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Zachary M. Portman
University of Minnesota, zportman@gmail.com

Skyler J. Burrows
Utah State University

Terry Griswold
USDA-ARS Pollinating Insects Research Unit

Mike Arduser
Conservation Research Institute

Aaron J. Irber
University of Minnesota

See next page for additional authors

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Zachary M. Portman[1*], Skyler J. Burrows[2], Terry Griswold[3], Mike Arduser[4], Aaron J. Irber[1], Rebecca K. Tonietto[5], Daniel P. Cariveau[1]

[1] Department of Entomology, University of Minnesota, St. Paul, Minnesota

[2] Department of Biology, Utah State University, Logan, Utah

[3] USDA-ARS Pollinating Insects Research Unit, Logan, Utah

[4] Conservation Research Institute, Chicago, Illinois

[5] Department of Biology, University of Michigan-Flint, Flint, Michigan

*Corresponding author: (email: zportman@umn.edu)

Abstract

We report the first records of *Pseudoanthidium nanum* (Mocsáry) (Hymenoptera: Megachilidae) in Illinois and Minnesota in 2016 and 2018, respectively. This represents a relatively rapid expansion since *P. nanum* was first detected in New Jersey in 2008. In order to help monitor the spread of this bee, we provide information on how to identify *P. nanum* and provide images of the general habitus, diagnostic features, and male genitalia. Finally, we confirm the taxonomic identity of *P. nanum* in the United States and highlight potential impacts on native anthidiines.

Keywords: *Anthidium*, Anthophila, invasive species, Midwest, range expansion

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The number of non-native bees in North America continues to increase as new species are introduced and existing species expand from the point of introduction (Cane 2003, Sheffield et al. 2011, Russo 2016). Cavity-nesting bees, particularly those in the family Megachilidae, make up an outsized proportion of adventive bees due to the ease of inadvertent transport of their nests (Cane 2003, Russo 2016). Megachilids that have recently been introduced or expanded their ranges in North America include *Anthidium florentinum* (Fabricius) (Normandin et al. 2017), *A. manicatum* (L.) (Gibbs and Sheffield 2009), *A. oblongatum* (Illiger) (Miller et al. 2002), *Megachile sculpturalis* Smith (Hinojosa-Díaz et al. 2005), and *Osmia taurus* Smith (Giles and Ascher 2006). For many of these species, information about their spread and current distribution is sparse or lacking, hampering our understanding of their rate of spread and potential effects on native bees and ecosystems.

A species of *Pseudoanthidium* Friese, identified as *P. nanum* (Mocsáry, 1881), was first detected in the United States in New Jersey in 2008 (Droege and Shapiro 2011, Ascher et al. 2014). The native range of *P. nanum* encompasses Europe, western Asia, and the Middle East (Fateryga and Popov 2017, Kuhlmann et al. 2018). After its initial detection in New Jersey, *P. nanum* was subsequently detected in New York in 2009 (Matteson et al. 2013, Ascher et al. 2014) and Maryland in 2010 (Droege and Shapiro 2011). Finally, *P. nanum* was reported from Cleveland, Ohio in 2016 (Spring 2017). The distribution of *P. nanum* in the United States appears to be restricted to urban and industrial areas (Droege and Shapiro 2011).

The genus *Pseudoanthidium* contains approximately 60 described species (and numerous undescribed species) divided among 12 subgenera (Litman et al. 2016). They are native to Europe, Asia, and Africa, with no native species in the New World or Australia (Michener 2007). The genus contains at least one additional species that has spread outside its native range (Russo 2016). *Pseudoanthidium repetitum* (Schulz), native to South Africa, was first detected in Australia in 2000, and has since spread rapidly and become one of the most common bees in some areas (Baumann et al. 2016). The invasion and rapid spread of *P. repetitum* has been attributed to its affinity for nesting in a wide range of man-made structures, especially meter-boxes and window frames (Baumann et al. 2016, Queensland Museum 2018).

Here, we present the first records of *P. nanum* in Illinois and Minnesota and confirm its taxonomic identity. These new speci-

Table 1: *Pseudoanthidium nanum* specimens examined from the United States.

Institution	Specimen ID	State	Year	Original Study
AMNH	AMNH_BEE00131649	New York	2009	Matteson et al. 2013
BBSL	DRO167202	Maryland	2010	Droege and Shapiro 2011
BBSL	DRO167193	Maryland	2010	Droege and Shapiro 2011
AMNH	AMNH_BEE00231799	New Jersey	2011	Ascher et al. 2014
AMNH	AMNH_BEE00231798	New Jersey	2011	Ascher et al. 2014
AMNH	AMNH_BEE00076577	New Jersey	2011	Ascher et al. 2014
AMNH	AMNH_BEE00290799	New Jersey	2011	Ascher et al. 2014
AMNH	AMNH_BEE00290786	New Jersey	2011	Ascher et al. 2014
Tonietto Lab/ INHS	20162340	Illinois	2016	This study
Tonietto Lab/ INHS	201610027	Illinois	2016	This study
Cariveau Lab/ UMSP	urb18-0723	Minnesota	2018	This study

mens match other specimens of *P. nanum* from the eastern United States, indicating a rapid spread across the country. We provide detailed images of the key identifying features of *P. nanum* in order to facilitate the identification and monitoring of this adventive species. Lastly, we highlight the fact that *P. nanum* is a member of a poorly understood species complex synonymized under the unavailable name *P. lituratum* (Panzer) by Warncke (1980) and frequently referenced by that name (Přidal 2004, Kuhlmann et al. 2018) and we confirm that the specimens in the United States match *P. nanum* as it was originally described in Europe (Mocsáry 1881).

Methods and Materials

Specimens examined for this study included novel collections from the midwestern United States, previously reported specimens from the eastern United States (Table 1), and specimens from the native range of *P. nanum* in Europe. The Minnesota specimen was collected in 2018 as part of a broader survey of the pollinators of urban gardens. Resources used to initially identify the bees included the USDA Exotic Bee ID Key (Burrows et al. 2018) and images from Droege and Shapiro (2011). The Minnesota specimen currently resides in the Cariveau Lab insect collection (University of Minnesota) and will be permanently deposited in the University of Minnesota Insect Collection (UMSP) in St. Paul, Minnesota. The two Illinois specimens were collected in 2016 as part of a broader study on urban garden pollinators. They are currently in the Tonietto lab collection (University of Michigan, Flint) and will be permanently deposited at the Illinois Natural History Survey (INHS) in Urbana, Illinois. Additional material was examined from the American Museum of Natural History (AMNH) in New York City, New York and the Pollinating Insects Research Unit (BBSL) in Logan, Utah.

Classification of *Pseudoanthidium* follows Litman et al. (2016). For the nomenclature of *P. nanum* (Mocsáry, 1881) we use a description year of 1881. The years 1879 and 1881 have both been used to refer to *P. nanum*, sometimes even in the same publication (e.g. Přidal 2004). We use the date of 1881 because that is when the volume of the journal was completed (see Baker 1996). The abbreviations S1…S8 and T1…T7 are used for sterna and terga, respectively. Photographs were taken using two systems: an Olympus DP27 camera mounted on an Olympus SZX16 stereomicroscope and a Keyence VHX-5000 microscope imaging system with a VH-Z20R lens and a VHX-S550E stand. Images from the Olympus camera were stacked using CombineZP software (Hadley 2010) and all photographic plates were compiled using Adobe Photoshop 2018 software (Adobe Systems Inc., San Jose, CA).

Results and Discussion

Details of the specimens from Illinois and Minnesota. Two *P. nanum* specimens, one male and one female, were collected in Illinois in 2016. The male, specimen number 20162340, was collected on 29 June 2016 in a pan trap by Elizabeth Kosson, Kristian Williams, and Nick Olson at Windy City Harvest Legends Farm, Chicago, Cook County, Illinois (41.812, –87.628). The female, specimen number 201610027, was collected in a pan trap on 26 Aug 2016 by Elizabeth Kosson, Kristian Williams, and Nick Olson at Windy City Harvest Rodeo Farm, Chicago, Cook County, Illinois (41.844, –97.691).

A single male *P. nanum* (Fig. 1), specimen number urb18-0723, was collected with a hand net from *Erigeron* sp. on 13 June 2018 by Aaron Irber at Corcoran Communi-

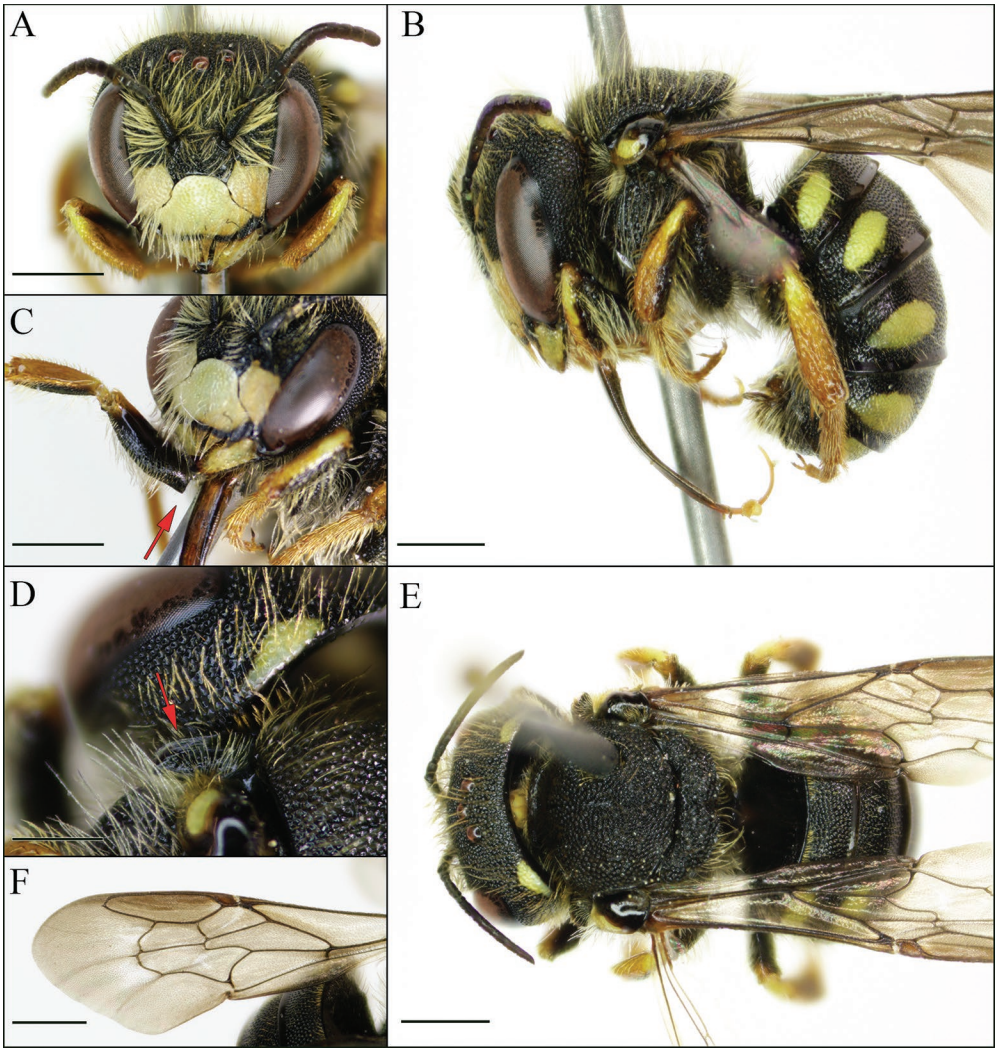

Figure 1: *Pseudoanthidium nanum* male: A) face B) body, lateral view C) conical-shaped base of fore-femur D) lamellate pronotal lobe E) body, dorsal view F) forewing. All scale bars = 1 mm, except 500 µm in D.

ty Garden, Minneapolis, Hennepin County, Minnesota (44.9428, −93.2368).

Identification of *Pseudoanthidium nanum* in the United States. Male *P. nanum* can be distinguished from other US anthidiini by a combination of the following diagnostic characters: lamellate ridge on the pronotal lobes (Fig. 1D), lateral combs on S5, and an apico-medial brush of long, wavy hairs on S3 (Fig. 2). Female *P. nanum* (Fig. 3) are more difficult to recognize, but they can be diagnosed by the following combination of characters: lamellate ridge on the pronotal lobes (as in Fig. 1D), fore-femur with conical base (Fig. 3C), 5 mandibular teeth, and the lack of arolia. These characters are all shared by males, except males have 3 mandibular teeth.

In addition to the diagnostic characters listed above, the following characters can help differentiate *Pseudoanthidium* from similar-looking species in the US: presence of scopal hairs on sterna in the female (Fig. 3B), presence of yellow maculations on the body (Figs. 1B, 3B), forewing with darkened marginal cell (Fig. 1F), anterior face of T1 smooth and divided from the posterior face by a small carina (Fig 1E), and a rounded

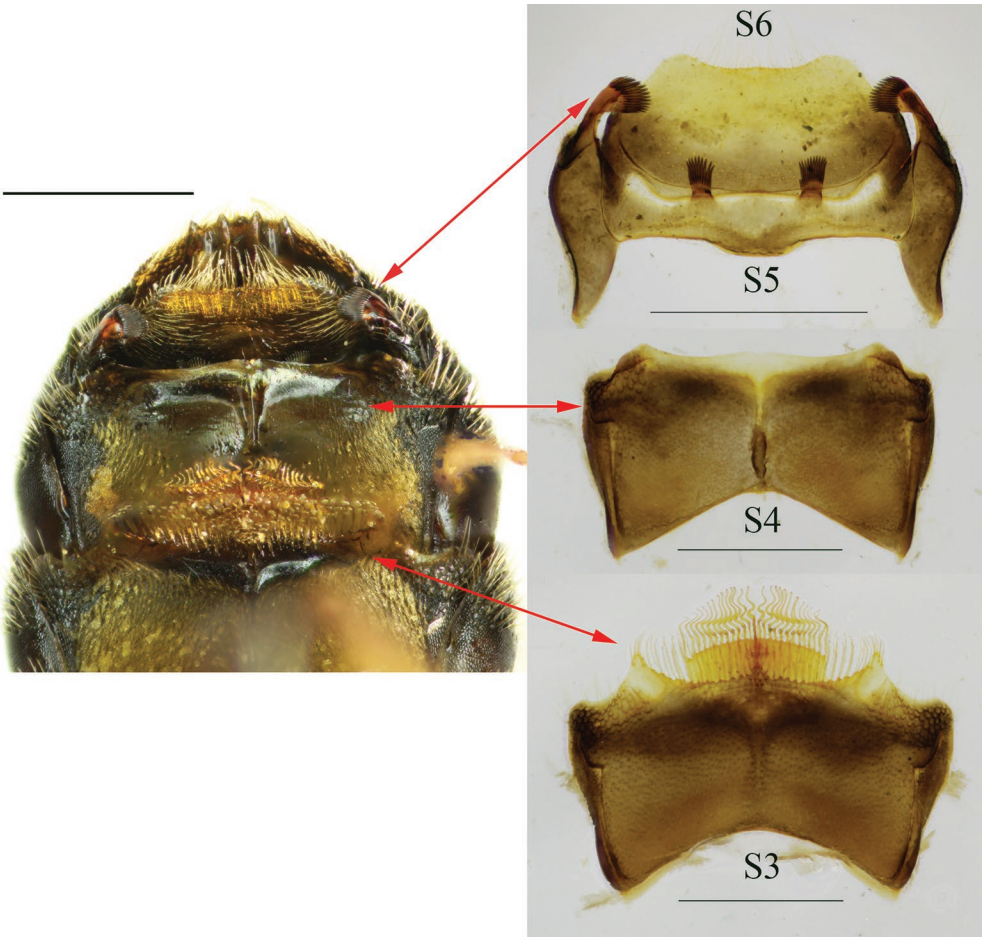

Figure 2: *Pseudoanthidium nanum* male apical sternites (S3–6) showing the diagnostic S3 hair brush and S5 lateral combs. All scale bars = 1 mm.

omaulus (surface between the lateral and anterior faces of the mesepisternum). In addition, the females have a distinct pattern of punctures on the clypeus, starting with relatively large punctures basally, with the punctures becoming gradually more minute and contiguous towards the apical margin (Fig. 3A).

In the United States, *P. nanum* is most likely to be confused with the genus *Anthidium* because the two genera look similar and share multiple characters. Indeed, *Pseudoanthidium* keys out to *Anthidium* in Mitchell (1962) due to the lack of pygidial plate, extensive yellow maculations, and lack of arolia. *Pseudoanthidium nanum* can be separated from all native *Anthidium* by the presence of a raised lamellate ridge on the pronotal lobes (Fig. 1D), however, it can be confused with a non-native *Anthidium* species, *A. oblongatum*, which also has a lamellate pronotal lobe (Miller et al. 2002, Gonzalez and Griswold 2013). Female *P. nanum* can be definitively separated from *A. oblongatum* by the number of mandibular teeth: *P. nanum* only has 5 teeth, whereas *A. oblongatum females* have 9–12 teeth. Male *P. nanum* can be separated from *A. oblongatum* (and all other North American Megachilidae) by the pair of lateral combs on S5 and hair brush on S3 (Fig. 2). In addition, male *P. nanum* have a conical projection on the fore-femur (Fig. 1C) and lack spines or protrusions on their apical terga, except for a minute medial nub on T7 (Fig. 4C). In contrast, *A. oblongatum* lacks a conical projection on the fore-femur and has lateral and medial spines on T6 and a broad medial emargination on T7 (illustrated in Fig. 254 of Gonzalez and Griswold 2013). Finally, *P. nanum* can be distinguished from all *Anthidium* in eastern North America, both native

Figure 3: *Pseudoanthidium nanum* female: A) face B) body, lateral view C) conical-shaped base of fore-femur D) body, dorsal view E) abdomen, dorsal view. All scale bars = 1 mm.

and exotic, by the small body size (5–7 mm body length).

The distinctive structure of the genitalia and hidden sterna of male *P. nanum* alone distinguishes it from all North American bees (Fig. 4). Features of the genitalia not readily apparent from the figure include: 1) the inner margins of the penis valves have fine hairs that extend along the entire inner length, except subapically where there are two stronger hairs on the left valve and one on the right valve; 2) the gonostyli have a dorsal carina that extends along their lateral margin for nearly all their length; and 3) the area between the penis valves appears more rectangular in the dorsal view (Fig. 4A) because the endophallus is slightly everted; the more horseshoe-shaped area between the penis valves as seen in the ventral view is closer to the "true" form (Fig. 4B).

The taxonomic identity of *Pseudoanthidium nanum* in the United States. Although the taxonomy of *Pseudoanthidium* contains unresolved issues, we confirm the specimens in the US can be assigned to *P. nanum*. In short, *P. nanum* is a member of species complex, generally referred to as the "*lituratum* group," that contains multiple

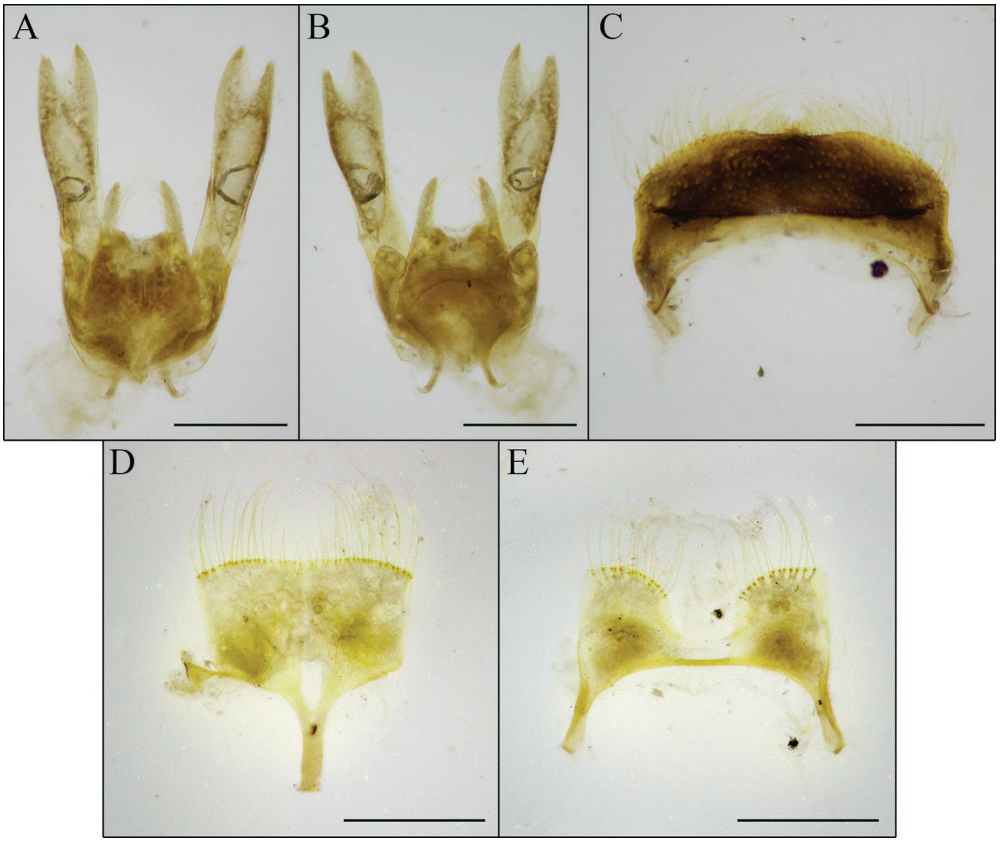

Figure 4: *Pseudoanthidium nanum* male A) genitalia, dorsal view, B) genitalia, ventral view, C) T7 D) S8 (right point of attachment broken off) E) S7. All scale bars = 500 μm.

closely-related species of unsettled taxonomic status (Přidal 2004, Kuhlmann et al. 2018). Adding to the confusion, although *P. lituratum* (Panzer) is not a valid name because it is a primary homonym (Přidal 2004, Aguib et al. 2010, Kuhlmann et al. 2018), it is still often used in the literature (e.g. Přidal 2004, Bogusch et al. 2017, Gonzalez et al. 2017). However, based on examination of specimens from the type locality of *P. nanum* originally determined by Mocsáry, we believe that the specimens in the United States correspond with *P. nanum* as originally defined (Mocsáry 1881). Specifically, Terry Griswold has examined a series of *P. nanum* in the Hungarian National History Museum originally determined by Mocsáry. Two permanently borrowed specimens from that series deposited in the BBSL collection were compared to US specimens; the locality for these two Mocsáry specimens is "Hungariae meridionalis comitatu Temesiensis," which matches the original type locality of *P. nanum*, though they are not old enough to be a part of the original type series.

Although the *P. nanum* in the US agree morphologically with the original definition of *P. nanum*, the specimens of *P. nanum* in our possession would not appear to match *P. nanum* as defined by Aguib et al. (2010). Specifically, in the US specimens, the structure of the lateral combs on S5 differs from that shown by Aguib et al. (2010) and the penis valves are more widely separated and less tapering. Study of Aguib et al.'s (2010) image of the S5 comb suggests it was taken at an oblique angle which could account for the disparity in shape. More clarity must await a broader taxonomic revision of the *lituratum* species group. Towards this end we provide images of the genitalia and apical sterna (Figs. 2 and 4), to illustrate our concept of Mocsáry's species and to assist in future taxonomic evaluation of the *lituratum* species group.

Other invasive Anthidiini in the North Central United States. In addition to *P. nanum*, there are already two other non-native anthidiine bees established in the North Central US: *A. manicatum* and *A. oblongatum*. *Anthidium manicatum* was first detected in the US in New York State in 1963 (Jaycox 1967), though it was not found in the Midwest until it was detected in Ohio in 1997 (Miller et al. 2002). Its range has increased rapidly since then, with new records in Illinois, Wisconsin, Idaho, California, and Colorado in 2006 and 2007 (Tonietto and Ascher 2008, Gibbs and Sheffield 2009). The timing of the arrival of *A. manicatum* in MN is not clear, with the first recorded specimens in the UMSP collection from 2013, though postings on BugGuide.net place it as early as 2008 (https://bugguide.net/node/view/199661).

Anthidium oblongatum is also a recent arrival to the North Central US. It was first found in northeastern US in 1994 (Hoebeke and Wheeler 1999). It was collected in Ohio in 2000, in Illinois in 2008, and in Michigan in 2010 (Miller et al. 2002, Tonietto and Ascher 2008, O'Brien et al. 2012). In Minnesota, the earliest collected specimens of *A. oblongatum* in the UMSP collection are from 2015, though there is a 2013 record of the bee from BugGuide.net (https://bugguide.net/node/view/804727).

Implications for native bees. It is unclear what effect *P. nanum* and other invasive anthidiines may have on the native bee fauna of the North Central US. Of particular concern are native anthidiines that are already rare in the North Central US, such as *A. psoraleae* Robertson and *A. tenuiflorae* Cockerell. Both species are largely western in distribution and are rare in the North Central US (Grundel et al. 2011, O'Brien et al. 2012, Gonzalez and Griswold 2013, Gibbs et al. 2017). However, given that *P. nanum* and the two invasive *Anthidium* species appear to be largely restricted to disturbed areas, their effects should be limited (Gibbs and Sheffield 2009, Droege and Shapiro 2011, Miller et al. 2002). In addition, *P. nanum* is likely a specialist on the pollen of Cynareae (Müller 1996, Gonzalez et al. 2017), further reducing its potential impact. However, given that *P. nanum* nests in stems and a variety of other cavities such as galls and snail shells (Litman 2012), it could potentially compete with native bees for nest sites. Finally, *P. nanum* and other non-native bees could be involved in spreading pests and disease to native bees, a largely hidden factor which is gaining increasing recognition as a major threat to native bee health (Colla et al. 2006, Murray et al. 2018).

Conclusion

It is important to monitor *P. nanum* in North America to better understand and predict its potential spread and impacts on native bees. Its presence in Minnesota represents a rapid range expansion from the initial area of introduction since it was first detected in New Jersey in 2008 (Droege and Shapiro 2011). This relatively rapid rate suggests that the bee will continue to spread across North America, a hypothesis supported by two unconfirmed reports of *P. nanum* in Oregon in 2018 on BugGuide and iNaturalist (https://www.inaturalist.org/observations/14356133, https://bugguide.net/node/view/1566202). However, we are reluctant to classify these unconfirmed reports as *P. nanum* due to the difficulty of identifying this species from photographs and because the West Coast distribution could possibly represent a separate introduction event. It is our hope that the resources provided here will assist in the identification and monitoring of *P. nanum* since it appears likely to continue to expand its range.

Finally, the unsettled taxonomy of *Pseudoanthidium* and previous uncertainty surrounding the species identity of *P. nanum* in the United States highlights the importance of basic taxonomy and the need for identification tools to monitor invasive species. As this species demonstrates, even in areas of the world with well-known bee faunas and hundreds of years of taxonomic history, there remains a substantial amount of work to be done (Gonzalez et al. 2013). In this case, it is important to confirm the species identity in order to compile accurate information on the biology and native range of *P. nanum*.

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Literature Cited

Aguib, S., K. Louadi, and M. Schwarz. 2010. Les Anthidiini (Megachilidae, Megachilinae) d'Algérie avec trois espèces nouvelles pour ce pays: *Anthidium* (*Anthidium*) *florentinum* (Fabricius, 1775), *Anthidium* (*Proanthidium*) *amabile* Alfken, 1932 et *Pseudoanthidium* (*Exanthidium*) *enslini* (Alfken, 1928). Zeitschrift fur Entomologie 31:121–152.

Ascher, J. S., S. Kornbluth, and R. G. Goelet. 2014. Bees (Hymenoptera: Apoidea: Anthophila) of Gardiners Island, Suffolk County, New York. Northeastern Naturalist 21: 47–71.

Baker, D. B. 1996. Priorities of publication for some nineteenth-century works describing new taxa of Hymenoptera, principally Apoidea. Archives of Natural History 23: 299–301.

Baumann, J., K. Walker, and C. Threlfall. 2016. African carder bee, *Afranthidium* (*Immanthidium*) *repetitum* (Hymenoptera: Megachilidae)—a new exotic species for Victoria. Victorian Naturalist 133: 21–25.

Bogusch, P., L. Bělastová, and P. Heneberg. 2017. Limited overlap of the community of bees and wasps (Hymenoptera: Aculeata) nesting in reed galls with those nesting in other cavities. Journal of Insect Conservation 21: 861–871.

Burrows, S., M. Christman, L. R. Spears, S. Smith-Pardo, R. A. Ramirez, T. Griswold, and A. J. Redford. 2018. Exotic Bee ID. USDA APHIS Identification Technology Program (ITP), Fort Collins, CO. (http://idtools.org/id/bees/exotic). Accessed Feb 2019.

Cane, J. 2003. Exotic non-social bees (Hymenoptera: Apoidea) in North America: Ecological implications, pp. 113–126. *In* K. Strickler and J.H. Cane (eds.), For Nonnative Crops: Whence Pollinators of the Future. Entomological Society of America, Lanham, MD.

Colla, S. R., M. C. Otterstatter, R. J. Gegear, and J. D. Thomson. 2006. Plight of the bumble bee: Pathogen spillover from commercial to wild populations. Biological Conservation 129: 461–467.

Droege, S. W., and L. H. Shapiro. 2011. An August survey of wild bees (Hymenoptera: Apoidea) in the northeastern port areas of Baltimore, Maryland and the second North American record of *Pseudoanthidium nanum* (Mocsáry). Maryland Entomologist 5: 33–44.

Fateryga, A. V., and I. B. Popov. 2017. New records of Vespidae and Megachilidae (Hymenoptera) in Russia. Экосистемы 9: 86–89.

Gibbs, J., J. S. Ascher, M. G. Rightmyer, and R. Isaacs. 2017. The bees of Michigan (Hymenoptera: Apoidea: Anthophila), with notes on distribution, taxonomy, pollination, and natural history. Zootaxa 4352: 1–160.

Gibbs, J., and C. S. Sheffield. 2009. Rapid range expansion of the wool-carder bee, *Anthidium manicatum* (Linnaeus) (Hymenoptera: Megachilidae), in North America. Journal of the Kansas Entomological Society 82: 21–29.

Giles, V., and J. S. Ascher. 2006. A survey of the bees of the Black Rock Forest Preserve, New York (Hymenoptera: Apoidea). Journal of Hymenoptera Research 15: 208–231.

Gonzalez, V. H., and T. L. Griswold. 2013. Wool carder bees of the genus *Anthidium* in the Western Hemisphere (Hymenoptera: Megachilidae): Diversity, host plant associations, phylogeny, and biogeography. Zoological Journal of the Linnean Society 168: 221–425.

Gonzalez, V. H., T. Griswold, and M. S. Engel. 2013. Obtaining a better taxonomic understanding of native bees: Where do we start? Systematic Entomology 38: 645–653.

Gonzalez, V. H., A. Olsen, M. Mallula, A. Tosunoglu, I. Çakmak, J. Hranitz, and J. Barthell. 2017. Bee visitors of *Centaurea solstitialis* L. (Asteraceae) in an urban environment in northwestern Turkey. Arthropod-Plant Interactions 11: 403–409.

Grundel, R., K. J. Frohnapple, R. P. Jean, and N. B. Pavlovic. 2011. Effectiveness of bowl trapping and netting for inventory of a bee community. Environmental Entomology 40: 374–380.

Hadley, A. 2010. CombineZP: Image stacking software.

Hinojosa-Díaz, I., O. Yanez-Ordonez, G. Chen, T. Petterson, and M. Engel. 2005. The North American invasion of the giant resin bee (Hymenoptera: Megachilidae). Journal of Hymenoptera Research 14: 69–77.

Hoebeke, E. R., and A. G. Wheeler. 1999. *Anthidium oblongatum* (Illiger): An Old World bee (Hymenoptera: Megachilidae) new to North America, and new North American records for another adventive species, *A. manicatum* (L.). University of Kansas Natural History Museum, Special Publication 24: 21–24.

Jaycox, E. R. 1967. An adventive *Anthidium* in New York state (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society 40: 124–126.

Kuhlmann, M., J. S. Ascher, H. H. Dathe, A. W. Ebmer, P. Hartmann, D. Michez, A. Müller, S. Patiny, A. Pauly, C. Praz, P. Rasmont, S. Risch, E. Scheuchl, M. Schwarz, M. Terzo, P. H. Williams, F.

Amiet, D. Baldock, Ø. Berg, P. Bogusch, I. Calabuig, B. Cederberg, A. Gogala, F. Gusenleitner, Z. Josan, H. B. Madsen, A. Nilsson, F. Ødegaard, J. Ortiz-Sanchez, J. Paukkunen, T. Pawlikowski, M. Quaranta, S. P. M. Roberts, M. Sáropataki, H.-R. Schwenninger, J. Smit, G. Söderman, and B. Tomozei. 2018. Checklist of the Western Palaearctic Bees (Hymenoptera: Apoidea: Anthophila). (http://westpalbees.myspecies.info). Accessed Feb 2019.

Litman, J. R. 2012. Phylogenetic systematics and the evolution of nesting behavior, host-plant preference, and cleptoparasitism in the bee family Megachilidae (Hymenoptera, Apoidea). Ph.D. dissertation, Cornell University, Ithaca.

Litman, J. R., T. Griswold, and B. N. Danforth. 2016. Phylogenetic systematics and a revised generic classification of anthidiine bees (Hymenoptera: Megachilidae). Molecular Phylogenetics and Evolution 100: 183–198.

Matteson, K. C., J. B. Grace, and E. S. Minor. 2013. Direct and indirect effects of land use on floral resources and flower-visiting insects across an urban landscape. Oikos 122: 682–694.

Michener, C. D. 2007. The Bees of the World, 2nd ed. Johns Hopkins University Press, Baltimore, MD.

Miller, S. R., R. Gaebel, R. J. Mitchell, and M. Arduser. 2002. Occurrence of two species of Old World bees, *Anthidium manicatum* and *A. oblongatum* (Apoidea: Megachilidae), in northern Ohio and southern Michigan. The Great Lakes Entomologist 35: 65–69.

Mitchell, T. B. 1962. Bees of the Eastern United States. Volume 2., North Carolina Experimental Station Technical Bulletin.

Mocsáry, S. 1881. Ujabb adatok Temesmegye hártyaröpű faunájához. Mathematikai és Természettudományi Közlemények 16: 1–70.

Müller, A. 1996. Host-plant specialization in western Palearctic anthidiine bees (Hymenoptera: Apoidea: Megachilidae). Ecological Monographs 66: 235–257.

Murray, E. A., J. Burand, N. Trikoz, J. Schnabel, H. Grab, and B. N. Danforth. 2018. Viral transmission in honey bees and native bees, supported by a global black queen cell virus phylogeny. Environmental Microbiology 21: 972–983.

Normandin, É., N. J. Vereecken, C. M. Buddle, and V. Fournier. 2017. Taxonomic and functional trait diversity of wild bees in different urban settings. PeerJ 5: e3051.

O'Brien, M. F., D. R. Swanson, and J. Monsma. 2012. *Anthidium oblongatum* (Apoidea: Megachilidae) confirmed as a Michigan resident, with notes on other Michigan *Anthidium* species. The Great Lakes Entomologist 45: 102–105.

Přidal, A. 2004. Checklist of the bees in the Czech Republic and Slovakia with comments on their distribution and taxonomy (Insecta: Hymenoptera: Apoidea). Acta Universitatis Agriculturae et Sylviculturae Mendelianae Brunensis 52: 29–66.

Queensland Museum. 2018. Meter-box carder bee. (http://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Insects/Wasps+and+bees/Common+species/Meter-box+Carder+Bee#.W7z8bmhKhPY). Accessed Feb 2019.

Russo, L. 2016. Positive and negative impacts of non-native bee species around the world. Insects 7(4): 69.

Sheffield, C. S., S. Dumesh, and M. Cheryomina. 2011. *Hylaeus punctatus* (Hymenoptera: Colletidae), a bee species new to Canada, with notes on other non-native species. Journal of the Entomological Society of Ontario 142: 29–43.

Spring, M. R. 2017. Impacts of Urban Greenspace Management on Beneficial Insect Communities. M.S. thesis, Ohio State University, Columbus.

Tonietto, R. K., and J. S. Ascher. 2008. Occurrence of the Old World bee species *Hylaeus hyalinatus*, *Anthidium manicatum*, *A. oblongatum*, and *Megachile sculpturalis*, and the native species *Coelioxys banksi*, *Lasioglossum michiganense*, and *L. zophops* in Illinois (Hymenoptera: Apoidea, Colletidae, Halictidae, Megachilidae). The Great Lakes Entomologist 41: 200–203.

Warncke, K. 1980. Die Bienengattung *Anthidium* Fabricius, 1804 in der Westpaläarktis und im turkestanischen Becken. Entomofauna 1: 119–209.