http://www.biodiversnathist.com
BIODIVERSITY AND NATURAL HISTORY
Research Article
Biodiversity and Natural History (2015) 1: 26-34

# Bioecological traits, abundance patterns and distribution extension of the soldierless Neotropical termite *Compositermes vindai* Scheffrahn, 2013 (Isoptera: Termitidae: Apicotermitinae)

Patrones de abundancia, bioecología y distribución de la termita neotropical sin soldados *Compositermes vindai* Scheffrahn, 2013 (Isoptera, Termitidae, Apicotermitinae)

M. Celina Godoy*, Enrique R. Laffont & Juan M. Coronel

Facultad de Ciencias Exactas y Naturales y Agrimensura, Universidad Nacional del Nordeste, Av. Libertad 5470 (W3400AAS), Corrientes, Argentina.
*Autor correspondiente: mcgodoy@exa.unne.edu.ar

**Abstract**

The soldierless Neotropical Apicotermitinae is considered among the less known termite groups and its ecological relevance warrants studies about the biology and diversity of their species. We investigated the presence, distribution and relative abundance of the recently described species *Compositermes vindai* Scheffrahn, 2013 in natural and anthropized ecosystems of northeastern Argentina. Their nests and populations, as well as their presence inside other Termitidae mounds were examined. A standardized sampling protocol for termites was applied at five sites, with 100 x 2 m transects. Worker morphometric data from the surveyed localities are also reported. *C. vindai* was found in protected environments with little disturbance as well as in other altered ecosystems. The abundance patterns of *C. vindai* in the sampled areas varied from rare to intermediate and seemed not to be significantly affected by the environmental changes of the sites due to their land uses. The microhabitats occupied were mainly superficial soil and other Termitidae mounds (*Cornitermes cumulans* Kollar, 1832; *Syntermes obtusus* Holmgren, 1911 and *Cortaritermes fulviceps* Silvestri, 1901). *C. vindai* subterranean and diffuse nests showed a core surrounding by scattered chambers and tunnels extending into the surrounding soil. The small size colonies comprised workers, brachypterous nymphs and white immature larvae. Winged imagoes or primary reproductives were not found. These new records also extend the distribution of *C. vindai* across the biomes and ecoregions of the Neotropical ecozone and constitute the first reports of *C. vindai* from Argentina.

**Key words:** *Anoplotermes* group, South America, humivorous termites.

**Resumen**

Las termitas Neotropicales sin soldados de la subfamilia Apicotermitinae, son consideradas uno de los grupos de isópteros menos conocidos, por lo que resulta importante analizar sus rasgos biológicos y diversidad. Se investigó la presencia, distribución y abundancia relativa de la especie recientemente descripta *Compositermes vindai* Scheffrahn, 2013 en ecosistemas naturales y antropizados del noreste de Argentina. Se examinaron sus nidos y poblaciones, así como su presencia en los montículos de otras termitas. Se aplicó un protocolo estandarizado de muestreo para isópteros en cinco sitios, con transectas de 100 x 2 m. También se registraron datos morfométricos de obreras. *C. vindai* fue detectada en ambientes protegidos poco perturbados, así como en otros ecosistemas alterados. Los patrones de abundancia de *C. vindai* en estas áreas variaron de rara a intermedia y la especie pareció no ser afectada de manera significativa por los cambios ambientales derivados de diferentes usos de la tierra. Los microhábitats ocupados fueron principalmente suelo superficial y montículos de otras Termitidae (*Cornitermes cumulans* Kollar, 1832; *Syntermes obtusus* Holmgren, 1911 y *Cortaritermes fulviceps* Silvestri, 1901). Los nidos subterráneos y difusos de *C. vindai* mostraron un núcleo rodeado por cámaras dispersas y túneles que se extendían en el suelo circundante. Las pequeñas colonias estuvieron compuestas por obreras, ninfas braquípteras e inmaduros. No se hallaron individuos alados ni reproductores primarios. Estos nuevos registros extienden la distribución de *C. vindai* a otros biomas y ecorregiones de la ecozona Neotropical y constituyen los primeros hallazgos de *C. vindai* para Argentina.

**Palabras clave:** grupo *Anoplotermes*, Sudamérica, termitas humívoras.

## INTRODUCTION

The recently described genus *Compositermes* Scheffrahn, 2013 belongs to the *Anoplotermes* group of the subfamily

Received: July 1, 2014
Accepted: March 20, 2015
Published online: June 2, 2015

Apicotermitinae. This genus includes seven soldierless Neotropical termite genera, mostly humivorous except for *Ruptitermes* Mathews (Scheffrahn, 2013). The group remains poorly known in the region (Mathews, 1977; Fontes, 1986, 1992; Kambhampati & Eggleton, 2000) although in recent decades several studies started to show its true diversity, abundance and ecological significance (Constantino, 1998; Torales *et al*., 1997, 2005, 2008; Davies, 2002; Roisin & Leponce, 2004; Roisin *et al*., 2006; Scheffrahn *et al*., 2006; Acioli, 2007; Carrijo *et al*., 2009; Bourguignon *et al*., 2009, 2010, 2011 a, b, 2013; Lopes & Ruvolo- Takasusuki, 2010; Šobotník *et al*., 2010; Oliveira *et al*., 2013; Scheffrahn, 2013).

One of the main aspects that helped to elucidate the diversity of soldierless Apicotermitinae was the recognition of the value of worker gut characters, for genera and species definition; mainly when winged imagoes are unknown (Grasse & Noirot, 1954; Sands, 1972, 1998; Fontes, 1992; Godoy & Torales, 1999; Donovan, 2002; Bourguignon *et al*., 2010, 2013). This is the case of *Compositermes,* where the characters allowing its recognition refer mainly to organs of the worker digestive tract, such as the enlarged enteric valve seating with a crown of sclerotized structures and the enteric valve cushions (Scheffrahn, 2013).

Little is known about the bioecological aspects of subterranean Neotropical Apicotermitinae. Among these the distribution and abundance in natural and altered ecosystems, the size and composition of the colonies, their nesting habits and their relationships with other termites are the most scarcely studied. Although it is estimated that most of the Neotropical Apicotermitinae build subterranean nests, these structures have been reported or described only in a few studies (Mathews, 1977; Fontes, 1986). In addition, some of these species are frequently located inside the mounds of other Termitidae as secondary occupants or inquilines; but many of these relationships and their particular characteristics are barely known (Redford, 1984; Domingos & Gontijo, 1996; Costa *et al*., 2009, Florencio *et al*., 2013).

This contribution analyzes the presence, relative abundance and distribution of *C. vindai* in various subtropical habitats of northeastern Argentina. The microhabitats occupied by this species and the characteristics of their nests and populations, as well as the interspecific associations with other mound-building Termitidae were investigated. Worker morphometric data from the surveyed localities are also given.

## MATERIAL AND METHODS

### Study sites and termite sampling

Surveys were conducted in natural and anthropized ecosystems of northeastern Argentina (Corrientes province) (Table 1). The standardized protocol for termites proposed by Jones & Eggleton (2000) was applied at each site, consisting of 100 m long and 2 m wide transects, divided into 20 contiguous sections (each 5 x 2 m). The termites were collected at each section during 1 h/person in different microhabitats (fallen trunks and branches, mounds, arboreal nests, under cow dung, etc.). Twelve samples of surface soil (about 12 x 12 cm, to 10 cm depth) were excavated in each section. Five transects in total were run at the selected sites (Table 1).

The total number of termite encounters within the transects were counted and the abundance of *C. vindai* was estimated in the surveyed areas, defining their occurrence, dominance and abundance patterns according to the categories established by Florencio & Diehl (2006). To determine the occurrence pattern, the species are categorized as rare (R, present in 1-10 % of sections), sporadic (S, present in 11-40% of sections), common (C, present in 41-70% of sections), frequent (F, present in 71-99% of sections) and constant (CS, present in 100% of sections). The following formula was applied:

$$OP = \frac{\text{Number of sections were the species was found}}{\text{Total number of evaluated sections}} \times 100$$

For the dominance pattern, the species are classified as rare (R, 1-10% of encounters), accessory (A, 11-49% of encounters), dominant (D, 50-100% of encounters) according to the following formula:

$$DP = \frac{\text{Number of encounters of each species}}{\text{Total number of encounters}} \times 100$$

The combination of both patterns is used as an indicator of the abundance of each species, according to the following categories: common (C, species with CS and D patterns), intermediate (I, species with R, S, C or F and A; and species with S, C, F or CS and R) and rare (R, species with R in occurrence and dominance patterns).

TABLE 1

Sampling sites in the Corrientes province (Argentina). References: MNP: Mburucuya National Park, HC: Humid Chaco, SCMS (CM): Southern Cone Mesopotamian Savannas (Campos and Malezales).

Sitios relevados en la provincia de Corrientes (Argentina). Referencias: Parque Nacional Mburucuyá, HC: Chaco Húmedo, SCMS (CM): Savanas Mesopotámicas del Cono Sur (Campos y Malezales).

| Locality (Department) | Georeferences | Ecoregion | Plant community | Transects | Date |
|---|---|---|---|---|---|
| Ita Paso (San Miguel) | 27°43'00'' S 57°13'39'' W | HC | *A. lateralis* savanna (grazed) | T1 | June 2005 |
| Gobernador Virasoro (Santo Tomé) | 28°04'01" S 56°03'26" W | SCMS (CM) | *A. compressus* and *Paspalum* sp. savanna (grazed) | T2 | May 2013 |
| MNP (Mburucuyá) | 28°00'22" S 58°02'31" W | HC | *Ocotea acutifolia* hygrophilous forest islet | T3 | July 2010 |
| MNP (Mburucuyá) | 28°01'24" S 58°03'07" W | HC | Savanna with *B. yatay* palm trees | T4, T5 | March 2012 |

The subterranean nests detected at each site were measured and photographed. The characteristics of the chambers and galleries were recorded. Total populations inside the nests were collected, assorted by castes and counted. Nest measurements included height (H), width (W), and thickness (T). Their volume (V) was then estimated assuming that nests have an ellipsoidal shape using the formula:

$$V = \frac{\pi HWT}{6}$$

### Identification and morphometrics

*C. vindai* samples collected from the surveys were fixed in FAA (formalin + alcohol + acetic acid). Other samples deposited at the Isoptera collection (FACENAC) of the Universidad Nacional del Nordeste (UNNE) were also studied. They came from six localities of the Corrientes province, Argentina (Table 2). Detailed analyses of the specimens were carried out under stereomicroscope and optical microscope, including external and gut morphology and morphometrics. The taxonomic identifications were made by comparisons with the original description of the species and references from relevant literature (Fontes, 1985, 1992; Constantino, 1999; Scheffrahn, 2013). Fifteen workers from five samples were examined and measured with an ocular micrometer attached to an Olympus SZH stereomicroscope. Six morphometric characters defined by Roonwal (1970) and Fontes (1992) were considered: total body length (TBL), maximum head width (MHW), maximum pronotum width (MPW), hind tibia length (HTL), fore tibia length (FTL), fore tibia maximum width (FTMW). The fore tibia length/width ratio (CTF/WR) was calculated. The number of antennae articles was also recorded. The distribution of *C. vindai* is discussed according to the scheme of Terrestrial Ecoregions of the World (Olson *et al*., 2001).

## RESULTS AND DISCUSSION

The presence of *C. vindai* was detected in several subtropical woody and herbaceous plants communities, with diverse alteration degrees by human action in northeastern Argentina, from the surveys reported in this study and the samples deposited at the FACENAC termite collection (Tables 1 and 2). Thus, *C. vindai* was found in protected environments with little disturbance such as islets of native hygrophilous forests (T3) and savannas with *Butia yatay* (Mart.) Becc. palms in reserve areas (T4 and T5), but the species was also present in other deeply altered ecosystems like *Pinus elliotii* Engelm. plantations and *Axonopus compressus* (Sw.) P. Beauv. (T2) and *Andropogon lateralis* Nees grasslands (T1) submitted to high grazing intensity. These are also the first records of *C. vindai* from Argentina.

The number of *C. vindai* encounters and the positive sections by transect at the sampled areas are showed in Table 3. Considering the five transects 13.71% of the

TABLE 2

FACENAC collection data of *C. vindai* in the Corrientes province (Argentina). References: HC: Humid Chaco, SCMS (CM): Southern Cone Mesopotamian Savannas (Campos and Malezales), SCMS (I): Southern Cone Mesopotamian Savannas (Ibera).

Datos de *C. vindai* en la provincia de Corrientes (Argentina) provenientes de la colección FACENAC . Referencias: HC: Chaco Húmedo, SCMS (CM): Savanas Mesopotámicas del Cono Sur (Campos y Malezales), SCMS (I): Savanas Mesopotámicas del Cono Sur (Iberá).

| Collection number (date) | Locality (Department) | Georeferences | Ecoregion | Plant community | Microhabitat |
|---|---|---|---|---|---|
| 0043 (2-VI-81) | Santa Ana (San Cosme) | 27°27'16"S 58°39'12"W | HC | *Paspalum notatum* grassland | *C. fulviceps* nest |
| 0322 (18-V-90) | El Carmen (Concepción) | 28°08'02"S 57°55'53"W | SCMS (I) | *A. lateralis* savanna | *C. fulviceps* nest |
| 0656 (18-III-93) | Villa Olivari (Ituzaingo) | 27°35'56"S 53°52'25"W | SCMS (I) | *P. elliotii* plantation | Under fallen *P. elliotii* logs |
| 0774 (5-V-94) | Campo Nalda (Mburucuyá) | 28°08'25"S 58°25'53"W | HC | *A. lateralis* savanna | *C. cumulans* nest |
| 0805 (4-VII-94) | San Carlos (Ituzaingo) | 27°44'16"S 55°54'18"W | SCMS (CM) | *Elyonurus muticus* grasslands | *S. obtusus* nest |
| 0986 (15-V-97) | MNP (Mburucuyá) | 28°01'18"S 58°02'44"W | HC | *A. lateralis* savanna | Abandoned *C. cumulans* nest |
| 1128 (21-X-93) | Campo Nalda (Mburucuyá) | 28°08'25"S 58°25'53"W | HC | *A. lateralis* savanna | Under cow dung |
| 1136 (24-XI-93) | Campo Nalda (Mburucuyá) | 28°08'25"S 58°25'53"W | HC | *A. lateralis* savanna | Superficial soil |
| 1270 (7-IV-94) | Campo Nalda (Mburucuya) | 28°08'25"S 58°25'53"W | HC | *A. lateralis* savanna | *C. cumulans* nest |

termite encounters corresponded to *C. vindai*. The occurrence, dominance and abundance patterns of *C. vindai* at the surveyed sites were variable although, overall *C. vindai* abundance was intermediate. Two places (T1 and T3) showed an intermediate abundance of the species while it was categorized as rare in the remaining locations. The abundance patterns observed at the sampled spots seem to indicate that *C. vindai*, together with other species of the *Anoplotermes* group, are widely distributed members of the termite assemblages in the region. Those patterns did not show clear relationships with the habitat disturbance degree of the sites due to their land uses. Therefore, intermediate abundance patterns were recorded from two points with different characteristics (T1 and T3). One of them (Ita Paso savanna, T1) was subjected to a marked intensity of cattle grazing. At that site, the natural herbaceous vegetation was largely consumed and the soil suffered continuous trampling and dung deposition. These activities produce environmental changes in the quantity and quality of biomass, biodiversity, nutrient cycling and soil structure, which can affect termite assemblages (Kurtz *et al*., 2010; Vasconcellos *et al*., 2010). Intermediate abundance was also recorded from the hygrophilous forest located within a protected area with little human influence (T3). Moreover, *C. vindai* was categorized as rare at the second grazing pasture (Gobernador Virasoro, T2) with similar characteristics to Ita Paso and at the scarcely disturbed *B. yatay* palm savannas (T4 and T5). The observed abundance patterns of *C. vindai* did not showed a clear influence of land use intensification in the analyzed sites and might suggest that the species would not be significantly affected by such environmental changes at those sites. In this regard, several studies in subtropical, semi -arid or arid ecosystems suggest that subterranean soil-feeding termites might show less sensitivity to anthropogenic disturbances in these environments, than the observed in tropical forests for this functional group (Bandeira, 1989; De Souza & Brown, 1994; Eggleton *et al*., 1995, 1996, 1997; Bignell & Eggleton, 2000; Bandeira & Vasconcellos, 2002; Bandeira *et al*., 2003; Davies *et al*., 2003; Jones *et al*., 2003; Florencio & Diehl, 2006; Donovan *et al*., 2007; Carrijo *et al*., 2009; Vasconcellos *et al*., 2010; Cunha & Orlando, 2011). However, it is noteworthy that this paper analyzed the relative abundance of a single species and not of all those of each feeding group, as in the aforementioned studies.

*C. vindai* was detected at different microhabitats during the surveys. The most frequently occupied microhabitat was superficial soil between 0 and 10 cm depth, where

Fig. 1: Central core of *C. vindai* subterranean nest with workers, nymph and larvae inside the chambers.

Fig. 1: Núcleo central del nido subterráneo de *C. vindai* con obreras y larvas dentro de las cámaras.

Fig. 2: Cell of *C. vindai* nest partially coated by dark faecal material of workers.

Fig. 2: Celda del nido de *C. vindai*, parcialmente cubierta con material fecal de obreras.

individuals were located inside subterranean cells and chambers. In the grasslands, these galleries and subterranean cells were usually placed around the bases and roots of *A. lateralis* and *A. compressus* clumps. We also found *C. vindai* as inquiline inside *Cornitermes cumulans* (Kollar, 1832) epigeal nests (Table 2). The *C. vindai* colonies

TABLE 3

Total number of termite encounters during the surveys and encounters, positive sections and occurrence, dominance and abundance patterns of *C. vindai*.

Número total de encuentros de termitas durante los relevamientos y número de encuentros, secciones positivas y patrones de ocurrencia, dominancia y abundancia de *C. vindai*.

| Transects | Termite encounters | *C. vindai* encounters | *C. vindai* positive sections | Occurrence patterns | Dominance patterns | Abundance patterns |
|---|---|---|---|---|---|---|
| 1 | 54 | 11 | 11 | Common | Accesory | Intermediate |
| T2 | 26 | 2 | 2 | Rare | Rare | Rare |
| T3 | 26 | 8 | 8 | Sporadic | Accesory | Intermediate |
| T4 | 39 | 2 | 2 | Rare | Rare | Rare |
| T5 | 30 | 1 | 1 | Rare | Rare | Rare |
| TOTAL | 175 | 24 (13.71%) | 24 | Sporadic | Accesory | Intermediate |

were located in some sectors of the *C. cumulans* nests, frequently at hypogeal or lateral areas of the mounds. In some cases, these nests had been abandoned by the builders and were occupied by *C. vindai* alone or with other Termitidae species. In Paraguay, *C. vindai* was also detected inside *Cornitermes* spp. nests (Scheffrahn, 2013). *C. vindai* was also discovered inside *Syntermes obtusus* Holmgren, 1911 and *Cortaritermes fulviceps* (Silvestri, 1901) nests (Table 2). On the other hand, *C. vindai* was not found inside *Termes saltans* (Wasmann) nests, another mound-building Termitidae located at the surveyed sites. Occasionally, *C. vindai* specimens were collected under fallen and partially degraded logs and branches, as well as below cattle dung (Table 2).

Three *C. vindai* hypogeal nests were detected at hygrophilous forest (two nests) and *B. yatay* palm savannas (one nest) of the Mburucuyá National Park (Argentina). The subterranean nests were of the diffuse type and consisted of networks of galleries and chambers whose center was located below the soil surface, at depths from 5 to 20 cm. Its internal structure showed a core or central region where the soil particles of the walls were consolidated and constituted a distinct zone from the surrounding soil, but friable. Inside these nearly ellipsoidal or ovoid central cores, several chambers and galleries accommodated groups of the colony members (Fig. 1). The inner surface of the cells was partially coated with a thin dark colored layer of workers faecal material that cemented the soil particles and plastered the cell walls (Figure 2). This material is composed of humic substances, digestive secretions and a large population of bacteria and has a defensive value because gives greater hardness to the nest structures (Noirot & Darlington, 2000). Those characteristics were similar to previous general descriptions of other subterranean Apicotermitinae nests that constitute also a defense mechanism as these termites react escaping while being attacked (Mathews, 1977; Noirot & Darlington, 2000; Acioli, 2007). The central blocks volumes of the nests varied between 0.183 and 0.330 l, but they constituted only part of the nest structures, connected to other less resistant outer cells and galleries that extend in the surrounding soil. With respect to the volume of Neotropical Apicotermitinae nests, we only found data for *Anoplotermes banksi* Emerson which builds arboreal nests (Martius & Ribeiro, 1996; Apolinario, 2000; Soki & Josens, 2010; Bourguignon *et al*., 2011 a; Pequeno *et al*., 2013). The volumes of the central cores of *C. vindai* nesting structures were lower than the mean value registered for the new *A. banksi* nests found annually in French Guiana, but close to the median of those volumes (Bourguignon *et al*., 2011a). According to the volumes calculated for *A. banksi* by Pequeno *et al*. (2013), eleven of the fifteen nests considered by these authors were similar to the *C. vindai* nests recorded in this study, with values lower than 0.2 l. However, since the precise limits of the subterranean nests are generally difficult to determine, it seemed likely that these central structures represent only a fragment of each nest (Lepage & Darlington, 2000). Despite the small number of reported nests, we consider the provided data as valuable because correspond to the first description of the *Compositermes* nests and the firsts records of Apicotermitinae nests from Argentina.

With regard to *C. vindai* populations, the total number of individuals housed in the central blocks of the subterranean nests (colony size) varied between 275 and 407 individuals (workers, brachypterous nymphs and white immature larvae). The workers were the most abundant individuals of these colonies, composing on average 75.13% of the recorded population. The nymphs and larvae were found at much lower percentages, with mean values of 5.32% and 19.55%, respectively. The larvae were always placed in neighboring cells of the central sector of each nest (Fig. 2). No alates, primary or replacement reproductives were found inside the nests. The estimations of colony size for soil-feeding termites are scarce and the previously known data relate mainly to species that build nests on trees or mounds like *A. banksi* in South America or those of the *Cubitermes* group in Africa (Martius & Ribeiro, 1996; Soki *et al*., 1996; Brauman *et al*., 2000). Among the subterranean species of the *Anoplotermes* group, the colonies of *Ruptitermes* are very small and consist of only a few tens of individuals, located either in the soil or as inquilines of other termite mounds (Acioli, 2007). According to our findings, *C. vindai* colonies were smaller if compared with *A. banski* populations that exceed 2,500 individuals per nest (Martius & Ribeiro, 1996) and were more similar in size to *Ruptitermes* colonies. Among soil-feeding species, only a few form large colonies with tens or hundreds of thousands individuals (Eggleton *et al*., 1995, 1997). In addition, the mounds of some soil-feeding termites apparently housed only about 10% of the colony members so population estimates may have deviations due to individuals that left the nest at the time of sampling or escape during the process (Eggleton *et al*., 1996). As a result, there are discrepancies in the estimated values even for the best studied species (Lepage & Darlington, 2000). Although the registered samples correspond to seven months and three seasons of the year, no winged imagoes were found. In order to find the still unknown *C. vindai* alates it is necessary to intensify the search mainly during the spring months (September to December) which are the swarming season for several Termitidae at this region (Coronel *et al*., 2001; Torales & Coronel, 2004; Torales *et al*., 1999, 2006; Annoni *et al*., 2013).

*C. vindai* workers (Figs. 3 and 4) were identified according to several distinctive characters that allow to differenciate this monospecific genus from other Neotropical Apicotermitinae. The most remarkable traits were the mandibles (Fig. 3c), the gut coiling (Fig. 4a), the dilated enteric valve seating (Fig. 4b) and the sclerotized paddles located at the enteric valve seating- third proctodeal segment junction (Fig. 4c). The morphometric characters measured in *C. vindai* workers are showed in Table 4. The total body length (TBL) although indicative, showed a wide

TABLE 4

Measurements of *C. vindai* workers (in mm) from Corrientes province (Argentina). n = 15.

Medidas de obreras de *C. vindai* (en mm) de la provincia de Corrientes (Argentina). n = 15.

| | Mean | SD | Range | Samples |
|---|---|---|---|---|
| Total body length | 4.25 | 0.47 | 3.70-5.10 | 5 |
| Maximum head width | 0.89 | 0.07 | 0.83-1.02 | 5 |
| Maximum pronotum width | 0.62 | 0.05 | 0.54-0.71 | 5 |
| Hind tibia length | 0.73 | 0.09 | 0.66-0.95 | 5 |
| Fore tibia length | 0.61 | 0.04 | 0.57-0.71 | 5 |
| Fore tibia maximum width | 0.15 | 0.03 | 0.13-0.20 | 5 |
| Fore tibia length/width ratio | 4.19 | 0.46 | 3.17-4.86 | 5 |
| Antennae articles | 14 | - | - | 5 |

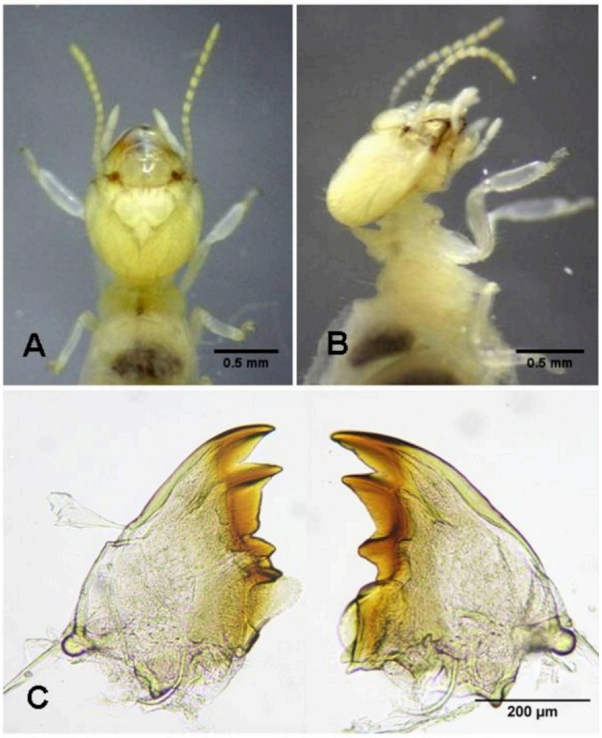


Fig. 3: *C. vindai* worker. (A) Dorsal view of head and pronotum. (B) Lateral view of head, pronotum and fore leg. (C) Mandibles.

Fig. 3: Obrera de *C. vindai*. (A) Vista dorsal de cabeza y pronoto. (B) Vista lateral de cabeza, pronoto y pata anterior. (C) Mandíbulas.

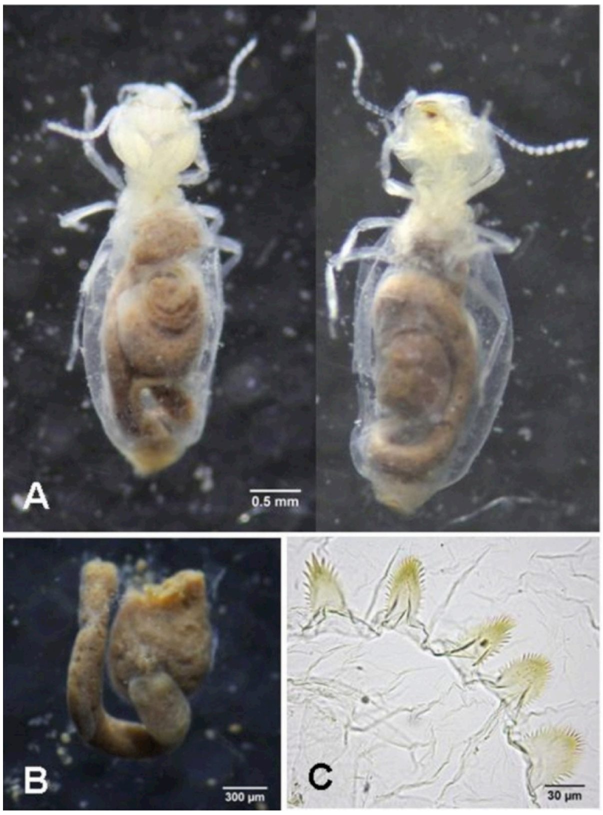


Fig. 4: *C. vindai* worker gut. (A) Gut coiling in dorsal (left) and ventral (right) views. (B) Enteric valve seating. (C) Ornamentation located at the enteric valve seating- third proctodeal segment junction.

Fig. 4: Tubo digestivo de obrera de *C. vindai*. (A) Configuración intestinal en vista dorsal (izquierda) y ventral (derecha). (B) Asentamiento de la válvula entérica. (C) Ornamentación localizada en la unión válvula entérica-tercer segmento proctodeal.

range of variation due to the contraction or expansion degree of the abdomen. The other five characters (MHW, MPW, HTL, FTL and FTMW) were similar to those previously determined for *C. vindai*, although the maximum values were higher. The fore tibia length/width ratio (FTL/WR) which indicates the dilatation degree of this segment also corresponded to the values recorded by Scheffrahn (2013).

With respect to the distribution of *C. vindai*, the previous records corresponded to two biomes of the Neotropical ecozone (Olson *et al*., 2001): Tropical and Subtropical Moist Broadleaf Forests (TSMF) and Tropical and Subtropical Grasslands, Savannas and Shrublands (TSGSS). In the TSMF biome, *C. vindai* was recorded in four ecoregions located in different countries: Parana - Paraiba inside forests (NT0150) in Paraguay, Guianian moist forests (NT0125) in French Guiana, Talamancan and Isthmian Pacific forests (NT0167) in Panama and Islands of Trinidad and Tobago in the Caribbean (NT0171). In the TSGSS biome, the earlier *C. vindai* reports were included in the Humid Chaco ecoregion (NT0708) in Paraguay (Bourguignon *et al*., 2013; Scheffrahn, 2013). The present study extends the distribution area of the species within this ecoregion, in northeastern Argentina. It is also reported for the first time, the presence of the species in the Flooded Grasslands and Savannas biome (FGS), particularly in the Southern Cone Mesopotamian Savannas ecoregion (NT0909). This ecoregion, also known as the Argentine Mesopotamian savannas or Mesopotamian grasslands (Daniele & Natenzon, 1994) is a flooded grassland ecoregion that comprises a mosaic of seasonally wet habitats, including grasslands, marshes, woodlands and gallery forests. It is located exclusively at the Corrientes, Misiones and Entre Rios provinces in northeastern Argentina. The region is considered as highly threatened due to destruction and degradation of natural habitats by cattle ranching and agriculture. Many specialist suggest the division of this ecoregion, due to environmental and vegetation differences in: Campos and Malezales region located at the northeast portion of Corrientes province and the Ibera (Ibera wetlands) at the central zone of the province, one of the most important South American wetlands (Burkart *et al*., 1999; Olson *et al*., 2001; Brown *et al*., 2006). *C. vindai* was found in both zones of this ecoregion.

The present records extends the distribution area of the species (Fig. 5) to higher S latitude than reported by Scheffrahn (2013) for the Eastern Paraguay and also confirm the ability of *C. vindai* to survive the lower winter temperatures of this region, at least for short time intervals. Although the Corrientes province climate is subtropical without dry season with an average temperature of 13-15 °C, sometimes during the winter (July) absolute minimum temperatures of -1 °C to -5.5 °C are registered, as well as infrequent frosts derived from incoming polar air masses (Carnevali, 1994). Though there has not been *C. vindai* registers from other argentine provinces so far, future surveys could allow new findings that would extend further the southern limits of its wide distribution.

In sum, the present results indicate that *C. vindai* is a widely distributed subterranean termite found in diverse subtropical ecosystems at two ecoregions of northeastern Argentina. The relative abundance of *C. vindai* was


Fig. 5: Distribution of *C. vindai* in Corrientes province (Argentina) including survey sites (*) and previous records from FACENAC collection (•). References: 1- Mburucuya National Park, 2- Ita Paso, 3- Gobernador Virasoro, 4- Santa Ana, 5- El Carmen, 6- Villa Olivari, 7- Campo Nalda, 8- San Carlos.

Fig. 5: Distribución de *C. vindai* en la provincia de Corrientes (Argentina) incluyendo los sitios relevados (*) y registros previos de la colección FACENAC (•). Referencias: 1- Parque Nacional Mburucuyá, 2- Itá Paso, 3- Gobernador Virasoro, 4- Santa Ana, 5- El Carmen, 6- Villa Olivari, 7- Campo Nalda, 8- San Carlos.

intermediate and it seemed not evidently affected by land use intensification at the sampled sites. The small colonies of this species were located mainly at superficial soil, inside other Termitidae mounds and at their own hypogeal nests.

**Acknowledgments**

To the staff of the Mburucuyá National Park for support during the study. To our colleagues of the Invertebrados Lab for help in field collections. To the Administracion de Parques Nacionales for allowing us to conduct the research at the Mburucuyá National Park. This research was funded by the Secretaría General de Ciencia y Técnica (Universidad Nacional del Nordeste, Corrientes, Argentina).

## REFERENCES

Acioli, A.N.S. (2007). Revisão taxonômica e relações filogenéticas do gênero Neotropical Ruptitermes Mathews, 1977 (Isoptera: Termitidae: Apicotermitinae). Doctoral Thesis, Universidade Federal do Amazonas, Brazil, 169 pp.

Annoni, G.M., Coronel, J.M., Laffont, E.R. (2013). Dinámica poblacional de Cortaritermes fulviceps (Silvestri, 1901) (Isoptera, Termitidae). Revista de Agricultura 88: 90-100.

Apolinário, F.B. (2000). Estudos ecológicos acerca de ninhos de térmitas (Insecta: Isoptera) em floresta de terra firme da Amazônia central, com ênfase em Anoplotermes banksi Emerson, 1925. Doctoral Thesis, Universidade Federal do Amazonas, Brazil, 202 pp.

Bandeira, A.G. (1989). Análise da termitofauna (Insecta: Isoptera) de uma floresta primaria e de uma pastagem na Amazonia Oriental, Brazil. Boletim do Museu Paraense Emílio Goeldi série Zoologia 5: 225-241.

Bandeira, A.G., Vasconcellos, A. (2002). A quantitative survey of termites in a gradient of disturbed highland forest in northeastern Brazil (Isoptera). Sociobiology 39: 429-439.

Bandeira, A.G., Vasconcellos, A., Silva, M.P., Constantino, R. (2003). Effects of habitat disturbance on the termite fauna in a highland humid forest in the Caatinga domain, Brazil. Sociobiology 42: 117-127.

Bignell, D.E., Eggleton, P. (2000). Termites in ecosystems. In: Abe, T., Bignell, D.E., Higashi, M. (Eds.). Termites: evolution, sociality, symbioses, ecology. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 363-387.

Bourguignon, T., Šobotník, J., Lepoint, G., Martin, J.M., Roisin, Y. (2009). Niche differentiation among Neotropical soldierless soil-feeding termites revealed by stable isotope ratios. Soil Biology and Biochemistry 41: 2038-2043.

Bourguignon, T., Scheffrahn, R.H., Křeček, J., Nagy, Z.T., Sonet, G., Roisin, Y. (2010). Towards a revision of the Neotropical soldierless termites (Isoptera: Termitidae): redescription of the genus *Anoplotermes* and description of *Longustitermes*, gen. nov. Invertebrate Systematics 24: 357-370.

Bourguignon, T., Leponce, M., Roisin, Y. (2011a). Are the spatio-temporal dynamics of soil-feeding termite colonies shaped by intra-specific competition? Ecological Entomology 36: 776-785.

Bourguignon, T., Šobotník, J., Lepoint, G., Martin, J.M., Hardy, O.J., Dejean, A., Roisin, Y. (2011b). Feeding ecology and phylogenetic structure of a complex neotropical termite assemblage, revealed by nitrogen stable isotope ratios. Ecological Entomology 36: 261-269.

Bourguignon, T., Šobotník, J., Hanus, R., Krasulová, J., Vrkoslav, V., Cvačka, J., Roisin, Y. (2013). Delineating species boundaries using an iterative taxonomic approach: The case of soldierless termites (Isoptera, Termitidae, Apicotermitinae). Molecular Phylogenetics and Evolution 69: 694-703.

Brauman, A., Bignell, D.E., Tayasu, I. (2000). Soil-feeding termites: biology, microbial associations and digestive mechanisms. In: Abe, T., Bignell, D.E., Higashi, M. (Eds.). Termites: evolution, sociality, symbioses, ecology. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 333-359.

Brown, A., Martínez, U., Acerbi, M., Corcuera, J. (2006). La Situación Ambiental Argentina 2005. Fundación Vida Silvestre Argentina, Buenos Aires, Argentina.

Burkart, R., Bárbaro, N., Sánchez, R.O., Gómez, D.A. (1999). Ecoregiones de la Argentina. Administración de Parques Nacionales, Buenos Aires, Argentina.

Carnevali, R. (1994). Fitogeografía de la provincia de Corrientes. INTA- Gobierno de la Provincia de Corrientes, Corrientes, Argentina.

Carrijo, T.F., Brandao, D., de Oliveira, D., Costa, D.A., Santos, T. (2009). Effects of pasture implantation on the termite (Isoptera) fauna in the Central Brazilian Savanna (Cerrado). Journal of Insect Conservation 13: 575-581.

Constantino, R. (1998). Catalog of the living termites of the New World (Insecta: Isoptera). Arquivos de Zoologia 35: 135-231.

Constantino, R. (1999). Chave ilustrada para a identificação dos géneros de cupins (Insecta: Isoptera) que ocorrem no Brasil. Papéis Avulsos de Zoologia 40: 387-448.
Coronel, J.M., Laffont, E.R., Torales, G.J., Porcel, E. (2001). Variación estacional en la composición de colonias de Termes saltans (Isoptera, Termitidae, Termitinae) en un sitio puntual de muestreo. FACENA 17: 3-13.
Costa, D.A., Assis de Carvalho, R., Ferreira de Lima Filho, G., Brandão, D. (2009). Inquilines and invertebrate fauna associated with termite nests of *Cornitermes cumulans* (Isoptera, Termitidae) in the Emas National Park, Mineiros, Goiás, Brazil. Sociobiology 53: 443-453.
Cunha, H.F., Orlando, T.Y. (2011). Functional composition of termite species in areas of abandoned pasture and in secondary succession of the Parque Estadual Altamiro de Moura Pacheco, Goiás, Brazil. Bioscience Journal 27: 986-992.
Daniele, C., Natenzon, C. (1994). Las regiones naturales de la Argentina: caracterización y diagnóstico. In: Daniele, C., Bukart, R., Del Valle Ruiz, L., Natenzon, C., Ardura, F. (Eds.). El sistema nacional de áreas naturales protegidas de la Argentina. Diagnóstico de su patrimonio y su desarrollo institucional. Administración de Parques Nacionales, Buenos Aires. pp. 1-34.
Davies, R.G. (2002). Feeding group responses of a Neotropical termite assemblage to rain forest fragmentation. Oecologia 133: 233-242.
Davies, R.G., Hernández, L.M., Eggleton, P., Didham, R.K., Fagan, L.L., Winchester, N.N. (2003). Environmental and spatial influences upon species composition of a termite assemblage across Neotropical forest islands. Journal of Tropical Ecology 19: 509-524.
DeSouza, O.F., Brown, V.K. (1994). Effects of habitat fragmentation on Amazonian termite communities. Journal of Tropical Ecology 10: 197-206.
Domingos, D.J., Gontijo, T.A. (1996). Multioccupation of termites mounds in Cerrado vegetation in South-Eastern Brazil. Revista Brasileira de Biologia 56: 717-723.
Donovan, S. (2002). A morphological study of the enteric valves of the Afrotropical Apicotermitinae (Isoptera: Termitidae). Journal of Natural History 36: 1823-1840.
Donovan, S.E., Griffiths, G.J.K., Homathevi, R., Winder, L. (2007). The spatial pattern of soil-dwelling termites in primary and logged forest in Sabah, Malaysia. Ecological Entomology 32: 1-10.
Eggleton, P., Bignell, D.E., Sands, W.A., Waite, B., Wood, T.G., Lawton, J. (1995). The species richness of termites (Isoptera) under differing levels of forest disturbance in the Mbalmayo Forest Reserve, southern Cameroon. Journal of Tropical Ecology 11: 85-98.
Eggleton, P., Bignell, D.E., Sands, W.A., Mawdsley, N.A., Lawton, J., Wood, T.G., Bignell, N.C. (1996). The diversity, abundance and biomass of termites under differing levels of disturbance in the Mbalmayo Forest Reserve, southern Cameroon. Philosophical Transactions of the Royal Society of London Series B-Biological Sciences 351: 51-68.
Eggleton, P., Homathevi, R., Jeeva, D., Jones, D., Davies, R., Maryati, D. (1997). The species richness and composition of termites (Isoptera) in primary and regenerating lowland dipterocarp forest in Sabah, east Malaysia. Ecotropica 3: 119-128.
Florencio, D.F., Diehl, E. (2006). Termitofauna (Insecta: Isoptera) em remanescentes de floresta estacional semidecidual em Sao Leopoldo, Rio Grande do Sul, Brasil. Revista Brasileira de Entomologia 50: 505-511.
Florencio, D.F., Marins, A., Rosa, C.S., Cristaldo, P.F., Araujo, A.P., Silva, I.R., De Souza, O. (2013). Diet segregation between cohabiting builder and inquiline termite species. PloS One 8: e66535. doi:10.1371/journal.pone.0066535
Fontes, L.R. (1985). Potentialities of the appearance of the worker gut in situ for the identification of Neotropical genera of Apicotermitinae (Isoptera, Termitidae). Annals of Entomology 3: 1-6.
Fontes, L.R. (1986). Two new genera of soldierless Apicotermitinae from the Neotropical region (Isoptera, Termitidae). Sociobiology 12: 285-297.
Fontes, L.R. (1992). Key to the genera of New World Apicotermitinae (Isoptera: Termitidae). In: Quintero, D., Aiello, A. (Eds.). Insects of Panama and Mesoamerica. Oxford University Press, New York, USA. pp. 242-248.
Godoy, M.C., Torales, G.J. (1999). Importancia taxonómica de la válvula entérica en el género Grigiotermes Mathews (Isoptera: Termitidae, Apicotermitinae). FACENA 15: 19-23.
Grassé, P., Noirot, C. (1954). Apicotermes arquieri: ses constructions, sa biologie. Considerations generales sur la sous famille des Apicotermitinae nov. Annales Des Sciences Naturelles Zoologie 16: 345-388.
Jones, D.T., Eggleton, P. (2000). Sampling termite assemblages in tropical forests: testing a rapid biodiversity assessment protocol. Journal of Applied Ecology 37: 191-203.
Jones, D.T., Susilo, F.X., Bignell, D.E., Hardiwinoto, S., Gillison, A.N., Eggleton, P. (2003). Termite assemblage collapse along a land-use intensification gradient in lowland central Sumatra, Indonesia. Journal of Applied Ecology 40: 380-391.
Kambhampati, S., Eggleton, P. (2000). Taxonomy and phylogeny of termites. In: Abe, T., Bignell, D.E., Higashi, M. (Eds.). Termites: evolution, sociality, symbioses, ecology. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 1-24.
Kurtz, D.B., J. Schellberg & M. Braun. (2010). Ground and satellite based assessment of rangeland management in sub-tropical Argentina. Applied Geography 30: 210-220.
Lepage, M., Darlington, J.PC. (2000). Population dynamics of termites. In: Abe, T., Bignell, D.E., Higashi, M. (Eds.). Termites: evolution, sociality, symbioses, ecology. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 333-362.
Pequeno, P.A.C.L., Franklin, E., Venticinque, E.M., Serrão Acioli, A.N. (2013). The scaling of colony size with nest volume in termites: a role in population dynamics? Ecological Entomology 38: 515-521.
Lopes, D., Ruvolo-Takasusuki, C. (2010). Differentiation of Apicotermitinae (Isoptera: Termitidae) termite species through esterases. Sociobiology 55: 805-814.
Mathews, A.G. (1977). Studies on termites from the Mato Grosso State, Brazil. Academia Brasileira de Ciencias, Rio de Janeiro, Brazil.
Martius, C., d'Arc Ribeiro, J. (1996). Colony populations and biomass in nests of the Amazonian forest termite *Anoplotermes banksi* Emerson (Isoptera: Termitidae). Studies on Neotropical Fauna and Environment 31: 82-86.
Noirot, C., Darlington, J.P. (2000). Termites nests: Architecture, regulation and defence. In: Abe, T., Bignell, D.E., Higashi, M. (Eds.). Termites: evolution, sociality, symbioses, ecology. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 121-139.
Oliveira, D.E., Carrijo, T.F., Brandao, D. (2013). Species

Composition of Termites (Isoptera) in different cerrado vegetation Physiognomies. Sociobiology 60: 190-197.

Olson, D., Dinerstein, E., Wikramanayake, E., Burgess, N., Powell, G., Underwood, E., D'Amico, J., Itoua, I., Strand, H., Morrison, J., Loucks, C., Allnutt, T., Ricketts, T., Kura, Y., Lamoreux, J., Wettengel, W., Hedao, P., Kassem, K. (2001). Terrestrial ecoregions of the world: a new map of life on Earth. BioScience 51: 933-938.

Redford, K.H. (1984). The termitaria of Cornitermes cumulans (Isoptera, Termitidae) and their role in determining a potential keystone species. Biotropica 16: 112-119.

Roisin, Y., Leponce, M. (2004). Characterizing termite assemblages in fragmented forests: A test case in the Argentinian Chaco. Austral Ecology 29: 637-646.

Roisin, Y., Dejean, A., Corbara, B., Orivel, J., Samaniego, M., Leponce, M. (2006). Vertical stratification of the termite assemblage in a Neotropical rainforest. Oecologia 149: 301–311.

Roonwal, M.L. (1970). Measurements of termites (Isoptera) for taxonomic purposes. Journal of the Zoological Society of India 21: 9-66.

Sands, W.A. (1972). The soldierless termites of Africa (Isoptera, Termitidae). Bulletin of the British Museum (Natural History) Entomology 18: 1-244.

Sands, W.A. (1998). The identification of worker castes of termite genera from soils of Africa and the Middle East. CAB International, Oxford, UK.

Scheffrahn, R.H. (2013). Compositermes vindai (Isoptera: Termitidae: Apicotermitinae), a new genus and species of soldierless termite from the Neotropics. Zootaxa 3652: 381-391.

Scheffrahn, R.H., Křeček, J., Chase, J.A., Maharajh, B., Mangold, J. (2006). Taxonomy, biogeography, and notes on termites (Isoptera: Kalotermitidae, Rhinotermitidae, Termitidae) of the Bahamas and Turks and Caicos Islands. Annals of the Entomological Society of America 99: 463-486.

Šobotník, J., Sillam-Dussès, D., Weyda, F., Dejean, A., Roisin, Y., Hanus, R., Bourguignon, T. (2010). The frontal gland in workers of Neotropical soldierless termites. Naturwissenschaften 97: 495-503.

Soki, K., Josens, G. (2010). Relation between termite numbers and the size of their mounds. Insectes Sociaux 57: 303-316.

Soki, K., Josens, G., Loreau, M. (1996). Growth and demography of *Cubitermes speciosus* mounds (Isoptera: Termitidae). Insectes Sociaux 43: 189-200.

Torales, G.J., Coronel, J.M. (2004). Qualitative and quantitative composition of colonies of *Microcerotermes strunckii* Sörensen (Isoptera, Termitidae). Sociobiology 43: 523-534.

Torales, G.J., Laffont, E.R., Arbino, M.O., Godoy, M.C. (1997). Primera lista faunística de los isópteros de la Argentina. Revista de la Sociedad Entomológica Argentina 56: 43-51.

Torales, G.J., Laffont, E.R., Arbino, M., Coronel, J.M. (1999). Composición de colonias de *Cornitermes cumulans* (Kollar) (Isoptera: Termitidae, Nasutitermitinae) en diferentes épocas del año. Revista de la Sociedad Entomológica Argentina 58: 189-196.

Torales, G.J., Laffont, E.R., Godoy, M.C., Coronel, J.M., Arbino, M.O. (2005). Update on taxonomy and distribution of Isoptera from Argentina. Sociobiology 45: 853-886.

Torales, G.J., Coronel, J.M., Laffont, E.R., Godoy, M.C., Arbino, M., Porcel, E. (2006). Analysis of the population from *Nasutitermes coxipoensis* nests (Isoptera: Termitidae, Nasutitermitinae), from a locality of the province of Corrientes (Argentina). Sociobiology 48: 223-236.

Torales, G.J., Coronel, J.M., Godoy, M.C., Laffont, E.R., Romero, V. (2008). Additions to the taxonomy and distribution of Isoptera from Argentina. Sociobiology 51: 31-47.

Vasconcellos, A., Bandeira, A.G., Moura, F.M., Araujo, V.F., Gusmaõ, M.A., Constantino, R. (2010). Termite assemblages in three habitats under different disturbance regimes in the semi-arid Caatinga of NE Brazil. Journal of Arid Environments 74: 298-302.