ISSN: 2177-8760
REVISTA DE CIÊNCIAS AGRÁRIAS
Amazonian Journal
of Agricultural and Environmental Sciences
www.ajaes.ufra.edu.br

DOI: https://doi.org/10.5281/zenodo.14206333

Physicochemical parameters of arboreal nests of *Constrictotermes cavifrons* (Holmgren, 1910) (Blattaria: Isoptera) in the Western Amazon

Parâmetros físico-químicos de ninhos arborícolas de *Constrictotermes cavifrons* (Holmgren, 1910) (Blattaria: Isoptera) na Amazônia Ocidental

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Recebido 25/03/2024 Aceito 05/11/2024 Publicado: 22/11/2024

Abstract:

Termites are a diverse and abundant group of insects that play a crucial role in maintaining the ecological balance of various Amazonian systems. Despite their importance, there is limited information regarding the ecology, biology, and physicochemical properties of nest materials for species such as *Constrictotermes cavifrons*. This study was conducted in a 1-ha area of primary *terra firme* forest at the Experimental Farm of the Federal University of Amazonas (FAEXP-UFAM) in Manaus, Amazonas state, Brazil. Field observations of termite activities, morphological data were collected, and samples from nests and adjacent soils were analyzed for physicochemical parameters. We identified an average of four nests/ha, located on tree trunks at an average height of 3.55 m above the ground and with an average volume of 0.026 m^3. Regarding physical parameters, the organic matter (OM) content in nests was significantly higher than that of the adjacent soil. The long, narrow arboreal nests, combined with their unique physicochemical composition and high OM content resulting from biogenic activity by termites, alter the physicochemical properties of the nests compared to the adjacent soil. This enhances the nest's quality from the perspective of agricultural fertility.

Keywords: conservation, minerals, oxisols, forests

Resumo:
Os cupins são um grupo de insetos diversificado e abundante que desempenham papel importante nos serviços ambientais em diferentes sistemas amazônicos. Porém, são escassas as informações sobre ecologia, biologia e a composição física e química de teores dos elementos que compõem os ninhos de muitas espécies, como *Constrictotermes caviforns*. Assim, este trabalho tem como objetivo ampliar o conhecimento sobre aspectos ecológicos e analisar as diferenças dos parâmetros físicos-químicos dos ninhos quando comparado com o solo adjacente. O estudo foi realizado em 1,0 ha de floresta primária de terra-firme, pertencente a Fazenda Experimental da Universidade Federal do Amazonas (FAEXP-UFAM), localizado na região de Manaus-AM. Observações de campo das atividades dos cupins, aspectos morfológicos e amostras dos ninhos e dos solos adjacentes foram

coletadas para análise dos parâmetros fisico-químicos. Foram encontrados 4 ninhos/ha, presos nos troncos das árvores em média 3,55 m em relação ao solo e com volume médio de 0,026 m^3. Dentre os parâmetros físicos, a concentração de MO presente nos ninhos foi muito superior a encontrada nos solos adjacentes. Os ninhos arborícolas são de formato longo e estreito, a composição físico-química e a elevada proporção de MO decorrente de estruturas biogênicas realizadas pelos cupins modifica os parâmetros físicos e químicos dos ninhos em relação ao solo adjacente, proporcionando excelente qualidade do ponto de vista da fertilidade agrícola.

Palavras-chave: conservação, minerais, latossolos, florestas

1. Introduction

The Amazon comprises various ecosystems, each characterized by unique abiotic factors that provide ecological support for specific plant and animal communities within particular regions. In this heterogeneous Amazonian landscape, termites stand out due to their high population density and species diversity (Demetrio *et al*., 2021; Ferreira *et al*., 2023). The insects are recognized for their ability to feed on cellulose at different stages of decomposition and for constructing nests on different substrates, which display a wide range of architectural forms and physicochemical properties (Bandeira, 1985; Pequeno *et al*., 2015; Alves-Oliveira *et al*., 2022).

Termite colonies can construct a variety of nests, including epigeal, underground, arboreal, and even nests within a single piece of wood. Epigeal and arboreal nests are particularly conspicuous and easily observed in both natural and anthropogenic environments. For these two classes of nests, it is estimated that there are between 26–100 nests/ha in the Amazon's primary *terra firme* forests, with a predominance of arboreal nests, accounting for 36–77% of the total (Bandeira, 1979; Constantino, 1992).

The genus *Constrictotermes* Holmgren, 1910 (Termitidae: Nasutitermitinae) comprises six species, all of which are restricted to South and Central America (Constantino, 2023). Three species are recorded in Brazil: (1) *Constrictotermes cyphergaster* (Silvestri, 1901), which constructs arboreal nests; (2) *Constrictotermes rupestris* (Constantino, 1997), which constructs nests on rocks at the soil surface—both species are found in open vegetation typical of the Cerrado and Caatinga biomes (Constantino & Costa-Leonardo, 1997; Bezerra-Gusmão *et al*., 2013); and (3) *Constrictotermes cavifrons* (Holmgren, 1910), widely distributed in the Amazon forest, which constructs arboreal nests attached to tree trunks and feed on microepiphytes growing on these trunks (Martius *et al*., 2000).

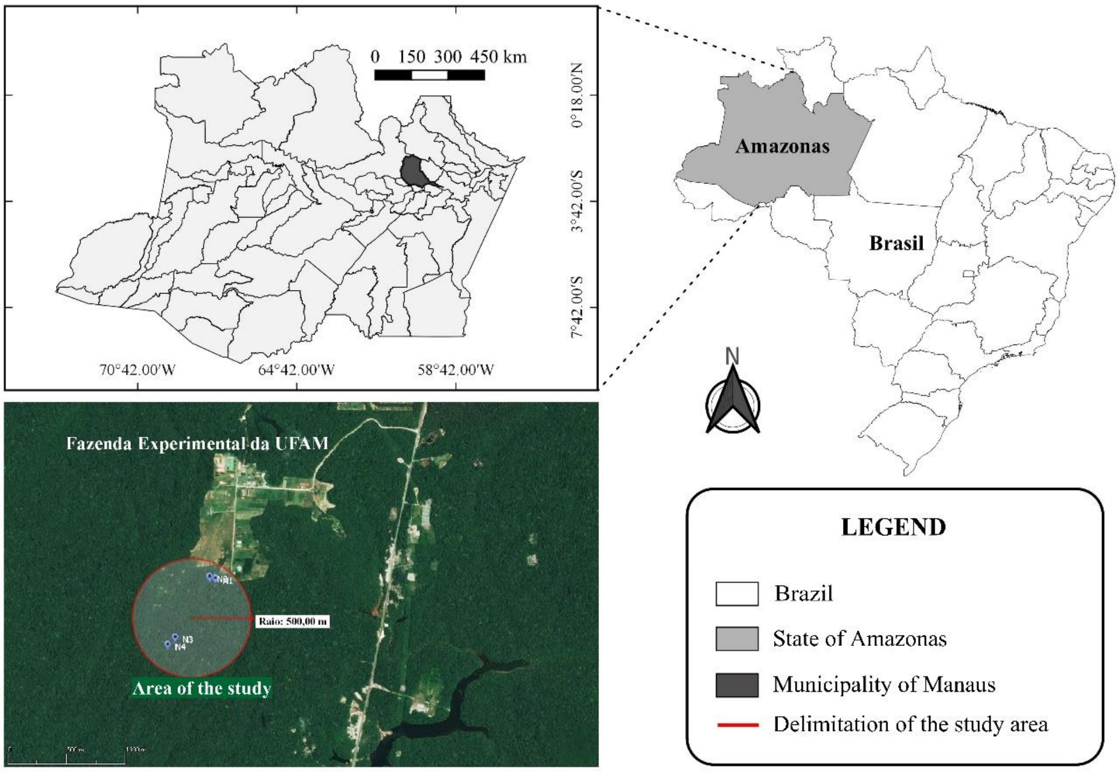
Information about *C. cavifrons* is scarce, with some knowledge derived from ecological surveys and biological notes (Constantino, 1991; 1992; Martius *et al*., 2000; Castro *et al*., 2021). Given the ecological importance of this species in *terra firme* forests, this study aims to enhance our understanding of its ecological aspects and to analyze the physicochemical differences between arboreal nests and the adjacent soil.

2. Material and Methods

Study area

This study was conducted at the Experimental Farm of the Federal University of Amazonas (FAEXP-UFAM), located in the municipality of Manaus, Amazonas, Brazil, at coordinates 02°37'17.1"S and 60°03'29.1"W (Figure 1). The area is characterized by slightly hilly relief. The predominant soil types are deep or very deep Oxisols, which may be clayey or very clayey, exhibiting either dystrophic or alic properties. These soils are characterized primarily by 1:1 type clay, kaolinite, and iron oxides (Teixeira *et al*., 2010).

Figure 1. Location map and aerial view of the sampling area.
Figura 1. Mapa de localização e vista aérea sobre área de amostragem.



FAEXP covers an area of 3,000 hectares. Its southern boundary adjoins lands owned by the Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis (Brazilian Institute of Environment and Renewable Natural Resources – IBAMA). To the north of FAEXP are the Estação Experimental de Fruticultura Tropical (Tropical Fruit Experimental Station – EEFT) and the Estação Experimental de Silvicultura Tropical (Tropical Silviculture Experimental Station – EEST), both managed by the Instituto Nacional de Pesquisas da Amazônia (National Institute for Amazon Research – INPA). The local vegetation is classified as *terra firme* tropical rainforest, characterized by a very dense canopy and a low-light understory, which features an abundance of palm trees (Rojas-Ahumada & Menin, 2010).

According to the Köppen classification, the region's characteristic climate is tropical without a dry season (Af). The average annual temperature is 26.7 ºC with minimal seasonal variation (25.9–27.7 ºC). Annual precipitation averages 2,420 mm, with August as the driest month, during which monthly precipitation is approximately 80 mm (Alvares *et al*., 2013).

Sampling of arboreal nests and adjacent soil

A 1-ha area of primary forest was demarcated, as illustrated in Figure 1, and subdivided into 16 plots of 625m² to facilitate the search for termite mounds of *C. cavifrons*. Each nest discovered was georeferenced, and the following variables were measured: (1) height above ground, (2) length, (3) semi-circumference, and (4) volume (m³) of the nest. Observations in the field, based on active termites, made it possible to detect the place of origin of the material used to build the nests, the trails and their eating habits. Samples of termite mounds and adjacent soil were collected in December/2019, July/2020, and September/2020. The termite specimens used in this study are preserved in 70% alcohol and were identified by comparison and incorporated into the Entomology and Acarology Laboratory's (LEA) collection at the Federal University of Amazonas.

An iron probe was used to extract subsamples from the top, middle, and base of each nest. Soil was collected at three equidistant points around the tree trunk containing the nest at a distance of

1.50 m and a depth of 0.20 m. Samples from both nests and soil were placed into labeled plastic bags, transported to the laboratory, and analyzed for their physical, chemical, and physicochemical properties.

Laboratorial analysis

In the laboratory, analyses were conducted on soil texture, soil density (Sd), organic matter (OM), active, exchangeable, and potential acidity, as well as fertility (macronutrients), following the methodology proposed by Embrapa (2011). Granulometric analysis was performed using the pipette method to separate the clay, sift for sand, and calculate the difference to obtain silt. Sd was determined utilizing the tension table method with volumetric rings. OM was assessed using the wet method in an acidic medium. Active acidity (pH) was measured in a $CaCl_2$ solution and by the SMP method (buffer), using a soil-to-solution ratio of 1:2.5. Potential acidity (H+Al) was extracted with a buffered $C_4H_6CaO_4$ solution at pH 7.0 and determined by titration. Exchangeable acidity was determined by titration, using 1 mol L^{-1} KCl as the extracting solution and 0.025 mol L^{-1} NaOH as the titrant.

Available P and K^+ were determined using UV-visible spectrophotometry. The exchangeable levels of Ca^{2+} and Mg^{2+} were analyzed through complexiometry, while Na^+ was extracted with a diluted HCl solution. After determining the exchangeable bases and potential acidity, the following values were calculated: sum of bases (SB), potential and effective cation exchange capacity (“T” at pH 7.0 and “t”), base saturation (V%), and Al^{3+} saturation (m%), following the method outlined by Camargo *et al*. (2009).

Statistical analyses

The investigated attributes of nests and soils were analyzed using descriptive statistics, estimating the mean, range, coefficient of variation (CV%), standard error, and standard deviation. Furthermore, Pearson's linear correlation test was conducted to establish the degree of association between the physicochemical attributes. All statistical analyses were performed using the BioEstat 5.3 program (Ayres *et al*., 2007).

3. Results and Discussion

Ecological aspects

The results indicate that the density of nests ranged from 1.0 to 11.0 nests/ha, aligning with predictions by Martius *et al*. (2000), who recorded 4.0 nests/ha for *C. cavifrons* (Holmgren, 1910). However, this density was considerably lower than that of the cogeneric *C. cyphergaster*, which has an estimated density of 59.0 ± 22.5 active nests/ha in the Caatinga region of Northeast Brazil (Vasconcellos *et al*., 2007).

The nests were constructed on straight trunks of trees belonging to three families: Icacinaceae (nest A), Nyctaginaceae (nest B), and Burseraceae (nests C and D). The species identified for the latter family include *Protium heptaphyllum* (Aubl.) Marchand, commonly known as white breu, and *Protium puncticulatum* J.F. Macbr., known as red breu, respectively. The average height of the nests in trees above the ground was 3.55 m, with a range from 1.70 to 4.89 m (Table 1). Notably, nests were also observed at heights up to 10 m above the ground in the same forest but outside the collection area. The height of the nests on tree trunks was likely influenced by factors such as their volume, population size, and age of the colony.

Regarding shape (Figure 2A), the nests were elongated and attached longitudinally to the tree trunk rather than surrounding it, with both upper and lower ends narrower than the central region. The average measurements for each nest were as follows: length, 1.13 m (0.80 m–1.36 m); semi-circumference, 0.49 m (0.40 m–0.58 m); volume, 0.026 m^3 (0.017 m^3–0.032 m^3). The exterior of the nests was characterized by diagonal grooves that seamlessly blended with the tree trunk, resembling its bark, which could easily lead to confusion with the trunk itself. Each nest features a single central trail connecting it to the ground. This trail, typically 3–5 cm wide, had striations similar in architecture to those of the nests (Figure 2B, C). The shape of the nest and the surface containing grooves suggest adaptations for effective rainwater drainage (Constantino, 1991; Martius *et al*., 2000). Termites use soil from around the trunk and roots of the host tree to build the nest and trail, as shown in Figure 2C.

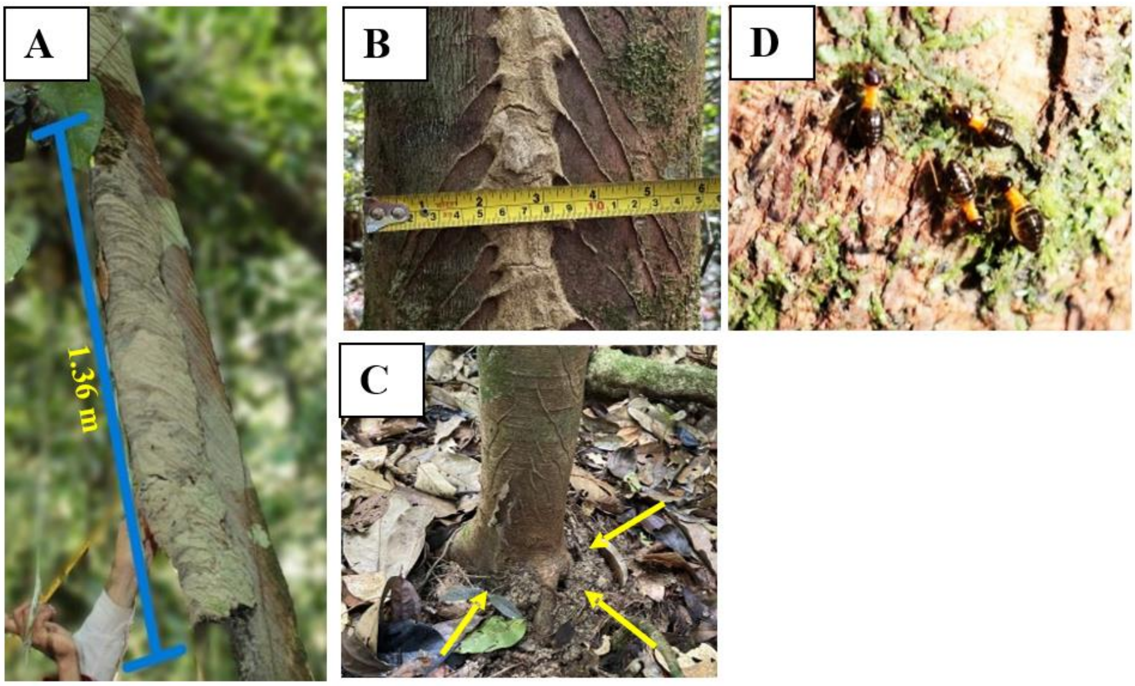
In the field, we observed that workers of *C. cavifrons* freely feed on lichens growing on tree trunks (Figure 2D). This foraging behavior aligns with observations by Martius *et al*. (2000), suggesting that this species feeds on lichens.

Table 1. Ecological and morphometric aspects of *C. cavifrons* nests in a primary forest, Manaus, Amazonas, Brazil.
Tabela 1. Aspectos ecológicos e morfométricos dos ninhos de *C. cavifrons* em floresta primária no município de Manaus, Amazonas, Brasil.

Nests	Height above the soil (m)	Length (m)	Semi-circumference (m)	Volume (m³)
A	4.89	1.20	0.58	0.032
B	3.11	1.15	0.56	0.029
C	4.51	0.80	0.40	0.010
D	1.70	1.36	0.40	0.017
Range	1.70–4.89	0.80–1.36	0.40–0.58	0.01–0.03
Mean	3.55	1.13	0.49	0.026
Stand. deviation	1.45	0.24	0.10	0.01
Stand. error	0.73	0.12	0.05	0.01
CV%	40.90%	20.93%	20.31%	46.80%

Where: CV% = coefficient of variation. *Onde: CV% = coeficiente de variação*.

Figure 2. *Constrictotermes cavifrons* (Isoptera: Termitidae) in a primary forest, Manaus, Amazonas, Brazil: nest size, shape and architecture (A); covered trails (B) and non-covered trails (C); origin of soil for building nests and trails indicated by yellow arrows (C); workers foraging on lichens on tree trunks (D).
Figura 2. *Constrictotermes cavifrons* (Isoptera: Termitidae) em floresta primária, Manaus, Amazonas, Brasil: tamanho, formato e arquitetura do ninho (A); trilhas cobertas (B) e não-cobertas (C); origem do solo para construção dos ninhos e trilhas, setas amarelas (C); operários forrageando sobre líquens no tronco de árvores (D).



Physicochemical parameters of arboreal nests

The levels of OM found in the nests were consistently higher, ranging from three to seven times greater than those found in the adjacent soils (Table 2). In terms of texture, all analyzed nests and adjacent soils (n = 8) had a high concentration of clay. Five of the samples were classified as very clayey (≥ 60.80% clay), while three were classified as clayey (≤ 60.40% clay). Nests generally displayed a high clay content, whereas the adjacent soils comprised a mix of 50% clayey and 50% very clayey textures. In nests characterized by a very clayey texture, the percentage of sand varied considerably (20.6–22.9%), whereas the silt content had a smaller variation (7.8–16.3%). Conversely, in nests with a clay texture, the silt fraction was predominant (36.0%) compared to the sand fraction (11.0%).

Epigeal nests found in sandy-clay soils demonstrate increased clay concentrations and decreased sand concentrations compared to the adjacent soils (Lima *et al*., 2018). This change in the physical composition of nests relative to the adjacent soils suggests that termites selectively transport minerals, incorporate OM, and form new structural aggregations of particles (Sousa *et al*., 2020). These biogenic changes made by termites contribute to structuring the physical composition and maintaining the shape of the nests.

Table 2. Physical parameters of arboreal nests of *C. cavifrons* (Isoptera: Termitidae) and adjacent soils in a primary forest, Manaus, Amazonas, Brazil.
Tabela 2. Parâmetros físicos dos ninhos arborícolas de *C. cavifrons* (Isoptera: Termitidae) e dos solos adjacentes em floresta primária, município de Manaus, Manaus, Amazonas, Brasil.

Physical parameters	OM	Sand	Silt	Clay	Nd-Sd	Texture
	g kg^{-1}	------------------- % -------------------			g cm^{-3}	
			Nests			
Range	58–173	11–22.9	7.8–36	53–71.6	0.7–0.87	
Mean	104.00	19.25	18.90	61.85	0.80	
Stand. deviation	53.71	5.59	12.03	7.63	0.08	3VC; 1C
Stand. error	26.85	2.80	6.01	3.81	0.04	
CV%	51.64%	29.04%	63.63%	12.33%	10.26%	
			Adjacent soils			
Range	14–34	13.5–21	11.5–25.6	55–75	0.86–0.92	
Mean	22.38	16.08	19.53	64.40	0.90	
Stand. deviation	8.79	3.43	6.52	8.65	0.03	2VC; 2C
Stand. error	4.39	1.71	3.26	4.33	0.01	
CV%	39.28%	21.33%	33.42%	13.43%	2.93%	

Where: OM = organic matter; Nd = nest density; Sd = soil density; VC = very clayey; C = clayey; CV% = coefficient of variation.
Onde: OM = matéria orgânica; Nd = densidade do ninho; Sd = densidade do solo; VC = muito argilosa; C = argila; CV% = coeficiente de variação.

Table 3 presents the chemical parameters of nests in comparison to the adjacent soils. The levels of macronutrients (P, K^+, Ca^{2+}, Mg^{2+}, and S) and Na^+ found in nests were much higher than those in the adjacent soils. Particularly, the available P levels ranged from 3 to 41 $mg.dm^{-3}$, whereas those in the adjacent soils ranged from 1 to 4 $mg.dm^{-3}$ (Table 3).

In the nests of *Nasutitermes ephratae* (Termitidae: Nasutitermitinae), which also constructs arboreal nests, the increase in P has been attributed to the enrichment of OM (López-Hernández, 2001) that is transported and incorporated into the nests. In the present study, P was positively correlated with increased levels of K^+ (r = 0.97), Na^+ (r = 0.99), S (r = 0.95), and Mg^{2+} (r = 0.97) (Table 5), which are also influenced by the presence of OM (Oliveira et al., 2012). Additionally, these elements are influenced by changes in the food's pH (organic compounds) after it passes through the intestine, where alkalinity can reach up to 10.9 in *Nasutitermes corniger* (Termitidae: Nasutitermitinae) (Köhler *et al*., 2012).

The concentrations of K^+ were found to be at least 5.5 times higher in nests compared to adjacent soils, showing positive correlations with Na^+ (r = 0.99) and Mg^{2+} (r = 0.96) (Table 5). Similarly, elevated K^+ levels have been recorded in termite mounds in secondary forests north of

Manaus (Ackerman *et al*., 2007) and in podzolized soils in the Viruá National Park, south-central Roraima, Brazil (Schaefer *et al*., 2017). The presence of this element in such high concentrations within nests may be attributed to processes such as acidification, complexation, precipitation, and oxidation-reduction occurring in the thermosphere (Lavelle *et al*., 1997), as well as the high clay contents found in the nests.

The S content in nests ranged from 16 to 370 mg.dm^{-3}, whereas in the adjacent soils, it was lower, between 6 and 24 mg.dm^{-3}. In contrast, the differences in Na^{+} concentrations were smaller, ranging from 30 to 104 mg.dm^{-3} in nests and 9 to 18 mg.dm^{-3} in adjacent soils. Positive correlations were observed between S and Mg^{2+}, SB, and t (r = 0.99). Similarly, Na^{+} showed positive correlations with Mg^{2+} (r = 0.95) and V (r = 0.97) (Table 5).

The levels of Ca^{2+} in nests varied from 1.7 to 3.6 cmol$_c$.dm^{-3}, while adjacent soils contained only 0.15 to 0.20 cmol$_c$.dm^{-3}. The same trend was observed for Mg^{2+}, with greater variation in nests (0.70–2.80 cmol$_c$.dm^{-3}) and lower variation in adjacent soils (0.00–0.1 cmol$_c$.dm^{-3}). However, Ackerman *et al.* (2007) recorded higher levels of Ca^{2+} in adjacent soils studying epigeal termite mounds, while Mg^{2+} showed no differences. The elevated Ca^{2+} and Mg^{2+} levels in nests are likely linked to the higher OM content and intense biological activity (Oliveira *et al*., 2012), although Ca^{2+} correlated only with T (r = 0.99).

Conversely, Mg^{2+} displayed positive correlations with OM (r = 0.99), P (r = 0.97), K^{+} (r = 0.96), Na^{+} (r = 0.95), S (r = 0.99), SB (r = 0.98), t (r = 0.98), and V (r = 0.97), and a negative correlation with Sd (r = 0.96) (Table 5). The higher concentrations of Ca^{2+} and Mg^{2+} in nests likely contributed to the reduced levels of exchangeable Al^{3+} (≤0.40 cmol$_c$.dm^{-3}) in nests, compared to the elevated Al^{3+} levels (≥1.30 cmol$_c$.dm^{-3}) (Table 3) found in adjacent soils.

Table 3. Chemical parameters of arboreal nests of *C. cavifrons* (Isoptera: Termitidae) and adjacent soils in a primary forest, Manaus, Amazonas, Brazil.
Tabela 3. Parâmetros químicos dos ninhos arborícolas de *C. cavifrons* (Isoptera: Termitidae) e de solos adjacentes em floresta primária, município de Manaus, Amazonas, Brasil.

Chemical parameters	**P**	**K^{+}**	**Na^{+}**	**S**	**Ca^{2+}**	**Mg^{2+}**	**Al^{3+}**
	mg dm^{-3}				cmol$_c$ dm^{-3}		
				Nests			
Range	3–41	140–300	30–104	16–370	1.7–3.6	0.7–2.8	0.1–0.4
Mean	21.25	217.50	67.50	156.50	2.33	1.53	0.20
Stand. deviation	16.42	71.36	31.30	151.42	0.86	0.93	0.14
Stand. error	8.21	35.68	15.65	75.71	0.43	0.46	0.07
CV%	77.27%	32.81%	46.37%	96.76%	37.06%	60.90%	67.70%
				Adjacent soils			
Range	1–4	18–34	9–18	6–24	0.15–0.20	0–0.1	1.3–1.9
Mean	2.50	26.50	14.50	13.00	0.18	0.06	1.55
Stand. deviation	1.29	7.72	4.36	7.75	0.03	0.05	0.26
Stand. error	0.65	3.86	2.18	3.87	0.01	0.02	0.13
CV%	51.64%	29.15%	30.06%	59.58%	16.50%	76.59%	17.07%

Where: P = available phosphorus; K^{+} = available potassium; Na^{+} = sodium; S = sulfur; Ca^{2+} = exchangeable calcium; Mg^{2+} = exchangeable magnesium; Al^{3+} = exchangeable aluminum; CV% = coefficient of variation.
Onde: P = fósforo disponível; K^{+} = potássio disponível; Na^{+} = sódio; S = enxofre; Ca^{2+} = cálcio trocável; Mg^{2+} = magnésio trocável; Al^{3+} = alumínio trocável; CV% = coeficiente de variação.

The physicochemical parameters presented in Table 4 show the impact of the changes that occur in nests. These changes resulted in a higher pH level, ranging from 4.10 to 5.90, with acidity varying from low to very high. In contrast, the pH in adjacent soils ranged from 3.50 to 4.00, indicating soils with very high acidity. However, contrary to these findings, Ackerman *et al*. (2007) observed that acidity was higher in epigeal termite mounds of various species in secondary forests in the Amazon compared to adjacent soils. In epigeal termite mounds, there is proportionally less OM content (Oliveira *et al*., 2012) than in arboreal nests of *C. cavifrons*. This difference could have influenced the levels of Al^{3+} and acidity, thereby affecting the highest and lowest concentrations of SB and Al^{3+}, respectively.

In nests, (H+Al) ranged from 3.42 to 5.21, while the buffering power (pH_{SMP}) ranged from 5.80 to 6.20. In contrast, adjacent soils exhibited (H+Al) values between 5.21 and 8.83, with pH_{SMP} ranging from 5.30 to 5.80 (Table 4). As a result, there was a negative correlation (-1.00) between (H+Al) and pH_{SMP} (Table 5), indicating that nests have a greater buffering capacity than adjacent soils, probably due to the amount of OM incorporated into them. Additionally, the SB found in nests was higher than that detected in adjacent soils (Table 4). According to Prezotti & Guarçoni (2013), SB can be classified into three categories: low (<2.0), medium (2.0-5.0), and high (>5.0). Based on this classification, in this study, nests presented base concentrations varying from medium to high, while all the areas of the adjacent soils had very low SB.

The T value in nests and adjacent soils was classified as average but was notably higher in nests. The t value, which represents the amount of cations occupied by exchangeable cations, ranged from medium to high in nests and from low to medium in adjacent soils (Table 4). Soils with a higher T load demonstrate an increased ability to retain positively charged nutrients such as K^+, Ca^{2+}, and Mg^{2+} (Prezotti & Guarçoni, 2013). Consequently, these analyses contribute to understanding the higher fertility observed in nests.

The V% and Al^{3+} saturation had an inverse relationship in both nests and adjacent soils (Table 4). Base saturation serves as an indicator to differentiate between soils with high fertility (Eutrophic, V≥50%) and those with low fertility (Dystrophic, V<50%) (Raij *et al*., 1997). The present findings imply that nests are more fertile and have a greater capacity to supply nutrients compared to adjacent soils. Unlike V%, the higher Al^{3+} saturation in adjacent soils reflects its toxicity (Raij *et al*., 1997).

Table 4. Physicochemical parameters of arboreal nests of *C. cavifrons* (Isoptera: Termitidae) and adjacent soils in a primary forest, Manaus, Amazonas, Brazil.
Tabela 4. Parâmetros físico-químicos dos ninhos arborícolas de *C. cavifrons* (Isoptera: Termitidae), e de solos adjacentes em floresta primária, município de Manaus, Amazonas, Brasil.

Physicochemical parameters	**pH**	**H+Al**	**SB**	**T**	**t**	**V**	**m**	**pH**
	$CaCl_2$	------------------------ $cmol_c\ dm^{-3}$ -------------------				------------- % ----------		SMP
				Nests				
Range	4.10–5.90	3.42–5.21	3.19-7.62	7.70-11.80	3.29-7.77	37.98-64.00	2.00-9.73	5.80–6.20
Mean	5.15	4.52	4.70	9.21	4.90	49.64	4.54	5.95
Stand. deviation	0.90	0.87	2.00	1.80	1.97	12.05	3.51	0.19
Stand. error	0.45	0.43	1.00	0.90	0.99	6.03	1.76	0.10
CV%	17.48%	19.19%	42.49%	19.56%	40.26%	24.28%	77.31%	3.22%
				Adjacent soils				
Range	3.50–4.00	5.21–8.83	0.26–.47	5.67–9.30	1.69–2.37	4.00–8.11	73.86-86	5.30–5.80
Mean	3.75	6.73	0.37	7.10	1.92	5.34	80.73	5.58
Stand. deviation	0.21	1.52	0.11	1.55	0.31	1.89	5.20	0.21
Stand. error	0.10	0.76	0.06	0.77	0.15	0.95	2.60	0.10
CV%	5.55%	22.55%	29.85%	21.83%	16.04%	35.49%	6.44%	3.70%

Where: pH_{CaCl2} = hydrogenionic potential; H+Al = potential acidity; SB = sum of bases; T = cation exchange capacity at pH 7.0; t = effective cation exchange capacity; V = base saturation; m = aluminum saturation; pH_{SMP} = buffering power; CV% = coefficient of variation.
Onde: pH_{CaCl2}= potencial hidrogeniônico; H+Al = acidez potencial; SB = soma de bases; T = capacidade de troca catiônica a pH 7,0; t = capacidade de troca catiônica efetiva; V = saturação por bases; m = saturação por alumínio; pH_{SMP} = poder tampão; CV% = coeficiente de variação.

Table 5. Pearson's simple correlation coefficients between the physicochemical attributes of nests and adjacent soils in a primary forest, Manaus, Amazonas, Brazil.
Tabela 5. Coeficientes de correlação simples de Pearson entre os atributos físicos e químicos de ninhos e solos adjacentes em floresta primária, município de Manaus-AM.

	Weight	Vol.	OM	Sand	Silt	Clay	Sd	pH	P	K^+	Na^+	S	Ca^{2+}	Mg^{2+}	Al^{+3}	H+Al	SB	T	t	V%	m%	pH_{SMP}
Weight	0.00	0.18	0.48	-0.40	0.46	-0.44	-0.45	0.13	0.28	0.29	0.19	0.40	0.61	0.46	-0.87	-0.14	0.51	0.50	0.46	0.39	-0.91	0.11
Vol.		0.00	0.93	0.75	-0.79	0.69	-0.96	0.99*	0.97	0.98*	0.97*	0.85	0.52	0.90	-0.16	-0.84	0.80	0.48	0.80	0.97*	-0.38	0.81
OM			0.00	0.58	-0.52	0.39	-0.99*	0.89	0.97*	0.98*	0.95	0.95	0.76	0.99*	-0.34	-0.69	0.94	0.70	0.93	0.99*	-0.58	0.65
Sand				0.00	-0.88	0.65	-0.58	0.73	0.75	0.72	0.81	0.68	0.38	0.63	0.54	-0.41	0.58	0.44	0.62	0.64	0.31	0.40
Silt					0.00	-0.94	0.58	-0.82	-0.68	-0.69	-0.73	-0.47	-0.03	-0.49	-0.35	0.72	-0.35	-0.04	-0.38	-0.62	-0.19	-0.72
Clay						0.00	-0.48	0.76	0.52	0.56	0.55	0.25	-0.23	0.31	0.15	-0.83	0.13	-0.25	0.14	0.50	0.07	0.84
Sd							0.00	-0.93	-0.97*	-0.98*	-0.95	-0.91	-0.68	-0.96*	0.36	0.77	-0.90	-0.62	-0.88	-1.0*	0.59	-0.73
pH								0.00	0.94	0.96*	0.93	0.78	0.42	0.84	-0.16	-0.89	0.72	0.37	0.72	0.94	-0.37	0.87
P									0.00	1.00*	1.00*	0.95*	0.70	0.97*	-0.13	-0.70	0.91	0.67	0.92	0.99*	-0.39	0.66
K^+										0.00	0.99*	0.93	0.66	0.96*	-0.19	-0.75	0.89	0.62	0.89	0.99*	-0.43	0.72
Na^+											0.00	0.94	0.68	0.95*	-0.04	-0.68	0.90	0.66	0.91	0.97*	-0.30	0.64
S												0.00	0.89	0.99*	-0.12	-0.46	0.99*	0.87	0.99*	0.93	-0.38	0.42
Ca^{2+}													0.00	0.84	-0.19	-0.06	0.93	0.99*	0.93	0.69	-0.41	0.01
Mg^{2+}														0.00	-0.24	-0.58	0.98*	0.80	0.98*	0.97*	-0.49	0.53
Al^{+3}															0.00	0.39	-0.21	-0.04	-0.15	-0.29	0.96*	-0.39
H+Al																0.00	-0.41	0.03	-0.39	-0.76	0.50	-1.0*
SB																	0.00	0.90	1.00*	0.90	-0.47	0.36
T																		0.00	0.91	0.63	-0.27	-0.08
t																			0.00	0.89	-0.41	0.34
V%																				0.00	-0.53	0.72
m%																					0.00	-0.48
pH_{SMP}																						0.00

* $p < 0,05$. OM: organic matter; Vol.: volume; Sd: soil density; H+Al: potential acidity; SB: sum of bases; T: cation exchange capacity at pH 7.0; t: effective cation exchange capacity; V%: base saturation; m%: aluminum saturation; pH_{SMP}: buffering power.
* $p < 0,05$. MO: Matéria orgânica; Vol.: volume; DS: densidade solo; H+Al: acidez potencial; SB: soma de bases; T: capacidade de troca catiônica a pH 7,0; t: capacidade de troca catiônica efetiva; V%: saturação por bases; m%: saturação por alumínio; pH_{SMP}: poder tampão.

4. Conclusion

Arboreal nests of *C. cavifrons* exhibit a long and narrow shape, with their physicochemical composition from the sorting, transportation, and aggregation of soil components such as sand, silt, and clay. This process leads to a structure that differs significantly from the surrounding soil. The high proportion of OM derived from the termite diet and organic remains alter all physicochemical parameters of the termite mound, enhancing its quality in terms of agricultural fertility.

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Acknowledgment
The Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM) for granting the Scientific Initiation scholarship to the student Gabriel Silva Leão Ferreira. The Coordenação de Transporte and the Fazenda Experimental of the Universidade Federal do Amazonas (FAEXP-UFAM) for all support and logistics during field activities.
Financing Sources
This research had financial support from the Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM), Notice N. 002/2018, Research Support Program – Universal Amazonas.
Conflict of Interest
The authors declare no conflict of interest.
Associate Editor
Saly Takeshita Yamaguti

ORIGINAL ARTICLE