Nest distribution and nesting habits of *Xylocopa ordinaria* Smith (Hymenoptera, Apidae) in a restinga area in the northern Rio de Janeiro State, Brazil

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ABSTRACT. Nest distribution and nesting habits of *Xylocopa ordinaria* Smith (Hymenoptera, Apidae) in the northern Rio de Janeiro State, Brazil. This paper aims to study the distribution of natural nests of *Xylocopa ordinaria* and characterize its nesting habits in the restinga of Grussai/Iquipari (RJ), supporting future studies on the pollinators management in the northern Rio de Janeiro state. The data obtained from Aug/2003 to Dec/2004, in an area of 11.6ha, were related to the nest distribution, substrate identification and dimensions, emergence, sex ratio, nest structure (n= 23 nests) and pollen content analysis of provisioning masses and feces. *X. ordinaria* nests were abundant and presented a clustered distribution. These bees do not present taxonomical affinity for nesting substrates, but preferences for wood availability and characteristics, being *Pera glabrata* the main substrate. *X. ordinaria* is a multivoltine species that tolerates co-specifics in their nests. These bees were generalist on their nectar and pollen consumption, but presented floral constancy while provisioning brood cells. These behaviors, activity along the year, flights throughout the day, and legitimate visits to flowers indicate the importance of *X. ordinaria* on the pollination of plants in the restinga.

KEYWORDS. Behavior; foraging; native bees; spatial distribution; *Xylocopini*.

RESUMO. Distribuição de ninhos e hábitos de nidificação de *Xylocopa ordinaria* Smith (Hymenoptera, Apidae) em área de restinga no norte do Estado do Rio de Janeiro, Brasil. Este artigo objetiva estudar a distribuição de ninhos naturais de *Xylocopa ordinaria* e caracterizar seus hábitos de nidificação na restinga de Grussai/Iquipari, fornecendo bases para estudos de manejo de polinizadores no Rio de Janeiro. Os dados foram obtidos entre Ago/2003 e Dez/2004, em uma área de 11,6ha, e correlacionados à distribuição dos ninhos, ao tipo de substrato e suas dimensões, à emergência, razão sexual, arquitetura do ninho (n=23) e ao conteúdo polínico presente em massas de aprovisionamento e fezes. Os ninhos de *X. ordinaria* foram abundantes e apresentaram distribuição agregada. Não foi verificada afinidade taxonômica por substratos de nidificação, mas quanto à disponibilidade e características da madeira, sendo *Pera glabrata* o substrato mais utilizado. *X. ordinaria* é uma espécie multivoltina que tolera a presença de co-específicos no ninho. Essas abelhas foram generalistas quanto às fontes de néctar e pólen, mas apresentaram constância floral no aprovisionamento de células de cria. Esses comportamentos, a atividade ao longo do ano, vôos ao longo do dia e visitas legítimas às flores indicam a importância de *X. ordinaria* na polinização de plantas da restinga.

PALAVRAS-CHAVE. Abelhas nativas; comportamento; distribuição espacial; forrageio; *Xylocopini*.

The restinga environment is geologically recent (Suguio *et al*. 1982), and is characterized as a group of ecosystems directly influenced by the ocean, presenting distinct plant community structures (Araújo & Henriques 1984). Studies on the bee fauna in restinga ecosystems have shown great abundance of *Xylocopa* Latreille, 1802 (Apidae, Xylocopini) (Gottsberger *et al*. 1988, Viana & Alves-dos-Santos 2002, Viana *et al*. 2002). These bees have been demonstrated as important pollinators of native plants because of their specialized behaviors on flowers and floral constancy (Buchmann 1983, Alves-dos-Santos 1999, Da Silva & Viana 2002).

The genus *Xylocopa* presents more than 700 species, with 50 species in Brazil (Silveira *et al*. 2002). *Xylocopa* comprises some of the largest bees (Gerling *et al*. 1989), which excavate their nests in wood and present solitary habits, except for some species that tolerate co-specifics in their nests (Camilo & Garófalo 1982, Camillo *et al*. 1986, Hogendoorn & Velthuis 1993). Hurd (1958) suggested that nesting substrates are chosen through their wood characteristics, but not botanical affinity, and the distribution of nesting substrates has been pointed out as the most important factor on the distribution and occurrence of *Xylocopa*.

Gerling *et al*. (1989) highlighted the necessity of detailed studies on the nesting habits and characteristics of nesting substrates of most *Xylocopa*. In Brazil, the nesting biology was studied for *X*. (*Neoxylocopa*) *frontalis* (Olivier, 1789) and *X*. (*N*.) *grisescens* Lepeletier, 1841 (Camillo & Garófalo 1982, Pereira 2002), for *X*. (*N*.) *suspecta* Moure & Camargo, 1988, in trap-nests (Camillo *et al*. 1986), and for *X*. (*Monoxylocopa*) *abbreviata* Hurd & Moure, 1963 (Ramalho *et al*. 2004). Studies on the ecology and nesting habits of *X. cearensis* Ducke, 1910 (Viana *et al.* 2002) and on the distribution of *Xylocopa* nests (Da Silva & Viana 2002) were performed in a sand dunes area in Salvador, Bahia state.

Xylocopa (Neoxylocopa) ordinaria Smith, 1874 occurs in Brazil in the states of Bahia, Espírito Santo, Rio de Janeiro, Mato Grosso do Sul, São Paulo, and Rio Grande do Sul (Silveira *et al*. 2002). These bees were indicated as effective pollinators of *Passiflora alata* Curtis, 1788 (Varassin & Silva 1999), and of yellow passion fruit, *Passiflora edulis* f. *flavicarpa* Deg, 1932 (Hoffmann *et al*. 2000). Data on biology and nesting habits of *X. ordinaria* are not available in the literature (Schlindwein *et al.* 2003).

In the restinga of Grussai/Iquipari Lagunar Complex, São João da Barra – Rio de Janeiro state, *X. ordinaria* is very abundant, and represented 98% of the carpenter bees, and 21% of all collected bees in a one-year flower-visiting bee survey performed. Observations of *X. ordinaria* on flowers suggest its importance as pollinator of many plant species in this area.

The objectives of this paper are to study the distribution of natural nests of *X. ordinaria* and to characterize its nesting habits in the restinga of Grussai/Iquipari Lagunar Complex, São João da Barra – Rio de Janeiro state, in order to obtain a better comprehension about its interactions with the environment, offering support for future studies on the pollinators management in the northern Rio de Janeiro state.

MATERIAL & METHODS

The study was carried out in the restinga of Grussai/Iquipari Lagunar Complex, located in São João da Barra, northern Rio de Janeiro state, Brazil (21º44´S; 41º02´W). RadamBrasil (1983) defines the climate of this region as tropical sub-humid to semi-arid, with mean annual precipitation ranging from 800 to 1200mm, and the highest precipitation rates on summer (October - March) and the lowest on winter (April - September).

Assumpção & Nascimento (2000) studying the vegetation communities in this restinga, draw attention to its unique characteristics and pointed out this ecosystem as a new element in the vegetation mosaic along the Brazilian coastal areas. After that, they proposed the distinction of four phytophysiognomies of the vegetation of the restinga of Grussai/Iquipari Lagunar Complex: Beach Grass formation, Beach Grass and Shrub formation, *Clusia* formation and Restinga Forest formation.

The nests of *X. ordinaria* were searched out by two observers between 09:00a.m. and 04:00p.m., from Aug/2003 to Dec/2004, in a line of 5,800m length perpendicular to the tidal line, passing through the four phytophysiognomies defined by Assumpção & Nascimento (2000). The nests were sought in a 10m buffer along the transect, summing up to an area of 11.6ha. Nests were marked with numbered targets and the measurements of the entrance height above ground, entrance diameter and substrate circumference were taken. The host plant material was collected for identification and deposited in the Herbarium of the "Centro de Biociências e Biotecnologia" of the "Universidade Estadual do Norte Fluminense (UENF)". With a GPS device the nested places were marked in order to perform the nest distribution analysis and correlation with the phytophysiognomies.

The nesting activity was investigated through a survey of bees on flowers from Jan/2003 to Dec/2003 and from observations of occupied and unoccupied nests between Aug/2003 and Dec/2004. In that survey, the bees were captured on flowers, monthly, by three collectors from 08:00a.m. to 04:00p.m., using entomological nets. The wing wear of *X. ordinaria* specimens captured in that survey were evaluated following Camillo & Garófalo (1989).

Observations of nesting activity throughout the day were carried out in September 20th, 21st and 23rd of 2004 for one nest, using a digital video camera to record the construction and provisioning behaviors, as well as the activities performed by the female.

From the marked nests, 30% were randomly collected and taken to the laboratory at the end of the observations to register the emergence and to identify the sexual ratio of this population. After the emergences, the internal measurements of the nests were taken as follows: tunnel length, cell length, cell diameter and operculum width.

The difference between dry and wet weight of two provisioning masses was analyzed before and after drying in air circulation stoven at 40ºC per 120 hours. The analysis of pollen morphotypes used by *X. ordinaria* was made from provisioning masses and feces taken from 17 provisioning cells of 13 nests collected in Sept-Oct/2004. The pollen material was prepared in slides with gelatine-fuchsin (Dafni, 1992). The different pollen morphotypes presented in each studied cell were identified through analysis of two pollen slides, prepared from each homogenized provisioning mass sample. In each slide 200 pollen grains were randomly counted and calculated the proportion of each pollen morphotype.

The nest distribution analysis followed the fit to the Poisson Distribution, through the analysis of the variance/mean index (Valdermeer & Goldberg 2003). For this analysis, the sampled area of 11.6ha was divided into 58 quadrats of 100x20m (0.2ha), and the nests presented in each quadrat were plotted as frequency of occurrence/quadrat.

Data on height above ground and circumference of nested substrates in the different phytophysiognomies were compared with the non-parametric test of Mann-Whitney (Callegari-Jacques 2004). In these analyses, Shrub formation and *Clusia* formation were considered together into one variable and Restinga Forest formation into another, since the data collected for the Shrub formation occurred in a transitional area Shrub/*Clusia*.

RESULTS

Between Aug/2003 and Dec/2004, 75 nests of *X. ordinaria* were found, from which 44% were habited by adults and the other 56% were marked (without activity or abandoned) due to entrance characteristics, such as: diameter, presence of fragments of wood (sawdust) at the entrance of the nest or nearby it. Although there are other two *Xylocopa* species in the area (*X. (N.) frontalis* and *X. (Schonnherria) macrops* Lepeletier, 1841), the nests identification by indirect characteristics was possible because of the relative abundance of *X. ordinaria* (98%) compared to the other two *Xylocopa* species and due to the great difference among their body sizes.

The density of nests in the study area was 6.5 nests/ha. When the phytophysiognomies were considered separately, the Shrub/*Clusia* area presented a nest density of 4.5 nests/ha and the Restinga Forest presented 7.6 nests/ha. The nests occurred in the Restinga Forest formation (72%), *Clusia* formation (24%) and Shrub/*Clusia* formation (4%), while no nests were found at the Beach Grass formation, where trees and shrubs are absent.

It was easier to find *X. ordinaria* nests after had found a first one on the same tree or on nearby trees, which suggested a clustered distribution. The variance/mean index analysis returned a value of 1.32 for the entire sampled area; but when the areas were analyzed separately, it returned values of 1.56 and 1.18 for the Shrub/*Clusia* area and Restinga Forest formation, respectively. Therefore, although the distribution may be considered clustered, the clustering level in the Restinga Forest is lower than in the Shrub/*Clusia* when the areas were considered separately.

All observed nests were excavated in dry rotten branches that presented no cracks or fissures, and could be found in live plants or broken branches upon the vegetation. The nests were dug in dry branches of *Pera glabrata* (Schott) Poepp. ex Baill, Euphorbiaceae (76%), dead branches of *Sideroxylon obtusifolium* (Humb. ex Roem. & Schult.) T.D. Penn., Sapotaceae (6%), branches of *Eugenia ovalifolia* Cambess. Myrtaceae (1%) and non-identified dry branches (17%).

The circumference of the substrates used by these bees ranged from 7 to 25.5cm (mean= 12.38 ± 4.14, n=62; Table I), and most of them (75.8%) presented less than 15cm. The entrance height above ground ranged from 30 to 400cm (mean= 162.89 ± 76.59, n=75; Table I), with 74.7% of the nests between 80 and 240cm.

The circumference of substrates used in the Shrub/*Clusia* area and Restinga Forest formation did not show statistical difference (Mann-Withney, Z=0.46, $p>0.05$; Table I), while the entrance height above ground was significantly higher in the Restinga Forest formation (Mann-Withney, Z=2.21, $p<0.05$; Table I).

The nests of *X. ordinaria* had elliptical entrance, with the greater diameter ranging from 1.2 to 1.8cm and with 90.2% of nests presenting entrance diameters between 1.3 and 1.5cm. The nests consisted of one to four tunnels, which have a vestibule and smooth walls. From the total sampled nests, 72.7% consisted of only one tunnel. The nests could have one to nine cells, which were barrel shaped and closed with an operculum made of wood dust (Table II). The operculum had two distinct surfaces: a rough and concave inner side and a smooth outer side.

From the 30 cells kept in the laboratory, 26 bees (11 males and 15 females) emerged, resulting in a sex ratio of 0.73 males/females. Two cells were infected by fungus and one cell was found without provisioning mass or immature. One adult of the cleptoparasite *Cissites maculata* Swederus, 1787 (Coleoptera, Meloidae) emerged from a *X. ordinaria* cell in Sep/2004.

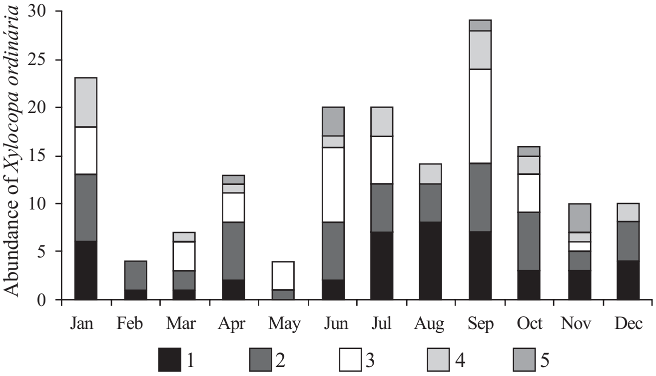

Fig. 1. Abundance of females of *Xylocopa ordinaria* collected on flowers through out the year 2003 and number of females with different wing wear per month (1 = young female to 5 = old female - as described by Camillo & Garófalo 1989).

Data of flower visiting bees showed active females along the whole year. Young females of *X. ordinaria* (1st stage of wing wear after Camillo & Garófalo 1989) were found on flowers on almost every month (except on May), with higher frequency between July and September (Fig. 1). Occupied nests were registered along the whole observation period, with higher relative abundance between July and December (Fig. 2). From the 33 nests observed with adults (44%), 14 had more than one female in their interior.

Table III indicates the plant species used by *X. ordinaria* in the restinga of Grussai/Iquipari Lagunar Complex for pollen and nectar collection. *X. ordinaria* was observed collecting pollen of *Solanum curvispinum* Dun., *Clusia hilariana* Schletch, *Allagoptera arenaria* (Gomes) Kuntze, and *Byrsonima sericea* DC. On poricidal flowers of *S. curvispitum*, *X. ordinaria* performed the vibration behavior (buzz pollination) to collect pollen. On the other flowers the foraging behavior was unspecialized. On their nectar foraging flights, *X. ordinaria* visited *Arrabidaea conjugata* (Vell.) Mart., *Mandevilla funiformis* (Vell.) K. Scum, *Manilkara subsericea*

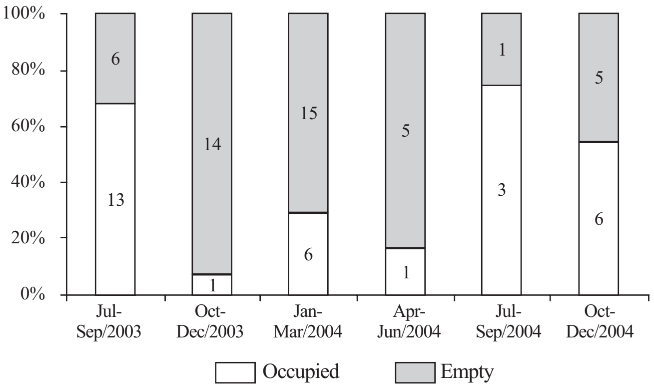

Fig. 2. Percentage of occupied and empty nests of *Xylocopa ordinaria* in the restinga of Grussai/Iquipari Lagunar Complex (numbers inside the bars correspond to the absolute number of nests).

Table I. Characterization of nesting substrates of *Xylocopa ordinaria* on two phytophysiognomies of the restinga of Grussai/Iquipari Lagunar Complex, São João da Barra, RJ.

Area	Entrance height above ground	Circumference of nested substrates	Nested host plant species
Shrub + *Clusia* formations	35 - 250cm (mean=134.9±62.4, n=21)*	7 - 23cm (mean=12.4±4.8, n=18)	*Pera glabrata* and dry branches of unidentified species
Restinga Forest formation	30 - 400cm (mean=175.5±74.7, n=53)*	7 – 25.5cm (mean=12.3±3.8, n=46)	*Pera glabrata*, *Sideroxylon obtusifolium*, *Eugenia ovalifolia* and dry branches of unidentified species

* significant differences (Mann-Withney, Z=2.21, p<0.05).

(Mart.) Dubard., *Passiflora alliacea* Barb. Rodr., and *Centrosema brasilianum* (L.) Benth. as its main nectar sources. The first two plant species have long tubular corollas that demands long proboscis for legitimate nectar collection. On *M. funiformis* flowers, females of *X. ordinaria* were robbers, as they pierced the base of the corolla with their galls and did not contact the reproductive organs of the flowers. This thief behavior was also observed in some flowers of *C. brasilianum*, which the specialized morphology requires large bees for pollination, preventing the access to nectar from small bees. *X. ordinaria* also visited *P. alliacea* as a nectar source, and its body size and behavior on flowers are adequate for pollination.

One observation of dehydration behavior was made, when a female of *X. ordinaria* was underneath a leaf exposed to the sun. For 14 min and 30 sec, the female opened and closed its galls several times, and a drop of nectar flowed to the top of the tongue being ingested again.

The analysis of the provisioning mass from two cells of the same nest showed that 23% and 20% of their weight was liquid. The analysis of provisioning masses or feces from 17 cells demonstrated the use of 16 pollen morphotypes, where two to five pollen morphotypes could be found in a single cell. The provisioning mass is homogeneous and has a predominant pollen type (mean=76.3%±17.7%, n=17), but other pollen morphotypes could be found.

The time spent on the provisioning activity was very variable, as a consequence of the time spent on the search for floral resources and availability of pollen. The nectar flights could occur while collecting pollen or after provisioning the cell with pollen. The flights for pollen collection lasted from three to eight minutes (mean=5.01±1.64, n=9) and the flights for nectar collection or feeding lasted from 1 to 65 minutes (mean=11.49±16.34, n=29).

DISCUSSION

The nests of *X. ordinaria* in the restinga of Grussai/Iquipari Lagunar Complex presented a higher density (6.5nests/he) when compared to the study performed by Da Silva & Viana (2002) for nests of *X. cearensis* (4.4nests/he), but similar to this species, the nests of *X. ordinaria* presented a clustered distribution. This distribution pattern may be related to the philopatry behavior presented by some *Xylocopa* species (Camillo & Garófalo 1989) or to restrictions imposed by nesting substrates distribution (Camillo & Garófalo 1989, Gerling *et al*. 1989, Hogendoorn & Velthuis 1993, Da Silva & Viana 2002). The last hypothesis is reinforced by the greater values of the variance/mean index for the Shrub/*Clusia* area compared to the Restinga Forest formation. The substrates at the first area are distributed in patches as a consequence of this plant community structure (Assumpção & Nascimento 2000, Esteves & Lacerda 2000), where the bushes environment facilitates the germination and growing of other plant species, such as the host plants of nests, and could directly influence the nests distribution.

The hypothesis of environmental restriction on the nest distribution is also corroborated when considering the study on the plant community structure of the restinga of Grussai/Iquipari Lagunar Complex (Assumpção & Nascimento 2000): 1. the absence of nests at the Beach Grass formation was expected, because shrubs or trees that would host nests are absent (Assumpção & Nascimento 2000); 2. at the Shrub/*Clusia* area the lower density of nests, compared to the Restinga Forest formation, may be correlated with the rare occurrence of potential nesting substrates. As indicated by Assumpção & Nascimento (2000), the main shrub species in this area are *Schinus terebinthifolia* Raddi, Anacardiaceae and *Eugenia sulcata* Spring ex Martius, Myrtaceae, pointed out by Lorenzi (2002 a,b) as hard and resistant to decomposition. These characteristics are unfavorable to excavation by *Xylocopa* species, which in general use soft substrates or substrates at the beginning of the decomposition process (Hurd 1958, Gerling *et al*. 1989). Besides that, the circumferences of the branches at the Beach Grass and Shrub formation are very small and probably inadequate to *X. ordinaria*; 3. the higher density of *X. ordinaria* nests at the Restinga Forest formation is associated with the distribution

Table II. Internal measurements of *Xylocopa ordinaria* nests collected from different substrates of the restinga of Grussai/Iquipari Lagunar Complex (measurements in cm).

Nest Characteristics	Range (mean±SD, n)
Number of brood cells	1 – 9 (4.63 ± 2.14, 19)
Tunnel length	7.1 – 38.0 (15.67 ± 7.21, 25)
Cell Length	1.50 – 2.64 (2.05 ± 0.27, 81)
Cell width	1.36 – 1.84 (1.56 ± 0.11, 83)
Operculum width	0.14 – 0.65 (0.36 ± 0.13, 51)

SD = Standard Deviation and n = number of observations.

Table III. Plant species used as nectar and pollen resources by *Xylocopa ordinaria* in the restinga of Grussai/Iquipari Lagunar Complex, São João da Barra, RJ.

Family	Species	Relative Abundance of *X. ordinaria* (%)	Main Resources	
			Pollen	Nectar
Anacardiaceae	*Schinus terebinthifolia* Raddi	1.7		X
Apocynaceae	*Mandevilla funiformis* (Vell.) K. Scum.	7.6		X
Apocynaceae	*Temnadenia stellaris* (Lindl.) Miers	2.5		X
Arecaceae	*Allagoptera arenaria* (Gomes) Kuntze	9.3	X	
Asteraceae	not identified	2.5		X
Bignoniaceae	*Arrabidaea conjugate* (Vell.) Mart.	18.6		X
Boraginaceae	*Cordia verbenaceae* DC.	3.4		X
Boraginaceae	*Heliotropium polyphyllum* Lehm.	0.8		X
Burseraceae	*Protium heptaphyllum* (Aubl.) Marchand	3.4		X
Cactaceae	not identified	1.7		X
Celastraceae	*Maytenus obtusifolia* Mart.	1.7		X
Clusiaceae	*Clusia hilariana* Schletch.	1.7	X	
Leguminosae	*Centrosema brasilianum* (L.) Benth.	4.2		X
Leguminosae	*Centrosema virginianum* (L.) Benth.	0.8		X
Leguminosae	*Crotalaria retusa* L.	3.4		X
Leguminosae	*Machaerium lanceolatum* (Vell.) Macbr.	0.8		X
Leguminosae	*Vigna sp.*	2.5		X
Leguminosae	*Zollernia glabra* (Spreng.) Yakovlev	0.8		X
Malpighiaceae	*Byrsonima sericea* DC.	1.7	X	
Malvaceae	*Sida cordifolia* L.	2.5		X
Myrtaceae	*Eugenia nitida* Cambess	1.7		X
Myrtaceae	*Eugenia ovalifolia* Camb.	2.5		X
Passifloraceae	*Passiflora alliacea* Barb. Rodr	4.2		X
Sapindaceae	*Paullinia weinmanniefolia* Mart.	2.5		X
Sapindaceae	*Urvillea rufescens* Cambess.	14.4		X
Sapotaceae	*Manilkara subsericea* (Mart.) Dubard.	0.8		X
Sapotaceae	*Sideroxylon obtusifolium* (R.&S.)P.	0.8		X
Solanaceae	*Solanum curvispitum* Dun.	0.8	X	

and occurrence of its main nesting substrates (*P. glabrata* and *S. obtusifolium*) at the study area (Assumpção & Nascimento 2000).

Assumpção & Nascimento (2000) considered *P. glabrata* as the most representative plant species of the Restinga Forest and *Clusia* formations, as a consequence of its high coverage index (relative frequency X relative coverage). Other factors that could contribute for the high frequency of nests in *P. glabrata* are the great number of branched plants at these areas (Assumpção & Nascimento 2000) and the characteristics of soft wood (Lorenzi 2002a). The higher frequency of nests in *S. obtusifolium* occurs at the most inner region of the Restinga Forest formation, which coincides with its area of greater relative frequency (Assumpção & Nascimento 2000).

The analysis of the nesting substrates used by *X. ordinaria* suggests that there are preferences for certain characteristics and abundance of substrates, independent of botanical affinity, as described for *X. frontalis* and *X. grisescens* (Camilo & Garófalo 1982, Pereira 2002), *X. suspecta* (Camillo *et al*. 1986), *X. pubescens* (Spinola) (Hogendoorn & Velthuis 1993, 1995), and *X. cearensis* (Da Silva & Viana 2002, Viana *et al*. 2002). Specificity to host plant species was observed for *X. virginica* (Linn.), *X. ciliate* Burmeister, 1876, and *X. artifex* Smith, 1874 (Gerling *et al*. 1989), and a strict association between *X. abbreviata* and *Echolirium espectabile* (Bromeliaceae) was described by Ramalho *et al*. (2004).

The substrate's circumference and the nest entrance height above ground were similar to that described for other *Xylocopa* species studied by Da Silva & Viana (2002). The frequency of nests at circumference intervals did not show significant difference between the two areas, therefore it is not possible to evaluate if there are preferences for these substrate's circumferences or if it is an ecological restriction imposed by the phenotypic characteristics of the host plant species in the restinga of Grussai/Iquipari Lagunar Complex. Studies on this preference should be performed in areas that present distinct plant structure characteristics. On the other hand, the analysis considering the variation of nest entrance height above ground revealed that it is higher at the Restinga Forest formation, area that presents taller plants (Assumpção & Nascimento 2000), suggesting that it is directly influenced by the vegetation characteristics.

The nests of *X. ordinaria* presented characteristics very similar to the nests of other *Xylocopa* species, such as number and shape of cells, number and length of tunnels and shape of the entrance (Camilo *et al*. 1982, Fernández & Parra 1985, Camilo *et al*. 1986, Gerling *et al*. 1989). However variations between cells of males and females are common (Steen & Schwars 2000, Pereira 2002, Ramalho *et al*. 2004) they were not considered in the present analysis.

Most nests of *X. ordinaria* presented a single tunnel, which could be determined by characteristics of the host plant species or by the circumference of the host substrate, as observed by Steen & Schwars (2000) for *X. bombylans* Smith nesting in plants of the genus *Banksia*, and by Ramalho *et al*. (2004) for *X. abbreviata* nesting in stems of *E. espectabile*. However, nests with more than one tunnel and more than one female were also observed. These are important factors for studies on intra-specific interactions inside the nest, determination of foraging and reproduction strategies, as well as distribution of tasks inside the nest (Hogendoorn & Velthuis 1993, 1995, 1999; Hogendoorn 1996), indicating *X. ordinaria* as a new potential species for studies concerning the evolution of social behavior among the carpenter bees (Michener 1974).

The causes of death of immatures of *X. ordinaria* were infestation of brood cells by fungus and cleptoparasitism by Coleoptera of the genus *Cissites*. The infestation by fungus has been described as one of the main causes of immature death (Gerling *et al*. 1989, Roubik 1989, Pereira 2002). On the other hand, the cleptoparasitism by species of *Cissites*, also reported by other authors (Hurd 1958, Gerling *et al*. 1989, Roubik 1989, Pereira 2002) was highlighted as a strict association of *Cissites* to *Xylocopa* species (Pinto & Bologna 1999).

The data of bees on flowers and the occurrence of occupied nests along the whole year suggest that *X. ordinaria* is a multivoltine species, presenting more than two generations per year. Though multivoltine, *X. ordinaria* presented greater nesting activity between July and December, and it could be associated with greater offer of flower resources in the area. Watmough (1983), studying the mortality, sexual ratio and fecundity of natural populations of carpenter bees, demonstrated that multivoltine species produce less individuals per generation, but the sum of the total individuals produced along a period of time is higher than the number produced by univoltine species, being the voltinism determinant of reproduction strategy and parental care.

From the data of flower visiting bees, we could identify the generalist habit of *X. ordinaria* for nectar flowers. These bees visited flowers with different morphologies and from different botanical families, where it could present specialized and legitimate behaviors acting as an effective pollinator. But in some species, *X. ordinaria* behave as a robber by perforating the corolla to reach the nectar, hidden in the deeper part of the flower and did not act as pollinators. Similar observations were made for other *Xylocopa* species in different ecosystems (Gottsberger *et al*. 1988, Gerling *et al*. 1989, Pereira 2002, Viana *et al*. 2002).

The results from the pollen analyses indicate *X. ordinaria* as a polilectic species on the gathering of pollen, using more than 16 different pollen morphotypes at the same period of the year to feed their brood. The presence of a predominant pollen morphotype in each provisioning mass indicates the effectiveness of *X. ordinaria* as pollinator of plants in the restinga of Grussai/Iquipari Lagunar Complex, since many visits to flowers of the same plant species are necessary to provisioning each brood cell (Buchmann 1983, Buchmann & Nabhan 1996).

Our observation of nectar dehydrating behavior was different from the ones made by Camillo & Garófalo (1982, 1989), Camillo *et al*. (1986) and Pereira (2002). They observed females dehydrating nectar at the entrance of the nest and, right after this behavior, the nectar will be transferred to the provisioning mass. The behavior of dehydrating nectar while foraging was also observed for males of *X. nigrocincta* Smith, 1854 (Wittmann & Scholz 1987). According to these authors, the dehydration increases the ratio energy/volume of nectar, which allows the males to persist more time on their mating territories. The nectar dehydration made by *X. ordinaria* females out of their nests might be related to the high energy demand associated to the time spent at foraging flights or to the deposition of this more concentrated nectar in the provisioning masses. The last hypothesis is corroborated by the small difference between wet and dry weight found for provisioning masses (~20%), indicating that only a small portion of provisioning masses is water.

Visits to flowers were observed all over the day, from early in the morning (05:00a.m.) through the end of the afternoon (06:00p.m.). This foraging flight behavior was also observed for other *Xylocopa* species, and Gerling *et al*. (1989) and Viana *et al*. (2002) highlighted that these bees can present floral constancy associated with the abundance of flower species on certain hours of the day. The time spent on foraging flights for pollen and nectar, as well as the time spent inside the nest, varied much, likely other *Xylocopa* species (Camillo & Garófalo 1982, Camillo *et al*. 1986, Gerling *et al*. 1989, Pereira 2002). These behaviors could be related to the flight distance to flower resources, as well as the type of activity performed by the female (pollen or nectar collecting, deposition and manipulation of food inside the brood cells, excavation activities). In order to better understand the nest construction and provisioning strategies, more detailed studies should be made concerning time spent in each activity and sequence of activities performed by females.

The present study demonstrated the great abundance and the clustered distribution pattern of *X. ordinaria* nests at the restinga of Grussai/Iquipari Lagunar Complex, and has suggested that these bees do not present botanical affinity for nesting substrates, but have preferences for wood availability and characteristics. *X. ordinaria* was characterized as a multivoltine species that tolerates co-specifics in their nests, indicating some level of sociality. These bees were generalist on their nectar and pollen consumption, but presented floral constancy while provisioning each brood cell with pollen. These behaviors summed to their activity along the year, flights through out the day, legitimate visits to flowers at period of greater blossoms indicate the importance of *X. ordinaria* on the pollination of plants in the restinga and suggest its utility for sustainable pollinator management programs of native and cultivated plants.

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