

## SHORT COMMUNICATION

# Osteophagia by *Nasutitermes guayanae* (Blattodea: Isoptera: Termitidae) on human bone remains in the Andean Amazon, Caquetá, Colombia

Yardany RAMOS-PASTRANA<sup>1,2\*</sup> , Eric CÓRDOBA-SUAREZ<sup>1</sup>, Marta WOLFF<sup>2</sup><sup>1</sup> Universidad de la Amazonia, Grupo de Investigación en Entomología – GIEUA, Laboratorio de Entomología, Florencia, Caquetá, Colombia<sup>2</sup> Universidad de Antioquia, Instituto de Biología, Grupo de Entomología – GEUA, Medellín, Colombia\*Corresponding author: [ya.ramos@udla.edu.co](mailto:ya.ramos@udla.edu.co);  <https://orcid.org/0000-0002-3193-6659>**ABSTRACT**

We present the first report of *Nasutitermes guayanae* feeding on human bone remains found in an urban area of the municipality of Florencia, Caquetá, Colombia, in the Colombian Amazon piedmont. The record indicates an expansion in the diet of these termites. The observation suggests that the association of *N. guayanae* with decomposing bodies may be a possible tool for the estimation of postmortem intervals.

**KEYWORDS:** bones, forensic entomology, Nasutiterminae, necrophagous insect

## Osteofagia por *Nasutitermes guayanae* (Blattodea, Isoptera, Termitidae) sobre restos óseos humanos en la Amazonia Andina, Caquetá, Colombia

**RESUMEN**

Presentamos el primer reporte de *Nasutitermes guayanae* alimentándose de restos óseos humanos encontrados en un área urbana del municipio de Florencia, Caquetá, Colombia, en el Piedemonte Amazónico colombiano. El registro indica una expansión en la dieta de esas térmitas. La observación sugiere que la asociación de *N. guayanae* con cuerpos en descomposición puede ser una posible herramienta para la estimación de intervalos postmortem.

**PALABRAS CLAVE:** entomología forense, huesos, insecto necrófagos, Nasutiterminae

Termites (Blattodea: Isoptera) are a specific group of nest-building, hemimetabolous insects characterized by eusocial behavior that includes castes (queen, king, workers, soldiers, and winged adults). They are found in tropical and subtropical regions (Prestes *et al.* 2014), are linked to a diverse range of substrates, and are represented by nearly 3,000 described species of which 612 are found in the Neotropical region (Constantino 2021). Although there are 26 recorded genera of Isoptera in Colombia (Vargas-Niño *et al.* 2005), there exists no species compilation or catalog for the country so far. Nevertheless, recent studies have demonstrated a considerable diversity associated to vegetable crops (Abadía *et al.* 2013; Beltrán-Díaz and Pinzón-Florian 2018). Termites are grouped into nine families (Krishna *et al.* 2013). Termitidae is the most diverse with 85 genera and 436 species (Constantino 2021). Three families have been reported in Colombia: Termitidae, Kalotermitidae and Rhinotermitidae (Vargas-Niño *et al.* 2005). The basic diet of termites is wood, however, in addition to vegetable material, the Termitidae may also feed

on fungi, lichens, hummus, termite feces, nest materials, dead termites (cannibalism), and mammal carcasses (Lima and Costa-Leonardo 2007). Thus, the Termitidae are considered ecologically relevant in the tropics for the recycling of organic matter, which facilitates nutrient cycling and improves the soil properties (Ashton *et al.* 2019).

*Nasutitermes* (Dudley, 1890) is considered the most diverse and widely distributed genus in the tropical region, with 248 described species (Constantino 2021). They feed mainly on wood and build nests with different shapes in different habitats, among which there are balloon-shaped nests on trees connected to the ground by galleries, mounds above ground level, and epigeal or subterranean nests (Pearce 1997).

Concerning necrophagy, there have been reports of the presence of *Nasutitermes* in vertebrate carcasses such as boas, sloths, turtles, agoutis (Thorne and Kimsey 1983), dogs (Eloi *et al.* 2020), and human bone remains (Derry 1911; Light 1929; Wood 1976; Wylie *et al.* 1987), among others (Table 1). Here we report a case of osteophagia by *Nasutitermes*

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**Table 1.** Species of termites (Blattodea: Isoptera) recorded in association with mammal carcasses. Adapted from Prestes *et al.* (2014).

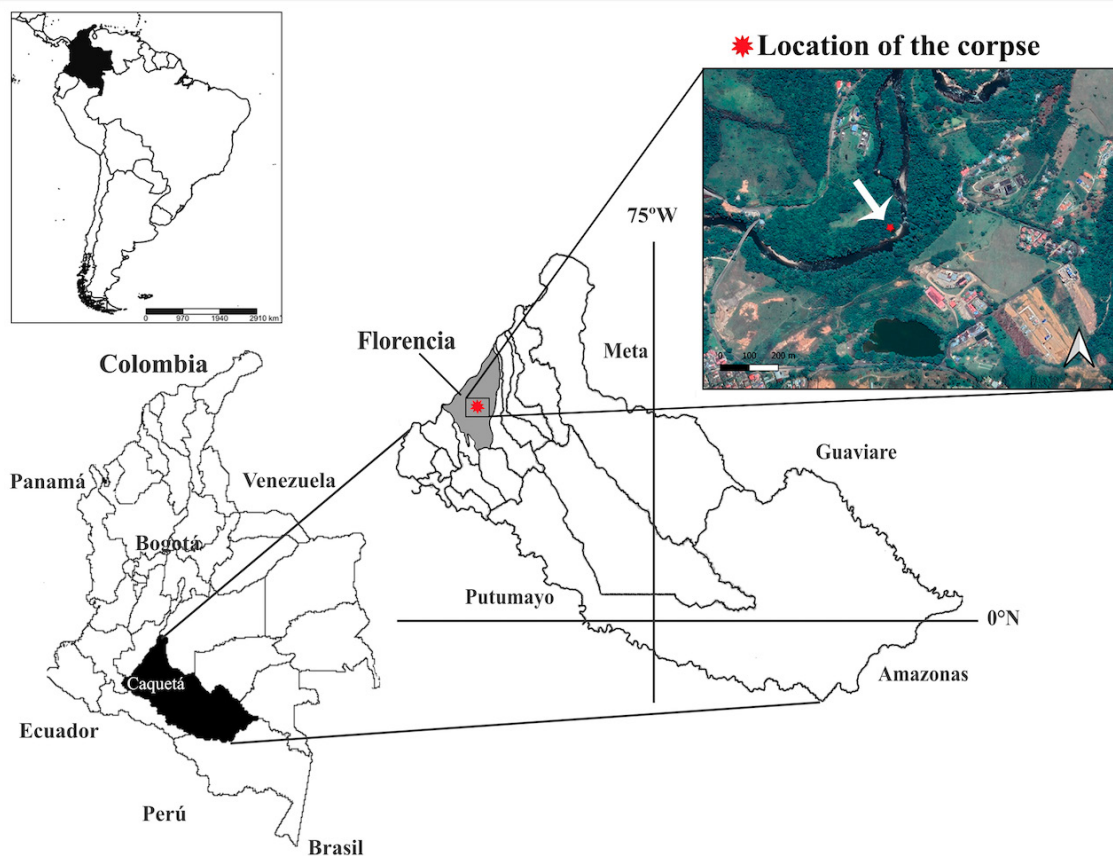
| Species                                       | Subfamily                    | Type of carcass  | Local                             | Reference                   |
|---|------------------------------|--|-----------------------------------|-----------------------------|
| <i>Nasutitermes guayanae</i> (Holmgren)       | Termitidae: Nasutiterminae   | Human bones  | Florencia, Caquetá, Colombia      | This study                  |
| <i>Nasutitermes callimorphus</i> Matheus      | Termitidae: Nasutiterminae   | Canis familiaris   | Brazil                            | Eloi <i>et al.</i> 2020     |
| <i>Anitermes amifer</i> silvestri             | Termitidae: Amitermitinae    | Human bones  | Brazil                            | Queiroz <i>et al.</i> 2017  |
| <i>Nasutitermes corniges</i> (Motschulsky)    | Termitidae                   | Human bones  | Brazil                            | Queiroz <i>et al.</i> 2017  |
| <i>Microcerotermes indistinctus</i> Hagen     | Termitidae: Amitermitinae    | Human bones  | Brazil                            | Queiroz <i>et al.</i> 2017  |
| <i>Rhynchotermes nasutissimus</i> (Silvestri) | Termitidae: Syntermitinae    | Rat  | Brazil                            | Prestes <i>et al.</i> 2014  |
| <i>Trinervitermes trinervoides</i> (Sjöstedt) | Termitidae: Nasutitermitinae | <i>Gallus domesticus</i> , <i>Ovis aries</i> , bovid bones | Sterkfontein Valley, South Africa | Backwell <i>et al.</i> 2012 |
| Unknown                                       | Unknown                      | Human bones  | Huaca de Luna, Peru               | Huchet <i>et al.</i> 2011   |
| <i>Reticulitermes</i> sp.                     | Rhinotermitidae              | Pig carrion  | Uyo, Nigéria                      | Ekanem and Dike 2010        |
| Unknown                                       | Termitidae                   | Rat carrion  | Caracas, Venezuela                | Velásquez 2008              |
| <i>Odontotermes</i> sp.                       | Termitidae: Macrotermitinae  | Grant's gazelle (also hooves)                              | Serengueti, Tanzania              | Freymann <i>et al.</i> 2007 |
| Unknown                                       | Unknown                      | Human fossil   | Laetoli, Tanzania                 | Kaiser 2000                 |
| Unknown                                       | Unknown                      | Elephants and buffalo bones                                | Zaire, Angola                     | Tappen 1994                 |
| <i>Mastotermes darwiniensis</i> (Froggatt)    | Termitidae: Macrotermitinae  | Elephants bones  | Hwange National Park, Zimbabwe    | Haynes 1991                 |
| <i>Pseudacanthotermes militaris</i> (Hagen)   | Mastotermitidae              | Elephant bones   | Hwange National Park, Zimbabwe    | Haynes 1991                 |
| <i>Nasutitermes carnarvonensis</i> (Hill)     | Termitidae: Nasutitermitinae | Human bones  | Carnarvon Region, Australia       | Wylie <i>et al.</i> 1987    |
| <i>Coptotermes acinaciformis</i> (Froggatt)   | Rhinotermitidae              | Recent and fossil mammal bones                             | Laboratory experiment             | Watson and Abbey 1986       |
| <i>Nautitermes nigriceps</i> (Haldeman)       | Termitidae: Nasutitermitinae | <i>Boa</i> , agouti, three-toed sloth, turtle              | Barro Colorado, Panama            | Thorne and Kimsey 1983      |
| <i>Nautitermes nigriceps</i> (Haldeman)       | Termitidae: Nasutitermitinae | <i>Boa</i> , agouti, three-toed sloth, turtle              | Barro Colorado, Panama            | Thorne and Kimsey 1983      |
| <i>Odontotermes zambesiensis</i> (Sjöstedt)   | Termitidae: Macrotermitinae  | Elephant cartilages and ligaments                          | Tsavo, Kenya                      | Coe 1978                    |
| Unknown                                       | Unknown                      | Cow jaw bones  | Amboseli National Park, Kenya     | Behrensmeyer 1978           |
| Unknown                                       | Unknown                      | Human bones  | Queensland, Australia             | Wood 1976                   |
| <i>Coptotermes formosanus</i> Shiraki         | Rhinotermitidae              | Human bones  | China                             | Light 1929                  |
| Unknown                                       | Unknown                      | Human bones  | Ancient Nubia, Egypt              | Derry 1911                  |

*guayanae* (Holmgren, 1910) on human bone remains in Colombia, which suggests a possible use for the determination of the postmortem interval in future cases as a new tool in forensic sciences.

On February 11, 2018, at 11:00 a.m., a skeletonized human body was found, approximately one kilometer from the urban center of Florencia, Department of Caquetá, Colombia (01°38'31.4"N; 075°36'44.1"W) (Figure 1), in the Andean piedmont between the Eastern Cordillera and the Amazon lowlands. The area is located at 310 m amsl with an average temperature of 25 °C, 80% relative humidity, and an average annual precipitation of 3,840 mm (IGAC 2010). The corpse was found in an area with abundant arboreal vegetation mainly composed of *Zygia longifolia* (Humb. and Bonpl. ex Willd.) Britton & Rose, 1928 at 300 m from the main road.

During the technical inspection of the corpse and the scene by police accompanied by authors YRP and ECS, it was noticed that the bone remains had a major termite

infestation. The termites were collected, fixated in 96% ethanol, and taken to the Entomology laboratory of the Universidad de la Amazonía (Caquetá, Colombia), where they were identified with the species keys proposed by Constantino (2002; 2012) and Malpica *et al.* (2010), and by comparing them with the redescription proposed by Ensaf *et al.* (2003). The identification was confirmed by a specialist (see Acknowledgments). The specimens were examined under an Olympus stereomicroscope and a 2x auxiliary lens. Photographs were taken with a Leica digital camera DFC450 coupled to a stereomicroscope Leica M205A. This system was connected to a computer with Leica Application Suite software, with an automatic mounting module (synchronization software) (<http://www.syncroscopy.com/syncroscopy/>). The map of the collection site was plotted using the Quantum GIS 2.16 software (Quantum GIS Development Team 2016). All specimens were deposited in the Colección del Laboratorio de Entomología of Universidad de la Amazonia – LEUA.

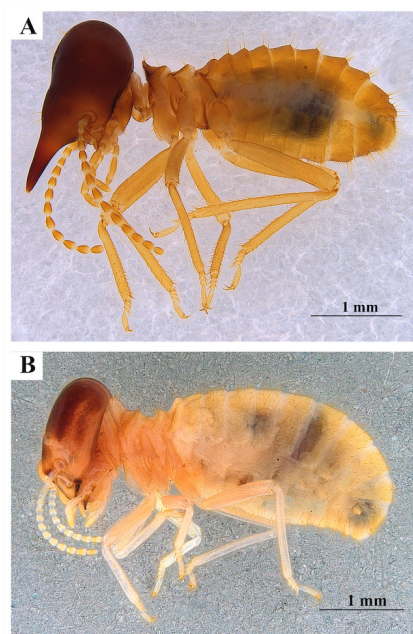


**Figure 1.** Geographical location of the human bone remains infested by *Nasutitermes guayanae* in Florencia, Caquetá, Colombia. This figure is in color in the electronic version.

In total, 81 *N. guayanae* specimens were collected, 16 soldiers (protecting the foraging area) (Figure 2a) and 65 workers (collecting the food) (Figure 2b), mainly on bone pieces such as the phalanges (Figure 3a) and the calcaneus (Figure 3b), where the bone degradation by the termites was noticeable.

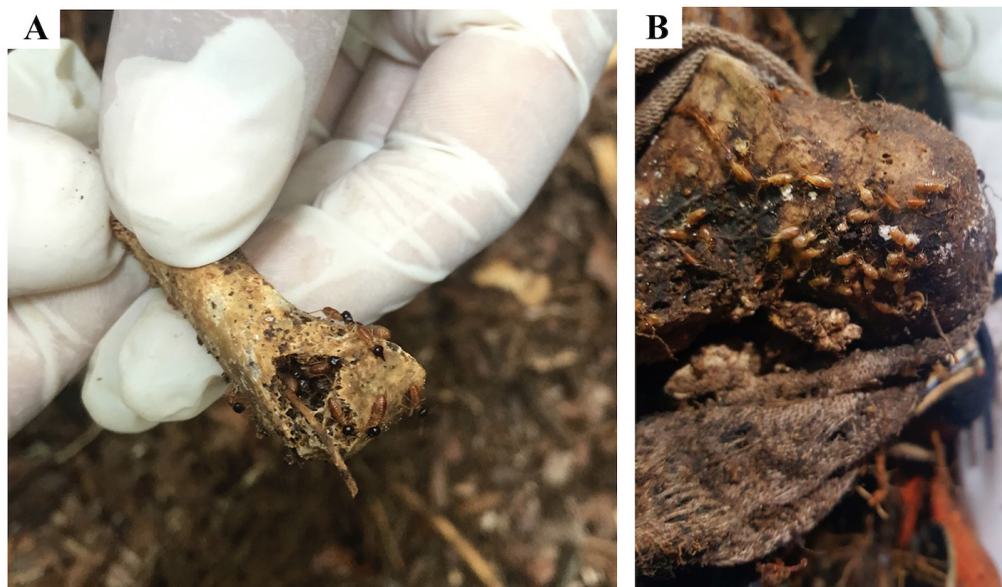
*Nasutitermes guayanae* is distributed in Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Panama, Peru, Suriname, Trinidad and Tobago, and Venezuela (Constantino 2021). The species is characterized by having 14-segment antennas, the second antennomer as long as the fourth, third antennomer shorter than the others; a conical nasus lighter colored than the head with 3-4 setae on the top and 4 setae at the base; 3-5 long and short setae in the vertex and posterior area of the head; and pronotum with 2-3 setae at the posterior margin (Malpica *et al.* 2010).

Regarding its biology, *N. guayanae* has occasionally been observed feeding on new and dry leaves in forests of the Brazilian Amazon (Gomes 1991), on wood (Constantino 1992), in orange plantations in the Colombian Caribbean coast (Abadía *et al.* 2013), and in a riparian forest in Venezuela (Malpica *et al.* 2010). We present the first report of *N. guayanae* feeding on human bone remains. The termites



**Figure 2.** Adults of *Nasutitermes guayanae*. A – left lateral view of soldier [LEUA-1149 (batch)]; B – left lateral view of worker [LEUA-1150 (batch)]. Scale bar = 1 mm. This figure is in color in the electronic version.





**Figure 3.** Bone pieces infested by *Nasutitermes guayanae*. A – phalanx; B – calcaneus. This figure is in color in the electronic version.

caused visible impact and damage on the bone pieces, which is consistent with the observations of Backwell *et al.* (2012), who claim insects, including termites, degrade bone structures to acquire the nutrients inside of them. Queiroz *et al.* (2017) also reported that termites can destroy bone preservation at any stage and that osteophagia can be noticed by the marks made by the termites, which are small holes and tunnels in the bone pieces.

With our observation, *N. guayanae* enters the list of termites that feed on bone remains of mammals and that are potentially relevant for forensic entomology. The association of insects with decomposing bodies is often the most accurate or the only method to determine the time elapsed after 72 hours since death (Anderson and VanLaerhoven 1996). Different decomposition states are attractive for diverse insect species, allowing the determination of a postmortem interval by determining the connection between the timing of decomposition, the identity of colonizing termites and the level of bone degradation. As the necrophagic habits of more insect species of the regional fauna become known, the local applicability of forensic entomology to establish postmortem intervals increases. Further studies should clarify the usefulness of *N. guayanae* for Neotropical forensic entomology.

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