

## Revision and cladistic analysis of the spider genus *Carapoia* González-Sponga (Araneae: Pholcidae), with descriptions of new species from Brazil's Atlantic forest

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**Abstract.** The pholcid genus *Carapoia* is revised and interspecific relationships are analysed cladistically. Five new species from the Brazilian Atlantic forest are described (*C. ubatuba*, *C. brescoviti*, *C. una*, *C. crasto*, *C. rheimsae*), and new records are given for the four previously described species. Cladistic analysis reveals a biogeographic split between a northern clade (Amazon, Venezuela, Guyana) and a southern clade (Brazilian Atlantic forest). While each of the three northern species is widely distributed, the six Atlantic forest species seem to be restricted to much smaller areas of forest remnants along the Atlantic coast.

**Additional keywords:** biogeography, morphology, phylogeny.

### Introduction

Brazil's Atlantic forest has been called one of the 'hottest hotspots' (Myers *et al.* 2000), with high numbers of endemic species scattered over a fragmented forest that retains only ~7.5% of its primary vegetation. The combination of endemism, fragmentation and continuing deforestation has led to the prediction that many Atlantic forest plant and animal taxa that are currently threatened will soon be extinct (e.g. Brooks and Balmford 1996; Silva and Tabarelli 2000).

South American pholcids continue to be poorly known, at least at species level. Many dozens, maybe hundreds, of undescribed species are available in collections (Huber 2000, unpublished data), and it is likely that a considerable number has not even been collected. For example, in an ongoing study of DNA barcoding in pholcids (J. J. Astrin, B. A. Huber, B. Misof, unpublished data), more than a third of species available for sequencing (most of them from Brazilian Atlantic forest) were undescribed. This imbalance between diversity and current knowledge mainly affects a few extremely species-rich genera, such as *Mesabolivar* González-Sponga, *Metagonia* Simon and *Tupigea* Huber. All of these genera occur in Brazilian Atlantic forest, with *Tupigea* being endemic to the region.

The genus *Carapoia* previously included only four species. It was erected for a Venezuelan species (*C. paraguaensis* González-Sponga, 1998) and, two years later, a couple of closely related species from the Brazilian Amazon and northern Peru were added (*C. ocaína* Huber, 2000 and *C. fowleri* Huber, 2000). The fourth species, originally described as *Litoporus genitalis* Moenkhaus, 1898 was tentatively transferred to *Carapoia* (Huber 2000). It shared

some of the synapomorphies with the other three species, but geographically it seemed very isolated (state of São Paulo) and no new records had been published since the original description, i.e. for over 100 years. Thus, not only was the assignment of the species to *Carapoia* tentative, but even the geographic origin of the specimens was dubious.

Recent intensive collecting, mostly by Brazilian arachnologists, has produced an amazing quantity of new material, including some specimens of *Carapoia*. This new material confirms the occurrence of *C. genitalis* in São Paulo and includes five further new species from the Brazilian Atlantic forest. Some of the new species originate from small forest fragments and are only known from the type localities, suggesting a significant level of threat. The present paper describes these new species, gives new records for all previously known species, presents a cladistic analysis of all known species and summarises our current knowledge of the genus.

### Materials and methods

Methods and terminology are as in Huber (2000). Measurements are in mm ( $\pm 0.02$  mm if two decimals are given) unless otherwise noted. Eye measurements are  $\pm 5$   $\mu$ m. Drawings were done with a camera lucida on a Nikon Labophot-2 compound microscope. Photos were made with a Nikon Coolpix 955 digital camera (1600  $\times$  1200 pixels) mounted on a Nikon SMZ-U dissecting microscope. For scanning electron microscope photos, specimens were cleaned ultrasonically, dried in hexamethyldisilazane (Brown 1993), and photographed with a Hitachi S-2460 scanning electron microscope. The numerical cladistic analysis was done using NONA, version 1.8 (Goloboff 1993). Cladogram analysis was done with WinClada, version 0.9.9+ (Nixon 1999). Material studied is deposited in the following institutions: Instituto Butantan, São Paulo (IBSP); Museo de Historia Natural La Salle,

Caracas (MHNLS); Museu Paraense Emílio Goeldi, Belém (MPEG); and Alexander Koenig Zoological Research Museum, Bonn (ZFMK).

## Taxonomy

### Genus *Carapoia* González-Sponga

*Carapoia* González-Sponga, 1998: 18–19. – Huber, 2000: 238.

Type species: *C. paraguaensis* González-Sponga, 1998.

#### *Diagnosis and description: an update*

The diagnosis and description given previously (Huber 2000) are mostly still valid, but in some regards require minor adjustments because of the new species described below. The newly described species with very elongate abdomens (*C. rheimsae*, *C. crasto*; Figs 91, 92) extend the size range to ~2.5–5 mm. Distance posterior median eyes (PME) to anterior lateral eyes (ALE) is sometimes even larger than previously known (50–100% of PME diameter). The male palpal femur often has a small but quite distinct dorsal projection (e.g. Figs 5, 22, 28). Legs are long in all known species, but in relation to the body length, are shorter in species with long abdomens (leg 1 only ~9–10× body length, compared with 11–13× in other species). Huber (2000) erroneously recorded the leg formula as 1423, but as in most (all?) long-legged pholcids, it is 1243. Curved hairs seem to occur in some species but not in others; among the new species, only males of *C. brescoviti* have curved hairs

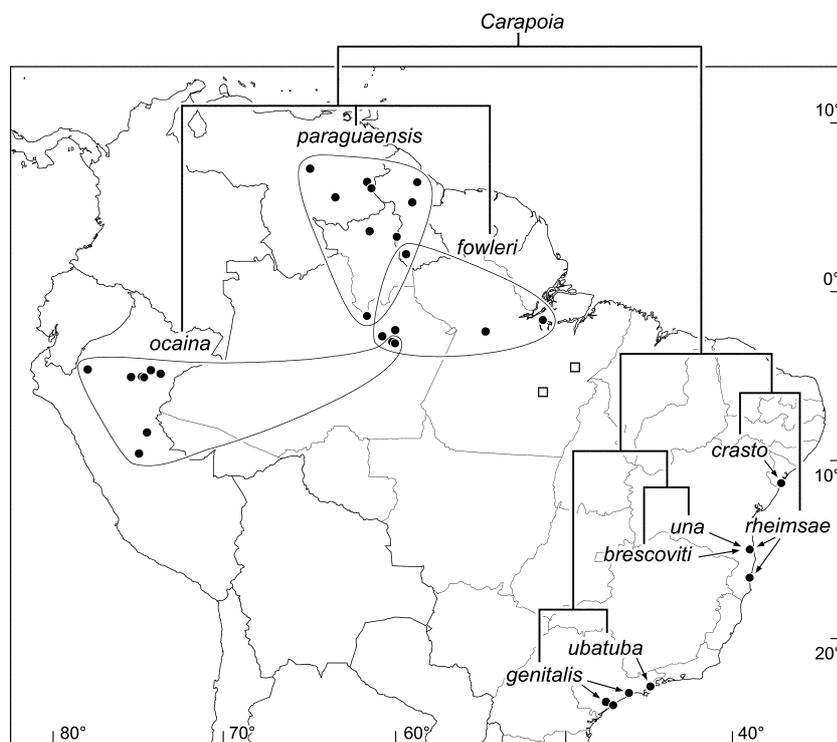
ventrally on femora 4. Prolateral trichobothrium is present on all tibiae. There are serrated hairs on the fourth tarsi in males and females, but they are arranged in patches of a few hairs distally (Figs 20, 46, 50, 72) rather than in a row as in other pholcids studied (Petrunkevitch 1909; Huber *et al.* 2005; Huber 2005a, 2005b). The abdomen is usually oval, but in *C. crasto* and *C. rheimsae* it is very elongate (Figs 91, 92). The male gonopore is a simple opening without epiandrous spigots (Figs 39, 67), but in some cases it has a membranous structure projecting from the opening (presumably an artefact, Figs 15, 65). The female internal genitalia are often filled with a large genital plug (Figs 16, 51, 97, 99).

The distribution can now be updated to include the Brazilian Atlantic forest (Fig. 1).

The genus now includes nine named species. The MPEG has at least two further species from Pará (light squares in Fig. 1). These species are not treated herein because only females are available.

#### *Relationships and biogeography*

The taxa and characters used for cladistic analysis are given in Tables 1 and 2 and the data matrix is given in Table 3. The matrix includes all described *Carapoia* species and six out-group species, which were selected to represent three closely related New World genera (the close relationship was indicated by molecular data: J. J. Astrin, B. A. Huber, B. Misof, unpublished data). The tree was rooted on the presumably



**Fig. 1.** Known distribution of *Carapoia*, with phylogenetic relationships superimposed. Open squares indicate undescribed species (only females known).

**Table 1. Taxa used for phylogenetic analysis**


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<i>Coryssocnemis simla</i> Huber, 2000
<i>Mecolaesthus longissimus</i> Simon, 1893
<i>Mesabolivar luteus</i> (Keyserling, 1891)
<i>Mesabolivar eberhardi</i> Huber, 2000
<i>Mesabolivar aurantiacus</i> (Mello-Leitão, 1930)
<i>Mesabolivar cyaneotaeniatus</i> (Keyserling, 1891)
<i>Carapoia ubatuba</i> , sp. nov.
<i>Carapoia brescoviti</i> , sp. nov.
<i>Carapoia rheimsae</i> , sp. nov.
<i>Carapoia una</i> , sp. nov.
<i>Carapoia crasto</i> , sp. nov.
<i>Carapoia genitilis</i> (Moenkhaus, 1898)
<i>Carapoia ocaina</i> Huber, 2000
<i>Carapoia fowleri</i> Huber, 2000
<i>Carapoia paraguayensis</i> González-Sponga, 1998

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least closely related taxon (*Coryssocnemis simla*). Analysis of the matrix using the NONA command string **amb-; hold5000; hold/50; mult\*100** resulted in two most parsimonious cladograms (length: 16 steps, consistency index: 75, retention index: 88), both of which resolve *Carapoia* as monophyletic (Figs 2, 3). However, depending on the position of *Mesabolivar luteus*, the characters supporting the monophyly of *Carapoia* vary slightly between cladograms. In the cladogram that groups *M. luteus* with other *Mesabolivar* species (Fig. 2), three characters support *Carapoia*: modified hairs on male chelicerae; dorsal projection on genital bulb; and diverging sclerites behind epigynum. In the cladogram that places *M. luteus* sister to *Carapoia* (Fig. 3), the diverging sclerites behind the epigynum support this grouping rather than the monophyly of *Carapoia*. Bremer support was low (2 for *Carapoia*, 2 for *C. rheimsae* + *C. crasto*, 1 for all other nodes) but this only reflects the fact that Bremer support has an upper bound in the number of characters on a branch.

The ambiguity regarding the position of *M. luteus* is especially interesting in light of recent molecular data. In a study by J. J. Astrin, B. A. Huber and B. Misof (unpublished data) using 16S rRNA and COI sequences, *Mesabolivar luteus* was nested within *Carapoia*, both in Bayesian and maximum parsimony analysis. *Mesabolivar luteus* shares the typical synapomorphology of *Mesabolivar* (median pocket on epigy-

num) and lacks modified hairs on the male chelicerae (in contrast to all known *Carapoia* species). However, the pair of sclerites in the female genitalia (see figs 913–915 in Huber 2000) are indeed reminiscent of the diverging sclerites in *Carapoia*.

The whitish protrusion dorsally on the genital bulb is a problematic character. The protrusion is not clearly developed in some species (e.g. *C. genitilis*, *C. rheimsae*) and similar structures occur in other genera as well (e.g. *Mesabolivar aurantiacus*, *M. cambridgei*, *Coryssocnemis simla*; see Huber 2000).

Within *Carapoia*, there is a split between the three northern (Amazon, Venezuela, Guyana) species and the six southern (Brazilian Atlantic forest) species (Fig. 1). The three northern species were not resolved further, but the southern species were fully resolved. *Carapoia rheimsae* and *C. crasto* share the elongated abdomen (Figs 91, 92) and the shape of the pore plates (Figs 37, 57). Together, they are sister to the four remaining species that share a U-shaped sclerite in the female internal genitalia (Figs 8, 25, 31). These four species split into two species pairs: *C. brescoviti* and *C. una* share the distinct lateral indentation of the pore plates (Figs 26, 32); and *C. ubatuba* and *C. genitilis* share a frontally enlarged epigynum (Figs 8, 93, 98).

#### *Carapoia ubatuba*, sp. nov.

(Figs 4–20, 73, 74, 93)

#### Material examined

*Holotype*. ♂, Fazenda Angelim (23°24'S, 45°04'W), Ubatuba, São Paulo, Brazil; 16–18.xii.2003 (B. A. Huber, C. A. Rheims, R. P. Indicatti, R. Schulz), IBSP (41221).

*Paratypes*. 8 ♂, 15 ♀, same data as holotype, IBSP 41222–3 (4 ♂, 10 ♀) and ZFMK (4 ♂, 5 ♀).

#### Diagnosis

Easily distinguished from known congeners by the dorsal projection on the procurus (Figs 5, 10) and by the male chelicer apophyses (Figs 6, 7, 11), and from most congeners (except *C. genitilis*) also by large epigynum (Figs 8, 93).

**Table 2. Characters used for phylogenetic analysis**


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(1) Median groove or pocket on epigynum: (0) absent, (1) present.
(2) Spines on male metatarsi: (0) absent, (1) present.
(3) Globular hairs on male chelicerae (e.g. Figs 6, 12): (0) absent, (1) present.
(4) Paired sclerite posteriorly on epigynum (e.g. Figs 9, 26): (0) absent, (1) present.
(5) Abdomen length (Figs 91–99): (0) > 2x as long as wide; < 2x as long as wide.
(6) Distal apophyses on male chelicerae (Fig. 29): (0) absent, (1) present.
(7) Distinct lateral indentation of pore plates (Figs 26, 32): (0) absent, (1) present.
(8) Dorsal whitish projection on genital bulb (e.g. Figs 5, 21): (0) absent, (1) present.
(9) Frontal sclerotised plate of epigynum: (0) normal size (e.g. Figs 25, 31), (1) enlarged (Figs 8, 93, 98).
(10) Procurus: (0) not clearly bifid distally (Figs 85–90), (1) clearly bifid distally (Figs 73–84).
(11) Pore plates: (0) frontally rounded (e.g. Figs 9, 26), (1) frontally pointed (Figs 37, 57).
(12) U-shaped sclerite in female internal genitalia: (0) absent, (1) present (Figs 8, 25, 31).

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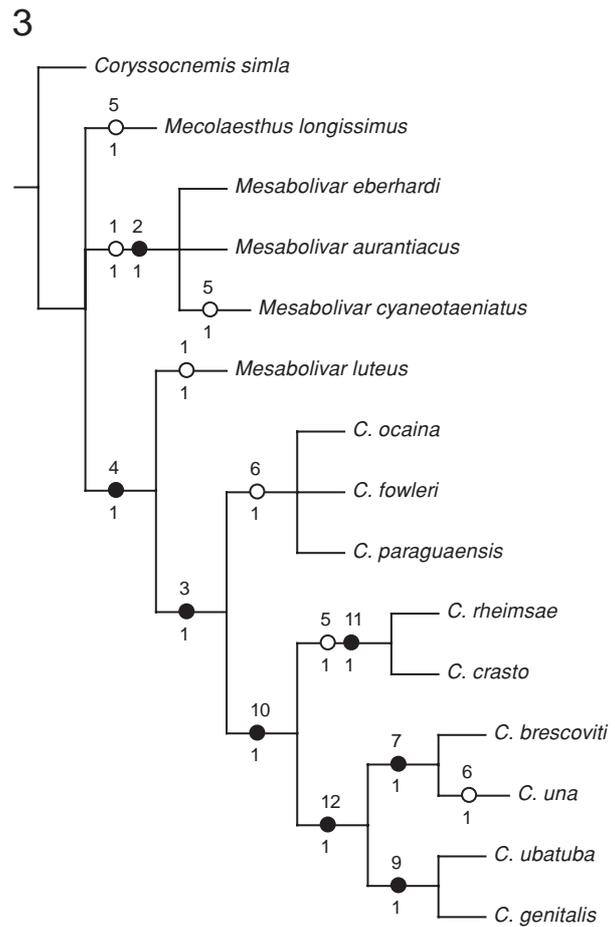
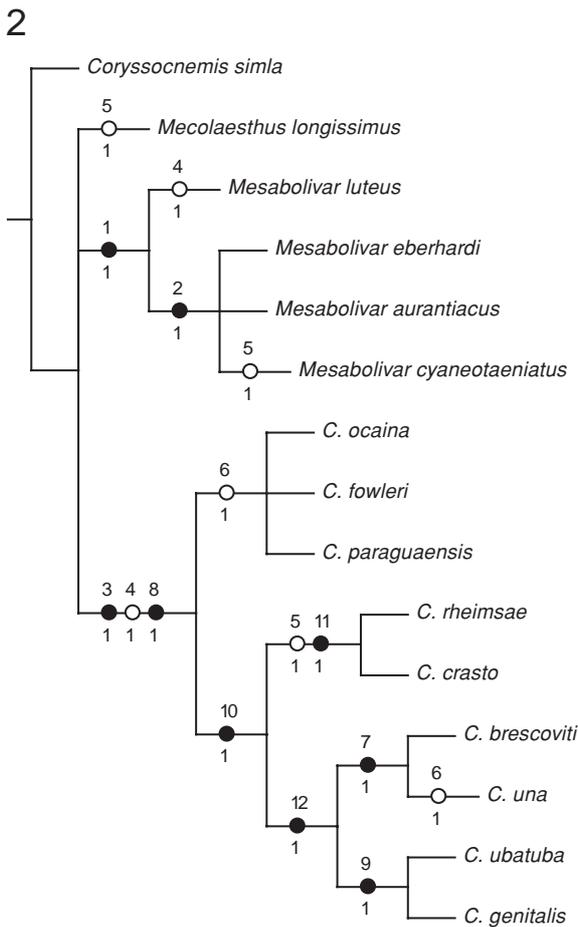
**Table 3. Matrix used for phylogenetic analysis**

Taxa	Characters	
	0000000001	11
	1234567890	12
<i>Coryssocnemis simla</i>	0000000?00	00
<i>Mecolaesthus longissimus</i>	0000100000	00
<i>Mesabolivar luteus</i>	1001000000	00
<i>Mesabolivar eberhardi</i>	1100000000	00
<i>Mesabolivar aurantiacus</i>	1100000?00	00
<i>Mesabolivar cyaneotaeniatus</i>	1100100000	00
<i>Carapoia ubatuba</i>	0011000111	01
<i>Carapoia brescoviti</i>	0011001101	01
<i>Carapoia rheimsae</i>	0011100101	10
<i>Carapoia una</i>	0011011101	01
<i>Carapoia crasto</i>	0011100101	10
<i>Carapoia genitilis</i>	0011000111	01
<i>Carapoia ocaina</i>	0011010100	00
<i>Carapoia fowleri</i>	0011010100	00
<i>Carapoia paraguaensis</i>	0011010100	00

*Description*

*Male (holotype)*

Total length 3.5 (3.7 with clypeus), carapace width 1.2. Leg 1: 38.2 (9.1 + 0.5 + 9.2 + 17.2 + 2.2), tibia 2: 5.5, tibia 3: 3.9, tibia 4: 5.0. Tibia 1 length/diameter (L/d): 80. Carapace pale ochre–yellow with distinct brown Y-mark medially and brown lateral bands, ocular area not darkened, clypeus with pair of slightly darker patches; sternum pale ochre–yellow; legs ochre–grey, tips of femora and tibiae lighter; abdomen greenish–grey, with distinct black marks dorsally, large light brown plate in front of gonopore, black line from gonopore less than halfway to spinnerets (cf. female, Fig. 93). Ocular area elevated and clearly separated from carapace, thoracic furrow distinct and deep; distance PME–PME 90 µm; diameter PME 140 µm; distance PME–ALE 105 µm; distance anterior median eyes (AME)–AME 25 µm, diameter AME 35 µm. Sternum wider than long (0.9/0.6). Chelicerae with modified hairs on proximal and distal projections (Figs 6, 7, 11, 12, 14). Palps as in Figs 4 and 5; coxa with retrolateral apophysis, trochanter



**Figs 2–3.** The two most parsimonious cladograms obtained by NONA using the matrix in Table 3. Numbers above/below hash marks indicate characters/character states. Black hash marks indicate unique, white hash marks indicate non-unique synapomorphies.

simple, femur with prominent retrolateral projection proximally, widened distally, with small dorsal projection and distinct ventro-distal apophysis, procurus with distinctive dorsal apophysis (Figs 5, 10), distally divided into two branches (Figs 73, 74); tarsal organ exposed (Fig. 13); bulb with complex membranous projection and pointed apophysis. Retrolateral trichobothrium of tibia 1 at 4%; legs densely covered with short hairs (Figs 18, 19), without spines and curved hairs, few vertical hairs; femur 3 slightly thicker than others (at midpoint: 0.31 v. 0.18–0.19); tarsus 1 with over 30 pseudosegments, distally quite distinct.

#### Variation

Tibia 1 in seven other males: 8.5–9.2 (mean 8.9).

#### Female

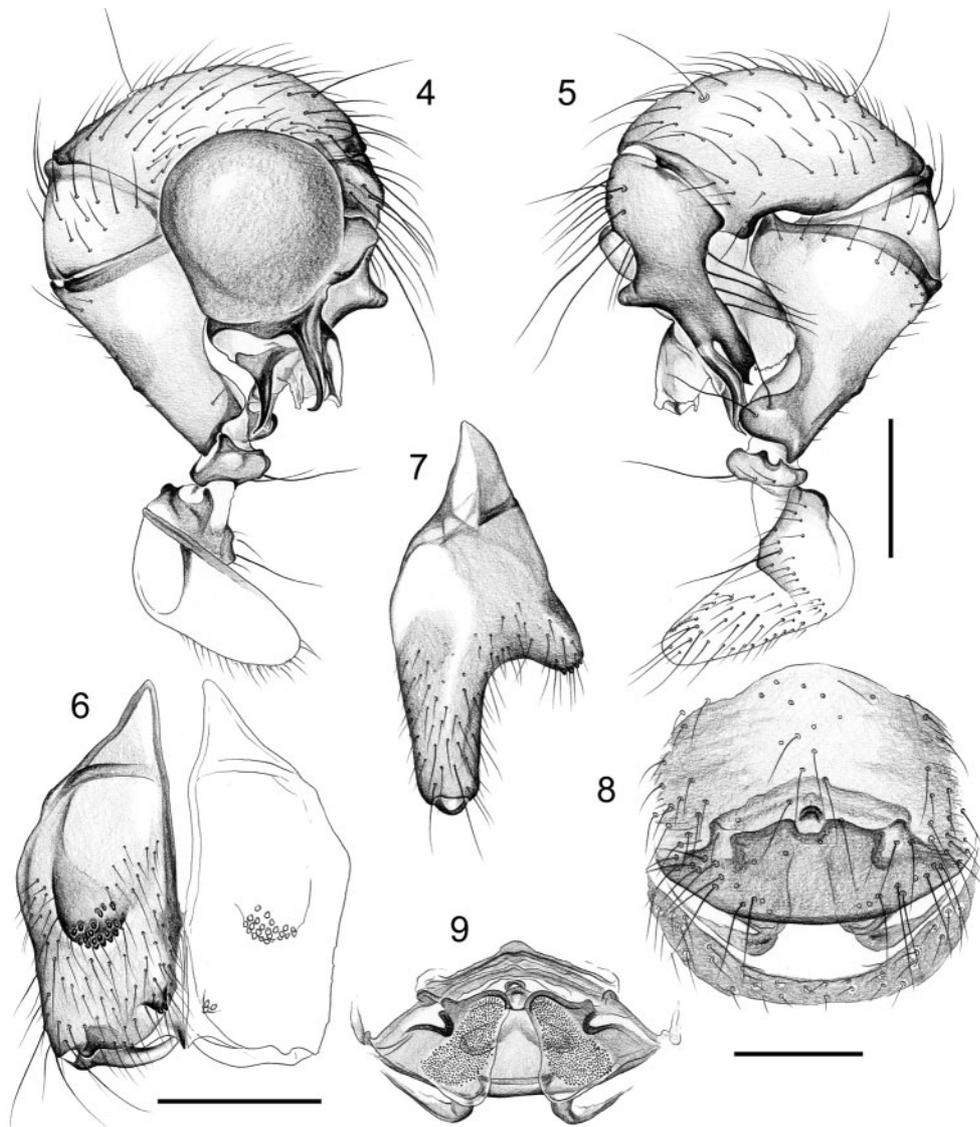
In general similar to male, but smaller and with shorter abdomen. Tibia 1 in 15 females: 6.5–7.0 (mean 6.7). Epigynum with large brown frontal plate (Fig. 93) and narrower but distinct posterior sclerite (Figs 8, 16); dorsal view as in Fig. 9. Anterior lateral spinnerets (ALS) with two spigots (Fig. 17).

#### Distribution

Known only from type locality (Fig. 1).

#### Etymology

The species name is a noun in apposition, derived from the type locality.



**Figs 4–9.** *Carapoia ubatuba*, sp. nov. 4–5, Left male palp, prolateral (4) and retrolateral (5) views. 6–7, Male chelicerae, frontal and lateral views. 8–9, Cleared female genitalia, ventral (8) and dorsal (9) views. Scale bars: 0.3 mm.

***Carapoia brescoviti*, sp. nov.**

(Figs 21–26, 75, 76, 95)

**Material examined**

*Holotype*. ♂, Reserva Biológica do Una (15°20'S, 39°15'W), Una, Bahia, Brazil; 13–16.iv.1998 (A. D. Brescovit *et al.*), IBSP (43679).

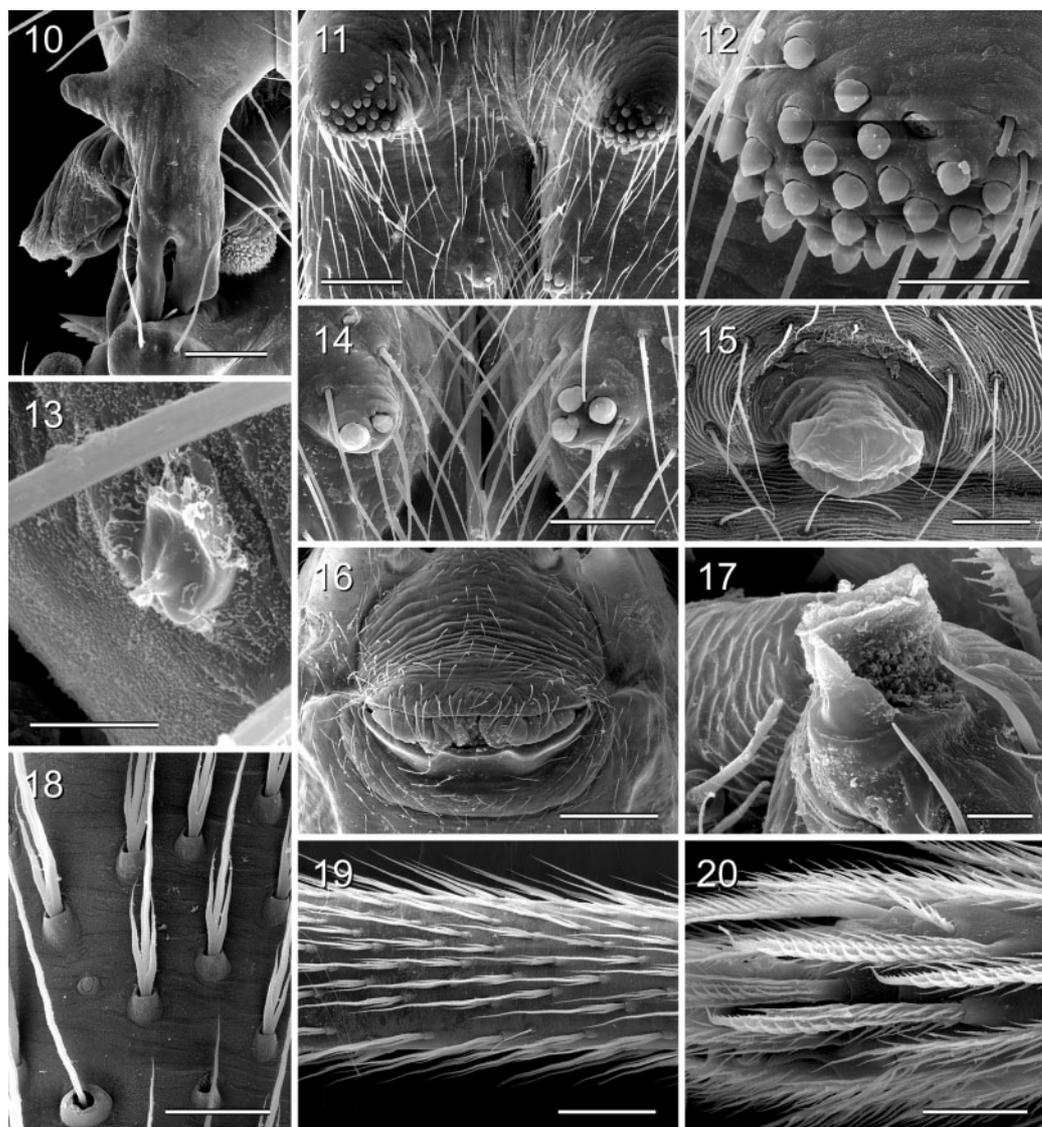
*Other material examined*. 3 ♀, same data as holotype (IBSP 43683, 43673).

**Diagnosis**

Easily distinguished from known congeners by strong bulbal apophysis provided with sclerotised teeth (Figs 21, 22) and by the shapes of the male cheliceral apophyses (Figs 23, 24), and from most congeners (except *C. una*) also by shape of the pore plates (Fig. 26).

**Description****Male (holotype)**

Total length 3.3 (3.4 with clypeus), carapace width 1.2. Leg 1: 33.8 (7.8 + 0.4 + 8.0 + 15.2 + 2.4), tibia 2: 4.7, tibia



**Figs 10–20.** *Carapoia ubatuba*, sp. nov. 10, Left procurus and bulb, retrolateral view. 11, Male cheliceral modifications. 12, Proximal male cheliceral apophyses with modified hairs. 13, Male palpal tarsal organ. 14, Distal male cheliceral apophyses with modified hairs. 15, Male gonopore. 16, Epigynum with genital plug. 17, Female ALS with widened and pointed spigots. 18, Trichobothrium and mechanoreceptors on male tibia 4. 19, Male tibia 4 hairs. 20, Female tarsus 4 tip, showing serrated hairs. Scale bars: 10  $\mu$ m (13, 17), 40  $\mu$ m (12, 14, 15, 18, 20), 100  $\mu$ m (10, 11, 19), 300  $\mu$ m (16).

3: 3.3, tibia 4: 4.3. Tibia 1 L/d: 90. Carapace ochre with wide median dark band that is frontally widened, lateral margins dark except posteriorly, clypeus also darker; sternum ochre–yellow; legs ochre–light brown, without light or dark rings; abdomen ochre–grey, densely covered with black spots, brown plate in front of gonopore, black mark from gonopore less than halfway to spinnerets (cf. female, Fig. 95). Ocular area elevated and clearly separated from carapace, thoracic furrow distinct; distance PME–PME 95  $\mu$ m; diameter PME 125  $\mu$ m; distance PME–ALE 115  $\mu$ m; distance AME–AME 25  $\mu$ m, diameter AME 40  $\mu$ m. Sternum wider than long (0.8/0.6). Chelicerae as in Figs 23 and 24, with modified hairs on distinctive frontal apophyses. Palps as in Figs 21 and 22; coxa with retrolateral apophysis, trochanter with small ventral apophysis, femur with prominent retrolateral projection proximally, tiny apophysis dorsally, widened distally, procurus simple except for

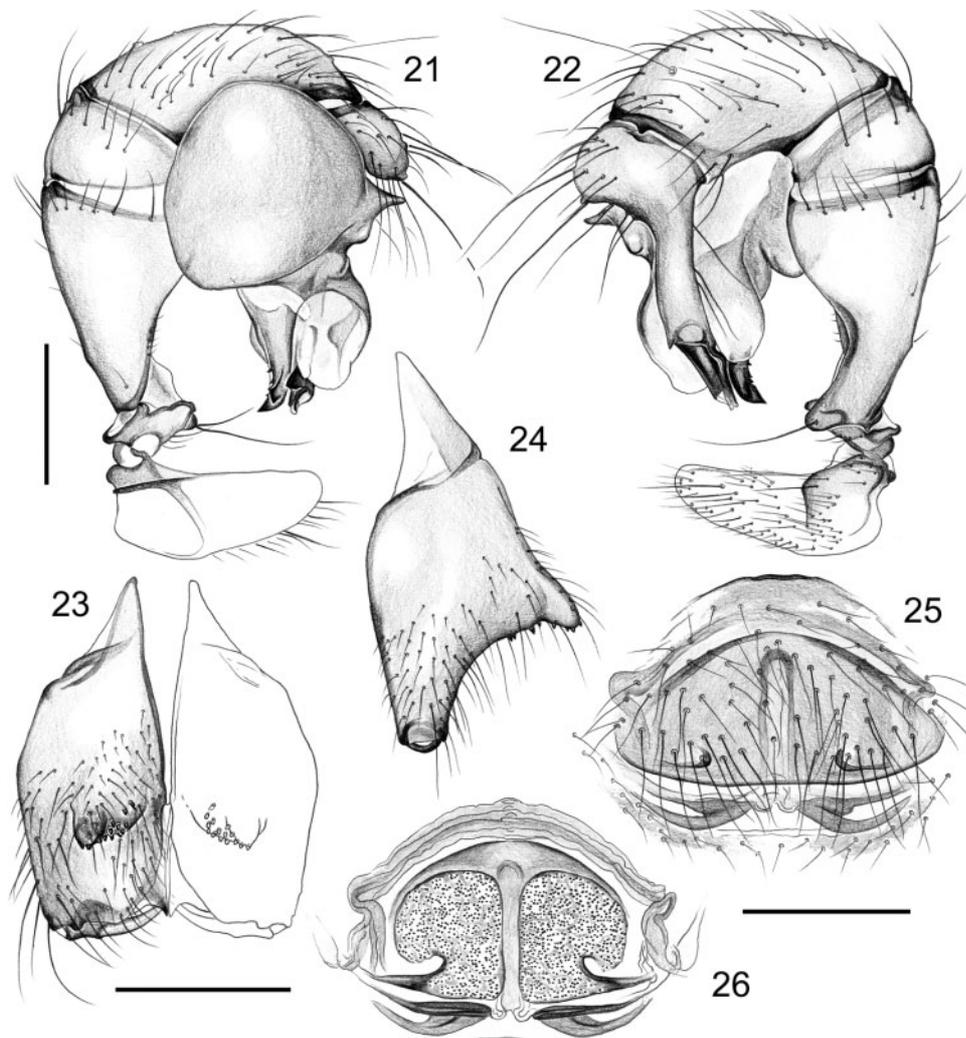
distinctive tip (Figs 75, 76); bulb with complex membranous projection and distinctive apophysis provided with sclerotised teeth. Retrolateral trichobothrium of tibia 1 at 3%; legs densely covered with short hairs, without spines, few vertical hairs, with many curved hairs ventrally on femur 4; femur 3 not thicker than others; tarsus 1 with over 35 pseudo-segments, distally distinct.

#### Female

In general similar to male. Tibia 1 in 3 females: 5.7, 5.8, 7.0. Epigynum very similar to *C. una*, but without median projection on posterior rim (Fig. 25); dorsal view as in Fig. 26.

#### Distribution

Known only from type locality (Fig. 1).



**Figs 21–26.** *Carapoia brescoviti*, sp. nov. 21–22, Left male palp, prolateral (21) and retrolateral (22) views. 23–24, Male chelicerae, frontal and lateral views. 25–26, Cleared female genitalia, ventral (25) and dorsal (26) views. Scale bars: 0.3 mm.

*Etymology*

Named for Antonio D. Brescovit, Instituto Butantan, São Paulo.

***Carapoia una*, sp. nov.**

(Figs 27–32, 38–46, 79, 80, 94)

*Material examined*

*Holotype.* ♂, Reserva Biológica do Una (15°20'S, 39°15'W), Una, Bahia, Brazil; 13–16.iv.1998 (A. D. Brescovit *et al.*), IBSP (43666).

*Paratypes.* 3 ♂, same data as holotype, IBSP (2 ♂: 43663, 43686) and ZFMK (1 ♂).

*Other material examined.* 10 ♀, same data as holotype (IBSP 43661–2, 43665, 43669, 43677–8, 43680–1, 43685).

*Diagnosis*

Distinguished from known congeners by shapes of procurus (tip) and male chelicerae (Figs 27–29, 79, 80), and by median projection on rim of epigynum (Figs 31, 45).

*Description**Male (holotype)*

Total length 3.6 (3.75 with clypeus), carapace width 1.3. Leg 1: 37.9 (8.5 + 0.5 + 8.8 + 17.7 + 2.4), tibia 2: 5.0, tibia 3: 3.4, tibia 4: 4.5. Tibia 1 L/d: 83. Carapace ochre, with dark median Y-mark and lateral margins frontally, ocular area not darkened, clypeus with pair of longitudinal darker stripes; sternum whitish–ochre; legs ochre, with barely visible darker rings on femora (subdistally) and tibiae (proximally and distally); abdomen mostly grey, with some small black spots dorsally and laterally, light brown plate in front of gonopore, black line from gonopore less than halfway to spinnerets (cf. female, Fig. 94). Ocular area elevated and clearly separated from carapace, thoracic furrow distinct and deep; distance PME–PME 115 µm; diameter PME 125 µm; distance PME–ALE 125 µm; distance AME–AME 25 µm, diameter AME 35 µm. Sternum wider than long (0.9/0.65). Chelicerae as in Figs 29 and 30, with relatively few modified hairs (Fig. 40) and pair of distal apophyses. Palps as in Figs 27 and 28; coxa with retrolateral apophysis, trochanter with small ventral projection, femur with prominent retrolateral projection proximally, widened distally, with small ventro-distal apophysis, procurus mostly simple, only distally with distinctive projections (Figs 79, 80); tarsal organ exposed (Fig. 41); bulb with large membranous projection and strong curved apophysis. Retrolateral trichobothrium of tibia 1 at 3%; legs densely covered with short hairs, without spines and curved hairs, few vertical hairs; femur 3 not thicker than others; tarsus 1 with over 30 pseudosegments, distinct distally. ALS and PMS with two spigots each (Figs 41, 44).

*Variation*

Tibia 1 in two other males: 9.1 (both).

*Female*

In general similar to male, but dark stripes on clypeus sometimes fused to single darker patch; tibia 1 in 10 females: 5.5–6.7 (mean 6.2). Epigynum a simple light brown plate (Figs 31, 94), with distinctive projection medially on rim (Figs 31, 45; in some specimens this projection is very small; their assignment is tentative); dorsal view as in Fig. 32. Spinnerets as in male (Fig. 43).

*Distribution*

Known only from type locality (Fig. 1).

*Etymology*

The species name is a noun in apposition, derived from the type locality.

***Carapoia crasto*, sp. nov.**

(Figs 33–37, 47–51, 81, 82, 92)

*Material examined*

*Holotype.* ♂, Mata do Crasto, Santa Luzia do Itanhý (11°23'S, 37°24'W), Sergipe, Brazil; 9–13.ix.1999 (A. D. Brescovit *et al.*), IBSP (43648).

*Paratypes.* 4 ♂, 5 ♀, same data as holotype, IBSP (3 ♂, 3 ♀: 43648, 43652, 43659) and ZFMK (1 ♂, 2 ♀).

*Other material examined.* Same locality as types, 12–14.xi.1996 (A. D. Brescovit, A.C.M. Fernandes), 1 ♀ and 1 ♀ abdomen (IBSP 10136).

*Diagnosis*

Easily distinguished from most known congeners by the long abdomen (Fig. 92; similar only in *C. rheimsae*); also by the shape of procurus tip (Figs 81, 82), male chelicerae (Fig. 35) and epigynum (Figs 36, 92).

*Description**Male (holotype)*

Total length 5.0 (5.1 with clypeus), carapace width 1.25. Leg 1: 41.8 (10.0 + 0.4 + 9.6 + 19.5 + 2.3), tibia 2: 5.9, tibia 3: 4.2, tibia 4: 5.1. Tibia 1 L/d: 90. Carapace pale ochre–yellow, with dark median band and lateral margins, ocular area not darkened, clypeus with pair of darker patches; sternum pale ochre–yellow; legs light brown, tips of tibiae whitish; abdomen dorsally with many black spots arranged in bands, light brown plate in front of gonopore, black line from gonopore 3/4 to spinnerets (cf. female, Fig. 92). Ocular area elevated and clearly separated from carapace, thoracic furrow distinct and deep; distance PME–PME 105 µm; diameter PME 95 µm; distance PME–ALE 95 µm; distance AME–AME 25 µm, diameter AME 40 µm. Sternum wider

than long (0.9/0.6). Chelicerae as in Figs 35 and 48, with modified hairs on pair of frontal apophyses (Fig. 49). Palps as in Figs 33 and 34; coxa with retrolateral apophysis, trochanter simple, femur with prominent retrolateral projection proximally, widened distally, procurus very simple (Figs 81, 82), only distally with distinctive projections; bulb with large membranous projection and curved apophysis. Retrolateral trichobothrium of tibia 1 at 4%; legs densely covered with short hairs, without spines and curved hairs, few vertical hairs; femur 3 slightly thicker than others (at

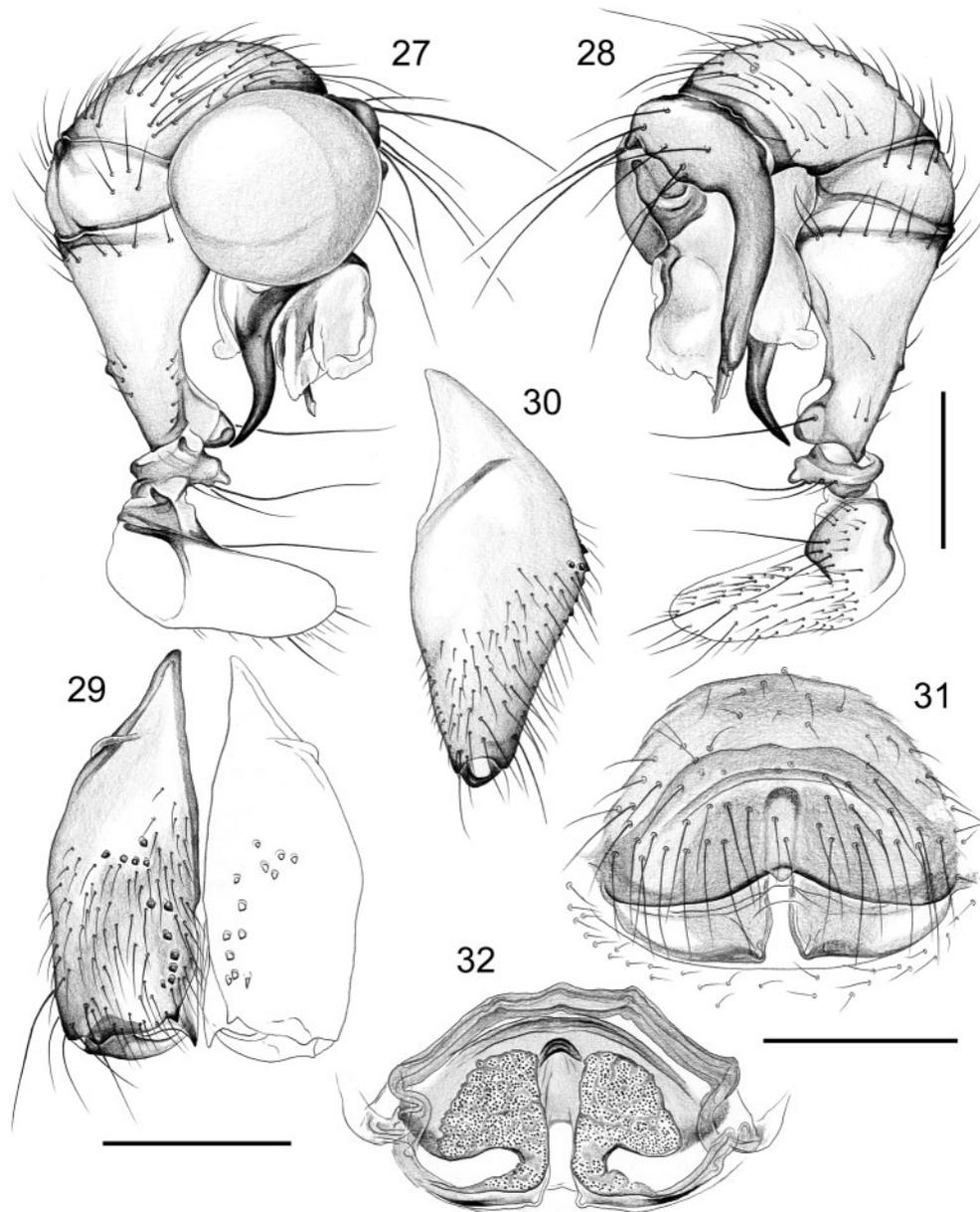
midpoint: 0.29 v. 0.19–0.20); tarsus 1 with over 20 pseudo-segments, only distally fairly distinct.

#### Variation

Tibia 1 in two other males: 10.4, 10.5.

#### Female

In general similar to male, but also femora distally whitish (especially femur 1) and clypeus with wide brown margin; tibia 1 in 3 females: 7.0, 7.1, 7.9. Epigynum very small in



**Figs 27–32.** *Carapoia una*, sp. nov. 27–28, Left male palp, prolateral (27) and retrolateral (28) views. 29–30, Male chelicerae, frontal and lateral views. 31–32, Cleared female genitalia, ventral (31) and dorsal (32) views. Scale bars: 0.3 mm.

relation to abdomen size (Fig. 92), simple light brown plate (Fig. 36); dorsal view as in Fig. 37.

*Distribution*

Known from type locality only (Fig. 1).

*Etymology*

The species name is a noun in apposition, derived from the type locality.

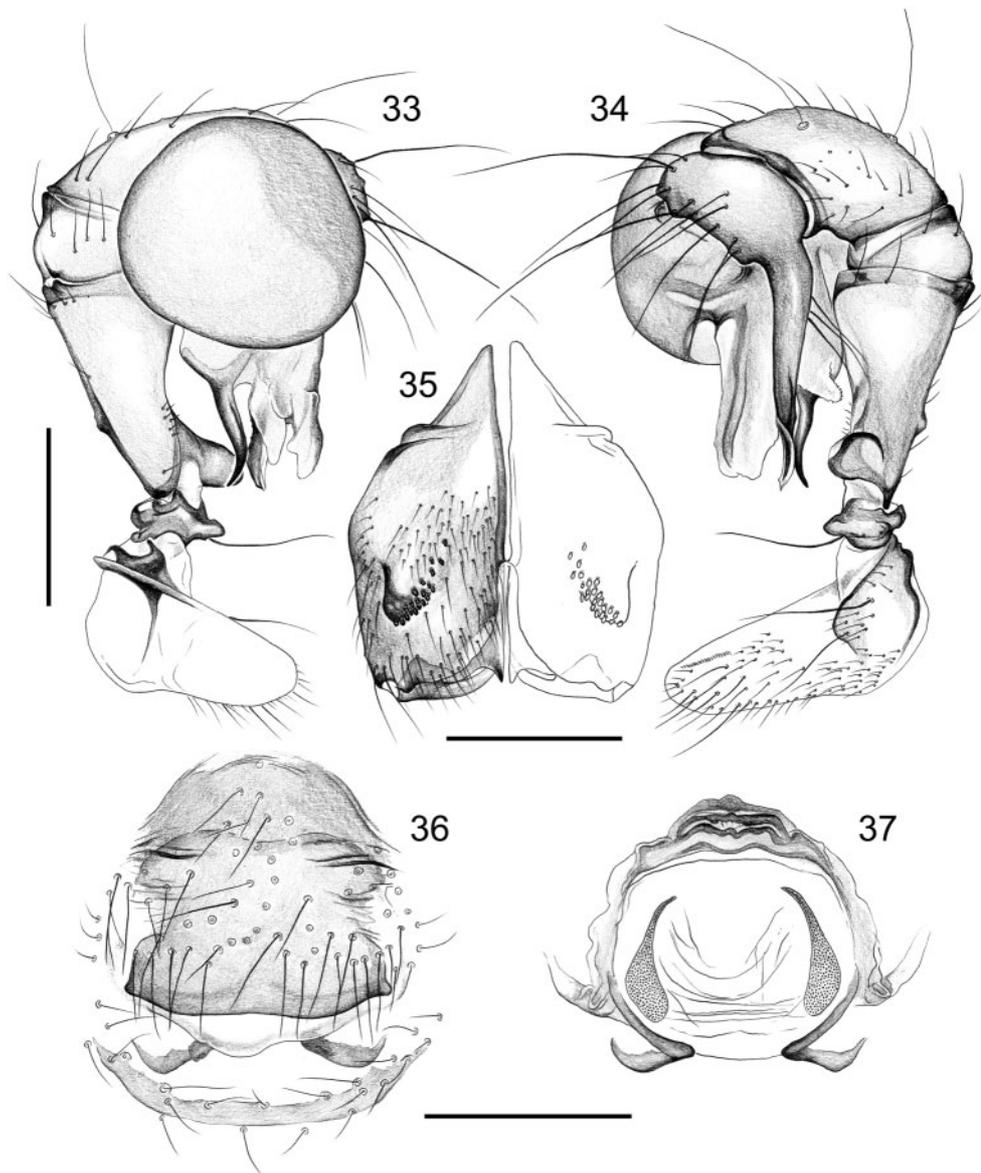
*Carapoia rheimsae*, sp. nov.

(Figs 52–57, 77, 78, 91)

*Material examined*

*Holotype*. ♂, Reserva Biológica do Una (15°20'S, 39°15'W), Una, Bahia, Brazil; 13–16.iv.1998 (A. D. Brescovit *et al.*), IBSP (43667).

*Other material examined*. 3 ♀, same data as holotype (IBSP 43684, 43675, 43676); **Brazil**: Bahia: Porto Seguro, Parque Nacional do Monte Pascoal (17°00'S, 39°15'W), 22.iv.1998 (A. D. Brescovit *et al.*), 1 ♂, 1 ♀ (IBSP 18511).



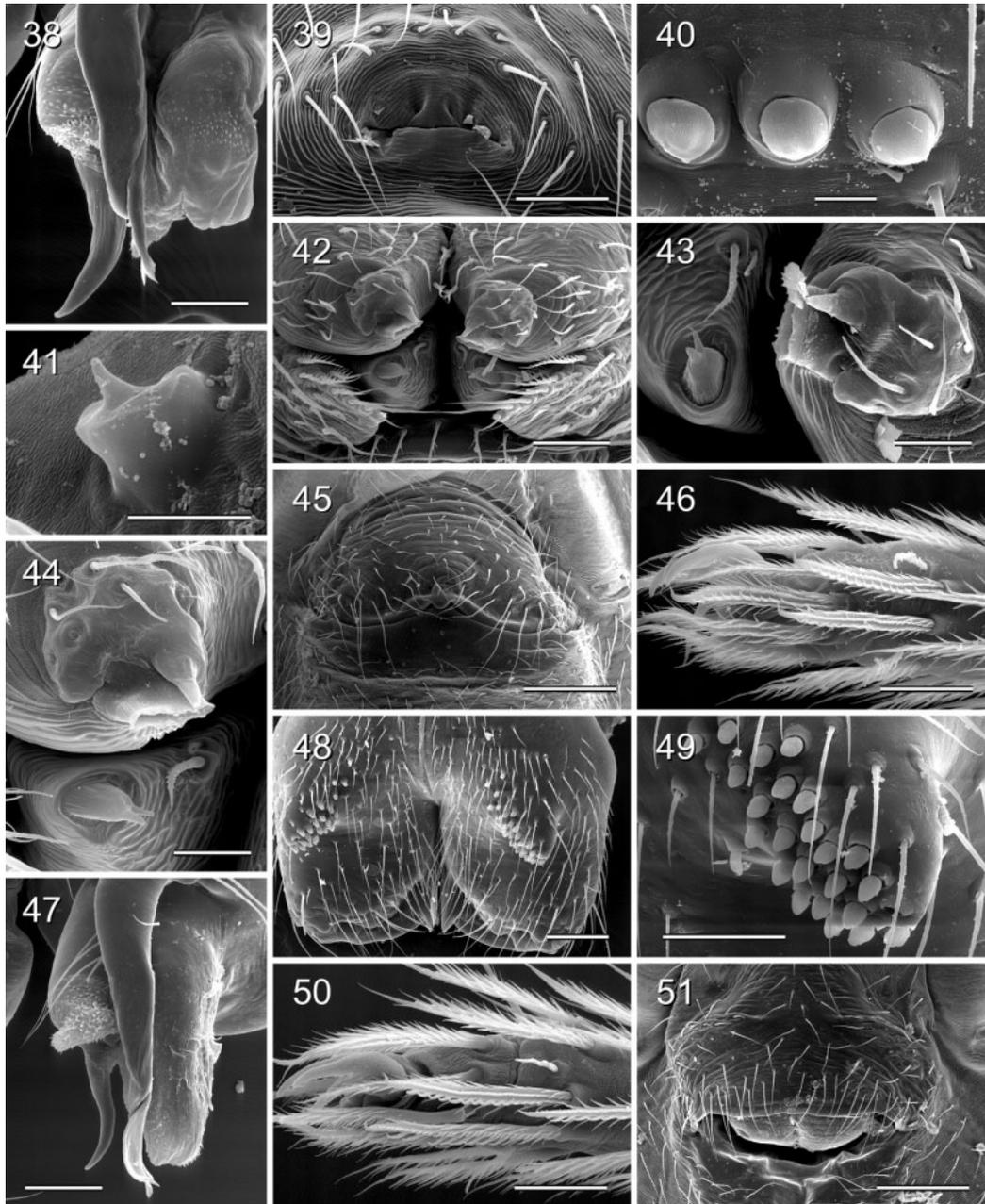
**Figs 33–37.** *Carapoia crasto*, sp. nov. 33–34, Left male palp, prolateral (33) and retrolateral (34) views. 35, Male chelicerae, frontal view. 36–37, Cleared female genitalia, ventral (36) and dorsal (37) views. Scale bars: 0.3 mm.

*Diagnosis*

Easily distinguished from most known congeners by the long abdomen (Fig. 91; similar only in *C. crasto*); also by shapes of procurus tip (Figs 77, 78), male chelicerae (Figs 54, 55) and epigynum (Fig. 56).

*Description**Male (holotype)*

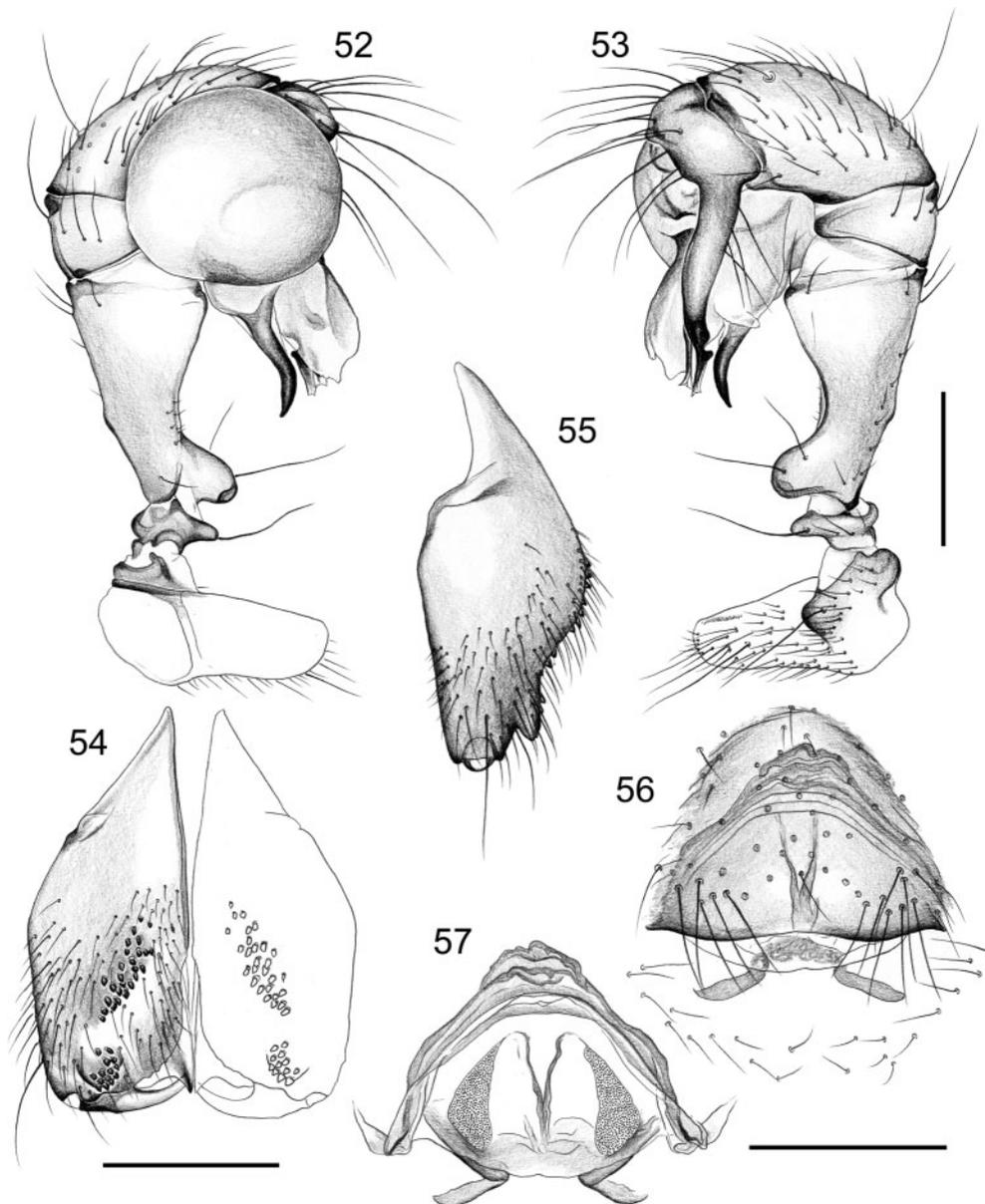
Total length 4.6 (4.8 with clypeus), carapace width 1.3. Leg 1: 43.0 (10.2 + 0.5 + 9.9 + 20.1 + 2.3), tibia 2: 6.0, tibia 3: 4.4, tibia 4: 5.3. Tibia 1 L/d: 80. Carapace pale ochre,



**Figs 38–51.** *Carapoa una*, sp. nov. (38–46) and *C. crasto*, sp. nov. (47–51). 38, Right procurus and bulbal projections, retrolateral view. 39, Male gonopore. 40, Modified hairs on male chelicerae. 41, Male palpal tarsal organ. 42, Male spinnerets. 43, Female anterior lateral spinnerets (ALS) and posterior median spinnerets (PMS). 44, Male ALS and PMS. 45, Epigynum. 46, Female tarsus 4 tip with serrated hairs. 47, Right procurus and bulbal projections, retrolateral view. 48, Male chelicerae, frontal view. 49, Male cheliceral apophysis with modified hairs. 50, Female tarsus 4 tip with serrated hairs. 51, Epigynum with genital plug. Scale bars: 10  $\mu$ m (40, 41), 20  $\mu$ m (43, 44), 30  $\mu$ m (46, 50), 50  $\mu$ m (39, 42, 49), 100  $\mu$ m (38, 47, 48), 200  $\mu$ m (45, 51).

median furrow and lateral margins frontally darker, ocular area not darkened; sternum whitish-ochre; legs ochre, tips of femora and tibiae whitish, no dark rings; abdomen greenish-grey, with many black spots dorsally and laterally, partly fused to longitudinal bands, light brown plate in front of gonopore, black line from gonopore 3/4 to spinnerets (cf. female, Fig. 91). Ocular area elevated and clearly separated from carapace, thoracic furrow distinct and deep; distance PME–PME 95  $\mu\text{m}$ ; diameter PME 135  $\mu\text{m}$ ; distance PME–ALE 105  $\mu\text{m}$ ; distance AME–AME 35  $\mu\text{m}$ , diameter AME 50  $\mu\text{m}$ . Sternum wider than long (0.95/0.7). Chelicerae as in Figs 54 and 55, with distinctive patches of modified

hairs. Palps as in Figs 52 and 53; coxa with retrolateral apophysis, trochanter with small ventral projection, femur with prominent retrolateral projection proximally, widened distally, procurus mostly very simple, distally divided into two branches (Figs 77, 78); bulb with complex membranous projection and strong apophysis. Retrolateral trichobothrium of tibia 1 at 3%; legs densely covered with short hairs, without spines, curved hairs, few vertical hairs (possibly slightly higher than usual density on metatarsi); femur 3 slightly thicker than others; tarsus 1 with over 20 pseudo-segments (difficult to count).



**Figs 52–57.** *Carapoia rheimsae*, sp. nov. 52–53, Left male palp, prolateral (52) and retrolateral (53) views. 54–55, Male chelicerae, frontal and lateral views. 56–57, Cleared female genitalia, ventral (56) and dorsal (57) views. Scale bars: 0.3 mm.

*Variation*

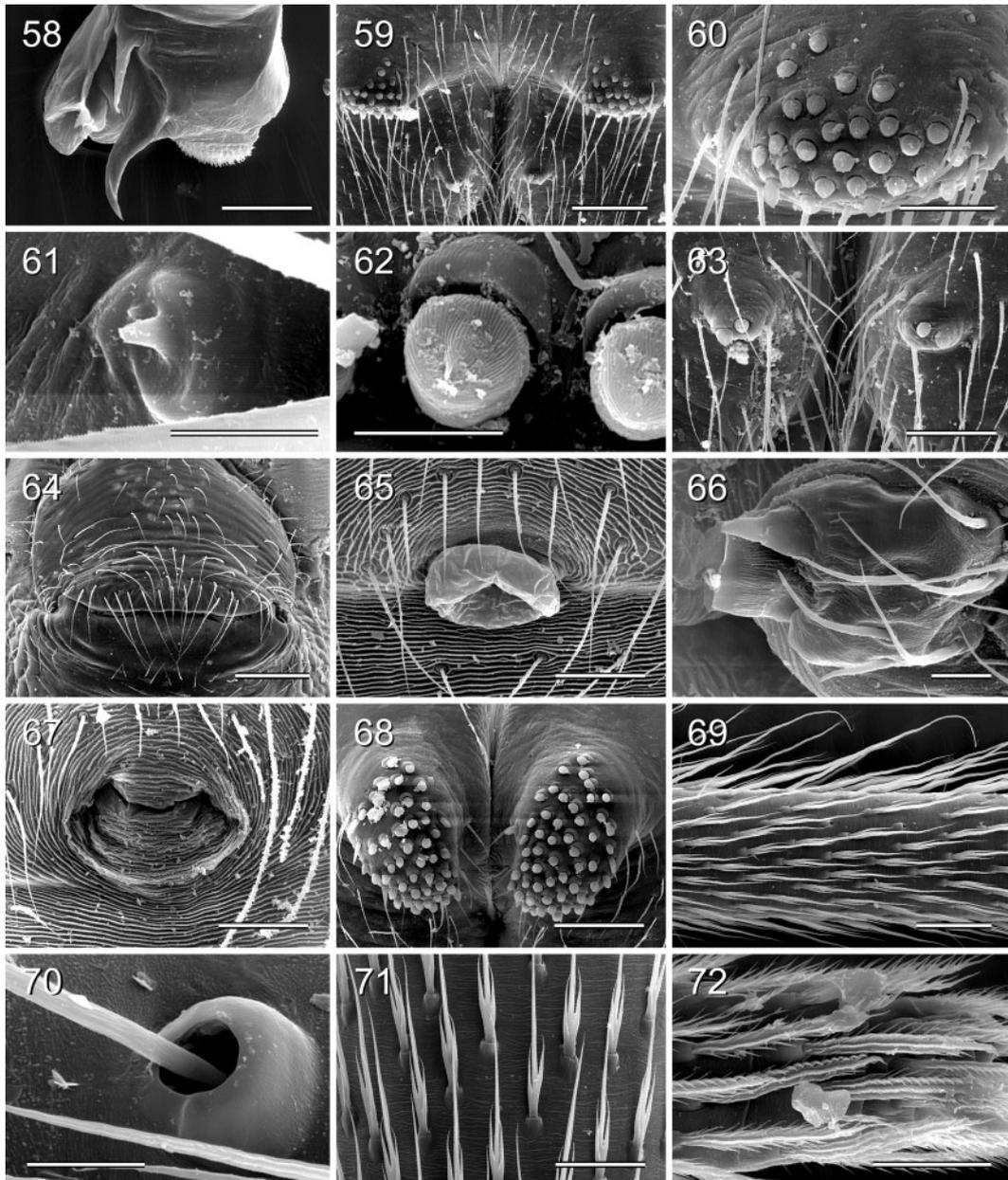
Tibia 1 in other male: 10.5. This male is smaller and thinner, but has longer legs. However, the palps are almost identical in size and shape, and the chelicerae have a very similar pattern of modified hairs.

*Female*

In general similar to male; tibia 1 in 3 females: 7.9, 8.1, 8.3. Epigynum a simple brown plate (Figs 56, 91); dorsal view as in Fig. 57.

*Distribution*

Known from two localities in Bahia (Fig. 1).



**Figs 58–72.** *Carapoia genitalis* (Moenkhaus) (58–66) and *C. paraguaensis* González-Sponga (67–72). 58, Right genital bulb projections, prolateral view. 59, Male chelicerae, frontal view. 60, Proximal cheliceral apophysis with modified hairs. 61, Male palpal tarsal organ. 62, Modified hairs on male chelicerae. 63, Distal cheliceral apophyses with modified hairs. 64, Epigynum. 65, Male gonopore. 66, Male anterior lateral spinnerets (ALS) with widened and pointed spigots. 67, Male gonopore. 68, Male cheliceral apophyses with modified hairs. 69, Male tibia 4 hairs. 70, Trichobothrium on female tibia 4. 71, Mechanoreceptors on male femur 4. 72, Female tarsus 4 tip with serrated hairs. Scale bars: 10  $\mu\text{m}$  (61, 62, 66, 70), 40  $\mu\text{m}$  (60, 72), 50  $\mu\text{m}$  (63, 65), 60  $\mu\text{m}$  (67, 71), 100  $\mu\text{m}$  (58, 59, 68, 69), 200  $\mu\text{m}$  (64).

*Etymology*

Named for Cristina A. Rheims, Instituto Butantan, São Paulo.

*Carapoia genitalis* (Moenkhaus)

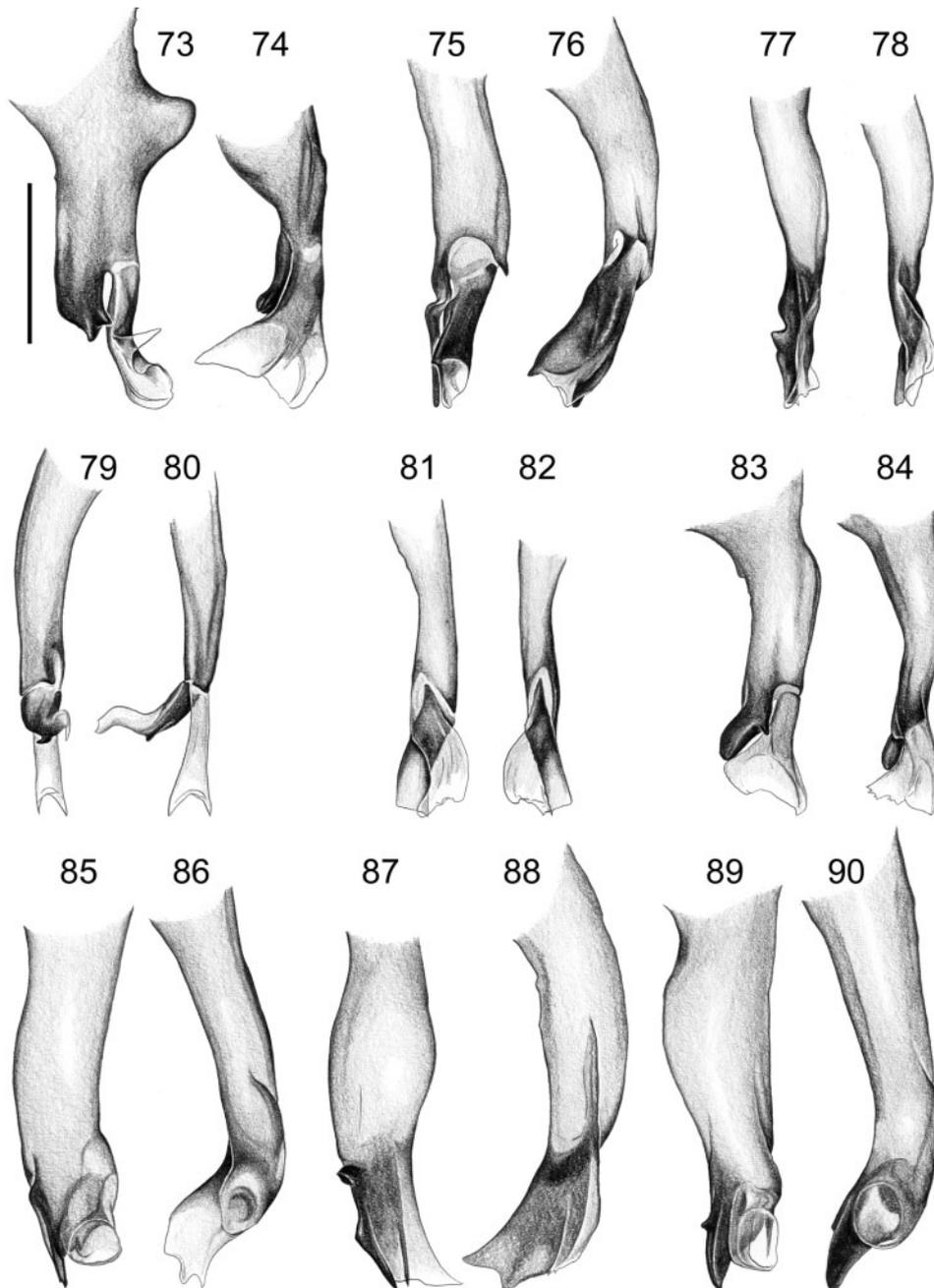
(Figs 58–66, 83, 84, 98)

*Litoporus genitalis* Moenkhaus, 1898: 107–110, plate 5, figs 5, 5a–d.

*C. genitalis*: Huber, 2000: 246, figs 973–979.

*New records*

**Brazil:** *São Paulo*: Peruibe, Estação Ecológica Juréia Itatins (24°33'S, 47°13'W), 16.iv.–3.vi.1999 (A. D. Brescovit *et al.*), 3 ♂, 7 ♀ (IBSP 25744, 24666, 24778, 24821, 24855, 25137, 25181, 25264, 25480, 25511); Paranapiacaba, Estação Biológica do Alto da Serra (23°46.7'S, 46°18.6'W), 27.vii.2000 (F. S. Cunha, C. A. Rheims), 2 ♂,



**Figs 73–90.** Left procrusi of all known *Carapoia* species, prolateral and dorsal views. 73–74, *C. ubatuba*. 75–76, *C. brescoviti*. 77–78, *C. rheimsae*. 79–80, *C. una*. 81–82, *C. crasto*. 83–84, *C. genitalis*. 85–86, *C. oacina*. 87–88, *C. fowleri*. 89–90, *C. paraguaensis*. All to same scale (scale bar: 0.2 mm).

1 ♀ (IBSP 23881, 23976); same locality, 14–15.xii.2003 (B. A. Huber, C. A. Rheims, R. P. Indicatti, R. Schulz), 1 ♂, 4 ♀ (ZFMK).

***Carapoia ocaina* Huber**

(Figs 85, 86, 99)

*C. ocaina* Huber, 2000: 242, figs 19–20, 131, 179, 955–961.

*New record*

**Brazil:** Amazonas: Manaus, Tarumã-Mirim river, Igapó (3°02'S, 60°05'W), 30.vii.1979 (J. Adis), 1 ♂, 1 ♀ (IBSP 17269).

***Carapoia fowleri* Huber**

(Figs 87, 88, 97)

*C. fowleri* Huber, 2000: 243, 342, figs 18, 962–972.

*New records*

**Brazil:** Amazonas: Manaus, Reserva do km 41, (~2°40'S, 60°00'W), viii.2000 (A. J. Santos), 3 ♂ (IBSP 37292, 37271); Pará: Melgaço, FLONA Caxiuanã, Estação Científica Ferreira Penna, 21.xi.–3.xii.2000 (A. B. Bonaldo), 1 ♂, 7 ♀ (MPEG 001912–14, 001921); same data but 10.ii.2002, 1 ♀ (MPEG 001911); same locality, 18/28.xi.2000 (A.A.M.B.), 1 ♂, 1 ♀ (MPEG 001909–10); same locality, 3.xii.2000 (R. Pinto-da-Rocha), 1 ♀ (MPEG 001915); same

locality, no date (A. B. Bonaldo), 1 ♀ without epigynum (MPEG 001916).

***Carapoia paraguaensis* González-Sponga**

(Figs 67–72, 89, 90, 96)

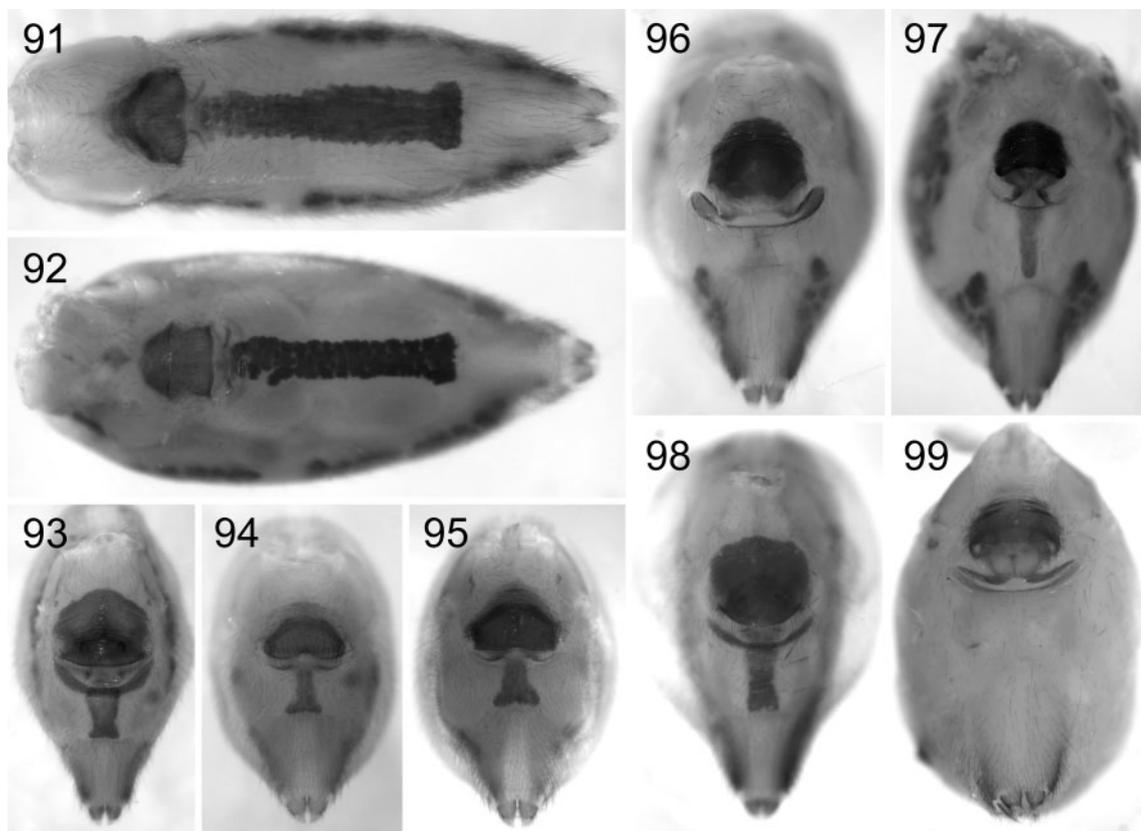
*C. paraguaensis* González-Sponga, 1998: 19–21, figs 1–10. – Huber, 2000: 240, figs 947–954.

*New records*

**Brazil:** Amazonas: Parque Nacional do Jaú, Moura (1°30'S, 61°40'W), 17.iii.1999 (S. H. Borges), 1 ♂, 1 ♀ (IBSP 28497, 28499). **Venezuela:** Bolívar: at km 44 from El Dorado (6°25'N, 61°38.5'W), ~200 m above sea level, near ground, 2.xii.2002 (B. A. Huber), 2 ♂, 3 ♀ (MHNLS: 1 ♂, 2 ♀, ZFMK: 1 ♂, 1 ♀); at km 102 from El Dorado (6°04'N, 61°24'W), ~500 m above sea level, near ground, 2.xii.2002 (B. A. Huber), 2 ♂ (MHNLS, ZFMK); at km 109 from El Dorado (6°01'N, 61°23.5'W), ~800 m above sea level, domed webs near ground, 3.xii.2002 (B. A. Huber), 1 ♀ (MHNLS).

**Acknowledgments**

Material studied herein was kindly lent by Alexandre Bonaldo (MPEG), Antonio Brescovit and Cristina Rheims (IBSP) and Osvaldo Villarreal (MHNLS). I am deeply indebted to A. Brescovit and C. Rheims for their hospitality



**Figs 91–99.** Female abdomens of all known *Carapoia* species in ventral view, at various scales. 91, *C. rheimsae*. 92, *C. crasto*. 93, *C. ubatuba*. 94, *C. una*. 95, *C. brescoviti*. 96, *C. paraguaensis*. 97, *C. fowleri*. 98, *C. genitalis*. 99, *C. ocaina*.

and support in Brazil in 2003 and to O. Villarreal and Abel Pérez González for their support in Venezuela in 2002. Two anonymous referees and A. Brescovit and C. Rheims commented on a previous version of the manuscript. Venezuelan material was collected under permit N° 01–11–0966 issued by the Dirección General de Fauna y Oficina Nacional de Diversidad Biológica in Caracas. This work is part of BIOTA/FAPESP – The Biodiversity Virtual Institute Program.

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Manuscript received 16 August 2005, revised and accepted 29 September 2005.