

A Male Sleeping Roost of a Sweat Bee, *Augochlorella neglectula* (Ckll.) (Hymenoptera: Halictidae), in Panamá

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ABSTRACT: A persistent sleeping roost is described for male sweat bees, *Augochlorella neglectula* (Ckll.), occurring on the rootlets of a hanging plant on a 4th story apartment balcony in an urban environment in central Panamá. The rootlets were used by the same males consistently within a season, as well as between seasons, although presumably different individuals were involved. Males probably do not use olfactory cues for local orientation to the sleeping rootlet, as inferred from choice tests between an un-used and used rootlet. Brief social interactions among males were generally pacific, although there was kicking and shoving when they first settled. Males became progressively more difficult to disturb further into the night.

Bees and wasps (Hymenoptera: Apoidea, Vespoidea) that sleep on plants have been known at least since Linnaeus (1758), who named a new bee species, *Apis florissomnis* [= *Chelostoma florissomne* (L.), Megachilidae], in reference to its sleeping behavior. Since then sleeping roosts have been described for a number of species, although their functional significance remains uncertain (e.g., Rau and Rau, 1916; Kaiser, 1995; Alcock, 1998; for early literature see Linsley, 1962). The term "sleeping aggregation" is used in the hymenopteran literature, although I use "sleeping roost" to draw attention to similar phenomena in other insects such as butterflies (e.g., Mallet, 1986) and vertebrates such as bats (e.g., Choe, 1994).

Usually only males sleep on plants, although sometimes roosts contain both males and females—the latter are typically brood parasitic species that have no nests (e.g., Kaiser, 1995). In some species (e.g., *Nomia tetrazonata* Ckll., Halictidae) males sleep on vegetation but do not cluster (Wcislo, 1993). Males in clusters often show fidelity to the same site over the course of a season (e.g., Linsley, 1962; Evans and Linsley, 1960; Alcock, 1998). Consequently, there are recurrent opportunities for social interactions, and thus sleeping roosts may require mechanisms to limit aggression if some positions within the roost are better than others (e.g., Allee, 1958; Moynihan, 1998). Within sleeping roosts, however, social interactions have been documented only rarely (e.g., Alcock, 1998). This note describes sleeping roosts of males of a neotropical bee, *Augochlorella neglectula* (Ckll.) (Hymenoptera: Halictidae: Augochlorini), in an unusual location that persisted across generations, as well as behavioral interactions among males within the aggregation.

Methods and Study Site

The sleeping roost occurred on a southeast facing balcony on the 4th story of a 5-story apartment building in a residential area of Panamá City (Edificio Gina, calle 58 y calle Abel Bravo, Obarrio, Panamá Province, Republic of Panamá). At the western end of the balcony a dead fern occupied a hanging pot made of a splayed coconut husk filled with soil that was suspended ~25 cm from the ceiling, and had numerous dried rootlets hanging down, some of which were used as sleeping roosts. A stingless bee (*Plebeia*, Apidae)

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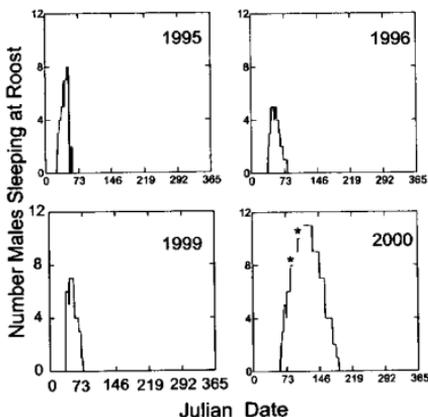


Fig. 1. Seasonal abundance of male *Augochlorella neglectula* at the sleeping roost for 4 years. * = no census data were recorded during these days.

swarm colonized the husk and established a colony within the soil of the hanging plant in March 1995; an active colony was located there ever since then. This end of the balcony receives strong early morning sunlight, but is shaded from the afternoon sun when males settle at the roost. A variety of houseplants were distributed around the balcony ($\sim 1.2 \times 8$ m).

The following manipulation was made to assess the cues that males use to locate their sleeping rootlet. During the day when males were away from the site, the rootlet that was used for sleeping (hereafter, "sleeping rootlet") was tied away from its original position and displaced to the right or left (based on a coin flip) a distance of approximately 5 cm. A second rootlet (hereafter, "new rootlet"), approximately matching the "sleeping rootlet" in size and architecture, was placed in the original position. The number of male bees returning to the two rootlets was recorded. Males were counted only if they were marked or if there was no uncertainty over the identity of an unmarked male (i.e., there was no subsequent movement after arriving at the site). To avoid pseudoreplication, this manipulation was done only one time in a given season.

Behavioral observations of bees were made in the late afternoon, and at night with ITT® 6015 night vision goggles or recorded on a SONY® TRV10 video camera with an infrared light. Some males were marked on the thorax with unique combinations of Testor's® enamel paints. Male-male interactions were scored as aggressive or pacific, as follows: arbitrarily, an interaction began when a male was within one body length of another male. If the male lunged at, or contacted, the other male with its body, the behavior was scored as aggressive. If males contacted each other with antennae or there was no contact, the interaction was scored as pacific.

Voucher specimens are deposited in the Dry Reference Collection of the Smithsonian Tropical Research Institute, Balboa, Republic of Panamá, and in the Snow Entomological Museum, University of Kansas. Linear statistical analyses were taken from Sokal and Rohlf (1995) and calculated using Systat® (Wilkinson 2000) on a personal computer, as for the circular statistics calculated using Oriana® (Kovach, 1994). Means are given with standard deviations.

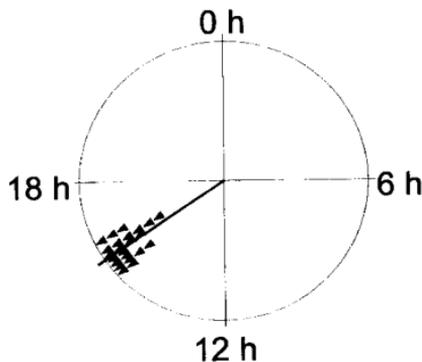


Fig. 2. Daily arrival times of male *Augochlorella neglectula* to the sleeping roost. Bold line is circular mean. Sunset varied from 18:10–18:30 hr during the roosting season.

Results

During the dry seasons (~January–May) of 1995–1996 and 1998–2000 five to 11 male *Augochlorella neglectula* clustered together on a rootlet on the sheltered side of a hanging plant on an apartment balcony. Sleeping roosts formed early in the dry season and persisted to the end of this season (Fig. 1); males did not roost in 1997, but roosted in 1998 although no quantitative data were recorded.

Each day males arrived in the late afternoon (15:30–16:00 hr) (Fig. 2); if there was inclement weather they arrived earlier. Until dark (~18:30 hr), males remained relatively active, sometimes shifting positions, grooming, and interacting with neighbors. During this time males were easily disturbed by approaching them with a very small twig, gently blowing on or touching them, vibrating the rootlet etc., and in all instances the males fled and resettled within approximately 30 min ($\bar{x} = 24.4 \pm 4.9$ min, $N = 7$ induced disturbances); I did not observe natural disturbances. Throughout the night the males were more difficult to disturb, and they fled or moved positions only after considerable prodding, and they did not respond to disturbances such as switching on the balcony light. In the morning bees departed between 7:00–7:30 hr (Fig. 3), and could be readily disturbed after sunrise. Male bees did not depart *en masse*, but rather individually. After departing, it is not known where males went and nothing is known about the mating behavior of this species; occasionally a male could be seen flying around flowers on the balcony.

Marked bees show short-term persistence to a particular sleeping site within a season. Seventeen of 29 (59%) males marked while at the sleeping rootlet were present at the same site at least seven days after marking. Between years, however, no males marked in one season were observed at the site the following season. In 1996 males used the same rootlet that males used in 1995. No sleeping aggregation formed at the site in 1997, and in 1998 males used a different nearby rootlet. At the end of the 1998 season, this sleeping rootlet was removed, and the following year males used another nearby rootlet. In 1999 and 2000 males used different, adjacent rootlets. The distance among rootlets used by bees between 1995–1996 and 1998–2000 was 3.03 ± 0.06 cm ($n = 5$). Following a change in the location of the sleeping rootlet, 51 of 65 males went to the new rootlet at the original location and ignored the displaced sleeping site even though it was only five cm away (G

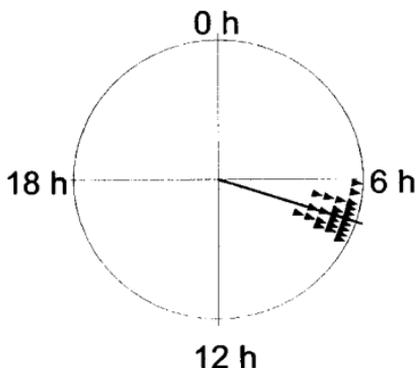


Fig. 3. Departure times of male *Augochlorella neglectula* from the sleeping roost. Bold line is circular mean. Sunrise varied from 06:30–06:15 hr during the roosting season.

test with Williams' correction, $G_{adj} = 22.2$, $P < 0.001$), suggesting that males use short-range visual cues to return to the general vicinity of the site.

Within a roost most males clustered, maintaining a personal space of about one body length (distance between males, $\bar{x} = 1.2 \pm 1.6$ body lengths, range = 0–8, $N = 24$, data from March 2000). The number of marked males was relatively low, so it was not possible to discern whether males form a dominance hierarchy. Nevertheless, there were some asymmetrical social relationships. In the year for which there are more behavioral data (1999), two males initiated 67% of 29 aggressive interactions yet they were the targets of a lower percentage (12%) of aggressive behaviors. During five nights each of these two aggressive males occupied different positions in the roost, and one of these males occupied both peripheral and central locations. If corroborated, then such observations suggest that male aggressive behavior is not associated with competition to obtain favorable positions within the roost.

Discussion

The sleeping roost of male *Augochlorella neglectula* is unusual for its location near human activity and unnatural light levels at night. Artificial light had no obvious influence on their sleep; sleeping bees generally exhibit increasingly longer periods of restful behavior with decreased respiration as the night progresses (see Kaiser, 1995). Nothing is known of mating behavior for this species, and the function, if any, of male social roosting is not understood, as true for the social behavior of male hymenopterans in general (see O'Donnell, 1999). As the height of the balcony above the street is approximately the same as the local forest canopy, it may be that males patrol among the treetops for females in more natural settings.

The multi-year persistence of the roost was also unusual. Within seasons, behavioral manipulations suggest that males use short-range visual cues to return to the general vicinity of the site, as do their female counterparts (e.g., Collett and Zeil, 1998). For some other bees, males appear to use olfactory cues (e.g., Alcock, 1998). Yet the observations that males (presumably different individuals) returned seasonally to the same rootlets, after intervals of many months (Fig. 1), are difficult to explain on the basis of visual cues alone. Speculatively, long-lasting residues of olfactory cues may bring the males initially to the

roost site, and subsequently males use visual cues once an individual is familiar with the site. No males marked in one season were observed at the roost site the following season. However, it is unclear whether this finding means that i) paint marks do not last from one season to the next; ii) the males died; or iii) the males change sites among years. Male longevity is not well documented for halictid bees, but the scant data suggest it is highly unlikely that males live more than a year as adults (see Wcislo, 1992).

Acknowledgments

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