

# A cuckoo slumber party? Rediscovery of *Nomada* (*Pachynomada*) *asteris* Swenk, 1913 (Hymenoptera: Apidae), with notes on unusual male aggregatory behavior

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## Abstract

Despite tremendous global diversity, little is known about *Nomada* bees. *Nomada* (*Pachynomada*) includes 14 species, all within the Nearctic region. *Nomada* (*Pachynomada*) *asteris* is a rare Kansas native that is described from a single female specimen collected in 1908 and 12 male specimens collected in 1949. The discovery of a putatively healthy population of *N. asteris* on the outskirts of Lawrence, KS, and a second female museum specimen in the collection at the University of Kansas marks 96 years since the female and 77 years since the male have been observed. An interesting observation was made on the aggregatory roosting behavior of male *N. asteris*, and is documented here for the first time. This observation marks the first formal description of aggregatory behavior of Nomadinae. These results highlight the importance of both observational surveys and museum specimens in the ongoing pursuit of understanding bee biology, behavior, and diversity, and signify a need for more-thorough modern survey efforts.

## Key Words

Aggregation, cleptoparasite, Kansas, museum specimens, observational surveys

## Introduction

The cleptoparasitic bees of *Nomada* Scopoli, 1770 encompass nearly 750 species described to date and exhibit a global distribution, though they are most prolific in the Northern Hemisphere. Of the 750 *Nomada* species, 14 are in *Nomada* (*Pachynomada*) Rodeck, 1945, all of which are native to North and Central America (Broemeling and Moalif 1988; Ascher and Pickering 2025). While *Nomada* is one of the largest genera in Apoidea, little is known about their biology or behavior, as preexisting literature has primarily focused on the group's taxonomy. The cleptoparasitic nature of *Nomada* contributes to their elusive nature and thus inherent rarity. Cleptoparasitic bees, also known as cuckoo bees, can be simply defined as those whose larvae feed on the provisions of their pollen-collecting hosts, and they do not create nests of their own

(Michener 2007; Danforth et al. 2019). In order for this life strategy to be effective, female cleptoparasites must be discrete and quick while laying their eggs so as to not be detected by the host female. Female cleptoparasites may also hide within the nests of their hosts and, if discovered, may fight with the host female, oftentimes resulting in the death of either the invading cleptoparasite or the host (Sick et al. 1994; Bogusch et al. 2006). Of the nearly 21,000 bees described to date, roughly 2,500 of them are cleptoparasites, or about 13%. Approximately 20% of the known cleptoparasites are in Apidae, primarily Nomadinae (Michener 2007; Danforth et al. 2019).

Discussion of the use of pheromones in interactions with host species and between the sexes of *Nomada* is featured in some studies, but notable mention of other behavior is minimal (Tengö and Bergström 1976, 1977; Vereecken and McNeil 2010; Schindler et al. 2018). Further, many species

within *Nomada* are comparatively rare and are known only by a few specimens, whereas others are more abundant and nearly cosmopolitan in their respective distributional range (Ascher and Pickering 2025). One of these rare taxa is *Nomada (Pachynomada) asteris* Swenk, 1913, a species that is only known from the holotype female, collected in 1908, and 12 male specimens collected in 1949 (Broemeling and Moalif 1988). Superficially, this species is similar to more common members of *Pachynomada*, such as *Nomada vineta* Say, 1837. The sampling disparity within *Nomada* no doubt results from morphological similarities that make it difficult to discern between species and their relatively low abundance, but it leaves significant gaps in our understanding of nomadine bees.

Nocturnal roosting behavior of bees and wasps has been well documented in the literature (Evans and Linsley 1960; Linsley 1962; Alcock 1998; Silva et al. 2011; Santos et al. 2014; Harms and Owens 2025). It is widely accepted that, due to not constructing nests, male bees attach to the stems of grasses, leaves, and center of flowers at night (Rau and Rau 1916; Michener 1974; Alcock 1998; Vereecken and McNeil 2010). Oftentimes, non-cleptoparasitic males will gather in sleeping aggregations or roosts, colloquially known as slumber parties, ranging from fewer than 10 individuals to several hundred, and mixed-genera aggregations are not uncommon (Rau and Rau 1916; Vereecken and McNeil 2010; Mahlmann et al. 2014; Santos et al. 2015). Our current understanding of sleeping behavior in bees is largely derived from eusocial apines, like honeybees (*Apis* spp.), stingless bees (tribe Meliponini), and bumblebees (*Bombus* spp.), and other prolific non-parasitic members of Apidae and Halictidae (Kaiser 1988, 1995; Alcock 1998; Weislo 2003; Alves-dos-Santos et al. 2009; Klein et al. 2014; Santos et al. 2014), leaving the behavior of cleptoparasitic species largely unknown. There have been some studies addressing roosting behavior of wild halictine cleptoparasites in *Biastes* (Westrich et al. 1992) and of other members of Nomadini in laboratory settings (Kaiser 1995), but there have been no studies to date involving aggregatory behavior in apine cleptoparasites, nor has this behavior been formally observed in the United States. Here we report on the chance rediscovery of *N. asteris* through a largely male aggregation in Kansas, USA, including discussion of floral record, roosting patterns, and potential future investigations. The identification of a second female specimen located in the University of Kansas Snow Entomological Collection and subsequent determination of a live female at the observation site are highlighted.

## Methods

### Observation

The discovery of a population of *N. asteris* on a patch of sawtooth sunflowers (*Helianthus grosseserratus* M. Martens) (Fig. 1E) occurred at Mutt Run Off-Leash Dog Park in Lawrence, KS on 22 September 2025 at approximately

17:45. Subsequent observations took place on 25 September 2025 at 18:45, 26 September 2025 at 19:00, and 28 September 2025. Count data for analysis was obtained on 26 September 2025 and is reported in Table 1. Other types of bees and insects at the site included non-parasitic eucerine bees, most likely in the genera *Melissodes* Latreille, 1829, *Eucera* Scopoli, 1770, or *Svastra* Holmberg, 1884, various members of Lepidoptera, soldier beetles in *Chauliognathus* Hentz, 1830, and the spotted cucumber beetle, *Diabrotica undecimpunctata* Mannerheim, 1843.

**Table 1.** Count data of *Nomada asteris* Swenk, 1913 across patches of *Helianthus grosseserratus* M. Martens, obtained on 26 September 2025.

| Patch                       | 1  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|-----------------------------|----|---|---|---|---|---|---|---|---|----|----|----|-------|
| <i>Nomada asteris</i> Count | 26 | 0 | 4 | 3 | 2 | 3 | 2 | 1 | 0 | 0  | 0  | 0  | 41    |

### Statistics

To determine statistical significance of the observational data (Table 1), the authors ran three statistical tests in R Core Team (2025), testing grouping or clustering at flower patches. A Chi-square goodness of fit test following a uniform distribution was performed using the `chisq.test` function. Then, a second Chi-square goodness of fit test following a Poisson distribution was performed. Lastly, the data was assessed using a Poisson model via the `glm` function.

### Photos

Photos were taken *in situ* using an iPhone 16 and a Nikon D3100 Digital SLR camera with a Yongnuo 50 mm 1:1.8 (YN50 mm F1.8N) full frame lens. It was not possible to collect specimens from the site without a collection permit from the Kansas Department of Fish and Wildlife. Museum specimen photos were taken using a Macropod Pro 3D photomicrography system from Macroscopic Solutions®, consisting of a Canon EOS 6D Mark II camera. Zerene Stacker™ software package was used to condense images into a single, fully focused image, which were later combined into plates using Adobe Photoshop® CC. Scalebars were added at this time.

### Identification of males

Identification of the *N. asteris* observed was done by comparing photos taken in-situ to museum specimens at the University of Kansas Snow Entomological Collection. Additionally, keys from Broemeling and Moalif (1988), Michener (2007), and Odanaka (2024) were used for visible traits. Defining characteristics included: from Broemeling and Moalif (1988): antennal scape globose, supraclypeal area, sides of face up to and around antennal sockets, labrum, clypeus, ring extending behind compound eyes



**Figure 1.** Photos of *Helianthus grosseserratus* and aggregatory *Nomada asteris* Swenk, 1913. **A.** Five males aggregating on a single flower; **B.** Two males on petals of flower; **C.** Male *N. asteris* resting on flower petal; **D.** Female on flower petal; **E.** Patch of *H. grosseserratus* where observations were made.

almost to vertex, pronotal lobes, tegulae, scutellum, and metanotum, creamy-white, antennae, legs, ferruginous, remainder of body dark fuscous to black. Odanaka (2024) was used to differentiate between *N. asteris* and other, morphologically similar species, namely members of the *N. vincta* group. From this, a single character was used in tandem with those previously noted to determine that the observed species was not a member of the *N. vincta* group (lack of maculations on propodeal sides).

### Identification of female

Identification was determined by comparison of the specimen to holotype photos on Discoverlife (Ascher and Pickering 2025), comparison to holotype description in Swenk (1913), and through the keys of Broemeling and Moalif (1988) and Michener (2007). Several key characteristics were considered during the identification of this specimen; from Swenk (1913): black or blackish small

spot behind ocelli, a spot on each side of collar, the tegulae (in reference to the pronotal lobes), elevated portion of mesoscutellum and metanotum, yellowish white, antennae red, the first three joints brightly so, the following joints lightly suffused with dusky, tergite 2 with large suboval yellowish white lateral spots, 3 and 4 with similar but slightly smaller spots, venter clear red; from Broemeling and Moalif (1988): 3 submarginal cells in forewing, abdominal terga never with complete transverse yellow or cream-colored bands, posterior-medial triangle on scutum darkened to fuscous. The female specimen identified differs from the holotype specimen in tergite 1 with small yellowish white lateral spots. The authors have attributed this to intraspecific variation and have identified the specimen to *N. asteris*. A live female (Fig. 1D) was found at the observation site. Though partially obscured by the angle of photo, several key characteristics are visible that distinguish this species from other, morphologically similar species. These characteristics, taken from Broemeling and Moalif (1988), include the yellowish white spots on each side of the collar, the tegulae, elevated portion of mesoscutellum and metanotum (Fig. 1D), first three antennal segments bright red, the remaining dusky, and incomplete transverse yellow or cream-colored bands. Darkened markings on the thorax comparable to those described in Broemeling and Moalif (1988) are also visible.

## Identification of flowers

Determined through comparison to descriptions in Long (1959), Long (1961), Heiser et al. (1969), and Gudžinskas and Petrulaitis (2014), as well as to photos from Kansas State University Libraries: Kansas Wildflower & Grasses (2026).

## Results

### *Nomada (Pachynomada) asteris* Swenk, 1913

**Material examined.** UNITED STATES • 8 ♂; Reece, Greenwood Co., Kansas; 37°47'56"N, 96°26'46"W; 7 Sep. 1949; Michener & Beamer leg; Taken *Amphiachyris dracunculoides*; *Nomada asteris* Swenk Det. Broemeling; SM0 424695 to 424702. UNITED STATES • 1 ♀; Falin property, 1.5 km N junction of 94<sup>th</sup> St & Kingman Rd., Jefferson Co., Kansas; 39°13'23"N, 95°24'14"W; 8 Sep. 2004–1 Oct. 2004; Z.H. Falin leg; ex. malaise, upper meadow; *Nomada* Det. C.D. Michener; *Nomada asteris* Swenk Det. N.D. Herbison; SM0626555.

**Notes.** The holotype specimen of *N. asteris*, a lone female, was collected by O.A. Stevens on September 19, 1908 in Manhattan, Kansas on *Aster puniculatus* Lam., non Mill. [= *Symphyotrichum lanceolatum* var. *lanceolatum* (Willd.) (Nesom 1994)]. It was described by Swenk (1913), and was originally placed within *Nomada (Holonomada)* Robertson, 1903. The holotype specimen is deposited in the University of Nebraska, Lincoln Type

Depository No. 1203. *Nomada asteris* was reassigned to *Nomada (Pachynomada)* by Rodeck (1945), with *N. vincata* serving as the type of the new subgenus. Twelve male specimens were collected by Michener-Beamer on September 7, 1949 but remained unidentified until Broemeling and Moalif (1988). Broemeling and Moalif (1988) described the male and redescribed the female, noting the sexual dimorphism as “unusual in this subgenus”.

Broemeling and Moalif (1988) note examination of 12 male specimens from the University of Kansas Snow Entomological Collection (KUSEMC) although at the time of this study the authors found only 8 of these male specimens. One male specimen is located at the USDA-ARS Bee Biology and Systematics Laboratory, catalogue number BBSL520825. It is likely that the remaining 3 males were distributed to other institutions and are not yet databased. In addition, searching for material in unsorted *Nomada* specimens at KUSEMC facilitated the discovery of a new female specimen (Fig. 3), with label data above.

Key characters found in both sexes that can be used to identify this species: yellowish-white spots on each side of the collar, pronotal lobes, and elevated portion of mesoscutellum and metanotum (Figs 2B, C, 3B–D). Characters for determining males: body black; antennal scape globular; mesepisternum largely ferruginous with circular creamy-white maculation; propodeum black, lacking maculations; scutellum, metanotum, creamy-white; limited to no black medially on white of scutellum (Fig. 2B, C). Characters for determining females: body ferruginous; abdominal terga never with complete transverse yellow or cream-colored bands; posterior-medial triangle on scutum darkened to fuscous (Fig. 3B–D).

**Distribution.** Kansas (Swenk 1913; Broemeling and Moalif 1988).

## Statistical analysis

The results from all statistical tests of this analysis were significant, indicating *N. asteris* aggregate to specific flower patches (Chi-square (uniform),  $\chi^2 = 169.44$ ,  $p = 4.998e-4$ ; Chi-square (Poisson),  $\chi^2 = 111.96$ ,  $p = 8.996e-3$ ; Poisson,  $\lambda = 3.416667$ ,  $z = 7.867$ ,  $DF = 11$ ,  $p = 4.519e-11$ ). Results of Poisson GLM indicated that the data did not follow an expected distribution and exhibited overdispersion (Poisson,  $\hat{c} = 8.953576$ ). No predictor variables were included in Poisson GLM.

## Discussion

### Field observations

As noted in the Methods section, the initial observation of *N. asteris* was on 22 September 2025 at approximately 17:45. At the time of the initial observation, the authors could identify the bees to *Nomada* but were unaware of

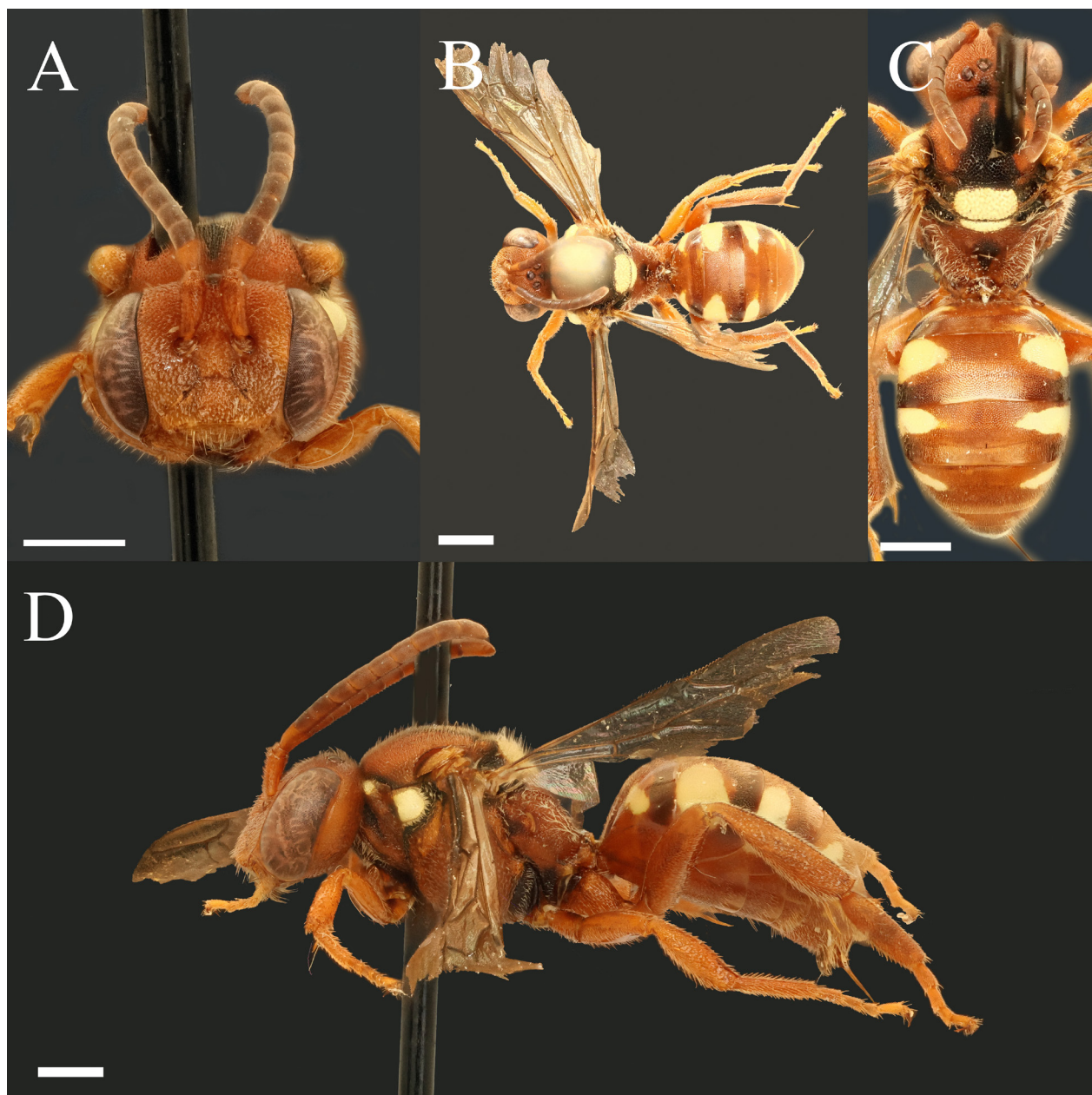


**Figure 2.** *Nomada asteris* Swenk, 1913 male (KUSEMC). **A.** Head, frontal view; **B.** Habitus, dorsal view; **C.** Habitus, lateral view. Scale bars: 1 mm.

the species. Individuals were somewhat active but did not fly between flowers unless disturbed. This was taken as an indicator that the males were beginning to roost, though the authors did not record data at this time due to the unplanned nature of this observation. On 25 September 2025 at 18:45, the authors recorded 38 roosting males present within the patch (Fig. 1E).

To better estimate the number of roosting males and investigate the possibility of movement to an-

other nearby sunflower patch, on 26 September 2025 at 19:00 the authors recorded the number of *N. asteris* present in the main patch (Fig. 1E) and walked throughout the rest of the approximately 45-acre field where the sample patch was located to assess the number of *N. asteris* at other sunflower patches in the same area. The authors considered a patch as any grouping of *H. grosseserratus* ramets at least 4 feet in diameter and at least 10 feet away from another grouping. 25



**Figure 3.** *Nomada asteris* Swenk, 1913 female (KUSEMC). **A.** Head, frontal view; **B.** Habitus, dorsal view; **C.** Propodeal region and terga, enlarged view; **D.** Habitus, lateral view. Scale bars: 1 mm.

males and one female *N. asteris* were recorded in the main sample patch (Fig. 1E). After visually assessing other isolated patches of sunflowers, the authors counted only 15 other *N. asteris*, all scattered throughout the other patches. There were no *N. asteris* found on other flowering plant species in the field. Data obtained is within Table 1. The authors returned to the sample patch on subsequent dates (28 September 2025 through 4 October 2025) and found one, then zero *N. asteris*, respectively. While the *H. grosseserratus* were blooming for several weeks after the initial finding, there were no further observations of *N. asteris*— it is likely that the authors' discovery occurred near the end of their typical adult season, making this chance observation a truly rare find.

### Statistical results, speculation and future studies

The significant results of this study suggest that the observations on aggregatory behavior of male *N. asteris* are non-normal, indicating overdispersion relative to the number of available *H. grosseserratus* patches. While overdispersion, specifically clustering, is considered common in ecological systems (Barron 1992; Richards 2008; Harrison 2014), the authors cannot determine the cause without additional data collection. Herein, the authors speculate on the possible drivers of aggregatory behavior and include considerations for future studies.

One possible explanation may be rooted in thermo-regulatory techniques. Males across all patches were observed to have three distinct roosting behaviors:

individuals on leaf margins, individuals on petal margins, and groups of individuals on petal margins (Fig. 1A–D). This is unique from other observations in the literature on male roosting behavior in that nearly all individuals observed roost along petal margins instead of along grass stems or in the flower’s center (Rau and Rau 1916; Alcock 1998; Vereecken and McNeil 2010). The outward preference for the margins of petals over other, previously documented relative locations could be reliant on the position of *H. grosseserratus* flowers relative to the sun. Numerous studies have addressed the eastward orientation of sunflowers in *Helianthus*, including Atamian et al. (2016) and van der Kooi (2016). Additional studies have examined the thermal properties of flowers themselves, particularly members of Asteraceae, finding that both the central disks and petals absorb, retain, and generate heat (Sapir et al. 2006; Dietrich and Körner 2014; van der Kooi et al. 2019). This explanation is furthered by the consideration of “shelter aggregations”, as noted in Allee (1927), in which bees aggregate because of small amounts of available shelter material. Given the small body size of *N. asteris*, it is likely that this ectothermic species would be highly reliant upon both solar radiation and would have retained floral heat for thermoregulation overnight and before flying. An alternative explanation that runs parallel to this floral thermal dependence is that the grouping of multiple *N. asteris* on single petals may reduce risk of freezing, promoting more ideal physiological conditions for clustered individuals. This has only been documented in bees honeybee-sized and larger (*Xylocopa* Latreille, Ostwald et al. 2022), but we cannot truly dismiss this possibility without additional research into this behavior in smaller bee taxa.

Another explanation may be reduced individual predator risk. Alcock (1998) believed this to be the driver for male aggregations, noting that this may provide protection via dilution effect—a strategy that greatly lowers the probability that an individual will be eaten by a predator. This is a behavior readily seen in other organisms, including other insects (Foster and Treherne 1981; Wrona and Dixon 1991; Mooring and Hart 1992). It may be that the unusual positional behavior of *N. asteris* is another predator avoidance technique, driven by relative positions of primary arthropod predators, such as crab spiders, on flowers (Morse 1981; Heiling et al. 2005, 2006). Several studies have shown that bees can see well-camouflaged predators and will actively avoid flowers where crab spiders are waiting (Heiling and Herberstein 2004; Heiling et al. 2005; Huey and Nieh 2017). Schmalhofer (1999) notes that the comfortable temperature range that summertime crab spiders can inhabit tends towards warmer temperatures, suggesting that spiders adapted to the high temperatures during the day may be less successful hunters at night due to their own thermal limitations. Following this logic, it is possible that the crab spiders are also reliant upon the heat retained by the flowers of *H. grosseserratus* overnight. Thus, perhaps the *N. asteris* are roosting on the edges of flower petals to avoid crab

spiders that may be positioned around the warm central disk of the flowers, relying on the thermal limits of the predators during cooler hours of the day and night, and roosting in groups to increase likelihood of survival should the crab spider still be capable of hunting.

Multi-year usage dependent on proximity to females may also drive aggregatory behavior in *N. asteris*. It has been documented that the males of some solitary bee species will return to the same site for nocturnal roosting both within and across seasons, and different generations being involved across seasons (Wcislo 2003). It is thought that the overnight location where males reside is determined by proximity to females, either where they will emerge or where they will forage, to increase chance of mating (Pinheiro et al. 2017). Males are highly competitive when it comes to mating opportunities (Velthuis and Gerling 1980; Paxton 2005; Alcock 2013). Additionally, multi-year nesting aggregations are common in non-parasitic, solitary bees because of preferential nesting conditions (Michener et al. 1958; Danforth et al. 2019; Tsiolis et al. 2022). Foraging cleptoparasitic female bees are likely to stay close to these aggregations (Danforth et al. 2019; Litman 2019; Moens et al. 2024). Given that *H. grosseserratus* is a perennial plant, it is likely that the patch observed here will be used again next year by male *N. asteris*. If this is the case, it may allude to the location of females and thus the host species, as well as the foraging preferences of the two species. *Nomada* are known parasites of several genera, most commonly *Andrena* Fabricius, 1775 (Cardinal et al. 2010; Litman et al. 2013; Danforth et al. 2019). Given the time of year and observations made by the authors, it is entirely plausible that *N. asteris* utilizes either a member of *Andrena* (*Callandrena*) Cockerell, 1898, or one of the eucerine species viewed at and around the observation site (Michener 2007; Danforth et al. 2019). While members of *Callandrena* are common in Kansas throughout the summer and fall, none were seen at the time of observation. Future investigations should be conducted with the goal of determining if this observation was a simple one-off and, if not, if *N. asteris* males exhibit a multi-year roost location preference. Additionally, future studies should aim to decipher diel behavior of both sexes, as well as locate the host species.

## Notes on iNaturalist observations

A tentative female specimen of *N. asteris* was reported on the civilian science platform iNaturalist in Norman, Oklahoma in late September, 2024 (Wingert 2024). Visible morphological characteristics, such as the darkened thoracic markings highlighted in Broemeling and Moalif (1988), might suggest that this specimen is *N. asteris*, but without additional images showing more of the key features confirmation of the observation is impossible. The specimen was flagged as a potential *N. asteris* by John S. Ascher, the noted taxonomist behind DiscoverLife,

but the species identification remains unresolved. However, it would not be out of the question for this to be a representative of the species given the location where the specimen was observed. The authors find it extremely likely that *N. asteris* is a prairie-associated species and is possibly distributed throughout the plains regions of Kansas, Nebraska, and Oklahoma. Future bee diversity and sampling surveys are needed to ascertain the true distributional range of this elusive bee.

## Conclusion

This is the first known observation of male aggregate behavior in cleptoparasitic bees in the United States. Although this is primarily observational data, it illuminates interesting behavior that elicits further exploration into the life history of this species. However, this study is not without caveats. By virtue of being a chance observation, the timeline during which the authors could obtain data was limited. Further, this study does not take into consideration factors such as environmental conditions, phenological timelines, or behavior at other times of day, such as overnight (nocturnal). For example, the authors did not directly observe if *N. asteris* males continue to exhibit the aggregatory behavior after sunset, only making observations at dusk. Moreover, the observational nature of this study only allows for speculation regarding drivers of this aggregatory behavior. Such drivers could include thermoregulation, predator avoidance, and resource availability in the form of mating opportunities, but will remain unknown until future studies are conducted.

In addition to these findings of aggregatory behavior, this study emphasizes the importance of the continued use of museum collections, including unsorted specimens, in ascertaining the status of rare and understudied bee species. Diversity and morphological similarities of *Nomada* can make species identification a difficult and time-consuming process, but that does not negate the importance of taxonomic work as the data gathered at the time of collection is crucial for understanding phenology, life history, and other important ecological information. The finding of a second pinned female specimen in unsorted material marks the second recorded female in the history of the species, and the label data associated with this female provides a broader window of seasonal activity, during which future research can be conducted to locate and study this rare Kansas native.

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