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SHORT COMMUNICATION

Backyard bees: multi-year fidelity to a sleeping roost site by male Melissodes bimaculatus (Lepeletier) (Hymenoptera: Apidae) and co-roosting by parasitic Triepeolus lunatus (Say) (Hymenoptera: Apidae) in southeastern Louisiana

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ABSTRACT: Little is known about the formation, persistence, or dissolution of sleeping clusters of male bees at night roosts. We report multi-year fidelity of male *Melissodes bimaculatus* (Lepeletier 1825) (Hymenoptera: Apidae) sleeping clusters to a single backyard patch of irises (Iridaceae: *Iris*) in Baton Rouge, Louisiana. In addition, during two consecutive years, individuals (at least one male and one female) of *Triepeolus lunatus* (Say 1824) (Hymenoptera: Apidae) co-roosted with the male *M. bimaculatus*. Individual bees settled near other bees for their nocturnal rest or nighttime inactivity periods. They also appeared to sometimes bias their specific choices for roosting positions toward plant parts against which or near which their bodies were somewhat camouflaged. Thermoregulation is an unlikely ultimate evolutionary explanation for aggregated sleeping behavior in these particular bees, but protection from predators through safety in numbers and opportunities to glean information from roost mates remain as plausible adaptive explanations. We propose an extension of the Information Center Hypothesis for co-roosting by parasitic bees with their host species.

KEYWORDS: Bee behavior, communal roost, Information Center Hypothesis, insect sleep, nocturnal rest, sleeping aggregation, sleeping cluster

More than a century ago, Rau and Rau (1916) encouraged entomologists to pay more attention to insect sleep. Even so, our understanding of insect behavior related to sleep or nocturnal rest remains fragmentary and incomplete (Helfrich-Förster, 2018). Among solitary bees, although each adult female generally sleeps in a nest that she constructs for her offspring, adult males often form sleeping aggregations or clusters in the open (i.e., not concealed in burrows, curled leaves, etc.; e.g., Banks, 1902; Linsley, 1962; Michener, 1974; Danforth *et al.*, 2019).

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Even though several reports have been made of male sleeping aggregations or roosts in solitary bee species (e.g., Mathewson and Daly, 1955; Alcock, 1998; Wcislo, 2003; Alves-dos-Santos *et al.*, 2009; Silva and Andrade, 2022), exceedingly little is known about the formation, longevity, and dissolution of these aggregations. We report multi-year observations from a backyard in Baton Rouge, Louisiana on a nighttime, early-summer roost site of male two-spotted longhorn bees, *Melissodes bimaculatus* (Lepeletier 1825) (Hymenoptera: Apidae) and occasional co-roosting by the parasitic cuckoo bee, *Triepeolus lunatus* (Say 1824) (Hymenoptera: Apidae).

MATERIALS AND METHODS

One of us (K.E.H.) first noticed active bees settling to roost in a small iris (Iridaceae: *Iris*) patch in his backyard (1320 Stephens Ave., Baton Rouge, LA 70808) on May 13, 2017. Thereafter, he opportunistically checked the focal iris-patch roost site and made observations, primarily during the months of May and June, from 2017 through 2021, and again during 2023 and 2024. The iris patch was dominated by horticultural irises ~1 m tall, but a taller sedge, *Cyperus alternifolius* (Cyperaceae; ~1.5 m tall at the southeastern margin of the patch), as well as a shorter aroid (Araceae), and a few additional small-statured herbaceous plants also occurred in the patch. A small perennial horticultural shrub, *Camellia sasanqua* (Theaceae; ~1 m tall in 2017, ~1.5 m tall in 2024), grew on the southeastern edge of the iris patch (just to the outside of the *C. alternifolius* cluster). The aboveground parts of the herbaceous plants died back each fall and winter, then resprouted from underground perennating organs and regrew each spring and summer. The iris patch was somewhat elliptical, measuring ~3 m across its north-south axis and ~2 m across its east-west axis. On June 6, 2017, there were about 500 iris leaves densely packed and distributed throughout the patch. The entire patch was mostly shaded throughout each day by nearby trees to the east and south of the patch. Although the *C. alternifolius* cluster expanded somewhat during the course of the study (~10 stems in 2017 to ~25 stems in 2024), the general character of the vegetation in each respective month was about the same from year to year, until the irises mostly failed to resprout during spring 2024.

On several late evenings (around sunset) and early mornings (around sunrise), K.E.H. visited the iris-patch roost site, noting the following: bee behavior and other animals present; numbers, identities, and sexes (as he was able) of bees at the iris patch; and general weather conditions. During most months of most years of the study, he also from time-to-time looked throughout his yard (back and front), especially around sunrise and sunset, but also opportunistically at other times of the day and night, for other possible bee roosts or ground-nest holes of female *Melissodes*, and remained vigilant for roosts in his neighborhood. K.E.H. collected three of the bees from the focal iris-patch roost during the first year of observations (2017) and B.E.O. identified and sexed them.

RESULTS

From one individual bee collected from the focal iris-patch roost, B.E.O. determined that the principal bees under observation were male *M. bimaculatus*. She identified the other two bees collected from the same roost as *T. lunatus*. All three specimens were vouchered at the Louisiana State Arthropod Museum: male *M. bimaculatus* = LSAM 0306947, collected May 18, 2017; male *T. lunatus*,= LSAM 0306948, collected May 26, 2017; female *T. lunatus* = LSAM 0306949, collected May 25, 2017. Both species are native to Louisiana (Owens *et al.*, 2018). *M. bimaculatus* males are easily distinguished from females by the cream-colored male clypeus. In Baton Rouge, LA, the only other superficially similar (i.e., mostly black and medium-to-large sized) bees to *M. bimaculatus* are female *Xylocopa micans* (Lepeletier 1841) (Hymenoptera: Apidae). However, *X. micans* females lack a light-colored clypeus and elongate antennae, are considerably larger, and have a more rotund body than male *M. bimaculatus*. Males of *X. micans* possess a light-colored clypeus, but have extensive fulvous pubescence on the notum and an iridescent surface on the metasoma. The other *Xylocopa* species common in the area is *X. virginica* (Linnaeus 1771) (Hymenoptera: Apidae), which is much larger and possesses dense, fulvous pubescence on the notum in both sexes. Neither species of *Xylocopa* is likely to be confused with *M. bimaculatus*. Accordingly, K.E.H. is confident that his field identifications of male *M. bimaculatus* at the focal roost were accurate.

During the years of his observations of the focal iris-patch roost, K.E.H.'s broader search efforts only resulted in one additional male *M. bimaculatus* roost in the same neighborhood (found by Dylan R. Harms about a block away, on the edge of a clump of ~2.5-m tall ornamental grasses in the front yard at 1352 Aberdeen Ave., containing 10 bees on May 31, 2017). We did not study this second roost in detail. In spite of K.E.H.'s search efforts, he did not find any ground-nest holes of female *M. bimaculatus* in the same backyard as the focal iris-patch roost.

K.E.H. observed single *T. lunatus* individuals co-roosting in the focal iris-patch roost with *M. bimaculatus* males in 2017 on May 13 (Fig. 1), 17, 20, 22, 25 (specimen LSAM 0306949), and 26 (specimen LSAM 0306948), and in 2018 on May 20, 29, and June 3. He did not determine the sexes of *T. lunatus* in the field. In any case, male *M. bimaculatus* were much more frequently encountered than were *T. lunatus*. All subsequent results reported below in the Results section concern sleeping clusters of male *M. bimaculatus*.

For the purposes of this report, we defined a sleeping cluster as two or more bees found together on the same leaf blade or plant stem, such that every individual in the cluster was within three body lengths of its nearest neighbor (Table 1). Sleeping clusters themselves were nearly invariably aggregated within the iris-patch roost site, i.e., clusters were closer to one another than would be expected by chance (as are the three sleeping clusters visible in Fig. 1). Accordingly, bees associated with one another at multiple spatial scales: individual bees were near one another within clusters, clusters were near one another, and no other roosting bees were encountered elsewhere in the same backyard (including a similarly sized iris patch at the base of a pecan tree, *Carya illinoinensis* [Juglandaceae], ~15 m away from the focal iris-patch roost site). In contrast to the fidelity that the bees appeared to show to the general roost location (i.e., invariant use of the iris patch), microsite fidelity (i.e., to individual leaves or stems) was far less closely maintained.

The same focal iris-patch roost site was used consistently during late spring and early summer for at least six out of seven years (Table 1). Bees consistently began using the roost site in May and, except for one bee present in July 2017, bees finished using the roost site by the end of June. Bees mostly settled into the roost site in the evening and left in the morning; bees were generally fully settled by 1/2 hr before sunset and gone by 1-2 hr after sunrise, except on cloudy, rainy, or overcast days. Weather conditions with diminished light levels appeared to cue bees to settle into the roost site earlier than normal after a day's activity period, or to remain in the roost site later than normal prior to beginning the day's activities. For example, on the unusually dark and cloudy afternoon just before a rainstorm on May 25, 2018, 11 male *M. bimaculatus* were settled together in the iris patch in one cluster on a single iris leaf, and three others were flying nearby, at 15:00 hr (~4 hr earlier than usual for bees to be settled into the roost). Certain weather conditions also appeared to dissuade bees from returning to roost during the roosting season, sometimes for a few days at a time. For example, after one male *M. bimaculatus* roosted in the iris patch on May 16, 2021, no

Figure 1. Three aggregated sleeping clusters of several male *Melissodes bimaculatus* in the backyard iris-patch roost in Baton Rouge, Louisiana, and a single co-roosting parasitic bee, *Triepeolus lunatus* (far right in the photo). We consider each group of bees on a separate leaf to be a separate sleeping cluster; accordingly, there is spatial aggregation of bees both within clusters and among clusters within the considerably larger iris-patch roost site. The photo was taken in the evening at 19:26 hr on May 13, 2017 (sunset occurred on that date at 19:51 hr).

bees were found in the patch during a rainy spell (rain each afternoon or evening from May 17 to 20); then, after a few sunny days, on May 28, six male *M. bimaculatus* roosted in a cluster on the bent, necrotic portion of an iris leaf.

Bees primarily attached themselves to leaves or stems using their mouthparts, often with their mandibles clamped tightly to a leaf margin (Figs. 1 and 2). In contrast, Rau and Rau (1938, pg. 545) reported that male *M. bimaculatus* "use only their legs, and not the mandibles, to cling to the stems." As they settled into the roost, bees often appeared to be attracted to other bees, as well as to necrotic portions of the plants on which they settled (e.g., although the main cluster in the foreground of Fig. 1 is on a healthy, non-necrotic leaf, the cluster at the far left and back is on a senesced iris flower; the cluster in Fig. 2 is on the necrotic portion of a bent iris leaf). Necrotic plant parts were sparsely but widely distributed throughout the focal iris patch, so the overall clustering we observed of bees in the roosts was not simply a consequence of clustering of necrotic plant tissues.

Considerably more bees were found in the focal iris-patch roost during the first two years of the study than during subsequent years (Table 1). The mean (± standard deviation) and maximum numbers of bees in 2017 were: 14.2 (± 6.6) and 23 bees (observed at 20:00 hr on May 18). The mean and maximum in 2018 were: 7.0 (± 5.8) and 17 bees (observed at 20:00 hr on May 20). In contrast, the mean number of bees during subsequent years of observations (2019-2023) ranged between 1.7 and 4.0, and the maxima ranged between 2 and 7 (Table 1).

Potential and confirmed predators of the bees were also present in the iris patch. At 6:22 hr on May 15, 2023, an assassin bug (Hemiptera: Reduviidae) carried a male *M. bimaculatus* in its mouthparts within the iris patch, while three live male *M. bimaculatus* were motionless and clamped by their mouthparts - each on its own separate iris leaf - but all within 1 m of one another. At 19:30 hr on May 30, 2019, a green anole, *Anolis carolinensis* (Squamata: Dactyloidae), lunged at a male *M. bimaculatus* that was flying among the leaves in the iris patch. Hemipterans and *A. carolinensis* were observed on several other occasions in the iris patch as well. On many occasions, orb-weaving spiders (Araneae: Araneidae) were present in the patch before, during, and after bees roosted, and on several occasions roosting dragonflies (Odonata) also occupied the iris patch overnight.

Table 1. Summaries of annual observations of male *Melissodes bimaculatus* sleeping clusters in the backyard iris-patch bee roost in Baton Rouge, Louisiana. Date of first check is the first date of the given year on which the patch was carefully inspected for bees; date of first appearance of bees is the first date on which male *M. bimaculatus* bees occupied the patch. Number of days patch was checked is the number of dates (sometimes approximate) on which the patch was carefully checked for bees; number of days on which bees were present is the number of dates on which male *M. bimaculatus* were observed in the patch, including and after the date of first appearance of bees in the patch. Date of last check is the last date on which the patch was carefully inspected for bees. Means and standard deviations of numbers of bees (summed over all clusters) and clusters (we included each singleton bee, i.e., > 3 body lengths from its nearest neighbor, as its own cluster) are reported per day on dates on which bees were encountered in the patch and tally only those bees settled in the patch (on a few dates a few bees were also flying in the vicinity of the patch, but those additional bees are not reported here). See Table 1 on following page.

Table 1. Summaries of annual observations of male *Melissodes bimaculatus* sleeping clusters in the backyard iris-patch bee roost in Baton Rouge, Louisiana.

Year	Date of first check; date of first appearance of bees	Number of days patch was checked; number of days on which bees were present	Date of last encounter of bees; date of last check	Mean number of bees ± st. dev. (range = minimum - maximum); mean number of clusters ± st. dev. (range = min. - max.)
2017	May 13; May 13	30; 26	July 23; Aug. 1	14.2 ± 6.6 (1 - 23); 2.8 ± 1.6 (1 - 8)
2018	Early May; May 20	~10; 6	June 3; July 23	7.0 ± 5.8 (3 - 17); 1.3 ± + 0.5 (1 - 2)
2019	Mid April; May 29	~12; 2	May 30; June 6	2.0 ± 0.0 (2 -2); 1.0 ± 0.0 (1 - 1)
2020	Mid April, but then no checks until June 2; June 2	~10; 3	June 4; mid June	1.7 ± 0.6 (1 - 2); 1.7 ± 0.6 (1 - 2)
2021	Early April; May 16	~12; 6	June 6; mid June	2.7 ± 1.9 (1 - 6); 1.0 ± 0.0 (1 -1)
2022	No checks - K.E.H. was out of town in May and June	Not applicable	Not applicable	Not applicable
2023	Mid April; May 9	~12; 5	May 24; June 8	4.0 ± 2.4 (1 - 7); 2.6 ± 1.1 (1 - 4)
2024	Mid April; no bees encountered	No bees encountered on ~10 days' checks	No bees encountered; late June	Not applicable

Figure 2. A sleeping cluster of two male *Melissodes bimaculatus* on the necrotic portion of an otherwise live iris leaf in the backyard iris-patch roost in Baton Rouge, Louisiana. The photo was taken in the morning at 7:06 hr on June 1, 2021 (sunrise occurred on that date at 6:03 hr).

DISCUSSION

Although nighttime sleeping aggregations, clusters, and roosts have been reported for several bee taxa, it is essentially unknown for the vast majority how they form, how long they last, and why they end. This contribution is one of a very few that have documented the occurrence of a bee roost in the same location across multiple years. For example, Wcislo (2003) reported consistent use of a roost site by five to 11 male *Augochlorella neglectula* (Ckll.) (Hymenoptera: Halictidae) clustered together "on a rootlet… of a hanging plant" on a 4th story apartment balcony in Panama City, Republic of Panama from 1995-1996 and 1998-2000. To our knowledge, our observations detail the longest multi-year site fidelity of any roost recorded for what are otherwise considered to be solitary bees.

Alcock (1998) reported the roosting behavior of male *Idiomelissodes duplocincta* (Cockerell) (Hymenoptera: Halictidae) during four summers in suburban Tempe, Arizona. Males often returned to the same plant, but "show little site fidelity to a particular stem" (Alock, 1998, pg. 74). Male *M. bimaculatus* in the present study exhibited a similar level of small-scale fidelity (same iris patch), and similar microsite inconsistency (individual leaves or plants varied).

Proposed adaptive advantages to nighttime aggregation include thermoregulation and safety in numbers against predators, possibly enhanced for those individuals best positioned within the selfish herd (Hamilton, 1971; Alcock, 1998; Wcislo, 2003; Yokoi *et al.*, 2017). Thermoregulation is unlikely for the *M. bimaculatus* that we observed, since they were generally not in physical contact with one another. In fact, after a given bee settled, it generally kicked at any subsequent bee attempting to settle too close to it. Explanations based on safety in numbers and the selfish herd remain plausible for the male bees we observed (just as suggested by Giulian *et al.*, 2024, for gregariously ground-nesting female *M. bimaculatus* in Berne, NY), especially since predators were at times present in the focal iris patch (e.g., *Anolis*, dragonflies, hemipterans, spiders).

Camouflage is a potential adaptive reason for bees to at times bias their selection of microsites toward dead plant parts. Rau and Rau (1916, pg. 243) cautiously suggested this possibility for roosting *Svastra obliqua* (Say 1837) in St. Louis, MO: "It is hard to refrain from calling this a case of protective environment rationally chosen by the insect. I surely would not have seen their brown bodies blending with the dingy burned leaves, had I not known just where to look for them." Silva and Andrade (2022) described two male sleeping aggregations of *M. nigroaenea* (Smith 1854) on dried inflorescences of *Bidens pilosa* (Asteraceae) on a campus of the University of Brasilia, Brazil. For the male *M. bimaculatus* that we observed, it is also possible that sometimes bees aimed to settle near other bees, but mistook senesced plant parts for them.

A mutually compatible alternative explanation for nighttime aggregations readily arises from the Information Center Hypothesis (ICH), which was originally proposed as a potential adaptive reason for birds to aggregate at night (Ward and Zahavi, 1973). Individuals could obtain information from roost mates that could be beneficial to them during subsequent activity periods, as Bijleveld *et al.* (2010) suggested in their expansion of the original ICH. Conspecific males could potentially glean information from roost mates about locations of resources (females, food). Both males and females of parasitic bees could obtain information from host males to more effectively or efficiently find female hosts. As a brood parasitic bee, *T. lunatus* is thought to use *M. bimaculatus* as a host (Rightmyer, 2006); J. S. Ascher (pers. comm., September 4, 2024) confirmed that although the host-relationship evidence is compelling, it remains indirect and circumstantial. Notably, Rau (1938, pg. 545) also observed co-roosting of *T. lunatus* with *M. bimaculatus* on July 18, 1922 in Wickes, MO, but he provided no hypothesis nor explanation for the behavior.

Disturbance or other unusual environmental circumstances, including predation, rain, cloudiness or otherwise reduced light levels, appeared to influence within-season fluctuations in numbers of bees at the roost. Accordingly, each of these factors may influence the day-to-day or season-long likelihood that sleeping clusters continue to form within a given roost site, and should be carefully evaluated in future studies. Although the numbers of iris leaves in the focal patch remained approximately the same from year-to-year during the months in which bees roosted, the severe reduction in numbers of iris leaves in the patch in 2024 might have caused the roost's dissolution. However, no other obvious environmental correlates compel a particular hypothesis for why considerably more bees were found in the roost during the first two years of the study than during subsequent years. In any case, future observations of roosts with marked bees (as in, e.g., Rau and Rau, 1916; Mathewson and Daly, 1955; Wcislo, 2003) would be especially informative, both to understand within-season dynamics and to determine whether or not any individual bees contribute toward year-to-year site fidelity by returning to the same roost in more than one year.

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Author Contributions

K.E.H. made the behavioral observations. B.E.O. identified the bees. K.E.H. prepared the original draft, and B.E.O. edited and approved the final version of the manuscript.

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