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Cover Photograph: The Rose Mallow Bee (*Ptilothrix bombiformis*) nectaring on planted Rose of Sharon (*Hibiscus syriacus*) near the nest site in East Brunswick, New Jersey, USA on 22 July, 2022. Photo by David Moskowitz.

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Observational Habitat Use of the Rose Mallow Bee *Ptilothrix bombiformis* Hymenoptera: Apodiae in a Suburban Landscape

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Abstract - Bees are declining globally due to a suite of impacts including habitat loss and fragmentation. However, the Rose Mallow Bee (*Ptilothrix bombiformis*) is a pollen specialist on Malvaceae that has adapted to the urban and developed environment by utilizing anthropogenic resources in these habitats. The present study explored habitat use of the Rose Mallow Bee at a nest aggregation in a developed landscape in East Brunswick Township, Middlesex County, New Jersey by determining their 1) nest size, 2) use of anthropogenic water resources and non-native floral resources, and 3) the distance the bees would fly from their nesting location to these resources. The bees utilized multiple anthropogenic water resources including stormwater basins and a lawn sprinkler puddle. The bees were also readily found on the commonly planted and non-native Rose of Sharon (*Hibiscus syriacus*). The maximum observed foraging distance the bees were found from their nesting site was 468 m for water resources and 322 m for pollen resources. Since urban and developed areas are typically rich in bee generalists and poor in bee specialists this study provides an opportunity to better understand the habitat use and role of bee specialists in highly anthropogenic environments.

Introduction

Habitat loss from urbanization is one of the leading causes of bees declining globally (De Palma et al. 2015, Geslin et al. 2016, Hernandez et al. 2009, Lerman et al. 2018, Potts et al. 2010, Russell et al. 2018, Winfree 2010). Human-induced habitat change is generally considered to have negative impacts on pollinator species (Winfree et al. 2010) but may also provide ecological opportunities for others (Matteson et al. 2008, McFrederick and LeBuhn 2006). Developed habitats in urban settings are typically rich in bee generalists and poor in bee specialists, owing to the unpredictable availability of floral resources (Danforth et al. 2019, Droege and Shapiro 2011). Solitary bees are important for ecosystem functions and pollination in urban areas (Andrade et al. 2019, Dorea et al. 2017, MacIvor et al. 2014) but their life histories and ecological functions in developed landscapes are not well understood (Braman and Griffin 2022, Brant et al. 2022, da Rocha-Filho et al. 2018, Martins et al. 2019).

Despite being a pollen specialist, *Ptilothrix bombiformis* Cresson 1878 (Rose Mallow Bee) has successfully adapted to the urban and developed landscape by utilizing anthropogenic resources (Gordon 2010, Mullikin et al. 2019, Mullikin 2022). The Rose Mallow Bee is a solitary ground nesting bee that is oligolectic on mallows (Malvaceae) (Fowler 2016, Fowler and Droege 2020). The emergence and foraging of adult Rose Mallow Bees are closely synchronized with the flowering period of mallows (Blanchard 1976, Rust 1980). Historically, and in natural habitats, the Rose Mallow Bee is a specialist on native *Hibiscus* species growing in wetlands. In the native habitat, their nests are typically located in nearby dry, hard-packed soils (Grossbeck 1911, Rau 1930, Rust 1980).

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Rose Mallow Bees can also colonize developed landscapes with suitable nesting and anthropogenic resources (Gordon 2010, Rau 1930). Manmade water sources and the commonly planted non-native *Hibiscus syriacus* L. (Rose of Sharon) or *Hibiscus syriacus* L. (Rose Mallow) are critical components for their nest construction and nest provisioning in developed landscapes (Mullikin et al. 2019, Mullikin 2022). Rose Mallow Bees collect water by landing on the surface of a water source and then fly back to the nest using the water to soften the excavation (Michener 1947, Rau 1930, Rust 1980). Rose Mallow Bees have been observed at a broad suite of anthropogenic water resources in developed landscapes including puddles, water faucets, planter water saucers and even a dog bowl (G. Camilo, Department of Biology, Saint Louis University, St. Louis, MO, 2023 pers. comm.; Mullikin 2022). In the urban and developed landscape, the Rose Mallow Bee has been able to exploit non-native mallows. The Rose Mallow Bee provisions each nest with mallow pollen that is the food resource for the developing larva (Rust 1980).

Despite its large size, being relatively easy to identify, and broad range across eastern and central North America (Ascher and Pickering 2010), only limited information has been published about the habitat use and foraging range of the Rose Mallow Bee (Michener 1947, Rau 1930, Rust 1980). As a pollen specialist adapting to the developed landscape, the Rose Mallow Bee may offer opportunities to better understand the role of specialist bees in urban and developed habitats (Collado and Bartomeus 2019, Droege and Shapiro 2011, Mullikin et al. 2019, Mullikin 2022). In this study the goal was to determine 1) the spatial extent of the nest aggregation, 2) which specific anthropogenic resources were used by the bees, and 3) the farthest distances the bees can be found from the nesting site in a developed landscape in East Brunswick Township, Middlesex County, New Jersey.

Methods

The Rose Mallow Bee nest aggregation was discovered on 15 July 2022 and the habitat study began on 19 July 2022. To determine the habitat use of the nesting Rose Mallow Bees, planted Rose of Sharon and water resources near the nest site were visited 3–4 times per week during the bee's flight period between 19 July 2022 and 18 August 2022. All Rose of Sharon within 500 m of the nest site were surveyed on each visit, extending the survey area 178 m beyond the farthest plants used by the bees. Reviewing aerial photographs and ground truthing was also conducted to determine other potential Rose Mallow Bee nest sites and water resources within approximately 1,000 m of the nest site, extending the survey area an additional 532 m beyond the stormwater basins and the puddle used by the bees. On 25 July 2022, the size and spatial extent of the nest aggregation was determined by walking the entire nest area and counting the nests. No bee specimens were collected as part of this study as the Rose Mallow Bee is relatively easy to identify and cannot be confused with any closely related species. Photographs were obtained of the bees at the nest site and the local water and floral resources (Fig. 1 and 2).

Results

A nesting aggregation of the Rose Mallow Bee was discovered on 15 July 2022 in a poorly maintained playing field at an elementary school in East Brunswick Township, Middlesex County, New Jersey (40° 25' 92" N - 71° 25' 98" W). Rose Mallow Bee nests are mostly recognized by their distinctive turret shape and excavated soil pellets. The nest aggregation consisted of 463 nests intermittently spread across 3,744 square meters. The

nest area occurs in a developed suburban landscape of single-family homes and commercial businesses bisected by numerous roads. A review of aerial photographs and ground truthing did not identify any other suitable or potential nest areas or Rose Mallow Bee nests within 1,000 m of the nest site.

No natural wetlands, watercourses, or waterbodies occur within 1,000 m of the nest site. The soils at the nest site are mapped as well-drained Sassafras Loam formed in acid, moderately fine textured Coastal Plain sediments (Jablonsky and Powley 1987). The nearest natural watercourses and wetlands are located 1.68 km and 1.9 km from the nest site across highly developed residential and commercial areas. The only water resources within 1,000 m of the nesting site are anthropogenic: four stormwater basins (455–998 m from the nesting site), an excavated pond at an old mine (913 m from the nesting site), three roadside puddles from lawn sprinkler runoff (134–268 m from the nesting site), and backyard swimming pools (221–1,000 m from the nesting site). Except for two of the roadside puddles, all of the water resources held water during the entire study period. Non-native Rose of Sharon has been widely planted at homes in the residential neighborhoods around the nesting location, the nearest 82 m away (Fig. 3). The nearest native *Hibiscus* sp. *Hibiscus moscheutos* L. (Swamp Rose Mallow) occurs along the emergent wetland edges of a manmade impoundment 1.64 km from the nest site.

Figure 1. Rose Mallow Bee nest site and floral resources. A) Nesting area in a poorly maintained ballfield. B) Rose Mallow Bee nest with distinctive turret and soil pellets. C) Rose Mallow Bee nectaring on Rose Mallow and covered with pollen. D) Planted Rose of Sharon used by the Rose Mallow Bees.

During the study, Rose Mallow Bees were found on each visit at two of the four stormwater basins (455 m and 468 m from the nest site), one of the three sprinkler puddles (241 m from the nest site) and on all Rose of Sharon (within 322 from the nest site). No Rose Mallow Bees were observed at the water resources beyond these distances from the nest site. The two stormwater basins and the sprinkler puddle used by Rose Mallow Bees held water during the entire survey period. The water in one of the stormwater basins was heavily coated with an oily sheen. The puddle used by the bees was caused by a lawn sprinkler that was pooling in the storm gutter. The two puddles not used by the bees were ephemeral, ponding only during sprinkler events and then drying within a few hours. Although most swimming pools were not accessible, the closest pool (221 m away from the nests) was also visited, and no bees were observed. This pool was an above ground structure with the water surface elevated approximately 1.2 m above the ground surface. By 13 August 2022, nesting activity was reduced to 10 active nests; on 18 August 2022, no active nests were found and no Rose Mallow Bees were observed at the water or floral resources.

Using the furthest observation points for the Rose of Sharon and the water resources visited by the bees suggests the nest aggregation was utilizing an area of approximately 15 h. (Fig. 3). Bees were easily observed flying to and away from the water and Rose of Sharon in the direction of the nest site and similarly from the nest site toward these resources.

Figure 2. Rose Mallow Bee water resources. A) Rose Mallow Bee collecting water for nest excavation. B) Sprinkler puddle used for water collection by the Rose Mallow Bees. C) Stormwater basin used for water collection by the Rose Mallow Bees. D) Stormwater basin with heavy oily sheen used by the Rose Mallow Bees for water collection.

Discussion

This study observed habitat characteristics and the distances Rose Mallow Bees flew from their nesting location to water and floral resources in a developed landscape. The Rose Mallow Bee nesting aggregation utilized a suite of anthropogenic habitat elements including planted Rose of Sharon and manmade water features within a developed landscape (Fig. 1 and 2). These habitat elements were separated from the nesting site by residential development and roads requiring the bees to traverse these areas to obtain pollen and water for nesting.

Specific information on the foraging range of the Rose Mallow Bee has not been reported but previous studies suggest in natural habitats nesting is usually in close proximity to water and floral resources (Rau 1930, Rust 1980). This study observed that approximately 500 m may be the limit that the Rose Mallow Bee flies for resources. The water resources utilized by the bees were permanent or predictable standing water which was likely targeted by the bees. Rust (1980) also reported water resources used by the Rose Mallow Bee as permanent. Both stormwater basins and the sprinkler puddle used by the bees held water for the duration of the study. The two sprinkler puddles not utilized were ephemeral and dried out within a few hours. However, bees were not observed collecting water from an aboveground pool and perhaps the elevated water surface or the depth was not suitable or potential chemical additives were repellent. All water resources used by the bees were at ground level and shallow (less than 0.3 m).

It is not known when the Rose Mallow Bee began utilizing anthropogenic resources, but they have been observed exploiting urban resources for at least a century (Rau 1930). Historically, cotton fields may have offered foraging opportunities for Rose Mallow Bees to exploit another anthropogenic Malvaceae floral resource, as *Gossypium hirsutum* L. (Cotton) is also part of the Malvaceae. Rose Mallow Bees have been observed foraging in

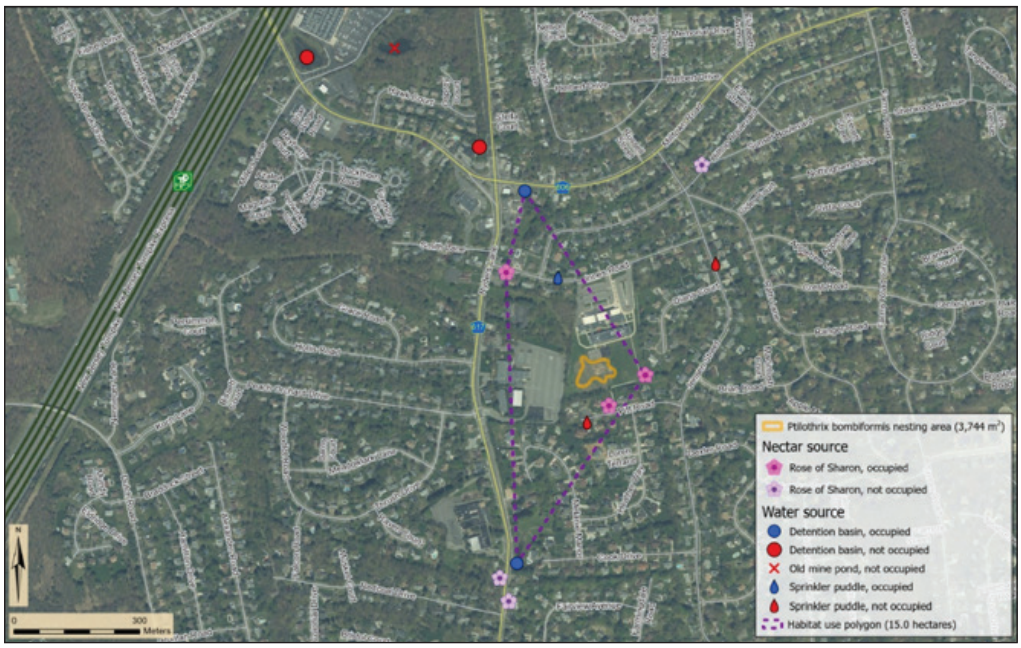

Figure 3. Rose Mallow Bee habitat use in a suburban landscape.

Cotton fields near freshwater wetlands where the Cotton is in flower earlier than the native mallow (Parys, et al. 2020; K. Parys, USDA Agricultural Research Service, Stoneville, MS, 2023 pers. comm.). Cotton was planted along the James River in Virginia as early as the 17th century (Hammond 1897) and the non-native *Hibiscus* spp. were cultivated in North America in the 18th century (P. Cornett, Monticello, Charlottesville, VA, 2022 pers. comm.). Thomas Jefferson planted Rose of Sharon (*Althea*, likely *Hibiscus syriacus*) at his estate in Monticello, Virginia in 1767 where native *Hibiscus laevis* All. (Halberd-Leaved Hibiscus) and Swamp Rose Mallow occur in the nearby wetlands (P. Cornett, Monticello, Charlottesville, VA, 2022 pers. comm.). Bees in these natural habitats could have easily foraged at the nearby planted *Hibiscus*, taking advantage of another Malvaceae pollen resource as they do now.

With global declines of bees (Lerman et al. 2018, Potts et al. 2010, Russell et al. 2018, Winfree 2010) because of habitat loss from urbanization (De Palma et al. 2015, Geslin et al. 2016, Hernandez et al. 2009) understanding the ecological functions of bees including solitary and specialist species in urban and developed environments is of increasing importance (Ayers and Rehan 2021, Braman and Griffin 2022, Brant et al. 2022, da Rocha-Filho et al. 2018). However, information about nest site selection for oligolectic bees is largely lacking (Antoine and Forrest 2021) potentially impacting conservation and habitat enhancement efforts. As a pollen specialist adapting to the developed landscape, the Rose Mallow Bee may offer opportunities to better understand the role and habitat requirements of specialist bees in urban and developed habitats (Collado and Bartomeus 2019, Droege and Shapiro 2011, Mullikin et al. 2019, Mullikin 2022).

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