

SHORT COMMUNICATIONS

Nesting Biology of *Euglossa dodsoni* Moure (Hymenoptera: Euglossinae) in Panama

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The orchid bee genus *Euglossa* contains more than 100 species distributed throughout the Neotropics from Paraguay to Mexico (Michener, 2000). Most species nest in protected cavities such as in logs, trunks, small cavities between rocks, and man-made constructions, but some species build their nests in exposed sites where they are attached to small branches or underneath leaves (Eberhard, 1988; Nemesio, 2006). Nest of many species are made of wax and resins mixed with plant material and other materials, creating a strong structure that provides protection against environmental fluctuations and predators (Roubik and Hanson, 2004). Most *Euglossa* females are solitary nesters, but multifemale nesting is facultative for some species (Soucy *et al.*, 2003; Augusto and Garofalo, 2004). In *E. hyacinthina*, for example, all females that cohabit in a nest are capable of reproducing and there are no clear indications of dominance among the individuals, with sex ratios biased toward females (Soucy *et al.*, 2003; Capaldi *et al.*, 2007).

Euglossa dodsoni Moure is a small orchid bee known from cloud forests in Costa Rica and Panama (Ramirez *et al.*, 2002), but otherwise little is known of its biology. Dodson (1966) described several aspects of its nesting biology based on a population found in Costa Rica. Here, we describe the nesting biology from a small population in western Panama, including information on external and internal nest architecture, contents and sex ratios.

Materials and Methods

Area of Study

We located a population of *E. dodsoni* during May, 2004, along an isolated trail leading from the main road between Fortuna and Bocas del Toro (Chiriquí Province, Republic of Panama), approximately 2 km E of the Fortuna Dam. Nests were collected and transported to the Centro de Investigaciones Jorge L. Arauz of the Smithsonian Tropical Research Institute for further analyses.

Nest Structure

We characterized each nest according to the following dimensions: height, width and depth (Fig. 1), using the main axis of the nest with entrance as the center. We also recorded the diameter of the nest entrance and whether it was closed or open. Once we opened the nests, we recorded the number of cells and diagrammed the locations and content of each cell. If cells are not re-used, these data might help to reconstruct the sequence of cell building. An empty cell containing a meconium would be the oldest one whereas a cell containing fresh pollen would be considered a more recently built one. The other cells would be considered intermediate following the sequence preadults, dark pupae, light pupae and larvae.

Cell Structure and Contents

For each cell, we recorded diameter, height and thickness of the wall. We also recorded whether the cell was open or closed, and its contents. Cell contents were classified as callow adult, pupa with dark eyes, pupa with white eyes, larva or pollen. We followed Wcislo and Engel (1997) for the description of pollen mass shape and orientation, and shape and location of fecal deposits. Pollen was stored for further analysis.

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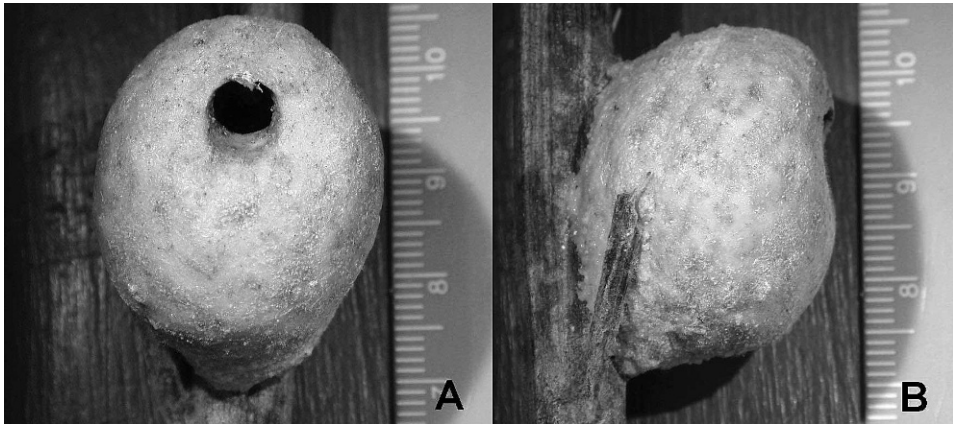


Fig. 1. Nest 11 of *Euglossa dodsoni*. A) Front view. B) Lateral view.

Individuals

Adult size was characterized by measuring head width and intertegular distance to the nearest 0.1 mm. Adults were either residents (found at the moment of the collection) or emerged later from cells. We also determined the sex of adults and pupae.

Statistical Analyses and Voucher Specimens

We analyzed the data using JMP, Version 5.1.2. SAS Institute Inc., Cary, NC, 1989–2007. We evaluated differences in body size (head width) by using a linear model including sex, nest and status (resident or emerged) as independent variables. Mean values are given with their standard errors. Vouchers are deposited in the entomological collection of the Smithsonian Tropical Research Institute in Panama.

Results

We found 16 nests of *E. dodsoni* along a ~500 m transect. Locally, bees appeared to be restricted to this small area as we did not find any nests despite intensive searching in areas ~500 m to each side of the area where the nests were found. The presence of *E. dodsoni* coincided with the absence of *E. hyacinthina*, which is typically abundant along roads at this locality (Soucy *et al.*, 2003; Capaldi *et al.*, 2007). As does *E. hyacinthina*, *E. dodsoni* also builds aerial nests on primary or secondary branches of *Baccharis* sp. (Asteraceae), which is abundant along the sides of the road.

Nest Structure and Cell Contents

Most nests (75%) were constructed on a vertical axis along a branch. On average, the nests were 29.4 ± 1.0 mm tall, 25.4 ± 0.9 mm wide and 20.8 ± 0.8 mm deep, giving the appearance of a small vertically oriented oval. The small entrance (diameter = 5.9 ± 0.2 mm) is a circular hole on one side, most often close to the top of the oval. Fourteen of 16 nests were open when the nests were collected, containing from 1 to 9 cells (mean = 4.7 ± 0.7) (see Fig. 2).

Cells are oriented in diverse directions, from completely vertical to slightly inclined to completely horizontal, and in some cases share walls with neighboring cells. In most cases we observed cells in different orientations within the same nest; however, in one case (Nest 5 containing six cells) all the cells were horizontal. In general it appears that the orientation is just a response to the space available for construction, with the vertical orientation being prevalent. There was an empty space between the external wall of the nest and the wall of each cell, which was frequently occupied by mycelia of an undetermined fungus.

In all nests ($N = 11$) we observed occupied cells: 5 had at least one cell with pollen, 7 had at least one larvae, 7 had at least one pupa and in 6 we found at least one adult. In contrast, we found empty cells in only 5 of the nests. The pollen mass had the shape of a slightly flattened sphere (category 2 in Wcislo and Engel's (1997) classification) and was always snug in the bottom of the cells (category 1 in Wcislo and Engel's (1997) classification).

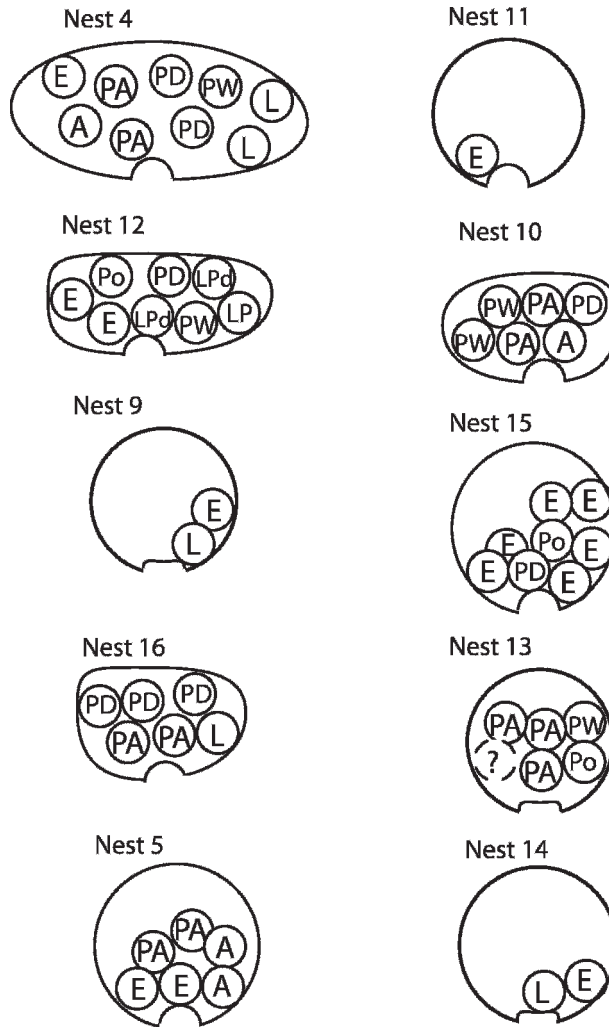


Fig. 2. Diagrams of the internal organization and content of nests of *E. dodsoni*. E = empty cell, A = Adult, PA = Pre-adult, PD = Pupa with dark eyes, PW = Pupa with white eyes, L = Larva, LPd = Pre-defecating Larva, Po = Pollen.

Fecal deposits were mostly cylindrical in shape; less often fecal deposits were flat and very rarely granulose. The location of the fecal deposits varied between the basal and the lateral side of the cell and was in some cases restricted to the basal quarter of the cell and in some cases restricted to the third quarter.

Sex Ratio

Resident bees were found in only 4 nests (all females), which is not surprising given that the collection was during the day, when the adults are foraging. In 3 other nests we found cells being provisioned but no resident bee. Our linear model showed that body size did not significantly vary among individuals from different nests ($F = 0.03$, $P = 0.86$, $N = 5$ nests), genders ($F = 0.31$, $P = 0.59$; $N_{\text{Females}} = 9$, $N_{\text{Males}} = 4$) or generations (i.e., residents vs. emerged) ($F = 1.61$, $P = 0.24$; $N_{\text{Residents}} = 4$, $N_{\text{Emerged}} = 9$) [ANOVA for full Model (3, 13) = 0.56, $P = 0.6535$].

From the pupae and adults we determined the sex ratio ($N = 8$ nests). In five nests we found a sex ratio of one [3/3 ($N = 2$ nests), 2/2 ($N = 1$ nest), 1/1 ($N = 2$ nests)]; in two nests the ratio was female biased (1/3

Table 1. Nest structure and number of cells. O = Open; C = Closed; B = Broken V = Vertical; I = Inclined; H = Horizontal; ND = Non determined.

Nest	Entrance	Height	Width	Depth	Entrance Diameter	Main Axis	#Cells
1	O	32.5	28.5	23.4	6.4	V	5
2	O	30.6	29.3	24.9	6.2	V	4
3	O	30.9	25.5	20.9	5.5	I	2
4	O	23.8	31.9	16.9	6.9	H	9
5	O	31.6	22.9	23.7	5.5	I	6
6	O/B	27	20.5	17.8	4.3	ND	ND
7	C	34.6	25.5	20.5	5.9	V	ND
8	O	29.1	24.2	24.1	6.2	V	1
9	O	24.2	18.5	15.3	5.2	V	2
10	O	27.1	24.7	22.3	5	V	6
11	O	29.7	25.5	22.3	6.2	V	1
12	O	24.5	30.1	16.6	6.1	H	8
13	C	36	26.8	22.9	7.6	V	6
14	O	27.1	24.3	20.6	5.8	V	2
15	O	34.8	26.1	22.6	6.9	V	8
16	O	26.1	21.5	17.5	5.2	V	6
Mean ± SE		29.35 ± 0.97	25.36 ± 0.88	20.77 ± 0.76	5.93 ± 0.20		4.7 ± 0.73

and 1/2). Only in one nest we found one male and no females. At the population level we found a ratio of 0.87, which is not significantly different from 1 (Chi-Square_{15,13} = 0.1430, d.f. = 1, $P = 0.70$).

Discussion

A previous report described the nest structure of *E. dodsoni* (Dodson, 1966). Here we confirm this earlier report, and add further notes on the biology of the species.

Several aspects are noteworthy. First, the population exhibited a very limited distribution, which was certainly not due to the availability of the host plant on which all the nests were found. Rather than host availability, strong wind currents may limit the distribution of the nests. All the nests were found within a corridor of approximately 30 m width, surrounded by high trees. On either side of this corridor the trees were smaller and the winds much stronger. The presence of *E. dodsoni* coincided with the absence of *E. hyacinthina*, another orchid bee typically nesting on the same plant as *E. dodsoni*. Nests of *E. hyacinthina* are larger, and may be less vulnerable to strong winds. Whether any competition exists between these species is unknown.

Table 2. Cell structure and contents. Measures are given with standard errors. For the right hand column, Number of adults (A)/ Number of Pupae (P)/ Number of larvae (L)/ Number of cells with pollen (Pol)/ Number of empty cells (E). For other columns, Wall = wall thickness, Empt = Empty, Occ = occupied.

Nest	Open/Closed	Diam. (mm)	Height (mm)	Wall (mm)	Empt/Occ	Male/Fem	A/P/L/Pol/E
1	4/1	4.66 ± 0.11	11.40 ± ND	0.68 ± 0.05	4/1	ND	0/0/1/0/4
2	1/3	6.20 ± 0.91	9.93 ± 0.72	0.40 ± 0.00	0/4	1/1	1/1/1/1/0
3	1/1	7.70 ± 0.20	11.70 ± 0.20	ND	0/2	ND	0/0/1/1/0
4	0/9	4.89 ± 0.12	10.94 ± 0.32	0.70 ± 0.07	0/9	3/3	4/3/2/0/0
5	2/4	5.52 ± 0.29	10.48 ± 0.25	0.57 ± 0.06	2/4	1/3	4/0/0/0/2
9	1/1	5.60 ± 0.30	9.20 ± 1.6	0.5 ± 0.10	1/1	ND	0/0/1/0/1
10	0/6	5.22 ± 0.24	11.70 ± 0.19	0.43 ± 0.03	0/6	3/3	4/2/0/0/0
12	1/7	4.92 ± 0.12	11.61 ± 0.33	0.70 ± 0.08	1/7	1/2	0/2/4/1/1
13	1/4	5.50 ± 0.20	11.10 ± 0.66	0.40 ± 0.00	0/5	1/1	1/3/0/1/0
15	6/2	5.52 ± 0.17	10.91 ± 0.39	0.6 ± 0.04	6/2	1/0	0/1/0/1/6
16	0/6	5.13 ± 0.24	10.32 ± 0.55	0.95 ± 0.20	0/6	2/2	2/3/1/0/0

A second interesting aspect is the distribution of cells within the nests. The internal organization inferred from the diagrams in Figure 2 suggests that the construction typically starts with a single vertical cell close to the entrance and more cells are added around it. However, from the internal organization observed, it is difficult to infer whether the resident bees reuse cells after the adults emerge and leave the nest. In some cases (e.g., Nests 4, 5), the resident bee starts a sequence of construction and seems to add more cells around it. In other cases the resident seems to reuse a cell only once the nest is full (e.g., Nest 12).

Finally, some data suggest that bees of more than one generation may cohabit a nest. In many cases (e.g., Nests 12, 13, 15) we found cells containing very contrasting stages of development and in some cases even empty cells. The presence of used empty cells in nests with cells being provisioned suggests that the resident and its offspring could cohabit, as reported for other species of *Euglossa* (Augusto and Garofalo, 2004). Whether such cohabitation leads to any kind of social interactions is unknown and warrants further investigation. The small size of the nests may impose a constraint on even a small group size, forcing most offspring to disperse, but additional observations are needed to validate this hypothesis.

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