pits concentrated at the first half, some pits may reach near the apex. Surface of the head capsule covered by thick bristles and hairs. Frontal tube surface with a few sparse bristles and a dense layer of decumbent short hairs; frontal tube apex with four rigid bristles smaller than those of head. Labrum glabrous. Bristles of the antennae concentrated at the apex of each article with short hairs on their surface; first article with bristles restricted to the apex. Pronotum with bristles on margins and two or three over its surface. Meso- and metanotum with many thick bristles on lateral and posterior margins. Abdominal tergites covered by many thick bristles of different sizes. Abdominal sternites with a line of thick, erected bristles and sparse short hairs oriented backward. Legs with many thick bristles and hairs over their surfaces. Tibial spurs 2:2:2. Head capsule varying from ferruginous orange to pale yellow, frontal tube brown/red, always darker than the head capsule. Body yellow to pale yellow. Measurements of four soldiers from MZUSP 9425 and four from MZUSP 13445: LN (1.38–1.44), LH (1.32–1.38), WN (0.61–0.67), WH (1.17–1.25), LT (2.27–2.40), LN/WH (1.11–1.18), LN/ LH (1.00–1.05), LH/LT (0.57–0.60).

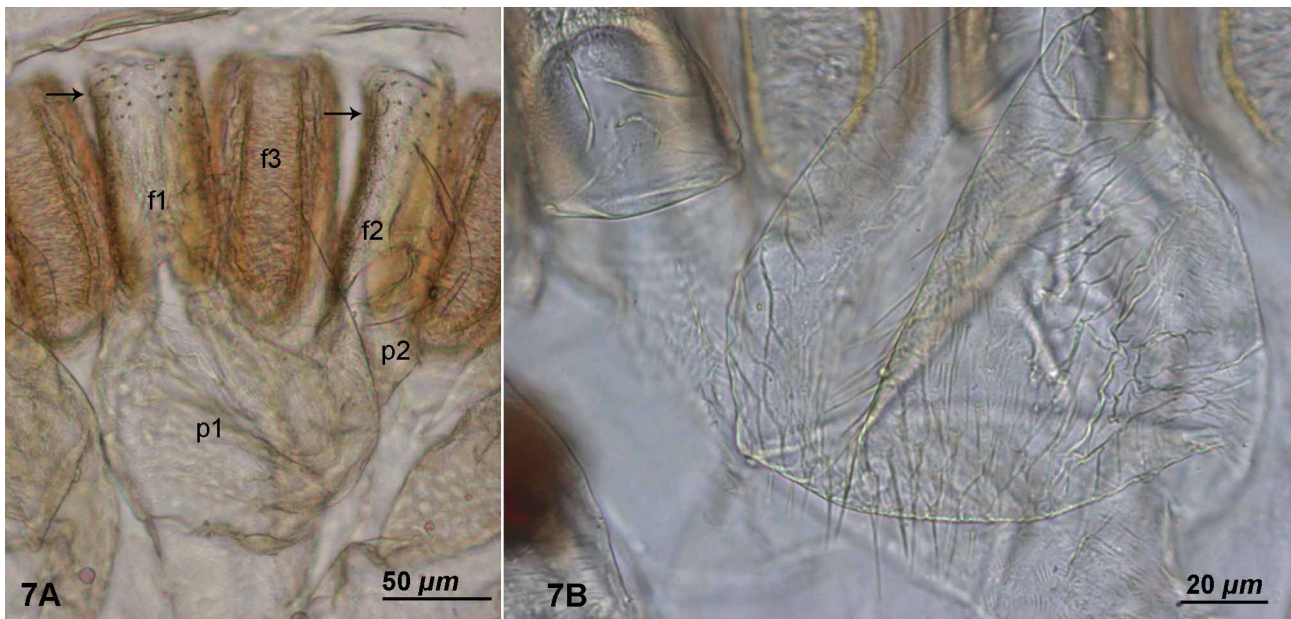


**FIGURES 3.** *Angularitermes coninasus* n. sp.: 3A, soldier head capsule, dorsal view. 3B, postclypeus, frontal view.



**FIGURES 4–6.** Worker of *Angularitermes coninasus* n. sp.: 4, mandibles; 5, digestive tube *in situ*: A, dorsal; B, right; C, ventral; and D, left views; 6, detail of mesenteric tongue and Malpighian tubules: A, profile; and B, internal views.

Worker (Figs. 4–8). Dimorphic. Differences among the dimorphic workers are restricted to their size. Head capsule trapezoidal, fontanelle and epicranial suture inconspicuous. Antennae with 15 articles, if 14 the 3<sup>rd</sup> is always subdivided. Postclypeus inflated. Anterior lobe of pronotum slightly emarginated. Tibial spurs 2:2:2. Head capsule with many bristles. Pronotum with bristles on the anterior and posterior margins; meso- and metanotum with bristles on posterior margins; abdominal tergites covered with many bristles and hairs; sternites with bristles and a dense layer of short hairs. Legs covered by scattered bristles and hairs. Measurements of four major and four minor workers from MZUSP 9425 and MZUSP 13445 are given as a range: major, WH (1.32–1.36), LT (1.87–1.96); and minor, WH (1.17–1.19), LT (1.64–1.74).



**FIGURE 7.** *Angularitermes coninasus* n. sp.: A, gizzard; and B, detail of the pulvillus I. f1, f2 and f3: first, second and third order folds, respectively, p1 and p2: pulvillus I and II respectively; and arrow: spines on the folds.



**FIGURE 8.** Enteric valve armature of the worker of *Angularitermes coninasus* n. sp., showing major cushions (large arrows) intercalated by minor cushions (thinner arrows). Observation: when enteric valve was mounted major cushions adopted different positions but there are no differences between them.

Mandibles (Fig. 4). Left mandible: apical tooth slightly larger than  $M_{1+2}$ ; angle between apical tooth and  $M_{1+2}$  tooth nearly acute;  $M_3$  with half size of  $M_{1+2}$ ; notable gap between  $M_3$  and molar prominence; molar tooth apex hidden by molar prominence; molar prominence very concave and without ridges. Right mandible: apical tooth approximately twice the size of  $M_1$ ;  $M_2$  reduced or absent; molar plate very concave and without ridges.

Digestive tube (Figs. 5–8). Crop well developed. Gizzard armature complete, surface of folds I and II ornamented with small and sparse spines (Fig. 7A); pulvillus I well developed, covered with long aciculiform spines on the superior portion and many lines with very small spines (4–6) on the inferior portion (Fig. 7B), pulvillus II reduced, surface smooth. Anterior end of midgut with a distinct hump dorsal to the insertion of the gizzard. Mixed segment very short, mesenteric tongue external to mesenteric arch (Fig. 6A). Malpighian tubules attached individ-

ually but closely adjacent in pairs at mesenteron-proctodeum junction; each tubule conspicuously dilated in its proximal part (Fig. 6A and B). Proctodeal segment ( $P_1$ ) short and tubular throughout its length. Enteric valve ( $P_2$ ) visible at left side (Fig. 5B).  $P_2$  with three major cushions intercalated with three minor ones (Fig. 8): major cushions with shorter spines on its surface and, after a deflection on the distal portion, a row of 4–6 larger spines pointing inward to gut lumen (Fig. 8, large arrows); minor cushions with only sparse small spines (Fig. 8, thinner arrows). Paunch ( $P_3$ ) with  $P_{3a}$  and  $P_{3b}$  dilated; proximal part of colon ( $P_{4a}$ ) dilated; U-turn short and visible at right view.

**Biology.** All samples were collected in a primary rainforest. *A. coninasus* n. sp. type material was sorted out of a domed shaped epigeal nest, measuring 29 cm in height and 55 cm in width at its base (Fig. 9). The surface of the nest was covered by loose soil, which also formed the peripheral layer of about 5 cm in depth with noticeable galleries larger than 1 cm in diameter. Galleries at the internal layer had 0.5 cm diameter and were occupied by intertwined roots extending almost 10 cm down in soil. There were no chimneys communicating interior with exterior. The nest was surrounded by a shallow litter layer and some sticks. Neither inquilines nor real pair were found within *A. coninasus* n. sp. nest.



FIGURE 9. Nest of *Angularitermes coninasus* n. sp. from Rondônia, Brazil.

**Comparisons.** Soldiers of *Angularitermes coninasus* n. sp., can be easily recognized among its congeners by having a short and strongly conical frontal tube, with a wide base. The combination of characters as microsculpture of the head capsule and frontal tube, pilosity and coloration distinguish *A. coninasus* n. sp. from the other species. *A. tiguassu* is morphologically similar to the new species but has a much narrower frontal tube at the base; antennae with 15 articles and LH/LT index 0.66–0.68. Workers are dimorphic. No other species of *Angularitermes* was reported as nest-building.

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