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Description of a nest of *Euglossa heterosticta* from Peru, with taxonomic notes (Hymenoptera: Apidae)

Claus Rasmussen¹, Evelyn Sánchez², & Charlotte Skov³

Abstract. The nest of *Euglossa* (*Euglossa*) *heterosticta* Moure is described as the first aerial nest in the otherwise cavity-nesting *purpurea*-group. Associated adult males and females emerged from the nest permitting taxonomic notes to be provided for the heretofore unknown female of *E. heterosticta*.

INTRODUCTION

The orchid bees (Apidae: Euglossini) are a tribe of long-tongued pollinators found only in the New World. The nest-building females have a corbicula, a basket-like structure on the metatibia for carrying nest material and provisions, while male orchid bees have unique morphological features on the legs that are used to collect fragrant compounds from orchids and other sources (Michener, 2007). The fragrant compounds are stored in the highly modified metatibia and most likely used in relation to mating (Bembé, 2004; Eltz *et al.*, 2005). Males can be attracted to artificial scent baits, a technique widely used since its discovery (Dodson *et al.*, 1969), and which has resulted in the collection and description of many new taxa (*e.g.*, Nemésio & Rasmussen, 2011). The tribe encompasses more than 232 described species in five genera (Nemésio & Rasmussen, 2011). The genus *Euglossa* Latreille accounts for about 56% of the species diversity and is sometimes divided into seven subgenera and multiple species-groups within subgenera (Ramírez *et al.*, 2002; Cameron, 2004; Michener, 2007; Hinojosa-Díaz

¹ Department of Bioscience, Aarhus University, Ny Munkegade 114, bldg.1540, DK-8000 Aarhus C, Denmark (alrunen@yahoo.com).

² Departamento de Entomología, Museo de Historia Natural, Av. Arenales 1256 Jesús María, Lima 14, Perú (eyss13@hotmail.com).

³ Middelfart Gymnasium og HF, Østre Houvej 97, 5500 Middelfart, Denmark (lotte_skov@post-master.co.uk).

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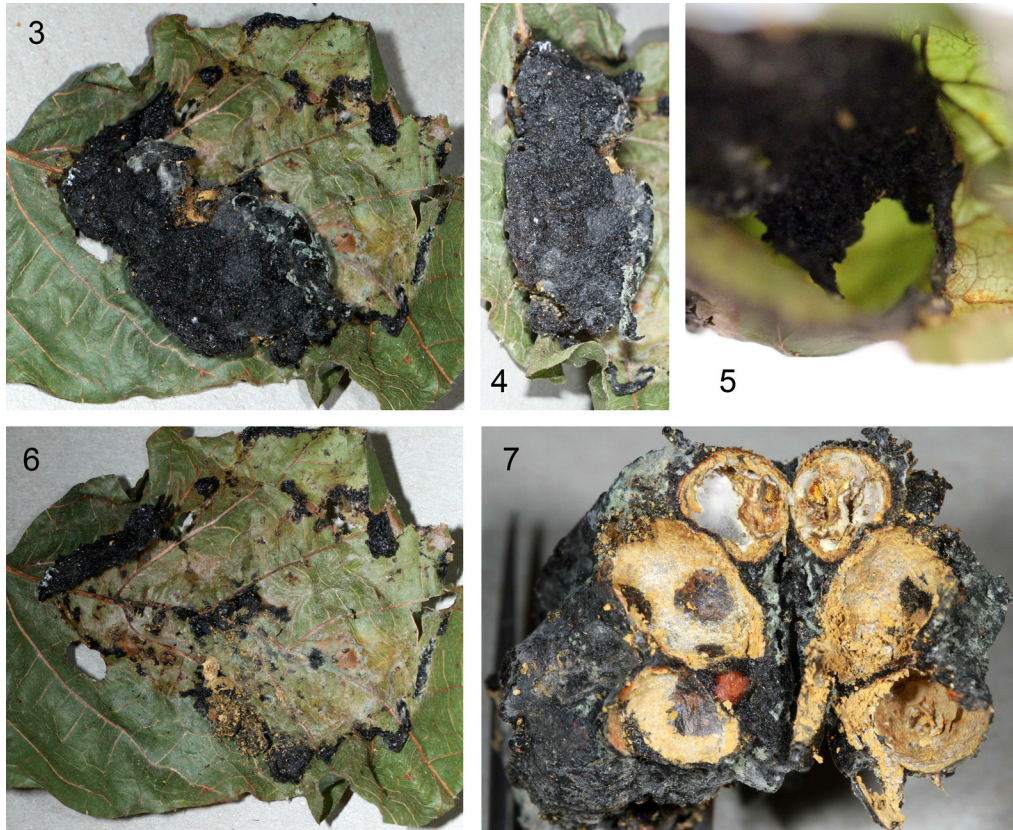


Figures 1–2. A nest of *Euglossa* (*Euglossa*) *heterosticta* Moure under the leaf of the “chopé” plant (probably *Gustavia* L., Lecythydaceae) in Peru. **1.** Nest prior to exposure; the arrow indicates the nest location. **2.** The same leaf now twisted to show the nest.

& Engel, 2012). According to accounts of orchid bee biology, the nests remain undescribed for the majority of the species, probably due to the fact that they are often well concealed and inconspicuous (Dressler, 1982; Cameron, 2004; Roubik & Hanson, 2004). Known nests of species of *Euglossa* can be divided roughly into two main types: aerial and cavity nests (Dressler, 1982; Cameron, 2004). Aerial nests are exposed and located on stems, twigs, and the undersides of leaves with the cells enclosed within a more or less spherical or cone-shaped resinous envelope (Cameron, 2004; Michener, 2007). Cavity nests contain cells, isolated or in small clumps, placed in small pre-existing cavities in tree branches, trunks, amongst roots, in cacao fruits, earthen banks, termite nests, or artificial cavities (Cameron, 2004; Roubik & Hanson, 2004; Michener, 2007). Some nests are built and occupied by a single female, while others contain multiple females living more or less cooperatively (Roberts & Dodson, 1967), or even parasocially (Garófalo, 1985; Otero, 1996).

We here report for the first time on a nest of *Euglossa* (*Euglossa*) *heterosticta* Moure found in northeastern Peru. The species is placed in the *purpurea* species group and is distributed from Costa Rica to Colombia (Roubik & Hanson, 2004), with recent confirmed reports also from Peru (Abrahamczyk *et al.*, 2011) and Brazil (Nemésio, 2009). While the fauna of orchid bees from northeastern Peru is little known, recent studies have surveyed localities in both San Martín and Loreto (Rasmussen, 2009; Abrahamczyk *et al.*, 2011; Nemésio & Rasmussen, 2014), and resulted in the discovery and description of a large and colorful new species of *Euglossa* (Rasmussen & Skov, 2006).

Most of the species of *Euglossa s.str.* have been thought to belong to the cavity nesters (Cameron, 2004), with the nest of *E. heterosticta*, among many others, unknown prior to this report (Roubik & Hanson, 2004). Of the 17 species listed in the *purpurea* species group by Bembé (2007), nests are known for only six of the species, all of which have been reported as cavity nesters: *E. atroveneta* Dressler in artificial cavities includ-



Figures 3–7. The nest of *Euglossa* (*Euglossa*) *heterosticta* Moure. **3.** Nest with the leaf partly removed. **4.** Same nest viewed on end. **5.** Exit hole for emerging bees, chewed through the resinous involucrum. **6.** The leaf with the nest completely removed. **7.** A cut through cells *b-c-d* (compare with figure 8) where the neighboring brood cells *e-g* are visible through the built-up pollen exines. Apparently the cells are not completely ovoid on the inside. Also notice the reddish surface of neighboring cell *g* as seen from cell *d*. This indicates the presence of a cell inner surface made by the bee.

ing wooden boxes (Ramírez Arriaga *et al.*, 1996) or tubular cavities (Roubik & Hanson, 2004); *E. dissimula* Dressler in palm stems (Roubik & Hanson, 2004); *E. hansonii* Moure in hollow stems or wood (Roubik & Hanson, 2004); *E. igniventris* Friese in sticks or wooden cavities (Roubik & Hanson, 2004); *E. purpurea* Friese in tubular cavities (Roubik & Hanson, 2004) and *E. aratingae* Nemésio [as *E. townsendi* Cockerell, see Nemésio (2009)] in trap nests using bamboo canes (Augusto & Garófalo, 2004) or similar wood cavities (Roubik & Hanson, 2004).

RESULTS

Description of the Nest

The nest of *E. heterosticta* was found and collected in secondary vegetation near the house of Santos Mena Taica in Reserva Natural de Tingana on the Rio Abisado (5.9157°S / 77.1153°W, 813 m a.s.l.), San Martín, Peru on May 30th, 2015 by C.R. and E.S. This was during the end of an extended wet season. The aerial nest was constructed

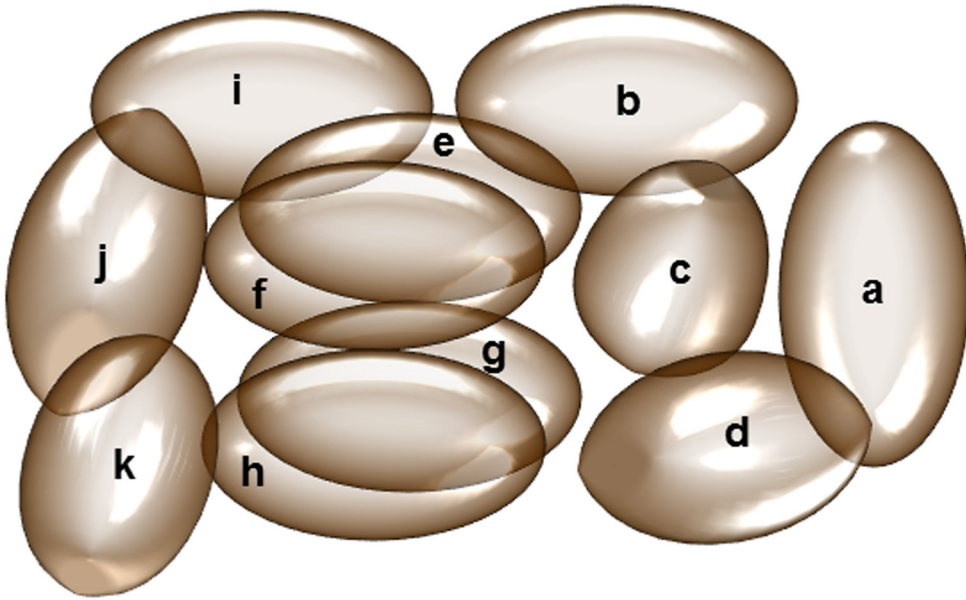
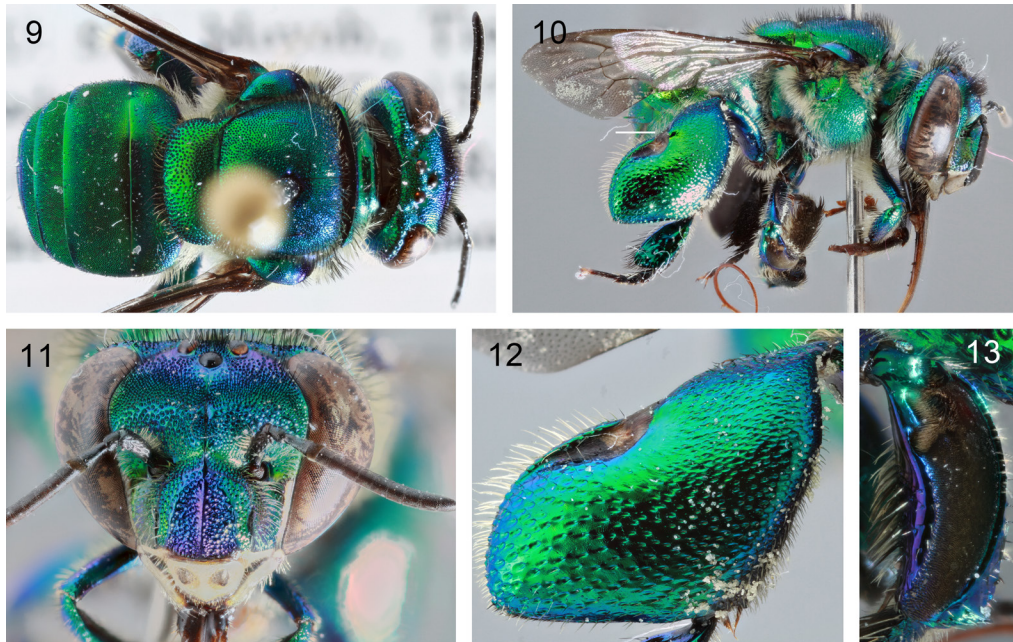


Figure 8. A 3-D representation of the cell cluster seen from above, with the leaf removed. The leaf was rolled around cells *b* and *j*. Judging from the sealed involucrum the nest appears to have been finished with no expansion possible.

below a green leaf (approx. 20 x 7 cm) about 1 m above the ground of a young “chopé” tree (probably *Gustavia* L., Lecythidaceae: Fig. 1). The leaf was folded halfway around the lightweight nest as seen in figures 2 and 3. Upon discovery, a single female resting on the outside of the nest was collected immediately for subsequent identification. The nest did not appear to have any openings and it was assumed that the female could be the foundress having recently sealed the nest. The outer protective layer, the involucrum, was made of a pliable dark, almost black, micro-perforated resinous material (Figs. 3, 4). Between the involucrum and the leaf, 11 brood cells were suspended on small pillars of resin on either side of the brood cluster. The 11 cells were arranged in an irregular, elongate cluster (approx. 4 x 2.5 x 1.5 cm). Figure 8 shows how the irregular cells were oriented in all directions, with the apparently newest cells placed basally towards the petiole and the oldest cells, including several open ones, placed apically towards the tip of the leaf. Brood cells were also made of a dark, resinous material with smooth inner surface that could be separated from the softer resinous material. The internal cell dimensions were 1.1 x 0.6 cm. Pollen exines covered most of the inner surface of the cells (Fig. 7).

After collection and transportation to Denmark, three adults emerged in a flight cage on July 3rd (34 days after collection) and following days. The nest had not been kept at climate conditions similar to the natural habitat and brood development likely was affected. Following emergence the nest was dissected and described. The first bee to emerge was a male followed by two females. During dissection, a fourth bee, a dead adult male, was found sitting outside cell *a* in the space below the leaf. Adults could have emerged from any of the open cells: *a*, *c*, *d*, *e*, *g*, or *h* (Figs. 7, 8). All open cells had uneven chew marks around the end of the cell. Two additional bees were found inside closed cells: the fifth bee was an adult male (cell *f*), while the sixth bee was

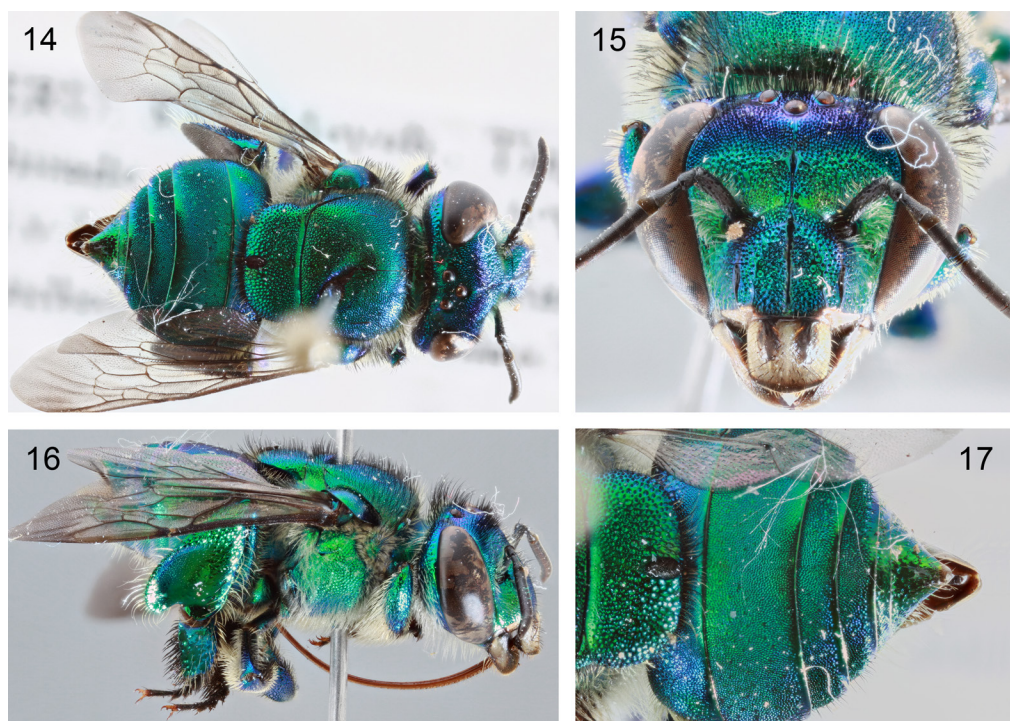


Figures 9–13. Male of *Euglossa* (*Euglossa*) *heterosticta* Moure that emerged from the nest. 9. Dorsal habitus view. 10. Lateral habitus view. 11. Frontal view. 12. Metatibia. 13. Mesotibia with tufts.

a female, brown-eyed pupa (cell *j*). Remaining cells (*b*, *i*, *k*) contained remains of dried up provision masses or debris, as well as mold. We also found several segments which appeared to be cocoons made by the mature larvae (Roberts & Dodson, 1967). Two more open cells than the number of adults encountered in the nest suggest that the bees could have escaped earlier or somehow the cells were not filled with provision by the nest foundress. No associated organisms were located in the nest. The exit from the nest was a small hole chewed by the first emerging bee through the involucrum (Fig. 5). The hole was made on the border between the leaf and the involucrum at the apical end of the leaf.

Taxonomy

Nemésio (2009) discussed the potential synonymy of *E. townsendi* (described from San Rafael, Veracruz, Mexico) with *E. heterosticta* (described from Cerro Campana, Panama), *E. anodorhynchi* Nemésio (described from Joinville, Santa Catarina, Brazil), and *E. avicula* Dressler (described from Conceição da Barra, Espírito Santo, Brazil). The problem of synonymy arose because the primary type for *E. townsendi* is a female, whereas the taxonomy of *Euglossa* is based exclusively on male characteristics, making it difficult to characterize a female without associated males. Although *E. townsendi* was described from a nest, apparently only females were reared out and the original nest was not described (Cockerell, 1904). Nemésio (2009) pointed out distinctive characters for all four taxa and provided illustrations of primary types or identified material of each of the four involved species. The issue remaining is to determine whether or not females of *E. heterosticta* are distinct from the female lectotype of *E. townsendi*. Based on comparisons between the published figure of the lectotype of *E. townsendi*



Figures 14–17. Female of *Euglossa (Euglossa) heterosticta* Moure that emerged from the nest. **14.** Dorsal habitus view. **15.** Frontal view. **16.** Lateral habitus view. **17.** Mesoscutellum and metasoma.

(Nemésio, 2009: his figure 84) and a female reared out from the present study we confirm that each is distinct and the two species should not be synonymized. The overall appearance of the females of the two species is somewhat similar with *E. townsendi*, being more bluish than *E. heterosticta*. However, the characteristic small and elliptical mesoscutellar tufts are markedly distinct: the length in *E. townsendi* being 0.25x as long as the length of the mesoscutellum, whereas it is 0.40x as long as the mesoscutellum in *E. heterosticta*. In addition, sculpturing of the female mesoscutellum is different; being subcontiguously punctate anterior to the tuft in *E. townsendi* (punctures separated by more or less flat interspaces up to 0.3 times the puncture diameter), compared with densely punctate in *E. heterosticta* (separated by more than 0.3 times).

DISCUSSION

The nest of *E. heterosticta* has not been described previously nor has the female been associated with the male. We have no knowledge of similar nests amongst species of *Euglossa*: aerial nesters construct either “domes” or “nut-shaped” nests. Compared to the morphologically similar *E. aratingae* (as *E. townsendi*: see Nemésio, 2009), the number of cells for that species (4–14 cells) are within range for the 11 cells we found (Augusto & Garófalo, 2004). The same authors also reported egg-to-adult time to range from 52–75 days depending on seasonality for *E. aratingae*. Such a time period compares well with other studies of the development of species in *Euglossa* (e.g., Andrade-Silva & Nascimento, 2012), and suggests that the nest of *E. heterosticta* would have been initiated several weeks before its collection.

Our findings contradict the observation by Dressler (1982), that nesting characteristics are shared amongst members of the same taxonomic grouping. To our knowledge, the known nests for six of the species in the monophyletic *purpurea*-group (see Ramírez *et al.*, 2010) are all made in cavities. While the nests remain unknown for the remaining species in the species group, this new aerial nest record for *E. heterosticta* indicates that nesting might not be as evolutionarily conserved as suggested by Dressler (1982). An obvious advantage of building exposed nests is to avoid the constraint available cavities have on nesting opportunities. At the same time, it is also noteworthy that multi-female nests are the result of nest re-use by succeeding generations of females. This is not possible with the present nest-design because leaves eventually fall to the ground making re-activation of the nest by succeeding generations impossible.

Nannotrigona melanocera (Schwarz) is a cavity nesting stingless bee, but the bees have been observed to seal off large exposed parts of the nest by constructing a protective involucrum (C.R., pers. obs.), thus rendering an aerial nest habitable for a cavity-nesting species by actively adding involucrum. As we have no other observations of nests of *E. heterosticta*, this species could also be a regular cavity nester like all of the closely related species, but this particular female was able to utilize this leaf by constructing an involucrum that formed a cavity. Therefore it is tempting to speculate that such opportunistic nesting behavior marks the transition from cavity-nesting orchid bees, the presumed ancestral trait for euglossine bees, to a derived aerial nest with pre-defined structural characteristics. If the latter is the case, it is not known whether the extended wet season or similar climatic conditions caused the change.

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