



OCCURRENCE OF TERMITES (ISOPTERA) IN NATURAL AND ANTHROPIZED SAND DUNES AREAS IN SOUTHERN BRAZIL WITH BIOLOGICAL NOTES ON THE SPECIES

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ABSTRACT

The knowledge about termites in *restinga* (sand dunes and adjacent areas) is incipient in Santa Catarina (SC) State coast, southern Brazil. Aiming to verify the diversity of the termitofauna, the presence of possible exotic species as well as aspects of the biology of the existing species, a survey was done in a natural and in an anthropized portion of *restinga*, from May to December 2009, during 90 hours. Termites were searched visually on different substrates at both places, sampled and conserved for identification. Nests were also searched, opened and studied. There were done 42 samplings that captured 84 individuals, from three species of Kalotermitidae (*Cryptotermes brevis*, *Glyptotermes canellae*, *Tauritermes vitulus*) and five species of Termitidae (*Anoplotermes ater*, *A. pacificus*, *Nasutitermes ehrhardti*, *N. itapocuensis*, *N. jaraguae*). All species are described for SC except *Anoplotermes ater* that represents a new occurrence for the State. *Cryptotermes brevis* is an exotic species into the region, introduced as a wood structural and furniture pest. *Nasutitermes* represented 83% of the total sampled. The greater occurrence of termites was of native xylophagous species. The found species appear to have no harmful expression in the urbanized areas, besides as opportunistic pests.

INTRODUCTION

Restinga ecosystems encompass the set of communities that occurring on sandy deposits along the Brazilian coast, that accompany a wide range of latitude (Cerqueira, 2000). Variations in the level of the groundwater, proximity to the ocean and terrain topography are among the factors responsible for the existence of a heterogeneous set of vegetation formations in *restinga* areas (Menezes & Araújo, 2005). The areas of *restinga* are represented by a mosaic of plant communities with different levels of complexity, defining several environmental profiles (Araújo *et al.*, 2004). Studies directed to the *restinga* fauna in Brazil are scarce when compared to the works on the vegetation, geology and geomorphology of these environments (Silva, 1999). In relation to insects, there are few publications about termite

species of coastal areas and the first report is by Fritz Müller, a naturalist who lived 45 years in eastern Santa Catarina State (SC), from 1852 to 1897, and undertook most of his scientific studies in the Atlantic Forest (rain forest), mainly in the large area bounded by the present municipalities of Florianópolis, Itajai, Joinville, Blumenau and their neighborhoods, being a pioneer in the study of *restinga* (Fontes, 2007). Fritz Müller was the first termitologist in Brazil and, among other studies, described in 1873 the humivorous termite *Anoplotermes pacificus* Muller, 1873 (Termitidae), noting that this species constructs epigeous nests of various shapes, frequent in the *restinga* forests near Joinville, in the northern part of SC. According to Kaiser (1953) and Araújo (1970), this species is indeed very abundant in arboreal *restinga* in the southern and southeastern regions of Brazil, and may eventually be endemic (Fontes, 1992). *A posteriori* work in Brazil with termites in *restinga* includes researches carried out in the southeast on the biology of *Anoplotermes pacificus* by Kaiser (1953), in the

south and southeast regions on taxonomy with biological notes on *Tauritermes vitulus* by Araújo & Fontes (1979), on *Atlantitermes guarinim* by Fontes (1979), on *Araujotermes caissara* by Fontes (1982), on *Anoplotermes pacificus* by Fontes (1992) and, in the northeast, on ecology of the set of species by Vasconcellos *et al.* (2005). Santos (2015) carried out a study on termites in a *restinga* area in Rio de Janeiro State, and found three native species of Termitidae (*Nasutitermes corniger* Motschulsky, 1855, *Nasutitermes jaraguae* Holmgren, 1910 and *Microcerotermes strunckii* Soerensen, 1884) and an exotic species of Rhinotermitidae (*Coptotermes gestroi* Wasmann, 1896). Besides these, the taxonomic work of the Holmgren (1910) is of great interest to the termite scholars of the *restinga* of southern Brazil, when describing species of SC of *Nasutitermes* (then denominated "Eutermes"), collected in the municipalities of Jaragua do Sul and Blumenau: *N. aquilinus* (Holmgren, 1910), *N. ehrhardti* (Holmgren, 1910), *N. itapocuensis* (Holmgren, 1910) and *N. jaraguae* (Holmgren, 1910). However, there is a lack of information about the biology of many other species.

In order to contribute to the knowledge about the diversity of termites in *restinga* of SC coast, this study was conducted to verify the diversity of the termitofauna, the presence of possible exotic species as well as biological aspects of the existing species.

MATERIALS AND METHODS

Study Area

The study region is located at the coordinates 26°12' 35.25" S 48°31' 49.46" W (Figure 1), in the district of Ubatuba, municipality of São Francisco do Sul (SFS), SC, located on an island of the northern coast of SC. The study was carried out in a portion of a natural *restinga* area on the beach of Ubatuba, located 12 kilometers from the center of SFS, between the beaches of Enseada and Itaguaçu, as well as in a portion of the urbanized area of the region. Encounters of specimens outside the delimited area were also considered. The *restinga* area is about 500 meters from the beach.



Figure 1. Aerial photo of the study area

According to Koeppen's classification (1948), the region presents humid subtropical mesothermic climate, with average temperature of the coldest month below 18°C and above 3°C,

hot summers typical of coastal areas, with average annual temperatures ranging from 15 to 25°C. The soil is predominantly sandy. The vegetation presents low and medium trees (3 to 6 meters high), with some emergent individuals that can reach up to 20 meters approximately, and consists of forest of continuous canopy, with great penetration of sunlight and with a layer of litter of thickness of approximately 10 centimeters. Margins are softer, with drier, sandy soil. In the middle of the forest, the soil is very humid and eventually soaked, with a large number of bromeliads (Figures 2 and 3).



Figure 2. Forest of restinga (external view) – Ubatuba, São Francisco do Sul, Santa Catarina State, Brazil



Figure 3. Forest of restinga (internal view) – Ubatuba, São Francisco do Sul, Santa Catarina State, Brazil

Methodology

The study was developed from May to December 2009, with collections lasting 6 hours per day. In May there were four collections, in June three, in July and August two each month, in September three and in December one; in October and November there were no collections due to excessive rains; this totaled 15 field trips, 42 samplings and a sampling effort of 90 hours. Termites were visually sought on soil, tree trunks, fallen branches, nests, buildings and gardens, collected and kept in 70% alcohol solution. The nests found were opened in order to collect all species and castes present and analyzed for their structure. Five excavations were carried out on the days of collection, in the middle of the *restinga* soil as well as in

gardens of the anthropized area, with a depth of about 60 centimeters. The taxonomic identification was carried out with taxonomic keys (Araujo, 1977, Fontes 1992, Constantino, 1999). Specimens representing each species were deposited in the scientific collection of the Univille Zoology Laboratory.

RESULTS

Diversity of the termitofauna and exotic species

A total of 84 individuals were collected in 42 samplings, representing five *genera* and eight species, which are included in Kalotermitidae (three *taxa*) and Termitidae (five *taxa*). The excavations carried out in the middle of the *restinga* soil as well as in gardens of the anthropized area did not allow to find specimens in the researched places.

Among the Kalotermitidae, the following species were found: *Cryptotermes brevis* (Walker, 1853) (two samples), *Glyptotermes canellae* (Muller, 1873) (one sample) and *Tauritermes vitulus* (Araujo & Fontes, 1979) (one sample).

In Termitidae Apicotermatinae, there were found *Anoplotermes ater* (Hagen, 1858) (one sample) and *Anoplotermes pacificus* Muller, 1873 (three samples). In Termitidae Nasutermatinae, there were found three species: *Nasutitermes ehrhardti* (Holmgren, 1910) (two samples), *N. itapocuensis* (Holmgren, 1910) (23 samples), *N. jaraguai* (Holmgren, 1910) (nine samples). The identifications of the three species of *Nasutitermes* followed the *criteria* adopted by Holmgren (1910) that are of a strictly morphological nature and give great weight to the dimensions (length and width) of the soldier's head. *Nasutitermes* was the best represented *genus*, defining 83% of the total sampled. It was observed a greater occurrence of xylophagous species.

Biological aspects of the existing species

Termites of dry wood (Kalotermitidae)

Cryptotermes Individuals were obtained in two samples collected in an urbanized area. One sample infested rafters in the ceiling of the rafts room of the National Museum of the Sea, located by the sea in SFS, that is, outside the study area. It is a venue of great tourist and cultural importance, and of expressive economic and tourist exchange with the place of study. The damage in the Museum was large, with a risk of collapse and the need to replace a large part of the roofing (Figure 4). The other sample was represented by winged individuals in nocturnal flight (at 8 p.m.), collected inside a house, on the 19th. Dec. 2009, in the district of Ubatuba, SFS. *Tauritermes vitulus*- A sample was collected from a dead burnt tree trunk of hardwood, in a garden on the edge of Babitonga Bay, on the beach of Palmas, SFS.

Termites of soil (Termitidae)

Glyptotermes canellade- A single sample was obtained, consisting of workers in the soil of *restinga* *Anoplotermes ater* - A single sample was obtained, with few specimens collected on a fallen tree trunk in the arboreal *restinga*. The workers are larger than those of *A. pacificus*. *Anoplotermes pacificus* - Two epigeous nests with active population and several abandoned and degenerating nests were found. The inhabited nests were of rounded shape and black color, with small whitish roots

alive in the surface; one of the nests surpassed the foliage, with basal width of 30 cm and height of approximately 50 cm (Figure 5), the other one grew supported on a tree root, presenting a basal width of approximately 20 cm and a height of 60 cm. Its surface had very dark areas of recent growth, interspersed with others partially covered by bryophytes and, then, greenish. This nest was partially invaded by *Nasutitermes itapocuensis*.



Figure 4. Damage caused by the action of termites of the species *Cryptotermes brevis* on the wooden roof rafters in the Raft Room at the National Museum of the Sea, São Francisco do Sul, SC. Ceiling lying on the floor

Tauritermes vitulus - A sample was collected from a dead, burnt tree trunk of hardwood, in a garden on the edge of Babitonga Bay, on the beach of Palmas, SFS.

Glyptotermes canellae - A single sample was obtained, consisting of workers in the soil of *restinga*.



Figure 5. Epigeous nest of *Anoplotermes pacificus* Arboreal termites (Termitidae)

Nasutitermes ehrhardti - Two nests were found. One was in the canopy of a dead *jeriva* palm, with a size of about 1 meter in diameter and situated 5 meters from the ground, in an pasture whose area was previously occupied by arboreal vegetation, a few kilometers from the experimental area (Figures 6 and 7). The specimens were collected in tunnels in the trunk. The other nest was in the *restinga* forest (Figure 8), completely enclosing a dead trunk and, therefore, appeared to be an epigeous nest; it was depleted and with few termites.

Table 1. List of sampled species and type of sampling place, in Ubatuba, São Francisco do Sul, Santa Catarina State, Brazil

Family	Subfamily	Species	Sampling place/ activity									Total	
			Winged individuals in flight	Urbanized area	Branch, stem, dead tree	Branch, stem, living tree	Branch, stem, fallen tree	Interior of restinga	Edge of restinga	Epigeous nest	Immature presence		Soil of restinga
Kalotermitidae		<i>Cryptotermes brevis</i> (Walker, 1853)	1	1									2
		<i>Glyptotermes canellae</i> (Muller, 1873)										1	1
		<i>Tauritermes vitulus</i> (Araujo & Fontes, 1979)			1								1
Termitidae	Apicotermitinae	<i>Anoplotermes ater</i> (Hagen, 1858)		1	1				1	1	1	1	7
		<i>Anoplotermes pacificus</i> Muller, 1873										1	1
	Nasutitermitinae	<i>Nasutitermes ehrhardti</i> (Holmgren, 1910)		1	1				1	1	1	1	7
		<i>Nasutitermes itapocuensis</i> (Holmgren, 1910)	1	1	1		1	1	1	1		1	8
		<i>Nasutitermes jaraguae</i> (Holmgren, 1910)		1	1	1	1	1	1			1	7
Total			2	5	5	1	2	4	4	3	2	6	34

Figure 6. Arboreal nest of *Nasutitermes ehrhardti*Figure 7. Nest of *Nasutitermes ehrhardti* (close view)

Nasutitermes itapocuensis - It was the most frequent species present in both urban and natural areas. In an urbanized area near the preserved *restinga*, it was obtained a sample of individuals that had attacked the wooden plinth inside one house and another one of individuals that had attacked the wood handle of tools stored in a house. In the arboreal *restinga*, it was the most common species in fallen logs in the interior and in the edges of the forest. A dead trunk lying on the bank of the *restinga*, sheltering a large population of this termite, species, was very degraded and fragile, highlighting the ecological importance of the species in the decomposition of wood and its re-incorporation in the dynamic of environmental organic cycling. In the forest it was not possible to see nests of this termite species, only tunnels in trunks and specimens inside or underneath them. No endogenous nest was found.



Figure 8. Nest of *Nasutitermes ehrhardti* in the forest of *restinga*

Nasutitermes jaraguae In an urbanized area near the preserved *restinga*, specimens were collected in tunnels in a masonry wall. They were also collected in tunnels on the outer wall of the National Museum of the Sea, in São Francisco do Sul. In the woods, they occurred in tunnels in live and dead trunks, as well as in fallen trunks and branches.

DISCUSSION

Of the eight species found, according to Araujo (1970), five were originally described for the eastern region of SC: *Tauritermes vitulus* from Blumenau, Itajaí and Itapema; *Anoplotermes pacificus* from Blumenau; *Nasutitermes ehrhardti* from Blumenau and Jaraguá do Sul (district of Itapocu) and of an unspecified locality in Rio Grande do Sul State (RS); *Nasutitermes itapocuensis* from Jaraguá do Sul (district of Itapocu) and Blumenau and of an unspecified locality in São Paulo State (SP); *Nasutitermes jaraguae* from Jaraguá do Sul (district of Itapocu). In Kalotermitidae, *Cryptotermes brevis* is an exotic and introduced species into the region, restricted to the wood in the human constructions as a structural and furniture pest, extremely weedy, of anthropophilic occurrence but it does not infest trees or abandoned wood in the open, outside the buildings (Brito, 2015). It is the dry wood termite species with the broader geographical distribution, being found from the south to the northeast of Brazil, always causing great damage (Fontes & Araujo, 1999; Milano & Fontes, 2002). Its introduction on the

coast of SC probably occurred after the studies of Fritz Müller, being the present record the first of the species in SFS, where it seems to be an important pest of the built wood. Still in Kalotermitidae, *Tauritermes vitulus*, in the original description, was reported in Blumenau, Itajaí and Itapema, in hardwood from residences and fences (Araujo & Fontes, 1979), which shows that it may be an opportunistic pest in dry urban wood. In Kalotermitinae also, *Glyptotermes canellae* distribution is described from SP to SC and the type locality as Blumenau (in SC) (Fontes, 1998). In Termitidae Apicotermatinae, *Anoplotermes ater* is a new occurrence for the species, according to Araujo (1977). Müller (1873) pointed out the presence of *A. ater* (Hagen, 1858), as a second species of *Anoplotermes* in Blumenau. In this way, this will be the first record of its distribution out of Blumenau. Still in Termitidae Apicotermatinae, Araujo (1977) records Blumenau as the type locality for *Anoplotermes pacificus* because, in the original article about this species, Fritz Müller (1873) refers to the presence of nests of this species in remarkable abundance in a recently felled forest in the nearby city of Joinville, SC, on a spongy, sandy-marshy soil. This last description corresponds precisely to an arboreal *restinga*, although much more humid than the study area of the present work. The occurrence of a large number of *A. pacificus* nests was also reported by Fontes (1992) who, in arboreal *restinga* in the municipality of Itanhaem (SP), counted 15 nests in an area of 25 m² and, in other places, of soaked soil, found nests constructed at the apex of great ferns, simulating arboreal nests, at heights of 30 to 170 cm. As to the distribution of this species, Fontes (1998) assumes its occurrence in the coastal forests of the states of Santa Catarina, Paraná and São Paulo, including slope forests and arboreal *restinga* and stated that records from other western locations (including Argentina, Paraguay, Bolivia and Peru) require confirmation and are probably incorrect identifications of this species.

In Termitidae Nasutitermitinae, *Nasutitermes ehrhardti* is a species that constructs very visible arboreous cartonated nests, that can reach relatively large dimensions and whose surface is dark brown and irregularly corrugated (Araujo, 1970). *Nasutitermes itapocuensis* is an example of a species with endogenous nest (built inside cavities and without any external sign), a mode described by Fontes & Milano (2002) and the nest that Fritz Müller (1873) characterized, under the name of "*Nasutitermes da jiçara*" (or *juçara*), that is, termite of the palm. The species is reported as an opportunistic pest in buildings close to forests and even in humid basements of houses located in well urbanized areas as Milano & Fontes (2002) reported to have recorded a nest of this species, collected in 2004 in a bathtub span, and that had caused focal infestation in the residence located in a well-wooded condominium on the outskirts of the city of Cotia, SP. *Nasutitermes jaraguae* is a species found in urban areas as well as in natural areas (Araujo, 1977). The species richness found was not very high. Fontes, (1998) carried out many collections in *restinga* forests in the regions of Itanhaem, Peruibe and Cananeia (state of São Paulo), as well as in Itapema, Palhoça and Florianópolis (state of Santa Catarina) and in all localities they found greater diversity and abundance of termites. The study by Kaiser (1953), on *Anoplotermes pacificus*, also reports higher values of the mentioned parameters. It is observed that there was no sampling of the species *Cortaritermes fulviceps* (Silvestri, 1901), *Diversitermes castaniceps* Holmgren, 1910 and *Araujotermes caissara* Fontes, 1982, of the family Termitidae (subfamily

Nasutitermitinae), which are common in the coastal strip of Santa Catarina and found in the arboreal *restinga*, as well as the less common but also present species in the region such as *Glyptotermes canellae* (Fr. Müller, 1873) and *Eucryptotermes wheeleri* Snyder & Emerson, 1949, of the Kalotermitidae family (Fontes & Araujo, 1999). Research about termites in Brazil were performed initially by Holmgren (1910) who realized strictly morphological taxonomic studies whereas Araujo & Fontes (1979) and Fontes (1982) presented notes on the biology of some species. The first works on termites in the eastern region of SC are from Müller (1873), who pointed out the existing diversity of *taxa* and reported many detailed observations on their biology in nine articles published from 1873 to 1887 (summarized in Fontes, 2007). Afterwards, few studies were done with termites in *restinga* in southern Brazil: Menzel (2009) worked only with the species *Cortaritermes fulviceps* in *restinga* in Rio Grande do Sul State (450 km far away) and Camorani & Gonçalves (2015) report research in *restinga* in the municipality of Cananeia (São Paulo State), 800 km far away from the present study, where they found *Microtermes* sp., *Nasutitermes* sp. and *Diversitermes* sp. The survey carried out in the present study allows a better knowledge of the regional fauna and the monitoring of new introductions of exotic species, facts that are relevant because of the possibility of the appearance of pests. This is specially important when referring to subterranean termites, whose expansion is progressing and of concern. In this way, Milano & Fontes (2002) report *Coptotermes gestroi* (Wasmann, 1896) as an important pest in urban areas and *Heterotermes assu* (Constantino, 2000), originally described as a native species in Brazil but which is in fact an exotic species with high capacity for invasion of native vegetation areas and also destruction of wood installations and equipment. Zorzenon and Potenza (2006) in turn report *Rhinotermes marginalis* L., native to the northern and western regions of Brazil, as a pest introduced and expanding in the urbanized areas of the eastern and southeastern regions, being present in depleted *restinga* forests and from which there is no knowledge of the capacity to invade vegetation reserves. Additionally, the knowledge about the sampled species in this work complements the taxonomy of three species of *Nasutitermes*, originally described for the region by Holmgren (1910).

Conclusion

The high occurrence of xylophagous sampled species gives to these *taxa* an importance in the environmental organic cycling, especially by termite *nasutos*, although the observed species did not appear to have weeded expression in the urbanized areas, except as opportunistic pests, with the restriction to the exotic xylophagous species *Cryptotermes brevis*, highly harmful to woodwork, although not invasive of forests.

The diversity and abundance of termite species are associated with the different existing profiles of *restinga*, which configures the termitofauna as a parameter to diagnose the environmental heterogeneity of this environment.

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