

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 Termite Neotropical sin soldados *Compositermes vindai* Scheffrahn, 2013 (Isoptera, Termitidae, Apicotermitinae)

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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 descrita *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 húmívoras.

INTRODUCTION

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

Apicotermatinae. 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 & Ruvalo-Takasusuki, 2010; Šobotnik *et al.*, 2010; Oliveira *et al.*, 2013; Scheffrahn, 2013).

One of the main aspects that helped to elucidate the diversity of soldierless Apicotermatinae 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 Apicotermatinae. 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 Apicotermatinae 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:

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

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	<i>A. lateralis</i> savanna (grazed)	T1	June 2005
Gobernador Virasoro (Santo Tomé)	28°04'01" S 56°03'26" W	SCMS (CM)	<i>A. compressus</i> and <i>Paspalum</i> sp. savanna (grazed)	T2	May 2013
MNP (Mburucuyá)	28°00'22" S 58°02'31" W	HC	<i>Ocotea acutifolia</i> hygrophilous forest islet	T3	July 2010
MNP (Mburucuyá)	28°01'24" S 58°03'07" W	HC	Savanna with <i>B. yatay</i> 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	<i>Paspalum notatum</i> grassland	<i>C. fulviceps</i> nest
0322 (18-V-90)	El Carmen (Concepción)	28°08'02"S 57°55'53"W	SCMS (I)	<i>A. lateralis</i> savanna	<i>C. fulviceps</i> nest
0656 (18-III-93)	Villa Olivari (Ituzaingo)	27°35'56"S 53°52'25"W	SCMS (I)	<i>P. elliotii</i> plantation	Under fallen <i>P. elliotii</i> logs
0774 (5-V-94)	Campo Nalda (Mburucuyá)	28°08'25"S 58°25'53"W	HC	<i>A. lateralis</i> savanna	<i>C. cumulans</i> nest
0805 (4-VII-94)	San Carlos (Ituzaingo)	27°44'16"S 55°54'18"W	SCMS (CM)	<i>Elyonurus muticus</i> grasslands	<i>S. obtusus</i> nest
0986 (15-V-97)	MNP (Mburucuyá)	28°01'18"S 58°02'44"W	HC	<i>A. lateralis</i> savanna	Abandoned <i>C. cumulans</i> nest
1128 (21-X-93)	Campo Nalda (Mburucuyá)	28°08'25"S 58°25'53"W	HC	<i>A. lateralis</i> savanna	Under cow dung
1136 (24-XI-93)	Campo Nalda (Mburucuyá)	28°08'25"S 58°25'53"W	HC	<i>A. lateralis</i> savanna	Superficial soil
1270 (7-IV-94)	Campo Nalda (Mburucuyá)	28°08'25"S 58°25'53"W	HC	<i>A. lateralis</i> savanna	<i>C. cumulans</i> 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 (Governador 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	<i>C. vindai</i> encounters	<i>C. vindai</i> 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 Apicotermittinae 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 Apicotermittinae 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 Apicotermittinae 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. banksi* 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 differentiate this monospecific genus from other Neotropical Apicotermittinae. 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

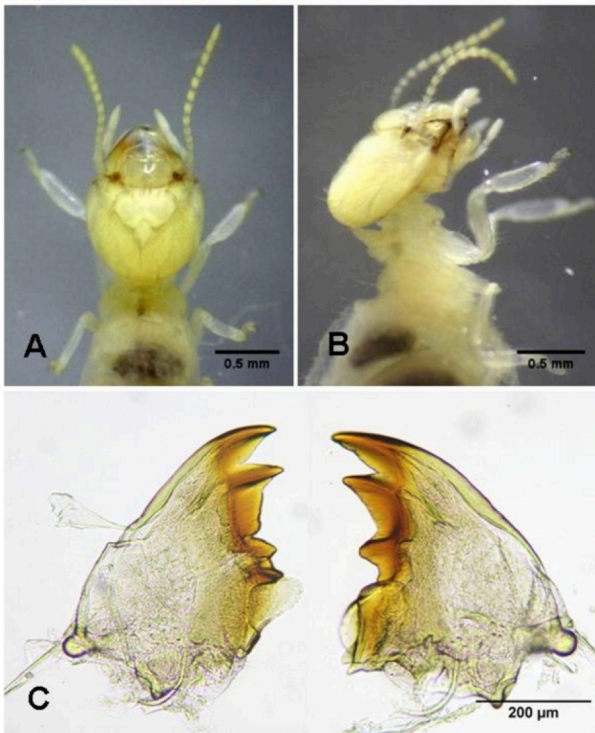


Fig. 3: *C. vindai* worker. (A) Dorsal view of head and pronotum. (B) Lateral view of head, pronotum and fore leg. (C) Mandibles.

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

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

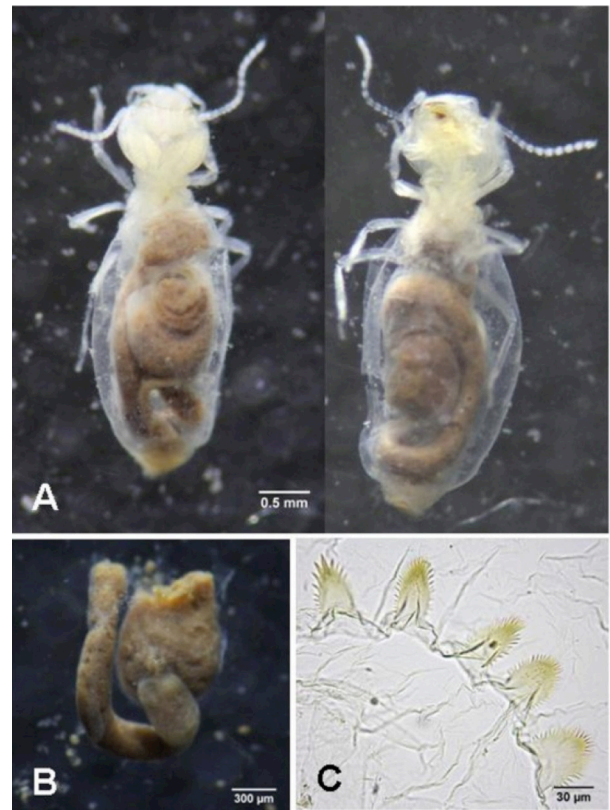


Fig. 4: *C. vindai* worker gut. (A) Gut coiling in dorsal (left) and ventral (right) views. (B) Enteric valve seating. (C) Ornamentation located at the enteric valve seating- third proctodeal segment junction.

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.

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 Ita Paso, 2- Gobernador Virasoro, 3 Mburucuyá National Park, 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- Ita Paso, 2- Gobernador Virasoro, 3- Parque Nacional Mburucuyá, 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 hypogean nests.

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