Journal of Melittology

Bee Biology, Ecology, Evolution, & Systematics

The latest buzz in bee biology

No. 99, pp. 1–6

4 December 2020

BRIEF COMMUNICATION

Record of *Anthophora* (*Clisodon*) *terminalis* in a wooden trap-nesting block and comparison to available nesting information (Hymenoptera: Apidae)

Colleen D. Satyshur[1] & Michael C. Orr[2]

Abstract. Bee nesting substrate choice can influence habitat use, conservation effort efficacy, and population or landscape-use modeling, but information on nesting sites are often scattered in the literature. Here we bring together the available information on nests of a widespread bee, *Anthophora* (*Clisodon*) *terminalis* Cresson, and describe an unusual new nesting substrate use for this species.

INTRODUCTION

Nesting habits in the genus *Anthophora* Latreille are fairly broad. Many species nest in the ground (Michener, 2007), but some may use preexisting cavities instead of excavating them (Torchio, 1971; Orr *et al.*, 2016). Wood nesting is rarer, reported only for species in the subgenus *Clisodon* Patton as well as for *Anthophora* (*Anthophoroides*) *signata* Brooks, although this is not likely its sole potential substrate (Brooks, 1988). The subgenus *Clisodon* contains five species that inhabit generally boreal habitats throughout Eurasia (Ascher & Pickering, 2019). Only one of them (*A. terminalis* Cresson) also occurs in North America. Records of *A. terminalis* nests (Table 1) include the use of dead or rotting wood, where the bee has been recorded to partly or fully excavate its own burrows and use the sawdust to line cells and form cell partitions (Cockerell, 1903; Sladen, 1919; Medler, 1964; Stephen *et al.*, 1969; Brooks, 1988). Other materials in which nests have been found include trap nests made from sumac stems (Medler, 1964) and cardboard tubes mounted in insulation boards housed within PVC

[1] Department of Ecology, Evolution and Behavior, University of Minnesota, 1987 Upper Buford Circle, Saint Paul, MN 55108, USA (csatyshu@umn.edu).

[2] Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, 1 Beichen West Road, Beijing 100101, P.R. China (michael.christopher.orr@gmail.com).

doi: https://doi.org/10.17161/jom.vi99.13315

ISSN 2325-4467

tubing (MacIvor & Packer, 2015). Based on 60 nests found in sumac trap nests in Wisconsin, Medler (1964) found "1/4–5/16 in. (6.25–7.8 mm) holes most suitable though bees did excavate walls to their desired size." Depending on the substrate, this species may also nest in large aggregations. Stephen *et al*. (1969) reported *A. terminalis*, *Megachile inermis* Provancher, and *Osmia* sp. "using a communal burrow excavated by a beetle in an aspen log." Dead logs may provide enough substrate for *A. terminalis* to appear as active as, "a strong colony of bumble-bees" (Sladen, 1919).

This species appears to be univoltine in North America (Cockerell, 1903; Medler, 1964), with records of nest construction in mid-late summer (Cockerell, 1903: August in New Mexico; Medler, 1964: August–September in Wisconsin). Young overwinter as a prepupa, which do not spin a cocoon (Medler, 1964). Despite obtaining 60 nests of *A. terminalis*, Medler (1964) did not find any parasitism. As in many species of *Anthophora*, food provisions are reported to be sour smelling and of a more liquid consistency (Cockerell, 1903; Medler, 1964).

Here we document a nest that was discovered as part of the Minnesota Bee Atlas, a multi-year citizen science project using bee nest blocks to study the presence and distribution of species in Minnesota (https://z.umn.edu/beeatlas). We also summarize the nesting records of this widespread bee.

TRAP METHODS AND NEST DESCRIPTION

The nest block that yielded *A. terminalis* was located in Washington County, Minnesota, near the city of Afton (44.9255°N, -92.8002°W). It was mounted within the Belwin Conservancy on the edge of a pond at a height of 183 cm (72 in.), facing east. The immediately surrounding area was primarily mixed conifer/deciduous woodland (the Conservancy also contains areas of restored grassland of tallgrass prairie). Blocks were made from untreated pine or Douglas fir, with a roof of cedar shingling. Each block measured approximately 8.9 × 14 × 27.9 cm (3.5 × 5.5 × 11 in.) and contained five tunnels each of six different diameters: 3.18 mm, 4.76 mm, 6.35 mm, 7.94 mm, 9.53 mm, and 11.11 mm. Tunnels were approximately 11.43 cm (4.5 in.) deep and spaced 2.54 cm (1 in.) away from other tunnels or the block edge.

In March 2016, a total of 116 nest blocks were sent to volunteers across the state of Minnesota who had been selected to hang and monitor a block in a semi-natural habitat. Recommended block placement was 0.9–1.5 meters high facing south or east in a semi-sunny location, allowing volunteers to accommodate mounting sites available at their specific locations. Volunteers were asked to record mounting conditions of their block and report evidence of nest plugs every 2–3 weeks during the growing season. Blocks were returned to the University of Minnesota in late fall, where they were surveyed by otoscope, overwintered and reared to emergence in a growth chamber the following year. Warming was accomplished with constant temperature steps, rather than by tracking local daily fluctuations, therefore the emergence dates suggest relative seasonality rather than actual emergence in field conditions. For rearing, each tunnel entrance was covered with a plastic test-tube cap with a hole cut out of the end and a replaceable test tube. Emerged bees in test tubes were removed daily and new tubes placed on tunnels.

During the 2016 flight season, a nest was made in a 6.25 mm diameter tunnel that later yielded a male and a female of *A. terminalis*. This nest would have remained undiscovered if all nest tunnels had not been prepared for emergence, as it was not visibly plugged. The block volunteer reported on nest tunnel status seven times be-

Figures 1–2. The nest of *Anthophora* (*Clisodon*) *terminalis* Cresson, entrance on the right. **1.** Showing full nest tunnel. Red marks indicate approximate call partition locations. **2.** Close up of occupied portion of tunnel. The inner end of the nest, on the left, still contained a disc of agglutinated wood and possibly mud. The tunnel walls can be seen to be slightly excavated and are lined with wood pulp, making the inner surface smooth. Three cells appear visible, though only two adults emerged, and no failed cell parts were evidenced upon opening. Photos courtesy of Thea Evans.

tween 8 May and 16 September 2016 and did not report any plug or bee activity for this tunnel. No plug was visible during the end of season otoscope survey of nest tunnels in the lab. This lack of detection is not uncommon in cases such as this, where nest construction ceased well below the front of the tunnel (the evidence of nest occupation extended 56 mm from the rear of the 113 mm tunnel).

Warming the growth chamber to break diapause began on 21 March 2017. The bees emerged on 17 and 18 April 2017, the female unexpectedly emerging before the male (most *Anthophora* are protandrous). When these bees emerged, material that resembled sawdust and pulverized mud was found in the tubes with them. Bee identification was done by C. Satyshur using the DiscoverLife *Anthophora* key and verified by S. Droege. Specimens are deposited in the University of Minnesota Insect Collection.

After the emergence season, this nest tunnel was opened using a chop saw, hammer and chisel (Fig. 1). The nest appears to have had three cells, though only two adults emerged, and no failed cell parts were evidenced upon opening. The tunnel walls were slightly excavated for each cell. At the innermost end of the tunnel, before the first cell, there was a disc of agglutinated wood and possibly mud still present. The first cell measured 10.8 mm long, 7 mm wide, with an upper partition of 2.3 mm thick, approximately. The second cell was 9.7 mm long, 7.3 mm wide, with the upper partition 2.3 mm thick, approximately. The third cell was 9.8 mm long and 7 mm wide, with an upper partition 2.1 mm thick, approximately. The partitions were no longer present, but left scars of wood fragments oriented outward into the tunnel space, whereas the walls of the cells themselves were lined with smooth agglutinated wood pulp, which was darker than the unused portion of the tunnel. In front of the cells there was evidence of a vestibule or incomplete 4^{th} cell, with some wall area darker stained and fully plastered with wood pulp, and some unstained, unlined wall below a partition scar of pale wood pulp.

DISCUSSION

Our record of *A. terminalis* nesting fits fairly well with previous descriptions of nest architecture describing sawdust as a nest cell partitioning material (Table 1), such

Table 1. Compilation of records of *Anthophora* (*Clisodon*) *terminalis* Cresson nesting. "—" indicates that a particular aspect was not addressed in a particular source.

Location	Date	Substrate	# Nests	# Cells	Nest length (cm)	Excavation	Reference
Beulah, NM, USA	August 1902	Dead fallen pine	"a number" 1+ opened	3–4	~10.2	Yes	Cockerell (1903)
Hull (Gatineau), QC, Canada	16 August 1913	Decayed but hard stump	"riddled with the burrows"	—	—	Yes	Salden (1919)
WI, USA, wild nest: Bayfield Co.	1952–1962; wild nest: 23 July 1952	sumac stem nest traps, "poplar log"	60 in sumac stems; 1 wild nest	Sumac: 5.8 av. Wild: 11	< 20.3 in sumac, cells 11mm	Yes, to different degrees	Medler (1964) R.E. Fye
—	—	"communal burrow excavated by a beetle in an aspen log"	1	—	—	No	Stephen *et al.* (1969)
Mad River Beach, Humboldt Co., CA, USA	—	"driftwood among sand dunes"	—	—	—	—	Brooks (1988)
Toronto, Canada	2013, part of 3-year study	cardboard tubes in PVC trap nests	—	—	<15	—	MacIvor & Packer (2015)
Cannibal Island, near Eureka, CA, USA	5 July 2014	thoroughly investi-gating driftwood	—	—	—	—	Orr (unpubl. data)
Near Afton, MN, USA	2016	pine/Douglas fir wooden nesting block	1	3	5.6	Slight widening of tunnel	This work

as the description in Medler (1964) that, "cells were composed of finely chewed sawdust. A more coarsely chewed sawdust was used to construct the partitions and terminal plugs. The latter plugs were made both in the tunnel and in an enlarged "cell" which was only partially filled with sawdust. This nest found in nature was essentially the same as those made in the trap-nests." The tunnel diameter in our record is within the range documented by Medler (1964), who stated that 1/4 or 5/16 in. (6.25 or 7.8 mm) holes were best but exact diameter was not necessary as the bees excavated the sides of the tunnels. The cell dimensions in our nest are also similar though slightly shorter. Medler (1964) states that cells were 7 mm wide and 11 mm long. Both Medler (1964) and Cockerell (1903) mentioned a smooth lining to the inside walls of the cells, which we also observed. However, extending beyond prior observations, the use of a fresh, solid wood nesting block in our study broadens our view of this species' nesting behavior, as other records show primarily nesting in softer, often rotting wood materials. This species appears to be an excavator, at least to some degree, maybe to get sawdust for nest partitions, similar to the obligate-excavator species in the genus *Ceratina* Latreille that use chewed pith to partition their nest cells (*e.g.*, Rehan & Richards, 2010; Vickruck *et al*., 2011). Medler (1964) reported that some *A. terminalis* even excavated their nests in the un-drilled fully pithy ends of the stem traps. We did observe some, though not much, bee-engineered change in the diameter of our pre-existing tunnel. The fact that *A. terminalis* has been recorded in trap nests twice suggests some adaptability in nest substrate use, a characteristic not often enough considered when discussing bee nesting.

Review of the available information and our new record suggests that *A. terminalis* may not be well-represented in surveys using solid wood nesting blocks or hard-sided tubes, which are commonly used for "wood-nesting" bees. We only obtained one nest of *A. terminalis*, despite having over 380 nest blocks deployed over three years across the state. This does not seem necessarily due to rarity, as the species is distributed across 24 counties in Minnesota in the University of Minnesota insect collection (as of September 2019). Development of variations in "nest trap" designs (*e.g.*, Sheffield *et al*., 2015) and rearing methods (*e.g.*, Graham *et al*., 2015; Leonard & Harmon-Threatt, 2019) may lead to alternate nest trapping methods for bees with atypical nesting substrate use, such as *A. terminalis*.

ACKNOWLEDGEMENTS

We thank the Belwin Conservancy and volunteer Loralee Bergmark for participating in the Minnesota Bee Atlas and hosting block #124. Thank you to Sam Droege for bee identification verification. Many thanks to Thea Evans for her hard work on the project and photography skills, and to the Minnesota Bee Atlas principal investigator Rob Blair and project manager Britt Forsberg. Victor Gonzalez and two anonymous reviewers are thanked for their improvements. Funding for the Minnesota Bee Atlas project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) (Legal Citation M.L. 2015, Chp. 76, Sec. 2, Subd. 03g). The Trust Fund is a permanent fund constitutionally established by the citizens of Minnesota to assist in the protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources.

REFERENCES

Ascher, J.S., & J. Pickering. 2019. DiscoverLife bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila) – online edition. [https://www.discoverlife.org/mp/20q?guide=Apoidea_species; last accessed December 2019].

Brooks, R.W. 1988. Systematics and phylogeny of the Anthophorine bees (Hymenoptera: Anthophoridae; Anthophorini). *University of Kansas Science Bulletin* 53(9): 436–575.

Cockerell, W.P. 1903. The nesting of a carpenter bee (*Clisodon terminalis*). *Birds and Nature in Natural Colors* 14: 127–128.

Graham, J.R., E. Willcox, & J.D. Ellis. 2015. The potential management of a ground-nesting, solitary bee: *Anthophora abrupta* (Hymenoptera: Apidae). *Florida Entomologist* 98(2): 528–536.

Leonard, R.J., & A.N. Harmon-Threatt. 2019. Methods for rearing ground-nesting bees under laboratory conditions. *Apidologie* 50(5): 689–703.

MacIvor, J.S., & L. Packer. 2015. 'Bee hotels' as a tool for native pollinator conservation: A premature verdict? *PLoS ONE* 10(3): e0122126.

Medler, J.T. 1964. *Anthophora* (*Clisodon*) *terminalis* Cresson in trap-nests in Wisconsin (Hymenoptera: Anthophoridae). *Canadian Entomologist* 96(10): 1332–1336.

Michener, C.D. 2007. *The Bees of the World* [2nd Edition]. Johns Hopkins University Press; Baltimore, MD; xvi+[i]+953 pp., +20pls.

Orr, M.C., T. Griswold, J.P. Pitts, & F.D. Parker. 2016. A new bee species that excavates sandstone nests. *Current Biology* 26(17): R792–R793.

Rehan, S.M., & M.H. Richards. 2010. Nesting biology and subsociality in *Ceratina calcarata* (Hymenoptera: Apidae). *Canadian Entomologist* 142(1): 65–74.

Sladen, F.W.L. 1919. Notes on the Canadian representatives of British species of bees. *Canadian Entomologist* 51(6): 124–130.

Sheffield, C.S., M.A. Wilkes, G.C. Cutler, & L. Hermanutz. 2015. An artificial nesting substrate for *Osmia* species that nest under stones, with focus on *Osmia inermis* (Hymenoptera: Megachilidae). *Insect Conservation and Diversity* 8: 189–192.

Stephen, W.P., G.E. Bohart, & P.F. Torchio. 1969. *The Biology and External Morphology of Bees; with a Synopsis of the Genera of Northwestern America*. Agricultural Experiment Station, Oregon State University; Corvallis, OR; 140 pp.

Torchio, P.F. 1971. The biology of *Anthophora* (*Micranthophora*) *peritomae* Cockerell (Hymenoptera: Apoidea, Anthophoridae). *Contributions in Science, Los Angeles County Museum* 206: 1–13.

Vickruck, J.L., S.M. Rehan, S.C. Sheffield, & M.H. Richards. 2011. Nesting biology and DNA barcode analysis of *Ceratina dupla* and *C. mikmaqi*, and comparisons with *C. calcarata* (Hymenoptera: Apidae: Xylocopinae). *Canadian Entomologist* 143(3): 254–262.

Journal of Melittology

A Journal of Bee Biology, Ecology, Evolution, & Systematics

The *Journal of Melittology* is an international, open access journal that seeks to rapidly disseminate the results of research conducted on bees (Apoidea: Anthophila) in their broadest sense. Our mission is to promote the understanding and conservation of wild and managed bees and to facilitate communication and collaboration among researchers and the public worldwide. The *Journal* covers all aspects of bee research including but not limited to: anatomy, behavioral ecology, biodiversity, biogeography, chemical ecology, comparative morphology, conservation, cultural aspects, cytogenetics, ecology, ethnobiology, history, identification (keys), invasion ecology, management, melittopalynology, molecular ecology, neurobiology, occurrence data, paleontology, parasitism, phenology, phylogeny, physiology, pollination biology, sociobiology, systematics, and taxonomy.

The *Journal of Melittology* was established at the University of Kansas through the efforts of Michael S. Engel, Victor H. Gonzalez, Ismael A. Hinojosa-Díaz, and Charles D. Michener in 2013 and each article is published as its own number, with issues appearing online as soon as they are ready. Papers are composed using Microsoft Word® and Adobe InDesign® in Lawrence, Kansas, USA.

Journal of Melittology is registered in ZooBank (www.zoobank.org), and archived at the University of Kansas and in Portico (www.portico.org).

http://journals.ku.edu/melittology
ISSN 2325-4467