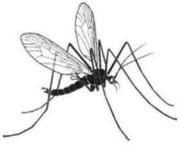


Key to the soldiers of South American *Heterotermes* with a new species from Brazil (Isoptera: Rhinotermitidae)

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A soldier-based key to the South American species of *Heterotermes* is presented. Six species are recognized: *H. assu* sp. n., *H. convexinotatus*, *H. crinitus*, *H. longiceps*, *H. sulcatus* and *H. tenuis*. *H. assu* sp. n., is described from the Brazilian Atlantic forest, including the imago, soldier and worker castes. *H. assu* is also recorded from urban areas as a pest. The imago of *H. longiceps* is described and illustrated for the first time. The soldiers of all species are illustrated and their known distribution mapped, with several new records.

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Introduction

The genus *Heterotermes* Froggatt, 1900 has about 50 described species from all major tropical and subtropical regions of the World. *Heterotermes* and *Reticulitermes* Holmgren, 1913 are currently the only genera placed in Heterotermitinae. *Reticulitermes* is restricted to the northern temperate zone, while *Heterotermes* is essentially tropical. Both *Heterotermes* and *Reticulitermes* are economically important, including some of the major pest termites in many regions. There are 9 described species of *Heterotermes* in the New World, 5 of them occurring in South America (Constantino 1998).

The New World species of *Heterotermes* were first revised by Snyder (1924), who recognized 6 species: *H. aureus* (Snyder, 1920), from southern United States and northern Mexico, *H. convexinotatus* (Snyder, 1924), from southern Mexico and Central America, *H. cardini* (Snyder, 1924), from the Bahamas, *H. crinitus* (Emerson, 1925), from Guyana, *H. longiceps* (Snyder, 1924), from central Brazil, and *H. tenuis* (Hagen, 1858), which is widespread in South America. Snyder's (1924) revision did not include *H. insularis* (Wasmann, 1903), from Cocos Island, Costa Rica, and he suggested that it could be a synonym of *H. convex-*

inotatus. Most of these species were initially included in the genus *Leucotermes* Silvestri, 1901, which was later synonymized with *Heterotermes* by Light (1933). Light (1933) described also *H. maculatus* from Mexico. Emerson (1971) stated that *H. convexinotatus* should be treated as a subspecies of *H. aureus*, but most authors still treat the former as a full species. Mathews (1977), described another species, *H. sulcatus*, from central Brazil, and also redescribed *H. longiceps*.

Species of *Heterotermes* are among the most widespread termites in South America, being abundant both in natural and urban environments. Several South American species, especially *H. tenuis*, have been reported to be important both as agricultural and structural pests. Despite their economic importance, and contrasting with the vast amount of literature on *Reticulitermes*, the biology and geographic distribution of *Heterotermes* species remains poorly known.

In this paper, a soldier-based key to the South American species of *Heterotermes* is presented, and a new species is described from the Brazilian Atlantic forest. The imago of *H. longiceps* is described for the first time, and new distribution records are added for other species.

Methods

Drawings were prepared with a camera lucida attached to a dissection microscope. Measurements were taken with a micrometric reticle on the eyepiece of a dissection microscope. Measurements presented in Tab. 1 correspond to the following numbers in Roonwal's (1970) system: length of head [to side base of mandibles] = no. 5; width of head = no. 17; width of head without eyes = no. 18; height of head [excluding postmentum] = no. 21; length of left mandible = no. 37; length of hind tibia = no. 85; width of pronotum = no. 68; length of pronotum = no. 65; diameter of eye = no. 48; length of ocellus = no. 55; length of forewing = no. 74. The distribution maps were prepared with the Generic Mapping Tools (Wessel & Smith 1998) based on the material examined and on published records (Snyder 1924; Emerson 1925; Snyder 1959; Mathews 1977; Torales et al. 1997). *H. tenuis* was not mapped because it is widespread and very common, recorded from Panama to northern Argentina, east of the Andes.

Terms used for hairs are comparative. Bristles are thick hairs with well-marked bases. Hairs are slender. Microscopic hairs are those visible only at magnifications of 40X or higher.

The material examined is deposited in the following entomological collections: Departamento de Zoologia, Universidade de Brasília, Brazil (DZUB), Museu Paraense Emílio Goeldi, Belém, Brazil, Museu de Zoologia da Universidade de São Paulo, Brazil (MZSP), Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, João Pessoa, Brazil (UFPB), Departamento de Entomología, Universidad Central de Venezuela, Maracay, Venezuela, Departamento de Biología Animal, Universidade Federal de Viçosa, Brazil.

Key to the soldiers of South American *Heterotermes*

Note: Soldier dimorphism is present in two species, but it is conspicuous only in *H. longiceps*. For this reason, major and minor soldiers are not treated separately in this key, and dimorphism is used as a supplementary character. However, this key should work even if only one type of soldier is available.

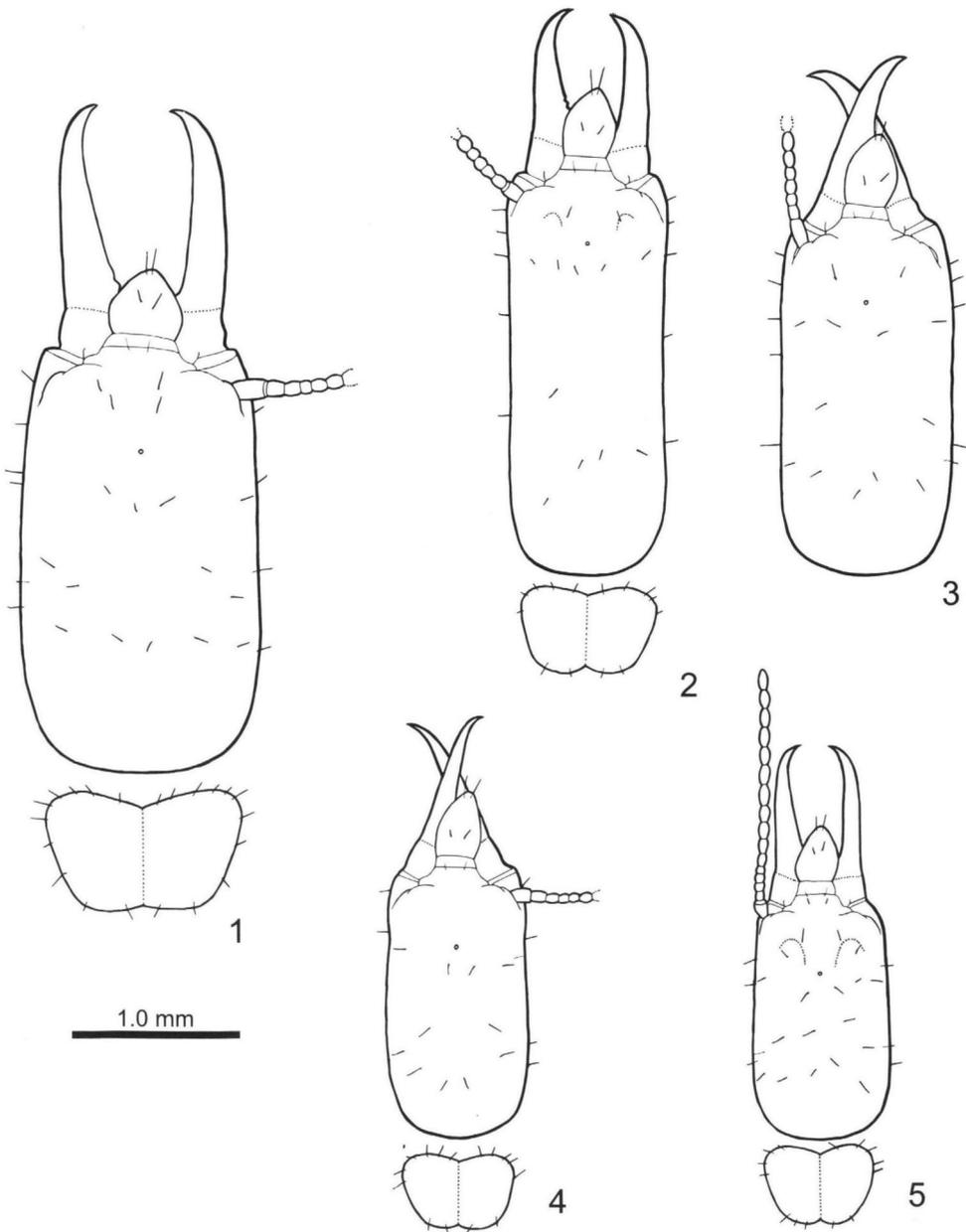
- 1. Pronotum with at least some hairs on surface (Fig. 6-9)..... 2

- Pronotum with hairs only on margins (Fig. 1-5)..... 4
- 2. Tergites with a line of bristles on posterior margin and numerous microscopic hairs on surface, width of head 0.79-0.84 mm; Colombia and Venezuela (Fig. 9, 14, 20)..... *H. convexinotatus*
- Tergites with a line of bristles on posterior margin and numerous long hairs on surface, about 1/3 of the length of marginal bristles..... 3
- 3. Head densely covered with hairs and bristles; mandibles light brown; postmentum with a narrow mid segment with parallel sides; soldier monomorphic; Guianas, Venezuela and Brazilian Amazonia; antennae with 14-15 articles, usually 14 (Fig. 8, 13, 21)..... *H. crinitus*
- Head with less dense hairs; mandibles dark brown; postmentum with concave sides; soldier dimorphic; antennae with 15-17 articles, usually 15 (Fig. 6, 7, 12, 22, 23)..... *H. tenuis*
- 4. Frons with two elevations in profile and a V-shaped groove between them; width of head 0.70-0.81 mm (Fig. 5, 15, 19)..... *H. sulcatus*
- Frons without elevations in profile..... 5
- 5. Width of head 1.32-1.62 mm; soldier monomorphic, antennae with 18 articles (Fig. 1, 10, 16)..... *H. assu*
- Width of head 0.85-1.03 m; soldier conspicuously dimorphic, antennae with 15-17 articles (Fig. 2-4, 11, 17, 18)..... *H. longiceps*

***Heterotermes assu* sp. n.**

Type material. - Holotype (soldier): BRAZIL. State of Espírito Santo. Presidente Kennedy, Praia das Neves, 27.iv.98, R. Constantino (DZUB). Paratypes: BRAZIL. *State of Espírito Santo.* Presidente Kennedy, Praia das Neves, 27.iv.98, R. Constantino (soldiers and workers); same locality, 30.iv.98, R. Constantino (soldiers and workers). *State of Minas Gerais.* Viçosa, 25.iv.99, M.P. Souza (soldiers and workers). *State of São Paulo.* São Paulo, 27.vi.95, A.T. Lelis (soldiers and workers); 30.iii.94, A.T. Lelis (soldiers and workers); 25.iii.95, A.T. Lelis (soldier); 14.i.98; L.F. Romagnano (soldiers, workers and alates); 10.xi.97, R. Amaral (soldiers and workers); 06.ii.00, D. K. Sukanuma (soldier); 15.ii.00, G. A. C. Lopez (soldier). All paratypes currently in DZUB; some will be deposited in MZSP.

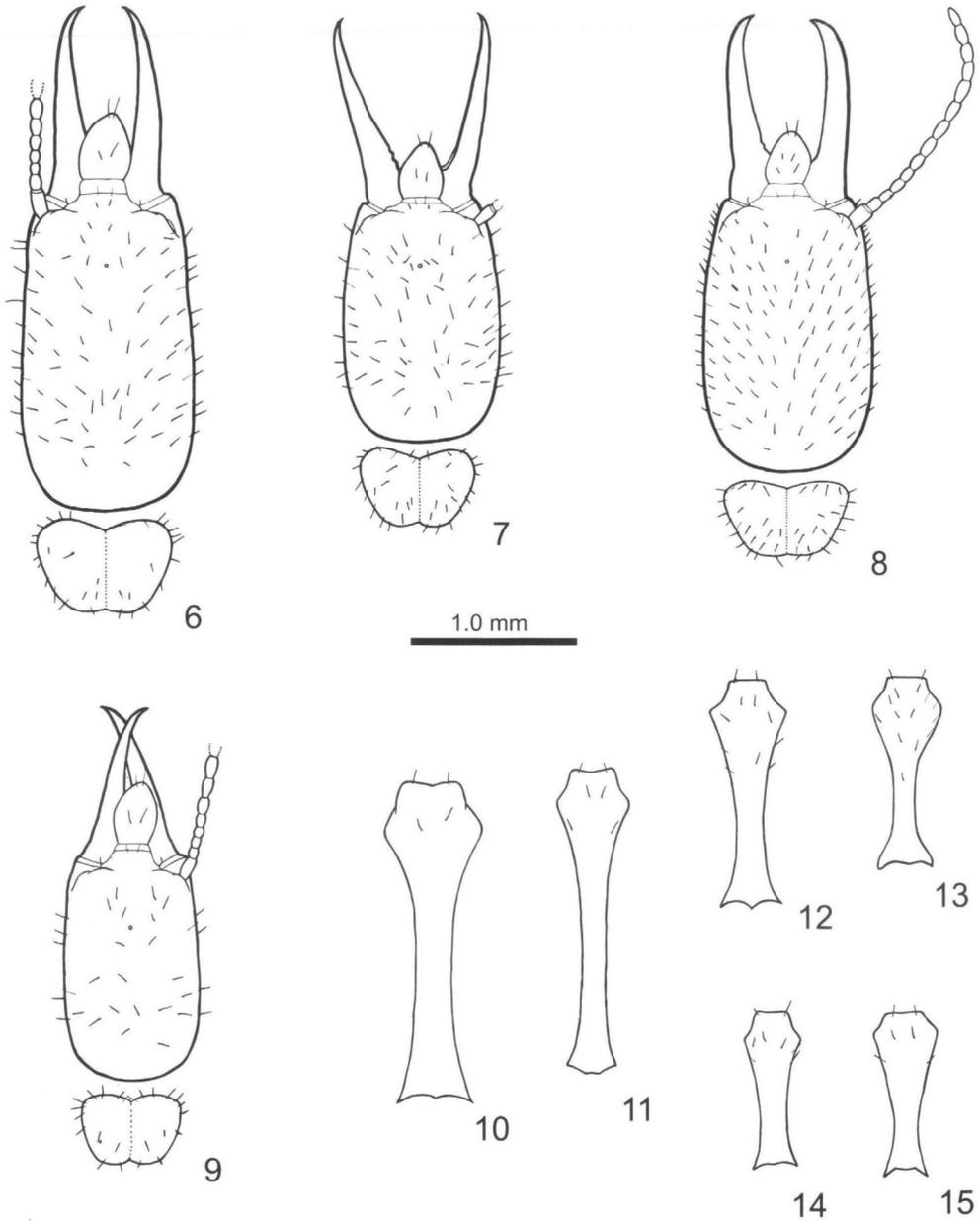
Imago (Fig. 24, 25). The head capsule is brown; the occiput is paler. The mandibles are the same color as the head, becoming darker near cutting edge and teeth. The antennae and palps are brownish-yellow, paler than head. The labrum and the postclypeus are brownish-yellow. The pronotum is brown, a little paler than the head. The metanotum and mesonotum are brownish-yellow. The tergites are the same color as the pronotum. The sternites are paler than the tergites. The legs are brownish-yellow. The wings are brownish. The head capsule has numerous bristles and hairs of variable size. The postclypeus has 4-6 bristles.



Figures 1-5. Head and pronotum of soldiers in dorsal view: (1) *Heterotermes assu*; (2) *H. longiceps*, major soldier from Brasília; (3) *H. longiceps*, major soldier from Espírito Santo; (4) *H. longiceps*, minor soldier; (5) *H. sulcatus*.

The labrum has 14-16 hairs of variable size. The pronotum has numerous bristles and hairs of variable size. The tergites and sternites have a row of

bristles on posterior margin and numerous hairs on surface. The tibial spurs are 3:2:2. The head capsule is oval, relatively wide. The antennae



Figures 6-15. Head and pronotum of soldiers in dorsal view (6-9); postmentum of soldiers (10-15): (6) *Heterotermes tenuis*, major soldier; (7) *H. tenuis*, minor soldier; (8) *H. crinitus*; (9) *H. convexinotatus*; (10) *H. assu*; (11) *H. longiceps*, major soldier; (12) *H. tenuis*, major soldier; (13) *H. crinitus*; (14) *H. convexinotatus*; (15) *H. sulcatus*.

have 20 articles: 1st is the longest, 2nd is as long as 3rd plus 4th, 4th is the shortest, 5th to 20th become slightly longer. The eyes are broadly oval.

The ocelli are present, but small, close to eyes. The fontanelle is small and rounded. The postclypeus is short and moderately inflated. The ante-

Table 1. Measurements of soldiers and imagoes of *Heterotermes assu* and of imagoes of *H. longiceps*.

| | <i>Heterotermes assu</i> | | <i>H. longiceps</i> | Imagoes (n=10) |
|-------------------------|--------------------------|--------------|---------------------|-------------------|
| | Soldiers | | Imagoes (n=2) | |
| | Holotype | Range (n=11) | | |
| Length of head | 2.41 | 1.97-2.65 | 1.14-1.19 | 0.92-0.96 |
| Width of head | 1.47 | 1.32-1.62 | 1.16-1.19 | 0.84-0.88 |
| Height of head | 1.15 | 0.97-1.26 | — | — |
| Length of left mandible | 1.5 | 1.38-1.56 | — | — |
| Length of hind tibia | 1.18 | 1.09-1.32 | 1.31 | 0.84-0.88 |
| Width of pronotum | — | — | 1.04-1.06 | 0.74-0.84 |
| Length of pronotum | — | — | 0.74-0.77 | 0.50-0.54 |
| Diameter of eye | — | — | 0.34-0.36 | 0.22-0.26 |
| Length of ocellus | — | — | 0.06 | — |
| Length of fore wing | — | — | 10.20-10.39 | 7.94-8.73 |

rior margin of pronotum is slightly emarginate; the posterior margin is nearly straight. The posterior margin of mesonotum and metanotum form a wide angle. The measurements are in Tab. 1.

Soldier (Fig. 1, 10, 16). Monomorphic. The head capsule is yellow, a little darker anteriorly. The mandibles are chestnut-brown, with yellow-brown base. The antennae and palps are about the same color as the head. The labrum is yellow, with a hyaline tip. The pronotum, mesonotum, metanotum, tergites and sternites are yellow, paler than head. The legs are pale yellow. The head capsule has a few scattered bristles: 4-7 on frons, 10-14 on vertex, 9-10 on each lateral side, 0-2 on underside. The postclypeus has 2 bristles. The postmentum has 4 bristles near anterior margin. The labrum has 4 bristles and 2-4 hairs. The pronotum has numerous bristles on margins, and none on surface. The mesonotum and metanotum have bristles on lateral and posterior margins. The tergites have an irregular row of bristles on posterior margin and scattered hairs of variable size on surface, which are more numerous on posterior segments; their surface also has numerous microscopic hairs. The pilosity of sternites is similar, but with more numerous hairs on surface. The foretibia has 12-14 short, thick bristles on inner margin, organized in two rows, and about 6 of the same bristles on outer margin, in a single row. The tibial spurs are 3:2:2. The head capsule is subretangular; the ratio of length of head to width of head is 1.52-1.75. The antennae have 18 articles: 1st is the longest, 2nd is longer than 3rd, 4th is the shortest, 3rd and 5th are subequal; 6th is longer than 5th, 6th to 18th becoming a little longer. The eyes are inconspicu-

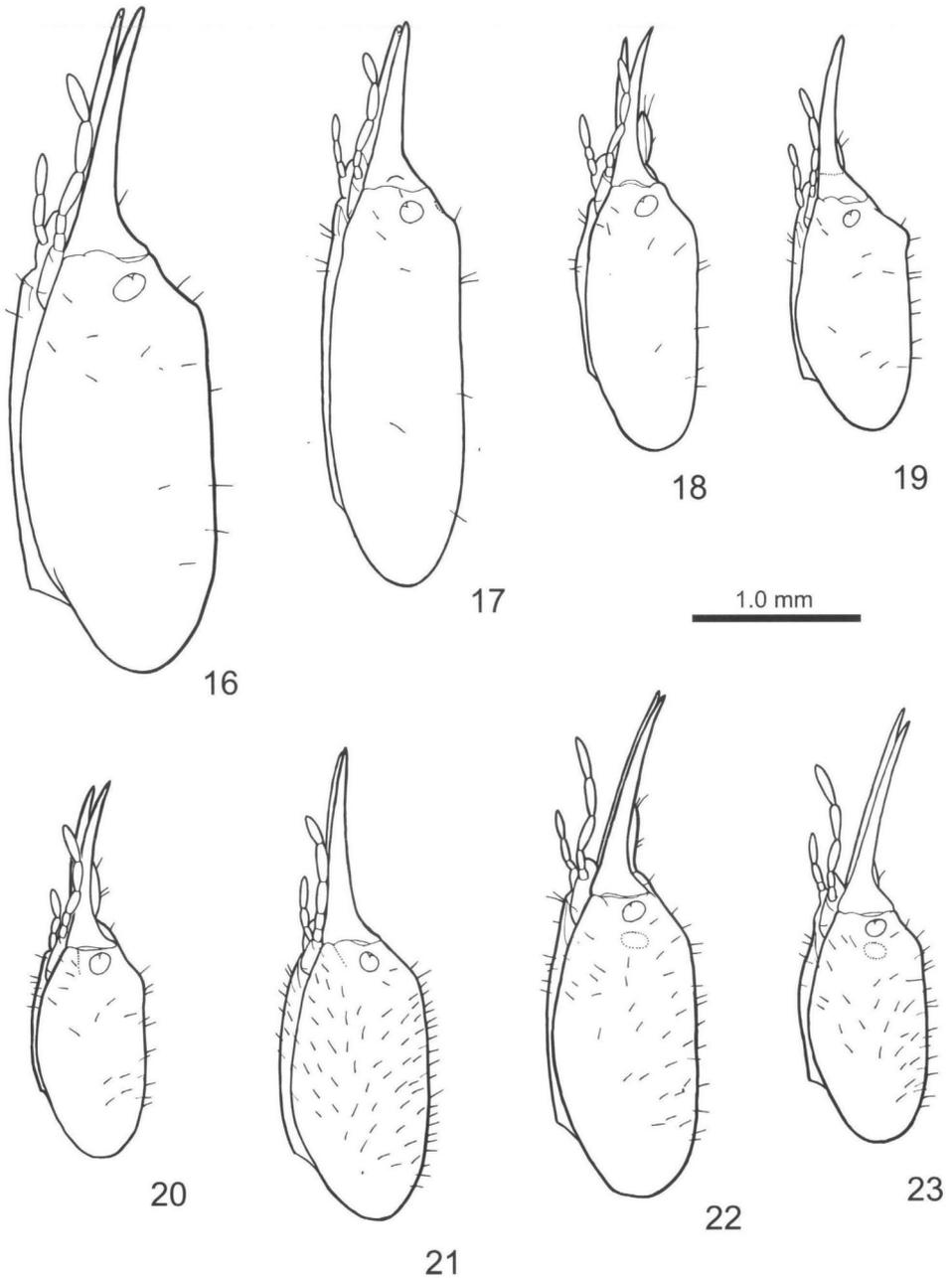
ous; the eye region is a little paler than the head. The labrum is tongue-shaped and relatively short. The pronotum is nearly as wide as head; its anterior margin is conspicuously emarginate; its posterior margin is nearly straight. The measurements are in Tab. 1.

Worker (Fig. 28, 29). The head capsule is white to yellowish-white. The remainder of body is whitish. The head capsule has many bristles and numerous hairs. The tergites and sternites have a row of bristles on posterior margin and many hairs on surface, which are longer and more numerous than those of soldier. The antennae have 18-19 segments. The width of head is 1.26-1.36 mm; the length of hind tibia is 0.86-1.06 mm (n=5). The mandibles are as in Fig. 28-29.

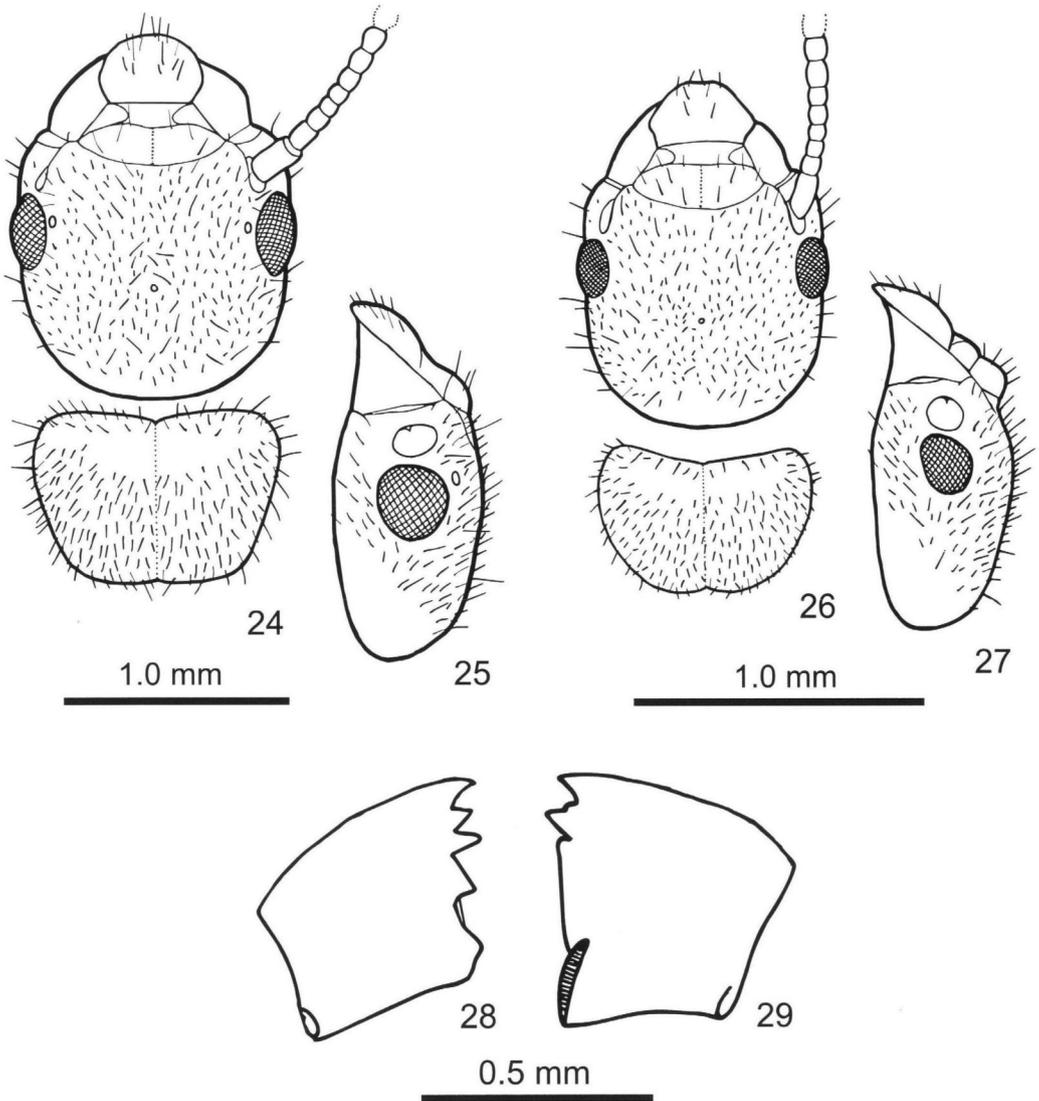
Etymology. – From the Tupi, *açu*, large.

Comparisons. – All castes are conspicuously larger than all other New World species of *Heterotermes*. The head of the soldier has fewer hairs than all species except *H. longiceps*, which has about the same number. The soldier labrum is shorter than in other species. The antennae of soldiers of other New World species have 14-17 articles, and of imagoes 16-17 articles. The head of the imago of all other New World species is conspicuously more elongate. Ocelli were present in the examined imagoes; some *Heterotermes* species seem to lack ocelli (*H. longiceps*) while in others they may be present or absent. If present, they are always very small.

Remarks. – *H. assu* seems to be native of the Brazilian Atlantic Forest. The type locality is a



Figures 16-23. Soldier heads in profile: (16) *Heterotermes assu* sp. n.; (17) *H. longiceps*, major soldier; (18) *H. longiceps*, minor soldier; (19) *H. sulcatus*. 20) *H. convexinotatus*; (21) *H. crinitus*; (22) *H. tenuis*, major soldier; (23) *H. tenuis*, minor soldier.



Figures 24-29. Head and pronotum of imagoes (24-27); mandibles of worker (28-29): (24-25) *Heterotermes assu*; (26-27) *H. longiceps*; (28-29) *H. assu*.

patch of restinga forest on top of sandy soil, at sea level and only about 500 m from the coastline. All other samples come from urban areas at higher elevations, where it has been reported as a structural pest.

***Heterotermes longiceps* (Snyder)**

Leucotermes longiceps Snyder, 1924:20 [major soldier]
Heterotermes longiceps; Mathews 1977:83 [major and minor soldiers]

Imago (Fig. 26, 27). The head capsule is brown, with a paler, oval area posterior to fontanelle. The

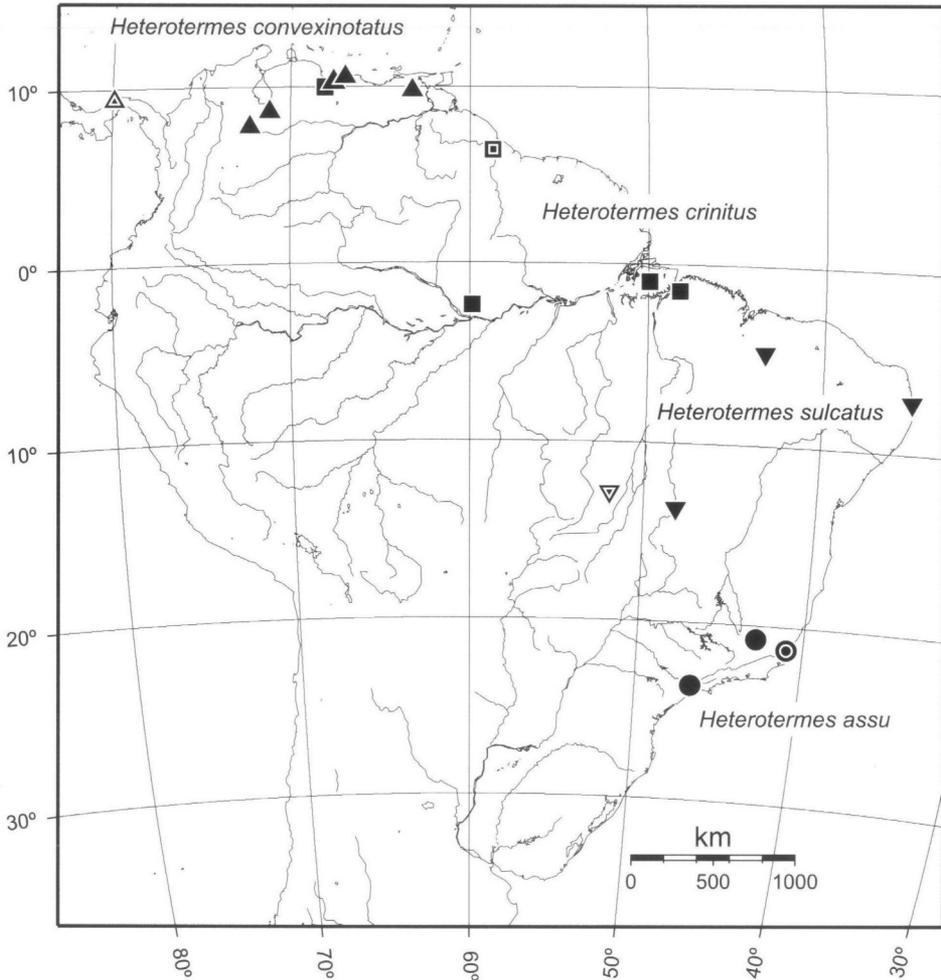


Figure 30. Distribution records of *Heterotermes* in South America: *H. assu* sp. n. (circle), *H. convexinotatus* (triangle), *H. crinitus* (square), and *H. sulcatus* (inverted triangle). The type-localities are indicated by a double symbol.

antennae and palps are brownish-yellow. The postclypeus and labrum are light brown. The pronotum is brown, with a T-shaped paler area in the middle. The mesonotum and metanotum are brownish-yellow. The tergites are paler than the pronotum but darker than the mesonotum. The sternites and legs are brownish-yellow. The wings are brownish. The head capsule has numerous hairs and bristles of variable size. The postclypeus has 6-8 bristles and a few short hairs. The labrum has 14-16 hairs and bristles. The pronotum has numerous hairs and bristles on margins and sur-

face. The tergites and sternites have a row of bristles on posterior margin and dense short hairs on surface. The tibial spurs are 3:2:2. The head capsule is elongate, and the fontanelle is small. The antennae has 17 articles: 1st is the longest, 3rd is the shortest, 4th and 5th are subequal; 6th to 17th are slightly longer. The eyes are oval, elongate, relatively small. The ocelli are absent in all examined specimens. The postclypeus is relatively long (length is about 0.18 mm compared to 0.12 mm in *H. tenuis*) and strongly inflated. The posterior margin of mesonotum and metanotum are

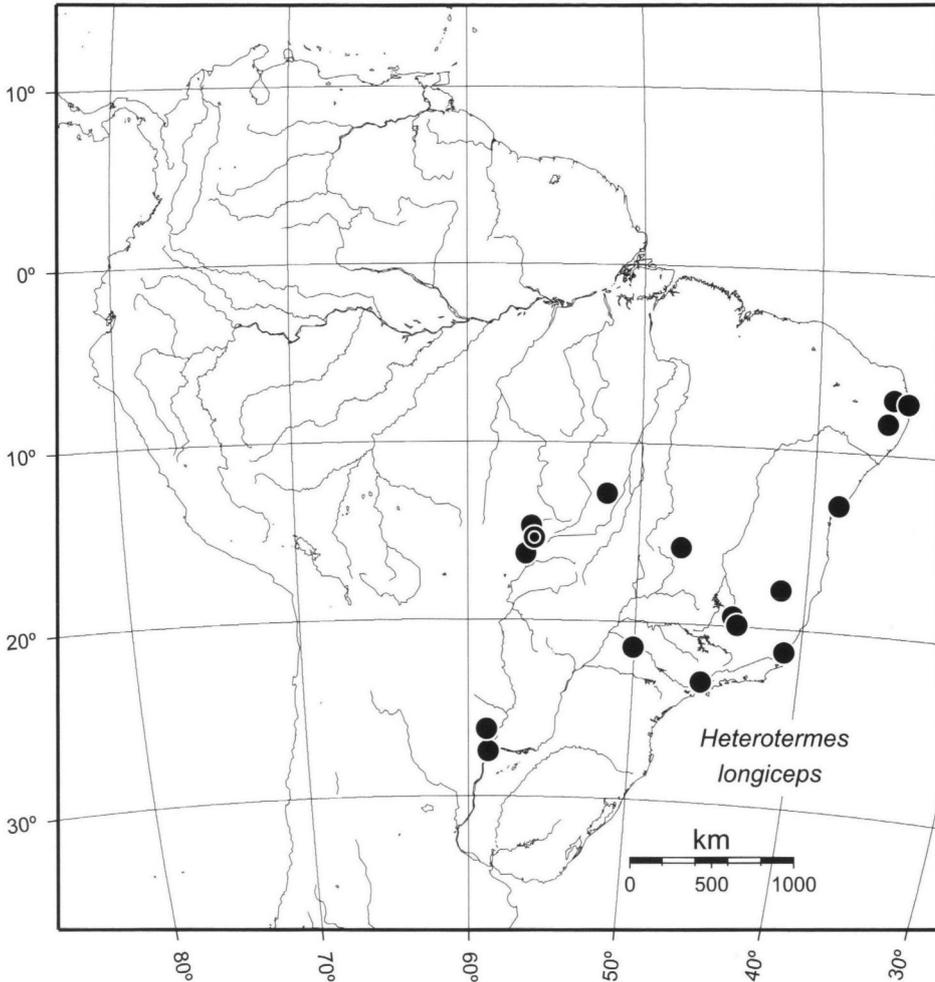


Figure 31. Distribution records of *Heterotermes longiceps* in South America. The type-locality is indicated by a double circle.

strongly concave, sometimes deeply V-shaped. The measurements are in Tab. 1.

Comparisons. – Very similar to the imago of *H. tenuis*, from which it can be distinguished on the size of the postclypeus, longer and more inflated in *H. longiceps*. The imago of *H. longiceps* is also darker.

Remarks. – The major soldier of *H. longiceps* shows a wide range of variation, especially in head length (Fig. 2 & 3). Specimens from central

Brazil tend to have more elongate heads, while those from the coastal region have shorter and wider heads. However, this variation seems to form a continuum, and it is not observed in imagos or minor soldiers. This species is second in South America in abundance and geographic range, being surpassed only by *H. tenuis*. It has also been reported as an agricultural and structural pest. In a recent termite survey in a savanna (cerrado) area in Brasília (Constantino, unpublished data), *H. longiceps* was the second most frequent species.

Material examined. – BRAZIL. *State of Bahia*. Salvador, 17.vi.99, A.T. Lelis (soldiers and workers). *Distrito Federal*. Brasília, 04.xi.1991, K. Kitayama (soldiers and workers); 09.ix.1992, K. Kitayama (soldiers and workers); 16.xii.1991, K. Kitayama (soldiers and workers); 1.x.1999, O. Kitade; 23.x.1999, R. Constantino (alates). *State of Espírito Santo*. Presidente Kennedy, Praia das Neves, 27.iv.98, R. Constantino (two samples with soldiers and workers). *State of Mato Grosso*. APM Manso, 11.v.1999, R. Constantino. *State of Minas Gerais*. Sete Lagoas, 30.viii.84, D.J. Domingos (soldiers and workers); João Pinheiro, 12.xi.98, N.R.A. Castro (soldier). *State of Paraíba*. João Pessoa, 21.xii.1993, A.G. Bandeira (soldiers and workers, UFPB). Areia, 29.xii.1998, M.P. Silva & A. Vasconcellos (two samples with soldiers, workers and alates, UFPB). *State of Pernambuco*. Caruaru, 15.i.1998, A. Vasconcellos (soldiers and workers, UFPB) State of São Paulo. Penápolis, 13.viii.96, R.D. Amaral (soldiers and workers). All samples are in DZUB, except the ones indicated to be in UFPB.

Discussion

Despite their abundance and economic importance, the South American species of *Heterotermes* remain poorly known. The geographic distribution of some species is still highly uncertain. *H. sulcatus*, for instance, was previously known only from its type locality, and is now reported as abundant in two distant localities. It is also surprising that *H. assu* sp. n., a large and conspicuous species, has never been reported by any entomologist, although it is native of the most densely populated area of South America.

The record of *Heterotermes crinitus* in Venezuela (Snyder 1959), near Lake Valencia, was never reconfirmed despite a good collecting effort in that region, especially around Maracay. Only *H. convexinotatus* has been found there. *H. crinitus* is possibly rare in that region, or lives in a very specific habitat not sampled. It is also possible that there was some error in that record.

Many taxonomic issues need to be examined in more detail. Before Snyder's (1924) revision, all South American *Heterotermes* were treated as *Heterotermes tenuis*, which was considered a widespread and variable species. It is possible, as it has been demonstrated for some groups of

Reticulitermes, that the species currently recognized morphologically correspond to several species complex.

The existence of additional undescribed species is likely, although *Heterotermes* does not seem to be highly diverse in the New World.

Acknowledgments

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