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Original article

Nesting biology of *Centris* (*Hemisiella*) *vittata* Lepeletier in southeastern Brazil (Hymenoptera, Apidae, Centridini)

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Abstract – Nests of *Centris vittata* were obtained from trap-nests at Santa Carlota Farm, Cajuru, SP, Brazil. The bees nested in bamboo canes ranging from 8.5 to 24.7 cm in length and from 0.9 to 1.9 cm in diameter. The bees constructed their nests with a mixture of soil and an oily substance. Completed nests had 1–8 urn-shaped cells arranged in a linear series, separated by a space filled with loose soil. The nest plugs resembled the bottoms of cells and were externally covered with an oily material. In some cases they were also covered with an another yellowish, sticky substance of unknown origin. The innermost cells of the nests produced females and the outermost cells males, resulting in proterandry. Females were significantly larger than males, and no dimorphism in males was found. Nests were parasitized by the megachilid bee, *Coelioxys* sp., the bombyliid fly, *Anthrax* sp. and by meloid beetles. *C. vittata* nested exclusively in the hot and wet season (September–April), producing at least two generations. © Inra/DIB/AGIB/Elsevier, Paris

nesting biology / trap-nest / *Centris vittata* / Apidae / Brazil

1. INTRODUCTION

Studies of *Centris* sp. bee nesting habits show that species of most subgenera excavate nests in the ground. Those of the subgenera *Hemisiella, Heterocentris* and *Xanthemisia* construct nests in existing holes [10, 11, 16, 17, 18]. Information on nesting biology is available for several nest-excavating species [1, 3, 5, 6, 8, 10, 11, 17, 33, 40–43]. However, the literature on this topic for species that nest in pre-existing cavities

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remains limited. Bertoni [4] reported finding hundreds of nests of *Centris (Hemisiella) lanipes* in mud walls of a house. Vesey-FitzGerald [39] found *Centris (Heterocentris) labrosa* and *Centris (Heterocentris) analis* nesting in old *Sceliphron* cells. Michener and Lange [29] described *C. lanipes* nests that were constructed in old beetle borings in logs and wooden buildings. Batra and Schuster [3] related that females of *Centris (Hemisiella) transversa* nested most often in old exposed bee cells in earth banks, but they also facultatively constructed new horizontal burrows. Parker [30] and Linsley et al. [28] reported *C. analis* nesting in old cells of *Melitoma*. Kimsey [26] observed *C. labrosa* nesting in the holes of a dead tree. Jayasingh and Freeman [23] obtained three nests of *Centris (Hemisiella) crassipes* from trap-nests in Jamaica. Utilizing trap-nests, Frankie et al. [16, 18] studied the preferred nesting habitats of *Hemisiella* and *Heterocentris* species in the Costa Rican dry forest. Although these authors have obtained nests of two *Hemisiella* species and four *Heterocentris* species, they provided no detailed description of the nests. Heithaus [20] and Frankie et al. [15, 17] reported information on seasonal nesting periods.

In this paper we present information obtained from trap-nests on the nesting biology and seasonal abundance of *Centris (Hemisiella) vittata*, a widespread species throughout South and Central America [34].

2. MATERIALS AND METHODS

2.1. Study site

The study was conducted at Santa Carlota Farm, Municipio of Cajuru (between 21° 18'–21° 27' S and 47° 12'–47° 18' W), State of São Paulo, Brazil. The farm has an area of 6 300 ha with altitudes ranging from 540 to 944 m. It is located between the Pardo and Cubatão river valleys, and it is drained by several streams. Of the total area, approximately 2 200 ha are isolated patches of native vegetation surrounded by cultivated land and/or pastures. In most cases there are narrow corridors of native vegetation connecting larger patches. Four plant communities are recognized at the farm: dry semi-deciduous forests, riparian forests, 'cerrados' (structurally a semi-deciduous xeromorphic low-arboreal woodland or low forest, or a closed to somewhat open scrub [14]) and 'cerradões' (structurally a semi-deciduous xeromorphic medium-tall to tall arboreal woodland (when it has a semi-open canopy) or forest (when it has a more or less closed canopy) [14]). In addition, there are some areas with several stages of secondary growth.

Trap-nests were placed in two areas of the farm: here, one is called the Santana Section (= SS), and the other, the Itaoca Section (= IS). The SS is characterized by an abandoned orchard with specimens of *Carica* sp., *Mangifera* spp., *Citrus* sp., *Myrciaria* sp., *Genipa* sp., *Eugenia* sp., *Musa* sp. and *Annona* sp.; about 50 m away there are two abandoned houses, a stable and a shed; adjacent to the orchard there is a pasture and a 'cerradão'. The IS is characterized by the presence of six abandoned houses surrounded by plots planted with sugar cane, corn, rice and sorghum; about 300 m away from the houses there are areas with dry semi-deciduous forest and riparian forest.

Two seasons are recognizable at the study site, based on precipitation and temperature. There is a cool dry season extending from May to August, with the mean monthly temperature ranging from 18.2 to 22 °C and precipitation from 0 to 116.2 mm. A hot and wet season extends from September to April, with the hottest months being January, February and March (25.9–27.9 °C) and the wettest being December, January and February (128.8–368.5 mm).

2.2. Methods

Trap-nests consisted of hollow bamboo canes which were cut so that the nodal septum closed one end of the cane. Of the 450 canes used, 210 were placed at SS and 240 at IS. Trap-nests varied in length from 7.0 to 25.0 cm and internal diameter from 0.5 to 2.5 cm though all sizes were not equally represented. The canes were placed horizontally in bundles of four to six units along two shelves in a shelter built at each study site. The shelves were 1.2 and 1.5 m from the ground. At SS, the canes were positioned so that its openings faced north, and at IS faced south. The trap-nests were inspected once per month from April 1988 to March 1990 at SS, and from April 1989 to March 1991 at IS. Each inspection was made

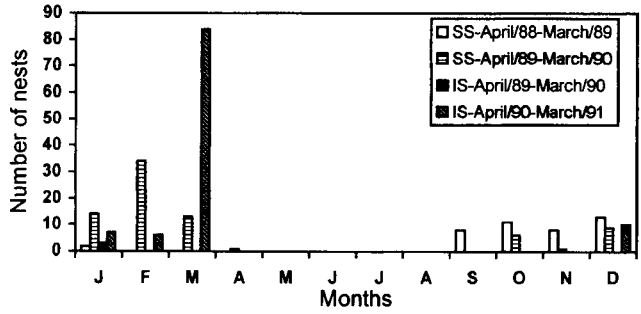


Figure 1. Number of nests of *C. vittata* obtained monthly, from April 1988 to March 1990, at Santana Section (SS), and from April 1989 to March 1991, at Itaoca Section (IS).

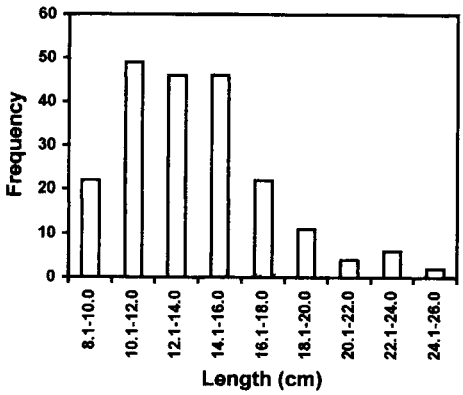


Figure 2. Distribution of lengths of bamboo internodes used by *C. vittata*.

with the aid of an otoscope. When traps contained completed nests, they were collected and replaced with empty ones. In the laboratory, each bamboo cane was introduced into a transparent plastic tube, 8.0 cm longer than the bamboo cane, with one end closed with a cork. As adults emerged into the plastic tube, the cork was removed and the adults were collected. The nests were kept at room temperature (21–29 °C) and they were observed daily until the adults emerged. When the last emergence from any given nest occurred, some 10–15 days later, it was opened to analyse its structures and to take measurements. Nests from which nothing emerged were also opened, and the cause and stage of mortality were recorded. In addition to these nests, other nests from SS were opened before adult emergence to examine cocoon and cell cap details. The head width of individuals was taken as a measure of body size.

3. RESULTS

3.1. Nest numbers and seasonality

C. vittata nested during the hot and wet season (September–April) with the highest frequencies of nesting occurring in February at SS and March at IS. Of the 230 nests obtained from 450 canes, 120 were established at SS and 110 at IS. The number of nests made per year ranged from three (April/89–March/90 at IS) to 107 (April/90–March/91 at IS) (*figure 1*).

3.2. Nest architecture

The bamboo canes utilized by the bees ranged from 8.5 to 24.7 cm in length (n = 208) (*figure 2*) and from 0.9 to 1.9 cm in diameter (n = 190) (*figure 3*). Space occupied by the nest within the trap was filled with a firm and hard sandy soil uniformly mixed with an oil-like substance, and the cells were moulded within this oily soil. The cells were oriented horizontally, constructed in linear series (*figure 4*), and separated by a 0.1–0.9 cm (x = 0.3 ± 0.2 cm; n = 80) space that was filled with loose soil which was easy to remove. The number of cells in completed nests (n = 230) ranged from 1 to 8, but 85.7 % of nests contained two (29.6 %), three (35.2 %) and four (20.9 %) cells only (*figure 5*). The number of cells was significantly correlated with the length of bamboo cane sections (r = 0.19; $P < 0.05$; n = 208).

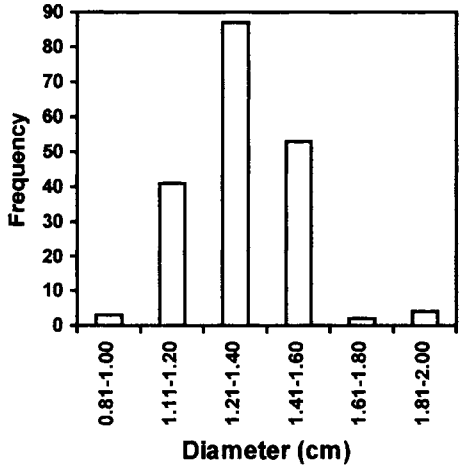


Figure 3. Distribution of diameter of borings in bamboo internodes used by *C. vittata*.

The cells were usually urn-shaped (*figure 6*). Sometimes they were elongated ovals, and in rare cases they were ovoid. Irrespective of the shape, all cells were rounded on the bottom and truncated at the cell closure. The inner cell wall was lined with a thin layer of a liquid oily material, giving the cell a shiny and smooth appearance. The inside measurements of cells ranged from 1.4 to 2.3 cm long (x = 1.9 ± 1.7 cm; n = 193), measured from the point where the cell cap joins the side of the cell to the cell bottom) and from 0.7 to 1.3 cm in maximum diameter (x = 1.0 ± 0.8 cm; n = 193). Female cells (x = 1.8 ± 0.2 cm long; n = 46 and x = 1.0 ± 0.1 cm wide; n = 44) were significantly longer and wider than male cells (x = 1.7 ± 0.2 cm long;

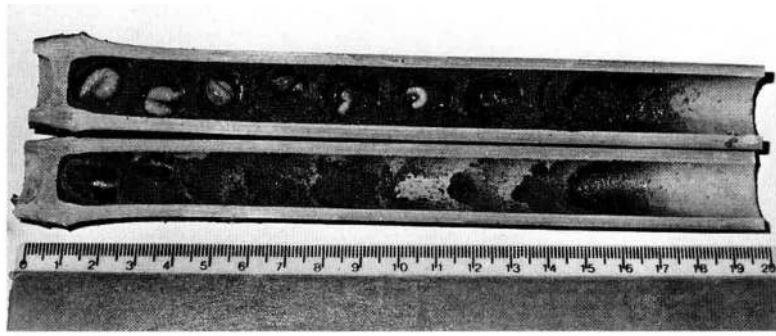


Figure 4. Bamboo internode split in half showing a seven-celled linear nest of *C. vittata* with larvae in different developmental stages.

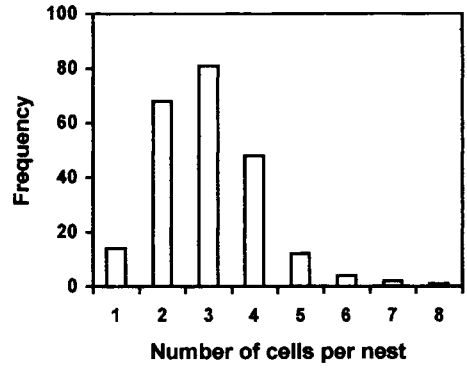
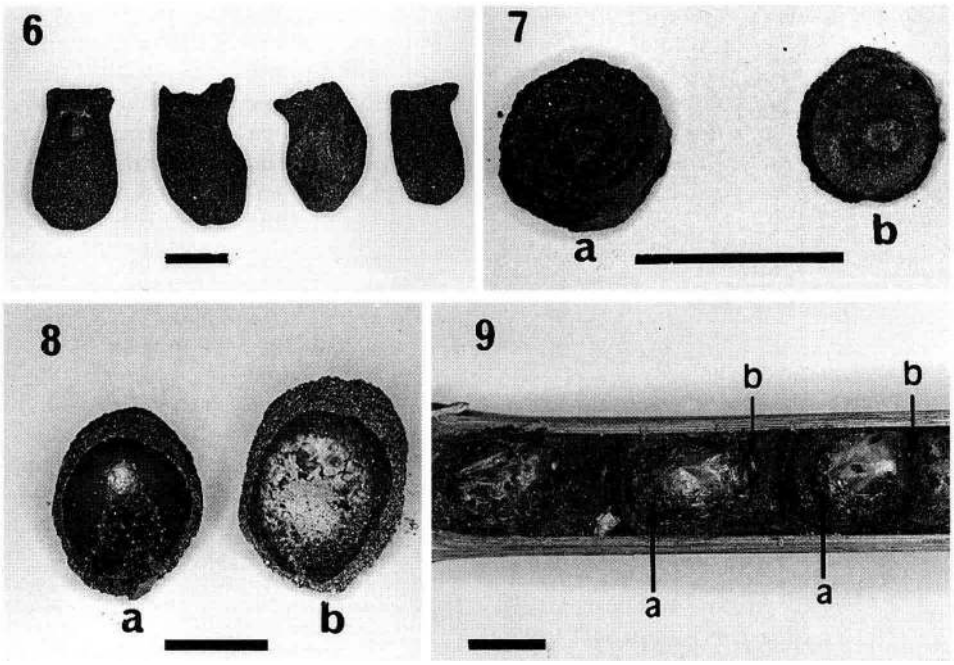


Figure 5. Distribution of number of cells constructed in nests of *C. vittata*.

n = 25 and x = 0.9 ± 0.1 cm wide; n = 25) (Mann-Whitney test, Z = –3.04 and Z = –3.89, $P < 0.05$, respectively).

The cell caps were round and made of the same oily soil utilized in cell construction. These caps joined the cell wall 2.0–3.0 mm below the edges of the cells and their thickness at the edges ranged from 0.2 to 0.8 cm (x = 0.3 ± 0.2 cm; n = 80). The inner surface of the cap was smooth, plane in some cases and slightly concave in others, with a depression at the centre or near it and showed no spiral pattern. The outer surface of the cap was rough, irregular



Figures 6–9. 6. Cells of *C. vittata* showing variation in form and size. **7.** Cell cap of *C. vittata*, outer (a) and inner (b) views. **8.** Nest plugs of *C. vittata* covered with oily material (a) and this plus a yellowish, sticky substance (b) (the photo was taken after the substances' hardening). **9.** Bamboo internode split in half, revealing the cocoons of *C. vittata* with faecal pellets compressed at the bottom (a) and showing the nipple at the top (b). Scale bars are 1 cm.

and slightly convex, exhibiting a structure like a short mound that corresponded in position to the depression on the inner surface. This structure could be observed only after removing the soil placed around it (*figure 7*). Both the inner and the outer surfaces of the cap were unlined with oily material.

Between the last brood cell and the nest plug there was a space filled loosely with soil apparently without any oily substance. The space ranged in length from 0.2 to 5.7 cm ($x = 1.9 \pm 1.3$ cm; $n = 50$). The nest plugs were built recessed from the bamboo cane entrance and they were made of the same material used in cell construction. The distance from nest plug to bamboo cane entrance ranged from 2.8 cm (in a six-celled nest) to 16.1 cm (in an one-celled nest). The plugs resembled the bottoms of cells, with their walls extending towards the cavity entrance. The inner side of the plug was rough and convex, and the outer side was smooth and profoundly concave. In the middle region the nest plugs ranged from 0.2 to 1.0 cm thick ($x = 0.4 \pm 0.1$ cm; $n = 103$) but their walls were not as thick. The outer side of the plug was covered with an abundant amount of liquid oily material, which hardened within a few days. In some nests, the plugs were also covered with another yellowish, sticky substance of unknown origin (*figure 8*).

Cocoons were thin, chestnut in colour, and appeared to have at least two layers of a translucent membrane. The outer layer was loosely attached to the cell wall. The inner

layer was fused with the outer layer along the entire cell. Faeces were applied to the bottom one-third of the cocoon between the two layers, and most faecal pellets were compressed at the bottom. The top of the cocoon had an opaque, cream-coloured nipple that filled the central depression of the cell cap (*figure 9*).

3.3. Contents of nests

Of the 230 nests obtained, 14 nests produced only females, nine nests had females and parasites, 17 nests had only males, five nests had males and parasites, 78 nests had both sexes, six nests had both sexes and parasites, four nests had only parasites, and in 15 nests all immatures were dead. In 72 out of 82 remaining nests, dead immatures were found in nests that produced females ($n = 19$), females and parasites ($n = 1$), males ($n = 26$), males and parasites ($n = 5$), both sexes ($n = 15$), both sexes and parasites ($n = 1$) and parasites ($n = 5$). From ten other nests, some female and male individuals emerged and escaped. These individuals were reared in nests producing females and males ($n = 4$), parasites ($n = 1$), and in nests that, in addition to producing females ($n = 1$), males ($n = 1$) or parasites ($n = 1$), contained some dead immatures or only dead immatures ($n = 2$).

3.4. Sequence of sexes in nests, period of development, sex ratio and size of individuals

In the nests that produced both sexes, males always emerged before females. Males are reared in cells closest to the nest entrance, and females are reared in cells further away. Although the total duration from oviposition to adult emergence has not been determined, the maximum interval between collection date of the nests and adult emergence may provide an estimate of that period. For males that period ranged from 43 to 91 days ($x = 59.2 \pm 9.4$; $n = 196$) while for females it was from 43 to 101 days ($x = 67.1 \pm 12.7$; $n = 132$). These estimates show that the developmental period of males is shorter than that for females, confirming the proterandry observed during emergence. These figures also suggest the occurrence of at least two generations during the nesting season.

The sex ratio of 216 individuals emerging from nests collected at SS was 54.6 % female to 45.4 % male (not significantly different from a 1:1 sex ratio; $x^2 = 1.67$, $P > 0.05$) while that of 275 individuals produced from nests collected at IS was 38.9 % female to 61.1 % male (significantly different from a 1:1 sex ratio; $x^2 = 13.09$, $P < 0.05$). Considering the samples from both sites together, the sex ratio was 45.8 % female to 54.2 % male which is not significantly different from a 1:1 sex ratio ($x^2 = 3.26$, $P > 0.05$).

The size of females ranged from 5.81 to 7.96 mm ($x = 7.06 \pm 0.44$ mm; $n = 170$), and, as in most bee species, they were significantly larger than the males (range from 4.81 to 6.31 mm; $x = 5.88 \pm 0.24$ mm; $n = 106$) ($t = 25.06$, df = 274, $P < 0.001$).

3.5. Immature mortality and nest associates

At SS, adult bees emerged from 222 of 333 constructed cells in the nests; among the remaining cells, 87 (26.1 %) contained dead immatures, from unknown causes, and 24 (7.2 %) had been parasitized by insects. The immatures died in the egg stage (43 cells), larval stage (22 cells), pupal stage (17 cells) and as pre-emergent adults (5 cells). Among the parasites, the megachilid bee *Coelioxys* sp. was reared from 19 cells, *Anthrax* sp. (Diptera: Bombyliidae) emerged from three cells, and larvae of meloid beetles were found in two cells. At IS, 279 cells produced adult bees, 57 cells (15.9 %) contained dead immatures and 22 cells (6.2 %) were parasitized. The immatures died in the egg stage (29 cells), larval stage (17 cells), pupal stage

(8 cells) and as pre-emergent adults (3 cells). Larvae of meloid beetles were found in 17 cells, and *Coelioxys* sp. was reared from five cells. The intersite difference in percentage brood survival was due to loss of immatures by unknown causes, which was significantly higher at SS ($x^2 = 10.89$, df = 1, $P < 0.01$). There was no difference between the parasitism rates of the two sites ($x^2 = 0.31$, df = 1, $P > 0,05$).

4. DISCUSSION

C. vittata characteristically makes use of trap-nests of various diameters. This is also true for several other bee and wasp species which nest in pre-existing cavities. Selection of a particular diameter of nesting burrow is probably a function of female body size [19, 27, 35].

Frankie et al. [16, 18], studying the preferred nesting habitats of *Centris* species that utilize pre-existing holes, reported that each species prefers a certain size entrance hole and that *C. vittata* nested in the largest diameter traps (11 mm). In our study, however, 84.4 % of nests were established in traps with diameters larger than 11 mm. This suggests that traps 11 mm in diameter are inappropriate for studies focused on this species, at least for the sites sampled here.

The mixture of soil and oily material used by *C. vittata* as nest construction material, as observed by Pereira [32], may be a characteristic of *Hemisiella* species. Females of *C. nitida*, *C. trigonoides* and *C. vittata* captured after having collected soil contained a mixture of oil plus soil on their legs [44]. Moreover, analysis of soil found around and between the cells of *C. nitida* yielded a thin layer chromatography pattern nearly identical to *Byrsonima crassifolia* oil, a Malpighiaceae species visited by *Centris* to collect oil [45]. The composition of the oil from *B. crassifolia* consists primarily of mono- and di-glycerides along with some tri-glycerides and free fatty acids [46].

As in other cavity nesters, the cell arrangement in nests of *Hemisiella*, *Heterocentris* and *Xanthemisia* species depends upon spatial limitations of the cavity [10]. Thus, the pattern of cell arrangement in nests of *C. vittata* followed the configuration of trap-nests used in this study. A similar pattern was found in a nest of *C. lanipes* constructed in an old hole made by wood boring Coleoptera [29]. In contrast, cell arrangements in *C. autrani* [21], *C. aethyctera* [40] and *C. inermis* [10] (= *segregata* Crawford, see [34], all nest-excavating species, were also similar to that of *C. vittata*, the difference being the stacking of cells in a vertical or nearly vertical burrow.

The shape of *C. vittata* cells is typical of the genus [6, 8, 33, 43]. Also, absence of a spiral structure on the inner surface of the cell cap and construction of the cell cap below the tops of the cell edges are characteristics shared by all *Centris* species with available nesting data, although the distance between the edge tops and the cell cap may vary among them. However, like *C. (Xerocentris) pallida* [1, 33] and *C. (Paracentris) mixta* [8], the structure of the outer surface of the cell cap of *C. vittata* did not show any passageways connecting the cell lumen with the exterior; this seems to occur also in *C. (Hemisiella) nigriventris* [25], *C. (Melanocentris) furcata* and *C. (Paracentris) autrani* [21] and *C. (Hemisiella) lanipes* [29] since no reference to a particular structure was provided by those authors. Thus, the absence of a passageway connecting the cell lumen with the exterior is a characteristic found in species belonging to several subgenera.

As related by Vinson et al. [45] and as observed in this study, the plug of *C. vittata* nests resembled a partial cell, and it was covered externally with oily material. Although such covering of the nest plug has not been observed in *C. (Hemisiella) trigonoides* [16], this trait is shared by several species of two subgenera: *C. nitida* [45], *C. tarsata* (Garófalo et al., unpubl. data), two additional *Hemisiella* species, and

C. bicornuta [16] and *C. analis* [16, 24], two *Heterocentris* species. Probably, the function of the oily material covering the nest plug is to provide greater protection to the nest, since the plug becomes harder after being covered. This may reduce the possibility of nest invasion by natural enemies.

The cocoons of *C. vittata* were similar to those of other *Centris* species not only in their shape which conforms to the inner surface of the cell, but also by the presence of a nipple on the top of the cocoon which occupies the depression above it on the inner surface of the cell cap [6, 8, 10, 11, 33, 40, 43]. In contrast, the presence of faeces between the two layers of the membrane of the cocoon was only observed in *C. flavofasciata* [43] and *C. collaris* [6].

What is known of the number of cells in nests of *Hemisiella* species indicates that there are one to eight cells in *C. lanipes* [29], from one to five cells in *C. transversa* [3], from two to six cells in *C. trigonoides* and from one to three cells in *C. vittata* [45]. These figures are not very different from those observed in this study, although 29.1 % of nests contained more cells than those reported for *C. vittata* by Vinson et al. [45]. The use of pre-existing holes for nests may suggest that the number of cells depends upon the spatial limitations of the cavity being utilized. Such a suggestion would be reinforced if a correlation were found between the length of bamboo cane internodes and the number of cells per nest. However, the low correlation coefficient value found in our study indicates a weak association between these parameters.

The rearing of females from the inner cells and males from the outer cells of *C. vittata* nests is a characteristic exhibited by many solitary bee and wasp species (see Krombein [27] also nesting in trap-nests. This was also observed by Jesus [24] in nests of *C. analis* established in trap-nests. Although some hypotheses have been proposed to explain this fact [22], the factors determining the distribution of the sexes within the nests are unknown [9]. In *C. vittata* nests, the males emerge before females, facilitated by the spatial arrangement of the sexes. This pattern of emergence was also reported for *C. pallida* [2], *C. caesalpinae* [33] and *C. fuscata* [6], all nest-excavating species that construct one cell at the end of each brood tunnel.

Dimorphism in males, as found in *C. pallida* [2], *C. inermis* [10], *C. flavifrons* [34], *C. flavofasciata* [7] and *C. caesalpinae* [33], was not observed in *C. vittata*. In this species, as in *C. mixta* [38], the males were significantly smaller than the females with very little overlap in their respective size ranges.

Coelioxys, Anthrax and meloid beetles were the insect parasites associated with the nests of *C. vittata*. Although *Coelioxys* and meloid beetles parasitized nests in both study sites, they differed spatially in their intensity of attack. At SS, the nests were attacked most often by *Coelioxys* (79.2 % of total parasitism), whereas nests at IS were more frequently parasitized by meloid beetles (77.3 % of total parasitism). Spatial variation in intensity of parasitism by nest associates, as observed in this study, has been reported in other studies of aculeate Hymenoptera (e.g. [12, 13, 36, 31, 37]).

Nesting activities by *C. vittata* occurred exclusively in the hot and wet season. This activity pattern differs from that observed in Costa Rica where *Centris* bees generally nest during most of the dry season (January–May) [15, 20]. *C. vittata*, in particular, seems to nest primarily from late January through March [17]. The difference between nesting seasons reflects the different flowering periods of plants utilized by populations in the areas where they occur. Frankie et al. [17] also reported that all of the tree-hole dwelling *Centris* pass through diapause in the late larval stage from July to November. This was not observed in populations studied here. Males and females reared from nests constructed in the late nesting season (March) emerge during the first part of the

cool and dry season (May and June). As the next nesting season begins around 3 months later, males and females or at least the females, will pass the adverse period taking shelter in unknown places.

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Résumé – Biologie de la nidification chez *Centris (Hemisiella) vittata* Lepeletier dans le sud-est du Brésil (Hymenoptera : Apidae, Centridini). Des nids-pièges ont été placés dans deux endroits de la ferme de Santa Carlota, Cajuru, état de São Paulo (Brésil) : dans la Section Santana (SS) et la Section Itaoca (IS). Ils consistaient en cannes de bambou de diamètre et de longueurs variés. Les cannes reposaient horizontalement sur des étagères placées dans un abri. Les nids-pièges ont été visités une fois par mois d'avril 1988 à mars 1990 à SS et d'avril 1989 à mars 1991 à IS. Lorsque les pièges renfermaient des nids entiers, ils étaient enlevés et remplacés par des pièges vides. Au laboratoire chaque canne de bambou était placée dans un tube en plastique transparent plus long de 8 cm et obturé à l'extrêmité par un bouchon. Les nids ont été conservés à température ambiante et observés quotidiennement jusqu'à l'émergence des adultes. Après l'émergence les nids ont été ouverts, leur structure a été analysée et des mesures ont été prises. Les nids d'où rien n'avait émergé ont également été ouverts et le stade auquel l'insecte était mort a été noté. Il y a eu au moins deux générations de *C. vittata* durant la saison chaude et humide, de septembre à avril (*figure 1*). Les abeilles ont nidifié dans des cannes de 0,5 à 24,7 cm de long (*figure 2*) et de 0,9 à 1,9 cm de diamètre (*figure 3*). Elles ont construit leur nid avec de la terre mélangée à une substance huileuse et les cellules ont été façonnées à l'intérieur de ce substrat. Les cellules étaient disposées horizontalement en lignes (*figure 4*) et leur nombre variait entre 1 et 8 par nid (*figure 5*). Elles avaient généralement une forme d'urne, arrondie au fond (*figure 6*) et tronquée à l'ouverture.

La surface interne de l'opercule était lisse, plate dans certains cas et légèrement concave dans d'autres, avec une dépression au centre ou près du centre. La surface externe était rugueuse, irrégulière et légèrement convexe avec une structure comme une petite butte correspondant à la dépression de la surface intérieure (*figure 7*). Le bouchon était situé en renfoncement par rapport à l'entrée de la canne de bambou. Sa face extérieure était couverte d'huile. Dans certains nids, les bouchons étaient aussi couverts d'une autre substance jaunâtre et collante, d'origine inconnue (*figure 8*). Les cocons, étaient fins et translucides, de couleur châtaigne et semblaient avoir une membrane au moins double. Le sommet du cocon avait un mamelon opaque de couleur crême qui s'encastrait dans la dépression centrale de l'opercule (*figure 9*). Les cellules du nid situées le plus à l'intérieur ont produit des femelles et celles situées le plus vers l'extérieur des mâles. Les nids ont été parasités par *Coelioxys* sp., *Anthrax* sp. et par des coléoptères méloïdés. Les matériaux utilisés par *C. vittata* pour la construction des nids sont caractéristiques de l'espèce *Hemisiella*. Comme chez d'autres insectes qui nidifient dans des cavité, la disposition des cellules suivait la configuration des nids-pièges. La forme des cellules de couvain, la construction de l'opercule à la jonction avec le bord de la cellule et la forme du cocon se retrouvent chez d'autres espèces du genre *Centris*. La structure de l'opercule de la cellule, dépourvu d'un passage reliant le

volume intérieur de la cellule à l'extérieur, diffère de chez la plupart des espèces du genre. On a déjà signalé chez d'autres espèces d'*Hemisiella* et d'*Heterocentris* la présence d'un bouchon recouvert d'une substance huileuse. L'activité de nidification n'a pas lieu à la même période qu'au Costa Rica, où les espèces de *Centris* nidifient généralement durant la plus grande partie de la saison sèche. La diapause, qui survient au stade larvaire au Costa Rica, n'a pas été observée chez les populations étudiées ici. Les adultes, au moins les femelles, passent la mauvaise saison en s'abritant dans des endroits inconnus.

nidification / nid-piège / *Centris vittata* / Apidae / Brésil

Zusammenfassung – Die Nistbiologie von *Centris (Hemisiella) vittata* Lepeletier im südöstlichen Brasilien (Hymenoptera, Apidae, Centridini). Zum Fangen von Nestern von *Centris (Hemisiella) vittata* wurden künstliche Nisthilfen auf der Farm Santa Carlota, Cajuru, im Staat São Paulo, Brasilien eingesetzt. Die Nisthilfen bestanden aus Bambusstengeln mit unterschiedlichen Durchmessern und Längen. Die Stengel wurden in Unterständen an den Untersuchungsorten auf horizontale Regale gelegt und wurden in zwei Gebieten der Farm aufgestellt, der Santana Sektion (= SS) und der Itaoca Sektion (= IS). Am Untersuchungsort SS wurden die Nisthilfen von April 1988 bis März 1990 einmal monatlich inspiziert, an dem Standort IS von April 1989 bis März 1991. Wenn die Nisthilfen fertiggestellte Nester enthielten, wurden sie eingesammelt und durch neue leere ersetzt. Im Labor wurde jeder Bambusstengel in ein durchsichtiges Plastikrohr überführt, das 8 cm länger war als das Bambusrohr. Ein Ende wurde mit einem Korken verschlossen. Die Nester wurden bei Raumtemperatur gehalten und täglich beobachtet, bis die adulten Tiere schlüpften. Nach dem Schlupf wurden die Nester geöffnet, ihre Strukturen analysiert und Messungen durchgeführt. Die Nester, aus denen keine Tiere schlüpften, wurden ebenfalls geöffnet und es wurde das Stadium der Mortalität erfaßt. *C. vittata* nistete in der heißen Jahreszeit (September–April, *Abb. 1*) und erzeugte mindestens zwei Generationen. Die Bienen nisteten in Röhren mit einer Länge von 8.5 bis 24.7 cm (*Abb. 2*) und einem Durchmesser von 0.9 bis 1.9 cm (*Abb. 3*). Die Bienen bauten ihre Nester mit einer Mischung aus Erde und einer öligen Substanz, in der sie die Zellen formten. Die Zellen waren in Serien reihenförmig horizontal angeordnet (*Abb. 4*), die Anzahl pro Nest betrug 1 bis 8 (*Abb. 5*). Sie waren gewöhnlich urnenförmig (*Abb. 6*), am Boden abgerundet und an der Zellöffnung abgestutzt. Die innere Oberfläche des Zellendeckels war glatt und in manchen Fällen flach, in anderen Fällen konkav, mit einer Mulde in oder nahe der Mitte. Die äußere Oberfläche des Deckels war rauh, unregelmäßig und leicht konvex und zeigte eine kurze hügelförmige Struktur, die in ihrer Position mit der Mulde in der Innenseite übereinstimmte (*Abb. 7*). Der Deckel des Nests wurde innen kurz vor der Öffnung des Bambusrohrs angelegt. Die Außenseite des Verschlusses war mit Öl bedeckt. Bei manchen Nestern waren die Verschlüsse mit einer weiteren gelblichen Substanz unbekannter Herkunft bedeckt (*Abb. 8*). Die Kokons waren dünn, durchscheinend, von kastanienbrauner Farbe und bestanden anscheinend aus mindestens zwei Membranschichten. Die Spitze des Kokons hatte einen durchscheinenden cremefarbenen Nippel, der die zentrale Mulde des Zellendeckels ausfüllte (*Abb. 9*). Aus den innen gelegenen Zellen des Nests schlüpften Weibchen, aus den äußeren Männchen. Die Weibchen waren deutlich größer als die Männchen, bei den Männchen wurde kein Dimorphismus gefunden. Die Nester wurden von *Coelix* sp, *Anthrax* sp und Ölkäferarten parasitiert. Die von *C vittata* für den Nestbau benutzten Materialien sind für *Hemisiella*-Arten charakteri-

stisch. Wie bei anderen höhlenbrütenden Arten folgte die Anordnung der Zellen der Struktur der Nisthilfen. Eigenschaften wie die Form der Brutzellen, der Aufbau der Zelldeckel unterhalb der oberen Zellränder und die Form des Kokons sind ähnlich wie bei anderen *Centris*-Arten. Die Struktur des Zelldeckels ohne einen den Zellenraum mit der Außenwelt verbindenden Durchgang weicht von den meisten der anderen Arten ab. Die Bedeckung des Nestverschlusses mit öliger Substanz wurde ebenfalls von anderen *Hemisiella* und *Heterocentris* Arten berichtet. Die Nistaktivität unterschied sich von der in Costa Rica, wo *Centris* Arten generell während des größten Teils der Trockensaison nisten. Ebenso wurde in der hier untersuchten Population keine Diapause im späten Larvenstadium gefunden, wie sie in Costa Rica vorkommt. Von den adulten Tieren suchen zumindest die Weibchen während der ungünstigen Jahreszeit an geschützten, noch nicht bekannten Orten Unterschlupf.

Nistbiologie / Nisthilfen / *Centris vittata* / Centridini / Apinae

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