Aparatermes thornatus (Isoptera: Termitidae: Apicotermitinae), a New Species of Soldierless Termite from Northern Amazonia

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Aparatermes thornatus (Isoptera: Termitidae: Apicotermitinae), a new species of soldierless termite from northern Amazonia

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Abstract

The worker of *Aparatermes thornatus* is described as the fourth species of a widespread Neotropical termite genus, *Aparatermes*, from the worker caste. This species occurs in northern Amazonia. The enteric valve armature of *A. thornatus* and the unique coloration of its worker's head capsule distinguish it from its 3 congeners. Molecular data recovered the proposed new species as a sister to *Aparatermes silvestrii*. Type material is deposited at Colección Entomológica Forestal, Universidad Distrital "Francisco Jose de Caldas" (CEFUDFJC - 45 National Registry of Collections) in Bogotá, Colombia, and the University of Florida, Termite Collection (UFTC) at the Fort Lauderdale Research and Education Center, Fort Lauderdale, Florida, USA.

Key Words: French Guiana; Colombia; Ecuador; worker; enteric valve armature; digestive tube; Isoptera: Blattodea: Termitoidae

Resumen

El obrero de *Aparatermes thornatus* se describe como la cuarta especie de un género neotropical de amplia distribución. Esta especie se encuentra en la región norte de la Amazonia. La armadura de la válvula entérica y la coloración distintiva del cuerpo diferencian a *A. thornathus* de las otras tres especies. Adicionalmente, los datos moleculares sitúan la nueva especie como especie hermana de *Aparatermes silvestrii*. El material tipo está depositado en la Colección Entomológica Forestal de la Universidad Distrital "Francisco José de Caldas" en Bogotá, Colombia, colección registrada con el numero 045 en el registro Nacional de Colecciones biológicas de Colombia y en la Colección de termitas de la Universidad de la Florida, en Fort Lauderdale, Research and Education Center, Fort Lauderdale, Florida, USA.

Palabras Clave: French Guiana; Colombia; Ecuador; worker enteric valve armature; digestive tube; Isoptera: Blattodea: Termitoidae

This paper describes a new species of a soldierless termite of the widespread Neotropical genus *Aparatermes*. Fontes (1986) described *Aparatermes* as a new genus, with *Aparatermes* abbreviatus (Silvestri 1901), formerly Anoplotermes, as the type species. Although Fontes (1986) recognized the importance of including digestive tube morphology in soldierless termite descriptions, as shown by Sands (1972) and Mathews (1977), he did not describe the enteric valve of *A. abbreviatus*. In addition, Fontes (1998) later transferred *Anoplotermes cingulatus* (Burmeister, 1839) to *Aparatermes*.

Aparatermes silvestrii (Emerson, 1925) was first included in *Ruptitermes* (Araujo 1977) and then synonymized the species with *Aparatermes* cingulatus by Šobotník et al. (2010). However, according to Acioli and Constantino (2015), *A. silvestrii* and *A. cingulatus* can be differentiated by their imagoes and disjunct geographic distribution. In their identification key, Bourguinon et al. (2016b) included the enteric cushions with scales and sometimes spines as a unique character to differentiate *Aparatermes* from *Ruptitermes* and other Apicotermitinae genera. We herein describe a new *Aparatermes* species, *A. thornatus*, based primarily on coloration, size, and digestive tube characters of the worker caste, in addition to mitochondrial gene cytochrome c oxidase subunit 1 (COI) sequences.

Materials and Methods

Specimens included in this paper were collected and preserved in 85% ethanol by O. Pinzón in Colombia, and R. Scheffrahn and his team in French Guiana, Ecuador, Trinidad and Tobago, and deposited at Colección Entomológica Forestal de la Universidad Distrital "Francisco Jose de Caldas" in Bogota, Colombia, and the University of Florida, Termite Collection at the Fort Lauderdale Research and Education Center, Fort Lauderdale, Florida, USA, respectively.

The enteric valve (EV) was dissected by excising the second proctodeal segment (P2) of the worker's gut with its content teased out using a pair of forceps. The tube was immersed in PVA mounting medium (Bioquip, Rancho Dominguez, California, USA), to completely detach the enteric valve from surrounding muscle tissue, then cut longitudinally to splay open the enteric valve for mounting in the medium. Description of the worker gut follows the terminology of Sands (1972) and Noirot (2001). Enteric valves of specimens from *A. abbreviatus*, *A. cingulatus*, and *A. silvestrii* from previous samples deposited at the University of Florida, Termite Collection were dissected and included for comparison. Morphometric characters (Table 1) were measured

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Table 1. Measurements (mm) of 19 workers from 7 colonies of *Aparatermes thornatus* (Roonwal, 1961, equivalence in parenthesis).

	Range	Mean
Length of head to lat. base mandibles (EE')	0.93 – 0.63	0.80
Maximum head width (RR')	1.11 – 0.82	0.92
Length of postclypeus (HH')	0.26 – 0.12	0.19
Width of postclypeus (JJ')	0.53 – 0.26	0.38
Length of protibia (CC')	0.84 – 0.53	0.68
Width of protibia (DD')	0.14 – 0.09	0.11
Protibia width ratio / length (Tibia Index)	0.19 – 0.11	0.16

following those of Roonwal (1970). Measurements were obtained with a micrometric reticule on the eyepiece of an Olympus SZX9 (Center Valley, Pennsylvania, USA) stereomicroscope.

Mitochondrial gene cytochrome c oxidase subunit 1 (COI) sequences from 2 samples of *A. thornatus* (UF EC 1334-1, BOLD accession number: ABV3376 and LS-2013 1573, BOLD: AAU1550) were obtained by DNA extraction, and PCR performed by the Canadian Centre for DNA Barcoding (University of Guelph, Guelph, Ontario, Canada) following standard high-throughput protocols (de Waard et al. 2008). The PCR employed the primers LepF1 and LepR1 (Hebert et al. 2003) that generated 652bp of the barcode region of COI. A phylogenetic tree was created under Bayesian Inference (BI) with the sequences of *A. thornatus*, 1 of *Ruptitermes arboreus* (BOLD: ACT1328), and 48 GenBank sequences: 35 sequences of Neotropical Apicotermitinae (21 species, 13 genera), 8 non-Neotropical Apicotermitinae genera, 5 non-Apicotermitinae Termitidae, and 1 Rhinotermitidae. The tree was constructed under the same parameters of other recently published papers on Neotropical Apicotermitinae (e.g., Carrijo et al. 2015; Scheffrahn et al. 2017). Sequences were aligned under MUSCLE algorithm implemented in Geneious v6.1.6 (Biomatters Ltd., Auckland, New Zealand). The Bayesian Inference analysis was conducted using *Heterotermes crinitus* (Emerson) (Blattodea: Rhinotermitidae) as an outgroup. The substitution model was the GTR + I + G, selected under the Akaike Information Criterion with the jModelTest2 (Darriba et al. 2012). The XML input files were generated with BEAUti 1.8.0 and the Bayesian Inference performed with BEAST 1.8.0 (Drummond et al. 2012). A Yule speciation process, with a random starting tree and strict molecular clock, was used as tree priors. Four Markov Chain Monte Carlo (MCMC) searches were conducted, each one for 20,000,000 generations, and were combined to search the most probable tree. Convergence and stationarity were assessed with Tracer 1.5 (Rambaut et al. 2014) and the first 1,000 trees were discarded as burn-in with TreeAnnotator 1.8.0 and visualized using FigTree 1.3.1.

TYPE SPECIES

Aparatermes abbreviatus (Silvestri 1901)

Results

Aparatermes thornatus Pinzon and Scheffrahn sp. nov. 2018
Imago. Unknown
Worker (Table 1, Figs. 1-3D).

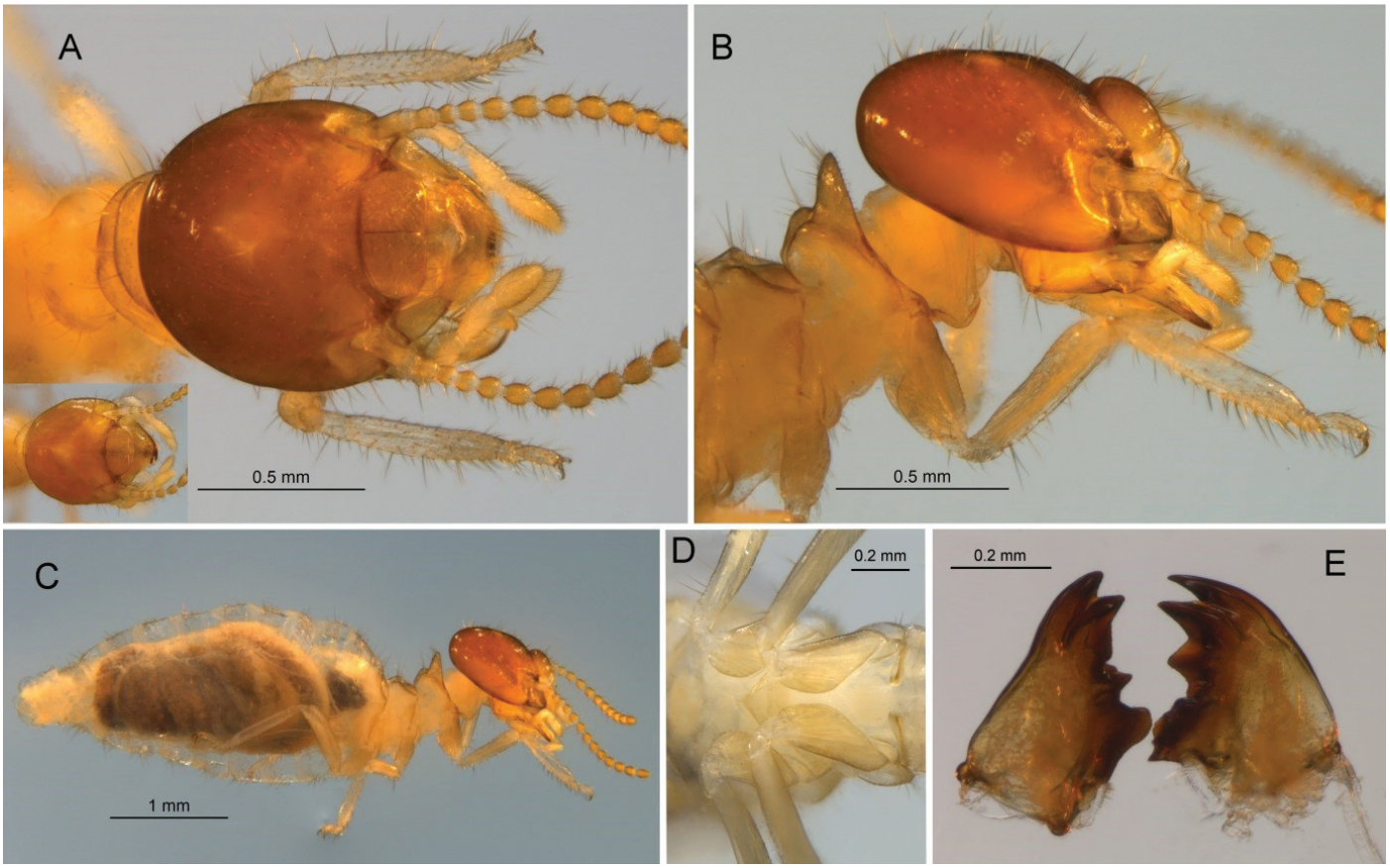

Fig. 1. *Aparatermes thornatus* worker: (A) dorsal view of head and fore legs (inset shows coloration and pigment variant); (B) lateral view of head and thorax; (C) lateral view of habitus; (D) ventral view of fore coxae; (E) mandibles.

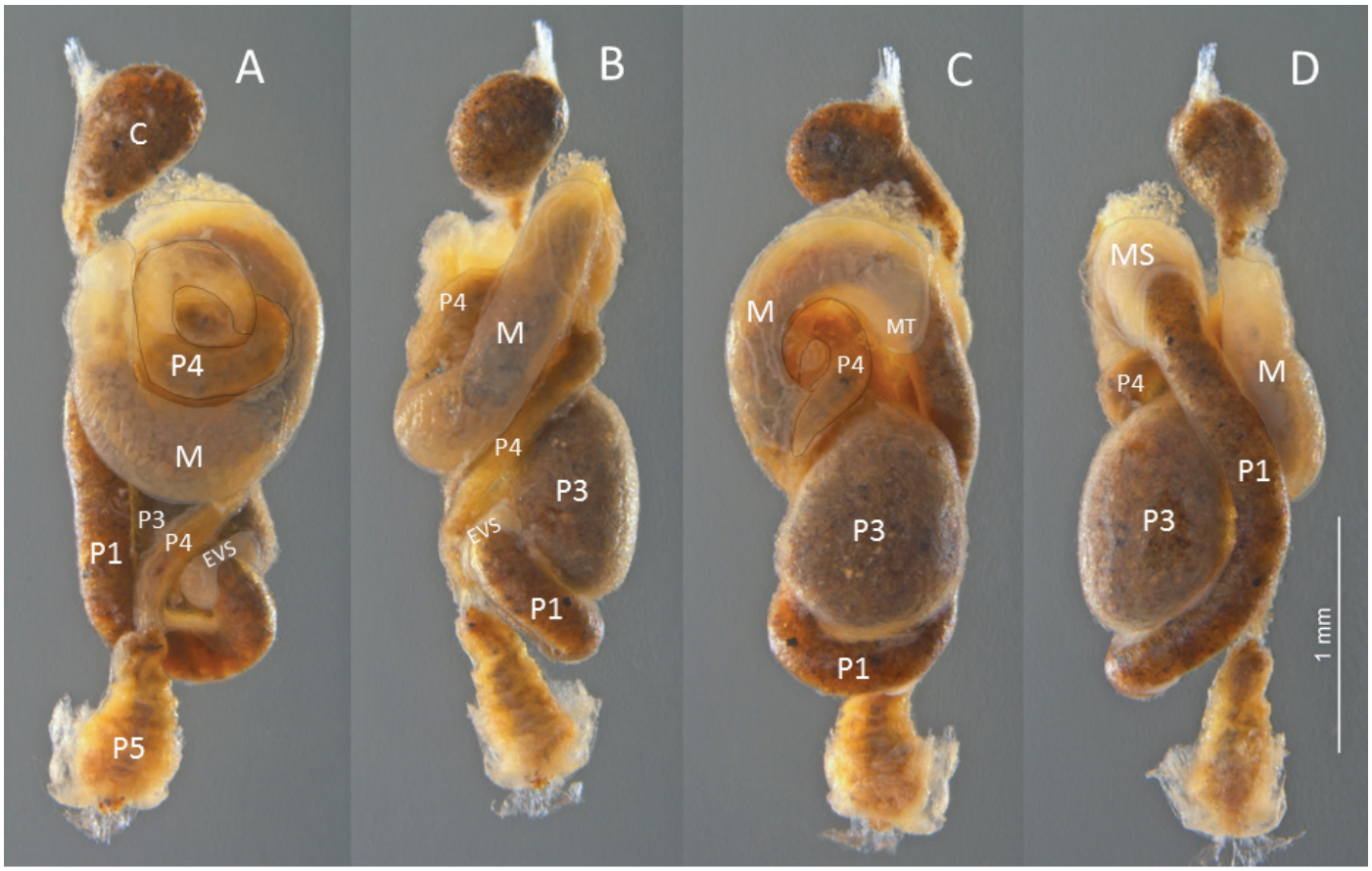

Fig. 2. *Aparatermes thornatus* worker gut: (A) dorsal; (B) lateral right; (C) ventral; (D) lateral left views. Abbreviations of gut sections: C = crop, EVS = enteric valve seating, M = mesenteron, MT = mesenteric tongue, P1–P5 = proctodeal segments.

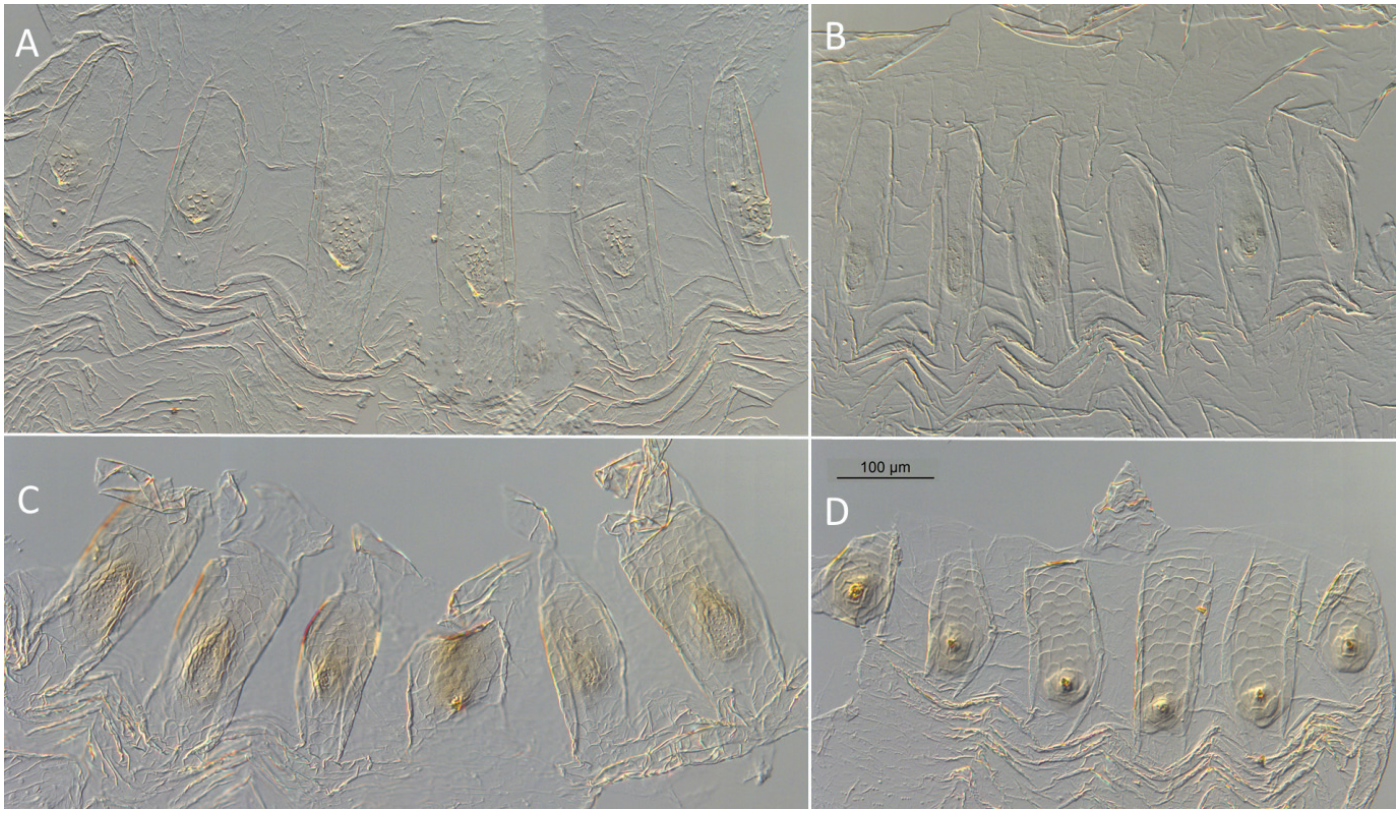

Fig. 3. *Aparatermes* enteric valve cushions: (A) *A. cingulatus*; (B) *A. abbreviatus*; (C) *A. silvestrii*; (D) *A. thornatus*.

TYPE MATERIAL

HOLOTYPE (worker) colony. Type locality: Francisco de Orellana, Parque Nacional Yasuni, 0.672000°W, 76.398000°S, 2-VI-2011, col. Scheffrahn, Chase, Mangold, Krecek, Myles, Nishimura, Setter, EC1334. All the type material will be kept at Universidad Distrital "Francisco Jose de Caldas".

ECUADOR: Holotype (worker) colony Francisco de Orellana, Parque Nacional Yasuni, 0.6720°W, 76.3980°S, 2-VI-2011, col. Scheffrahn, Chase, Mangold, Krecek, Myles, Nishimura, Setter, EC1332-EC1334. FRENCH GUIANA: Eau Crique Forest, 5.6310°W, 52.9840°S, 12-II-2008. col. J. Krecek, UF no. FG464; additional colonies (same data) FG177, FG775. COLOMBIA: Casanare, Villanueva. Gallery Forest Caño "Los Micos", 4.6420°W, 72.9260°S, 8-XI-2013, col. O. Pinzón; LS 2013-1137, LS 2013-1573 (Colección Entomológica Forestal Universidad Distrital "Francisco José de Caldas"). TRINIDAD AND TOBAGO: Mount Harris, 10.4670°W, 61.1230°S, 31-V-2003, col. Scheffrahn, Krecek, Chase, Mangold, Maharajh, Warner, TT2018.

DESCRIPTION

Monomorphic. Head capsule dark orange to reddish brown; fontanelle spot large, lighter, and rather diffuse; spot often forming triangular apex with base along postclypeal suture (Fig. 1A inset). Postclypeus strongly inflated; labrum trapezoidal in dorsal view. Antennal articles becoming darker toward apex. Pronotum concolorous with fontanelle spot; posterolateral corners raised. Head and pronotum with numerous long setae interspersed with shorter setae. Foretibia slightly inflated; middle and hind tibia slender. Anterior of fore coxa usually lacking hairs; foretibia with about a dozen stout and a few slender setae along ventral margin. Dentition of mandibles as in Fig. 1E. Both mandibles with first marginal tooth projecting beyond apical tooth.

Digestive tube characterized by a rather small crop and voluminous P3. Mesenteron completes a full circle and is terminated by a short and thick mesenteral tongue. Proctodeal segment 1 is even in diameter along its 180° course; enteric valve seating trilobed. Enteric valve composed of 6 cushions each bearing thorn-like spines near their anterior bases; remainder of cushions covered with scale-like reticulations; cushions vary in size with the longest cushion furthest removed from the shortest.

ETYMOLOGY

The specific name refers to the 6 thorn-like spines on the enteric valve cushions.

COMPARISONS

Aparatermes thornatus workers fit Fontes (1986) and Bourguignon et al. (2010) generic description; however, several characters are very distinct from its 3 congeners. Of the 4 *Aparatermes* species, *A. thornatus* is the smallest. The head capsule coloration of *A. abbreviatus*, *A. cingulatus*, and *A. silvestrii* ranges from pale yellow to light orange (Fontes 1986) whereas that of *A. thornatus* is strongly reddish in color. Another diagnostic character to separate *A. thornatus* from its congeners is that all of its enteric valve scaly cushions are thorn-adorned, whereas the other species vary in their thorn number (e.g., *A. cingulatus* Bourguignon et al. 2013) (Fig. 3).

MOLECULAR ANALYSIS

The phylogenetic tree (Fig. 5) recovered the genus *Aparatermes* as paraphyletic, with the species *A. cingulatus* and *A. abbreviatus* more closely related to *Compositermes*, *Tetimatermes*, and *Ruptitermes*. *Aparatermes thornatus* was recovered as a sister group of *A. silvestrii*. The sample *Aparatermes* sp. A, of Bourguignon et al. (2016a), was clustered within the 2 samples of *A. thornatus*, suggesting that these samples belong to the new species described herein. A BLAST search of the COI sequence from *A. thornatus* also gives a 97% similarity match with the sample reported by Bourguignon et al. (2016a).

ECOLOGY AND DISTRIBUTION

There are no behavioral notes of *A. thornatus* when collected; however, its flocculent gut contents suggest that they feed on rather rich organic debris. Their darker color suggests that *A. thornatus* workers might forage in the open as do species of *Ruptitermes*. The distribution of *A. thornatus* is currently known from northern Amazonia into Trinidad and Tobago (Fig. 4). *Aparatermes silvestrii* has the broadest distribution from Trinidad and Tobago south to central Paraguay. *Aparatermes* abbreviatus and *A. cingulatus* straddle southern Amazonia to the north and extend in the drier regions southward to central Argentina.

Discussion

The use of enteric valve armature and gene sequences is becoming particularly useful to separate New World soldierless Apicotermitinae genera and species (Borguinon et al. 2013, 2016a; Carrijo et al. 2015;

Fig. 4. Distribution of *Aparatermes* from University of Florida Termite Collection records.

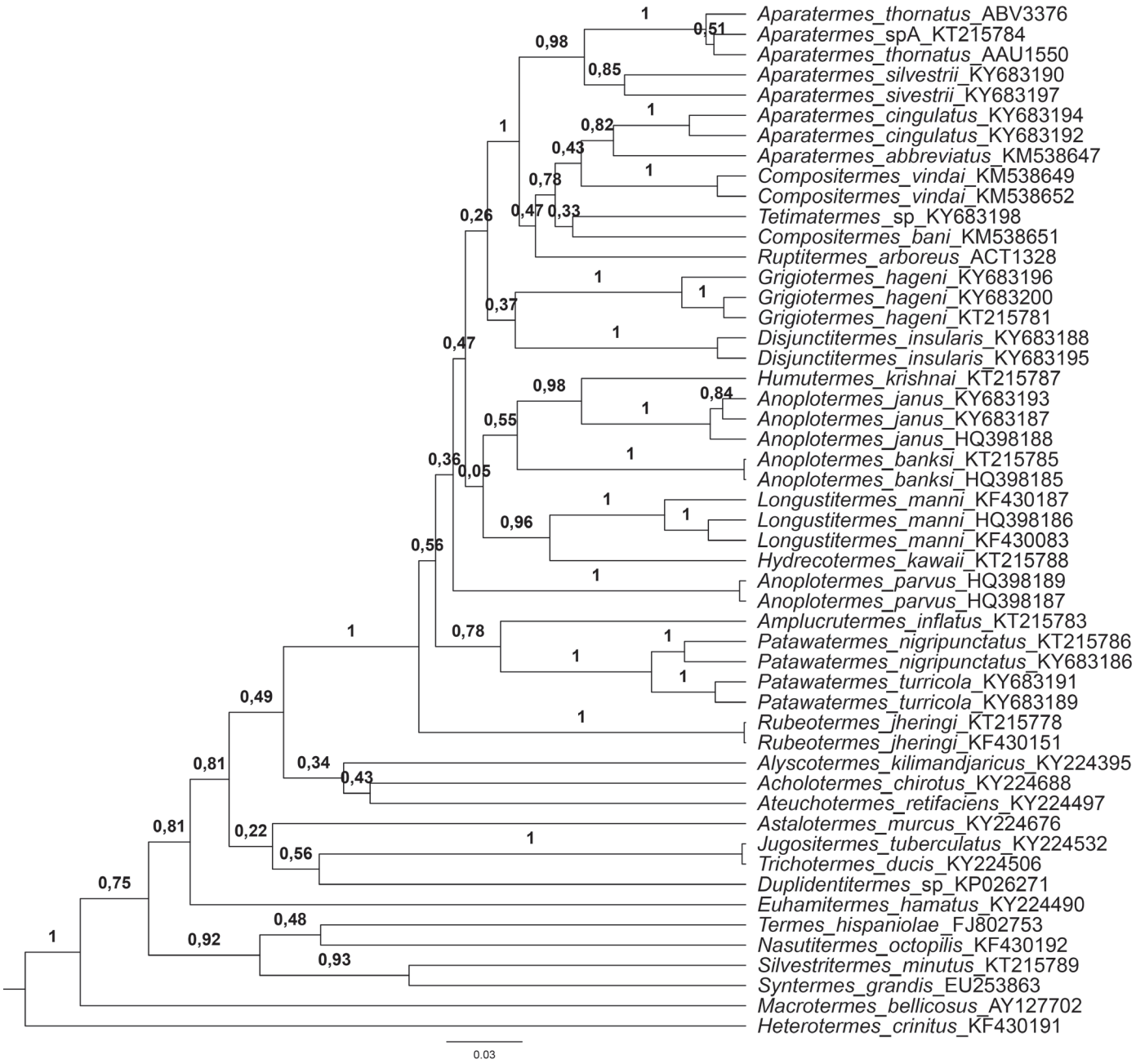

Fig. 5. Bayesian phylogeny of all described soldierless New World genera using the mitochondrial Cytochrome Oxidase subunit 1 COI barcode gene showing posterior probabilities. Tree rooted on terminal *Heterotermes crinitus*.

Scheffrahn et al. 2017). Besides coloration and size differences of the worker, *A. thornatus* enteric valve armature possesses a conspicuous thorn on each of the cushions, whereas the other species vary in thorn number (e.g., *A. cingulatus* Bourguignon et al. 2013). Also, the reddish coloration and smaller size of *A. thornatus* is distinct from other species. In addition, COI gene sequences also support a strong distinction of *A. thornatus* from its sister species *A. silvestrii*.

The results of our study support that *A. thornatus* and *A. silvestrii* should be separated in a new genus; however, given the low branch support recovered in the phylogeny, we prefer to not make any taxonomic change in genus level. Acioli and Constantino (2015) indicate that "a revision of the '*silvestrii*' group is underway and will be published," so it is believed that deeper discussions on the genera relationships should be made by this revision coming soon.

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lection permit no. 06-2011-FAU-DPAP-MA signed by Juan Moscoso, Dir. Provincial del Ambiente Pichincha, Ministerio de Ambiente, 11 Mar 2011. Export permit no. QCAZ-11026e, Museo de Zoología, Pontificia Universidad Católica del Ecuador. No collection permit was required for French Guiana.

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