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OCCURRENCE AND ANALYSIS OF BORINGS MADE BY SOLITARY WASP IN CAVES: A STUDY IN CAVE ICHNOLOGY

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ABSTRACT – The present study investigated entire or partially lithified nests of solitary wasps found in caves in the Brazilian states of São Paulo, Minas Gerais, Goiás, Mato Grosso, Ceará and Bahia. The width and depth of the individual cells, as well as the length, width and height of each nest were measured, and the morphology analyzed. The volumes of the nests from Altinópolis (São Paulo State) were calculated, and the total number of cells was counted. Four different morphological patterns were found for the nests. Many of the nests show evidences of reoccupation by other wasps, even when preservation was already in progress, being both contemporary and older reoccupation patterns observed. Important processes of preservation observed were encrustation and lithification of the original nest material, with the pattern of alteration apparently depending on the location of the nest while exposed to percolating mineral-containing waters. Permineralization was, however, also observed in some of the cells.

Key words: icnofossils, caves, Hymenoptera, nests, Brazil.

INTRODUCTION

As caves are environments quite propitious for the processes leading to fossilization, they often harbor a wide variety of fossils. Animals can enter for shelter or water, or their bones transported in by underground rivers and their periodic flooding. Once inside the cave, these remains are shielded from the action of the sun, wind and rain, as well as the predatory action of other animals, resulting in preservation by various processes of fossilization. In this way, although extremely old fossils are associated with caves, they are deposited largely *in situ* at the host rock, and do not represent allochthonous of transportation of material into caves.

Body fossils of various large late Pleistocene mammals have been found in caves in the Brazilian states of Minas Gerais, Bahia, São Paulo, Ceará, and Piauí (Morato, 2004). Older karst systems developed in limestone dating from the Late Cretaceous, such as those in Apodi, in the Brazilian state of Rio Grande do Norte, also contain body fossils of marine invertebrates, especially mollusks and echinoderms, in the host rock (Monteiro *et al*., 2007; Benaim & Senra, 2007). Coprolites, tracks, and claw marks of mammals and invertebrate burrows and borings (mostly by insects) have been also mentioned in these deposits (*e.g.* Watson, 1969; Genise *et al.*, 2000; Mikuláš, 2001; Genise & Cladera, 2004; Manning, 2007). In fact, many Hymenoptera (wasps, bees, and ants) and Isoptera (termites), for example, are occasionally found in caves, especially near entrances (Lino, 2001), in Neotropical Region (Menke & Fernandez, 1996). Fossilized wasp nests are quite well known worldwide (*e.g.* Bown & Ratcliffe, 1988; Genise *et al*., 2000; Genise & Cladera, 2004; Yoshida *et al*., 2003).

In order to contribute to expand the knowledge of trace fossils in caves, the present study aims to analyze: (i) the morphology of lithified wasp nests found in caves from different regions in Brazil, describing their architecture, and registering their grade of preservation; and (ii) the evidence of reoccupation by other wasps.

MATERIAL AND METHODS

Area of study and settings

Nests were collected between the years of 2001 and 2007 in various caves in different Brazilian states. The data referring to the collection sites are summarized in Table 1, and the location of the cities where they were collected is shown in Figure 1.

The nests, generally still adhering to the walls of the conduits of the caves, were firmly fixed by the visible mineral deposits encrusting them. In those caves where the nests were found on the floor, they were fewer (except for the nests found in Lapa do Bode cave) and had apparently been transported further into the cave than their original location, probably from the action of water and/or gravity. These nests on the floor of the cave evidenced the most extensive superficial encrustation and, at times, even permineralization. These processes of preservation, some in an advanced stage, were quite obvious due to the altered state of the nests.

Wasp nests were found in three sandstone caves: Itambé, Cachoeira, and Kiogo Brado. Itambé and Cachoeira caves are included at the Botucatu Formation (Paraná Basin), Guarani Aquifer context (Upper Jurassic, Early Cretaceous), composed by well polished grains deposited in a desertic environment (Leonardi & Cavalho, 2002). The Kiogo Brado cave was opened in rocks of the Alto Garças Formation (diamictites) and Iapó Formation (shales and sandstones), both from the Group Ivaí, from the Late Ordovician to Early Silurian of Paraná Basin (Borghi & Moreira, 2002). Zé Branco cave (MG), is set in granite from the Araçuaí Orogen (Neoproterozoic to Carboniferous). Some limestone caves where the wasp nests were collected (Bonita, Vai e Vem, Uropygi, and Lapa do Bode caves) are associated to the Bambuí Group metamorphic rocks, dating from the Neoproterozoic (Chaves *et al.*, 2007). Gruta do Mocó is associated to the Neoproterozoic Ubajara Group rocks (Santos *et al.*, 2008) and the Córrego Verde cave is on the Mesoproterozoic Rio Pardo Grande Group rocks (Santos *et al.*, 2004).

Methods

The study was conducted in the Laboratory of Zoology (Department of Biology) of the Federal University of Lavras, in the Brazilian state of Minas Gerais. After taking the nests to the laboratory, they were cleaned and labeled to identify the place of origin. Sketches representing the shape and architecture of each nest were made. The length, width and height of the nests were measured, as well as the width and depth of the individual cells. These measurements were made using a digital caliper and registered on the sketch of the nest. Each cell of a given nest was given a number on the sketch of that nest to facilitate its identification. Those cells in the interior of the nest which proved difficult to measure directly were measured by inserting a wooden toothpick into the cell, and the depth marked on it for measurement. When individual cells had been somewhat damaged by erosion and lost their original shape, an approximation based on the anatomy of the nest and the other remaining cells was made, although those cells which had undergone excessive deterioration were excluded from consideration.

Multiple measurements were made for each nest trait (length, width and high of the cells and the nest), since these were of irregular shapes. Two or three measurements of each trait of the nests were performed, depending on the size of the nest, with three measurements provided for larger nests and two for the smaller ones depending on the nest size. The arithmetic average was calculated independently for each nest trait. For the estimate of the total number of cells of each nest, only those cells clearly visible (open) were counted or, when closed, were recognizable. As no nest was cut open, any cells hidden in the interior were not counted. Moreover, when the total number of open cells was counted, those which were exposed during the removal of the nest from the rock were not considered.

In addition to the size of the nests, other variables were determined, including the number of reoccupied cells, whether the reuse was contemporary or relict, the degree of fossilization, and state of preservation.

The volumes of the nests collected in caves from Altinópolis were also calculated. These nests were all from the same general area and were still affixed to the cave walls. It was thus possible to analyze this set of nests for the effect of size on the structural parameters and also the reutilization by contemporany wasps. Each nest was wrapped in plastic film and placed in a graduated column of water. The calculation of volume was based on the amount of water dislocated and transformed into cubic millimeters. Some nests which had deteriorated tremendously or were connected to others could not be measured directly for volume, but molds were made in clay for each of these nests individually to ascertain the displacement of water in the column. The data are presented in Appendix 1.

Linear regression tests were used to verify the existence (or not) of a correlation between the variables tested. Those which did not show a normal distribution were set to a logarithmic (Log_{10}). When normalization was not possible, non-parametric Spearman correlation tests were done.

The fossilized nests are deposited in the didactical collection of paleontology of the Federal University of Lavras (Department of Biology), in the Brazilian state of Minas Gerais.

RESULTS

Nests structural patterns

Four basic structural patterns were observed in the collected nests. Most of them (93) were of relatively oval shape. These included most of the nests in Altinópolis and Ituaçu, as well as all those from São Domingos, Uruaçu, Chapada dos Guimarães, Ubajara, and Novo Oriente de Minas, and four nests from Januária (Table 1; Figure 1). These nests show many interior cells and present great variation in preservation. The maximum width of the cells varied from 7.99 to 14.5 mm, and the maximum depth from 9.81 to 26.33 mm. The number of cells in each nest varied from 4 to 24. The average depth of the cells varied from 9.81 to 23.58 mm and the average width varied from 14.50 to 7.03 mm. The total number of open cells varied from 1 to 23 and the number of cells reoccupied varied from 1 to 13. The length of the nest varied from 27.0 to 112.23 mm, the width from 18.71 to 90.98 mm, and the height from 10.94 to 68.84 mm. The volume of the nests in Altinópolis varied from 10.000 mm^3 to 132.000 mm^3.

The second structural pattern consists of smaller, more compact nests with all cells superficially located. Eleven of these nests were collected: two from Januária, four from Altinópolis and five from Ituaçu. The maximum width of the cells in these nests varied from 8.04 to 10.96 mm, with a maximum depth of 10.24 to 18.24 mm. The average width varied from 6.34 to 8.84 mm, with an average depth of 8.07 to 13.76

mm. The number of cells varied from 5 to 10, and the open cells from 4 to 10. The length of the nests varied from 27.61 to 33.60 mm, and the width from 15.49 to 30.00 mm, with a height varying from 16.16 to 31.82 mm. In this type of nest, no reoccupied cell was observed.

The third structural pattern is represented by a single nest collected in Pau Brasil (BA) (Figure 2B). This nest was built inside a speleothem but was found loose on the floor of the cave. There were 34 cells, with a maximum width of 10.34 mm, and a maximum depth of 24.05 mm. The average width was 5.49 mm, and the average depth was 14.88 mm. All of the cells were open, but no reoccupation was observed. The nest was 107.76 mm long and 63.40 mm wide, with a height of 29.82 mm.

Another nest consisting of a single cell was also found in a cave in Altinópolis. This cell was 7.99 mm wide and 16.48

Table 1. Lithology and location of the caves in which the fossilized nests were collected.

Municipality	State	Cave	Lithology	Number of collected nests	Place of collection
Altinópolis	São Paulo	Itambé e Cachoeira	Sandstone	49	Walls
Novo Oriente de Minas	Minas Gerais	Zé Branco	Granite	1	Walls
Januária	Minas Gerais	Bonita	Limestone	6	Floor
São Domingos	Goiás	Vai e Vem	Limestone	2	Floor
Uruaçu	Goiás	Uropygi	Limestone	1	Floor
Chapada dos Guimarães	Mato Grosso	Kiogo Brado	Sandstone	14	Walls
Ubajara	Ceará	Mocó	Limestone	3	Walls
Pau Brasil	Bahia	Córrego Verde	Limestone	1	Floor
Ituaçu	Bahia	Lapa do Bode	Limestone	28	Floor

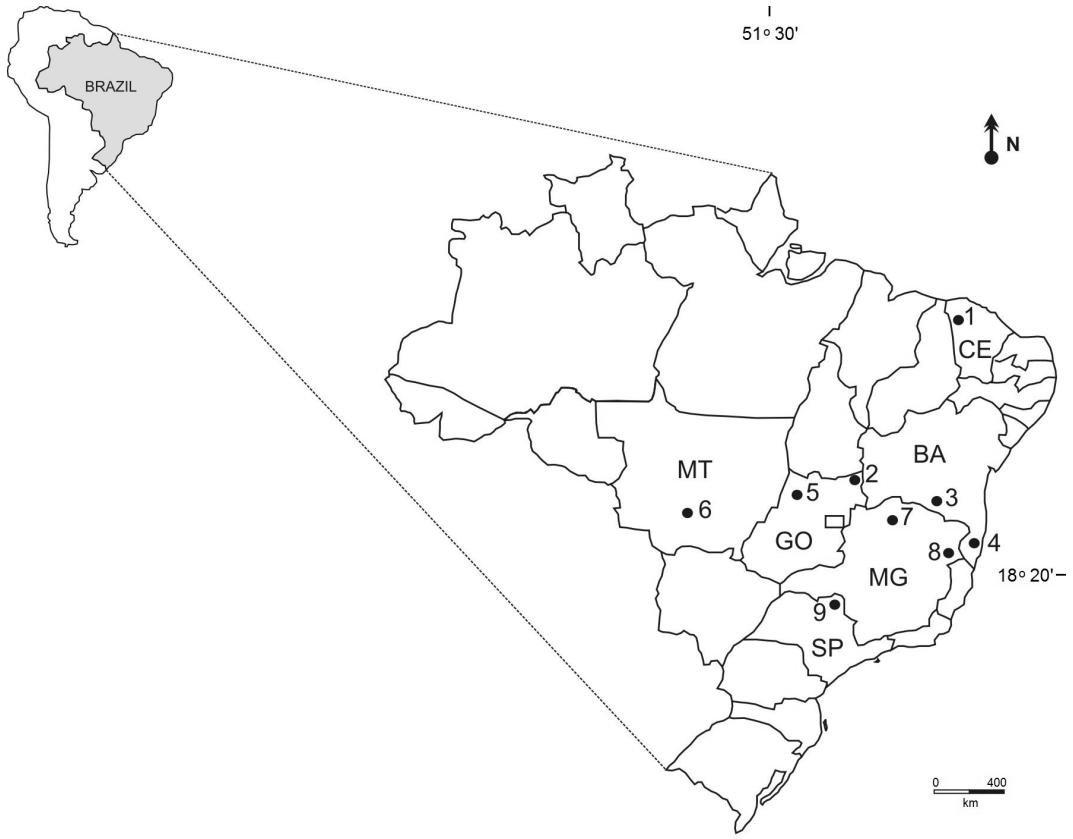

Figure 1. Location of the caves in which the fossilized nests were collected. 1, Ubajara; 2, São Domingos; 3, Ituaçu; 4, Pau Brasil; 5, Uruaçu; 6, Chapada dos Guimarães; 7, Januária; 8, Novo Oriente de Minas; 9, Altinópolis. **Abbreviations: BA**, Bahia State; **CE**, Ceará State; **GO**, Goiás State; **MG**, Minas Gerais State; **MT**, Mato Grosso State; **SP**, São Paulo State. Out of scale.

mm long. The cell was open and had not been reoccupied. The nest was 16.48 mm long and 7.99 mm wide, with a height of 9.81 mm and a volume of 1.241 mm^3.

Simple linear regression for 105 of the nests revealed a significant correlation between the total number of cells and the length of the nests ($F_{1.103}$ = 109.3; R = 0.72; p< 0.00), as well as with both width ($F_{1,103}$ = 42.21; R = 0.54; p < 0.00) and height ($F_{1.103}$ = 34.77; R = 0.50; p < 0.00). Significant correlations were also found between average depth of cells and length ($F_{1.103}$ = 7.63; R = 0.26; p < 0.01), width ($F_{1.103}$ = 6.89; R = 0.25; p < 0.01) and height ($F_{1.103}$ = 6.47; R = 0.24; p < 0,01) of the nests. The number of open cells also showed a significant correlation with the length ($F_{1.103}$ = 13.18; R = 0.34; p < 0.00), width ($F_{1.103}$ = 4.55; R = 0.21; p < 0.03) and height ($F_{1.103}$ = 13.44; R = 0.340; p < 0.00) of the nests.

Simple linear regression of the 44 nests collected in Altinópolis showed significant correlations between the volume of the nests and the number of open cells ($F_{1.43}$ = 4.09 ; R = 0.30; p < 0.00), as well as with the total number of cells ($F_{1.43}$ = 49.42 ; R = 0.73; p < 0.00) and the length ($F_{1.43}$= 53.08 ; R = 0.75; p < 0.00), width ($F_{1.43}$ = 30.86; R = 0.65; p < 0.00) and height ($F_{1.43}$ = 85.03; R = 0.82; p < 0.00) of the nests.

Degree of preservation

The most important of the preservation processes acting on the nests were encrustation and the lithification of the original nest material (Figure 2). The minerals deposited on the nests varied as a function of the lithology of the cave where they were found. The nests at Altinópolis (SP) and Chapada dos Guimarães (MT), for example, were found in sandstone caves and the mineral deposited during the diagenesis apparently was silica. This same silification was observed in the granite cave in Novo Oriente de Minas (MG). In the limestone caves, the mineral deposited was calcium carbonate, apparently in the form of calcite.

The grade of lithification also varies according to the exposure of the open nest to the percolating mineral-containing waters. The most lithified nests were those found loose on the caves floors, where the circulating waters had been able to deposit minerals throughout the nest, and the entire structure became lithified. Nevertheless, the nests still adhered to the cave walls also suffered at least a superficial lithification, probably by percolation of water flowing down along the walls. In these cases, the more internal parts of the nests were often free of lithification.

The great variety of lithification patterns was reflected in the permineralization of the individual cell. This process occurred in some of the cells and not in others, independent of the specific nest. Without permineralization, the cells were generally found to be empty, although in some cases, the nest recently had been reoccupied, and the pupae or its remains were still visible.

Reoccupation of fossil nests

During the collection trips in the field, some nests which were totally or partially lithified were found to have been reoccupied by present-day wasps. This reoccupation was quite clear, as the cells involved were visibly different from those in the rest of the nest (the cover is topographically distinct from the nest surface - it is slightly sunken) (Figure 3). Moreover, reoccupied cells were closed off with recent, unmineralized material (consisting of 72 such instances). Other cells which had been reoccupied were open, and the remains of wasps which had failed to leave the cell were visible, such as wings or the corpses of recently-hatched larvae. However, these remains were not sufficient for its proper identification.

Relict reoccupation of some of the cells during the recent past was also confirmed. In some of the nests, these cells had suffered mineralization (in 83 cases of reoccupation). In these cases, relict reoccupation was not identified by the make-up of the covering material nor the presence of larvae and pupae in their interior, but rather by the distinct coloration of the cells (Figure 3A). Recently reoccupied cells displayed a different color than did those of relict reoccupation, already partly fossilized, which were more homogeneous in color similar to the rest of the nest and often displayed topographical variation (Figure 3A). The surface of an original nest presented a relatively smooth and regular external appearance such that it was difficult to identify the original cells until the wasps had perforated the cell and left the nest. When cells were reoccupied, the coverings of the cells were not deployed at the same level as the external surface of the other cells in the nest, but rather were slightly sunken.

Cell reoccupation was not found in all of the preserved nests, however. Present-day reoccupation, for example, was found only in nests which were still attached to the walls of caves, whereas some of those found loose on the floor only revealed past reuse.

Most of the nests which had been reoccupied were collected from the municipality of Altinópolis (30 nests, with 133 cells reused). Moreover, most of these nests having the remnants of wasp pupae in cells were also found in this cave. Although the majority of the reoccupied cells were observed in nests from caves in Altinópolis, some 12 cells of 4 different nests from Kiogo Brado cave (Chapada dos Guimarães, MT) were also reoccupied, as well as nine in nests collected from Bode cave (Ituaçu, BA); moreover, a single reoccupied cell was found in a nest collected in Vai e Vem cave (Uruaçu, GO).

For the 105 nests collected, there was a significant correlation between the number of cells reoccupied and the length of the nests ($F_{1.103}$ = 28.93; R = 0.47; p < 0.00), as well as with their height ($F_{1.103}$ = 5.75; R = 0.22; p < 0.02) and width ($F_{1.103}$ = 27.18; R = 0.46; p < 0.00). The 44 nests from the caves in Altinópolis also revealed a significant correlation between number of cells reoccupied and the volume of the nest (R Spearman = 0.57; p < 0.00). The graphs showing these relations are presented in Figure 4.

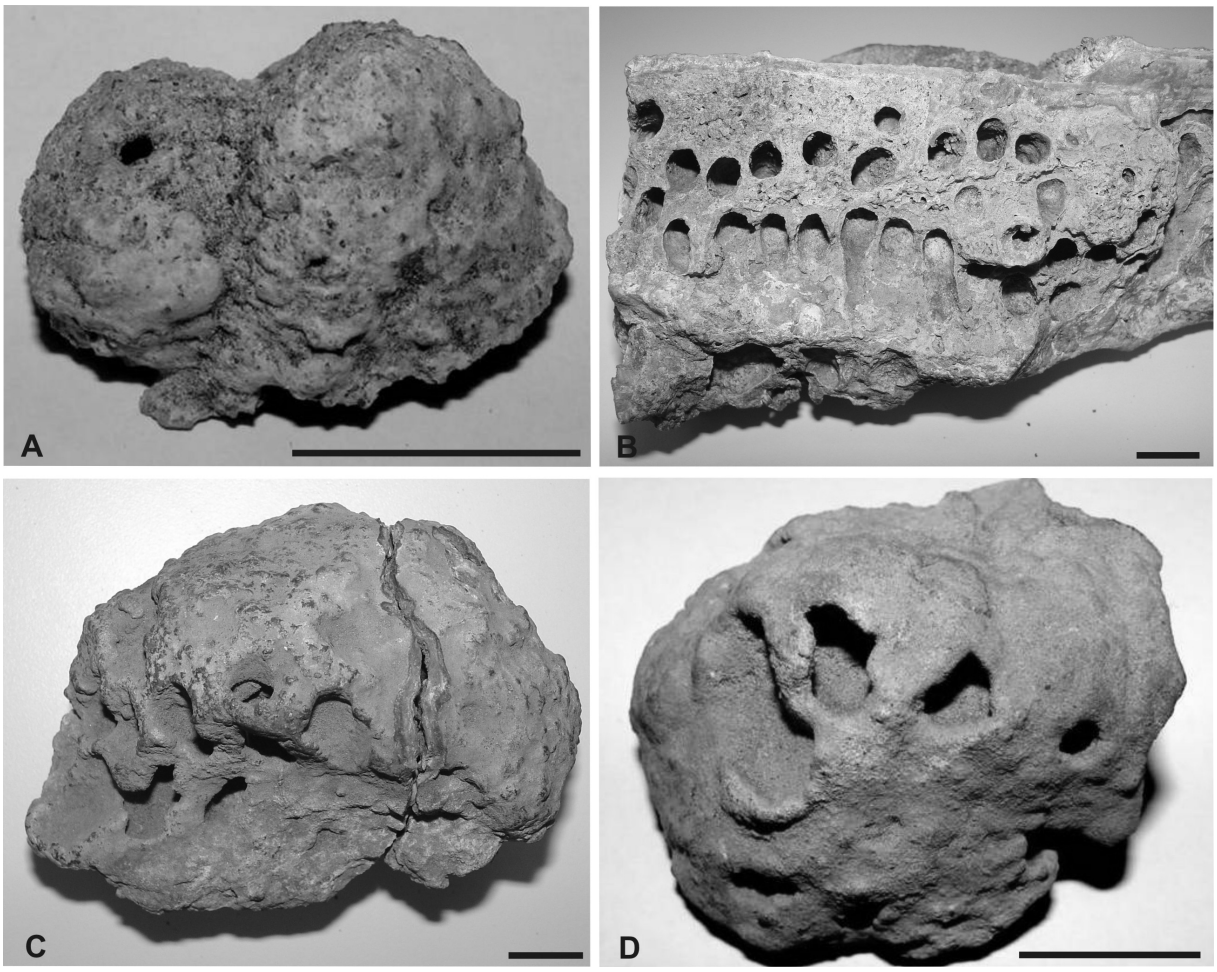

Figure 2. Fossilized nests collected in some selected caves. **A**, Mocó cave; **B**, Córrego Verde cave; **C**, Vai e Vem cave; **D**, Bode cave. Observe the lithification and encrustation around the nests. Scale bars = 10 mm.

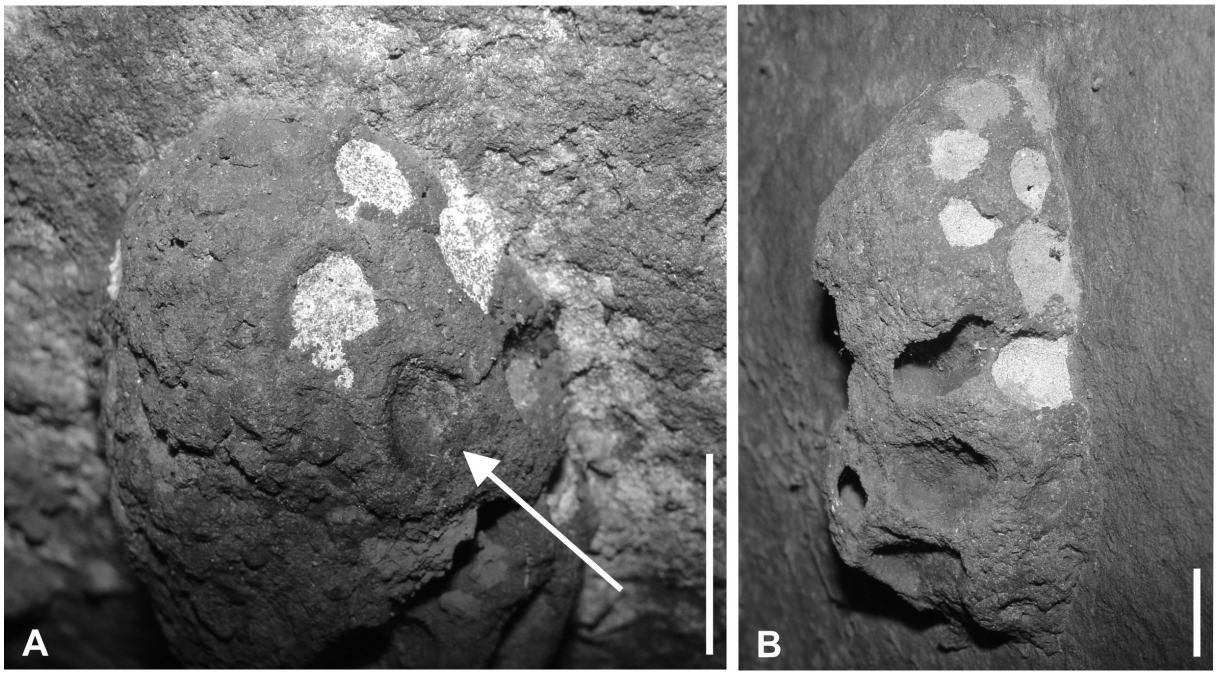

Figure 3. Fossilized nests observed in caves located in Altinópolis. **A**, detail of an incrustated wasp nest located in a cave wall. The cells apertures were closed by recent wasps (see the whitish color of the covered aperture of the reoccupied cells). The white arrow indicates a relict reoccupation (the cover is fossilized); **B**, several reoccupied cells in a fossil nest located in the same cave. Scale bars = 10 mm.

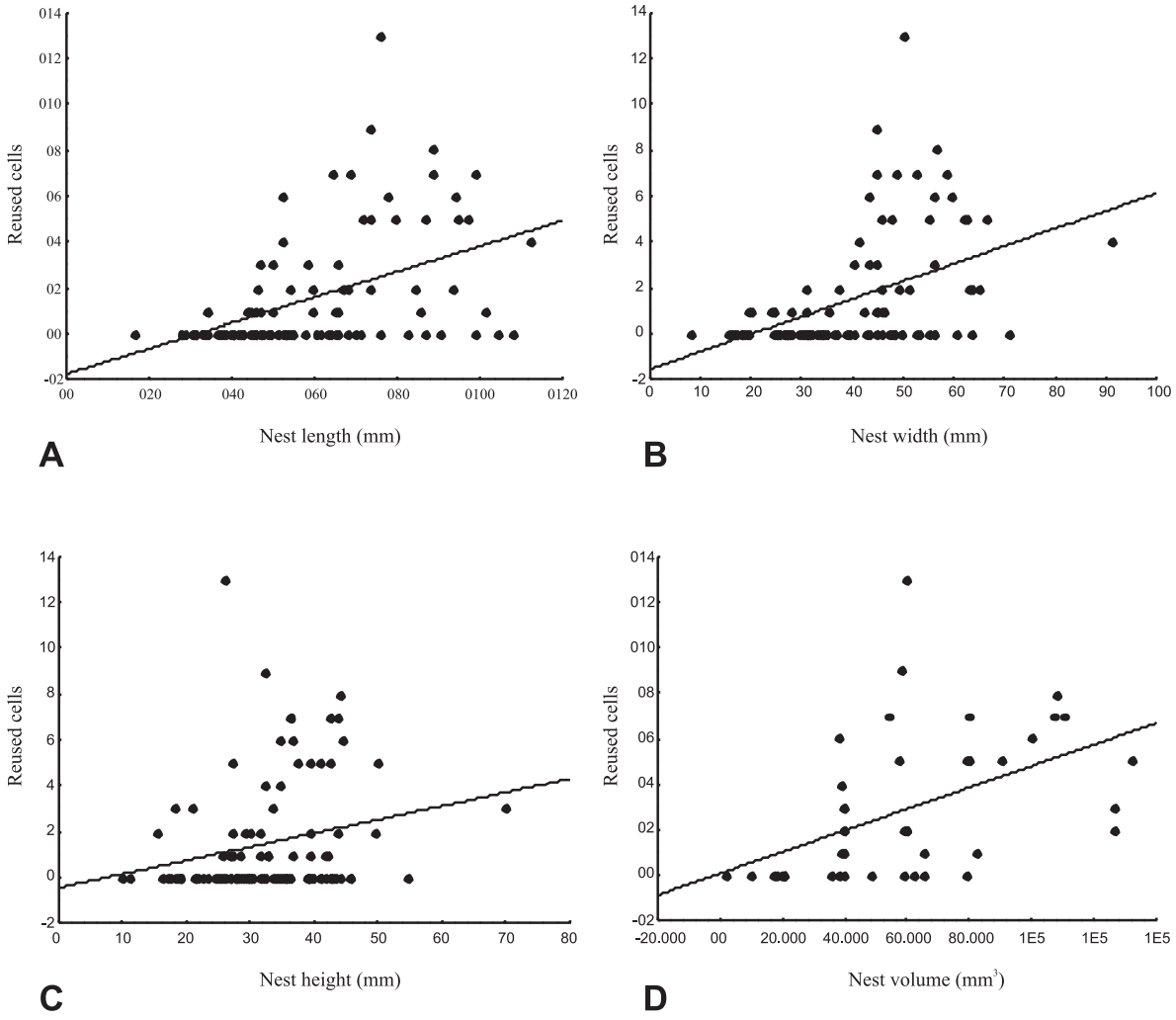

Figure 4. Relation between number of reoccupied cells and nest length (**A**), width (**B**), height (**C**), and volume (**D**).Volume data only for the nests collected in Altinópolis caves.

DISCUSSION

The nests studied herein were not dated due its rarity, the destructive nature of the samples extraction for isotopic dating, and the high costs for sampling and running the tests. Preservation of biogenic structures in carbonatic caves might be a result of a very fast lithification by incrustation. Thus, there is no accurate control about the age of these nests. But in some cases, especially those in which the cells are completely filled by minerals, they could represent subfossil nests. The nests found in siliciclastic and granitic caves probably were preserved by much slower infilling processes, since these caves are composed by less water soluble minerals (*e.g.* SiO_2), taking more time to penetrate into the cells and permineralize them. All of the nests found in limestone caves were completely calcified, which shows that lithification is common (and possible more rapid) in these caves, which was to be expected, given the high solubility of calcium carbonate.

No significant difference was found between the number of cells involved in contemporary reoccupation and that in relict reoccupation. Modern reoccupations could be identified by the borings of wasps which did not leave the nest, or the presence of living larvae undergoing development, although relict reoccupations could only be identified by the fact that a wasp had failed to emerge, since successful emergence of wasps would have left no fossil traces.

Most of the nests studied herein were probably built by wasps of the genus *Sceliphron*, a genus of solitary wasp of the family Sphecidae, due to the ornamentation confined to one side of the nest while the opposite side is flat and smooth as it is usually fixed to a vertical substrate and the cells constructed adjoined one another along the long axis of the nest (Bown & Ratcliffe, 1988). The reoccupation of the nests of solitary wasps has been reported in the literature. According to Pinto *et al.* (2001), nests constructed by *Sceliphron* are reoccupied by wasps of the genus *Pison*. Moreover, Peruquetti & Del Lama (2003) describe the reoccupation of nests of *Trypoxylon* (Sphecidae), and González *et al.* (2004) point out that wasps of the genus *Melittobia* are ectoparasites of the larvae of *Sceliphron*, so that they also take advantage of the nests of *Sceliphron*.

Although the literature does mention the reoccupation of nests from certain species of wasps (*e.g.* Pinto *et al.*, 2001;

Peruquetti & Del Lama, 2003; González *et al.*, 2004), this practice has not yet been described for nests which have been partially or completely preserved. The data presented here increase our knowledge of the capacity of certain genera of solitary wasps to use pre-existing nests. It has been suggested that the reoccupation of nests may be important in the evolution of social systems (Michener, 1974), especially for those taxa or lineages that are less advanced. Reoccupation may reflect the permanence of two or more females in the original nest, or the association of one or more females in nests already established by another female (Peruquetti & Del Lama, 2003).

Finally, although ichnology can provide information supporting an interpretation of many features of life in the past which are of interest to paleontology, it has yet to be explored rigorously, especially for reports from caves. The study of wasp nests preserved in caves and its comparison with the well known wasp nests preserved in open soils worldwide, may contribute for the understanding of the presence of fossil wasps' nests in caves and also for the recognition of these particular structures in the fossil record.

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Appendix 1. Morphometrical features measured from each fossilized wasp nest. Nests volume were only calculated for the nests collected in caves located in Altinópolis.

Nest number	Maximum cell width (mm)	Maximum cell length (mm)	Number of cells	Average cell length (mm)	Average cell width (mm)	Opened cells	Reoccupied cells	Nest length (mm)	Nest width (mm)	Nest heigh (mm)	Nest volume (mm3)
1	9,31	19,52	17	13	8,16	8	0	66	56	45,5	-
2	10,28	13,93	10	10,1	6,34	10	0	31	30	28	-
3	10,64	14,74	6	13,76	7,8	5	0	28,55	26,9	18,8	-
4	11,9	20,05	20	14,37	8,15	12	0	99,24	71,1	54,6	-
5	11,72	18,19	5	15,7	9,44	1	0	50,94	45,9	24,9	-
6	12,86	21,18	13	15,39	8,67	9	1	45,72	44,7	36,6	-
7	10,34	24,05	34	14,88	5,49	34	0	107,8	63,4	29,8	-
8	11,2	17,81	15	15,11	10,44	7	2	84,75	63,3	49,5	126.000
9	12,41	16,32	4	13,7	9,57	4	0	45,5	36,5	24,3	20.000
10	10,16	22,25	9	17,25	8,87	9	0	45,42	39,1	21,8	18.000
11	10,59	18,31	8	15,32	7,95	8	0	41,86	33,2	17	20.000
12	12,21	19,87	18	16,19	9,71	8	1	101,6	46,1	31,4	82.000
13	10,99	19,91	10	16,92	10,22	8	2	93,54	45,7	27,2	40.000
14	13,03	23,88	8	22,2	11,72	5	2	54,26	48,9	29,8	59.000
15	11,53	17,58	5	16,69	9,98	5	0	31,28	27,7	10,9	-
16	14,5	23,58	8	23,58	14,5	3	6	52,39	43,3	34,6	38.000
17	11,89	17,87	4	13,52	9,07	4	0	38,3	18,7	31,5	17.000
18	10,95	26,33	6	19,9	7,92	6	1	65,59	44,8	27,1	40.000
19	9,92	18,25	6	15,88	8,24	6	0	34,09	30,5	19,1	19.000
20	10,59	21,98	12	19,43	9,01	10	2	68,2	65,1	43,5	60.000
21	9,56	19,82	14	15,36	8,36	4	4	112,2	91	34,7	-
22	13,72	23,7	9	18,76	10,47	3	0	63,09	52,4	34,2	62.000
23	10,1	18,49	13	13,71	7,03	8	0	51,4	49,8	28,2	48.000
24	12,7	20,68	22	16,03	8,53	15	7	98,99	48,4	42,6	110.000
25	10,54	18,59	5	18,59	10,54	2	3	49,63	44,5	33,3	40.000
26	12,67	21,55	19	18,43	9,74	1	5	96,95	62,3	37,1	132.000
27	10,66	20,98	18	17,6	8,88	5	7	88,51	52,3	43,9	107.000
28	13,07	24,67	21	17,05	9,23	10	1	86,06	45,9	27	65.000
29	13,63	23,15	6	18,48	11,46	2	0	58,07	47,4	25,7	35.000
30	9,8	21,99	4	16,43	8,89	1	0	40,3	30,7	17,4	10.000
31	12,07	22,29	8	19,09	11,02	8	0	54,85	47	27,7	38.000
32	12,46	20,08	12	15,63	9,4	12	0	71,13	53,2	39	-
33	10,8	22,76	22	17,97	8,68	19	6	94,13	56,1	44,4	100.000
34	11,08	22,47	11	17,14	9,06	3	7	64,47	44,8	36,3	54.000
35	10,79	21,99	23	16,88	8,45	23	5	86,79	62,5	49,8	-
36	13,22	17,72	13	15,11	8,95	8	5	71,96	66,6	42,6	79.000
37	10,39	19	12	15,75	8,75	9	3	65,57	56,3	18,2	40.000
38	7,99	16,48	1	16,48	7,99	1	0	16,48	7,99	9,81	1.291
39	11,77	24,05	18	17,69	9,29	5	0	82,66	55,1	28,5	65.000
40	12,84	20,36	9	17,65	9,75	4	2	73,55	63	29	60.000
41	11,58	22,02	24	17,64	9,51	6	5	94,4	45,9	39,3	80.000
42	10,3	20,74	12	16,91	8,32	8	0	64,8	42,4	27,8	40.000

43	10,99	18,35	18	15,36	8,62	5	13	75,85	50,1	26	60.000
44	10,81	21,2	17	19,43	8,84	10	5	73,68	47,4	40,8	90.000
45	13,45	21,05	18	17,13	9,69	10	5	79,49	55,3	27,2	57.000
46	11,47	19,93	15	16,34	8,55	10	3	58,57	43	69,8	126.000
47	11,74	18,8	13	15,97	9,44	10	4	52,26	40,8	32,2	39.000
48	12,7	19,19	13	16,23	9,92	13	0	63,78	39,2	21,4	20.000
49	11,84	20,04	12	16,46	8,71	12	0	60,97	44,8	40,8	79.000
50	11,58	22,47	9	18,84	8,03	9	0	68,02	47,9	42,8	59.000
51	11,37	19,22	10	18,75	10,11	3	7	68,82	58,3	36,3	80.000
52	11,99	21,05	17	15,85	10,13	12	8	88,7	56,8	43,9	108.000
53	9,6	16,11	7	12,85	8,54	6	1	65,03	42,2	25,6	39.000
54	10,96	12,43	8	10,58	8,84	8	0	33,6	18,2	18,7	-
55	10,45	18,24	9	11,98	7,5	9	0	30,81	19,4	21,1	-
56	9,98	18,2	8	12,24	7,78	8	0	27,61	25	16,2	-
57	8,04	10,24	8	8,07	6,93	8	0	30,46	15,5	18,4	-
58	8,62	15,54	14	15,17	8,11	5	9	73,52	44,5	32,4	58.000
59	10,29	22,52	8	18,13	8,3	8	0	90,46	55,9	26,7	-
60	9,56	24,06	12	18,75	8,73	10	2	59,39	51,4	31,7	40.000
61	10,45	18,09	9	15,3	8,36	7	0	48,96	33,6	23,4	-
62	9,61	15,6	4	14,56	8,12	3	0	37,86	31	18,9	-
63	8,49	18,13	8	16,13	7,52	5	0	41,41	38,9	22,5	-
64	10,51	22,08	13	18,11	8	12	0	60,36	36,3	39,1	-
65	11,61	20,48	16	17,41	8,71	16	0	86,99	27	42,6	-
66	10,41	18,11	7	16,61	9,34	0	2	67,32	37,2	15,2	-
67	11,77	20,64	7	15,84	9,34	4	1	44,67	35,2	27	-
68	11,34	20,2	5	18,6	9,15	0	3	47,09	40,4	21,1	-
69	9,96	27,4	10	19,81	9,14	5	6	78,06	59,2	36,5	-
70	10,92	20,99	14	18,35	9,38	10	0	69,96	48,1	33,5	-
71	9,63	20,3	9	16,99	8,7	0	0	104,5	60,4	32,3	-
72	12,23	21,88	18	19,68	9,32	16	0	75,76	49,4	40	-
73	8,63	17,17	4	15,28	8,02	2	0	47,15	30,8	29,4	-
74	11,46	18,12	7	16,53	6,13	7	0	53,13	31,5	29,3	-
75	12,2	20,16	10	16,71	5,9	10	0	49,23	43,2	35,6	-
76	10,68	20,02	9	15,49	8,67	9	0	52,7	31,1	25,1	-
77	13,1	19,9	6	15,55	9,56	6	0	30,51	40,3	30,5	-
78	8,7	17,57	9	15,43	7,09	8	1	43,7	24,5	32,6	-
79	10,49	20,44	14	17,07	8,13	8	0	53,26	32,5	42,3	-
80	9,79	20,24	9	17	8,31	9	0	47,42	24,7	44,2	-
81	10,08	21,06	13	16,99	8,46	8	2	46,56	30,5	39,2	-
82	9,64	18,14	5	15,65	8,03	4	1	34,49	20,1	32,6	-
83	9,74	19,95	21	17,03	7,44	20	0	54,61	33,9	41,8	-
84	9,45	17,77	7	15,52	7,35	6	0	36,87	18,1	31,8	-
85	9,69	15,85	7	14,41	6,96	7	0	36,69	18,9	29,8	-
86	7,97	19,7	5	18,9	7,09	5	0	41,83	16,2	29,4	-
87	9,31	19,57	6	15,26	7,66	5	1	34,07	19,5	28,1	-
88	9,86	18,42	6	16,2	7,6	6	0	45,03	26,6	40,7	-
89	8,69	17,15	20	15,4	5,96	20	0	53,35	34,2	39,1	-
90	9,07	25,54	6	21,13	8,63	5	1	43,59	24,2	32,8	-
91	9,29	22,06	8	15,35	7,94	7	0	42,56	27,1	33,7	-
92	9,17	19,26	10	16,56	7,96	10	1	46,92	24,5	39,4	-
93	11,58	18,57	8	17,87	9,18	4	0	54,25	26,2	43,4	-
94	11,16	17,29	6	15,85	9,26	3	0	47,18	25	35,2	-
95	10,16	18,8	9	16,75	8,38	3	0	40,48	25,3	35,8	-

96	11,38	20,63	13	17,67	8,77	6	1	49,59	28	42,2	-
97	10,33	20,95	14	16,9	8,91	10	1	59,99	30,7	41,5	-
98	10,07	20,09	15	16,7	8,17	8	0	52,33	27,4	39,2	-
99	11,25	21,2	14	17,59	9,17	7	0	48,7	35	45,7	-
100	8,76	19,96	11	17,52	8,37	9	0	40,12	26,3	35,3	-
101	9,99	20,06	6	19,14	9,08	6	0	40,09	16,7	25,8	-
102	9,97	18,1	7	16,58	8,91	5	0	39,36	24,8	36,3	-
103	8,94	17,3	7	14,77	7,64	4	0	42,41	29,2	34,7	-
104	8,69	19,71	8	16,83	7,52	6	0	44,45	30,4	39,5	-
105	9,02	18,15	5	16,01	8,55	4	0	33	16,8	26,8	-