Brief Communication / Comunicación Breve

If you can't stand the heat, get out of the kitchen! Notes on the influence of temperature on the nesting of social wasps

Si no puedes soportar el calor, ¡sal de la cocina! Notas sobre la influencia de la temperatura en el anidamiento de avispas sociales

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ZooBank: urn:lsid:zoobank.org:pub:BCC3F5B7-6290-4348-B021-7D247210F159
https://doi.org/10.35249/rche.50.2.24.03

Abstract. For social wasps, the selection of the nesting substrate represents the success or failure of the colony, and temperature is a determining factor for this selection. With the increase in global temperature due to climate change, it is essential to understand how temperature actually interferes in the selection of the foundation site of social wasp colonies. Here, we describe a curious nest-founding strategy on a rocky outcrop in the state of Minas Gerais, Brazil. Social wasps selected the lighter areas of the outcrop where they had greater success in developing their colonies. These lighter areas absorb less heat and had a lower average temperature when compared to darker areas.

Key words: Climate change; Polistinae; thermoregulation; Vespidae.

Resumen. Para avispas sociales, la selección del sustrato de anidación representa el éxito o fracaso de la colonia, y la temperatura es un factor determinante para esta selección. Con el aumento de la temperatura global debido al cambio climático, es esencial entender cómo la temperatura interfiere realmente en la selección del sitio de fundación de las colonias de avispas sociales. Aquí se describe una curiosa estrategia de fundación de nidos en un afloramiento rocoso en el estado de Minas Gerais, Brasil. Las avispas sociales seleccionaron las áreas más claras del afloramiento donde tuvieron mayor éxito en el desarrollo de sus colonias. Estas áreas más claras absorven menos calor y tenían una temperatura promedio más baja en comparación con las áreas más oscuras.

Palabras clave: Cambio climático; Polistinae; termorregulación; Vespidae.

Given the recent reports on the increase in global temperature due to climate change (IPCC 2021), it is of paramount importance not only to predict what will happen to the planet's fauna and flora but also to understand how each species deals individually with thermal variations. The increase in temperature will affect the dispersion and survival of insects since minimal changes can have a crucial effect on the development of these organisms, which play a fundamental role in the balance of the ecosystem, since their basic physiological functions, such as locomotion, growth and reproduction, are regulated by environmental temperature.

Insects from the Neotropics are particularly susceptible to temperature increases, as they

Received 29 February 2024 / Accepted 4 April 2024 / Published online 30 April 2024
Responsible Editor: José Mondaca E.

have narrower thermal limits (Deutsch *et al.* 2008). Populations of social wasps, in turn, are potentially interesting for their role in controlling populations of other insects acting as controllers of urban and agricultural pests (Prezoto *et al*. 2019), additionally, they play a role as pollinators for certain plants and have the potential to be utilized as bioindicators of urban impact (Clemente *et al.* 2012; Maciel *et al.* 2023). However, these populations are already facing the consequences of climate change, as highlighted in the studies by Dejean *et al.* (2011, 2022).

To thermoregulate the nests, social wasps can vibrate their wings together to ventilate the nest or even deposit water droplets on the surface of the nest, however, one of the main strategies adopted by social wasps to deal with high temperatures is substrate selection for nesting (Jones & Oldroyd 2007). The nests of social wasps have a great diversity of materials, complex structures in their construction and are responsible for the protection of individuals and the development of offspring (Barbosa *et al*. 2021).

In this scenario, for more accurate calculations and projections of the consequences of climate change, the real microclimatic conditions experienced by organisms in their habitat are much more appropriate. For this reason, it is essential to know the behavioral strategies related to temperature performed by these insects. Thus, the study aimed to describe a curious nest foundation strategy on a rocky outcrop of campo rupestre with open, high altitude formation on rocks in southeastern Brazil.

Observations were carried out in May 2016 (cold/dry) and October 2017 (hot/humid) on a rocky outcrop in the Parque Estadual do Ibitipoca (21°40'44''S / 43°52'55''O, 1350-1780 m a.s.l.), in the municipality of Lima Duarte, Minas Gerais, Brazil. The area is composed of outcrops of quartzite rocks, with predominant vegetation of rupestrian fields (Rodela & Tarifa 2002) and plants tolerant to water stress, due to the high incidence of light and wind (Forzza *et al*. 2013).

To measure the temperature of the rocky outcrop and facilitate the counting of the nests, a thermographic camera was used (FLIR ONE Gen 2™). Ten lighter and ten darker points were evaluated at each visit, totaling 40 points. Measurements were taken every hour between 6:00 a.m. and 4:00 p.m. The software FLIR Tools (FLIR Systems™) was used to analyze the thermal images, to differentiate the abundance of nests for each color of rock, Mann-Whitney test was used with the Bioestat 5.3 software (Ayres *et al.* 2007).

In total, 76 nests of *Polybia scutellaris* (White, 1841) distributed across the rocky outcrop (Fig. 1A), of which 62 were located in the lighter areas of the outcrop. Furthermore, those nests in the lighter areas were visibly larger and most of them were active (n=45), while the 14 nests located in the darker areas were smaller or were abandoned, this may indicate that conditions in lighter areas are more favorable for nest development.

Data analysis showed that in the hot/humid period the average temperature found in the light rocks was 29.8 °C with a maximum of 42.2 °C and a minimum of 17 °C; for the dark rocks the mean was 37.5 °C with a maximum of 59.2 °C and a minimum of 26.1 °C (Fig. 1B). For the cold/dry period, the average temperature found in the light rocks was 21.3 °C with a maximum of 25.1 °C and a minimum of 16.9 °C; for the dark rocks the average was 22.1 °C with a maximum of 28.2 °C and a minimum of 16.7 °C (Fig. 1B). There was a significant difference between the average temperatures between the two outcrop areas in the hot/humid period ($p=0.0083$), that is, this suggests that darker areas may become hotter in direct sunlight. In the cold/dry period ($p=0.1592$), there was no significant difference.

Social wasps select the best nesting sites that favor the greatest chance of success for their colonies (Weszel *et al*. 1998; Barbosa *et al*. 2021), based on this, we can state that rocky outcrops such as the one studied present favorable conditions for the development of *P. scutellaris* colonies, due to the large number of active colonies recorded. However, there seems to be a preference for the lighter areas of the outcrop, since lighter surfaces absorb less heat, thus keeping the temperature of the colonies more controlled, benefiting their development,

as extremely high temperatures favor the dehydration of individuals and can cause the mortality of the larvae, due to its sensitivity, or affect its normal development. Excessive heat also impairs the wasps' ability to regulate body temperature, negatively affecting activity and efficiency in searching for food, as they spend more time inside the nest.

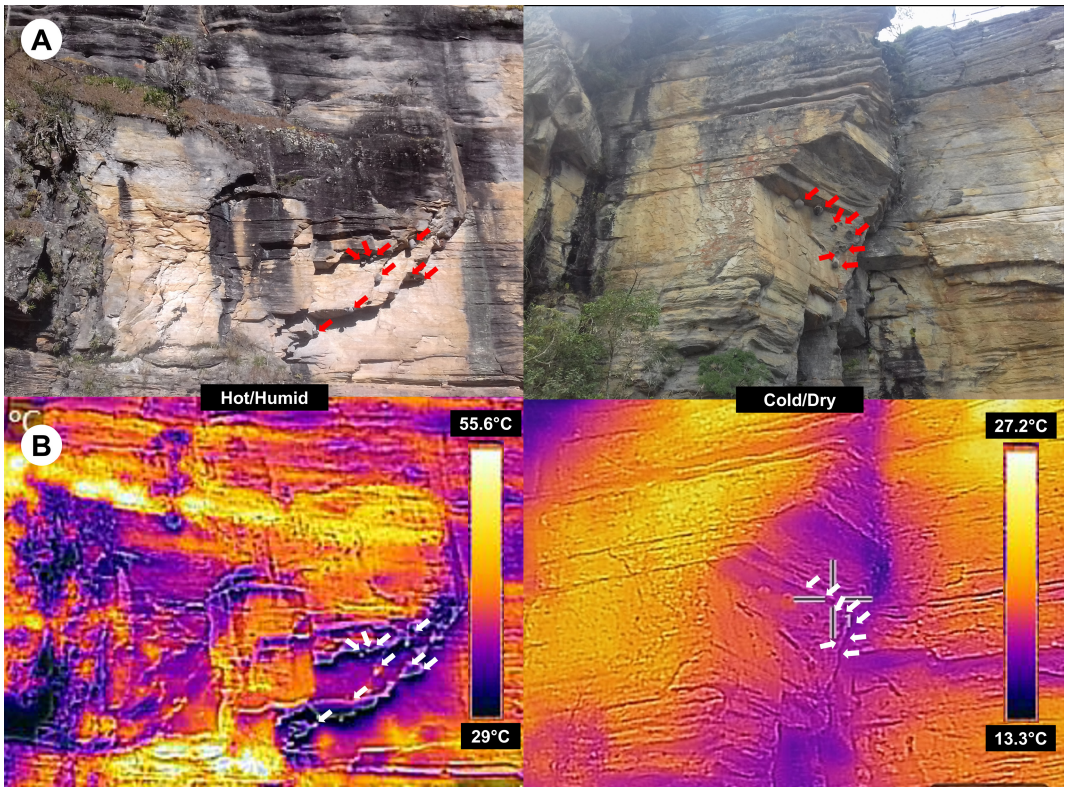

Figure 1. **A.** Image of the rocky outcrop with the highest concentration of nests in the brightest areas. **B.** Thermal image of the rocky outcrop demonstrating the temperature gradient in relation to the rock color variation. The red arrows point to the nests on the rocky outcrop. / **Figura 1. A.** Imagen del afloramiento rocoso con la mayor concentración de nidos en las áreas más brillantes. **B.** Imagen térmica del afloramiento rocoso que muestra el gradiente de temperatura en relación con la variación del color de la roca. Las flechas rojas señalan los nidos en el afloramiento rocoso.

Acknowledgments

This work was supported by the Universidade Federal de Juiz de Fora (UFJF), the Instituto Nacional de Pesquisas da Amazônia (INPA), the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), the Conselho de Desenvolvimento Científico e Tecnológico (CNPq) and the Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM). TTM is granted by CNPq (PCI-DB, Process 301762/2024-4) and MLO thanks CNPq for their productivity grants (Processes 311016/2023-5).

Author Contributions

TTM: Conceptualization**,** Investigation, writing - original draft. **BCB:** Investigation, writing - original draft. **MLO:** writing - review & editing. **FP:** Resources, writing - review & editing.

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