Zootaxa 5683 (1): 001–051
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5683.1.1
http://zoobank.org/urn:lsid:zoobank.org:pub:73980A59-8CA6-4AA2-8DAD-FB9403203A5B

A faunal treatment of the *Megachile* (Hymenoptera: Megachilidae) of Montana with a key for their identification

ZOE A. PRITCHARD[1], MICHAEL A. IVIE[2], KEVIN M. O'NEILL[3] & CASEY M. DELPHIA[1,*]

[1]*Montana Entomology Collection, Montana State University, Marsh Labs, Room 50, 1911 West Lincoln St., Bozeman, MT 59717*
zoepritchard12@gmail.com; https://orcid.org/0000-0002-0622-2486
[2]*Montana Entomology Collection, Montana State University, Marsh Labs, Room 50, 1911 West Lincoln St., Bozeman, MT 59717*
mivie@montana.edu; https://orcid.org/0000-0003-0996-2946
[3]*Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717*
koneill@montana.edu; https://orcid.org/0000-0001-8943-0282
[*]*Corresponding author: casey.delphia@montana.edu; https://orcid.org/0000-0003-0037-2210*

Abstract

We provide the first statewide inventory of the species of *Megachile* in Montana from 5,406 records, based on collecting efforts in 2019–2021 and physical specimen data from publications, natural history museums, private collections, and online data aggregators. We documented 35 species within the state, six of which are new state records: *Megachile casadae* Cockerell, *Megachile centuncularis* (Linnaeus), *Megachile gentilis* Cresson, *Megachile mellitarsis* Cresson, *Megachile mendica* Cresson, and *Megachile snowi* Mitchell. These were predicted to occur in Montana based on existing range data but had not been previously sampled due to limited prior collecting. We also confirmed *Megachile dakotensis* Mitchell and *Megachile nevadensis* Cresson to occur in eastern Montana, which had not been recorded in the state for 85 and 84 years respectively, most likely from a lack of collecting in their ranges. Based on published distributional data, we identified eight native species that might be found in the state with further collecting, as well as two introduced species that could reach Montana in the future. This work adds important *Megachile* species range data in North America, articulates several taxonomic challenges within the group, and will aid future identifications of Montana *Megachile* through a taxonomic key provided here.

Key words: museum, pollinator, wild bees, leafcutting bees, resin bees, natural history collection

Introduction

Megachile Latrielle *s. l.* (Hymenoptera: Megachilidae) (*sensu* Michener 2000, 2007) is a large and diverse bee genus occurring world-wide, except Antarctica (Michener 2007). The divisions of this group into subgenera and even genera is an on-going debate with no consensus (Raw 2002; Gonzalez 2008; Bzdyk 2012; Trunz *et al*. 2016; Praz 2017; Gonzalez *et al*. 2019, Burrows *et al*. 2021). Treatments based on regional faunae differ in number and membership of subgenera versus those based on wider coverage, but no comprehensive world-wide system is universally accepted. Here, we will simply follow the classification system used by Sheffield *et al*. (2011) and, for species not covered in that work, Raw (2002). Diagnostic characters of the genus *Megachile* include two submarginal cells in the forewing, stigma over twice as long as broad, a lack of an arolium between the tarsal claws, female with an abdominal scopa, female mandible with 3–5 teeth, and male tergite 6 with a preapical carina (Michener 2007; Burrows *et al*. 2021). Species of *Megachile* are found in a diversity of landscapes and habitats and they exhibit a wide range of floral preferences, behaviors, and morphological traits (Michener 2007; Gonzalez 2008). Sheffield *et al*. (2011) summarized what is known about nesting biology and floral use by many of the species of *Megachile* found in Montana, but there are several species for which little is known about their life history.

In addition to their fundamental contribution to biodiversity, bees in the genus *Megachile* are of particular agricultural interest. The best-studied species, *Megachile rotundata* (Fabricius), is an Old-World native, introduced and managed widely in western North America for alfalfa (*Medicago sativa* L.; Fabaceae) seed production (e.g., Gerber & Akre 1969; Pitts-Singer & Cane 2011). It is the second most economically important managed field crop

Accepted by T.J. Wood: 20 Jun. 2025; published: 19 Aug. 2025

pollinator behind the honey bee, *Apis mellifera* L. (Pitts-Singer & Cane 2011); there are also feral populations of *M. rotundata* across North America including Montana (O'Neill *et al*. 2010). Wild species of *Megachile* may also be of conservation interest, as one study showed that over 120 years, bees in the family Megachilidae declined at a higher rate than those of other families within a community, potentially because of habitat alteration impeding nesting (Burkle *et al*. 2013).

Although work from the 1920s to recent years (Mitchell 1924, 1926a, 1927a, 1927b, 1934, 1935a, 1935b, 1936, 1937a, 1937b, 1937c, 1937d, 1943, 1956; Ivanochko 1979; Raw 2002; Gonzalez & Griswold 2007; Bzdyk 2012; Trunz *et al*. 2016; Praz 2017; Gonzalez *et al*. 2019) has contributed revisions, keys, and records of *Megachile*, Montana remains an especially large data gap in our understanding of the distribution of this group, as it has been for other bee taxa (Dolan *et al*. 2017). Montana supports a diversity of landscapes and habitat types with relatively little urbanization, and it is a location where eastern and western species pairs are sympatric (Dolan *et al*. 2017). Thus, it is an area of interest relevant to testing morphological distinctions—namely identifications made by geography—and examining taxonomic and biodiversity questions related to species status and hybrid zones.

Published literature prior to this research includes 29 species of *Megachile* recorded from Montana since the first specimen, collected in 1899. The goals of our study were to 1) compile and, when possible, verify previous literature records, data records, and museum specimens of Montana *Megachile*, 2) sample *Megachile* in understudied regions of Montana, 3) publish county-level distributions of *Megachile* species occurring in Montana, 4) create a taxonomic key to aid identification of Montana *Megachile*, and 5) provide a dataset of Montana *Megachile*. This study contributes to the overarching goals of the Wild Bees of Montana Project to provide baseline data on the state's bee faunas and their distributions, and taxonomic tools for the user community.

Material and Methods

Megachile Inventory

We compiled a dataset of all known Montana *Megachile* records and specimens from museum collections, laboratories, individuals, literature, and online data aggregators. The foundation for the study were the historic collections in the Montana Entomology Collection (MTEC) at Montana State University, Bozeman. In addition, we requested loans from collections that had online records of Montana *Megachile* and sent out a general request for Montana *Megachile* specimens to entomological museum collection managers (Supp. Table S1).

We incorporated literature records with unique specimen identifiers into the dataset, and these determinations were trusted without examination of the specimens (Kuhlman & Burrows 2017; Reese *et al*. 2018; Delphia *et al*. 2019a; LaManna *et al*. 2020), except in cases of concern (see Results: Taxonomic Challenges). When a publication mentioned occurrence of a *Megachile* species not linked to individual specimen data (e.g., MONTANA: 1♂, 1♀) (Mitchell 1934, 1935a, 1935b, 1936, 1937a, 1937b, 1937c, 1942, 1944; Butler 1965; Gerber & Akre 1969; Hurd 1979; O'Neill & Seibert 1996; O'Neill & O'Neill 2003; O'Neill *et al*. 2004; O'Neill *et al*. 2010; O'Neill & O'Neill 2011; O'Neill *et al*. 2011; Delphia & O'Neill 2012; O'Neill *et al*. 2014; O'Neill *et al*. 2015; Donahoo *et al*. 2021), we added pertinent information (i.e., year of publication, county record) to first publication records and county records (Table 1; Fig. 1) but not the dataset or specimen counts. We did not consider thesis or gray literature records for first published records.

After checking for repetition among specimen data from loans, online data sources (Symbiota Collections of Arthropods Network [SCAN], Global Biodiversity Information Facility [GBIF], Discover Life, and Biodiversity Information Serving Our Nation [BISON]), and publication records, we incorporated into our dataset those Montana *Megachile* specimens from the online data aggregators SCAN and GBIF that met certain criteria (Supp. Table S2) (GBIF 2021; SCAN 2021). (Data in BISON and Discover Life were not incorporated because all records were repeated in other sources.) If a SCAN or GBIF record had a unique specimen identifier, was housed in a specimen repository, and we were not able to borrow the physical specimen, we considered the data for inclusion in our dataset using the following criteria. If the species listed was already known to occur within a particular Montana county, we included the record in our dataset. If the occurrence was a known Montana species but a new county record and there was an expert identifier listed with the specimen, we included the specimen in our dataset. We did not incorporate data from specimens representing new county records with unknown determiners that we were unable to examine.

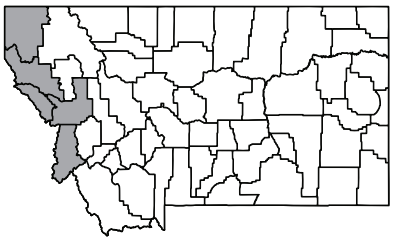

Figure 1A. *Megachile* (*Chelostomoides*) *angelarum* in MT, 13 specimens in 5 counties.

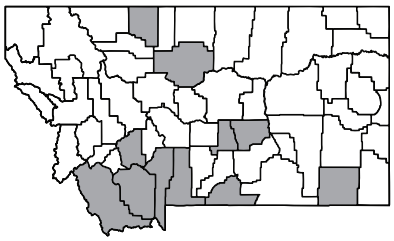

Figure 1B. *Megachile* (*Megachiloides*) *anograe* in MT, 31 specimens in 11 counties.

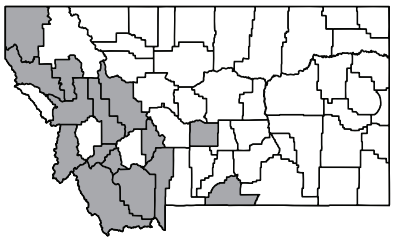

Figure 1C. *Megachile* (*Eutricharaea*) *apicalis* in MT, 317 specimens in 15 counties.

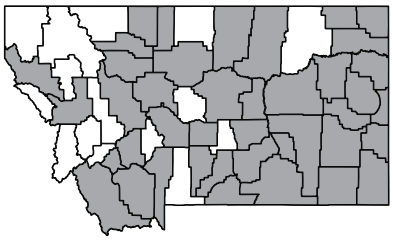

Figure 1D. *Megachile* (*Litomegachile*) *brevis* in MT, 533 specimens in 41 counties.

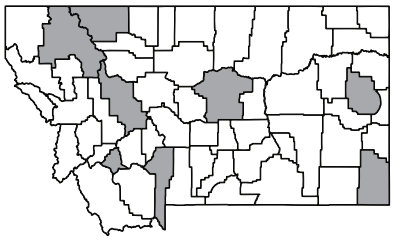

Figure 1E. *Megachile* (*Chelostomoides*) *campanulae* in MT, 33 specimens in 8 counties.

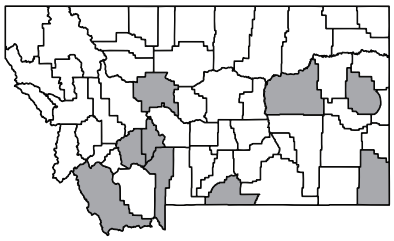

Figure 1F. *Megachile* (*Megachiloides*) *casadae* in MT, 13 specimens in 9 counties.

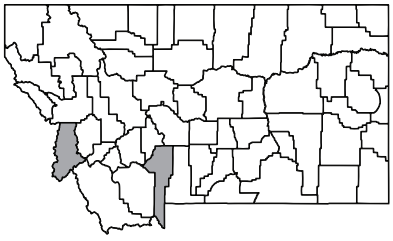

Figure 1G. *Megachile* (*Megachile*) *centuncularis* in MT, 6 specimens in 2 counties.

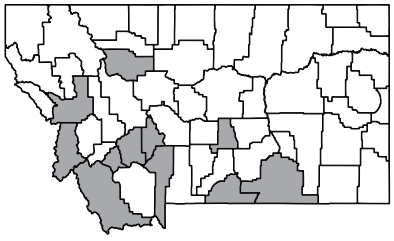

Figure 1H. *Megachile* (*Litomegachile*) *coquilletti* in MT, 119 specimens in 11 counties.

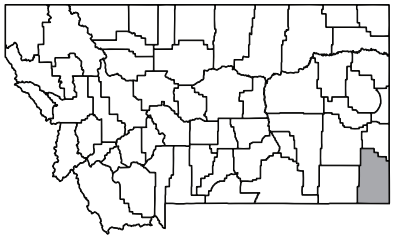

Figure 1I. *Megachile* (*Megachiloides*) *dakotensis* in MT, 2 specimens in 1 county.

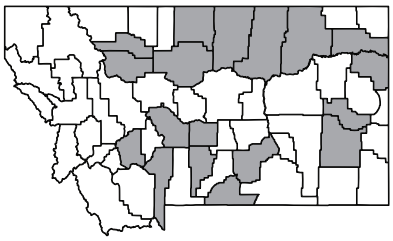

Figure 1J. *Megachile* (*Xanthosarus*) *dentitarsus* in MT, 115 specimens in 18 counties.

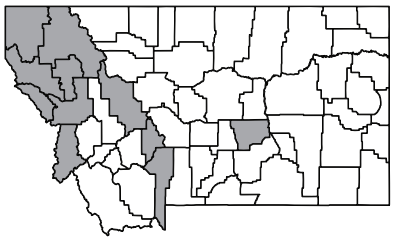

Figure 1K. *Megachile* (*Sayapis*) *fidelis* in MT, 46 specimens in 11 counties.

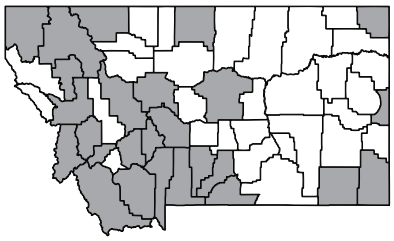

Figure 1L. *Megachile* (*Xanthosarus*) *frigida* in MT, 276 specimens in 26 counties.

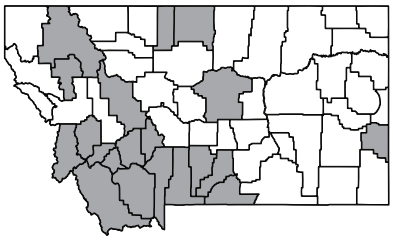

Figure 1M. *Megachile* (*Xanthosarus*) *gemula* in MT, 63 specimens in 20 counties.

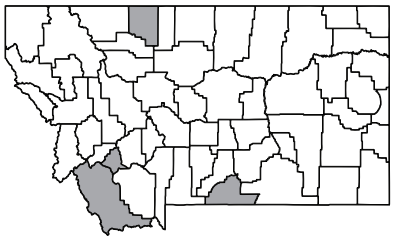

Figure 1N. *Megachile* (*Litomegachile*) *gentilis* in MT, 7 specimens in 4 counties.

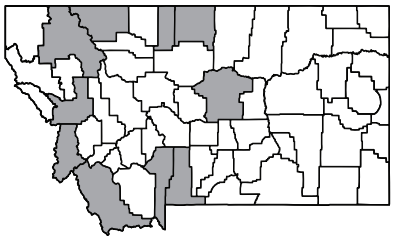

Figure 1O. *Megachile* (*Megachile*) *inermis* in MT, 42 specimens in 10 counties.

FIGURE 1. County-level distribution of each *Megachile* species in Montana. Females identified as *Megachile latimanus*/*Megachile perihirta* (and data without recorded specimen sexes) are counted here as *M. perihirta* as they are not distinguishable from one another in Montana. Males identified as *Megachile lapponica*/*Megachile relativa* (and data without recorded specimen sexes) are counted here as *M. relativa* as they are not distinguishable from one another in Montana. Mitchell county records are included on maps but not in specimen counts. Two specimens did not have county-level localities and are not included in maps but are included in specimen counts.

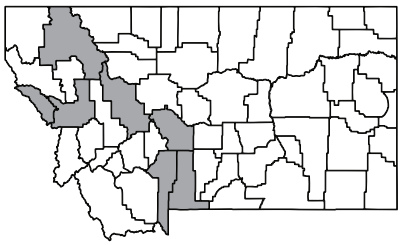

Figure 1P. *Megachile* (*Megachile*) *lapponica* in MT, 67 specimens in 7 counties.

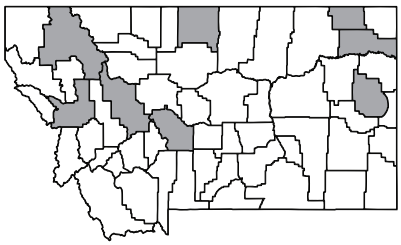

Figure 1Q. *Megachile* (*Xanthosarus*) *latimanus* in MT, 8 specimens in 8 counties.

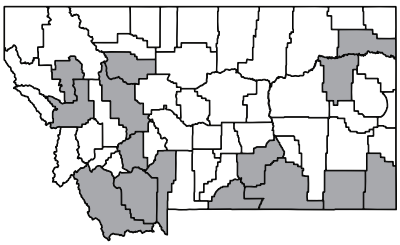

Figure 1R. *Megachile* (*Litomegachile*) *lippiae* in MT, 39 specimens in 15 counties.

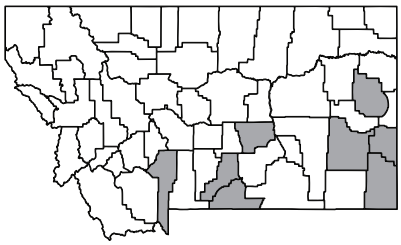

Figure 1S. *Megachile* (*Megachiloides*) *manifesta* in MT, 9 specimens in 8 counties.

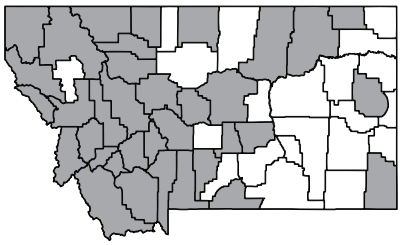

Figure 1T. *Megachile* (*Xanthosarus*) *melanophaea* in MT, 411 specimens in 35 counties.

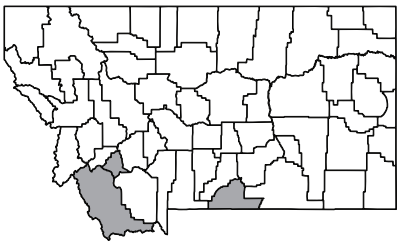

Figure 1U. *Megachile* (*Sayapis*) *mellitarsis* in MT, 3 specimens in 3 counties.

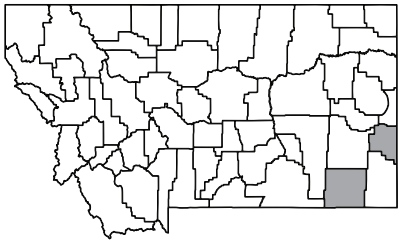

Figure 1V. *Megachile* (*Litomegachile*) *mendica* in MT, 2 specimens in 2 counties.

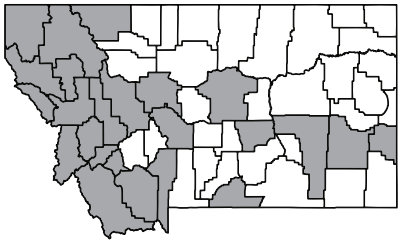

Figure 1W. *Megachile* (*Megachile*) *montivaga* in MT, 135 specimens in 24 counties.

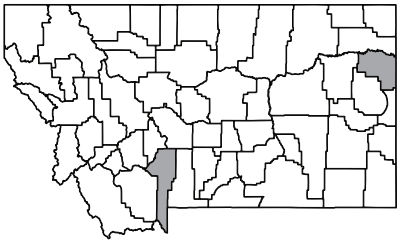

Figure 1X. *Megachile* (*Megachiloides*) *nevadensis* in MT, 1 specimen in 1 county, literature record in 1 county.

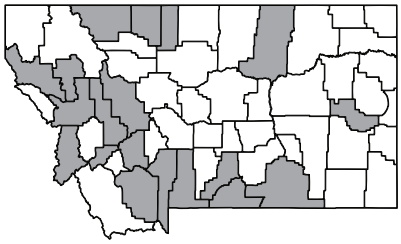

Figure 1Y. *Megachile* (*Litomegachile*) *onobrychidis* in MT, 389 specimens in 19 counties.

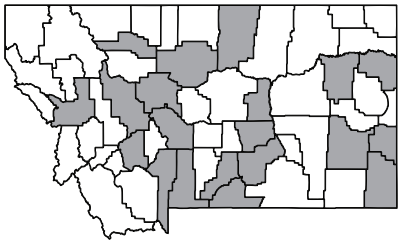

Figure 1Z. *Megachile* (*Argyropile*) *parallela* in MT, 122 specimens in 20 counties.

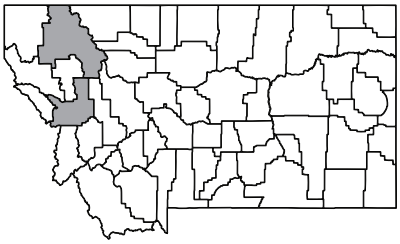

Figure 1AA. *Megachile* (*Megachiloides*) *pascoensis* in MT, 2 specimens in 2 counties.

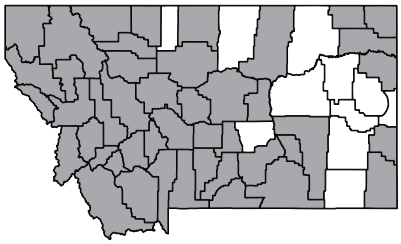

Figure 1AB. *Megachile* (*Xanthosarus*) *perihirta* in MT, 1192 specimens in 45 counties.

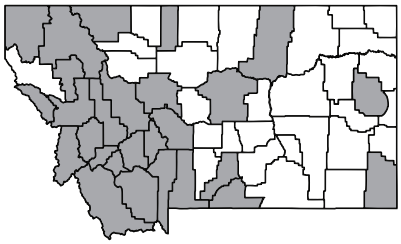

Figure 1AC. *Megachile* (*Sayapis*) *pugnata* in MT, 251 specimens in 27 counties.

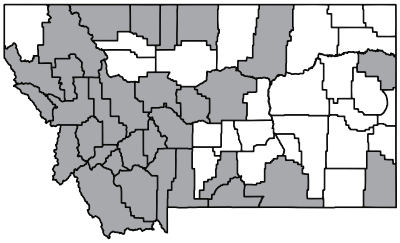

Figure 1AD. *Megachile* (*Megachile*) *relativa* in MT, 614 specimens in 31 counties.

FIGURE 1. (Continued).

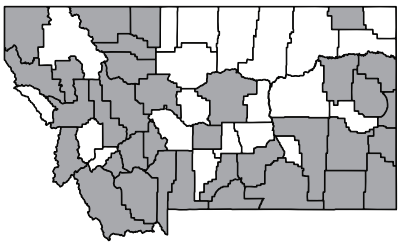

Figure 1AE. *Megachile* (*Eutricharaea*) *rotundata* in MT, 407 specimens in 35 counties.

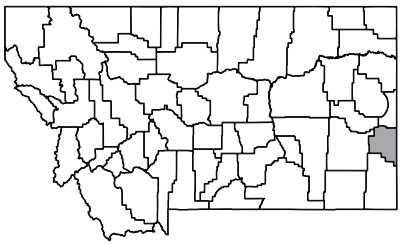

Figure 1AF. *Megachile* (*Litomegachile*) *snowi* in MT, 1 specimen in 1 county.

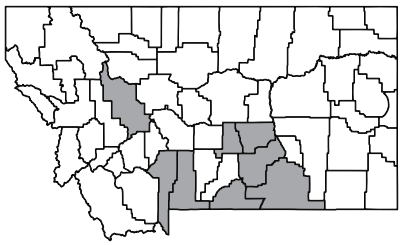

Figure 1AG. *Megachile* (*Megachiloides*) *subnigra* in MT, 18 specimens in 8 counties.

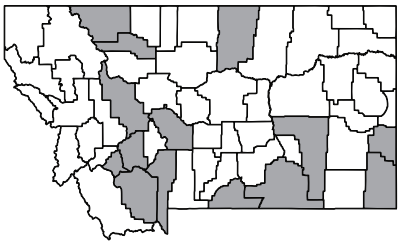

Figure 1AH. *Megachile* (*Litomegachile*) *texana* in MT, 32 specimens in 14 counties.

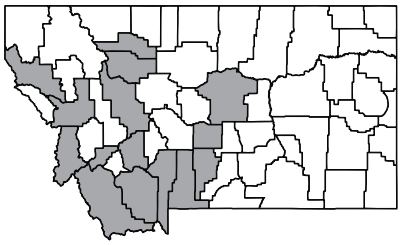

Figure 1AI. *Megachile* (*Megachiloides*) *wheeleri* in MT, 68 specimens in 15 counties.

FIGURE 1. (Continued).

TABLE 1. *Megachile* species, earliest date of record, first published record, county records, and number of specimens recorded from Montana. Recorded counts of specimens include a count of one for each county record of a species by Mitchell. "Earliest recorded specimen" refers to the earliest date of collection for a specimen in our dataset with a unique identifying code.

Species (Alphabetical order)	Earliest Recorded Specimen (Year)	First Published Record for Montana	Total (N) County Records	Total (N) Montana Specimens[1]
Megachile (*Chelostomoides*) *angelarum* Cockerell, 1902	2015	Kuhlman and Burrows (2017)	5	13
Megachile (*Megachiloides*) *anograe* Cockerell, 1908	1916	Mitchell (1936)	11	31
Megachile (*Eutricharaea*) *apicalis* Spinola, 1808	2013	Kuhlman and Burrows (2017)	15	317
Megachile (*Litomegachile*) *brevis* Say, 1837	1949	Mitchell (1935a)	41	533
Megachile (*Chelostomoides*) *campanulae* (Robertson, 1903)	1990	Reese *et al*. (2018)	8	33
Megachile (*Megachiloides*) *casadae* Cockerell, 1898	1964	**New state record**	9	13
Megachile (*Megachile*) *centuncularis* (Linnaeus, 1758)	1940	**New state record**	2	6
Megachile (*Litomegachile*) *coquilletti* Cockerell, 1915	1902	Kuhlman and Burrows (2017)	11	119
Megachile (*Megachiloides*) *dakotensis* Mitchell, 1926b	2020	Mitchell (1937a)	1	2
Megachile (*Xanthosarus*) *dentitarsus* Sladen, 1919	1914	Mitchell (1936)	18	115
Megachile (*Sayapis*) *fidelis* Cresson, 1878	1917	Mitchell (1937c)	11	46
Megachile (*Xanthosarus*) *frigida* Smith, 1853	1904	Reese *et al*. (2018)	26	276
Megachile (*Xanthosarus*) *gemula* Cresson, 1878	1904	Mitchell (1935b)	20	63
Megachile (*Litomegachile*) *gentilis* Cresson, 1872	1936	**New state record**	4	7
Megachile (*Megachile*) *inermis* Provancher, 1888	1920	Mitchell (1935b)	10	42
Megachile (*Megachile*) *lapponica* Thomson, 1872[3]	1931	Mitchell (1942)	7	67

.....continued on the next page

TABLE 1. (Continued)

Species (Alphabetical order)	Earliest Recorded Specimen (Year)	First Published Record for Montana	Total (N) County Records	Total (N) Montana Specimens[1]
Megachile (*Xanthosarus*) *latimanus* Say, 1823[2]	1946	Mitchell (1935b)	8	8
Megachile (*Litomegachile*) *lippiae* Cockerell, 1900	1964	Mitchell (1935a)	15	39
Megachile (*Megachiloides*) *manifesta* Cresson, 1878	1917	Mitchell (1937a)	8	9
Megachile (*Xanthosarus*) *melanophaea* Smith, 1853	1902	Mitchell (1935b)	35	411
Megachile (*Sayapis*) *mellitarsis* Cresson, 1878	2018	**New state record**	3	3
Megachile (*Litomegachile*) *mendica* Cresson, 1878	2015	**New state record**	2	2
Megachile (*Megachile*) *montivaga* Cresson, 1878	1931	Mitchell (1935b)	24	135
Megachile (*Megachiloides*) *nevadensis* Cresson, 1879	2021	Mitchell (1937a)	2[4]	1[4]
Megachile (*Litomegachile*) *onobrychidis* Cockerell, 1908	1931	Kuhlman and Burrows (2017)	19	389
Megachile (*Argyropile*) *parallela* Smith, 1853	1913	Mitchell (1937b)	20	122
Megachile (*Megachiloides*) *pascoensis* Mitchell, 1934	2015	Mitchell (1934)	2	2
Megachile (*Xanthosarus*) *perihirta* Cockerell, 1898[2]	1899	Mitchell (1936)	45	1192
Megachile (*Sayapis*) *pugnata* Say, 1837	1904	Mitchell (1937c)	27	251
Megachile (*Megachile*) *relativa* Cresson, 1878[3]	1904	Mitchell (1935b)	31	614
Megachile (*Eutricharaea*) *rotundata* (Fabricius, 1787)	1963	Gerber and Akre (1969)	35	407
Megachile (*Litomegachile*) *snowi* Mitchell, 1927	2019	**New state record**	1	1
Megachile (*Megachiloides*) *subnigra* Cresson, 1879	2012	Mitchell (1937a)	8	18
Megachile (*Litomegachile*) *texana* Cresson, 1878	1926	Mitchell (1935a)	14	32
Megachile (*Megachiloides*) *wheeleri* Mitchell, 1927	1904	Mitchell (1937a)	15	68

[1] Mitchell county records are added to the total county records if unique from specimen data, but not included in counts of total Montana specimens.

[2] Female specimens identified as *Megachile latimanus*/*Megachile perihirta* are counted as *M. perihirta* because males of *M. perihirta* were more abundant than *M. latimanus*.

[3] Male specimens identified as *Megachile lapponica*/*M. relativa* are counted as *M. relativa* because females of *M. relativa* were more abundant than *M. lapponica*.

[4] One specimen in one county plus one literature record in one county.

To establish the earliest published record of a species from Montana, we started with Hurd (1979), and for each Montana record we traced it back to the first record for each synonym listed. We then traced that first species record forward to establish its modern name and locate any additional Montana records. For more recent first published records, we examined known taxonomic, biological, and ecological literature, and conducted searches of Zoological Record, Biodiversity Heritage Library, Google Scholar, and Web of Science.

Repositories of Montana *Megachile* specimens examined are in Supplementary Table S1, and sources of Montana *Megachile* data records used are in Supplementary Table S2, including laboratories, institutions, curators, and individuals that contributed specimens and data. Some of these institutions also contributed reference specimens for comparison of species. Additionally, we borrowed reference specimens for comparison of species from the Museum of Comparative Zoology (MCZC, Harvard University, Cambridge, Massachusetts [Crystal A. Maier]).

Field Collection of Montana *Megachile*

In 2019, 2020, and 2021, we prioritized collecting in eastern Montana counties lacking prior *Megachile* records, and regions likely to hold potential new state records. We predicted new state records for *Megachile* species based on

trusted records very near the Montana border, from two "sides" of Montana (e.g., Saskatchewan and Wyoming or Idaho and South Dakota) or from adjacent habitats outside of the state that are contiguous with Montana landscapes, such as prairie potholes and shortgrass prairies. Predictions of potential new Montana records led us to target collecting near Baker, Caldera, Bridger, and Medicine Rocks State Park in the summers of 2019 and 2020. In 2021, we conducted additional general collecting in Beaverhead, Silver Bow, Madison, and other counties.

We collected bees from May through September in 2019–2020 using several collecting methods: pan traps (i.e., "bee bowls", "bowl traps"), netting, trap nests, bee buckets, Lindgren funnels, crossvane-panel traps, and vane traps, with an emphasis on pan traps and netting (Supp. Table S3). At pan-trap sites we placed a series of 15 colored (7 yellow, 6 blue, and 2 white), 20 oz. ice-cream bowls filled 75% with soapy water (modified from Droege 2015) at ground level for approximately 24 hours. We then retrieved the samples and stored them in 70% EtOH until being brought to the lab for processing (see Specimen Processing). Pan trapping kits were also sent to one-room schoolhouses in remote rural areas with a lesson plan on sampling bees, adding samples from areas identified as having low prior sampling. In the spring we placed trap nests [bundles of cardboard tubes of various inner diameters within which solitary bees will create nests (Staab *et al*. 2018)] at various locations approximately 2 m from the ground with their openings facing southeast and retrieved them in the fall or following spring. Cardboard tubes collected in the fall that appeared to have nesting activity were put in plastic containers with screen lids and placed in cold storage (6°C) to induce winter diapause, after which they were removed in spring and brought to room temperature to initiate bee emergence (O'Neill & O'Neill 2010). In 2021, we sampled by hand netting in June and July. Lastly, we processed and incorporated into the dataset bycatch from the statewide Montana Pest Survey Program's bucket traps (Brambila *et al*. 2021), Lindgren funnels (Lindgren 1983; Gustafson 1996), and crossvane-panel traps (Czokajlo *et al*. 2001), as well as bycatch from Glacier National Park (Ivie *et al*. 1998) caught in pitfall, flight intercept, and Lindgren funnel traps from 1989 to 1993.

Specimen Processing

Bees netted in the field were pinned the same day. Alcohol-preserved bees from pan traps, Lindgren funnels, crossvane-panel traps, pitfall traps, malaise traps, and vane traps were washed and blow-dried following Droege (2015) before pinning or point mounting. We labeled mounted specimens with locality information and unique specimen identifier labels (barcodes). We recorded these data in an Excel spreadsheet (see Data Entry and Analysis) and archived the specimens in the MTEC.

Species Identification

We identified *Megachile* specimens using the most current taxonomic keys available (Mitchell 1934, 1935a, 1935b, 1936, 1937a, 1937b, 1937c, 1937d, 1962, 1980; Sheffield *et al*. 2011; Bzdyk 2012; Sheffield 2020) and with comparison to reference specimens including those species identified as new state records. Terry Griswold (USDA-ARS Pollinating Insects Research Unit, Logan, Utah) verified species identifications of all material collected before 2020. We follow the classification of Sheffield *et al*. (2011) and, for species not in that work, we follow Raw (2002).

Nomenclatural Records

Abbreviated synonymical tables were created for all *Megachile* species recorded from Montana. Citations are limited to only those that include Montana records or are critical to understanding the names used here (e.g., cases of misidentifications published under older names). For more complete synonymies, see Hurd (1979), Raw (2002), Michener (2007), Sheffield *et al*. (2011 and references therein), Bzdyk (2012), and Gonzalez *et al*. (2019).

Many references are made to Sheffield *et al*. (2011) throughout our paper. That paper brings together much useful information of potential interest to the reader, but repeats the work of others without citation, as acknowledged and corrected by Sheffield (2020). Any citation of Sheffield *et al*. (2011) here is intended to include reference to the

origins of the material in that paper as corrected by Sheffield (2020), but for simplicity and ease of reading, we will not repeat a long list of such references with each use.

Data Entry and Analysis

We entered Darwin-compliant data for each specimen according to the xBio:D format (https://xbiod.osu.edu/). For specimens and records lacking georeferencing data, we used Google Earth® (http://earth.google.com) to approximate localities and entered them in the dataset as "polygons." Locality information from previously databased records was checked and corrected as needed using Google Earth®.

We included published specimen data for specimens we did not examine in our dataset from Kuhlman & Burrows (2017), Reese *et al*. (2018), Delphia *et al*. (2019a), and LaManna *et al*. (2020). If no exact collection date was available, we used the last year of collecting recorded in the publication. As some first records in Reese *et al*. (2018) were repeated in LaManna *et al*. (2020) and also on SCAN, we used the data from SCAN in our dataset because they included the most comprehensive information (e.g., specific localities, collection dates).

Literature records from Mitchell's works not represented by examined specimens, and therefore without unique specimen identifiers, were not used in the analysis of specimen numbers. When Mitchell literature provided earliest county records, we included them in the county record count and county-level distribution maps. In the absence of specimen data, we used the year corresponding to the publication for earliest county records. If no exact collection date was available, we used the last year of collecting recorded in the publication as the earliest recorded specimen year.

Female specimens identified as *Megachile latimanus* Say/*Megachile perihirta* Cockerell or identifications without sex listed were treated in analyses as *M. perihirta*. Males identified as *Megachile lapponica* Thomson/*Megachile relativa* Cresson or identifications without sex listed were treated in analyses as *M. relativa*. See Results: Taxonomic Challenges below.

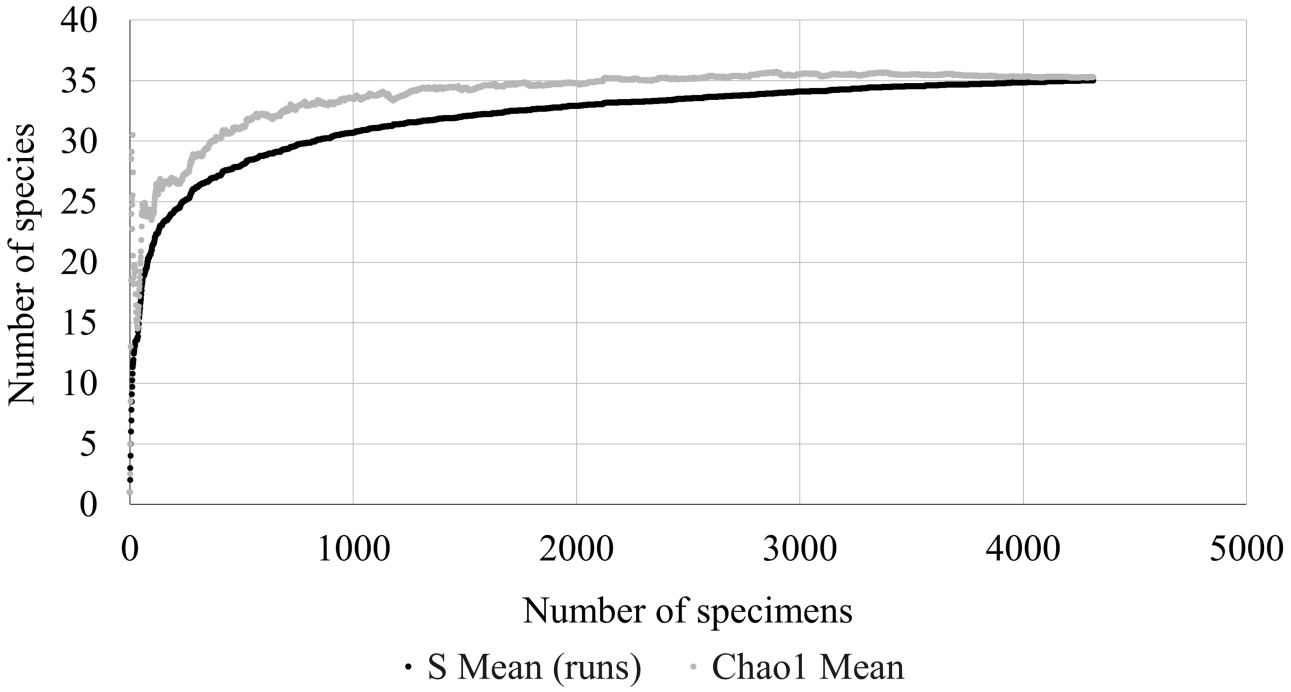

FIGURE 2. Montana *Megachile* species accumulation curve. The state of Montana was counted as a single sample and the data were randomized 100 times in EstimateS (Colwell 2013). Females identified as *Megachile latimanus*/*Megachile perihirta* (and data without recorded specimen sexes) are counted here as *M. perihirta*. Males identified as *Megachile lapponica*/*Megachile relativa* (and data without recorded specimen sexes) are counted here as *M. relativa*.

We generated a Chao1 species richness predictor (Chao 1984) from our dataset using EstimateS (Colwell 2013). We considered the combined state records as a single sample, ran the data as an "individual-based abundance sample" with specimen counts for each species, and randomized the sample 100 times. EstimateS generated a Chao1 mean species richness predictor and the species accumulation curve (Fig. 2).

County-level maps were created in Adobe Illustrator® using a vector graphic created with open source QGIS (QGIS Geographic Information System. Version 3.26.3. QGIS Association. http://www.qgis.org) and using maps from a free public database (www.naturalearthdata.com). The distribution map was also created using these same tools and edited using Adobe Photoshop®.

Key Creation

We wrote and illustrated taxonomic keys and accompanying notes based on the accumulated Montana *Megachile* specimens, reference material, and characters used in publications (Mitchell 1924, 1926a, 1926b, 1927a, 1927b, 1934, 1935a, 1935b, 1936, 1937a, 1937b, 1937c, 1937d, 1962; Ivanochko 1979; Sheffield *et al*. 2011; Bzdyk 2012; Sheffield 2020). Our keys build on these previous works, and we acknowledge them as the source of some of the terminology and wording used. We used entomological terms according to Torre-Bueno (1989). Variation of Montana specimens from published data is reflected in the wording of our key.

We created illustrations in Adobe Illustrator® (with an XP-PEN Deco 01-V2 tablet) based on photographs taken with a Canon 6D DLSR with an MP-E 65mm lens and an iPhone 11, illustrations from Bzdyk (2012), and photographs from Sheffield *et al*. (2011). Any images traced from Bzdyk (2012) or Sheffield *et al*. (2011) are labeled accordingly.

Results

We documented 35 species of *Megachile* in Montana, based on 5,406 specimens from all 56 counties (Fig. 1). This includes new state records for six species: *Megachile casadae* Cockerell, *Megachile centuncularis* (Linnaeus), *Megachile gentilis* Cresson, *Megachile mellitarsis* Cresson, *Megachile mendica* Cresson, and *Megachile snowi* Mitchell. These species would have been predicted to occur in Montana based on their known distributional records but had not been previously collected in the state. Based on our examination of distributional records, we identified additional species that may be found in the state with future sampling, mainly from records in the Wasatch, Great Plains, and northern Wyoming (see Discussion).

We included specimen data from publications, natural history collections, online aggregators based on vouchered specimens, and private collections (Table 2; Supp. Tables S1–2). Based on our qualifiers for use of digital data, we excluded two records from our dataset, as they were new county records with unknown determiners that we did not reexamine (SEMC469014, *Megachile parallela* Smith from Ravalli Co. and BBSL988318, *Megachile dentitarsus* Sladen from Cascade Co.).

All documented localities of Montana *Megachile* specimens are shown in Figure 3. As of 2021, the largest fraction of *Megachile* specimens has been collected in the two western counties of Gallatin and Missoula, together accounting for 2,092 specimens, or 39% of the total (Fig. 4B). In contrast, 8 (of 56) counties have 10 or less specimens of *Megachile*, and 44 have less than 100 (Fig. 4B). Gallatin, Missoula, Lewis and Clark, Beaverhead, Jefferson, and Ravalli Counties, all in the west, also have six of the seven highest counts of *Megachile* species documented ($\geq$ 16) as of 2021 (Fig. 5B). Records of *Megachile* collected from 1899–2014, before increased collecting by the Wild Bees of Montana Project, documented 2,476 specimens (Fig. 4A). Most specimens (2,930; 54%), almost half of the county records (221; 43%), and four of the six new state records were collected from 2015–2021, as part of the Wild Bees of Montana Project and other recent studies (Kuhlman & Burrows 2017; Reese *et al*. 2018; Delphia *et al*. 2019a; LaManna *et al*. 2020).

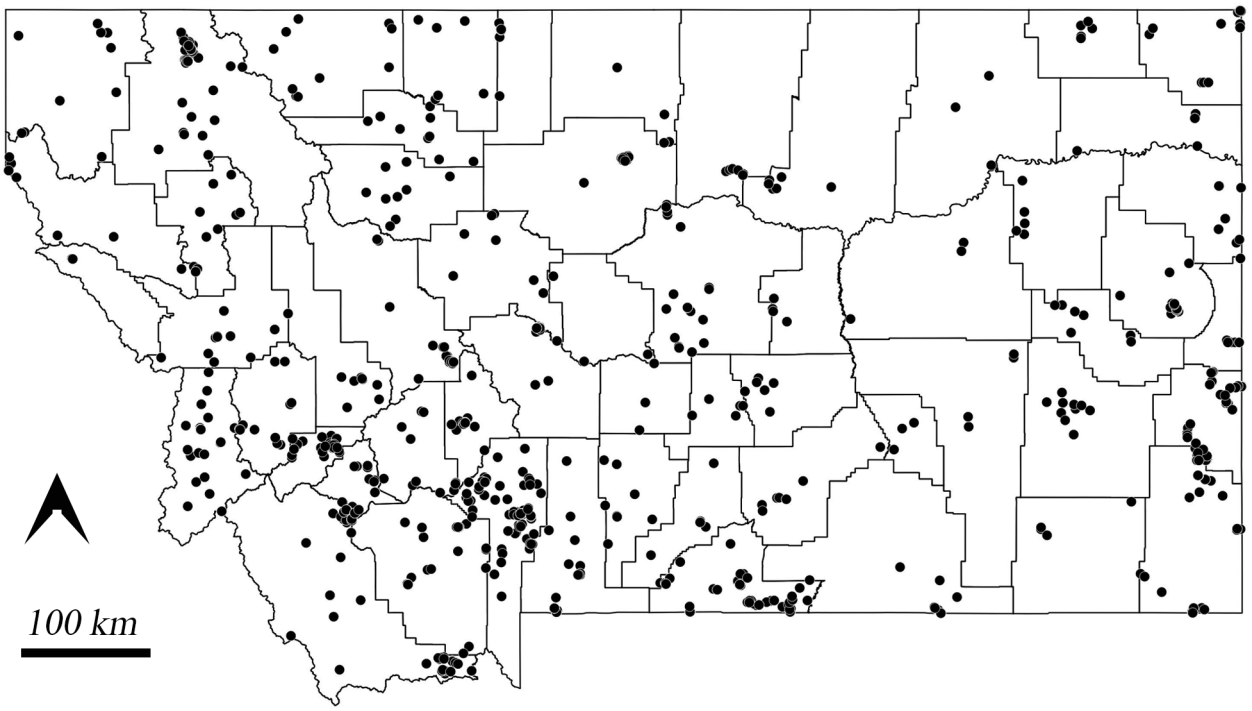

FIGURE 3. Dot map of all Montana *Megachile* localities. Mitchell literature records are not included in the map.

TABLE 2. Publications and theses recording Montana *Megachile* species. First published state records are indicated in bold text. Thesis records repeated in publications are not included.

Publication	Species Recorded from Montana
Mitchell, T. B. (1934)	***M. pascoensis***
Mitchell, T. B. (1935a)	***M. brevis*, *M. brevis* var. *nupta*, *M. texana*, *M. texana* var. *cleomis*, *M. texana* var. *lippiae***
Mitchell, T. B. (1935b)	***M. gemula*, *M. inermis*, *M. melanophaea*, *M. melanophaea wootoni*, *M. montivaga*, *M. relativa*, *M. vidua* (= *latimanus*)**
Mitchell, T. B. (1936)	***M. anograe*, *M. dentitarsus*, *M. perihirta***
Mitchell, T. B. (1937a)	***M. dakotensis*, *M. manifesta*, *M. nevadensis*, *M. subnigra*, *M. wheeleri***
Mitchell, T. B. (1937b)	***M. parallela***
Mitchell, T. B. (1937c)	***M. fidelis*, *M. pugnata***
Mitchell, T. B. (1942)	***M. nivalis* (= *lapponica*)**
Mitchell, T. B. (1944)	*M. anograe*
Butler, G. D. (1965)	*M. dentitarsus, M. fidelis, M. lippiae, M. manifesta*
Gerber and Akre (1969)	***M. rotundata***
Hurd (1979)	*M. anograe*, *M. dakotensis*, *M. dentitarsus*, *M. fidelis*, *M. manifesta*, *M. melanophaea wootoni, M. nevadensis*, *M. pascoensis*, *M. subnigra*
O'Neill and Seibert (1996)	*M. brevis*
Jensen *et al*. (2003)	*M. relativa*, *M. rotundata*
O'Neill and O'Neill (2003)	*M. rotundata*
O'Neill *et al*. (2004)	*M. rotundata*
Fultz 2005	*M. brevis*, *M. latimanus*, *M. melanophaea*, *M. perihirta*, *M. pugnata*, *M. relativa, M. vidua*[1]

.....continued on the next page

TABLE 2. (Continued)

Publication	Species Recorded from Montana
Sheffield and Westby (2007)	*M. lapponica* (= *nivalis*)
Pearce (2008)	*M. concinna*[2]
O'Neill *et al*. (2010)	*M. rotundata*
O'Neill and O'Neill (2011)	*M. rotundata*
O'Neill *et al*. (2011)	*M. rotundata*
Delphia and O'Neill (2012)	*M. rotundata*
Pearce *et al*. (2012)	*M. brevis, M. inimica*[3]*, M. lippiae, M. parallela, M. rotundata*
O'Neill *et al*. (2014)	*M. rotundata*
O'Neill *et al*. (2015)	*M. rotundata*
Kuhlman and Burrows (2017)	***M. angelarum***, ***M. apicalis***, *M. brevis*, ***M. coquilletti***, *M. lapponica*, *M. lippiae*, *M. melanophaea*, *M. montivaga*, ***M. onobrychidis***, *M. pascoensis*, *M. perihirta*, *M. pugnata*, *M. relativa*, *M. rotundata*
Reese *et al*. (2018)	*M. angelarum*[4], *M. apicalis*, *M. brevis*, ***M. campanulae***, ***M. frigida***, *M. gemula*, *M. lapponica*, *M. latimanus*, *M. melanophaea*, *M. montivaga*, *M. onobrychidis*, *M. parallela*, *M. perihirta*, *M. pugnata*, *M. relativa*, *M. rotundata*, *M. subnigra*, *M. texana*, *M. wheeleri*
Delphia *et al*. (2019a)	*M. angelarum*[5], *M. anograe*, *M. apicalis*, *M. brevis*, *M. campanulae*, *M. frigida*, *M. lapponica*, *M. latimanus*, *M. melanophaea*, *M. montivaga*, *M. parallela, M. perihirta*, *M. pugnata*, *M. relativa*, *M. rotundata*, *M. subnigra*
Delphia *et al*. (2019b)	*M. frigida*, *M. gemula*
Adhikari *et al*. (2019)	*M. anograe*, *M. brevis*, *M. circumcincta*[6], *M. dentitarsus*, *M. perihirta*
Burkle *et al*. (2020)	*M. angelarum*[4], *M. campanulae*, *M. melanophaea*
LaManna *et al*. (2020)	*M. angelarum*[4], *M. apicalis, M. brevis*, *M. campanulae*, *M. fidelis*, *M. frigida*, *M. gemula*, *M. lapponica*, *M. melanophaea*, *M. montivaga*, *M. onobrychidis*, *M. parallela*, *M. perihirta*, *M. pugnata*, *M. relativa*, *M. rotundata*, *M. wheeleri*
Donahoo *et al*. (2021)	*M. rotundata*

[1] Misidentification of *M. vidua*, this specimen, housed in the Montana Entomology Collection (MTEC 088592), was later identified as a male *M. frigida*.

[2] Misidentification of *M. concinna*, this specimen, housed in the Montana Entomology Collection (MTEC 088326), was later identified as a male *M. lippiae*.

[3] Misidentification of *M. inimica*, this specimen, housed in the Montana Entomology Collection (MTEC 057005) was later identified as a male *M. pugnata*.

[4] Misidentification of *M. angelarum*, these specimens, housed in the Burkle Community Ecology Lab at Montana State University (5718LR, 19730CHS, 68812LR, 64728LR, 1725CHS, 73A817LR), were later identified as female *M. campanulae*.

[5] Misidentification of *M. angelarum*, these specimens, housed in the O'Neill Research Collection (KMOC #1435, KMOC #1436, KMOC #1437), were later identified as female *M. campanulae*.

[6] Misidentification of *M. circumcincta*, this specimen, housed in the Montana Entomology Collection (MTEC 035028), was later identified as a male *M. perihirta*.

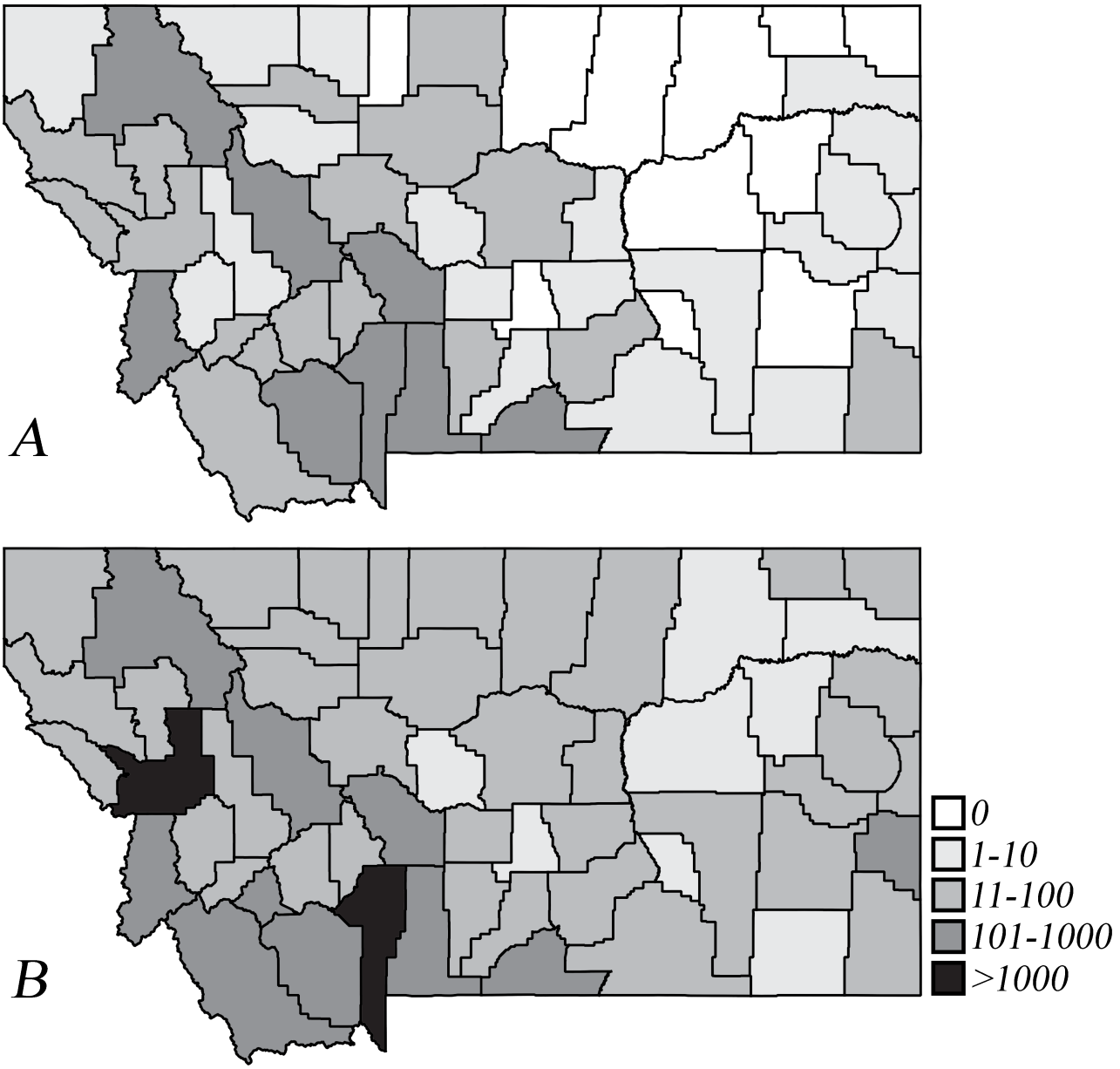

FIGURE 4. Number of *Megachile* specimens in each Montana county in 2014 (A) and 2021 (B).

From 2019–2021, targeted sampling as part of this study added the first *Megachile* specimen records to five Montana counties (Blaine, Custer, Daniels, Phillips, and Sheridan) and added a statewide total of 1,277 specimens (24% of the total, a 31% increase) and 147 county records (29% of the total 513 records, a 40% increase). The methods by which the most *Megachile* specimens were collected were pan traps (1,060), netting (846), and trap nests (432). All methods and their specimen counts are listed in Supplementary Table S3. Targeted collecting at Medicine Rocks State Park resulted in collection of two specimens of *Megachile dakotensis* Mitchell, which had not been recorded in the state for 85 years (Mitchell 1937a) but was predicted to occur in the area based on the known distribution of the species (see Discussion). Collecting in Richland County resulted in one specimen of *Megachile nevadensis* Cresson, which had not been recorded in the state for 84 years.

The Chao1 analysis predicts 35 species of *Megachile* to occur in Montana (Fig. 2) (mean = 35.25 [SD: ± 0.74; 95% CI: 35.01, 39.79]) (Supp. Material 1: Raw Data for Chao1).

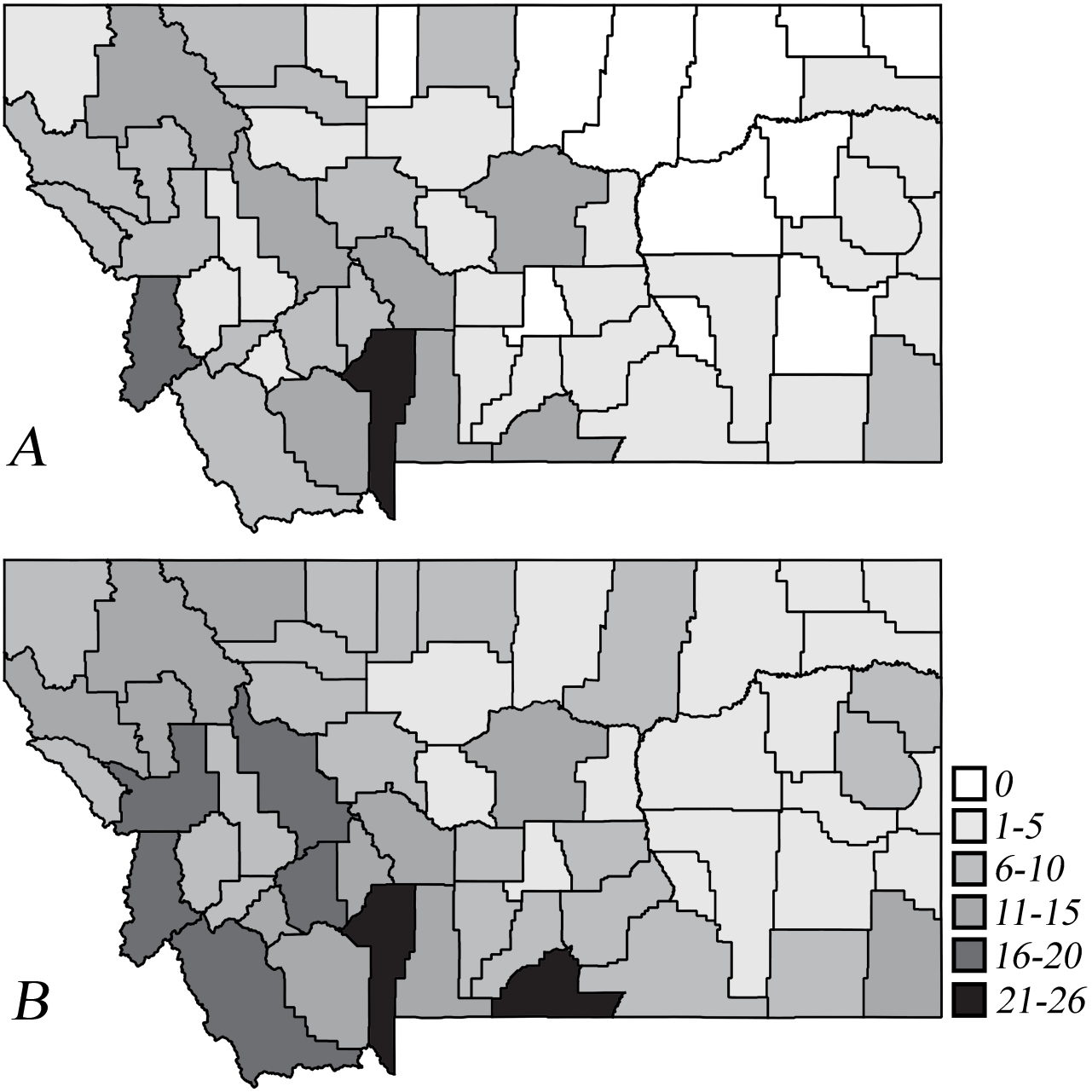

FIGURE 5. Number of *Megachile* species in each Montana county in 2014 (A) and 2021 (B).

Erroneous Records

Seven erroneous historical records were identified, and vouchers were either reassigned or excluded from the dataset (see Supp. Material 2: Erroneous Records).

Taxonomic Challenges

***Megachile angelarum* Cockerell/*Megachile campanulae* (Robertson) females.** Mitchell (1937d, 1956) distinguishes female *M. angelarum* and *M. campanulae* using geography and the presence or absence of a T5 apical setal band. According to Mitchell, *M. angelarum* is considered "western" in its distribution whereas *M. campanulae* is "eastern." In his species description, Mitchell states *M. angelarum* has "first to fifth terga with

entire and distinct white apical fasciae" whereas *M. campanulae* is "definitely lacking [fasciae] on the fifth", and his accompanying keys use "Fifth abdominal tergum white-fasciate…" in *M. angelarum* and "Fifth tergum not fasciate…" in *M. campanulae* to distinguish the species (Mitchell 1937d). Similarly, in Mitchell (1956) *M. angelarum* and *M. campanulae* are differentiated using "Fifth abdominal tergum white fasciate apically…" in *M. angelarum* and "Fifth tergum not fasciate…" in *M. campanulae*. Sheffield *et al*. (2011) utilized the same character and geographic distribution to distinguish the two species: "Tergum 5 without white apical fascia; QC-MB" and "Tergum 5 with white apical fascia; BC."

To identify our Montana material, we used the available keys and the presence/absence of a T5 setal band, resulting in essentially all females being identified as *M. angelarum* and all males being identified as *M. campanulae*. In addition, many of the females had been collected from *Campanula rotundifolia* L. of which *M. campanulae* is a known visitor. This irregularity prompted us to dig further into this issue. Upon examination of Mitchell's *Bees of the Eastern United States* (volume 2) we found that, despite the species description for *M. campanulae* stating T5 is "entirely lacking the apical fasciae", in his key, Mitchell uses "Fascia of tergum 5 reduced and inconspicuous…" for *M. campanulae* to distinguish it from another eastern species *Megachile exilis parexilis* (Mitchell) with a complete T5 setal band (as in *M. angelarum*) stating, "Abdominal tergum 5 with a conspicuous, entire, white, apical fasciae…" (Mitchell 1962). Reexamination of our Montana material using this new interpretation of the T5 hair band as "reduced and inconspicuous" (Mitchell 1962) for *M. campanulae* versus "absent" (Mitchell 1937d, 1956), and the presence of an "entire and distinct" T5 setal band for *M. angelarum* as originally stated (Mitchell 1937d, 1956), as well as examination of additional characters for both species, we found that many of the females that we originally identified as *M. angelarum* are *M. campanulae*. We also reexamined female specimens identified as *M. angelarum* in Kuhlman and Burrows (2017), Reese *et al*. (2018), Delphia *et al*. (2019a), and LaManna *et al*. (2020). All but the single specimen in Kuhlman and Burrows (2017), which is west of the Continental Divide, were re-identified as *M. campanulae*. (In several of these publications all of the males were already identified as *M. campanulae*). To our knowledge, this issue has gone unnoticed until now because few people are working in locations where the ranges of these two species overlap as they do in Montana.

Therefore, in this work, we used a modification of the T5 apical setal band character, as well as additional characters to distinguish females of the two species. In a fresh specimen, as judged by a completely intact apical wing margin, the completeness of the T5 apical setal band may be used. *Megachile angelarum* has a T5 apical setal band that is mostly complete medially and is similar in width and density to the apical setal bands of T1–4; individual setae of T5 are thick and plumose. *Megachile campanulae* displays a T5 apical setal band that is incomplete medially and is narrower and less dense than the apical setal bands of T1–4; individual setae of T5 are thinner and less plumose. In worn specimens, the completeness and appearance of the T5 apical setal band is unreliable, and therefore the punctation of the scutum relative to the scutellum and the punctation along the occipital suture should be used. In *M. angelarum* the punctation on the scutum and the scutellum is similar (close and evenly spaced, dense). In *M. campanulae*, the punctation on the scutum is more dense (close and evenly spaced) compared to the punctation on the scutellum, which is irregular and inconsistent. On the posterior edge of the head margin, on the occipital suture, *M. angelarum* has a smooth, shiny occipital suture without a line of punctures, whereas *M. campanulae* displays a line of punctures appearing as a slight carina.

***Megachile latimanus* Say/*Megachile perihirta* Cockerell females.** Mitchell (1936) considered females of *M. perihirta* and *M. latimanus* so similar morphologically that it is "nearly impossible to separate by anything other than geographic location." *Megachile perihirta* is considered to generally occur west of the 100th meridian, whereas *M. latimanus* is usually found east of the 100th meridian, an arbitrary boundary between "eastern" and "western" North America (Sheffield *et al*. 2011). Similarly, Mitchell (1936) describes *M. perihirta* occurring from the west coast to Montana, Alberta, Wyoming, Colorado, and Texas, and *M. latimanus* occurring east of Montana, from North Carolina to Nova Scotia, west to Alberta, Wyoming, and Colorado. Therefore, Mitchell suggests that in areas where their ranges overlap, which includes Montana, only male determinations should be used to identify these two species until there is more known on the species distributions along the continental divide. Based on our identifications of male specimens, both *M. perihirta* and *M. latimanus* occur across the state, although *M. latimanus* males (8 specimens) were much less abundant than *M. perihirta* males (282 specimens). Stretching from the eastern to western borders of the state (Fig. 1AB), *M. perihirta* is known from all the counties where *M. latimanus* males are known (Fig. 1Q), and *M. latimanus* reaches to near the Idaho border in the west. Therefore, we cannot use geography to identify female specimens to species in Montana.

Among the Montana specimens examined of this species pair, we were unable to morphologically distinguish females into two forms. Alongside geography, Mitchell (1936) used the size of the patch of black pubescence on the scutum and scutellum to identify female specimens to species, with *M. perihirta* having a larger patch of black pubescence that often extends into the scutellum compared to *M. latimanus*, which displays a smaller patch. However, Mitchell (1936) adds that "individual variations destroy the value of this character as a means of identification." In the Montana specimens examined, the size of the black pubescence patch was intermediate (usually a medium amount of black pubescence was present on the scutum) such that we could not reliably identify these specimens to species. Sheffield *et al*. (2011) pointed to pale pubescence on T6 of *M. latimanus*, versus intermixed black and white pubescence on T6 of *M. perihirta*, which again was not distinct in our series. With the lack of consistently distinct morphological characters and the overlap of geographic ranges, we identified all female specimens as "*M. latimanus*/*M. perihirta*" and considered all female specimens to be the more abundant *M. perihirta* for the purposes of analyses.

***Megachile gentilis* Cresson females.** Montana specimens that we identified as female *M. gentilis* varied slightly from the descriptions of Mitchell (1935a) and Sheffield *et al*. (2011). Both earlier works describe completely black scopal setae on S6, whereas many of our Montana specimens displayed a few pale setae among the black setae. We consider this simply unreported intraspecific variation.

***Megachile brevis* Say females.** Some Montana specimens that we identified as female *M. brevis* varied somewhat from the descriptions of Mitchell (1935a) and Sheffield *et al*. (2011). Both earlier works describe the scopal setae of S6 as being mostly pale, whereas 16 of our specimens (out of 432 females examined) displayed black scopal setae on the apical half and pale scopal setae on the basal half of S6. Again, we consider this unreported intraspecific variation.

***Megachile lippiae* Cockerell/*Megachile coquilletti* Cockerell females.** *Megachile lippiae* female specimens are difficult to discern from *M. coquilletti*. Characters used to separate these species include T6 of *M. lippiae* having pale-colored appressed setae and intermixed erect black setae, and the profile of T6 being distinctly concave in lateral view (Mitchell 1935a [as *M. texana* var. *lippiae*]; Sheffield *et al*. 2011 [as *M. lippiae*]). In contrast, *M. coquilletti* has appressed black setae on T6, which is "just perceptibly concave" in lateral profile (Mitchell 1935a).

The pale-colored appressed setae on T6 of *M. lippiae* can be quite difficult to see. They are most easily viewed from a lateral profile of T6 while tilting the specimen back and forth to see the sheen of these appressed lighter setae. Adding complexity, additional plumose pale setae are often found in small patches on the T6 lateral margins of *M. coquilletti*. We did not consider these few lateral plumose setae as appressed setae that would distinguish a specimen as *M. lippiae*. We instead relied on an overall sheen of appressed pale setae on T6 as diagnostic for *M. lippiae*.

The T6 concavity was also a problematic character because many of our specimens that we identified as *M. lippiae* and *M. coquilletti* exhibited a more intermediate state that we could not easily characterize as either distinctly concave or just perceptibly concave. Therefore, to distinguish these species we use both the T6 concavity and the pale appressed setae characters in our key, with the addition of a previously unused character, a carina on the apical clypeal margin.

***Megachile manifesta* Cresson/*Megachile nevadensis* Cresson/*Megachile wheeleri* Mitchell females.** Mitchell (1937a) advises that females of *M. nevadensis* are difficult to discern from those of *M. manifesta* and *M. wheeleri*, both of which were collected in Montana during this study, though no females of *M. nevadensis* were collected. *Megachile nevadensis* is typically "larger and much more ochraceous pubescent than the other two species" (Mitchell 1937a), but as color and size can vary, the punctation of T5 alongside the coloration of setae on S5 are important characters to distinguish these three species. *Megachile wheeleri* has a polished, sparsely punctate T5, and black scopal setae, at least apically, on S5 (Mitchell 1937a). *Megachile nevadensis* also has a polished, sparsely punctate T5, but pale-colored scopal setae on S5 (Mitchell 1937a). *Megachile manifesta* has close punctures on T5 and black scopal setae apically on S5 (Mitchell 1937a; Sheffield *et al*. 2011).

Based on Mitchell's key to *Xeromegachile* (1937a), we used the distinctively widely spaced punctures (2–4 diameters apart) on a polished and shiny T5 to distinguish *M. wheeleri* from *M. nevadensis*, which had a moderately shiny T5 with punctures spaced ≤ 1 diameters apart in our reference specimens from California and Utah (seemingly closer together than Mitchell [1937a] describes). This character also distinguishes *M. wheeleri* from *M. manifesta*, which similarly displayed close punctures, ≤ 1 diameter apart, on T5.

Also, based on Mitchell (1937a), we used the presence of black scopal setae on the apical ¼ to ⅓ of S5 and pale scopal setae basally on S5 to distinguish *M. manifesta* from *M. nevadensis*, which has all pale scopal setae apically

and basally on S5. Additionally, for our specimens identified as *M. manifesta*, the area posteriad the central scutum exhibited evenly spaced, dense punctures that were almost touching, whereas in *M. nevadensis* the punctures in this area were variable and spaced 1–2 diameters apart.

One specimen that we identified as *M. manifesta* (specimen MTEC 046014) presented difficulty and should be examined if *M. manifesta* is revisited in any future revision. This specimen exhibited black scopal setae on the apical half and white scopal setae on the basal half of S6, making it not quite fit into couplet 14 of the *Xeromegachile* key (Mitchell 1937a), which separates specimens that have entirely pale scopal setae on S6 (except a darker tuft apically) from specimens that have entirely black scopal setae on S6. Due to the apparent variation in this character, we chose not to use this character in our key.

***Megachile anograe* Cockerell females.** *Megachile anograe* females are generally characterized by pale scopae on S2–4 (Mitchell 1936), and this was consistent with all our Montana specimens, but some rare extralimital specimens are reported to be melanistic and have completely black scopae on S2–6 (Sheffield *et al*. 2011; also, specimens MCZ15711, from Umatilla, Oregon, and MCZ15712, from Utah, *in lit*., C. Meier, 22 March 2021). The melanistic form could lead to species misidentifications if this variant was to be found in Montana in the future. We have accounted for this possible variation in our key.

***Megachile anograe* males.** Among our Montana specimens of *M. anograe*, we found intraspecific variation that should be examined in future revisions of *Megachile* or the subgenus *Megachiloides*. The characters used to identify *M. anograe* males (= *Megachile alamosana* Mitchell; Mitchell 1934, 1936, 1937a) include the absence of a white apical setal band on T5, a shallow median emargination of the clypeal margin, and sparse T5 punctures (Mitchell 1937a). Three male *M. anograe* specimens (MTEC 050668, MTEC 050667, and MTEC 042258) exhibited variation in the clypeal margin and some indication of the presence of a T5 apical setal band. Specimen MTEC 050668 had some white setae along the apical margin of T5 suggesting the presence of an apical setal band and a shallow median emargination of the clypeal margin, MTEC 050667 had a T5 apical setal band and a clypeal margin with a beveled edge, and MTEC 042258 lacked a T5 apical setal band (as in Mitchell's species description) and had a lumpy, minutely-denticulate-multi-tuberculate median emargination of the clypeal margin.

Without any reference material of male *M. anograe* for comparison with our specimens, this variation was concerning during the determination process. However, additional characters were explored (Mitchell 1936 as *M. alamosana*) and suggested (Terry Griswold, *in lit*., 21 April 2021), including presence of a small patch of black setae apicomedially on S5 and the presence of an elongate fovea on the dorsal hind femur. All of the specimens we identified to *M. anograe* exhibited both of these characters, which we also included in our key.

***Megachile subnigra* Cresson females.** Female specimens from Montana that we identified as *M. subnigra* exhibited white apical setal bands on T2–T6 (though sometimes appearing reduced). In some cases, where specimens were somewhat bedraggled, the setal bands appeared to be absent, such that the pubescence on the tergites resembled that of *Megachile gemula* Cresson, with no white apical setal bands and overall white pubescence on T1 and T2. Because of this, and because *M. gemula* can also have black scopal setae on S2–6, occasional specimens of these two species could easily be confused. Our key accounts for those *M. subnigra* specimens with visible white apical setal bands on the tergites as well as those where the white apical setal bands are reduced or difficult to see due to specimen condition, and therefore the species keys out twice. Additionally, there is a pale form of *M. subnigra* (Sheffield *et al*. 2011) occurring in the Western U.S. (Sheffield *in lit*. 12 June 2020) that we did not see in Montana material, but is a possible variant that could present difficulty in identification.

***Megachile lippiae* Cockerell/*Megachile texana* Cresson males.** Males of *M. lippiae* and *M. texana* are very similar to one another morphologically and their distributions overlap in Montana. Mitchell (1935a) considered *M. lippiae* to be a subspecies of *M. texana*, which he distinguished from *M. texana* based on the amount of black pubescence (little to none) on the scutum, scutellum, and T1 of *M. lippiae*. Similarly, according to Bzdyk (2012), male *M. lippiae* have no black pubescence, except on the vertex of the head, whereas *M. texana* have black pubescence on the vertex of the head and the scutum. Sheffield *et al*. (2011) raised *M. lippiae* to a species based on CO1 data (divergence levels of 2.59%) and the morphological characters used by Mitchell (1935a). Sheffield and Genaro (2013) reported a 2.65% divergence in COI between *M. texana* and *M. lippiae*, although the number of specimens sampled and geographic origin thereof were not reported. Similarly, according to Bzdyk (2012), male *M. lippiae* have no black pubescence, except on the vertex of the head, whereas *M. texana* have black pubescence on the vertex of the head and the scutum.

Our Montana specimens exhibited varying amounts of dark setae mixed with pale setae on the scutum and dorsal

surface of the tergites, making it difficult to determine if there was "enough" black setae to identify a specimen as *M. texana*. We determined specimens with greater than 50% black pubescence on the scutum, tergites with significant bands of black pubescence, and vertex of head with greater than 50% black pubescence to be *M. texana*, and specimens with less than 25% black pubescence on the scutum and mostly white pubescence on the dorsal tergites and vertex of head to be *M. lippiae*.

***Megachile texana* Cresson/*Megachile cleomis* Cockerell.** We do not recognize *M. cleomis* as a valid species in this paper, following Bzdyk (2012). Sheffield and Genaro (2013) briefly made a claim of dividing *M. texana* from *M. cleomis*, with a purported separation of eastern and western haplotypes. Their stated justification was limited to a 1.45% divergence in COI, which is short of the 2–3% threshold for species recognition commonly used (Jones *et al*. 2011; Sharkey *et al*. 2021). No morphological characters were mentioned, the line between eastern and western haplotypes was not disclosed, no number of exemplars nor geographic origins thereof were provided in the paper. As such, their claim as given to date is neither well supported nor subject to evaluation. A promised forthcoming phylogeny has so far not been published. Given these problems, we choose to follow Bzdyk (2012) and treat these species as synonyms. Historic records for *M. cleomis* are from California, and all our records are from east of the Continental Divide, so even if the two are eventually split, it is likely our populations will remain *M. texana*.

***Megachile lapponica* Thomson/*Megachile relativa* Cresson males.** *Megachile lapponica* and *M. relativa* males are morphologically similar but *M. lapponica* is most common in northwestern North America, and *M. relativa* is widespread in the U.S. and Canada (Sheffield & Westby 2007). This geographic distinction is not useful in Montana, as their ranges overlap.

The male of *M. lapponica* was described for the first time by Sheffield and Westby (2007), as *Megachile nivalis* Friese, and later synonymized with *M. lapponica* based on CO1 and morphological characters by Sheffield *et al*. (2011). Characters used to separate males of *M. lapponica* and *M. relativa* include the shape of the hypostomal cavity, the size of the hypostomal tubercle, the comparative length of the r and Rs wing veins, and comparisons of various genital structures (Sheffield & Westby 2007). *Megachile relativa* is described as having a shallow hypostomal cavity, short hypostomal tubercle, and subequal lengths of veins r and Rs along the marginal cell of the forewing. *Megachile lapponica* is described as having a deep hypostomal cavity, a long hypostomal tubercle, and shorter r compared to Rs vein along the marginal cell of the forewing. However, Sheffield *et al*. (2011) also states that "the male of *M. lapponica* can only be distinguished with certainty from *M. relativa* by examining the genitalia." The gonocoxite's dorsal lobe in *M. relativa* is short, subequal in length to the width of the gonobase, and not reaching the gonoforceps base. In *M. lapponica*, the gonocoxite's dorsal lobe is longer than the width of the gonobase and reaches the base of the gonoforceps (Sheffield & Westby 2007).

Among our Montana specimens, we could not see any clear differences in the hypostomal cavity or tubercle to separate species with confidence-although most seemed to have shallow cavities and short tubercles, which would suggest *M. relativa*. The forewing r and Rs veins were not reliable characters in our specimens. We also found no clear differences in the genitalia of specimens based on the hypostomal cavities and tubercles.

Parallel to our approach with female *M. perihirta* and *M. latimanus*, given the lack of distinct morphological characteristics to separate the males of these two species, we identified male specimens in our dataset and key as *M. lapponica/M. relativa*. In our analyses, male *M. lapponica/M. relativa* specimens were counted as *M. relativa* based on the greater abundance of *M. relativa* females in Montana.

***Megachile mellitarsis* Cresson males.** Sheffield *et al*. (2011) and Mitchell (1937c) describe males of *M. mellitarsis* without a T5 apical setal band. In our limited sampling of *M. mellitarsis* males, we found one specimen with a T5 apical setal band and suggest further examination of using this trait for identification.

Key to the *Megachile* Species of Montana

This key was written based on previous works by Mitchell (1924, 1926a, 1927a, 1927b, 1934, 1935a, 1935b, 1936, 1937a, 1937b, 1937c, 1937d, 1962, 1980), Ivanochko (1979), Sheffield *et al*. (2011), and Bzdyk (2012) (see also Sheffield 2020) and includes both sexes of the species that have been documented in Montana, their possible color variants, as well as species we most expect (based on their distributions or expected spread) to eventually be found in the state. We suggest reading the Taxonomic Challenges before using the key for greater ease of use and better understanding.

Difficulties in identifying *Megachile* to species often arise with specimens that were old when collected (i.e., they display wing and mandibular wear), grimy specimens, and specimens with closed mandibles or leg positioning that may obscure characters. Specimens may be re-washed in hot water and soap to remove grime from setae or teeth and then carefully blow-dried. If the mandibles are closed, opening the mandibles of a relaxed specimen using a pin may be useful. Similarly, repositioning the legs away from the body of a relaxed specimen can help for viewing certain characters, especially in males, as can extending/separating the individual tergites from one another to reveal the basal half, especially tergite 6 from tergite 5, in females.

The genus *Megachile* is characterized by having two submarginal cells subequal in length, no arolium between the tarsal claws, a labrum that is longer than wide, an apically depressed first metasomal tergite, and 3-jointed maxillary palpi. Females display scopa on the sternites, and males display a preapical carina on tergite 6 (Mitchell 1934; Michener 2007; Burrows *et al*. 2021). Users should refer to Michener, McGinley, and Danforth (1994) to first identify specimens to the genus *Megachile*. Entomological terms follow Torre-Bueno (1989). Certain species key out multiple times to account for variation in characters.

Abbreviations used in key

S1–S6: Sternites on the ventral surface of the metasoma.
T1–T6: Tergites on the dorsal surface of the metasoma.

Key to *Megachile* species of Montana: female specimens (i.e., 10 flagellomeres, 6 tergites)

1 Metasomal sternites with white apical setal bands between scopal setae (Fig. 6A); T2 with lateral, ovate fovea 2
- Metasomal sternites without white apical setal bands between scopal setae; T2 without lateral, ovate fovea 3

2 S5 scopal setae all black; clypeal margin with small median tubercle (Fig. 6D); T3 with lateral, ovate fovea. . . . . .*Megachile* (*Eutricharaea*) *apicalis* Spinola
- S5 scopal setae white, sometimes apical half with black setae; clypeal margin without median tubercle, essentially straight; T3 without lateral, ovate fovea . . . . . .*Megachile* (*Eutricharaea*) *rotundata* (Fabricius)

[Note: *Megachile* (*Eutricharaea*) *pusilla* Pérez also keys out at 2'. This species has not been recorded from Montana but is an introduced species that could potentially occur in the state. *Megachile pusilla* has black setae laterally on T5–6 at most, while *M. rotundata* has black setae laterally on T2–6.]

3 Metasoma rounded in dorsal view, T2–3 widest, then narrowing from T4–6 (Fig. 6B) 4
- Metasoma subparallel in dorsal view, T2–4 subequal in width (Fig. 6C) 32

4 Tergites without white apical setal bands; T1–2 covered in pale yellow to white pubescence contrasting entirely dark pubescence on T3–5. 5
- Most tergites with white apical setal bands; T1–2 sometimes with pale pubescence, but T3–5 without entirely black pubescence 7

5 S2–6 scopal setae orange; T6 usually with pale appressed setae . . . . . *Megachile* (*Xanthosarus*) *melanophaea* Smith

[Note: *Megachile* (*Xanthosarus*) *circumcincata* (Kirby) also keys out at 5. This species has not been recorded from Montana but could potentially occur in the state. *Megachile circumcincta* has entirely pale pubescence on the ventral mesosoma and coxae, whereas *Megachile melanophaea* has dark pubescence on the ventral mesosoma and coxae.]

- S2–6 scopal setae reddish-brown to black; T6 usually with dark appressed setae. 6

6 Basal mandibular tooth truncate (Fig. 7E); mandible from lateral view square basally, with parallel sides for a distance as long as wide, then tapering apically (Fig. 6J); S2–6 scopal setae reddish-brown to black . . . . . *Megachile* (*Xanthosarus*) *gemula* Cresson

- Basal mandibular tooth pointed (Fig. 7B); mandible from lateral view gradually tapering in width towards apex (Fig. 6I); S2–6 scopal setae entirely black . . . . . .*Megachile* (*Megachiloides*) *subnigra* Cresson (part)

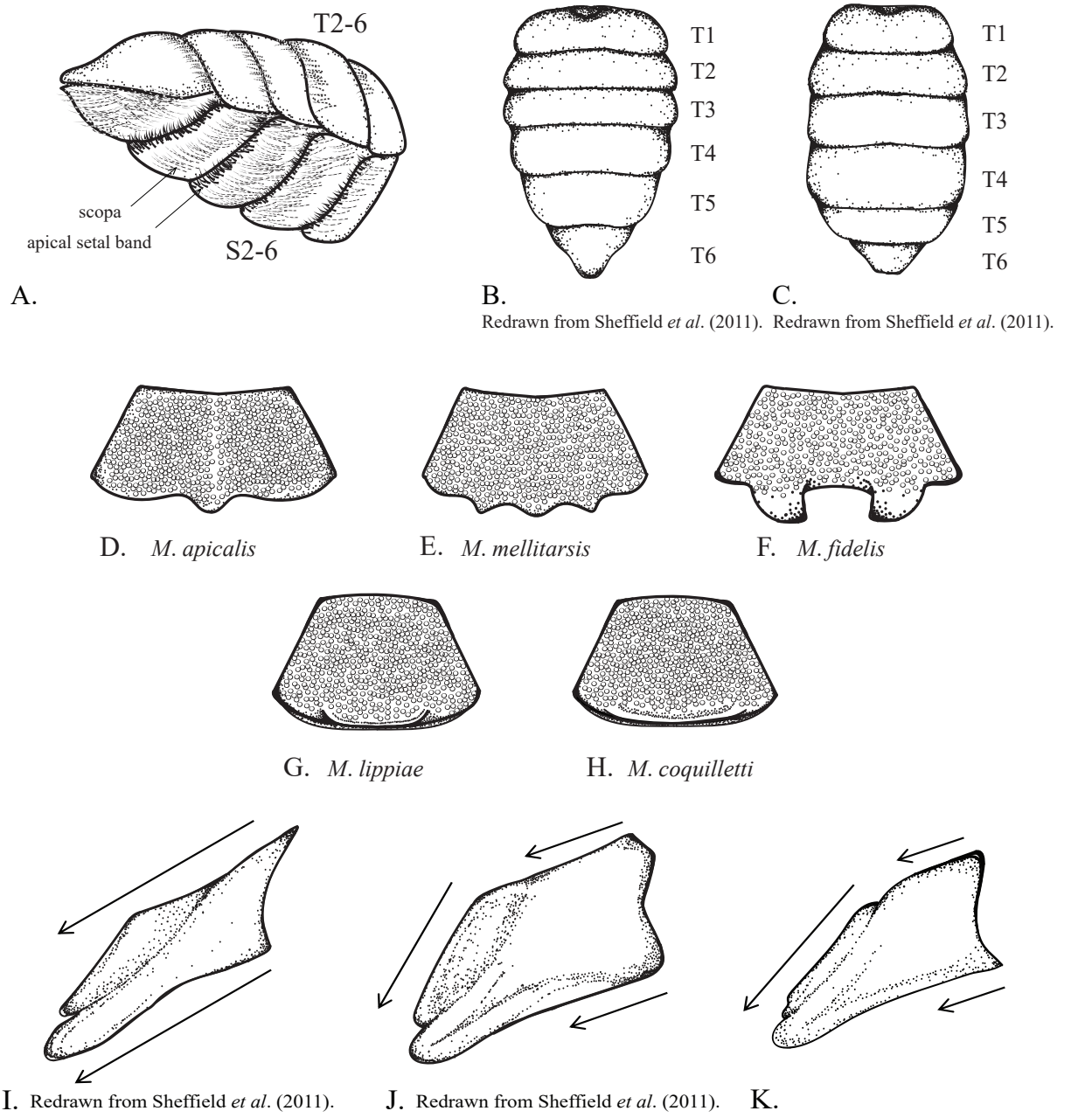

FIGURE 6. Female *Megachile* characters. (A) Ventral view of metasoma with white apical setal bands on S2–6, (B) Dorsal view of rounded metasoma, widest at T2–3, (C) Dorsal view of subparallel metasoma, (D–H) Anterior view of clypeus: (D) *M. apicalis*, (E) *M. mellitarsis*, (F) *M. fidelis*, (G) *M. lippiae*, (H) *M. coquilletti*, (I) Lateral view of mandible gradually tapering in width towards apex, (J) Lateral view of mandible with base square-shaped with parallel sides for a distance as long as wide, then tapering apically, and (K) Lateral view of mandible square basally, with sides parallel for approximately ⅓ the length of mandible, then tapering apically.

7 S2–4 scopal setae entirely black. . . . . .*Megachile* (*Megachiloides*) *subnigra* Cresson (part)

[Note: There is a pale form of *M. subnigra* that has not been recorded from Montana but could potentially occur in the state. This form has all white scopal setae, T6 straight in lateral profile, and 4-toothed mandibles without basal tooth with an angulation appearing as a weak additional tooth (i.e., appearing 5-toothed).]

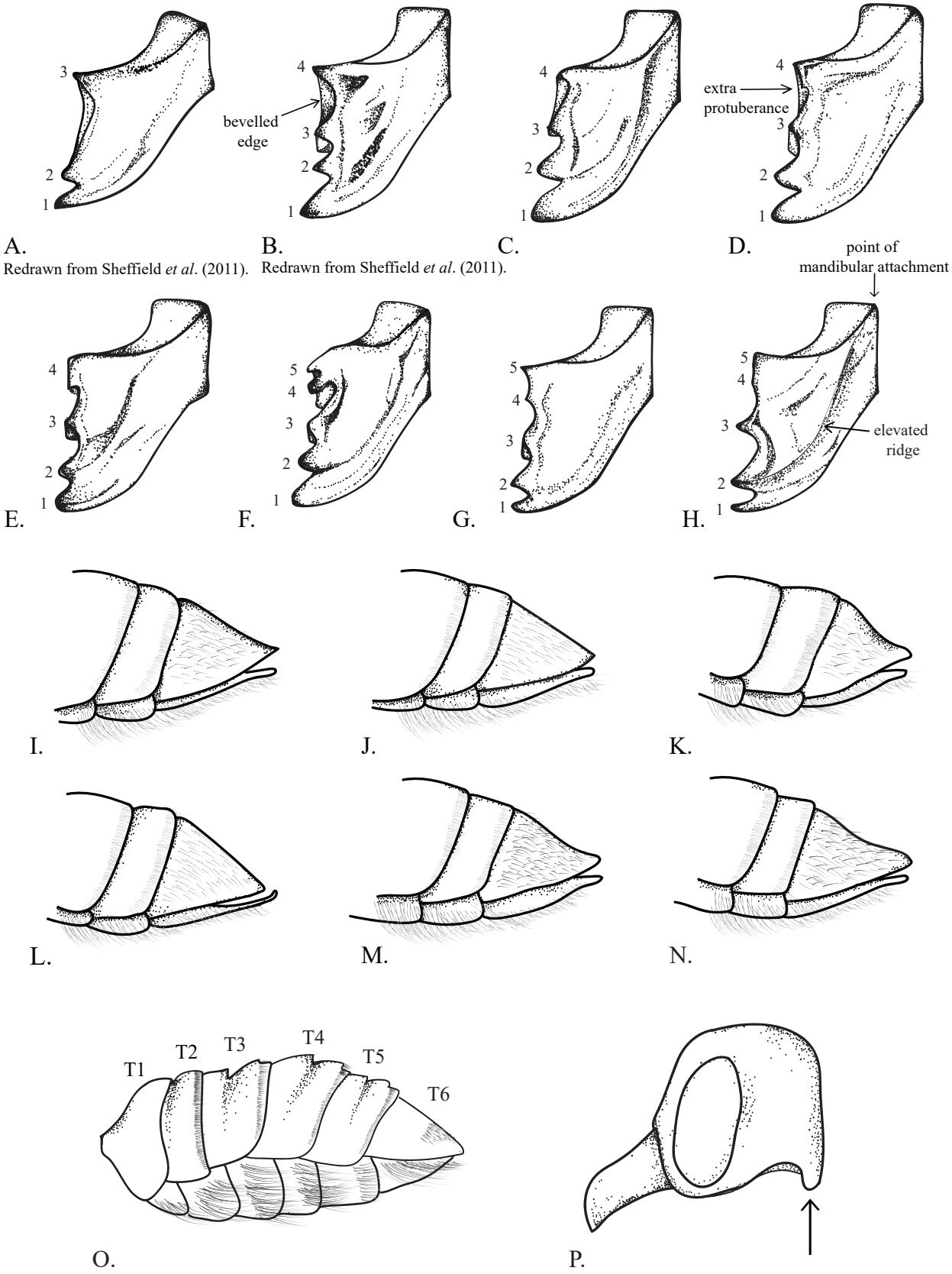

FIGURE 7. Female *Megachile* characters. (A–H) Anterolateral view of mandible, (I–N) Lateral view of metasoma, tergites 4–6, (O) Lateral view of tergites on *M. dakotensis*, and (P) Lateral view of head with pronounced tooth on the posterior genal margin on *M. pugnata*.

[Note: Rare, melanistic forms of *Megachile* (*Megachiloides*) *anograe* Cockerell (S2–6 scopal setae black) also key out at 7 but have 3-toothed mandibles (4-toothed in *M. subnigra*). This form has not been recorded from Montana.]

- S2–4 scopal setae usually white, yellow, or orange 8

8 Mandible 3-toothed (Fig. 7A). 9
- Mandible 4- (Figs. 7B–E) or 5-toothed (Figs. 7F–H) 10

9 T6 smooth and shiny, with punctures 3–5 diameters apart . . . . . .*Megachile* (*Megachiloides*) *anograe* Cockerell
- T6 pitted and dull, with punctures ≤ 1 diameter apart . . . . . .*Megachile* (*Megachiloides*) *pascoensis* Mitchell

10 S6 scopal setae mostly (greater than 75%) pale, ivory to orange (can have black setae apically on S6) (*M. mendica* can approach ca. 50% black setae apically) 11
- S6 scopal setae mostly (greater than 75%) dark, brown to black (*M. casadae* and *M. texana* can approach ca. 50% pale setae basally) 22

[Note: Setal coloration can be an unreliable character, as it can change or fade with time. Coloration can also vary intraspecifically, and specimens with questionable coloration can be keyed out in both directions.]

11 Mandibles 5-toothed, with deepest emargination between tips of 3rd and 4th tooth, emargination strongly angled towards 4th tooth (Fig. 7F) 12
- Mandibles 4- or 5-toothed, with emarginations between all teeth similar in depth (Figs. 7B–E, G–H) 13

12 T3–5 with apical setal bands consistently wide, as wide medially as laterally; T1–2 usually covered in white pubescence; T6 with appressed pale setae . . . . . *Megachile* (*Xanthosarus*) *dentitarsus* Sladen
- T3–5 with apical setal bands inconsistent in width, wider laterally than medially, often incomplete; T1–2 usually covered in yellow pubescence; T6 with appressed yellow to orange setae . . . . . .*Megachile* (*Xanthosarus*) *latimanus* Say and *Megachile* (*Xanthosarus*) *perihirta* Cockerell

[Note: The females of *M. latimanus* and *M. perihirta* cannot be reliably separated in Montana based on morphology. See Taxonomic Challenges in results above.]

13 Basal mandibular tooth truncate (Fig. 7E); T6 setae dark brown to black. . . . . *Megachile* (*Xanthosarus*) *frigida* Smith
- Basal mandibular tooth rounded or pointed (Fig. 7B–D, G–H); T6 setae color variable 14

14 Mandibles without cutting edge ventrad the tooth plane (Fig. 7H); mandible surface with elevated ridge running diagonally from apex of 2nd tooth to the dorsal point of mandibular attachment (Fig. 7H). . . . .*Megachile* (*Megachile*) *montivaga* Cresson
- Mandibles with cutting edge ventrad the tooth plane, sometimes only present as small, angled edge (Figs. 7B–G); mandible surface without elevated ridge 15

15 Mandibles 4-toothed (sometimes basal tooth with angulation appearing as a weak additional tooth [i.e., appearing 5-toothed]) (Figs. 7B, 7D). 16
- Mandibles 5-toothed (Fig. 7G). 20

16 Clypeal margin with two broadly incurved emarginations (Fig. 6E); tarsi and basitarsus reddish brown, contrasting black tibia . . . . . .*Megachile* (*Sayapis*) *mellitarsis* Cresson
- Clypeal margin without two broad emarginations; tarsi and basitarsus brown to black, not contrasting tibia 17

17 S6 upcurved at the tip, extending beyond T6 (Fig. 7L); T6 straight in lateral profile with pale, velvety, appressed setae (Fig. 7L) . . . . . *Megachile* (*Argyropile*) *parallela* Smith
- S6 not upcurved or extending beyond T6 (Fig. 7I–K, M–N). 18

18 T6 convex basally and concave apically in a “pinched shape” in lateral profile (Fig. 7K); mandibles with 4 distinct teeth (Fig. 7B) . . . . . .*Megachile* (*Litomegachile*) *brevis* Say
- T6 straight in lateral profile (Fig. 7J); mandibles 4-toothed, basal tooth with angulation appearing as a weak additional tooth [i.e., appearing 5-toothed] 19

19 T6 with pale appressed setae . . . . . *Megachile* (*Litomegachile*) *snowi* Mitchell
- T6 with brown appressed setae. . . . . *Megachile* (*Litomegachile*) *mendica* Cresson

20 Body size 17–20 mm long; clypeus shiny and sparsely punctate medially (punctures 1–3 diameters apart); clypeal margin with four prominent tubercles. . . . . *Megachile* (*Megachile*) *inermis* Provancher

- Body size 9–12 mm long; clypeus densely punctate medially (punctures ≤ 1 diameter apart); clypeal margin irregular, without prominent tubercles 21

21 T6 with black setae . . . . . *Megachile* (*Megachile*) *centuncularis* (Linnaeus)
- T6 with golden setae . . . . . *Megachile* (*Megachile*) *relativa* Cresson

22 T2 in dorsal view with lateral, erect black setae 23
- T2 in dorsal view without lateral, erect black setae 24

23 T3–5 strongly concave medially between surrounding apical and basal grooves, when viewed from lateral profile (Fig. 7O); ocellocular distance shorter than ocelloccipital distance (Fig. 8J) . . . . . *Megachile* (*Megachiloides*) *dakotensis* Mitchell
- T3–5 flat to slightly concave medially, with no prominent apical or basal grooves; ocellocular distance longer than ocelloccipital distance (Fig. 8L) . . . . . *Megachile* (*Litomegachile*) *texana* Cresson

24 Clypeus shiny and sparsely punctate medially (punctures 2–3 diameters apart), becoming more densely punctate laterally . . . . . *Megachile* (*Megachiloides*) *casadae* Cockerell
- Clypeus with dense punctation medially and laterally (punctures ≤ 1 diameter apart) 25

25 Mandibles 5-toothed (Fig. 7G) OR mandibles 4-toothed, basal tooth with angulation appearing as a weak additional tooth (i.e., appearing 5-toothed) (Fig. 7D) 26
- Mandibles distinctly 4-toothed (Figs. 7B–C) 27

26 S5 scopal setae black, at least apically; mandibles 5-toothed (Fig. 7G) . . . . . *Megachile* (*Megachile*) *lapponica* Thomson
- S5 scopal setae white; mandibles 4-toothed with basal mandiblular tooth angulate, appearing as a weak additional tooth (i.e., 5-toothed) (Fig. 7D) . . . . . *Megachile* (*Litomegachile*) *gentilis* Cresson

27 Mandibles with asymmetrical emargination between tips of 3rd and 4th tooth, emargination deepest closer to 4th tooth (Fig. 7C) AND mandible from lateral view gradually tapering in width towards apex (Fig. 6I) 28
- Mandibles with semicircular, symmetrical emargination between tips of 3rd and 4th tooth (Fig. 7B) AND mandible from lateral view square basally, with sides parallel for approximately ⅓ the length of mandible, then tapering apically (Fig. 6K) 30

28 T5 with punctures 2–4 diameters apart medially, surface polished and shiny . . . *Megachile* (*Megachiloides*) *wheeleri* Mitchell
- T5 with punctures ≤ 1 diameter apart medially, surface matte to shiny 29

29 S5 scopal setae all white; area directly posterior of scutum center with variable punctation 1–2 diameters apart . . . . . *Megachile* (*Megachiloides*) *nevadensis* Cresson
- S5 scopal setae at least partly black; area directly posterior of scutum center with consistently spaced punctures almost touching . . . . . *Megachile* (*Megachiloides*) *manifesta* Cresson

30 T6 strongly convex basally and concave apically in a "pinched shape" in lateral profile (Fig. 7K) . . . . . *Megachile (Litomegachile) onobrychidis* Cockerell
- T6 concave apically in lateral profile (Figs. 7M–N) 31

31 T6 with suberect pale setae and erect black setae; T6 concave apically in lateral profile (Fig. 7N); apical margin of clypeus with short median carina 2 times as long as diameter of median ocellus (Fig. 6G) . . . . *Megachile* (*Litomegachile*) *lippiae* Cockerell
- T6 with suberect and erect brown to black setae (sometimes with suberect pale setae in small patches laterally); T6 slightly to moderately concave apically in lateral profile (Fig. 7M); apical margin of clypeus with long transverse carina 4 times as long as diameter of median ocellus (Fig. 6H) . . . . . *Megachile* (*Litomegachile*) *coquilletti* Cockerell

32 Genal margin with pronounced tooth posteriorly (Fig. 7P); clypeal margin with three tubercles . . . . . *Megachile* (*Sayapis*) *pugnata* Say
- Genal margin without tooth posteriorly; clypeal margin variable 33

33 Mandibles without cutting edge ventrad the 2nd and 3rd tooth 34
- Mandibles with cutting edge ventrad the 2nd and 3rd tooth 35

34 In fresh specimens (as judged by a completely intact apical wing margin), T5 white apical setal band mostly complete medially, similar in width and density to T1–4 apical setal bands, individual setae thick and plumose; in all specimens, vertex of head with small and dense punctation (ca. 8–10 punctures between lateral ocelli and posterior margin of vertex); scutum and scutellum with similar punctation (close and evenly spaced); occipital suture smooth and shiny, impunctate . . . . . *Megachile* (*Chelostomoides*) *angelarum* Cockerell
- In fresh specimens (as judged by a completely intact apical wing margin), T5 white apical setal band incomplete medially, narrower and less dense than T1–4 apical setal bands, individual setae thinner and less plumose; in all specimens, vertex of head with large, sparse punctation (ca. 4–6 punctures between lateral ocelli and posterior margin of vertex); scutum punctation

close and evenly spaced compared to scutellum punctation, which is irregular and inconsistent; occipital suture with a line of punctures appearing as a slight carina . . . . . *Megachile* (*Chelostomoides*) *campanulae* (Robertson)

[Note: *Megachile* (*Callomegachile*) *sculpturalis* Smith keys out at 34'. This species has not been recorded from Montana but could potentially occur in the state. *Megachile sculpturalis* has a large body size (21–25 mm long), contrasting the much smaller body sizes of *M. angelarum* (10–11 mm long) and *M. campanulae* (10–12 mm long). *Megachile sculpturalis* also has yellow pubescence on T1 with a white apical setal band and black apical setal bands on T2–5, whereas *M. angelarum* and *M. campanulae* have white apical setal bands on T2–5.

35 Clypeal margin with two broadly incurved emarginations (Fig. 6E). . . . . *Megachile* (*Sayapis*) *mellitarsis* Cresson (part)

[Note: *Megachile* (*Sayapis*) *inimica* Cresson also keys out at 35. This species has not been recorded from Montana but could potentially occur in the state. *Megachile inimica* has all red or all black legs, while *M. mellitarsis* has red tarsi contrasting with the black tibia.]

- Clypeal margin with two prominent, wide, lateral tubercles (at least as long as wide), surrounding median triangular tubercle (Fig. 6F) . . . . . *Megachile* (*Sayapis*) *fidelis* Cresson

Key to *Megachile* species of Montana: male specimens (i.e., 11 flagellomeres, 7 tergites)

1 Probasitarsus narrow, not excavated ventrally (Fig. 8A), often brown to black 2
- Probasitarsus usually widely expanded, excavated ventrally, (Fig. 8B), often white to yellow (except *M. gemula* which has an excavated, but narrow, dark brown to black probasitarsus) 19

2 T6 (anterior to the transverse carina, Fig. 9C–D) with tomentose, pale setae 3
- T6 (anterior to the transverse carina) bare or with sparse setae 12

3 T2 with lateral, ovate fovea 4
- T2 without lateral, ovate fovea. 5

4 T3 with lateral, ovate fovea . . . . . *Megachile* (*Eutricharaea*) *apicalis* Spinola
- T3 without lateral, ovate fovea. . . . . *Megachile* (*Eutricharaea*) *rotundata* (Fabricius)

[Note: *Megachile* (*Eutricharaea*) *pusilla* also keys out at 4'. This species has not been recorded from Montana but is an introduced species that could potentially occur in the state. *Megachile pusilla* has a genal tooth posterior to the ventrad point of mandibular attachment that is longer than wide, whereas *M. rotundata* has a genal tooth that is as long as wide.]

5 T5 with white apical setal band, sometimes in depressed apical groove (sometimes reduced to lateral sides, as in *M. coquilletti*) 6
- T5 without white apical setal band (may have some setae laterally). 11

6 T6 transverse carina deeply emarginate medially (Fig. 9A) 7
- T6 transverse carina weakly emarginate, often appearing as a continuous jagged edge (Fig. 9B) . . . . . *Megachile* (*Litomegachile*) *brevis* Say

7 Mandible 4-toothed; apical margin of T6 (ventrad the transverse carina) with two pairs of prominent teeth laterally (Fig. 9C) . . . . . *Megachile* (*Argyropile*) *parallela* Smith
- Mandible 3-toothed; apical margin of T6 (ventrad the transverse carina) with two pairs of small teeth laterally (Fig. 9D). . . . 8

8 Protarsomeres 2–4 light to dark yellow . . . . . *Megachile* (*Litomegachile*) *coquilletti* Cockerell
- Protarsomeres 2–4 brown to black 9

9 Apical margin of T6 (ventrad the transverse carina) with submedian teeth closer to each other than to lateral teeth (Fig. 9E) or distances subequal . . . . . *Megachile* (*Litomegachile*) *snowi* Mitchell
- Apical margin of T6 (ventrad the transverse carina) with submedian teeth closer to lateral teeth than to each other (Fig. 9F) 10

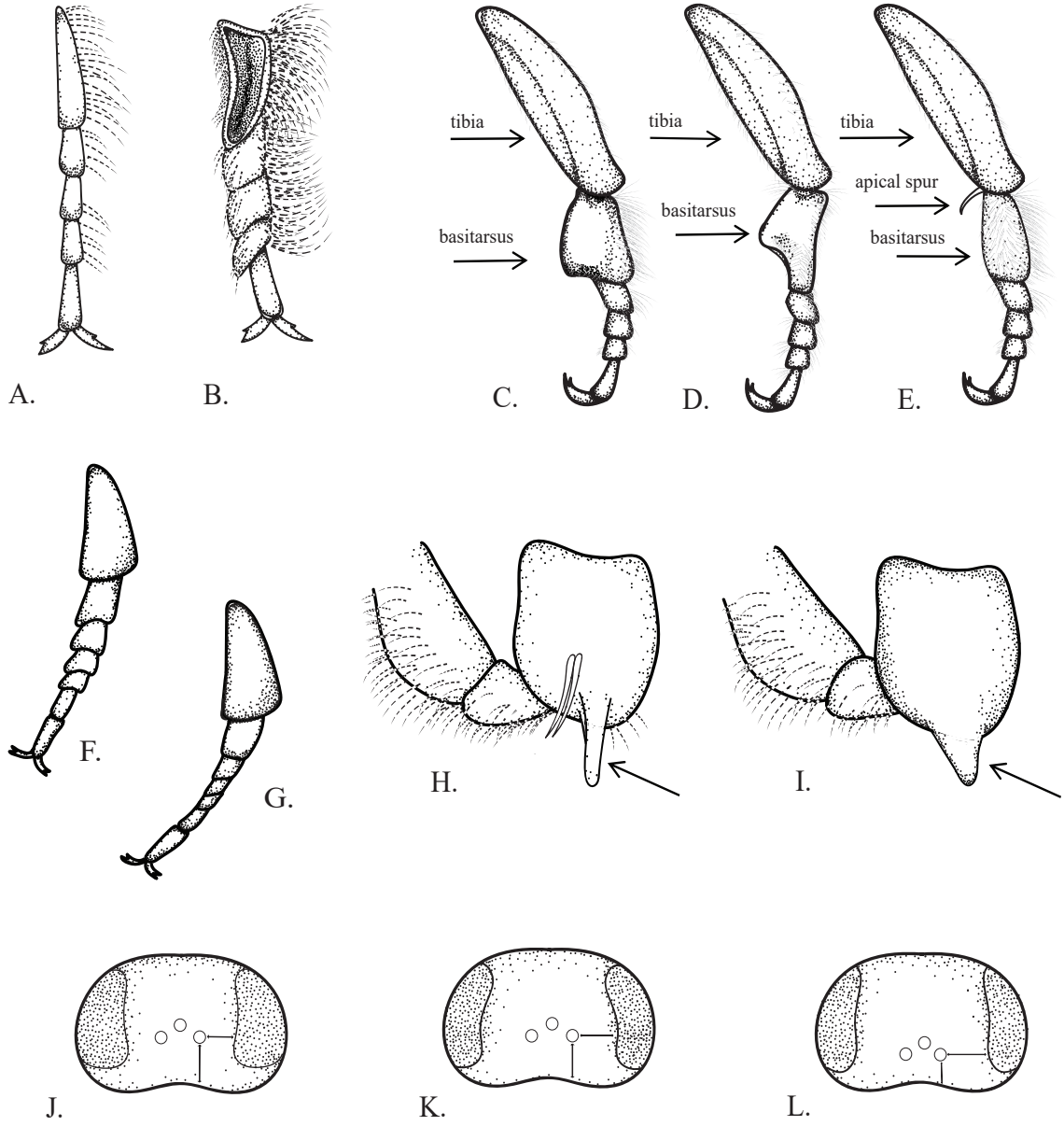

FIGURE 8. Male *Megachile* characters. (A) Probasitarsus not expanded or excavated ventrally, (B) Probasitarsus widely expanded and excavated ventrally, (C–E) Anterior view of mesobasitarsus and mesotibia, (F) Lateral view of triangular metatarsomeres on *M. manifesta*, (G) Lateral view of quadrate metatarsomeres on *M. wheeleri*, (H) Ventral view of procoxal spine, longer than wide, (I) Ventral view of procoxal spine, wide and spatulate, (J–L) Dorsal view of vertex of head: (J) Ocelloccipital distance longer than ocellocular distance, (K) Ocelloccipital distance equal to ocellocular distance, and (L) Ocelloccipital distance shorter than ocellocular distance.

10 Scutum with greater than 50% black pubescence (viewed laterally); tergites with significant bands of black pubescence (viewed laterally); vertex of head with greater than 50% black pubescence . . . . . *Megachile* (*Litomegachile*) *texana* Cresson
\- Scutum with less than 25% black pubescence (viewed laterally); tergites with mostly white pubescence (viewed laterally); vertex of head with mostly white pubescence . . . . . *Megachile* (*Litomegachile*) *lippiae* Cockerell

11 T4–5 somewhat dull, with punctures ca. 1 diameter apart . . . . . *Megachile* (*Litomegachile*) *gentilis* Cresson
\- T4–5 polished and shiny, with punctures 2–4 diameters apart. . . . . *Megachile* (*Litomegachile*) *mendica* Cresson

12 S4 not visible, retracted 13
\- S4 visible 14

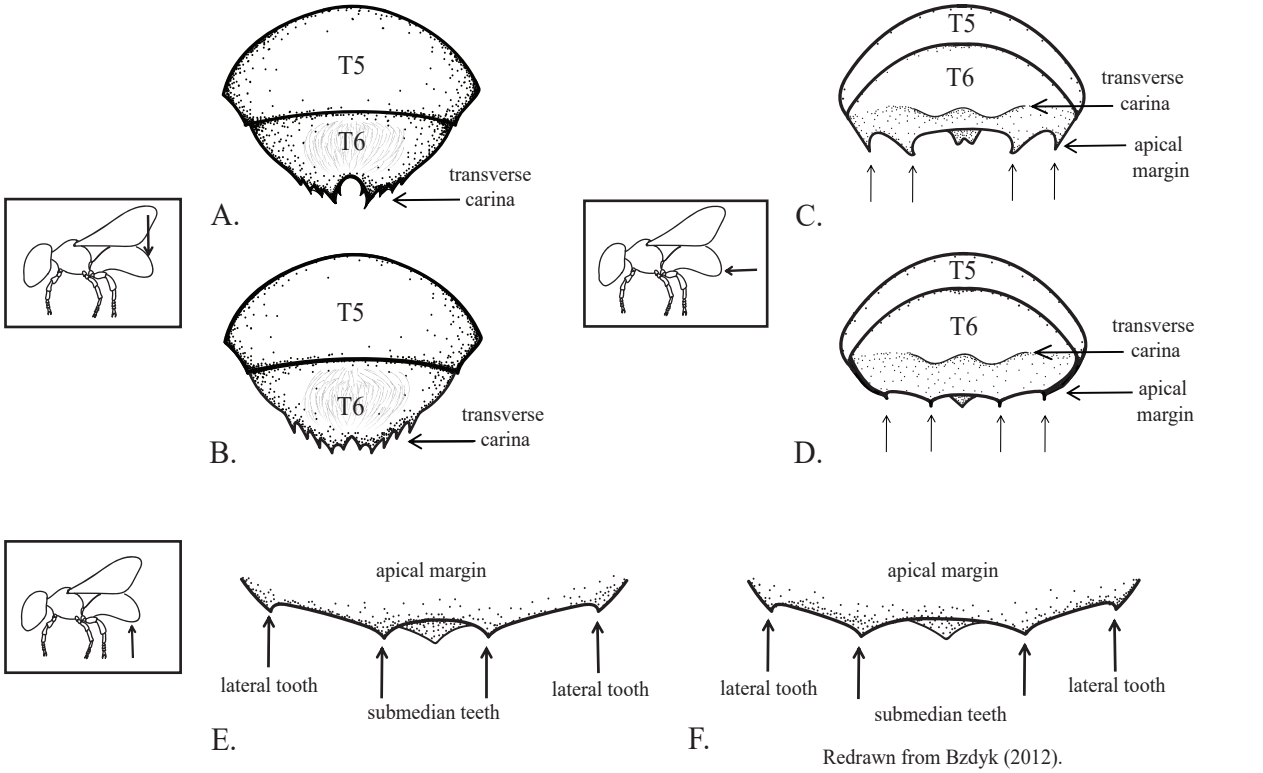

FIGURE 9. Male *Megachile* T6 characters. (A–B) Transverse carina, (C) Apical margin with two pairs of prominent teeth on *M. parallela*, (D) Apical margin with two pairs of small teeth, (E) Apical margin (ventrad the transverse carina) with submedian teeth closer to each other than to lateral teeth, and (F) Apical margin (ventrad to the transverse carina) with submedian teeth closer to lateral teeth than to each other.

13 Vertex of head with large, sparse punctation (ca. 4 punctures between lateral ocelli and posterior margin of vertex); small procoxal spine present but obscured by dense, plumose setae . . . . . *Megachile* (*Chelostomoides*) *campanulae* (Robertson)
- Vertex of head with small and dense punctation (ca. 9 punctures between lateral ocelli and posterior margin of vertex); small procoxal spine visible amidst surrounding short setae . . . . . *Megachile* (*Chelostomoides*) *angelarum* Cockerell

14 Procoxal spine present, may be reduced to a small nub and covered with small tuft of dense orange setae 15
- Procoxal spine absent 18

15 Procoxal spine prominent, longer than wide 16
- Procoxal spine nub-like, wider than long and covered with small tuft of dense orange setae 17

16 Ocelloccipital distance greater than ocellocular distance (Fig. 8J); T2–4 strongly depressed basally and apically (Fig. 10D) . . . . . *Megachile (Megachiloides) dakotensis* Mitchell
- Ocelloccipital distance less than ocellocular distance (Fig. 8L); T2–4 moderately depressed basally but not depressed apically (Fig. 10E) . . . . . *Megachile* (*Litomegachile*) *onobrychidis* Cockerell

17 Mandibular teeth unevenly spaced, 2nd tooth closer to apical tooth; ocelloccipital distance longer than ocellocular distance (Fig. 8J); body size 11–16 mm long . . . . . *Megachile* (*Megachile*) *inermis* Provancher
- Mandibular teeth evenly spaced from one another; ocelloccipital distance approximately subequal to (Fig. 8K) or shorter than (8L) ocellocular distance; body size 9–11mm long . . . . . *Megachile* (*Megachile*) *montivaga* Cresson

18 Clypeal margin with small triangular median tubercle . . . . . *Megachile* (*Megachile*) *lapponica* Thomson and *Megachile* (*Megachile*) *relativa* Cresson

[Note: The males of Montana *M. lapponica* and *M. relativa* cannot be reliably separated based on morphology. See Taxonomic Challenges in results above.]

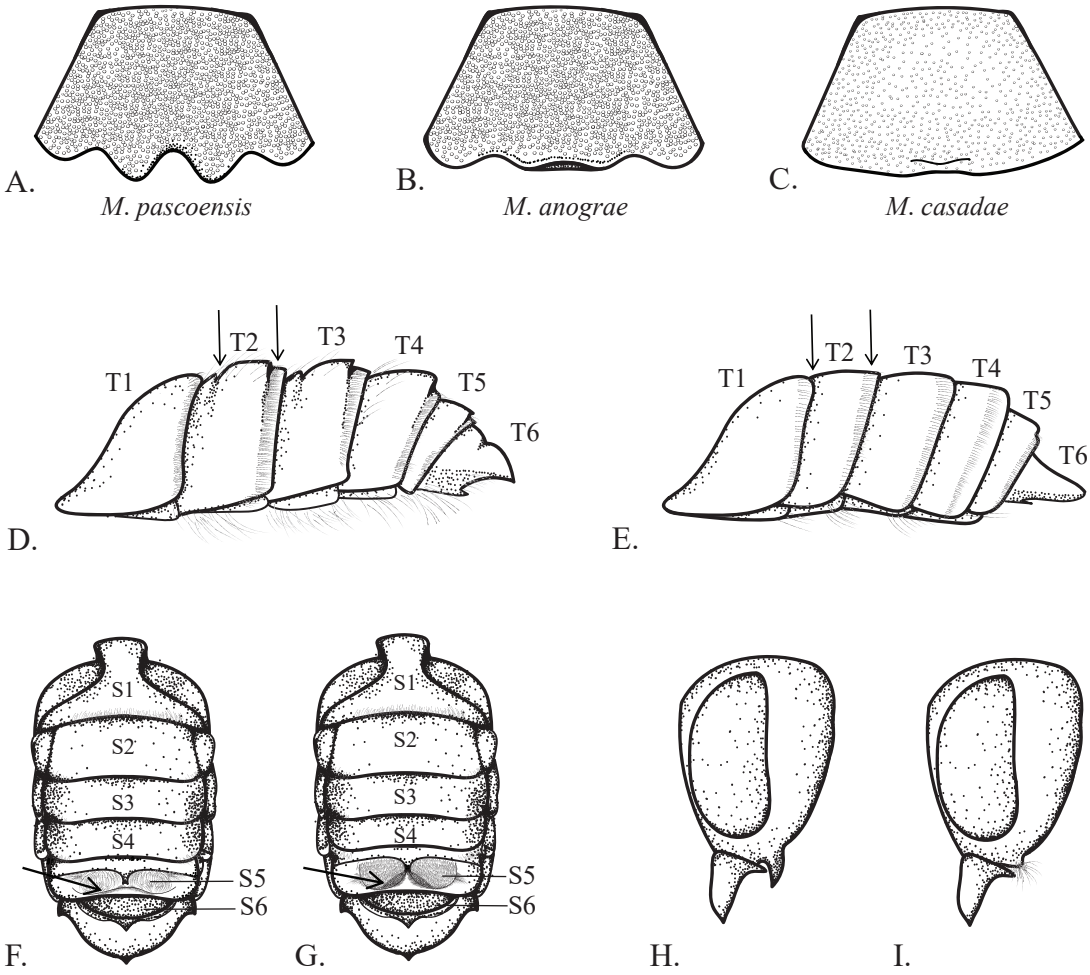

FIGURE 10. Male *Megachile* characters. (A–C) Anterior view of clypeus: (A) *M. pascoensis*, (B) *M. anograe*, (C) *M. casadae*, (D) Lateral view of tergites on *M. dakotensis*, (E) Lateral view of tergites on *M. onobrychidis*, (F) Ventral view of sternites without apicomedial setal patch on S5, (G) Ventral view of sternites of *M. anograe* with apicomedial setal patch on S5, (H) Lateral view of genal margin with tooth at least as long as wide, and (I) Lateral view of genal margin without obvious tooth.

- Clypeal margin without median tubercle . . . . . *Megachile* (*Megachile*) *centuncularis* (Linnaeus)

19 Mesobasitarsus with smooth, glabrous protuberance ventrally (Figs. 8C–D); mesotibia without apical spur (Figs. 8C–D); mesofemur widely enlarged, at least 2 times as wide as mesotibia 20
- Mesobasitarsus without protuberance ventrally (Fig. 8E); mesotibia with apical spur (Fig. 8E); mesofemur about 1.5 times as wide as mesotibia 22

20 Ventral mesepisternum (from ventral view of mesosoma, directly anterior to mesocoxa) with small spine . . . . . *Megachile* (*Xanthosarus*) *dentitarsus* Sladen
- Ventral mesepisternum (from ventral view of mesosoma, directly anterior to mesocoxa) with smooth, spineless carina 21

21 Mesobasitarsus from anterior view with narrowly rounded, ventral protuberance basally (Fig. 8D); ventral side of mesofemur smooth and convexly rounded . . . . . *Megachile* (*Xanthosarus*) *perihirta* Cockerell
- Mesobasitarsus from anterior view with wide, rounded, ventral protuberance basally (Fig. 8C); ventral side of mesofemur widely depressed . . . . . *Megachile* (*Xanthosarus*) *latimanus* Say

22 Mandibles 4-toothed 23
- Mandibles 3-toothed 25

23 Profemur with two brown stripes ventrally . . . . . *Megachile* (*Xanthosarus*) *frigida* Smith
- Profemur without two brown stripes ventrally (often one stripe occurs on *M. circumcincta*) 24

24 Dorsal face of protibia with posterior angle acute, apex entirely dark . . . . . *Megachile* (*Xanthosarus*) *gemula* Cresson

[Note: *Megachile* (*Xanthosarus*) *circumcincta* (Kirby) also keys out at 24. This species has not been recorded from Montana but could potentially occur in the state. *Megachile circumcincta* has a white apical setal band on T5 (absent in *M. gemula*) and often has one brown stripe on the ventral profemur. The dorsal face of the protibia of *M. circumcincta* has an acute posterior angle as in *M. gemula*, but the apex is yellow, whereas the apex of the protibia of *M. gemula* is dark brown to black.]

- Dorsal face of protibia with posterior angle rounded and spatulate, apex entirely pale . . . . . *Megachile* (*Xanthosarus*) *melanophaea* Smith

25 Procoxal spine thin and narrowly pointed (Fig. 8H) 26
- Procoxal spine wide and spatulate (Fig. 8I) 28

26 Protarsi distinctly yellow; front basitarsus with elongated apical dilation reaching apex of 3rd tarsomere . . . . . *Megachile* (*Sayapis*) *mellitarsis* Cresson
- Protarsi white or pale yellow to dark brown; front basitarsus with apical dilation not reaching 3rd tarsomere 27

27 Probasitarsus along basal ⅓ of posterior edge of scoop-shaped dilation with dark setae . . . . *Megachile* (*Sayapis*) *pugnata* Say
- Probasitarsus along entire posterior edge of scoop-shaped dilation with dark setae . . . . . *Megachile* (*Sayapis*) *fidelis* Cresson

[Note: *Megachile* (*Sayapis*) *inimica* Cresson also keys out at 27'. This species has not been recorded from Montana but could potentially occur in the state. *Megachile inimica* has a patch of short, suberect setae at the base of the procoxal spine (setae shorter than flagellomere 1), whereas *M. fidelis* has a few long, erect setae (setae longer than flagellomere 1) at the base of the procoxal spine.]

28 Genal margin directly posterior to the ventral mandibular attachment with tooth as-long-as or longer-than-wide (the prolegs may need to be repositioned to see this character) (Fig. 10H) 29
- Genal margin directly posterior to the ventral mandibular attachment without obvious tooth, often with a tuft of setae (Fig. 10I) 31

29 Procoxal spine with short, suberect setae in patch at base . . . . . *Megachile* (*Megachiloides*) *nevadensis* Cresson
- Procoxal spine without patch of setae at base 30

30 Ventral mesepisternum (from ventral view of mesosoma, directly posterior to the procoxal spine) with smooth, rounded carina, not protruding; metatarsomeres triangular from lateral view (Fig. 8F) . . . . . *Megachile* (*Megachiloides*) *manifesta* Cresson
- Ventral mesepisternum (from ventral view of mesosoma, directly posterior to the procoxal spine) with protruding triangular carina; metatarsomeres quadrate from lateral view (Fig. 8G) . . . . . *Megachile* (*Megachiloides*) *wheeleri* Mitchell

31 Pubescence on meso- and metalegs mostly black . . . . . *Megachile* (*Megachiloides*) *subnigra* Cresson
- Pubescence on meso- and metalegs mostly pale 32

32 Clypeal margin emarginate medially and laterally (Figs. 10A–B) 33
- Clypeal margin mostly straight, with slight emargination medially (Fig. 10C). . . . . *Megachile* (*Megachiloides*) *casadae* Cockerell

33 Clypeal margin with deep U-shaped median emargination (as deep as wide) (Fig. 10A); S5 narrowly rimmed apicomedially with dark brown setae (Fig. 10F); metafemur with hint of pale fovea dorsally . . . . . *Megachile* (*Megachiloides*) *pascoensis* Mitchell
- Clypeal margin with wide, shallow median emargination (2–3 times as wide as deep) (Fig. 10B); S5 with black apicomedial setal patch (Fig. 10G); metafemur with distinct, elongate, brown fovea dorsally . . . . . *Megachile (Megachiloides) anograe* Cockerell

[Note: *Megachile* (*Callomegachile*) *sculpturalis* (Smith) also keys out at 33'. This species has not been recorded from Montana but is an introduced species that could potentially occur in the state. *Megachile sculpturalis* has extremely large, unevenly-spaced punctures on T2–3, T2–4 basally depressed, T2–5 without white apical setal bands, a carinate genal margin, a large body size (> 20 mm long), and lacks dorsal fovea on the metafemur as seen in *M. anograe*. *Megachile anograe* has white apical setal bands on T1–4, lacks a carinate genal margin, and is smaller (10–11 mm long) than *M. sculpturalis*.]

Synonymical Tables, Diagnoses, and Notes for Montana *Megachile* Species (arranged alphabetically by species name):

Synonymical tables are not exhaustive and represent literature records for Montana only and relevant nomenclatural acts important to understanding our usage, including usage in papers cited in the text.

Megachile (*Chelostomoides*) *angelarum* Cockerell, 1902

Megachile angelarum Cockerell, 1902: 70. Burkle *et al*. 2020: 7.
Megachile (*Chelostomoides*) *angelarum*; Mitchell 1937d: 386; 1956: 131. Sheffield *et al*. 2011: 26. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 69.
Chalicodoma (*Chelostomoides*) *angelarum* (Cockerell); Butler 1965: 15. Hurd 1979: 2073.

Diagnosis. The female of *M. angelarum* can be recognized by its subparallel metasoma (viewed dorsally) (Fig. 6C), mandibles without cutting edges, clypeal margin that is medially emarginate and laterally crenulate, white T5 apical setal band which is similar in width and appearance to the T1–4 apical setal bands, vertex of head with small, dense punctation (ca. 8–10 punctures between lateral ocelli and posterior margin of vertex), and a smooth, shiny, impunctate occipital suture. The female of *M. angelarum* is most similar to *M. campanulae*, which has a medially incomplete T5 white apical setal band that is thinner and less plumose than those on T1–4, and large, sparse punctation on the vertex of head (ca. 4–6 punctures between lateral ocelli and posterior margin of vertex) (see Taxonomic Challenges). The male of *M. angelarum* can be distinguished by its retracted S4 and dense punctation on the vertex of the head (ca. 9 punctures between lateral ocelli and posterior margin of vertex). Male *M. angelarum* are most similar to *M. campanulae*, which have large, sparse punctation on the vertex of the head (ca. 4 punctures between lateral ocelli and posterior margin of vertex).

Notes. These mason bees use plant resins, not leaves, to construct nest cells in existing cavities and are therefore not leafcutting bees. This species was first recorded in the published literature from Montana in 2017 from Missoula County, though the earliest recorded specimen year is 2015 (Kuhlman & Burrows 2017; Table 1). It is now known from five counties in Western Montana (Fig. 1A). For further details on identification issues see Taxonomic Challenges. Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Megachiloides*) *anograe* Cockerell, 1908

Megachile anograe Cockerell, 1908: 261. Adhikari *et al*. 2019: Supplementary Table S4.
Megachile (*Derotropis*) *anograe*; Mitchell 1936: 158; 1944: 142. Hurd 1979: 2062. Ivanochko 1979: 257.
Megachile (*Megachiloides*) *anograe*; Raw 2002: 16. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 52. Delphia *et al*. 2019a: 25.
Megachile (*Derotropis*) *laurita* Mitchell, 1927a: 115; 1936: 160.
Megachile (*Megachiloides*) *laurita*: Raw 2002: 18.
Megachile (*Xeromegachile*) *alamosana* Mitchell, 1934: 329.
Megachile (*Derotropis*) *alamosana*; Mitchell 1936: 158; 1937a: 330; 1944: 142.
Megachile (*Megachiloides*) *alamosana*; Raw 2002: 16. Scott *et al*. 2011: 55.

Diagnosis. The female of *M. anograe* can be distinguished by its 3-toothed mandibles (Fig. 7A) and a smooth and shiny T6 with well-separated punctures (3–5 diameters apart). For information on the rare melanistic form (not seen in Montana) see Taxonomic Challenges. In Montana, females of this species are only likely to be confused with *M. pascoensis*, which also has 3-toothed mandibles, but in *M. pascoensis* T6 is pitted and dull with closely spaced punctures (≤ 1 diameter apart). The male of *M. anograe* can be distinguished by its wide and spatulate procoxal spine (Fig. 8I), medially and laterally emarginate clypeus (Fig. 10B), fovea on the dorsal metafemur, and apicomedial setal patch on S5 (Fig. 10G). Males of *M. anograe* are most similar to *M. pascoensis*, but the clypeal margin is much more deeply emarginate medially in *M. pascoensis* (Fig. 10A). For further details on identification issues see Taxonomic Challenges.

Notes. At the continental scale, *M. anograe* and *M. pascoensis* are in general allopatric, with *M. anograe* east

of the continental divide and *M. pascoensis* to the west. This division so far holds in Montana. *Megachile anograe* is the more common of the two in Montana, occurring in the drier southern and central counties east of the divide (Fig. 1B) while the rarer *M. pascoensis* is known only from the wetter northwest Montana west of the divide (Fig. 1AA). Sheffield *et al*. (2011) report melanistic forms in the western U.S., though we did not find them in Montana. Photographs, a full morphological description, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Eutricharaea*) *apicalis* Spinola, 1808

Megachile apicalis Spinola, 1808: 259.
Megachile (*Eutricharaea*) *apicalis*; Mitchell 1962: 120. Hurd 1979: 2057. Cooper 1984: 225. Sheffield *et al*. 2011: 29. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 69.
Megachile virginiana Mitchell, 1926a: 113.

Diagnosis. The female of *M. apicalis* can be identified by the white apical setal bands on S2–6 (Fig. 6A), black scopal setae on S5, and lateral, ovate fovea on T2 and T3. Females of *M. apicalis* are most similar to *M. rotundata*, which have white scopal setae on S5 and lateral, ovate fovea on T2 only. The male of *M. apicalis* can be distinguished by the lateral, ovate fovea on T2 and T3. Males of *M. apicalis* are most similar to *M. rotundata,* which have lateral, ovate fovea on T2 only.

Notes. *Megachile apicalis* is an accidentally introduced species in the United States, first collected in Montana in 2013 from localities in Deer Lodge, Sanders, and Lake Counties. It was first documented in the literature by Kuhlman & Burrows (2017). This species may contribute to pollination of the invasive yellow star-thistle (*Centaurea solstitialis*), though not as strongly as *A. mellifera* (Barthell *et al*. 2001). *Megachile apicalis* is currently present in western Montana but is expected to spread further (Fig. 1C). It is established on both coasts of the U.S. and seems to be moving into Montana from the Pacific Northwest region (see Discussion: Notes on *Megachile* (*Eutricharaea*) *rotundata* and Introduced *Megachile* Species). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *brevis* Say, 1837

Megachile brevis Say, 1837: 407. O'Neill and Seibert 1996: 321. Pearce 2008: 51, 107. Drons 2012: 58. Pearce *et al*. 2012: 101. Adhikari *et al*. 2019: Supplementary Table S4.
Megachile (*Litomegachile*) *brevis*; Mitchell 1935a: 13; 1962: 114. Butler 1965: 2. Hurd 1979: 2051. Ivanochko 1979: 78. Fultz 2005: 134. Gonzalez 2008: 35. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 33. Bzdyk 2012: 37. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 70. Engel 2020: 10.
Megachile brevis var. *nupta*; Mitchell 1935a: 13.

Diagnosis. The females of *M. brevis* can be identified by the usually all pale yellowish white scopal setae on S2–S6 (except occasionally black scopal setae on the apical half of S6; see Taxonomic Challenges), 4-toothed mandibles with an even, semicircular emargination between the 3rd and 4th teeth (Fig. 7B), appressed white setae on T6, and the "pinched shape" of T6, which is convex basally and concave apically (viewed laterally) (Fig. 7K). The females of *M. brevis* are most similar to *M. onobrychidis*, which has entirely black scopal setae on S6 and black setae on T6. For further details on identification issues see Taxonomic Challenges. The males of *M. brevis* can be identified by the narrow probasitarsus, which is not excavated ventrally (Fig. 8A), tomentose, white setae on T6, and weakly emarginate transverse carina on T6 (Fig. 9B).

Notes. *Megachile brevis* is a commonly collected species found widely in Montana (Fig. 1D) that nests in a variety of substrates (Sheffield *et al*. 2011). Photographs, illustrations, full morphological descriptions, and notes on the biology of this species can be found in Sheffield *et al*. (2011) and Bzdyk (2012).

Megachile (*Chelostomoides*) *campanulae* (Robertson, 1903)

Oligotropus campanulae Robertson, 1903: 171.
Megachile (*Chelostomoides*) *campanulae*; Mitchell 1934: 301; 1937d: 389; 1956: 136; 1962: 182. Raw 2002: 7. Gonzalez 2008: 37. Scott *et al*. 2011: 54. Sheffield *et al*. 2011: 28. Drons 2012: 58. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24.
Chalicodoma (*Chelostomoides*) *campanulae*; Hurd 1979: 2073.
Megachile campanulae; Burkle *et al*. 2020: 7.
Chelosomoides (*Chelosomoides*) *campanulae*; Engel 2020: 10.
Oligotropus wilmingtoni Mitchell, 1924: 156.
Megachile angelarum, not Cockerell, 1902 (misidentification); Reese *et al*. 2018: 21. Delphia *et al*. 2019b: 24. Burkle *et al*. 2020: 7. LaManna *et al*. 2020: Supplementary Material pg. 40.

Diagnosis. The female of *M. campanulae* can be identified by its subparallel metasoma (viewed dorsally) (Fig. 6C), mandibles without cutting edges, clypeal margin that is medially emarginate and laterally crenulate, a medially incomplete T5 apical setal band that is thinner and less plumose than T1–4 apical setal bands, vertex of head with large, sparse punctation (ca. 4–6 punctures between lateral ocelli and posterior margin of vertex), close and evenly spaced scutum punctation compared to irregular and inconsistent scutellum punctation, and a line of punctures on the occipital suture appearing as a slight carina. Females of *M. campanulae* are most similar to *M. angelarum* (see *M. angelarum* above) (see Taxonomic Challenges). The male of *M. campanulae* can be identified by its retracted S4 and large, sparse punctation on the vertex of the head (ca. 4 punctures between lateral ocelli and posterior margin of vertex). Males of *M. campanulae* are most similar to *M. angelarum* (see *M. angelarum* above).

Notes. In Montana, *M. campanulae* has been collected in scattered western and eastern localities (Fig. 1E). These mason bees use plant resins, not leaves, to construct nest cells in existing cavities or trap nests (O'Neill & O'Neill 2016) and are therefore not leafcutting bees. Because of misidentifications noted above in the synonymical table, the morphological description of the female in Sheffield *et al*. (2011) is not accurate. See Table 2, Supplementary Material 2: Erroneous Records, and Taxonomic Challenges for further explanation. The vouchers for the misidentified specimens (Reese *et al*. 2018; Burkle *et al*. 2020; LaManna *et al*. 2020) are in the Burkle Community Ecology Lab at Montana State University identified as female *M. campanulae* (5718LR, 19730CHS, 68812LR, 64728LR, 1725CHS, 73A817LR). The vouchers for the misidentified specimens (Delphia *et al*. 2019b) are in the O'Neill Research Collection at Montana State University identified as female *M. campanulae* (KMOC #1435, KMOC #1436, KMOC #1437) (Table 2).

Megachile (*Megachiloides*) *casadae* Cockerell, 1898

Megachile casadae Cockerell, 1898: 127. Drons 2012: 58.
Megachile (*Xeromegachile*) *casadae* Cockerell; Mitchell 1934: 302; 1937a: 348; 1944: 136. Butler 1965: 7. Hurd 1979: 2063.
Megachile (*Megachiloides*) *casadae* Cockerell; Raw 2002: 17. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 54.
Megachile austinensis Mitchell, 1927a: 105.

Diagnosis. The female of *M. casadae* can be identified by a shiny and sparsely punctate clypeus medially, 4-toothed mandibles with an asymmetrical emargination between the 3rd and 4th teeth that is deepest closer to the 4th tooth (Fig. 7C), black scopal setae on S6, and T6 with an elevated ridge apicomedially (appears laterally "pinched" in dorsal profile), with dense brown setae along ridge directed medially. The male of *M. casadae* can be identified by 3-toothed mandibles, wide and spatulate procoxal spines (Fig. 8I), and a slight medial emargination in its otherwise mostly straight clypeal margin (Fig. 10C).

Notes. This species is a new state record for Montana. *Megachile casadae* is most common to the south of Montana (Fig. 1F) and reaches its northernmost extent in Montana, east of the divide, and southern Alberta. Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Megachile*) *centuncularis* (Linnaeus, 1758)

Apis centuncularis Linnaeus, 1758: 575.
Megachile (*Athemois*) *centuncularis*; Mitchell 1935b.
Megachile (*Megachile*) *centuncularis*; Mitchell 1962: 124; 1980: 25. Butler 1965: 5. Hurd 1979: 2055. Ivanochko 1979: 145. Gonzalez 2008: 35. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 44. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. centuncularis* can be identified by its 5-toothed mandibles with evenly deep emarginations between all teeth (Fig. 7G), black setae on T6, and yellow to orange scopal setae on S2–6. It is most similar to *M. relativa*, which has golden setae on T6. The male of *M. centuncularis* can be identified by its narrow brown to black probasitarsi (Fig. 8A), sparse setae on T6, absence of a procoxal spine, and absence of a median tubercle on the clypeus. The male of *M. centucularis* is most similar to *M. lapponica*/*M. relativa*, which has a small triangular median tubercle on the clypeal margin.

Notes. This species is a new state record for Montana, though it is widespread elsewhere in North America. In Montana, it has been sparsely collected in a few western localities (Fig. 1G). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *coquilletti* Cockerell, 1915

Megachile mendica coquilletti Cockerell, 1915: 535.
Megachile (*Litomegachile*) *coquilletti*; Mitchell 1935a: 21. Butler 1965: 2. Hurd 1979: 2052. Ivanochko 1979: 93. Sheffield *et al*. 2011: 35. Bzdyk 2012: 41. Kuhlman and Burrows 2017: 12. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. coquilletti* can be distinguished by its moderately concave T6 (Fig. 7M) with brown to black setae (often with suberect pale setae in small patches laterally), 4-toothed mandibles with a semicircular, symmetrical emargination between the 3rd and 4th teeth (Fig. 7B), and long transverse medial carina on the apical margin of the clypeus (four times as long as diameter of median ocellus) (Fig. 6H). Females are difficult to distinguish from *M. lippiae*, which has suberect pale setae and erect black setae on T6 and a short medial carina on the apical margin of the clypeus (two times as long as diameter of median ocellus) (Fig. 6G). For further details on identification issues see Taxonomic Challenges. The male of *M. coquilletti* can be distinguished by its narrow probasitarsus (Fig. 8A), which is not excavated ventrally, and light to dark yellow coloration on tarsomeres 2–4.

Notes. This species has been collected in central and western Montana (Fig. 1H). Photographs, illustrations, full morphological descriptions, and notes on the biology of this species can be found in Sheffield *et al*. (2011) and Bzdyk (2012).

Megachile (*Megachiloides*) *dakotensis* Mitchell, 1926

Megachile dakotensis Mitchell, 1926b: 164.
Megachile (*Xeromegachile*) *dakotensis*; Mitchell 1937a: 335; 1944: 136; 1962: 145. Hurd 1979: 2063.
Megachile (*Megachiloides*) *dakotensis*; Raw 2002: 17.

Diagnosis. The female of *M. dakotensis* can be identified by the shape of T3–5, which are strongly concave between the depressed apical and basal grooves (Fig. 7O), reddish tibiae apically, and the asymmetrical emargination between its 3rd and 4th (basal) teeth with emargination deepest closer to the 4th tooth (Fig. 7C). The male of *M. dakotensis* can be identified by its procoxal spine (Fig. 8H), which is longer than wide, reddish tibiae apically (front tibiae can be yellowish apically), and the shape of T2–4, which are strongly concave between the depressed apical and basal grooves (Fig. 10D).

Notes. Mitchell (1937a) recorded this species from Montana without a more specific locality, and since then, only two specimens have been collected in Montana, both at Medicine Rocks State Park, near the eastern border, in 2020 (Fig. 1I). We have been unable to locate Michell's voucher. This rarely collected species was first described in Mitchell 1926b, then redescribed in Mitchell (1937a) and Mitchell (1962) with male characters illustrated. Photographs of both sexes can be found on BOLD (http://www.barcodinglife.org).

Megachile (*Xanthosarus*) *dentitarsus* Sladen, 1919

Megachile dentitarsus Sladen, 1919: 85. Drons 2012: 58. Adhikari *et al*. 2019: Supplementary Table S4.
Megachile (*Xanthosarus*) *dentitarsus*; Mitchell 1936: 127. Butler 1965: 11. Hurd 1979: 2067. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 73.

Diagnosis. The female of *M. dentitarsus* can be identified by its consistently wide, white apical setal bands on T3–5 and its 5-toothed mandibles (Fig. 7F), with the deepest emargination between the 3rd and 4th tooth, strongly angled towards the 4th tooth. Females are most commonly confused with *M. latimanus/M. perihirta* females, which have medially incomplete apical setal bands. The male of *M. dentitarsus* can be identified by its widely expanded and ventrally excavated probasitarsus (Fig. 8B), the smooth, glabrous ventral protuberance on its mesobasitarsus (Fig. 8D), and the small spine on the ventral mesepisternum (viewed ventrally, directly anterior to mesocoxa). Males are most similar to *M. perihirta*, in which the ventral mesepisternum (viewed ventrally, directly anterior to mesocoxa) has a smooth, spineless carina instead of a spine.

Notes. In Montana, this species is widespread east of the continental divide (Fig. 1J). Photographs, a full morphological description, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Sayapis*) *fidelis* Cresson, 1878

Megachile fidelis Cresson, 1878: 120. Drons 2012: 58.
Megachile (*Sayapis*) *fidelis*; Mitchell 1937c: 180. Butler 1965: 12. Hurd 1979: 2070. Ivanochko 1979: 325. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 64. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 22. Sheffield and Heron 2019: 70. Engel 2020: 10.

Diagnosis. The female of *M. fidelis* is distinguished by its subparallel metasoma (viewed dorsally) (Fig. 6C) and clypeal margin with two prominent, wide, lateral tubercles surrounding a median triangular tubercle (Fig. 6F), which is unique among documented Montana *Megachile* species. The male of *M. fidelis* is distinguished by its thin and narrowly pointed procoxal spine (Fig. 8H) and its widely expanded and ventrally excavated probasitarsus (Fig. 8B) with dark setae along the entire posterior edge of the scoop-shaped dilation. The male of *M. fidelis* is most similar to *M. pugnata*, which has dark setae along only the basal ⅓ of the posterior edge of the scoop-shaped dilation.

Notes. This species has been recorded mainly in western Montana (Fig. 1K), with one record further east in Musselshell County, but it would be expected to be found in the eastern half of the state due to a record of *M. fidelis* from the Black Hills of South Dakota (Drons 2012). Photographs, a full morphological description, and notes on the biology of this cavity-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Xanthosarus*) *frigida* Smith, 1853

Megachile frigida Smith, 1853: 193. Drons 2012: 58.
Megachile (*Delomegachile*) *frigida*; Mitchell 1942: 116; 1944: 135; 1962: 133. Butler 1965: 6. Hurd 1979: 2059. Ivanochko 1979: 195.
Megachile (*Xanthosarus*) *frigida*; Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 76. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 25. Delphia *et al*. 2019b: 649. Sheffield and Heron 2019: 70.
Megachile (*Delomegachile*) *frigida appalachensis* Mitchell, 1962: 134.
Megachile (*Delomegachile*) *vidua* var. *appalachensis* Mitchell, 1935b: 205.
Megachile vidua, not Smith, 1853 (misidentification); Fultz 2005: 134.

Diagnosis. The female of *M. frigida* can be identified by its 4-toothed mandibles with a truncate basal mandibular tooth (Fig. 7E), dark brown to black setae on T6, and mostly yellow to orange scopal setae on S6. The female of *M. frigida* is most similar to *M. latimanus/M. perihirta*, which has 5-toothed mandibles (Fig. 7F) and orange setae on T6. The male of *M. frigida* can be identified by its widely expanded and ventrally excavated probasitarsus (Fig. 8B) and two brown stripes on the ventral profemur, which is unique among male *Megachile* documented in Montana.

Notes. This widespread, distinctive species is found across Montana, though it has been sparsely collected in

the eastern half of the state (Fig. 1L). It is known to nest in rotting logs, cavities, and bark mulch (Sheffield *et al*. 2011; Delphia *et al*. 2019b). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011). The voucher for the misidentified specimen (Fultz 2005) is in the MTEC identified as a male *M. frigida* (MTEC 088592) (Table 2; Supp. Material 2: Erroneous Records).

Megachile (*Xanthosarus*) *gemula* Cresson, 1878

Megachile gemula Cresson, 1878: 118. Mitchell 1927b: 178. Drons 2012: 58.
Megachile (*Delomegachile*) *gemula* Cresson; Mitchell 1935b: 181; 1936: 185; 1962: 134. Butler 1965: 6. Hurd 1979: 2059. Ivanochko 1979: 186.
Megachile (*Xanthosarus*) *gemula*; Raw 2002: 36. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 78. Reese *et al*. 2018: 23. Delphia *et al*. 2019b: 649. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. gemula* can be identified by white pubescence on T1–2 that contrasts with the dark pubescence on T3–5, reddish-brown to black scopal setae on S2–6, 4-toothed mandibles with a truncate basal tooth (Fig. 7E), and base of mandibles square-shaped (viewed laterally) with parallel sides for a distance as long as wide, then tapering apically (Fig. 6J). Females of *M. gemula* are most similar to *M. melanophaea*, which have mandibles gradually tapering in width towards apex (from a lateral view) (Fig. 6I) and orange scopal setae on S2–6. The male of *M. gemula* can be identified by its narrow, ventrally excavated probasitarsus, 4-toothed mandibles, and acute posterior angle of the dorsal face of the protibia, the apex entirely dark. The male of *M. gemula* is most similar to *M. melanophaea*, in which the dorsal face of the protibia has a rounded and spatulate posterior angle that is entirely cream to pale yellow at the apex.

Notes. *Megachile gemula* is found widely in Montana though, like many species, has not been extensively collected in eastern regions of the state (Fig. 1M). It is known to nest in poplar logs and hollow twigs (Sheffield *et al*. 2011). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *gentilis* Cresson, 1872

Megachile gentilis Cresson, 1872: 267.
Megachile (*Litomegachile*) *gentilis*; Mitchell 1935a: 23. Butler 1965: 3. Hurd 1979: 2053. Gonzalez 2008: 35. Sheffield *et al*. 2011: 36. Bzdyk 2012: 44. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. gentilis* can be identified by the black scopal setae on S6, white scopal setae on S2–5, and 4-toothed mandibles with an angulate basal mandibular tooth appearing as a weak additional tooth (i.e., 5-toothed) (Fig. 7D). The female of *M. gentilis* is closest to *M. mendica*, which has mostly yellow to light orange scopal setae on S6 but can approach ca. 50% black scopal setae apically. For further details on identification issues see Taxonomic Challenges. The male of *M. gentilis* can be identified by its narrow probasitarsus, which is not excavated ventrally, T5 without a white apical setal band (may have some setae laterally), and T4–5 dull with punctures ca. 1 diameter apart. The male of *M. gentilis* is closest to *M. mendica*, in which T4–5 is polished and shiny, with punctures 2–4 diameters apart.

Notes. This species is a new state record for Montana and has been collected from scattered localities in central and western Montana (Fig. 1N). *Megachile gentilis* nests in natural cavities as well as trap nests (Sheffield *et al*. 2011). Photographs, illustrations, full morphological descriptions, and notes on its biology can be found in Sheffield *et al*. (2011) and Bzdyk (2012).

Megachile (*Megachile*) *inermis* Provancher, 1888

Megachile inermis Provancher, 1888: 323. Drons 2012: 58.
Megachile (*Anthemois*) *inermis*; Mitchell 1935b: 171.
Megachile (*Megachile*) *inermis*; Mitchell 1962: 126. Hurd 1979: 2055. Ivanochko 1979: 133. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 45. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. inermis* can be identified by its distinctively large body size (17–20 mm long), shiny clypeus with sparse punctation medially (punctures 1–3 diameters apart), and clypeal margin with four prominent tubercles. The male of *M. inermis* can be identified by its large body size (11–16 mm long), unevenly spaced 3-toothed mandibles (2nd tooth closer to apical tooth), and its nub-like procoxal spine, which is wider than long and covered with a small tuft of dense orange setae. Males are most similar to *M. montivaga*, which has evenly spaced teeth.

Notes. *Megachile inermis*, a distinctively large species, has been recorded in several localities in western Montana (Fig. 1O). This species is known to nest in cavities and rotting logs (Sheffield *et al*. 2011). Photographs, a full morphological description, and notes on its biology can be found in Sheffield *et al*. (2011).

Megachile (*Megachile*) *lapponica* Thomson, 1872

Megachile lapponica Thomson, 1872: 227.
Megachile (*Megachile*) *lapponica*; Sheffield *et al*. 2011: 47. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 70.
Megachile nivalis Friese, 1903: 246.
Megachile (*Anthemois*) *santiamensis* Mitchell, 1934: 311.
Megachile (*Anthemois*) *nivalis*; Mitchell 1935b: 174; 1942: 115.
Megachile (*Megachile*) *nivalis*; Mitchell 1962: 129. Hurd 1979: 2056. Ivanochko 1979: 170. Sheffield and Westby 2007: 178. Scott *et al*. 2011: 55.

Diagnosis. The females of *M. lapponica* can be identified by their 5-toothed mandibles with evenly deep emarginations between teeth (Fig. 7G), brown to black scopal setae on S6, and scopal setae on S5 black apically and yellow to pale orange basally. The female of *M. lapponica* is most similar to *M. relativa*, which has golden scopal setae on S6, and *M. centuncularis*, which has black setae on T6. The males of *M. lapponica* cannot be reliably separated from males of *M. relativa* in Montana based on external morphology or by examining the genitalia (see Taxonomic Challenges; Sheffield & Westby 2007). Males of *M. lapponica*/*M. relativa* can be recognized by the absence of a procoxal spine, small median triangular tubercle on the clypeal margin, narrow brown to black probasitarsi, evenly spaced 3-dentate mandibles, and T6 with sparse setae, not tomentose. *Megachile lapponica*/*M. relativa* is most similar to *M. centuncularis* (see *M. centuncularis* above).

Notes. *Megachile lapponica* females have been found in scattered localities across the western half of Montana (Fig. 1P). Photographs, a full morphological description (but see Taxonomic Challenges), and notes on the biology of *M. lapponica* can be found in Sheffield *et al*. (2011).

Megachile (*Xanthosarus*) *latimanus* Say, 1823

Megachile latimanus Say, 1823: 81.
Megachile (*Xanthosarus*) *latimanus*; Mitchell 1936: 130; 1962: 157. Hurd 1979: 2067. Ivanochko 1979: 268. Fultz 2005: 134. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 79. Reese *et al*. 2018: 23. Delphia *et al*. 2019a: 25. Engel 2020: 11.
Megachile (*Delomegachile*) *vidua* Smith, 1853: 192. Mitchell 1935b: 200.
Megachile latimanus/perihirta; Pearce 2008: 57.

Diagnosis. The females of *M. latimanus* cannot be reliably separated from *M. perihirta* in Montana based on morphology (see Taxonomic Challenges). *Megachile latimanus*/*M. perihirta* have 5-toothed mandibles with the deepest emargination between the 3rd and 4th teeth, emargination strongly angled towards the 4th tooth (Fig. 7F), and medially incomplete apical setal bands on T3–5. Females are most similar to *M. dentitarsus*, which has T3–5 apical setal bands consistently wide, as wide medially as laterally. The male of *M. latimanus* can be identified by its widely expanded and ventrally excavated probasitarsus (Fig. 8B), the wide, rounded, ventral protuberance of the mesobasitarsus basally (viewed anteriorly) (Fig. 8C), and the widely depressed ventral side of the mesofemur. Males are most similar to *M. perihirta*, which has mesobasitarsus with narrowly rounded, ventral protuberance basally (Fig. 8D) and the smooth, convexly rounded ventral side of mesofemur.

Notes. *Megachile latimanus* has been recorded in a few scattered localities across Montana (Fig. 1Q).

Photographs, a full morphological description (but see Taxonomic Challenges), and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *lippiae* Cockerell, 1900

Megachile cleomis var. *lippiae* Cockerell, 1900: 15.
Megachile texana var. *lippiae* Cockerell, 1900: 223. Mitchell 1935a: 37.
Megachile lippiae; Pearce 2008: 51. Pearce *et al*. 2012: 101.
Megachile (*Litomegachile*) *lippiae*; Butler 1965: 3. Hurd 1979: 2053. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 38. Bzdyk 2012: 46. Kuhlman and Burrows 2017: 12. Sheffield and Heron 2019: 70. Engel 2020: 10.
Megachile concinna, not Smith, 1879 (misidentification); Pearce 2008: 107.

Diagnosis. The female of *M. lippiae* can be identified by its suberect white setae and erect black setae on T6 and apically concave T6 (viewed laterally) (Fig. 7N). The female is difficult to discern from *M. coquilletti* (see *M. coquilletti* above) (see Taxonomic Challenges). The male of *M. lippiae* can be identified by its narrow probasitarsus, which is not excavated ventrally, the apical margin of T6 (ventrad to the transverse carina) with submedian teeth closer to lateral teeth than to each other (Fig. 9F), the scutum with less than 25% black pubescence, and mostly white pubescence on the dorsal tergites and vertex of head. The male of *M. lippiae* is most similar to *M. texana*, which has greater than 50% black pubescence on the scutum, tergites with significant bands of black pubescence, and the vertex of head with greater than 50% black pubescence (see Taxonomic Challenges).

Notes. *Megachile lippiae* has been collected widely across Montana (Fig. 1R). Photographs, illustrations, full morphological descriptions, and notes on the biology of this species can be found in Sheffield *et al*. (2011) and Bzdyk (2012). Sheffield and Genaro (2013) briefly made a claim of validity for *Megachile cleomis* Cockerell. See Taxonomic Challenges above for a discussion of this issue. The voucher for the misidentified specimen (Pearce 2008) is in the MTEC identified as a male *M. lippiae* (MTEC 088326) (Table 2; Supp. Material 2: Erroneous Records).

Megachile (*Megachiloides*) *manifesta* Cresson, 1878

Megachile manifesta Cresson, 1878: 122. Drons 2012: 58.
Megachile (*Xeromegachile*) *manifesta*; Mitchell 1937a: 352. Butler 1965: 8. Hurd 1979: 2064.
Megachile (*Megachiloides*) *manifesta*; Raw 2002: 18. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 55.

Diagnosis. The female of *M. manifesta* can be identified by its 4-toothed mandibles with an asymmetrical emargination between the 3rd and 4th teeth that is deepest nearer the 4th tooth (Fig. 7C), black scopal setae on S6 and at least the apical part of S5, the basal portion with white scopal setae, and T5 surface matte to shiny with punctures ≤ 1 diameter apart medially. Females are closest to *M. nevadensis*, which has all white scopal setae on S5, and *M. wheeleri*, which has the surface of T5polished and shiny with punctures 2–4 diameters apart medially (see Taxonomic Challenges). The male of *M. manifesta* can be identified by its wide and spatulate procoxal spine without a setae patch at the base (Fig. 8I), triangular metatarsomeres (viewed laterally) (Fig. 8F), and a smooth, rounded carina on the ventral mesepisternum (viewed ventrally, directly posterior to the procoxal spine). The male of *M. manifesta* is most similar to *M. wheeleri*, which differs in having quadrate metatarsomeres (viewed laterally) (Fig. 8G).

Notes. This species, in general occurring in the western U.S. and Canada, is found in drier areas of eastern and south-central Montana (Fig. 1S). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Xanthosarus*) *melanophaea* Smith, 1853

Megachile melanophaea Smith, 1853: 191. Drons 2012: 58. Burkle *et al*. 2020: 7.
Megachile (*Delomegachile*) *melanophaea*; Mitchell 1935b: 190; 1962: 138. Butler 1965: 6. Hurd 1979: 2060. Ivanochko 1979: 215. Fultz 2005: 134.

Megachile (*Xanthosarus*) *melanophaea*; Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 81. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 23. Delphia *et al*. 2019a: 25. Sheffield and Heron 2019: 70.
Megachile melanophaea wootoni; Mitchell 1935b: 190.

Diagnosis. The female of *M. melanophaea* can be distinguished by its white pubescence on T1–2, contrasting the dark pubescence on T3–5, orange scopal setae on S2–6, and mandibles gradually tapering in width from base to apex (viewed laterally) (Fig. 6I). The female of *M. melanophaea* is most similar to *M. gemula* (see *M. gemula* above). The male of *M. melanophaea* can be identified by its 4-toothed mandibles and the dorsal face of the protibia, which has a rounded, spatulate posterior angle and an entirely pale apex. The male of *M. melanophaea* is most similar to *M. gemula* (see *M. gemula* above).

Notes. This species has been collected widely in Montana, with sparser records in the eastern part of the state, reflecting the general trend of more intensive collecting in the western portion of the state (Fig. 1T). Photographs, a full morphological description, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Sayapis*) *mellitarsis* Cresson, 1878

Megachile mellitarsis Cresson, 1878: 121.
Megachile (*Sayapis*) *mellitarsis*; Mitchell 1937c: 194. Hurd 1979: 2071. Ivanochko 1979: 328. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 66. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. mellitarsis* can be distinguished by the two broadly incurved emarginations on its clypeal margin (Fig. 6E), 4-toothed mandibles with evenly deep emarginations between all teeth, and reddish-brown tarsi contrasting the black tibia on the legs. The male of *M. mellitarsis* can be distinguished by the thin, narrowly pointed procoxal spine (Fig. 8H), orangish brown meso- and metatarsi, and the distinctly yellow protarsi with elongated apical dilation that reaches apex of the 3rd tarsomere. The male of *M. mellitarsis* is closest to *M. pugnata* and *M. fidelis*, both of which have front basitarsi with apical dilation not reaching 3rd tarsomere. For more details on identification issues see Taxonomic Challenges.

Notes. This species is a new state record for Montana. Other than a record from British Columbia's Western Interior Basin (Sheffield 2019), this dry-land species is at the northern edge of its known range in southern Montana (Fig. 1U). Photographs, a full morphological description, and notes on the biology of this species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *mendica* Cresson, 1878

Megachile mendica Cresson, 1878: 126. Drons 2012: 58.
Megachile (*Litomegachile*) *mendica*; Mitchell 1935a: 26; 1962: 117. Butler 1965: 3. Hurd 1979: 2053. Ivanochko 1979: 96. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 39. Bzdyk 2012: 47. Sheffield and Heron 2019: 70. Engel 2020: 10.

Diagnosis. The female of *M. mendica* is distinguished by its mostly yellow to orange scopal setae on S5 and S6, with only a few black scopal setae, T6 straight (viewed laterally) (Fig. 7J) with brown appressed setae, and 4-toothed mandibles with an angulate basal tooth, appearing as a weak additional tooth (i.e., 5-toothed) (Fig. 7D). Females of *M. mendica* are most similar to *M. gentilis* (see *M. gentilis* above), and *M. snowi,* which has white appressed setae on T6 (*M. snowi* is a prior subspecies of *M. mendica*; Byzdk 2012). The male of *M. mendica* is distinguished by its narrow probasitarsus, which is not excavated ventrally (Fig. 8A), T5 without a white apical setal band, and T4–5 polished and shiny with punctures 2–4 diameters apart. The male of *M. mendica* is most similar to *M. gentilis* (see *M. gentilis* above) and *M. snowi*, which differs in having a complete T5 white apical setal band.

Notes. This species is a new state record for Montana and has only been collected from two localities in eastern Montana (Fig. 1V). Photographs, illustrations, full morphological descriptions, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011) and Bzdyk (2012).

Megachile (*Megachile*) *montivaga* Cresson, 1878

Megachile montivaga Cresson, 1878: 124. Drons 2012: 58.
Megachile (*Anthemois*) *montivaga*; Mitchell 1935b: 167.
Megachile (*Megachile*) *montivaga*; Mitchell 1962: 127. Butler 1965: 5. Hurd 1979: 2056. Ivanochko 1979: 127. Gonzalez 2008: 35. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 49. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 70. Engel 2020: 10.

Diagnosis. The female of *M. montivaga* is distinguished by its light yellow to orange scopal setae on S2–S6, appressed cream-colored setae on T6, its 5-toothed mandibles, which have no cutting edge ventrad the tooth plane, and an elevated ridge running dorsally from the apex of the 2nd tooth to the point of attachment of the mandible (Fig. 7H). The male of *M. montivaga* is distinguished by its three evenly spaced mandibular teeth and its nub-like procoxal spine, which is wider than long and covered with a small tuft of dense orange setae. The male of *M. montivaga* is most similar to *M. inermis* (see *M. inermis* above).

Notes. *Megachile montivaga* has been widely collected in western Montana and from a few eastern localities (Fig. 1W). It is known to nest in soil and old stems. Photographs, a full morphological description, and notes on its biology can be found in Sheffield *et al*. (2011).

Megachile (*Megachiloides*) *nevadensis* Cresson, 1879

Megachile nevadensis Cresson, 1879: 209.
Megachile (*Xeromegachile*) *nevadensis*; Mitchell 1937a: 359. Hurd 1979: 2064.
Megachile (*Megachiloides*) *nevadensis*; Raw 2002: 19. Scott *et al*. 2011: 56.

Diagnosis. The female of *M. nevadensis* can be identified by its black scopal setae on S6, white scopal setae on S5, T5 with punctures ≤ 1 diameter apart medially, and 4-toothed mandibles with an asymmetrical emargination between the 3rd and 4th teeth that is deepest nearer the 4th tooth (Fig. 7C). The females are most similar to *M. manifesta* (see *M. manifesta* above) and *M. wheeleri*, which has T5 with punctures 2–4 diameters apart medially (see Taxonomic Challenges). The male of *M. nevadensis* can be identified by its 3-toothed mandibles, its wide and spatulate procoxal spine (Fig. 8I), with a short, suberect patch of setae at the base, and carina on mesepisternum with long setae touching the hind coxae. The males are most similar to *M. wheeleri* and *M. manifesta*, neither of which have a patch of setae at the base of the procoxal spine.

Notes. This species was recorded from Bozeman, Montana, by Mitchell (1937a), but we were unable to locate the voucher (see Discussion: Searching for Mitchell's Montana Species). However, collecting in eastern Montana resulted in collection of one male specimen of *M. nevadensis* in 2021 (Fig. 1X). The species was first described in Cresson (1879), then redescribed in more detail in Mitchell (1937a) with illustrations of male characters. Photographs of both sexes can be found on BOLD (http://www.barcodinglife.org).

Megachile (*Litomegachile*) *onobrychidis* Cockerell, 1908

Megachile onobrychidis Cockerell, 1908: 266.
Megachile (*Litomegachile*) *brevis onobrychidis*; Butler 1965: 2. Hurd 1979: 2052. Scott *et al*. 2011: 55.
Megachile (*Litomegachile*) *onobrychidis*; Ivanochko 1979: 90. Sheffield *et al*. 2011: 41. Bzdyk 2012: 50. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 22. Sheffield and Heron 2019: 70. Engel 2020: 10.

Diagnosis. The female of *M. onobrychidis* can be identified by the shape of T6, which is strongly convex basally and concave apically (Fig. 7K), black setae on T6, 4-toothed mandibles with an even semicircular emargination between the 3rd and 4th teeth (Fig. 7B), and black scopal setae on S6. The females are most similar to *M. brevis* (see *M. brevis* above*)*. The male of *M. onobrychidis* can be identified by the sparse setae on T6, the shape of the procoxal spine, which is longer than wide, and the shorter ocelloccipital distance compared to the ocellocular distance (Fig. 8L).

Notes. *Megachile onobrychidis* is found across Montana, though like many other species, has been less collected

in eastern parts of the state (Fig. 1Y). Photographs, illustrations, full morphological descriptions, and notes on its biology can be found in Sheffield *et al*. (2011) and Bzdyk (2012).

Megachile (*Argyropile*) *parallela* Smith, 1853

Megachile parallela Smith, 1853: 191. Pearce 2008: 51. Drons 2012: 58. Pearce *et al*. 2012: 101.
Megachile (*Argyropile*) *parallela*; Mitchell 1937b: 48. Mitchell 1943: 12; 1944: 132; 1962: 159. Butler 1965: 10. Hurd 1979: 2066. Ivanochko 1979: 303. Gonzalez and Griswold 2007: 3. Gonzalez 2008: 161. Scott *et al*. 2011: 54. Sheffield *et al*. 2011: 23. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 69. Engel 2020: 10.
Megachile (*Argyropile*) *asterae* Mitchell, 1943: 13.

Diagnosis. The female of *M. parallela* can be identified by the upcurve at the apical end of S6, which extends past T6 (Fig. 7L) and the appressed white to yellow setae on T6. The male of *M. parallela* can be identified by the two pairs of prominent teeth on the apical margin of T6, (Fig. 9C) and large, semi-circular emargination of the pre-apical carina of T6.

Notes. This species is recorded from localities across Montana (Fig. 1Z). Photographs, a full morphological description, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Megachiloides*) *pascoensis* Mitchell, 1934

Megachile (*Xeromegachile*) *pascoensis* Mitchell, 1934: 320.
Megachile (*Derotropis*) *pascoensis*; Mitchell 1944: 142. Hurd 1979: 2062.
Megachile (*Megachiloides*) *pascoensis*; Raw 2002: 16. Kuhlman and Burrows 2017: 13.
Megachile gabrielensis Michell, 1934: 346; 1936: 159.

Diagnosis. The female of *M. pascoensis* can be identified by its 3-toothed mandibles (Fig. 7A) and pitted, dull T6 with punctures ≤ 1 diameter apart. The females are most similar to *M. anograe* (see *M. anograe* above). The male of *M. pascoensis* can be identified by its clypeal margin, which has a deep U-shaped median emargination (as deep as wide) (Fig. 10A) and the white apical setal band on T5.

Notes. This distinctive species is rare outside of California. In Montana, it is known from a historical record (Mitchell 1934) and two specimens from Missoula County (Kuhlman & Burrows 2017) (Fig. 1AA). The species was first described in Mitchell (1934) (male = *M. pascoensis*; female = *M. gabrielensis*) and has not been redescribed or illustrated since. Photographs of the types of both sexes can be found on Big-Bee (Seltmann *et al*. 2021).

Megachile (*Xanthosarus*) *perihirta* Cockerell, 1898

Megachile perihirta Cockerell, 1898: 126. Drons 2012: 58. Adhikari *et al*. 2019: Supplementary Table S4.
Megachile (*Xanthosarus*) *perihirta*; Mitchell 1936: 136. Butler 1965: 11. Hurd 1979: 2067. Fultz 2005: 134. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 83. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 23. Delphia *et al*. 2019a: 25. Sheffield and Heron 2019: 70. Engel 2020: 11.
Megachile fortis, not Cresson, 1872 (misidentification); Simanonok 2018: 89.
Megachile circumcincta, not Kirby, 1802 (misidentification); Adhikari *et al*. 2019: Supplementary Table S4.

Diagnosis. The females of *M. latimanus* and *M. perihirta* cannot be reliably separated in Montana based on morphology (see *M. perihirta* above) (see Taxonomic Challenges). *Megachile latimanus*/*M. perihirta* has 5-toothed mandibles with the deepest emargination between the 3rd and 4th teeth, emargination strongly angled towards the 4th tooth (Fig. 7F), and medially incomplete apical setal bands on T3–5. The male of *M. perihirta* can be identified by its widely expanded probasitarsus (Fig. 8B), which is excavated ventrally, narrowly rounded, ventral protuberance on its basal mesobasitarsus (viewed anteriorly) (Fig. 8D), and smooth, convexly rounded anterior mesofemur. The males are most similar to *M. dentitarsu*s (see *M. dentitarsus* above).

Notes. *Megachile perihirta* is a common, widespread species in Montana (Fig. 1AB). Photographs, a full

morphological description (but see Taxonomic Challenges), and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011). The vouchers for the misidentified specimens (Simanonok 2018) are in the Burkle Community Ecology Lab at Montana State University identified as female *M. latimanus*/*M. perihirta* (8713MS16, 19715EE, 20725MS16, 11617MS16, 9721EE) (Table 2; Supp. Material 2: Erroneous Records). The voucher for the misidentified specimen (Adhikari *et al*. 2019) is in the MTEC identified as a male *M. perihirta* (MTEC 035028) (Supp. Material 2: Erroneous Records).

Megachile (*Sayapis*) *pugnata* Say, 1837

Megachile pugnatus Say, 1837: 408.
Megachile (*Sayapis*) *pugnata*; Mitchell 1937c: 201; 1962: 179. Butler 1965: 14. Hurd 1979: 2072. Ivanochko 1979: 316. Fultz 2005: 134. Gonzalez 2008: 36. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 67. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 25. Sheffield and Heron 2019: 70. Engel 2020: 11.
Eumegachile (*Sayapis*) *pugnata* (Say); Mitchell 1980: 51.
Megachile pugnata; Drons 2012: 58.
Megachile inimica, not Cresson, 1872 (misidentification); Pearce 2008: 51. Pearce *et al*. 2012: 101.

Diagnosis. The female of *M. pugnata* can be identified by its parallel-sided tergites (Fig. 6C), pronounced tooth on the posterior genal margin (Fig. 7P), and clypeal margin with three tubercles. The genal tooth of the female cannot be mistaken for any other Montana *Megachile* species. The male of *M. pugnata* can be identified by its thin and narrowly pointed procoxal spine (Fig. 8H) and the scoop-shaped dilation of its probasitarsus, which has dark setae along the basal ⅓ of the posterior edge. The males are most similar to *M. fidelis* (see *M. fidelis* above).

Notes. This large, distinctive species is widespread in Montana, although most records are from the west (Fig. 1AC). The fact that records extend to the southeast border indicates it will be found more broadly with more collecting in the under-sampled eastern part of the state. Photographs, a full morphological description, and notes on the biology of this cavity-nesting species can be found in Sheffield *et al*. (2011), who report that it is a *Helianthus* specialist. The voucher for the misidentified specimen (Pearce *et al*. 2012) is in the MTEC identified as a male *M. pugnata* (MTEC 57005) (Table 2; Supp. Material 2: Erroneous Records).

Megachile (*Megachile*) *relativa* Cresson, 1878

Megachile relativa Cresson, 1878: 126. Mitchell 1927b: 179. Jensen 2003: 195. Fultz 2005: 82. Drons 2012: 59.
Megachile (*Anthemois*) *relativa*; Mitchell 1935b: 162.
Megachile (*Megachile*) *relativa*; Mitchell 1962: 129. Butler 1965: 5. Hurd 1979: 2056. Ivanochko 1979: 153. Sheffield and Westby 2007: 178. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 51. Kuhlman and Burrows 2017: 13. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 25. Sheffield and Heron 2019: 70. Engel 2020: 10.
Megachile aspera Mitchell, 1924: 158.

Diagnosis. The female of *M. relativa* can be identified by its 5-toothed mandibles (Fig. 7G), yellow-orange scopal setae on S2–6, and golden pubescence on T6. The females are most similar to *M. centuncularis* (see *M. centuncularis* above). The males of *M. relativa* cannot be reliably separated from males of *M. lapponica* in Montana based on external morphology or by examining the genitalia (see Taxonomic Challenges; Sheffield & Westby 2007). Males of *M. lapponica*/*M. relativa* can be recognized by the absence of a procoxal spine, small median triangular tubercle on the clypeal margin, narrow brown to black probasitarsi (Fig. 8A), evenly spaced 3-dentate mandibles, and T6 with sparse setae, not tomentose. *Megachile lapponica*/*M. relativa* is most similar to *M. centuncularis* (see *M. centuncularis* above).

Notes. In Montana, this species has been collected widely but with only a few eastern localities, reflecting the general lack of collecting in the region (Fig. 1AD). Photographs, a full morphological description (but see Taxonomic Challenges), and notes on its biology can be found in Sheffield *et al*. (2011). This species readily accepts trap nests (Jensen *et al*. 2003).

Megachile (*Eutricharaea*) *rotundata* (Fabricius, 1787)

Apis rotundata Fabricius, 1787: 303.
Megachile rotundata; Gerber and Akre 1969: 1. Jensen 2003: 195. O'Neill and O'Neill 2003: 447; 2011: 223. O'Neill *et al*. 2004: 619. Pearce 2008: 51. O'Neill *et al*. 2010: 775. O'Neill *et al*. 2011: 917. Delphia and O'Neill 2012: 380. Drons 2012: 59. Pearce *et al*. 2012: 97. O'Neill *et al*. 2014. O'Neill *et al*. 2015: 1. Soltani *et al*. 2017: 827. Donahoo *et al*. 2021: 444.
Megachile (*Eutricharaea*) *rotundata* (Fabricius). Mitchell 1962: 122. Ivanochko 1979: 113. Cooper 1984: 225. Gonzalez 2008: 35. Scott *et al*. 2011: 54. Sheffield *et al*. 2011: 31. Kuhlman and Burrows 2017: 12. Reese *et al*. 2018: 21. Delphia *et al*. 2019a: 24. Sheffield and Heron 2019: 69. Engel 2020: 10.
Apis pacifica Panzer 1798: 16.
Megachile (*Eutricharaea*) *pacifica*; Hurd 1979: 2057.

Diagnosis. The female of *M. rotundata* can be identified by its white apical setal bands on S2–6 (Fig. 6A), white scopal setae on at least the basal half of S5, lateral, ovate fovea on T2, and the absence of lateral, ovate fovea on T3. The females are most similar to *M. apicalis* (see *M. apicalis* above). The male of *M. rotundata* can be identified by its lateral, ovate fovea on T2 and the absence of lateral, ovate fovea on T3. Males of *M. rotundata* are most similar to *M. apicalis* (see *M. apicalis* above).

Notes. *Megachile rotundata* is an introduced species that is economically important for alfalfa seed production (reviewed in Pitts-Singer & Cane 2011). The first specimen of *M. rotundata* in Montana is from 1963. *Megachile rotundata* has now been recorded statewide in Montana (Fig. 1AE). It is the only *Megachile* species that has legal standing in Montana, as the subject of the "Alfalfa Leaf-Cutting Bee Management Act" (2021 Montana Code Annotated Title 80. Agriculture Chapter 6. Apiculture Part 11. Alfalfa Leaf-Cutting Bees). *Megachile rotundata* are known to nest in a variety of substrates, including cavities, trap nests, and holes in vertical banks (see Discussion: Notes on *Megachile* (*Eutricharaea*) *rotundata* and Introduced *Megachile* Species). Photographs, a full morphological description, and notes on its biology can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *snowi* Mitchell, 1927

Megachile mendica snowi Mitchell, 1927: 113.
Megachile (*Litomegachile*) *mendica snowi*; Mitchell 1935a: 31. Butler 1965: 4. Scott *et al*. 2011: 55.
Megachile (*Litomegachile*) *snowi*; Bzdyk 2012: 55. Sheffield and Heron 2019: 70.

Diagnosis. The female of *M. snowi* can be identified by its mostly yellow to orange scopal setae on S6, white to golden appressed setae on T6, T6 straight (viewed laterally) (Fig. 7J), and 4-toothed mandibles with an angulate basal mandibular tooth, appearing as a weak additional tooth (i.e., 5-toothed) (Fig. 7D). The female of *M. snowi* is most similar to *M. mendica* (see *M. mendica* above). The male of *M. snowi* can be identified by its white apical setal band on T5 and by the apical margin of T6 (ventrad the transverse carina), which has submedian teeth that are either closer to each other than to the lateral teeth or all teeth are subequal to each other (Fig. 9E). Males of *M. snowi* are most similar to *M. mendica* (see *M. mendica* above).

Notes. This species is a new state record for Montana. *Megachile snowi,* a now-recognized species previously recognized as a subspecies of *M. mendica*, has only been collected from one locality in eastern Montana, a northern extension of its known range (Fig. 1AF). Illustrations and a full morphological description can be found in Bzdyk (2012).

Megachile (*Megachiloides*) *subnigra* Cresson, 1879

Megachile subnigra Cresson, 1879: 208.
Megachile (*Xeromegachile*) *subnigra*; Mitchell 1937a: 364; 1944: 138. Hurd 1979: 2065. Ivanochko 1979: 252.
Megachile (*Megachiloides*) *subnigra*; Raw 2002: 21. Scott *et al*. 2011: 56. Sheffield *et al*. 2011. Reese *et al*. 2018: 22. Delphia *et al*. 2019a: 25. Sheffield and Heron 2019: 70.
Megachile (*Xeromegachile*) *angelica* Mitchell, 1934: 318.
Megachile (*Xeromegachile*) *blaisdelli* Mitchell, 1934: 336.
Megachile (*Xeromegachile*) *moschata* Mitchell, 1934: 338.

Diagnosis. The female of *M. subnigra* can be identified by its all-black scopal setae on S2–6 and 4-toothed mandibles with a pointed basal mandibular tooth (Fig. 7B). The female of *M. subnigra* is most similar to *M. gemula*, which has reddish-brown scopal setae on S2–6 and a truncate basal mandibular tooth (Fig. 7E). For further details on identification issues see Taxonomic Challenges. The male of *M. subnigra* can be identified by the mostly black pubescence on the mid and hind legs, cream to yellow colored protarsi, and the wide, spatulate procoxal spine (Fig. 8I) with a short suberect patch of setae at the base.

Notes. *Megachile subnigra* is known from the southern half of central Montana, in the upper Yellowstone and upper Missouri drainages (Fig. 1AG). Photographs, a full morphological description, and notes on the biology of this ground-nesting species can be found in Sheffield *et al*. (2011).

Megachile (*Litomegachile*) *texana* Cresson, 1878

Megachile texana Cresson, 1878: 125. Drons 2012: 59.
Megachile (*Litomegachile*) *texana;* Mitchell 1935a: 32; 1962: 118. Butler 1965: 4. Hurd 1979: 2054. Ivanochko 1979: 103. Scott *et al*. 2011: 55. Sheffield *et al*. 2011: 42. Bzdyk 2012: 56. Reese *et al*. 2018: 22. Sheffield and Heron 2019: 70. Engel 2020: 10.
Megachile texana var. *cleomis*; Mitchell 1935a: 32.

Diagnosis. The female of *M. texana* can be identified by its 4-toothed mandibles, which have an even semicircular emargination between the 3rd and 4th tooth (Fig. 7B), and the lateral, erect, black setae on T2–6 (viewed dorsally). The male of *M. texana* can be identified by the apical margin of T6 (ventrad the transverse carina), which has submedian teeth that are closer to the lateral teeth than to each other (Fig. 9E), greater than 50% black pubescence on the scutum, tergites with significant bands of black pubescence, and vertex of head with greater than 50% black pubescence. This species is most similar to *M. lippiae* (see *M. lippiae* above and Taxonomic Challenges).

Notes. *Megachile texana* has been recorded mainly east of the divide in Montana (Fig. 1AH). Photographs, illustrations, full morphological descriptions, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011) and Bzdyk (2012). Sheffield and Genaro (2013) briefly made a claim of dividing *M. texana* from *Megachile cleomis* Cockerell. See Taxonomic Challenges above for a more complete discussion.

Megachile (*Megachiloides*) *wheeleri* Mitchell, 1927

Megachile wheeleri Mitchell, 1927: 107.
Megachile (*Xeromegachile*) *wheeleri* Mitchell. Butler 1965: 9. Hurd 1979: 2066. Ivanochko 1979: 244. Mitchell 1937a: 355.
Megachile (*Megachiloides*) *wheeleri* Mitchell. Raw 2002: 21. Scott *et al*. 2011: 56. Sheffield *et al*. 2011: 61. Reese *et al*. 2018: 22. Sheffield and Heron 2019: 70.
Megachile spokanensis Mitchell, 1927: 109.

Diagnosis. The female of *M. wheeleri* can be identified by its 4-toothed mandibles with an asymmetrical emargination between the 3rd and 4th tooth, emargination deepest closer to 4th tooth, and the widely spaced punctures on the apical half of T5, which are separated by 3–4 diameters. Females of *M. wheeleri* are most similar to *M. manifesta (*see *M. manifesta* above) and *M. nevadensis* (see *M. nevadensis* above and Taxonomic Challenges). The male of *M. wheeleri* can be identified by its wide and spatulate procoxal spine without a setal patch at the base, the protruding triangular carina on the ventral mesepisternum (viewed ventrally, directly posterior to the procoxal spine), and the quadrate metatarsomeres (viewed laterally) (Fig. 8G).

Notes. This species occurs in central Montana and the lower elevations of western Montana, west of 109° (Fig. 1AI). This is the only member of *Megachiloides* besides the rarely seen *M. pascoensis* that has been found west of the divide. Photographs, a full morphological description, and notes on the biology of this soil-nesting species can be found in Sheffield *et al*. (2011).

Discussion

Bringing together the historical records of Montana *Megachile* and new records from targeted collecting provides a more complete picture of the diversity and distribution of the 35 *Megachile* species so far known in the state. Some *Megachile* species are quite widespread and commonly collected, whereas others were found in only limited numbers and regions of Montana. *Megachile perihirta* was collected in the greatest number of counties, 45, with 1,192 records (Fig. 1AB). Two species, *M. nevadensis* and *M. snowi*, are singletons, each having only one record in Montana. There were three doubletons: *M. dakotensis, M. mendica*, and *M. pascoensis*. *Megachile dakotensis*, *M. mendica*, and *M. snowi* were all collected only in eastern Montana (Figs. 1I, 1V, 1AF) while *Megachile pascoensis* is only known from northwest Montana (Fig. 1AA).

As the Chao1 mean estimator of species richness was 35.25 species (95% CI from 35.01 to 39.79; Fig. 2) and the species accumulation curve approaches an asymptote at 35 species, we documented the Chao1 mean predicted diversity in the state, but more species are possible given the 95% CI for the Chao 1 mean ranges up to 40 species. Range data of other *Megachile* species known in nearby states similarly suggests that several additional species could occur in Montana (See Unrecorded *Megachile* Potentially in Montana below).

Future faunistic bee studies should emphasize eastern and xeric regions of Montana, historically under-collected areas. Two new state records (*M. mendica* and *M. snowi*) were recorded in the southeast parts of Montana and many of the predicted *Megachile* species are hypothesized to occur in southern and eastern Montana (Figs. 1V, 1AF). Warm temperate xeric zones are high in bee biodiversity and abundance (Michener 1979; Orr *et al*. 2021). The arid landscapes and lack of prior research highlight the importance of future faunistic bee studies in southeast Montana.

With baseline faunistic data, further scientific questions may be asked of the bee populations in Montana. However, there are several limitations to a complete faunistic treatment of the bee species of Montana. First is the sheer size of the state and distance from research centers with the resulting lack of prior bee collecting statewide, plus the extensive time and labor involved in collecting and specimen preparation, and the taxonomic challenges (including need for revisions).

Another issue in faunistic projects is existing biodiversity data without voucher specimens. Online resources such as Discover Life and traditional publications present records of species without vouchers deposited in a collection, and these are problematic for future research as they cannot be traced or replicated. Suspicious records with corresponding vouchers, in contrast, can be corrected or verified, advancing understanding of species ranges with accurate data. In this study, we verified and corrected several such suspicious records of Montana *Megachile* species and clarified their status (see Supp. Material 2: Erroneous Records).

Lastly, taxonomic literature and resources for *Megachile* and other bee genera need updating. As more researchers aim to identify bees with limited regional keys available, the available keys may be misleading in the scope of possible species or the possible intraspecific morphological variation regionally. In this study, we supplemented key use with reference specimens for all the *Megachile* species we deemed to potentially occur in Montana. We found unreported morphological variation in our reference specimens and Montana material that we incorporated in our key to attempt to improve this situation.

Unrecorded *Megachile* Potentially in Montana

Eight North American species of *Megachile* are recorded in literature and databases occurring close to or in continuous landscapes with Montana but have not yet been recorded in the state. These species are predicted to possibly occur in Montana and may be uncovered through further faunistic work. Many species on this list (e.g., *Megachile wyomingensis*, *Megachile latita*, and *Megachile hookeri*) are very rarely collected and have not been critically examined since Mitchell, who may have had only one to very few specimens. All need a review as part of a comprehensive revision.

Megachile (*Xanthosarus*) *circumcincta* (Kirby) is a boreal species ranging from Alaska through British Columbia and Alberta into northern Saskatchewan (Mitchell 1935b; Sheffield *et al*. 2011; Sheffield 2021). It has also been recorded from the mountains of Colorado (Mitchell 1935b; Scott *et al*. 2011 = *Megachile giliae* Cockerell). With records both north and south of Montana, this species is predicted to occur widely in Montana.

Megachile (*Megachiloides*) *hookeri* Cockerell, which Mitchell states may be a color variation of *M*. *nevadensis* (Mitchell 1937a*)*, was collected 200 km away from the Montana border in Pavillion, Wyoming (BBSL518981). It is also recorded in Lehi, Utah (Mitchell 1937a), and Colorado (Scott *et al*. 2011). From the Wyoming record, we predict *M*. *hookeri* may be found in the south-central badlands region of Montana near Bridger.

Discover Life shows an unvouchered Montana centroid record for *Megachile* (*Sayapis*) *inimica* Cresson (Discover Life 05 May 2021). There is a specimen record near Montana from Moran, Wyoming (AMNH UID653582), the identification of which was verified by Corey Smith (*pers*. *com*., 24 Mar 2021). As this species is also recorded close to the Wasatch Range in Willard, Utah (BBSL519969), we predict *M*. *inimica* may occur in southwest Montana, especially in the Centennial Valley (Beaverhead Co.) and surrounding area.

Megachile (*Megachiloides) latita* Mitchell was recorded in badland habitats in Worland, Wyoming and Maybell, Colorado (Mitchell 1934). As Worland is near the Montana border, we predict this species may occur in south-central Montana in the contiguous xeric area south of Bridger.

Megachile (Leptorachis) petulans Cresson has been recorded to occur widely in the eastern, southern, and central U.S. but has fewer western records (Discover Life 01 June 2021, Mitchell 1937b). As it has been recorded from Jamestown, North Dakota (Mitchell 1937b), a prairie pothole region, it would possibly be found in the prairie pothole region of northeast Montana near Plentywood and Caldera, approaching the North Dakota and Saskatchewan borders.

Megachile (*Megachiloides*) *umatillensis* (Mitchell) was recorded from Cornish, Utah, near the Wasatch Range (SEMC416330, Discover Life, 05 May 2021), in southern British Columbia (Sheffield *et al*. 2011; Sheffield & Heron 2019), in Santa Clara, Utah, in Roggen, Colorado, and in Washington (Mitchell 1936). With records north, west, and south of Montana, we predict this species is likely to occur at least along the western or southern borders of Montana, but we have not detected it so far.

Megachile (Megachiloides) wyomingensis Mitchell was recorded from badlands near Worland, Wyoming (Mitchell 1937a). It is also recorded from Sweetwater Co., Wyoming (SEMC498031) and Leota, Utah (BBSL519311), on Discover Life (01 June 2021). From these records, *M*. *wyomingensis* may possibly occur in the same area of south-central Montana, specifically south of Bridger, in the xeric landscape.

Further afield, but worth considering, specimens of *Megachile* (*Chelostomoides*) *subexilis* Cockerell are known from Fossil Butte National Monument, Wyoming (USGS_DRO314013), Timpanogos Cave National Monument, Utah (AMNH_BEE00079322), Provo, Utah (AMNH_BEE0007931), and Badlands National Park, South Dakota (USGS_DRO246767). This distribution suggests that this species is somewhat likely to occur in the badlands of south-central Montana near Bridger, the Black Hills region of Carter Co., and/or in the southwest corner of the state in or near the Centennial Valley (Beaverhead Co.).

Two introduced Eurasian species that may reach Montana. *Megachile* (*Eutricharaea*) *pusilla* Pérez is an invasive species originally from the Mediterranean region (Ghazi-Soltani *et al*. 2017) that is expanding its range in the U.S., including the west (Discover Life 01 June 2021), with the closest records being in Otero and Yuma Counties of Colorado (Scott *et al*. 2011) and in Timpanogos, Utah (AMNH_BEE00010214). Although not currently known from the state, *M*. *pusilla* could feasibly reach Montana as its range expands in the future.

One last invasive species to watch for is *Megachile* (*Callomegachile*) *sculpturalis* (Smith). This native of eastern Asia is spreading from the eastern U.S. and now is established in most states east of the Mississippi River (Stevens *et al*. 2019). The predicted range of this species includes far western Montana with a lower probability along the Yellowstone River Valley (*loc*. *cit*.).

The Importance of Vouchers

Voucher specimens are very important in creating reproducible research (Turney *et al*. 2015). We mention specific specimens that presented taxonomic challenges so that future researchers can reference and examine these specimens if more work is needed. Without vouchers in a museum, the results of our study would not be verifiable or reproducible. When there were incorrect records published or posted online with vouchers (as in *M*. *policaris* and *M*. *circumcincta*) we were able to identify the specimens ourselves or entail the help of curators to trace the specimens in question and correct the identifications and range distributions of these species. For mysteries such as *M*. *sublaurita*, in the absence of a voucher, we are left to speculate (see Supp. Material 2: Erroneous Records).

Searching for Mitchell's Montana Species

Megachile dakotensis was recorded to occur in Montana with no further locality by Mitchell (1937a), but no specimens were discovered from the state between then and our study. A 1921 record of the species in Marmarth, North Dakota, at the American Museum of Natural History shows a record ca. 10 km from the Montana border (AMNH_BEE00019636). From this information, we predicted that the species could be found in a similar dry badland landscape in southeastern Montana. We focused sampling efforts on the eastern border of Montana in 2019 and 2020 and collected one male and one female *M. dakotensis* in Carter Co., at Medicine Rocks State Park in bee bowls on 20 July 2020 (Fig. 1I).

Megachile nevadensis was recorded from Bozeman, Montana by Mitchell (1937a), and was not recorded from Montana again until this study, despite Bozeman, in Gallatin Co., being the most intensively collected part of Montana. Other nearby records include Crow Heart Butte, Wyoming (Mitchell 1936), 13 mi southwest of Dubois, Wyoming (BBSL519101), and Sheridan, Wyoming (BBSL519179). In Montana, this species would be predicted to occur in the southern parts of the state, but collecting efforts surprisingly resulted in only one specimen, from Richland Co., relatively far to the north and east of what was expected.

For the missing Mitchell vouchers of *M. nevadensis* and *M. dakotensis*, we contacted specific collection managers of collections found to hold Montana material of *Bombus* (Dolan *et al*. 2017), the home institution of Mitchell at North Carolina State University, and the major bee collections in North America, but these specimens were not found. All checked their collections and reported these specimens were not present. We also put out a general call via the Entomological Collection Network and Beemonitoring listservs to search for these Montana specimens. The Mitchell specimens of neither species were located for this project, though both species records have now been verified in the state.

Notes on *Megachile* (*Eutricharaea*) *rotundata* and introduced *Megachile* Species

Megachile rotundata, or the alfalfa leafcutting bee, is native to Eurasia and was detected in the U.S. in the 1930s after being accidentally introduced (Pitts-Singer & Cane 2011). Soon after, it was propagated across the western U.S. for alfalfa seed pollination, being first noted in Montana in 1969 (Gerber & Akre 1969). It is managed for alfalfa seed pollination widely, including in Montana. Today, among managed species, its economic value is second only to honey bees in crop pollination (Pitts-Singer & Cane 2011).

Although *M. rotundata* are usually thought of as managed in agricultural fields, feral populations also exist in the wild, though floral visitation appears to primarily favor Eurasian weeds (Jensen 2003; O'Neill *et al*. 2010; Pearce *et al*. 2012). *Megachile rotundata* accepts a diversity of nest materials and nesting sites (MacIvor & Moore 2013; Sheffield 2017). In the Wolf Mountains of Montana (45.0386°N, 107.0307°W), a wild nesting aggregation was found in holes in sandstone cliffs far from alfalfa fields (ZAP pers. obs., 2019).

Stem nesting behavior in *Megachile* makes them more likely to be accidentally transported to new regions, as they readily nest in human-made substrates and can be transported in materials like irrigation tubing or drilled holes in wood or metal (Russo 2016; Poulsen & Rasmussen 2020). These introductions could be an issue for native species as one study in California suggested that invasive *Megachile* could potentially compete with native *Megachile* for nesting sites (Cane 2003).

Megachile (*Eutricharaea*) *apicalis* Spinola is an accidentally introduced species that is now established in the U.S. (Cooper 1984; Russo 2016) and found in Montana. This species was first recorded from Montana by Kuhlman and Burrows (2017) in Missoula Co., and we record specimens from 11 counties in Montana dating from 2013 (Fig. 1C). It is already documented in much of the western U.S., and is associated with an invasive rangeland weed, *Centaurea solstitialis* L. (Asteraceae) (Barthell *et al*. 2001; McIver *et al*. 2009; Sheffield *et al*. 2011). In Montana, Kuhlman and Burrows (2017) suggest that *M. apicalis* may be using *Centaurea stoebe* L. (Asteraceae), a Montana weed that is a relative of *C. solstitialis*.

Conclusion

Collecting of *Megachile* in Montana has historically been geographically biased and remains extremely uneven statewide. Future bee collecting should focus on the under-sampled regions of eastern and central Montana, particularly those predicted to have high bee diversity including Makoshika State Park, Medicine Rocks State Park, the prairie regions, the xeric regions (such as the region south of Bridger), and those with affinities to the Great Plains. There are also remaining gaps in western Montana: the high alpine, the Bob Marshall Wilderness Complex, the Big Hole, the Purcell-Cabinet Wilderness, and the northern Bitterroot Range.

Megachile specimens are less collected than some other bee taxa, like *Bombus*, and historical and museum data remain sparse for Montana *Megachile*. Extensive collecting is required throughout the state to better document diversity even in moderately well-collected areas. Further collecting of *Megachile* might reveal more species in Montana, as our Chao1 confidence interval indicates. Bee collecting efforts in Montana should keep watch for potential new state records of the introduced species *M. pusilla* and *M. sculpturalis*, and the predicted native species *M. circumcincta*, *M. hookeri*, *M. inimica*, *M. latita*, *M. petulans, M. subexilis*, *M. umatillensis*, and *M. wyomingensis*.

More taxonomic work is needed to clarify relationships of *Megachile*, especially the taxonomic challenges discussed herein. Revision of the subgenera that have not been recently revised should be a priority, but in fact a comprehensive revision of North American *Megachile* is needed, to allow better regional keys, and to aid in identifying species ranges and possible conservation concerns. With several taxonomic challenges just in the *Megachile* fauna of Montana, revisional work alongside support of taxonomists is needed to advance our understanding of this group and the other bee genera of Montana.

Acknowledgments

This project was possible through the help of many individuals. We thank Justin Runyon, Cheryl Fimbel, Joshua Botti-Anderson, Joshua Wallace, Chloe Rice, Frank Etzler, J.P. Kole, Jordan Rainey, Robert Fowler, Lorena Santos, Katie Behme, William Griffiths, James Pritchard, Zach Lenning, Orty Bourquin, and LaDonna Ivie for help with field work; Cheryl Fimbel for coordinating with one-room schoolhouses and processing specimens; and Rob Fimbel and Robert Fowler for assisting with specimen curation.

We thank Cheryl Fimbel, Jordan Rainey, Elizabeth Reese, and Shea Crowther for testing the keys; Terry Griswold, Cory Sheffield, and Victor Gonzalez for specimen identification; Cory Sheffield, Daniel Johnson, Hector Carcamo, Jennifer Thomas, Victor Gonzalez, Zachary Falin, Owen Lonsdale, Sophie Cardinal and Douglas Yanega for going out of their way to help track down missing vouchers and clarify historical problems.

Several individuals, institutions, and collection managers loaned us Montana *Megachile* specimens: Virginia Scott at the University of Colorado Natural History Museum in Boulder, CO; Terry Griswold at the USDA-ARS Pollinating Insects Research Unit, Logan, UT; Catherine E. Siebert in Bozeman, MT; Casey M. Delphia in Bozeman, MT; Luciana Musetti at the C. A. Triplehorn Insect Collection, The Ohio State University, Columbus, OH; Jennifer Thomas, Victor Gonzalez, and Zachary Falin at the Snow Entomological Museum, University of Kansas, Lawrence, KS; Peter T. Oboyski at the Essig Museum of Entomology, Berkely, CA; Luc Leblanc at the William F. Barr Entomological Museum at University of Idaho, Moscow, ID; Jerome G. Rozen Jr. and Corey Smith at the American Museum of Natural History, New York, NY; Robert Zuparko at the California Academy of Sciences, San Francisco, CA; Paul Johnson at the Severin McDaniel Insect Research Collection, South Dakota State University, Brookings, SD; Karen Wright at Texas A&M University Insect Collection, College Station, TX; Alexandra Morphew and Joshua Campbell at USDA-ARS, Sidney, MT; Kevin O'Neill at Montana State University, Bozeman, MT; Tommy McElrath at the Illinois Natural History Survey Insect Collection, University of Illinois Urbana Champaign, Champaign, IL. Alexandra Morphew, Ann Rodman, Bethanne Bruninga-Socolar, Laura Burkle, Erik Oberg, Marirose Kuhlman (MPG Ranch, Missoula, MT), and Sam Droege also contributed specimen records or allowed examination of material for this study.

This project was supported by the Montana Department of Agriculture Specialty Crop Block Grant Program (18SC007084, 20SC02612, 21SC07014, 24SC009705), the MS Foundation Endowed Fund for MS Students in Entomology funded by Tom Helm and Alieda Stone, and the Montana Institute on Ecosystems Yellowstone Graduate

Scholarship. Montana Pest Survey Program funding from the Montana Department of Agriculture facilitated setting traps that contributed specimens to this study. This is a contribution of the Montana Agricultural Experiment Station.

References

Adhikari, S., Burkle, L.A., O'Neill, K.M., Weaver, D.K., Delphia, C.M. & Menalled, F.D. (2019) Dryland organic farming partially offsets negative effects of highly simplified agricultural landscapes on forbs, bees, and bee-flower networks. *Environmental Entomology*, 48 (4), 826–835. https://doi.org/10.1093/ee/nvz056

Barthell, J., Randall, J., Thorp, R. & Wenner, A. (2001) Promotion of seed set in yellow star-thistle by honey bees: evidence of an invasive mutualism. *Ecological Applications*, 11 (6), 1870–1883. https://doi.org/10.1890/1051-0761(2001)011[1870:POSSIY]2.0.CO;2

Brambila, J., Jackson, L.D., Meagher, R.L., Restom Gaskill, D. & Derksen, A. (2021) *Plastic bucket trap protocol*. United States Department of Agriculture Cooperative Agricultural Pest Survey, Washington, D.C. Available from: https://download.ceris.purdue.edu/file/2573 (accessed 14 June 2021)

Burkle, L.A., Delphia, C.M. & O'Neill, K.M. (2020) Redundancy in wildflower strip species helps support spatiotemporal variation in wild bee communities on diversified farms. *Basic and Applied Ecology*, 44, 1–13. https://doi.org/10.1016/j.baae.2020.02.005

Burkle, L.A., Marlin, J.C. & Knight, T.M. (2013) Plant-pollinator interactions over 120 years: loss of species, co-occurrence, and function. *Science*, 339, 1611–1615. https://doi.org/10.1126/science.1232728

Burrows, S., Ritner, C., Christman, M., Spears, L., Smith-Pardo, A., Price, S., Ramirez, R., Griswold, T. & Redford, A. (2021) Exotic Bee ID. Available from: https://idtools.org/id/bees/exotic/ (accessed 21 June 2021)

Butler, G.D. (1965) *The distribution and host plants of leaf-cutter bees in Arizona. Technical Bulletin 167*. Agricultural Experiment Station, The University of Arizona, Tucson, Arizona, 19 pp.

Bzdyk, E.L. (2012) A revision of the *Megachile* subgenus *Litomegachile* Mitchell with an illustrated key and description of a new species (Hymenoptera, Megachilidae, Megachilini). *ZooKeys*, 221, 31–61. https://doi.org/10.3897/zookeys.221.3234

Cane, J.H. (2003) Exotic nonsocial bees (Hymenoptera: Apiformes) in North America: ecological implications. *In*: Strickler, K. & Cane, J.H. (Eds.), *For Nonnative Crops, Whence Pollinators of the Future? Thomas Say Publications in Entomology: Proceedings*. Entomological Society of America, Lanham, Maryland, pp. 113–126. https://doi.org/10.4182/ZSGH5376.2003.113

Chao, A. (1984) Nonparametric estimation of the number of classes in a population. *Scandinavian Journal of Statistics*, 11, 265–270.

Cockerell, T.D.A. (1898) Some bees of the genus *Megachile* from New Mexico and Colorado. *Annals and Magazine of Natural History*, Series 7, 1 (2), 125–130. https://doi.org/10.1080/00222939808677940

Cockerell, T.D.A. (1900) The New Mexico bees of the genus *Megachile* and a new *Andrena*. *Annals and Magazine of Natural History*, Series 7, 6 (31), 7–20. https://doi.org/10.1080/00222930008678335

Cockerell, T.D.A. (1902) Hymenoptera of southern California I. *Bulletin of the Southern California Academy of Sciences*, 1, 70–71.

Cockerell, T.D.A. (1915) XLVII.—*Descriptions and records of bees*.—LXVII. *Annals and Magazine of Natural History*, Series 8, 15 (90), 529–537. https://doi.org/10.1080/00222931508693669

Colwell, R.K. (2013) EstimateS: Statistical estimation of species richness and shared species from samples. Version 9. Available from: http://purl.oclc.org/estimates/ (accessed 3 May 2021)

Cooper, K.W. (1984) Discovery of first resident population of the European bee, *Megachile apicalis*, in the United States (Hymenoptera: Megachilidae). *Entomological News*, 95, 225–226.

Cresson, E.T. (1872) Hymenoptera Texana. *Transactions of the American Entomological Society*, 4, 153–292. https://doi.org/10.2307/25076272

Cresson, E.T. (1878) Descriptions of new North American Hymenoptera in the collection of the American Entomological Society. *Transactions of the American Entomological Society*, 7, 61–136. https://doi.org/10.2307/25076368

Czokajlo, D., Ross, D. & Kirsch, P. (2001) InterceptTM Panel Trap, a novel trap for monitoring forest Coleoptera. *Journal of Forest Science*, 47 (Special Issue No. 2), 63–65.

Delphia, C.M., Griswold, T., Reese, E.G., O'Neill, K.M. & Burkle, L.A. (2019a) Checklist of bees (Hymenoptera: Apoidea) from small diversified vegetable farms in south-western Montana. *Biodiversity Data Journal*, 7, e30062.

https://doi.org/10.3897/BDJ.7.e30062
Delphia, C.M. & O'Neill, K.M. (2012) Supersedure of *Isodontia mexicana* (Saussure) (Hymenoptera: Sphecidae) nests by *Megachile rotundata* (F.) (Hymenoptera: Megachilidae): Do bees destroy wasp cocoons? *Journal of the Kansas Entomological Society*, 85 (4), 380–383.
https://doi.org/10.2317/0022-8567-85.4.380
Delphia, C.M., Runyon, J.B. & O'Neill, K.M. (2019b) Clear plastic bags of bark mulch trap and kill female *Megachile* (Hymenoptera: Megachilidae) searching for nesting sites. *Journal of the Kansas Entomological Society*, 92 (4), 649–654.
https://doi.org/10.2317/0022-8567-92.4.649
Dolan, A.C., Delphia, C.M., O'Neill, K.M. & Ivie, M.A. (2017) Bumble Bees (Hymenoptera: Apidae) of Montana. *Annals of the Entomological Society of America*, 110 (2), 129–144.
https://doi.org/10.1093/aesa/saw064
Donahoo, C.K., O'Neill, K.M., Delphia, C.M. & Peterson, R.K.D. (2021) Mortality dynamics and life tables of *Megachile rotundata* (Hymenoptera: Megachilidae), a pollinator managed for alfalfa seed production. *Environmental Entomology*, 50 (2), 444–454.
https://doi.org/10.1093/ee/nvaa176
Droege, S. (2015) The very handy manual: how to catch and identify bees and manage a collection. Available from: https://www.usgs.gov/centers/eesc/science/native-bee-inventory-and-monitoring-lab?qt-science_center_objects=0#. (accessed 14 June 2021)
Drons, D.J. (2012) *An Inventory of Native Bees (Hymenoptera: Apiformes) in the Black Hills of South Dakota and Wyoming*. M.S. Thesis, South Dakota State University, Brookings, South Dakota, 88 pp.
Engel, M.S. (2020) Bees in Kansas. *The Kansas School Naturalist*, 64 (2), 1–13.
Fultz, J.E. (2005) *Effects of shelterwood management on flower-visiting insects and their floral resources*. M.S. Thesis, Montana State University, Bozeman, Montana. [unknown pagination]
Friese, H. (1903) Neue Arten der Bienen gattung *Megachile* aus Amerika. *Zeitschrift für Systematische Hymenopterologie und Dipterologie*, 3 (4), 246–248.
GBIF (2021) Global Biodiversity Information Facility. Available from: http://www.gbif.org (accessed 2 March 2021)
Gerber, H.S. & Akre, R.D. (1969) The external morphology of *Megachile rotundata* (Fabricius) (Hymenoptera: Megachilidae). *Melanderia*, 1, 1–36.
Ghazi-Soltani, G., Bénon, D., Alvarez, N. & Praz, C. (2017) When different contact zones tell different stories: Putative ring species in the *Megachile concinna* species complex (Hymenoptera: Megachilidae). *Biological Journal of the Linnean Society*, 121, 815–832.
https://doi.org/10.1093/biolinnean/blx023
Gonzalez, V.H. (2008) Phylogeny and classification of the bee tribe Megachilini (Hymenoptera: Apoidea, Megachilidae), with emphasis on the genus *Megachile*. Doctoral dissertation, University of Kansas, Lawrence, Kansas, 274 pp.
Gonzalez, V.H. & Griswold, T.L. (2007) A review of the North and Central American *Megachile* subgenus *Argyropile* Mitchell (Hymenoptera: Megachildae). *Zootaxa*, 1461 (1), 1–14.
https://doi.org/10.11646/zootaxa.1461.1.1
Gonzalez, V.H., Gustafson, G.T. & Engel, M.S. (2019) Morphological phylogeny of Megachilini and the evolution of leaf-cutter behavior in bees (Hymenoptera: Megachilidae). *Journal of Melittology*, 85, 1–123.
https://doi.org/10.17161/jom.v0i85.11541
Gustafson, D.L. (1996) Lindgren Funnel Trap. Available from: http://mtent.org/projects/aquatic_invertebrates/methods/funnel.html (accessed 24 June 2021)
Hurd, P.D. (1979) Apoidea. *In*: K.V. Krombein, Hurd, P.D., Smith, D.R. & Burks, B.D. (Eds.), *Catalog of Hymenoptera in America North of Mexico*. *Vol. 2*. Smithsonian Institution Press, Washington, D.C., pp. 1741–2209.
Ivanochko, M. (1979) *Taxonomy, Biology, and Alfalfa Pollinating Potential of Canadian Leaf-Cutting Bees: Genus Megachile Latreille (Hymenoptera: Megachilidae)*. M.S. Thesis, McGill University, Montreal, Quebec, 378 pp.
Ivie, M.A., Ivie, L.L. & Gustafson, D.L. (1998) A Final Report. The Effects of the Red Bench Fire of 1988 on Beetle Communities in Glacier National Park, Montana, USA, 1989–1993. *NPS Cooperative Agreement CA*, 1268-1-9017, 1–163.
Jensen, P.D., O'Neill, K.M. & Lavin, M. (2003) Pollen provision records for three species of solitary bees (Hymenoptera: Megachilidae; *Megachile*, *Heriades*) in southwestern Montana. *Proceedings of the Entomological Society of Washington*, 105, 196–203.
Jones, M., Ghoorah, A. & Blaxter, M. (2011) jMOTU and taxonerator: Turning DNA barcode sequences into annotated operational taxonomic units. *PLoS ONE*, 6 (4), e19259.
https://doi.org/10.1371/journal.pone.0019259
Kuhlman, M. & Burrows, S. (2017) Checklist of bees (*Apoidea*) from a private conservation property in west-central Montana. *Biodiversity Data Journal*, 5 (e11506), 1–26.
https://doi.org/10.3897/BDJ.5.e11506
LaManna, J.A., Burkle, L.A., Belote, R.T. & Myers, J.A. (2020) Biotic and abiotic drivers of plant-pollinator community assembly across wildfire gradients. *Journal of Ecology*, 109 (2), 1000–1013.
https://doi.org/10.1111/1365-2745.13530
Lindgren, B.S. (1983) A multiple funnel trap for scolytid beetles (Coleoptera). *The Canadian Entomologist*, 115, 299–302.

https://doi.org/10.4039/Ent115299-3
Linnaeus, C. (1758) *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio Decima, Reformata*. Laurentii Salvii, Holmia, 824 pp.
MacIvor, J.S. & Moore, A.E. (2013) Bees collect polyurethane and polyethylene plastics as novel nest materials. *Ecosphere*, 4 (12), 1–6.
https://doi.org/10.1890/ES13-00308.1
McIver, J., Thorp, R. & Erickson, K. (2009) Pollinators of the invasive plant, Yellow Starthistle (*Centaurea solstitialis*), in north-eastern Oregon, USA. *Weed Biology and Management*, 9, 137–145.
https://doi.org/10.1111/j.1445-6664.2009.00331.x
Michener, C.D. (1979) Biogeography of the bees. *Annals of the Missouri Botanical Garden*, 66 (3), 277–347.
https://doi.org/10.2307/2398833
Michener, C.D. (2000) *The Bees of the World*. Johns Hopkins University Press, Baltimore, Maryland, xiv + [i] + 913 pp., 16 pls.
Michener, C.D. (2007) *The Bees of the World. 2nd Edition*. Johns Hopkins University Press, Baltimore, Maryland, xvi + [i] + 953 pp., 20 pls.
Michener, C.D., McGinley, R.J. & Danforth, B.N. (1994) *The Bee Genera of North and Central America (Hymenoptera: Apoidea)*. Smithsonian Institution Press, Washington, 209 pp.
Mitchell, T.B. (1924) New megachilid bees. *Journal of the Elisha Mitchell Scientific Society*, 40 (3), 154–165.
Mitchell, T.B. (1926a) New species of *Megachile*, with notes and corrections (Hymenoptera). *Transactions of the American Entomological Society*, 52, 111–118.
Mitchell, T.B. (1926b) On the *Megachile* of South Dakota. *Psyche: A Journal of Entomology*, 33, 162–167.
https://doi.org/10.1155/1926/64737
Mitchell, T.B. (1927a) New Megachilid bees. *Psyche*, 34, 104–121.
https://doi.org/10.1155/1927/86083
Mitchell, T.B. (1927b) Notes on the Megachilidae. *Psyche*, 34, 178–181.
https://doi.org/10.1155/1927/68184
Mitchell, T.B. (1934) A revision of the genus *Megachile* in the Nearctic region. Part I. Classification and descriptions of new species (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 59, 295–361. [1933]
Mitchell, T.B. (1935a) A revision of the genus *Megachile* in the Nearctic region. Part II. Morphology of the male sternites and genital armature and the taxonomy of the subgenera *Litomegachile*, *Neomegachile* and *Cressoniella*. *Transactions of the American Entomological Society*, 61 (1), 1–44.
Mitchell, T.B. (1935b) A revision of the genus *Megachile* in the Nearctic region. Part III. Taxonomy of the subgenera *Anthemois* and *Delomegachile* (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 61 (3), 155–205.
Mitchell, T.B. (1936) A revision of the genus *Megachile* in the Nearctic region. Part IV. Taxonomy of the subgenera *Xanthosarus*, *Phaenosarus*, *Megachiloides* and *Derotropis* (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 62 (2), 117–166.
Mitchell, T.B. (1937a) A revision of the genus *Megachile* in the Nearctic region. Part V. Taxonomy of the subgenus *Xeromegachile* (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 62, 323–382. [1936]
Mitchell, T.B. (1937b) A revision of the genus *Megachile* in the Nearctic region. Part VI. Taxonomy of subgenera *Argyropile*, *Leptorachis*, *Pseudocentron*, *Acentron* and *Melanosarus* (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 63, 45–83.
Mitchell, T.B. (1937c) A revision of the genus *Megachile* in the Nearctic region. Part VII. Taxonomy of the subgenus *Sayapis* (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 63, 175–206.
Mitchell, T.B. (1937d) A revision of the genus *Megachile* in the Nearctic region. Part VIII. Taxonomy of the subgenus *Chelostomoides*, addenda and index (Hymenoptera: Megachilidae). *Transactions of the American Entomological Society*, 63, 381–421.
Mitchell, T.B. (1942) Notes and descriptions of Nearctic *Megachile* (Hymenoptera, Megachilidae). *Pan-Pacific Entomologist*, 18, 115–118.
Mitchell, T.B. (1943) Records and descriptions in the Megachilid subgenus *Argyropile* (Hymenoptera, Megachilidae). *Pan-Pacific Entomologist*, 19, 12–16.
Mitchell, T.B. (1944) New species and records in the *Megachile* (Hymenoptera, Megachilidae). *The Pan-Pacific Entomologist*, 20, 132–143.
Mitchell, T.B. (1956) Notes and descriptions in the Megachilid subgenus *Chelostomoides*. *The Pan-Pacific Entomologist*, 32 (3), 129–138.
Mitchell, T.B. (1962) Bees of the eastern United States, Volume 2. *North Carolina Agricultural Experiment Station Technical Bulletin*, 152, 1–557.
Mitchell, T.B. (1980) *A Generic Revision of the Megachiline Bees of the Western Hemisphere*. Contribution from the Department of Entomology, North Carolina State University, Raleigh, North Carolina, ii + 95 pp.
O'Neill, K.M., Delphia, C.M. & O'Neill, R.P. (2014) Oocyte size, egg index, and body lipid content in relation to body size in the solitary bee *Megachile rotundata*. *PeerJ*, 2, e314.
https://doi.org/10.7717/peerj.314

O'Neill, K.M., Delphia, C.M. & Pitts-Singer, T.L. (2015) Seasonal trends in the condition of nesting females of a solitary bee: wing wear, lipid content, and oocyte size. *PeerJ*, 3, e930. https://doi.org/10.7717/peerj.930
O'Neill, K.M. & O'Neill, J.F. (2010) Cavity-nesting wasps and bees of central New York state: the Montezuma wetlands complex. *Northeastern Naturalist*, 17 (3), 455–472. https://doi.org/10.1656/045.017.0307
O'Neill, K.M. & O'Neill, J.F. (2016) Brood parasitism of the resin bee *Megachile campanulae* (Robertson) by *Coelioxys modesta* Smith (Hymenoptera: Megachilidae). *Journal of the Kansas Entomological Society*, 89 (2), 117–127. https://doi.org/10.2317/0022-8567-89.2.117
O'Neill, K.M. & O'Neill, R.P. (2003) Sex allocation, nests, and prey in the grass-carrying wasp *Isodontia mexicana* (Saussure) (Hymenoptera: Sphecidae). *Journal of the Kansas Entomological Society*, 76 (3), 447–454.
O'Neill, K.M., O'Neill, R.P., Blodgett, S. & Fultz, J.E. (2004) Composition of pollen loads of *Megachile rotundata* in relation to flower diversity (Hymenoptera: Megachilidae). *Journal of the Kansas Entomological Society*, 77, 619–625. https://doi.org/10.2317/E-24.1
O'Neill, K.M., O'Neill, R.P., Kemp, W.P. & Delphia, C.M. (2011) Effect of temperature on post-wintering development and total lipid content of alfalfa leafcutting bees. *Environmental Entomology*, 40 (4), 917–930. https://doi.org/10.1603/EN10320
O'Neill, K.M., Pearce, A.M., O'Neill, R.P. & Miller, R.S. (2010) Offspring size and sex ratio variation in a feral population of alfalfa leafcutting bees (Hymenoptera: Megachilidae). *Annals of the Entomological Society of America*, 103 (5), 775–784. https://doi.org/10.1603/AN09183
O'Neill, K.M. & Seibert, C. (1996) Foraging behavior of the robber fly *Megaphorus willistoni* (Cole) (Diptera: Asilidae). *Journal of the Kansas Entomological Society*, 69 (4), 317–325.
O'Neill, R.P. & O'Neill, K.M. (2011) Pollen load composition and size in the leafcutting bee *Megachile rotundata* (Hymenoptera: Megachilidae). *Apidologie*, 42 (2), 223–233.
Orr, M.C., Hughes, A.C., Chesters, D., Pickering, J., Zhu, C.D. & Ascher, J.S. (2021) Global patterns and drivers of bee distribution. *Current Biology*, 31 (3), 451–458. https://doi.org/10.1016/j.cub.2020.10.053
Pearce, A.M. (2008) Pollinators of slender white prairieclover. M.S. Thesis, Montana State University, Bozeman, MT, 195 pp.
Pearce, A.M., O'Neill, K.M., Miller, R.S. & Blodgett, S. (2012) Diversity of flower-visiting bees and their pollen loads on a wildflower seed farm in Montana. *Journal of the Kansas Entomological Society*, 85 (2), 97–108. https://doi.org/10.2317/JKES111202.1
Pitts-Singer, T.L. & Cane, J.H. (2011) The Alfalfa Leafcutting Bee, *Megachile rotundata*: the world's most intensively managed solitary bee. *Annual Review of Entomology*, 56, 221–237. https://doi.org/10.1146/annurev-ento-120709-144836
Poulsen, N.R. & Rasmussen, C. (2020) Island bees: do wood nesting bees have better island dispersal abilities? *Apidologie*, 51, 1006–1017. https://doi.org/10.1007/s13592-020-00778-x
Praz, C.J. (2017) Subgeneric classification and biology of the leafcutter and dauber bees (genus *Megachile* Latreille) of the western Palearctic (Hymenoptera, Apoidea, Megachilidae). *Journal of Hymenoptera Research*, 55, 1–54. https://doi.org/10.3897/jhr.55.11255
Provancher, L. (1888) *Additions et Corrections au Volume II de la Faune Entomologique du Canada Traitant des Hyménoptères*. Darveau, Quebec, 475 pp. https://doi.org/10.5962/bhl.title.46411
Raw, A. (2002) New combinations and synonymies of leafcutter and mason bees of the Americas (*Megachile*, Hymenoptera, Megachilidae). *Zootaxa*, 71 (1), 1–43. https://doi.org/10.11646/zootaxa.71.1.1
Reese, E.G., Burkle, L.A., Delphia, C.M. & Griswold, T. (2018) A list of bees from three locations in the Northern Rockies Ecoregion (NRE) of western Montana. *Biodiversity Data Journal*, 6, e27161. https://doi.org/10.3897/BDJ.6.e27161
Robertson, C. (1903) Synopsis of Megachilidae and Bombinae. *Transactions of the American Entomological Society*, 29, 163–178.
Russo, L. (2016) Positive and negative impacts of non-native bee species around the World. *Insects*, 7 (69), 1–22. https://doi.org/10.3390/insects7040069
Say, T. (1823) A description of some new species of Hymenopterous Insects. *Western Quarterly Report*, 2, 71–82.
Say, T. (1837) Descriptions of new species of North American Hymenoptera, and observations on some already described. *Boston Journal of Natural History*, 1, 361–416.
SCAN (2021) Symbiota collection of arthropods network. Available from: http://www.scan-bugs.org (23 January 2021).
Scott, V., Ascher, J., Griswold, T. & Nufio, C. (2011) The Bees of Colorado. *Natural History Inventory of Colorado*, 23, 1–100.
Seltmann, K.C., Allen, J., Brown, B.V., Carper, A., Engel, M.S., Franz, N., Gilbert, E., Grinter, C., Gonzalez, V.H., Horsley, P., Lee, S., Maier, C., Miko, I., Morris, P., Oboyski, P., Pierce, N.E., Poelen, J., Scott, V.L., Smith, M., Talamas, E.J., Tsutsui,

N.D. & Tucker, E. (2021) Announcing Big-Bee: An initiative to promote understanding of bees through image and trait digitization. *Biodiversity Information Science and Standards*, 5, e74037.
https://doi.org/10.3897/biss.5.74037

Sharkey, M.J., Janzen, D.H., Hallwachs, W., Chapman, E.G., Smith, M.A., Dapkey, T., Brown, A., Ratnasingham, S., Naik, S., Manjunath, R., Perez, K., Milton, M., Hebert, P., Shaw, S.R., Kittel, R.N., Solis, M.A., Metz, M.A., Goldstein, P.Z., Brown, J.W., Quicke, D.L.J., van Achterberg, C., Brown, B.V. & Burns, J.M. (2021) Minimalist revision and description of 403 new species in 11 subfamilies of Costa Rican braconid parasitoid wasps, including host records for 219 species. *ZooKeys*, 1013, 1–665.
https://doi.org/10.3897/zookeys.1013.55600

Sheffield, C.S. (2017) Unusual nesting behavior in *Megachile* (*Eutricharaea*) *rotundata* (Hymenoptera: Megachilidae). *Journal of Mellitology*, 69, 1–5.
https://doi.org/10.17161/jom.v0i69.6532

Sheffield, C.S. (2020) Corrigendum: Leafcutter and mason bees of the genus *Megachile* Latreille (Hymenoptera: Megachilidae) in Canada and Alaska. *Canadian Journal of Arthropod Identification*, AC05. [published online]
https://doi.org/10.3752/cjai.2020.AC05

Sheffield, C.S. (2021) The bees of Canada. Available from: https://www.beesofcanada.com/ (accessed 7 April 2021).

Sheffield, C.S. & Genaro, J.A. (2013) A new species of *Megachile* (*Litomegachile*) from Cuba, the Antilles (Hymenoptera: Megachilidae). *Journal of Melittology*, 19, 1–17.
https://doi.org/10.17161/jom.v0i19.4564

Sheffield, C.S. & Heron, J.M. (2019 [2018]) The bees of British Columbia (Hymenoptera: Apoidea, Apiformes). *Journal of the Entomological Society of British Columbia*, 115, 44–85.

Sheffield, C.S., Ratti, C., Packer, L. & Griswold, T. (2011) Leafcutter and mason bees of the genus *Megachile* Latreille (Hymenoptera: Megachilidae) in Canada and Alaska. *Canadian Journal of Arthropod Identification*, 18, 1–107.
https://doi.org/10.3752/cjai.2011.18

Sheffield, C.S. & Westby, S.M. (2007) The Male of *Megachile nivalis* Friese, with an updated key to members of the subgenus *Megachile* s. str. (Hymenoptera: Megachilidae) in North America. *Journal of Hymenoptera Research*, 16 (1), 178–191.

Simanonok, M.P. (2018) *Plant-pollinator network assembly after wildfire*. Ph.D. Dissertation, Montana State University, Bozeman, Montana, 132 pp.

Sladen, F.W.L. (1919) Further notes on the *latimanus* group of the bee genus *Megachile*. *Canadian Entomologist*, 51 (4), 85.

Smith, F. (1853) *Catalogue of Hymenopterous Insects in the Collection of the British Museum*. *Part I. Andrenidae and Apidae*. Printed by Order of the Trustees, London, 197 pp.

Spinola, M. (1808) *Insectorum Liguriae Species Novae aut Rariores*. sumptibus auctoris, typis Yves Gravier, Genuæ, 262 pp.
https://doi.org/10.5962/bhl.title.65985

Staab, M., Pufal, G., Tscharntke, T. & Klein, A.M. (2018) Trap nests for bees and wasps to analyse trophic interactions in changing environments—A systematic overview and user guide. *Methods in Ecology and Evolution*, 9, 2226–2239.
https://doi.org/10.1111/2041-210X.13070

Stevens, K.C., Cameron, J. & Ellis, J.D. (2019) *Giant resin bee Megachile sculpturalis (Smith) (Insecta: Hymenoptera: Megachilidae). Entomology and Nematology Department, UF/IFAS Extension Publication EENY-733*. University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS), Gainesville, Florida, 4 pp. Available from: https://edis.ifas.ufl.edu/pdf/IN/IN125800.pdf (accessed 27 June 2021)

Thomson, C.G. (1872) *Hymenoptera Skandinaviens.* typis expressit H. Ohlsson, Lundae, 342 + 286 pp.
https://doi.org/10.5962/bhl.title.9332

Torre-Bueno, J.R. de la. (1989) *The Torre-Bueno glossary of entomology*. New York Entomological Society, New York, New York, 840 pp.

Trunz, V., Packer, L., Vieu, J., Arrigo, N. & Praz, C.J. (2016) Comprehensive phylogeny, biogeography and new classification of the diverse bee tribe Megachilini: Can we use DNA barcodes in phylogenies of large genera? *Molecular Phylogenetics and Evolution*, 103, 245–259.
https://doi.org/10.1016/j.ympev.2016.07.004

Turney, S., Cameron, E.R., Cloutier, C.A. & Buddle, C.M. (2015) Non-repeatable science: assessing the frequency of voucher specimen deposition reveals that most arthropod research cannot be verified. *PeerJ*, 3, e1168.
https://doi.org/10.7717/peerj.1168

U. S. National Pollinating Insects Database (2021) United States Department of Agriculture, Agriculture Research Service, Bee Biology and Systematics Laboratory, Logan, Utah. Available from: http://ww.discoverlife.org (accessed 1 June 2021)

SUPPLEMENTARY MATERIALS. The following supporting information can be downloaded at the DOI landing page of this paper.

TABLE S1. Laboratories, institutions, and individuals that contributed Montana *Megachile* specimens. "Specimen" refers to physical bee specimens with unique identifying codes that we examined on loan.

TABLE S2. Laboratories, institutions, individuals, online data aggregators, and publications that contributed Montana *Megachile* records. "Record" refers to data corresponding to a specimen with a unique identifying code. Records were included in our dataset if they were not a new county record or were identified by an expert taxonomist.

TABLE S3. Montana *Megachile* specimens by collecting method (N = 2,681). "Pan trap" refers to data entered as: "Bee bowl", "Bowl", "Bowl trap", "Pan", and "Pan trap" and where no color was associated with the trap. "Blue pan trap" refers to data entered as: "Blue pan trap", "Blue bowl", and "Blue cup". "Yellow pan trap" refers to data entered as: "Yellow pan", "Yellow pan trap", "Yellow bowl", and "Yellow cup". "White pan trap" refers to data entered as: "White bowl", "White pan trap", and "White cup". "Bee Bucket" refers to data entered as: "Bee bucket", "Yellow bucket", "Bucket trap", and "Yellow bucket trap". "Pitfall trap" refers to data entered as: "Pit trap", "Pitfall trap", and "Pitfall".

Raw Data for Chao1.

Erroneous Records