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Pan traps and bee body size in unmanaged urban habitats

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Abstract

Pan traps are among the most popular methods employed to survey bees and changes in some functional traits, such as body size, are increasingly used to understand how bee communities and species respond to landscape changes. Herein we assess body size differences between bees captured at ground-level and elevated (70 cm) pan traps in unmanaged urban habitats in northwestern Turkey. We compare body size at the community level as well as for the sweat bee *Lasioglossum malachurum* (Kirby) (Halictidae: Halictini), the most abundant species. We also compare the diversity, richness and abundance of bees sampled at both heights. A total of 31 species (13 genera of three families) were captured. We did not find significant differences in the abundance nor in the species richness between heights, and Simpson's indices were similar. At the community level, average intertegular distance was significantly greater in bees collected at the elevated traps than on the ground. Intertegular distances in *L. malachurum* did not differ between elevated and ground-level pan traps. Our results show an effect of pan trap height on bee body size in the urban habitat surveyed, thus suggesting that assessing bee body size from samples collected with either ground-level or elevated pan traps alone might result in biased estimates of this functional trait.

Keywords

Anthophila, Halictidae, intertegular distance, sampling bias, urban ecology

Introduction

Pan traps of different colors placed at different heights have been successfully used as complementary methods in monitoring bee communities across a number of habitats and landscapes of both tropical and temperate environments (e.g., Wilson et al. 2008, Tuell and Isaacs 2009, Droege et al. 2010, Ulyshen et al. 2010, Nuttman et al. 2011, Gonçalves and Oliveira 2013, Geroff et al. 2014). These traps have become popular among bee ecologists and conservation biologists because they are readily available, inexpensive, and are not collector biased. In addition, a large number of traps can be used for long periods at multiple locations (Droege et al. 2010). The use of these traps has not only allowed rapid assessments of the richness, diversity, abundance, and phenology of bees but has also provided insights into their behavior. For example, some studies have revealed species- and sex-specific color preferences, which are similar to the color of their host flowers (Heneberg and Bogusch 2014). Studies using pan traps at different heights above the ground have also supported the idea that bees tend to forage in a horizontal stratum (Gumbert and Kunze 1999, Cane et al. 2000). Elevated pan traps often capture a greater abundance, as well as a different composition of bees, than those placed on the ground, including large-bodied bees that are never or rarely caught in ground-level pan traps (Tuell and Isaacs 2009, Geroff et al. 2014).

Body size affects bee foraging behavior (Greenleaf et al. 2007) and changes in this functional trait are increasingly used to understand how bee communities and species might respond to changes in landscape (Wray et al. 2014, Renauld et al. 2016). Herein we assess body size differences between bees captured at ground-level and elevated pan traps (70 cm) in unmanaged urban habitats in northwestern Turkey. This information might be useful when designing survey protocols aimed to assess body size distributions across habitats. We compare body size at the community level as well as for the sweat bee *Lasioglossum malachurum* (Kirby) (Halictidae: Halictini), the most common species captured at both heights. We also compare the diversity, richness and abundance of bees sampled at both heights.

Materials and methods

This study was conducted at two unmanaged areas separated by 900 m in the Görükle Campus of Uludağ University in Bursa, Turkey (40°13'35"N, 28°52'13"E, 56m). In addition to grasses, these sites were dominated by wild carrots (*Daucus carota* L., Apiaceae), whose primary umbels occasionally reached up to 2 m in height; *Heracleum platytaenium* Boiss (Apiaceae), *Echinops microcephalus* Sm. (Asteraceae), *Sonchus asper* (L.) Hill (Asteraceae), and *Cota tinctoria* (L.) J. Gay ex Guss (Asteraceae) were also common in both sites. On each site we set up two parallel transects of pan traps 1 m apart. Each stratified pair, one on the ground and one elevated, was 2 m apart, for a total of 10 pairs per transect. Each elevated pan trap was placed 70 cm above the pan trap on the ground. Pan traps consisted of plastic bowls spray-painted fluorescent yellow (Solo® plastics Soufflé Cup, 3.25 oz.) and half filled with soapy water. This color was chosen because preliminary observations suggest that it is the most effective color to capture bees at the study area. We built the elevated pan traps using a white PVC tube (2 cm in diameter, 86 cm in length) and the upper one-third of a transparent 0.5 L plastic bottle. The tube's lower end was cut at a diagonal with a pipe cutter so that it was easily inserted into the ground. At the upper end we placed the screw cap of a cut plastic bottle, which served as a support for the plastic bowl; the latter was secured to the bottle with clear adhesive tape. The PVC tube was inserted into the ground until the bottom of the bowl was 70 cm above the ground, a height that exceeded the minimum height of *D. carota*, the tallest surrounding flowering plant. We collected bees and refilled the pan traps with soapy water every two days from July 19 to July 24, 2015. We pinned all specimens and estimated their body size by measuring the minimum intertegular distance (Cane 1987) with an ocular micrometer on a Leica S6E stereomicroscope. Specimens are deposited in the Beekeeping Development and Research Center, Uludağ University, Bursa, Turkey.

We used a Chi-square analysis to test for differences in abundance and species richness of bees collected at different heights. We also calculated the Simpson (1-D) and Sørensen indices to estimate the diversity and similarity between the samples and used a two-sample t-test to detect differences in body size between the community of bees collected at the ground and elevated traps, as well as between specimens of *Lasioglossum malachurum* collected at both heights. Averages are given with standard errors.

Results

We collected 154 specimens representing a total of 31 species belonging to 13 genera and three families. Similar counts of individuals and species were captured at both heights (Abundance: X^2 (1, n = 154) = 0.234, p = 0.629; Richness: X^2 (1, n = 40) = 0.90, p = 0.343). Nine species were collected at both heights and, according to the Sørensen index (0.45), these communities moderately overlap; similar Simpson's indices were also obtained at both heights (Table 1). *Lasioglossum malachurum* was the most common species, accounting for 30.5% of all bees collected, and was equally captured at both heights, X^2 (1, n = 47) = 0.191, p = 0.662). Overall, average intertegular distance was 42.2% greater in bees collected at the elevated traps ($\bar{x}$ = 2.29 mm ± 0.216, 0.98–6.64, n = 42) than bees at ground-level traps ($\bar{x}$ = 1.61 mm ± 0.088, 0.83–3.05, n = 34, two-sample t-test, t= 2.91, df: 53, p = 0.003). For *L. malachurum*, average intertegular distance at elevated traps (1.41 ± 0.016 mm, 1.20–1.55, n = 24) was not significantly different from ground-level traps ($\bar{x}$ = 1.39 ± 0.017 mm, 1.25–1.53, n = 22, two-sample t-test, t= -0.70, df: 43, p= 0.489; Fig. 1).

Table 1. Average intertegular distance and number of specimens of each bee species collected from pan traps placed on the ground and at 70 cm above ground. Supraspecific classification follows Michener (2007).

Bee taxa	Intertegular distance (mm)	Ground	Elevated
Family Apidae			
Amegilla sp.	3.50	0	1
Apis mellifera L.	2.83	1	5
Ceratina sp. 1	1.27	4	1
Eucera sp. 1	2.60	0	1
Eucera sp. 2	3.05	0	1
Eucera sp. 3	3.50	0	1
Xylocopa iris (Christ)	4.28	0	3
Xylocopa violacea (L.)	6.03	0	3
Family Halictidae			
Halictus (*Seladonia*) sp.	1.22	1	6
Halictus scabiosae (Rossi)	3.10	0	2
Halictus sp. 1	1.91	0	3
Halictus sp. 2	1.60	2	0
Halictus sp. 3	1.11	0	2
Lasioglossum malachurum (Kirby)	1.40	22	25
Lasioglossum (*Evylaeus*) sp. 1	1.53	1	3
Lasioglossum (*Evylaeus*) sp. 2	1.23	0	2
Lasioglossum (*Evylaeus*) sp. 3	1.23	1	0
Lasioglossum (*Dialictus*) sp.1	1.49	1	2
Lasioglossum (*Dialictus*) sp. 2	1.25	1	0
Lasioglossum (*Dialictus*) sp. 3	1.06	0	3
Lasioglossum (*Dialictus*) sp. 4	0.83	1	0
Lasioglossum (*Dialictus*) sp. 5	1.02	2	1
Lasioglossum (s. str) sp. 1	2.00	24	11
Lasioglossum (s. str) sp. 2	2.10	0	1
Family Megachilidae			
Anthidium florentinum (Fabricius)	3.75	0	1
Hoplitis sp.	2.35	3	0
Hoplosmia sp.	1.46	3	0
Lithurgus chrysurus Fonscolombe	2.90	1	1
Osmia erythrogastra Ferton	1.57	5	0
Osmia bidentata Morawitz	1.63	1	0
Pseudoanthidium lituratum (Panzer)	2.03	0	1
Total specimens		74	80
Total species		17	23
Simpson's Index		0.80	0.87

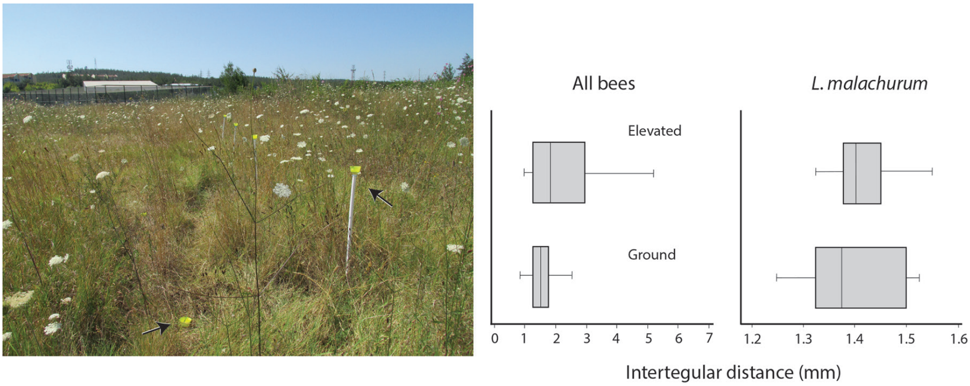

Figure 1. One of the unmanaged areas at Uludağ University in Bursa, Turkey, surveyed using pan traps placed on the ground and at 70 cm above ground (left); boxplots (right) showing the intertegular distance of all bees and *L. malachurum* collected at each height.

Discussion

We showed that, on average, larger bees are captured more often with elevated pan traps than with ground-level traps in the urban environments surveyed. As in previous studies, large-bodied bees such as *Xylocopa*, *Eucera* and *Anthidium* were captured exclusively or, in the case of honey bees, more frequently in elevated traps than at ground-level traps. Species of these groups were often seen either flying across the field or foraging at taller inflorescences, and had been previously collected at the same area with aerial nets only. Pan traps located at a height that exceeds the minimum height of the tallest surrounding flowering plants, as in our study, might act as beacons given that bees and other pollinators are naturally attracted to flowers or inflorescences of taller plants (e.g., Gumbert and Kunze 1999, Lortie and Aarssen 1999).

Differences in foraging behavior associated with intraspecific variations in body size have been documented in social species, such as bumble bees (e.g., Goulson et al. 2002). Social halictids often exhibit caste-associated size variation (e.g., Michener 1990) that could affect foraging. While size variation was observed in *Lasioglossum malachurum*, counter to our expectations, specimens collected in elevated pan traps were not, on average, larger than those collected at the ground level. However, as this was a short term experiment with small sample sizes, this result is hardly conclusive. Determining whether a similar pattern in the body size distribution across bees occurs in other habitats and ecosystems is an important consideration for understanding pollination services as well as providing appropriate resources for bee conservation efforts. From a practical point of view, our results suggest that assessing bee body size from samples collected with either ground-level or elevated pan traps alone might result in biased estimates of this trait. This is likely true for other sampling methods as well. For example, inexperienced or less-experienced collectors using aerial nets might be biased to capture large, slow-flying, noisy or conspicuous bees when compared with more experienced collectors. Our results also contribute to the increasing body of evidence demonstrating that a more complete picture of the bee communities can be obtained by incorporating multiple sampling methods and examining particular traits such as body size, even in disturbed, open, grassy habitats.

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References

Cane JH (1987) Estimation of bee size using intertegular span (Apoidea). Journal of the Kansas Entomological Society 60: 145–147.

Cane JH, Minckley RL, Kervin LJ (2000) Sampling bees (Hymenoptera: Apiformes) for pollinator community studies: pitfalls of pan-trapping. Journal of the Kansas Entomological Society 73: 225–231.

Droege S, Tepedino VJ, Lebuhn G, Link W, Minckley RL, Chen Q, Conrad C (2010) Spatial patterns of bee captures in North American bowl trapping surveys. Insect Conservation and Diversity 3: 15–23. doi: 10.1111/j.1752-4598.2009.00074.x

Geroff RK, Gibbs J, McCravy KW (2014) Assessing bee (Hymenoptera: Apoidea) diversity of an Illinois restored tallgrass prairie: methodology and conservation considerations. Journal of Insect Conservation 18: 951–964. doi: 10.1007/s10841-014-9703-z

Gonçalves RB, Oliveira PS (2013) Preliminary results of bowl trapping bees (Hymenoptera, Apoidea) in a southern Brazil forest fragment. Journal of Insect Biodiversity 1: 1–9. doi: 10.12976/jib/2013.1.2

Goulson D, Peat J, Stout JC, Tucker J, Darvill B, Derwent LC, Hughes WOH (2002) Can alloethism in workers of the bumblebee *Bombus terrestris* be explained in terms of foraging efficiency? Animal Behaviour 64: 123–130. doi: 10.1006/anbe.2002.3041

Greenleaf SS, Williams NM, Winfree R, Kremen C (2007) Bee foraging ranges and their relationships to body size. Oecologia 153: 589–596. doi: 10.1007/s00442-007-0752-9

Gumbert A, Kunze J (1999) Inflorescence height affects visitation behavior of bees–A case study of an aquatic plant community in Bolivia. Biotropica 31: 466–477. doi: 10.1111/j.1744-7429.1999.tb00389.x

Heneberg P, Bogusch P (2014) To enrich or not to enrich? Are there any benefits of using multiple colors of pan traps when sampling aculeate Hymenoptera? Journal of Insect Conservation 18: 1123–1136. doi: 10.1007/s10841-014-9723-8

Lortie CJ, Aarssen LW (1999) The advantage of being tall: higher flowers receive more pollen in *Verbascum thapsus* L. (Scrophulariaceae). Ecoscience 6: 68–71.

Michener CD (1990) Reproduction and castes in social halictine bees. In: Engels W (Ed.) Social Insects: an Evolutionary Approach to Castes and Reproduction. Springer-Verlag, New York, 77–121. doi: 10.1007/978-3-642-74490-7_6

Michener CD (2007) The Bees of the World [2nd Edition]. Johns Hopkins University Press, Baltimore, MD, 953 pp.

Nuttman CV, Otieno M, Kwapong PK, Combey R, Willmer P, Potts SG (2011) The utility of aerial pan-trapping for assessing insect pollinators across vertical strata. Journal of the Kansas Entomological Society 84: 260–270. doi: 10.2317/JKES110319.1

Renauld M, Hutchinson A, Loeb G, Poveda K, Connelly H (2016) Landscape simplification constrains adult size in a native ground-nesting bee. PLoS ONE 11(3): e0150946. doi: 10.1371/journal.pone.0150946

Tuell JK, Isaacs R (2009) Elevated pan traps to monitor bees in flowering crop canopies. Entomologia Experimentalis et Applicata 131: 93–98. doi: 10.1111/j.1570-7458.2009.00826.x

Ulyshen MD, Soon V, Hanula JL (2010) On the vertical distribution of bees in a temperate deciduous forest. Insect Conservation and Diversity 3: 222–228. doi: 10.1111/j.1752-4598.2010.00092.x

Wilson JS, Griswold T, Messinger OJ (2008) Sampling bee communities (Hymenoptera: Apiformes) in a desert landscape: are pan traps sufficient? Journal of the Kansas Entomological Society 81: 288–300. doi: 10.2317/JKES-802.06.1

Wray JC, Neame LA, Elle E (2014) Floral resources, body size, and surrounding landscape influence bee community assemblages in oak-savannah fragments. Ecological Entomology 39: 83–93. doi: 10.1111/een.12070