

# The unknown house of an old neighbor: the nest of *Zethus (Zethoides) nodosus* Zavattari (Hymenoptera: Vespidae)

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**Abstract.** Despite being mostly solitary and nesting in cavities, *Zethus* is more widely known by its few representatives that build external aerial nests. Here, nests of *Zethus nodosus* collected in the first decades of the twentieth century in surrounding areas of the Museu de Zoologia da Universidade de São Paulo are described and ponderations about the absence of more recent material are made.

**Keywords.** *Zethus olmecus* species group; Nest architecture; Habitat loss.

## INTRODUCTION

Nests of *Zethus* Fabricius, 1804 are still poorly known. Despite its great diversity, very few nests have been found and described, with only 15 recorded at the time of the revision of the genus (Bohart & Stange, 1965) and a few later additions being made (Stange, 1969; Garcete-Barrett & Klassen Dück, 2010; Cooper, 2014, 2016; Lopes *et al.*, 2019, 2021). Among *Zethus* species, *Z. miniatus* is perhaps the most widely known. This is mainly due to the fact of presenting subsocial behavior as reported by Ducke (1914), mistakenly as *Z. lobulatus*, and their aerial nests which makes them widely detected.

*Zethus miniatus* nests are comprised of a cluster of several exposed barrel-shaped cells made of vegetable matter (Ducke, 1914). Bohart & Stange (1965) described the nest of *Z. schadei* Bohart & Stange, that presents a very similar aspect of several barrel-shaped cells. Both species belong to the *Zethus olmecus* species group, whose 14 representatives occur from Mexico to the South American tropics (Bohart & Stange, 1965; Lopes & Noll, 2018; Lopes *et al.*, 2020). The other 12 species included in the group do not have any or lack significant information on nest architecture (Bohart & Stange, 1965), but it would be expected that wasps of closely related species build similar nests.

*Zethus nodosus* Zavattari, 1912 is a small wasp (genus wise) also belonging to the *Z. olmecus* group, measuring approximately 1,0 cm long. This

species has been recorded from only two localities so far: San Bernardino, Paraguay, where only the type has been collected; and São Paulo city, Brazil, where more specimens have been reported (Bohart & Stange, 1965). Some of these specimens were specifically collected in the Ipiranga neighborhood, where the Museu de Zoologia da Universidade de São Paulo is situated. Fortunately, the museum collection harbored not only the wasps, but also its nests that were collected in the past from the proximities of the Museum but were overlooked until now. Herein, these nests of *Z. nodosus* are described and questionings about the absence of more material is made.

## MATERIAL AND METHODS

During a visit to the Museu de Zoologia da Universidade de São Paulo (MZSP), four nests were found in the Hymenoptera nest collection, all collected from the proximities of the Museum at least 100 years ago. Nests with cell clusters were measured with a digital pachymeter, while cell openings and length were measured with the aid with the microscope reticle. One of the nests was deposited together with three specimens which were identified following the key to species in Bohart & Stange (1965). The other nests are tentatively assigned to the species. Before the description of each nest, the entirety of label information is given.

## RESULTS

Of the four examined nests, only one (Nest 1) presented specimens deposited alongside, permitting to ascertain the species it belonged to. These specimens were identified as *Zethus nodosus*. The others (Nests 2, 3 and 4) did not have any wasps deposited or association with wasp specimens in the collection and were tentatively assigned to this same species as the architecture was highly similar.

### Nest 1

**Collecting data:** the nest is deposited in the MZSP and the label reads "BRASIL: Horto botânico, 25.viii.1922, H. Luederwaldt col.". There are three specimens pinned in the same box, two females (Fig. 1) and one male. The botanical garden ("Horto botânico") mentioned in the label probably referred to the botanical garden beside the museum, where Luederwaldt conducted many studies of necrophagous Coleoptera (Pujol-Luz *et al.*, 2008).

**Overall aspect (Fig. 2A, B):** the nest is fixed on the side of a thin branch and comprised by a cluster of six adjacent and exposed cells that are nearly perpendicular to the substrate. An incomplete single isolated cell is found higher up the branch, but it is unknown if it belongs to the same wasp(s) that built the cluster.

**Fixation:** a single branch runs on the side of four cells, where it is partially englobed by vegetable matter and resinous material. Traces of macerated plant and resinous material are sparsely spread along the branch below the nest, ceasing briefly above the ramification (Fig. 2C).

**Brood cells:** there are six cells, all reniform, with the curvature going around the axis of the branch clockwise, when looked from above. The lower five cells have their openings lined up, facing the same direction, with the upper two cells closed, the two immediately below open,



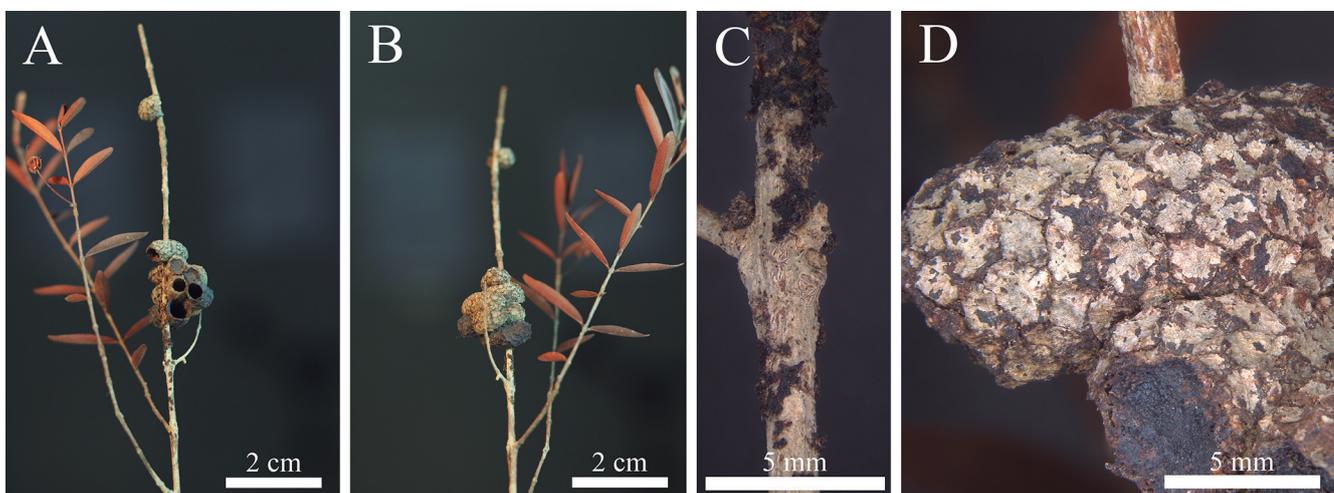
**Figure 1.** Female of *Zethus (Zethoides) nodosus* Zavattari deposited alongside nest.

and the lowest one incomplete. The three cells to the left are fixed to the substrate and the other two stacked on their side. The upper cell of the cluster is built with its bottom close to the basal third of the length of the cell below and its opening deviates to the left. The isolated cell above is incomplete and built counterclockwise, nearly perpendicular to the orientation of the upper cell of the cluster. External walls are comprised by scale-like cuttings of leaves intercalated by resinous matter (Fig. 2D, E). They are of a pale beige color on the isolated and upper four cells of the cluster. The lowest complete cell has a pale beige bottom half and the other half dark brown, and the incomplete lower cell is entirely dark brown. The internal walls are of dark finely macerated plant material.

**Measurements:** Nest height = 18.95 mm; width = 16.28 mm; length = 10.75 mm.

### NEST 2

**Collecting data:** nest is deposited in MZSP accompanied by five loose cup-shaped mud cells and a *Ptilothrix* bee. Label reads "Ninho de [Nest of] *Odynerus*, São Paulo, 10.viii.02, Beron leg.". No adult wasps are deposited with the nest.



**Figure 2.** Nest of *Zethus nodosus* (Nest 1). (A) View of openings. (B) View of cell bottoms. (C) Closeup of masticated vegetable material and resinous matter smudged on branch. (D) Closeup of external surface showing scale-like leaf fragments covering cells.

**Overall aspect (Figs. 3A, B):** the nest is very similar to the one described above, attached to a twig, with a total of five cells. Only two cells are obliquely and directly attached to side of the substrate, followed by two cells attached the first two and the fifth and final cell attached to the latter. The cells have a slender appearance with slighter, but still clockwise, curvature around the twig. There are also blots of resinous and vegetable matter smudged along the twig below the nest. There are no notes relating to the *Zethus* nest with the mud cells and the bee and it is probable that they were simply collected in the same event.

**Measurements:** Nest height = 13.81 mm; width = 14.06; length = 15.97 mm.

### Nest 3

**Collecting data:** nest is deposited in MZSP and label reads "Brasil: SP: São Paulo, Ipiranga, xi.1915, H. Luederwaldt col., Número catálogo 19147". No adults are deposited with the nest.

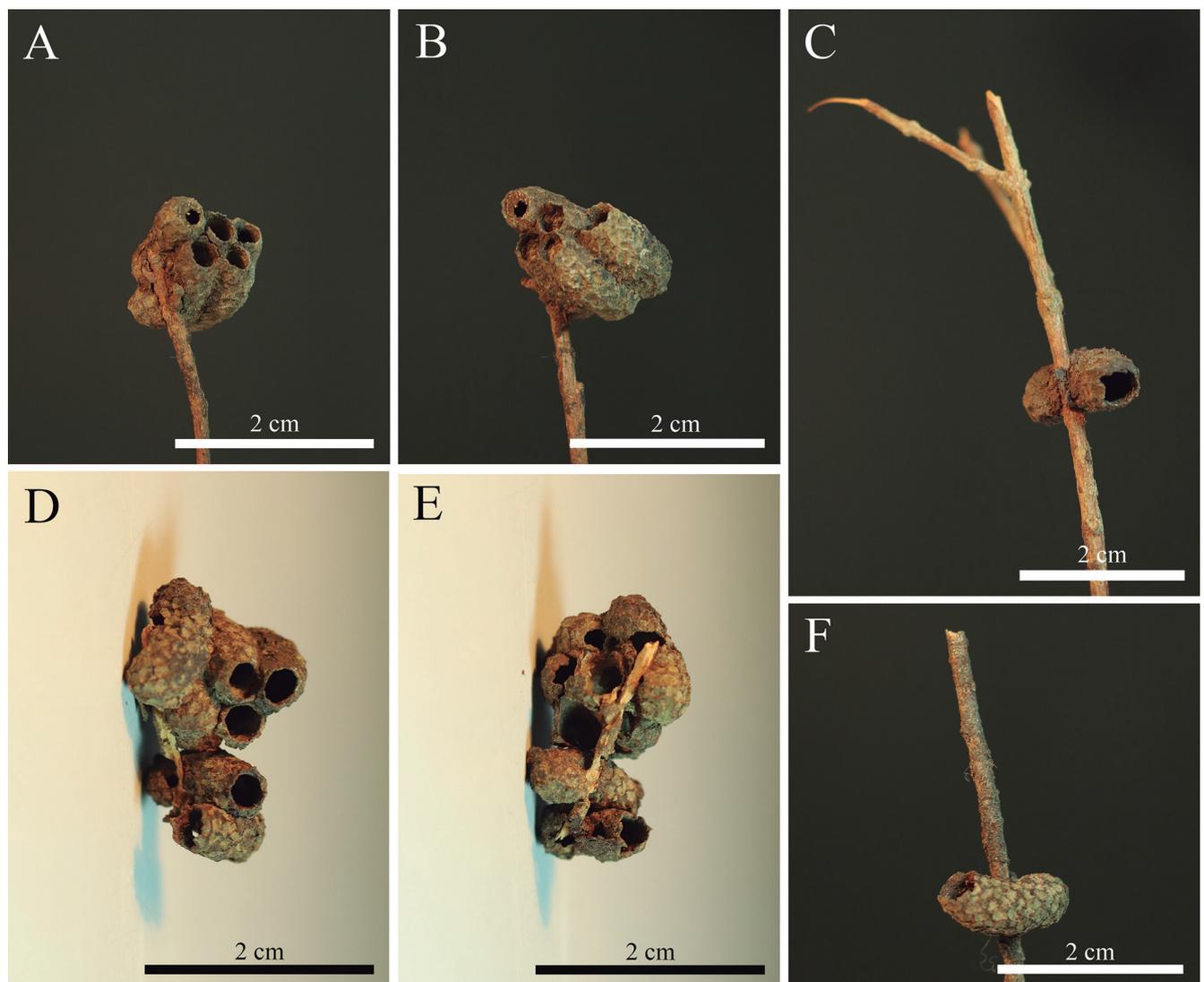
**Overall aspect (Fig. 3C):** this nest is comprised of a single cell that is attached to a small thin branch briefly before a ramification. The cell is also reniform following a clockwise orientation around the branch. There is vegetable and resinous matter sparsely spread on the branch below the nest.

**Measurements:** Cell length = 11.4 mm; opening = 2.7 mm.

### Nest 4

**Collecting data:** nest is deposited in MZSP and label reads "Brasil: SP: São Paulo, Ipiranga, 27.i.1907, H. Luederwaldt col.". No adults are deposited with the nest.

**Overall aspect (Figs. 3D-F):** there are two separate structures stored in the same box: a cluster of damaged cells (Figs. 3D, E) and a single cell attached to a stick (Fig. 3F). The single cell stands out for having the opening curved upwards. Also, blots of vegetable and resinous matter are present both below and above the cell.



**Figure 3.** Nests tentatively assigned to *Zethus (Zethoides) nodosus*. Lateral views of Nest 2 (A, B), Nest 3 (C) and Nest 4 (D-F) showing cluster (D, E) and isolated cell (F).

The cell cluster has a broken twig along its sides, but it is not possible to determine if it was broken off the same branch that supports the single cell. The remaining structure suggests the cluster was comprised of at least eight cells, one of which had only the bottom intact. This nest strays from the pattern observed on previous nests, as the three upper cells that are fixed to the substrate are oriented counterclockwise. They serve as fixation point to three cells that are oriented clockwise. The lower two cells that are attached to the stick are also built clockwise. Besides the orientation, the cells are not aligned, regardless of being clockwise or not, they are not consistent with the direction of the openings.

**Measurements:** Isolated cell length = 13.9 mm; opening=3.6 mm. Cluster height=25.92 mm; width=14.02 mm.

## DISCUSSION

*Zethus* wasps are usually not abundant and seldomly collected (Bohart & Stange, 1965). This is evident by the low number of specimens deposited in scientific collections, what makes their nests even rarer to come across. The fact that four of these nests have similar architecture and that there are no other species of the *Z. olmecus* group deposited in the collection from the same sites make it even more probable that the nests without wasps alongside also belong to *Z. nodosus*.

The only aspects that seemed to deviate from a certain pattern is the degree of the curvature of the cells, slighter in Nest 2, and the cells that could be oriented in different directions (clockwise/counterclockwise) in the same nest, in Nest 4. While there is no report of curvature in known nests of the *Z. olmecus* species group, the inversion of cell direction (openings of different cells facing opposite directions) is also seen in *Z. miniatus* (Fig. 4) (personal observation), but the architecture of these species can be differentiated.

The nests of *Z. nodosus* follow a very similar pattern of several cells built together from macerated foliage to the known nests of *Z. miniatus* and *Z. schadei* (Bohart & Stange, 1965; Ducke, 1914), with one exception: the reniform cells curving around the substrate. The latter species present barrel-shaped cells, that are also perpendicular to the substrate, but without any evident curvature. Should this curved aspect be unique to *Z. nodosus*, it could prove to be a taxonomically important behavioral character. However, to determine this, it is necessary to know the nests of the other species of the group.

One of the more curious questions is whether *Z. nodosus* also portrays a subsocial behavior like *Z. miniatus*. Although three specimens accompanied Nest 1, there is no information whether those adults were at the nest at the time of collecting or emerged from the nest posteriorly. Coincidentally, there are three open cells on this nest, what leads to give more credibility to the second hypothesis. Nevertheless, the sociality degree of *Z. nodosus* is a question that can be answered only from observation or collecting of new nests.

A worrying fact is that the nests and specimens of this species were collected over 100 years ago and there are no newer records in the literature nor in the collection. This raises questions about why so, since the examined material was collected in the surrounding areas of the Museum, theoretically easy to access. Most nests were collected by Hermann Luederwaldt who passed away in 1934, only 12 years after the last nest was collected. So, the first and optimistic hypothesis is that the simple absence of collecting effort, as no one after Luederwaldt may have bothered to collect the nests, led to the lack of more recent records.

Coincidentally, during this same period as Luederwaldt's passing, the Ipiranga neighborhood presented accentuated urbanization process (Ambrogi, 1982). The Ipiranga region was labeled unproductive before 1890, despite its historically rich importance for being home to the "Independence Cry". However, it later became a large industrial complex due to the relatively cheap land cost (Ambrogi, 1982). Emergence of large brickworks industries in the area were clear signs of the demand for building material to support the high number of constructions. However, only after the implementation of electric tramways leading into the neighborhood that



**Figure 4.** Nest of *Zethus (Zethoides) miniatus* observed in Ribeirão Preto, São Paulo, Brazil.

residential started to settle in the region (Ambrogi, 1982). This is upheld by great population growth from 12.064 in 1920 to 40.825 in 1934 (Ambrogi, 1982). This process started to change the landscape of the Ipiranga neighborhood. Previously, green areas in the Ipiranga neighborhood were large and plentiful, but as it became more impacted by urbanization, these areas grew smaller (Ambrogi, 1982). These numbers were just the beginning, as of 2010, the Ipiranga district population reached over 100.000 (SMUL, 2022). This rational leads to the second and pessimistic view where the species may not have endured the loss of its habitat and is, at least, locally extinct.

Whether the species still lingers in San Bernardino, Paraguay is another question as no material from this location other than the type has been published. This disjunct distribution is probably only apparent, and it is possible *Z. nodosus* occurs elsewhere and simply has not been recorded between these two localities due to lack of collecting effort. There are several species of *Zethus* whose ranges are known to englobe points situated in Atlantic Forest and Humid Chaco (Bohart & Stange, 1965) and this case should not be discarded for *Z. nodosus*.

### CLOSING REMARKS

This is one more contribution to the largely unknown *Zethus* nesting behavior. Nevertheless, it highlights natural history collections as source not only for morphological, molecular, and distributional data, but for behavioral characters as well. Finally, collecting efforts should be made to determine if *Zethus nodosus* presents subsocial traits and to determine if the species still lingers in the remaining green areas of the Ipiranga neighborhood or if the MZSP has lost one of its neighbors.

**CONFLICTS OF INTEREST:** Author declares there are no conflicts of interest.

**FUNDING INFORMATION:** The study was funded by the São Paulo Research Foundation (FAPESP) grants #2021/00766-0 and #2019/09215-6.

**ACKNOWLEDGEMENTS:** I thank Gabriela Camacho for giving access to the MZSP collection, Henrique Moleiro for helping in the search for nests in the collection, Rafael Sousa for advice in image acquisition and Beatriz Coelho for identifying the bee specimen.

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