SPATIAL DISTRIBUTION OF *CORTARITERMES FULVICEPS* NESTS (SILVESTRI, 1901) (ISOPTERA, TERMITIDAE, NASUTITERMITINAE) IN COASTAL *RESTINGA* AREAS IN RIO GRANDE DO SUL STATE

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INTRODUCTION

Animal and plant distribution in the environment is a fundamental characteristic to analyze populations, for it can provide important information about the life history and the dynamics of such populations, as well as their regulation processes, such as competition (Haase, 1995). Spatial distribution of organisms in ecosystems is considered one of the main questions in ecology and it has been calling the attention of ecologists, specially, when it comes to plants (Assunção, 2000) and social insects (Albuquerque *et al.*, 005). They can reveal general patterns of distribution of other organisms due to their position in the trophic chain, as well as due to their great capacity to adapt and modify several types of habitats (Clark & Evans, 1954). Termites, for example, when they modify soil structure and fertility (Lavelle *et al.*, 997; Hedde *et al.*, 005; Yamada *et al.*, 005; Inoue *et al.*, 006; Richard *et al.*, 006), they can influence directly or indirectly the distribution of local vegetation (Donovan *et al.*, 007; Waller, 2007) and, consequently several invertebrates and vertebrates (Colli *et al.*, 006).

Micro - habitat variations such as the soil nutrients' concentration, including carbon, hydrogen and nitrogen (Yamada *et al.*, 005; Richard *et al.*, et, 2006), along with edge effects and vegetation gaps are extremely important for the distribution of isoptera's colonies. Climate conditions such as temperature, humidity and rainfall, as well as habitat characteristics involving soil type and depth (Hulugalle *et al.*, 997) are also important for the distribution of this taxon. Other relevant factors such as daily fluctuations concerning temperature, air and soil, deforestation, primary vegetation removal and micro - climate changes may be responsible for isoptera distribution (De Souza & Brown, 1994). The measure between sand, clay and silt and their distribution in the soil profile are limiting factors to build nests. Soils with good amount of clay are easier for the termites to work with, either for those that build epigeous nests or for the subterranean ones, while sand makes it difficult for nests and their galleries to hold (Lee & Wood, 1971). The latter, due to its low amount of fine material, among other factors, may lead to the lack of building species of epigeous nests (Jones, 2000; Jouquet *et al.*, 000).

OBJECTIVES

Due to their extreme environmental characteristics, dune and restinga ecosystems are generally harsh and unfriendly for most organisms; therefore, they have specific fauna and flora, which are highly important regarding the maintenance of local diversity. Due to their ecological characteristics, termites are important components of the fauna of such environments because, besides helping nutrient cycling (Jouquet *et al.*, 006; Waller, 2007), their nests can be used as local shelters for the survival of other organisms (Jones, 2000, Colli *et al.*, 006). Taking it into consideration, this article aimed to answer which is the distribution pattern of *Cortaritermes fulviceps'* nests (Silvestri, 1901) (Isoptera, Termitidae, Nasutitermitinae) at restinga areas among dunes with different anthropization levels.

MATERIAL AND METHODS

A) Study Area

The municipality of Torres is within the north coastal ecosystems of Rio Grande do Sul State, Brazil. Itapeva Hill and Beach ($29^0$23'S, $49^0$46'W) are state areas of permanent preservation (APPs) (Brasil, 2000). The hill is approximately 80 meters high and it is located 300 meters from the beach, which is six kilometers wide (www.torres.rs.gov.br). The beach features mobile dunes, permeated by the *restinga*'s pionner vegetation in humid areas, being Compositeae and Gramineae families the most abundant (Cordazzo & Seeliger, 1995). In some places among the dunes there are small Casuarina's (Casuarinaceae) *capões*, exotic and intruding genre which panicles form a thick layer above the soil, making it difficult for the native pioneer vegetation to establish. However, the local vegetation is still abundant and the dune and *restinga* area at Itapeva Beach suffers low anthropic action, due to low foot traffic and no vehicle traffic.

Praia Grande ($29^0$20'S, $49^0$43'W) is two kilometers wide and it is considered the principal beach of the city, therefore concentrating most part of the tourists. Although it is also considered an APP due to the urban expansion, it presents few remaining mobile dunes, narrow sand strip due to its removal and, mostly, intense foot and vehicle traffic. *Restinga*'s pioneer vegetation is scarce, being Compositeae and Gramineae the most abundant families. *Cakile* genre (Crucifera) is found growing together with *Panicum* (Gramineae) and *Blutaparon* (Amaranthaceae) in garbage disposal places (Cordazzo & Seeliger, 1995), fact that does not occur in Itapeva.

B) Pattern of Internidal Spacing

In May 2006, two restinga areas among the dunes were evaluated, one at Itapeva Beach and the other at Praia Grande, being all *C. fulviceps'* s epigeous nests found along six hectares of each area spatially delimited. The position of each nest in relation to two fixed perpendicular points were measured and registered on a database.

C) Data Analysis

C. fulviceps' nests density in each area was estimated from the number of nests found divided by the sampled area size (Jones, 2000; Jones *et al.*, 003; Roisin & Leponce, 2004). The nests' mean densities by square meters of both areas were compared using Wilcoxon - Mann - Whitney's U Test - BioEstat software version 4.0 (Ayres *et al.*, 007). To verify if there is nest clumping, Passage software was used (Rosenberg, 2006). To determine the spatial distribution pattern, SADIEShell software was used (Spatial Analysis by Distance Indices) (Perry *et al.*, 996; 2000), which is considered the most efficient analysis method if compared to the multivariate analysis methods (Donovan *et al.*, 007).

RESULTS AND DISCUSSION

There were found 175 *C. fulviceps* nests, being 152 at Itapeva Beach and 23 at Praia Grande. The mean distance between nests at Itapeva Beach was 9,81 + 3,15 m, being the minimum distance 0,40 m and the maximum 76,5 m. At Praia Grande, the mean internidal distance was 10,95 + 1,82 m; minimum distance 2,00 m and maximum 125,00 m. Nest density at Itapeva Beach and at Praia Grande was, respectively, 0,025 nests/sq ^{2} and 0,004 nests/sq ^{2}, being this significant difference shown by Wilcoxon - Mann - Whitney's U Test (Z(U) = 1,92; P < 0,05).

At Itapeva Beach, C. fulviceps's nests are distributed continuously along the evaluated area, while at Praia Grande they were found gathered basically in two spots. At Itapeva Beach, the distribution pattern index of *C. fulviceps* was clumped (I = 1,54; P <0,05), while at Praia Grande it was regular (I = 2, 41; P <0,05). However, excluding the nests (n = 8) that are very far from the others from the sample analyzed at Praia Grande, the distribution was marginally clumped (n = 15; I = 1,48; P <0,05).

Of all the termites that build epigeous nests, *C. fulviceps* is abundant at the coastal *restinga* area at the far north of Rio Grande do Sul State. Both studied areas are apparently similar concerning soil structure and topography. They are located at the same altitude and are practically in the same geographical coordinates and are submitted to the same weather conditions. The main differences between the areas are specially related to the most abundant vegetation and the less intense anthropization level at Itapeva Beach, if compared to Praia Grande's. At both areas, *C. fulviceps'* nests were generally located among the dunes, which are rich locations in terms of vegetation and with more concentration of nutrients, especially because they get swampy during hard rain periods.

Termite species that build subterranean nests and those that build epigeous nests require the exact amount of sand, silt and clay to deposit particles while building nests and the associated galleries (Lee & Wood, 1971). The sandy soil, for example, has a small amount of fine material, therefore it can be determining to the lack of building species of epigeous nests (Jones, 2000; Jouquet *et al.*, 000), as well as hypogeous, a fact that may be responsible for the lack of other species of Nasutitermitinae, such as *Cornitermes cumulans* (Kollar) at *restinga* areas among the dunes, as well as of genres from the Apicotermitinae subfamily, such as *Anoplotermes*, *Aparatermes* and *Grigiotermes*.

The mean distance between *C. fulviceps* nests at Itapeva Beach was practically the same found at Praia Grande. However, at Itapeva Beach the distances, minimum and maximum, between the nests were well below the ones observed at Praia Grande. The difference between the nest densities of both areas is probably reflecting local conditions (Albuquerque *et al.*, 005; Begon *et al.*, 007). The more abundant vegetation at Itapeva Beach may favor the colonies' survival and growth of this termite species, which is reflected in the increased number of nests.

Internidal distance and nest density may be related to the amount of vegetal biomass on each area (Theunis *et al.*, 005), which seem to regulate colony distribution. The low abundance of vegetation at Praia Grande may be considered a limiting factor to these insects, for it reduces the amount of available food (cellulose from the roots), which may induce the increase of intraspecific competition (Domingos, 1985). Other changes at the micro - habitat, such as edge effects and vegetation gaps are also responsible for the termites' colonies distribution (Pomeroy, 1989; De Souza & Brown, 1994).

C. fulviceps' nest distribution was different when compared both *restinga'* s coastal areas. At Itapeva Beach, there was a clumped pattern, while at Praia Grande it was regular. Clumped distribution of nests may be associated with low amplitude of the flight dispersal of winged (Henderson, 1996), to regularity and to the great area with vegetation (Crist, 1998) that is present at Itapeva Beach, as well as the need of specific micro - habitats for nesting such species (Noirot, 1970; Lee & Wood, 1971; Eggleton, 2000; Noirot & Darlington, 2000).

At Praia Grande, the regular distribution pattern may be a result of greater intra - specific competition due to the shortage of the available feeding resources (Domingos, 1985; De Souza & Brown, 1994). However, when we exclude the nests that were far from the others from the data analysis, the distribution started to be marginally clumped, demonstrating that there is evidence of a positive relation between the vegetation abundance and the *C. fulviceps'* nest distribution. However, it is important to point out that the small sampled number (n = 23) is inadequate for trustable statistical analyses (Callegari - Jacques, 2004) and the results may only be artifacts of calculation.

The clumped distribution of nests observed at Itapeva Beach is probably associated to favorable environmental characteristics regarding *C. fulviceps's* survival, such as the presence of feeding sources and soil temperature (Crist, 1998). At Praia Grande, formation of concentration points of the population in swampier areas and where there was more abundant vegetation was observed, which may indicate the presence of ideal micro - habitats for this species (Noirot, 1970; Lee & Wood, 1971; Crist, 1998; Eggleton, 2000; Noirot & Darlington, 2000; Albuquerque *et al.*, 005; Deblauwe *et al.*, 007).

CONCLUSION

The results obtained at Itapeva Beach and at Praia Grande suggest that biotic and/or abiotic local conditions, especially vegetation abundance and the anthropic disturbances may interfere in density and in *C. fulviceps'* distribution pattern. At Itapeva Beach, termites found more favorable environmental conditions to their survival, for it is an APP; therefore, there is low foot traffic and no vehicle traffic, while Praia Grande, although an APP as well, is subject to intense anthropic disturbances.

Finally, factors' analysis that influence the distribution patterns of termite populations can provide important information to studies on such group of social insects. The existing relations between termites and biotic factors, specially the possible dependence between the distribution and the density of species and vegetation, as well as with abiotic factors, principally soil temperature and humidity, are very significant to understand the regulation processes of termite populations at restingas' coastal ecosystems.

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