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DNA barcoding insufficiently identifies European wild bees (Hymenoptera, Anthophila) due to undefined species diversity, genus-specific barcoding gaps and database errors

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[Correction added on 25 April 2024, after first online publication: "Correspondence" section has been updated in this version.]

Abstract

Recent declines in insect abundances, especially populations of wild pollinators, pose a threat to many natural and agricultural ecosystems. Traditional species monitoring relies on morphological character identification and is inadequate for efficient and standardized surveys. DNA barcoding has become a standard approach for molecular identification of organisms, aiming to overcome the shortcomings of traditional biodiversity monitoring. However, its efficacy depends on the completeness of reference databases. Large DNA barcoding efforts are (almost entirely) lacking in many European countries and such patchy data limit Europe-wide analyses of precisely how to apply DNA barcoding in wild bee identification. Here, we advance towards an effective molecular identification of European wild bees. We conducted a high-effort survey of wild bees at the junction of central and southern Europe and DNA barcoded all collected morphospecies. For global analyses, we complemented our DNA barcode dataset with all relevant European species and conducted global analyses of species delimitation, general and genus-specific barcoding gaps and examined the error rate in DNA data repositories. We found that (i) a sixth of all specimens from Slovenia could not be reliably identified, (ii) species delimitation methods show numerous systematic discrepancies, (iii) there is no general barcoding gap across all bees and (iv) the barcoding gap is genus specific, but only after curating for errors in DNA data repositories. Intense sampling and barcoding efforts in underrepresented regions and strict curation of DNA barcode repositories are needed to enhance the use of DNA barcoding for the identification of wild bees.

KEYWORDS
insect decline, pollinator, species delimitation, taxonomic impediment

Čandek Klemen and Gregorič Matjaž co-supervised the project.

1 | INTRODUCTION

In the last decades, the planet is undergoing intense global ecosystem changes (Barnosky et al., 2012) and mass extinctions are expected throughout the tree of life (Dirzo et al., 2014). Recently, noticeable declines in insect populations have become of concern (Lister & Garcia, 2018). Among the system services that functioning ecosystems provide, pollination is certainly among the noteworthy. In this context, the observed declines in wild pollinators, especially wild bees (Williams & Osborne, 2009), pose a threat to many natural and agricultural ecosystems (Steffan-Dewenter et al., 2005). Namely, three quarters of agricultural and wild plants are pollinated by insects (Potts et al., 2015) and the yearly value of insects in agriculture is estimated at 153 billion Euro (Gallai et al., 2009). Additionally, pollinators in general and bee communities specifically, can be utilized as bioindicators in environmental assessments (Nieto et al., 2014). The global insect decline is currently attributed to climate change, fragmentation of natural habitats, changes in land use, anthropogenic spread of parasites, diseases and alien plant species and phytopharmaceuticals and their interactions (Vanbergen et al., 2013, 2014).

The application of biological data to societal problems often relates to biodiversity monitoring that is largely limited to correct specimen identification. The superfamilial clade Anthophila encompasses over 20,000 species of bees worldwide (Cardinal, 2018). The traditional species monitoring and specimen identification of such a large group relies on morphological character identification, but is hindered mainly by the incomplete taxonomic and diagnostic treatment of taxa, as well as a decline in this expertise (Sheffield et al., 2009). For example, the group Anthophila contains several morphologically cryptic taxa, for example, within the genera *Bombus* (McKendrick et al., 2017) and *Andrena* (Gueuning et al., 2020) and several species are tough to diagnose morphologically even for experts (Magnacca & Brown, 2012). Such morphological identification is manual and time consuming, while taxonomic expertise is in decline worldwide and completely lacking in some regions (Hopkins & Freckleton, 2002; Potts et al., 2021; Wheeler et al., 2004). Therefore, current monitoring efforts are inadequate in performing efficient and standardized pollinator surveys (Gill et al., 2016).

The use of molecular approaches can help in addressing the shortcomings of traditional approaches, for example, in determination of commonly misidentified taxa (Carolan et al., 2012; Gueuning et al., 2020; McKendrick et al., 2017) and can, in combination with traditional taxonomic approaches, create a taxonomic feedback loop, which can lead to species discovery and better-resolved taxonomies (Gibbs, 2018; Page et al., 2005). In the last two decades, DNA barcoding has become a standard approach for molecular identification of organisms (Hebert, Cywinska, et al., 2003; Krehenwinkel et al., 2019). However, its effective use in species identification depends on the completeness of DNA barcoding reference libraries (Villalta et al., 2021). Besides containing DNA barcodes of as many species as possible, a well-characterized intraspecific variability in a database greatly boosts the accuracy of DNA-based identification (Phillips et al., 2019; Villalta et al., 2021). Unfortunately, only few national and regional DNA barcode reference libraries for wild bees have been developed so far, for example, for Ireland (Magnacca & Brown, 2012), Germany (Schmidt et al., 2015), China (Hua et al., 2016), Canada (deWaard et al., 2019; Sheffield et al., 2009, 2017), Chile (Packer & Ruz, 2017), Switzerland (Gueuning et al., 2020) and France (Villalta et al., 2021).

Slovenia is a good example of the obstacles molecular identification of bees is currently facing. At a relatively small surface area, Slovenia is one of Europe's biodiversity hotspots (Šilc et al., 2020) and is occupied by 575 wild bee species (Gogala, 2023). However, only 12 DNA barcode sequences for four species of *Bombus* and three sequences of the domesticated *Apis mellifera carnica* are currently published from Slovenia (BOLD Identification System tool; Ratnasingham & Hebert, 2007; accessed 17. Feb. 2024). Therefore, databases do not fully capture the intraspecific variability of these species, rendering the accuracy of DNA-based identification questionable. Many European countries are represented by similarly poor representative DNA sequences. Notably, most of these are southern European countries that bear the highest diversity of wild bees (Leclercq et al., 2023; Potts et al., 2021). Such patchy data limits Europe-wide analyses of precisely how to apply DNA barcoding in wild bee identification. For example, the presence of a barcoding gap, that is, the intraspecific genetic divergence being an order of magnitude smaller than the inter-specific genetic divergence, is needed for successful species identification (Meyer & Paulay, 2005). For many animal taxa, sequence divergence thresholds of 2%–3% are suitable (Barrett & Hebert, 2005; Hebert et al., 2004; Hebert, Ratnasingham, & DeWaard, 2003), but not so in some groups, for example, butterflies, flies and wild bees (Gibbs, 2018). Consequently, while the application of DNA barcoding for wild bee monitoring has proven useful in many regional cases (Creedy et al., 2020; deWaard et al., 2019; Hua et al., 2016; Villalta et al., 2021), it is still insufficient on larger scales, for example in yet unexplored regions or on the scale of entire continents.

Here, we advance towards an effective molecular bee identification of European wild bees. We conducted a high-effort survey of wild bees in Slovenia and DNA barcoded all morphologically determined species, thus creating the first such effort in the region. Then, we compared the efficacy of morphological diagnosability to molecular diagnoses based on existing DNA barcode repositories that mostly include central European wild bee fauna. For our further meta-analyses, we complemented our DNA barcode dataset with all relevant species sequences, maximizing the geographic range for all species. Based on this, we first conducted species delimitation analyses to discover potential systematic discrepancies and thus diagnostic mistakes. Then, we tested for a potential uniform barcoding gap among all bees. Because such a barcoding gap does not exist, we conducted genus-level analyses to explore patterns at a finer scale and inform future research. To do that, we tested for genus-specific barcoding gaps and estimated potential database identification errors.

2 | MATERIALS AND METHODS

2.1 | Sampling and morphological identification

We collected bees twice a month from April to September 2020 at 50 sampling sites (Appendix S1) in five areas throughout Slovenia. Blue and yellow vane traps and blue, yellow and white pan traps were used. We selected these two trap types to increase sampling efficiency, as each trap type catches about a quarter of unique taxa (own data). Traps were filled with water with added detergent (as surfactant). After 48-hour exposure in the field, we collected all bees from traps and stored them in 70% ethanol. Prior to the preparation of bees for dry entomological collections, we removed one (in large species) or three (in small species) legs and stored these legs as tissue samples in 2-mL Eppendorf tubes filled with 96% ethanol. We determined all specimens to species level according to Fauna Helvetica Apidae 1–6 (Amiet et al., 1999, 2001, 2004, 2007, 2010, 2017). We used leg-tissue samples of selected individuals of all morphologically determined species to obtain DNA barcodes. For some species that we did not obtain from traps (marked in Appendix 1), we obtained tissue samples for DNA barcoding from dry collections. However, these were not older than 1 year.

2.2 | DNA extraction and amplification

For DNA extraction, we used one to three legs from representative specimens of all species. Due to morphological variation, we used one specimen per species per locality (see Section 3, Appendixes 1 and 2). We extracted DNA using the QIAGEN DNeasy Blood & Tissue Kit (QIAGEN N. V., The Netherlands) through a modified Quick-Start protocol. Specifically, (i) we incubated the tissue with Proteinase K while vortexing at 450 rpm overnight; (ii) we added an additional final spin on the centrifuge before adding the elution, to ensure the removal of all the other buffers and ethanol; and (iii) we performed the elution with AE buffer warmed up to 70°C, with any additional elution having an increased incubation time from the regular 1–5 min. Using the TaqFlexi PCR Kit (Promega, USA), we amplified the standard DNA barcoding region for animals, that is, the 658 bp fragment of the mitochondrial cytochrome c oxidase (*cox1*) gene (Hebert, Cywinska, et al., 2003). We first used the BeeCox1 primers (Bleidorn & Henze, 2021) for all samples. When these failed, we used the Folmer primers (Folmer et al., 1994) using both the BeeCox protocol and Folmer protocols. At Macrogen Europe, all amplicons were sequenced from both directions. *Cox1* samples that yielded low-quality sequences were multiplied and sequenced again. We assembled and edited same sample sequences using Geneious Pro 5.6.7 (Biomatters Inc., New Zealand).

2.3 | Data analyses

2.3.1 | Dataset assembly

We compared each sequence to “Species level barcode records” at the BOLD Identification System tool (Ratnasingham & Hebert, 2007) to check for potential discrepancies between morphological and molecular species identifications. We assigned a molecular identification (BOLD species best hit; Appendix 2) when a single species identity score exceeded 95%. If more than one species had an equal identity score above 95%, we did not assign a molecular species identification. For specimens whose closest BOLD hit did not have a sequence identity above 95%, we also did not assign a molecular species identification. We then morphologically re-examined every specimen whose molecular and morphological species identity did not match in order to find and correct misidentifications that might have happened during initial specimen determination. In cases of persisting identity mismatch, we continued our analyses using morphological identification.

For each sequence, we calculated the “BOLD best hit” and “BOLD other close hits” (Appendix 2), which formed the basis for our extended global dataset. In order to identify potential global systematic discrepancies, we aimed to include all species names that have closely associated sequences in data repositories. Under “BOLD other close hits” (Appendix 2), we listed all species, other than the best-hit species, that had their sequence identities above 95%. Then, we datamined BOLD for all available sequences of species matching our morphological species identity, their “BOLD best hit” and their “BOLD other close hits”, totaling 11,167 sequences (retrieved 16 January 2023). Next, we undertook dataset optimization: we removed sequences that did not include the barcoding region or were shorter than 500 nucleotides, resulting in 8190 sequences. Then, we selected one high-quality sequence of each species per country, to represent a population, thus enabling calculation of intraspecific distances. We removed sequences with “unknown” locations, except when no other sequence with country information was available for a species. When multiple choices per country were available, we selected the longest sequence that also included identifier information. This process resulted in 914 useful sequences that we combined with our original 365 sequences from Slovenia, to create our final optimized dataset of 1279 sequences belonging to 226 species. We checked for misspelled and outdated species names (synonyms) and corrected them according to currently valid taxonomic catalogues at Integrated Taxonomic Information System (www.itis.gov) and Catalogue of Life (https://www.catalogueoflife.org/).

2.3.2 | Phylogeny and species delimitation

We used MEGA-X (Tamura et al., 2021) to align sequences and to check for the best-fit substitution model. We used MrBayes (Huelsenbeck & Ronquist, 2001) to reconstruct a *cox1* phylogeny based on our optimized dataset and *Ammoplanus marathroicus* as an outgroup. We used the generalized time-reversible model with gamma distribution and invariant sites as suggested by AICc and BIC criterion in MEGA-X. We ran two independent runs, each with four MCMC chains, for 15 million generations, with a sampling frequency of 1000 and relative burn-in set to 25%, the starting tree was random. We ran MrBayes analysis on CIPRES Science Gateway v. 3.3 (Miller et al., 2010). We performed two species delimitation analyses; a phylogenetic tree-based multi-rate Poisson tree analysis under ML and Markov chain Monte Carlo (mPTP; Kapli et al., 2017), ran online (https://mptp.h-its.org/#/tree) and a genetic distance-based Assemble Species by Automatic Partitioning (ASAP; Puillandre et al., 2021), ran online (https://bioinfo.mnhn.fr/abi/public/asap/).

2.3.3 | DNA barcoding gap

The bee clade Anthophila is taxonomically challenging with potentially numerous errors in public databases, such as BOLD. Therefore, we expected a significant overlap between intra- and inter-specific genetic distances both across and within its genera. We were interested in the extent of these errors and how much confidence we can have in a "universal" bee barcoding gap. The existence and size of the barcoding gap depend on its definition and the context of biological data (Čandek & Kuntner, 2015; Collins & Cruickshank, 2012; Hebert et al., 2004; Hebert, Cywinska, et al., 2003; Meyer & Paulay, 2005; Phillips et al., 2022; Stoeckle & Thaler, 2014; Zhang et al., 2017). Therefore, we first checked for an overlap between intra- and inter-specific genetic distances using the standard Kimura 2-parameter (K2P; Kimura, 1980) and then estimated the proportion of potentially misidentified sequences that needed to be removed in order to arrive to the smallest acceptable barcoding gap of 2% difference between the largest intra-specific and smallest inter-specific distance (see below). We first searched for such a barcoding gap in the entire clade Anthophila and then performed the same analyses at a lower phylogenetic level. As wild bee families in Europe are represented mostly by few large genera (Figure 1), performing family-level barcoding-gap analysis is unfeasible. Rather, we performed it on the genus level.

We calculated K2P genetic distances, a standard in DNA barcoding literature (Hebert, Cywinska, et al., 2003), in Mega X (Kumar et al., 2018). We binned these distances into 53 classes of identical size using 0.05% increment (from 0.05% to 26.5%). We then transformed this frequency distribution into relative values to get a straightforward observation of the intra- and inter-specific overlap proportions. To test for a "true" barcoding gap, that is, not obscured by obvious misidentifications, it is sometimes suggested to trim the distance dataset, thereby removing the effect of erroneous sequences that are abundant in public repositories and often represent well over 5% of all sequences (Baena-Bejarano et al., 2023; Čandek & Kuntner, 2015; Meier

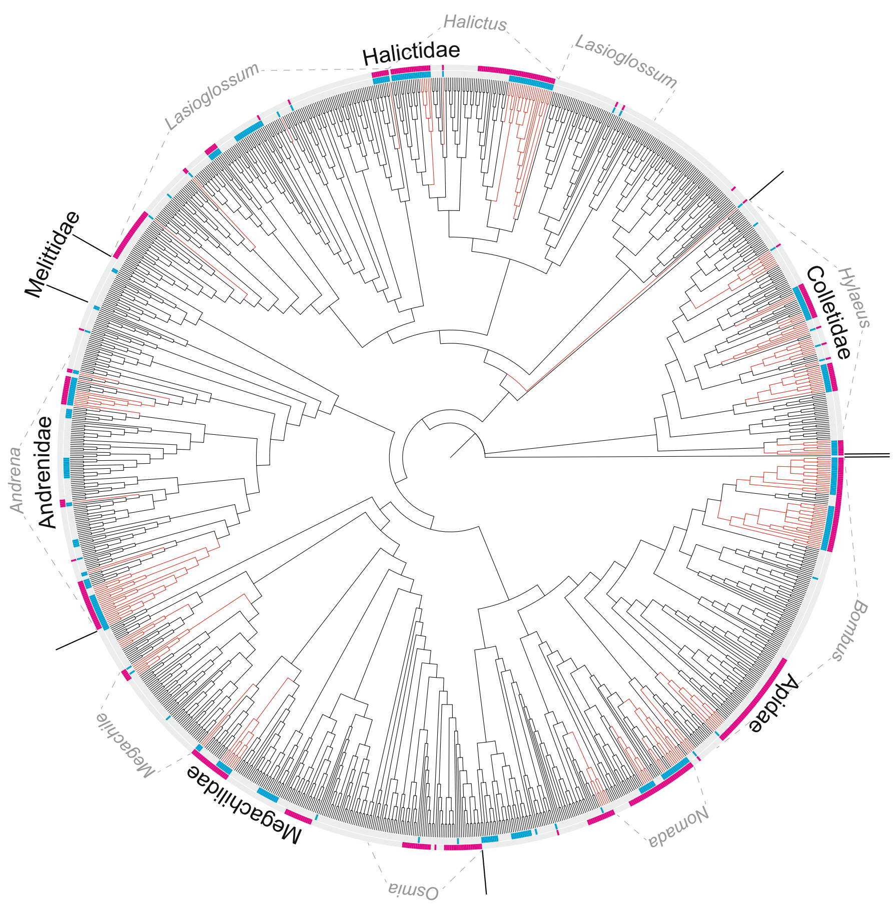

FIGURE 1 Summary *cox1* phylogeny of European wild bees. The topology is from the Bayesian analysis. Red branches mark clades that are not monophyletic based on morphological identification. Coloured rectangles mark taxonomic discrepancies between the morphological identification and the two species delimitation methods: the mPTP (blue) and ASAP (pink) rectangles mark any such discrepancy, be it a suggested higher or lower species diversity. Details are visualized in Appendix S2.

et al., 2006, 2008; Meiklejohn et al., 2019; Wu et al., 2021). We trimmed roughly equal number of distances at both extremes (largest intraspecific and smallest interspecific) to open a 2% wide barcoding gap (Figure 2). Although any barcoding gap width is to a degree arbitrary, we believe our approach to be statistically justifiable and a conservative test since it: (i) builds on prior studies that have established that most animal species show <2% intraspecific variation in *cox1*, but more than 4% divergence from their nearest neighbour (Ratnasingham & Hebert, 2013); (ii) uses the "universal" 2% threshold, which successfully delimits most animal species (Hebert, Cywinska, et al., 2003; Hubert & Hanner, 2016). it functions as a "buffer zone" between the largest intra- and smallest inter-specific distances, meaning that any dataset for which a 2% wide barcoding gap is uncovered, DNA barcodes are likely to be highly (often 100%) effective; (iii) employs the 2% distance in a similar fashion to how BOLD delimits nearest neighbours (Meyer & Paulay, 2005; Ratnasingham & Hebert, 2007, 2013; BOLD Systems handbook, Ratnasingham & Hebert, 2007; accessed 27. Feb. 2024); (iv) it acknowledges the expected misidentifications (Čandek & Kuntner, 2015); and (v) it should account for unpublished or unknown portions of biodiversity that can shift the position of, or even close the simple "no width" barcoding gap. Thus, inferring a barcoding gap of a certain width (2%) through trimming genetic distances at both intra- and inter-specific extremes is a robust, quick and widely applicable test to estimate the proportions of likely erroneous sequences in datasets or databases. We used this approach for the entire Anthophila clade and for the eight large genera within it. These eight genera represent 74.7% of our data and are appropriate for barcoding gap analyses since they are sufficiently diverse to allow confident calculation of both intra- and inter-specific distances. For these analyses, we treated all cf. species as species.

3 | RESULTS

In total, we collected and morphologically determined 378 bee specimens, belonging to 163 species from 31 genera from all six European families. We had varying amplifying success among specimens, depending on: (i) species, where some presented a greater amplification challenge, but the pattern was not family specific; (ii) primers, where most species amplified well using the BeeCox1 primers, while in some we used the traditional Folmer primers; (iii) the infestation with the parasitic fly *Thecophora atra*, where the infestation was specific to the genera *Halictus* and *Lasioglossum*. Finally, we managed to obtain *cox1* barcode sequences for 365 of the 378 specimens.

3.1 | Species identification

Using our DNA barcodes in the BOLD Systems identification tool, the molecular identification, compared to the morphological identification, unequivocally inferred the same genus in all cases (100%) and the same species in 272 of the 365 specimens (74.5%). We then double checked the morphological identification of the specimens whose molecular identification inferred a different species and discovered a clear identification mistake based on morphology or a labeling mistake in 39 specimens. A further check against the corrected morphological dataset reveals a remaining identification mismatch between the morphological and molecular identification approaches in 61 specimens (16.7%). In Appendix 2, we list both the morphological and molecular identifications of all samples, as well as their closest BOLD hits.

3.2 | Species delimitation analyses

Our phylogenetic analyses recovered all six families monophyletic, albeit only three (Apidae, Halictidae, Megachilidae) with strong support (>95% posterior probability). From the 31 genera, all but *Lasioglossum* and *Sphecodes* recovered monophyletic, where *Lasioglossum* is clearly divided into two large, non-sister groups, while *Sphecodes* recovered polyphyletic due to a single specimen that is likely a misidentification (Figure 1, Appendix S2). Although several nodes of our phylogeny are poorly supported and inferring phylogenetic relationships among clades is not a scope of this study, 38 clades across the phylogeny recovered poly- or paraphyletic, indicating general taxonomic discrepancies (Figure 1, red branches).

The two species delimitation analyses contrast in estimating a larger and smaller species number compared to our dataset of 226 species that comprise morphologically identified individuals and BOLD datamined sequences (Table 1). The mPTP analysis of our phylogenetic tree favoured multicoalescent rate over single coalescent rate and recovered 254 species. The ASAP analysis on the entire dataset of 1278 sequences recovered 10 best partitions, of which the highest confidence one (ASAP-score = 15.00, p-val = 1.80e-04, W = 1.85e-05, Threshold dist. = 0.056641) recovered 187 hypothesized species. Other partitions ranged from 181 to 311 hypothesized species. In general, ASAP was conservative in delimiting species and estimated 39 fewer species compared to our dataset, while mPTP indicates 28 additional species than there are available names (Table 1, Appendix S2). In some genera, the two methods estimate an inverse number of species relative to the number of morphospecies, for example, in *Bombus*, *Hylaeus* and *Osmia*. In several other genera, however, the two methods both estimate a larger or smaller number of species, for example, in *Andrena*, *Lasioglossum* and *Nomada* (Table 1). In sum, both species delimitation methods sometimes suggest cryptic species diversity, that is, one name hides more than one biological species, while in other cases, both methods suggest some species will likely have to be synonymized. These two types of taxonomic discrepancies appear at numerous spots across the entire phylogeny (Figure 1, blue (mPTP) and pink (ASAP) parts of the circle). For example, both methods suggest *Bombus*

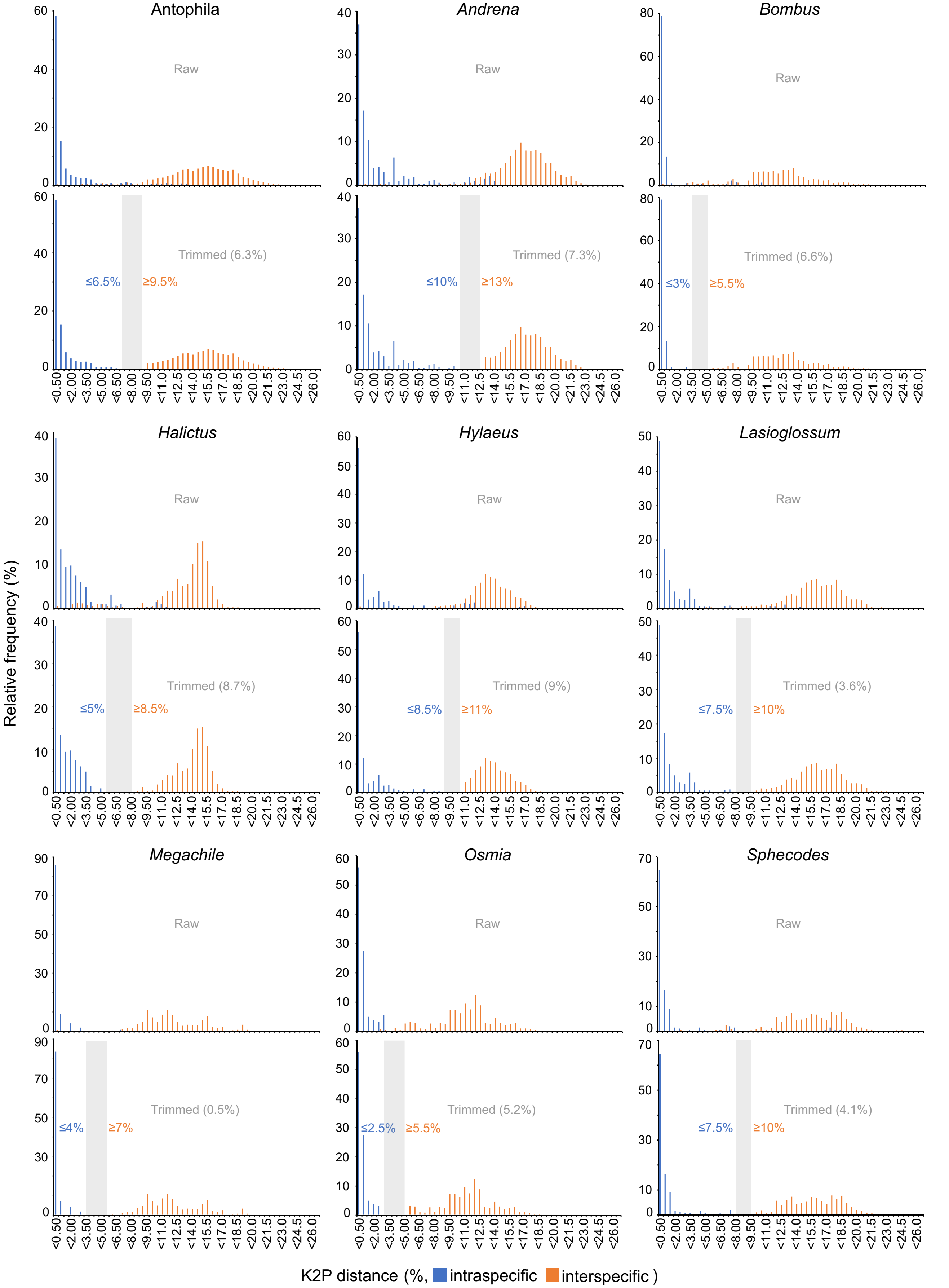
Antophila
Raw
Trimmed (6.3%)
≤6.5%
≥9.5%
Andrena
Raw
Trimmed (7.3%)
≤10%
≥13%
Bombus
Raw
Trimmed (6.6%)
≤3%
≥5.5%
Halictus
Raw
Trimmed (8.7%)
≤5%
≥8.5%
Hylaeus
Raw
Trimmed (9%)
≤8.5%
≥11%
Lasioglossum
Raw
Trimmed (3.6%)
≤7.5%
≥10%
Megachile
Raw
Trimmed (0.5%)
≤4%
≥7%
Osmia
Raw
Trimmed (5.2%)
≤2.5%
≥5.5%
Sphecodes
Raw
Trimmed (4.1%)
≤7.5%
≥10%
Relative frequency (%)
K2P distance (%, intraspecific interspecific)

FIGURE 2 Frequency distributions of intra- and inter-specific genetic distances calculated using the Kimura 2-parameter (K2P) model in the entire clade Anthophila and eight large European bee genera. For each group, raw and trimmed data are plotted in a separate graph, with the trimmed graph indicating the amount of trimmed extreme intra- and inter-specific distances (in grey) and the barcode gap position (interval limits in blue and orange).

hypnorum, *Anthophora plumipes*, *Andrena subopaca*, *Lasioglossum leucozonium*, *Halictus smaragdulus* and several more to contain at least two species. On the extreme, *Lasioglossum villosulum* might hide from two (ASAP) and up to six (mPTP) species. On the other hand, both methods suggest several species pairs or groups, for example, *Bombus ashtoni* and *B. bohemicus* and *Halictus simplex*, *H. compressus* and *H. langobardicus*, to belong to a single species. In extremes, five species of *Nomada* (*N. panzeri*, *N. glabella*, *N. leucophthalma*, *N. ferruginata*, *N. flava*) and four species of *Andrena* (*A. nitida*, *A. limata*, *A. flavipes*, *A. thoracica*) are suggested to represent single species (Appendix S2).

3.3 | Barcoding gap and error rates in databases

There was an overlap between intra- and inter-specific genetic distances across all bees, indicating that a barcoding gap based on raw data does not exist (Figure 2). By trimming 6.25% of extreme values, however, we inferred a barcoding gap at 6.5%–9.5% genetic distance. Similarly, there was an overlap between intra- and inter-specific genetic distances in all eight investigated genera (Figure 2). Trimming extreme values in these, we inferred a barcoding gap at different positions. However, in all genera, the barcoding gap lies partially or entirely outside the one inferred for the Anthophila clade. For example, the barcoding gap in *Osmia* is at 2.5%–5.5% genetic distance and in *Andrena* at 10%–13% genetic distance. Additionally, the trimming amount needed to reach the minimum set barcoding gap of 2% genetic distance was drastically different among genera (Figure 2). In extremes, 0.45% values in *Megachile* and 8.95% values in *Hylaeus* had to be trimmed. We can use these extreme values that obscure the barcoding gap to roughly estimate the proportion of errors that pest public databases. Depending on dataset composition (e.g., the proportion of conspecifics vs. heterospecifics within a clade) and the number of recently diverged species with truly low differences in their genetic composition, each erroneous sequence produces extreme intra- or inter-specific (or both) values. Therefore, each percent of the trimmed extreme values reflects between 0.5% and 1% of erroneous sequences. To put this into a more tangible perspective: in *Sphecodes* we trimmed 4.1% of the extreme distances and therefore expect that our dataset contains between 2.05% and 4.1% erroneous sequences. Our *Sphecodes* dataset comprises 64 representatives and thus we can expect between 1 and 3 sequences to be potentially misidentified. Indeed, a close examination of our species delimitation analyses and phylogenetic tree hints at two dubious *Sphecodes* identities: *S. cephalotes* which could be a conspecific of *S. monilicornis* and *S. geoffrellus* which is not a part of *Sphecodes* clade and thereofore a clear mistake.

4 | DISCUSSION

We show that molecular identification of bees using DNA barcoding is not yet achievable at a satisfactory level. While our results show reliable genus-level identification, there is a considerable mismatch between morphological and molecular species-level identifications, likely due to missing data and insufficiently curated databases, taxonomic discrepancies in large genera and the lack of a uniform barcoding gap across bees in general.

Our molecular identifications based on *cox1* barcodes show that a quarter of the specimens were determined unreliably using morphology. About half of these inconsistencies were due to identification and labeling mistakes during determination. However, even after double checking all dubious identifications, a sixth (16.7%) of all specimens remained dubiously identified, indicating deeper determination issues in bees in general. This is an expected mistake type in large invertebrate inventories and was also detected in previous bee-inventories. For example, Herrera-Mesías et al. (2022) found an 11% mismatch between morphological and metabarcoding determinations on average, with differences among experts, where 3% of these differences were attributed to false positives due to environmental contaminations and 1.3% to false negatives due to insufficient sequencing depth. A similar identification mismatch of 10%–20% was found in other regional bee inventories (e.g., Gibbs, 2018; Herrera-Mesías et al., 2022; Magnacca & Brown, 2012; Schmidt et al., 2015). This mismatch is probably higher in countries with the largest gaps in DNA data availability, that is, southern and eastern Europe (Leclercq et al., 2023).

Unreliable identifications likely fall into two categories. First, as is true for most or perhaps all (mega)diverse organism groups, taxonomic discrepancies remain in several of their subgroups, hindering the creation of completely reliable identification guides; and second, the genetic variation among populations within species is insufficiently known (Praz et al., 2022). For example, it could be that some species, likely the widely distributed ones, are in fact complexes of several species; or that some valid species are indeed populations of a single species and morphological variation within a species was thought to reflect biological species. Our species delimitation results corroborate both assumptions for European bees (Figure 1, Appendix S2). While both species delimitation methods indicate cryptic species diversity as more common, there are several cases of species complexes that will likely have to be synonymized in future taxonomic revisions.

Besides resolving taxonomic discrepancies, successful molecular identification also necessitates a well-documented intra-specific versus inter-specific variability in the used DNA barcodes (Phillips et al., 2019; Villalta et al., 2021). Ideally, there is an established DNA barcoding gap, allowing for reliable molecular identification of

TABLE 1 The number of species per genus.

Taxon	Global data set	mPTP	ASAP
Andrenidae	38	49	40
Andrena	36	45	38
Panurgus	2	4	2
Apidae	53	49	31
Amegilla	1	1	1
Anthophora	4	6	6
Bombus	20	21	12
Ceratina	3	5	3
Epeoloides	1	1	1
Eucera	3	2	1
Nomada	16	9	4
Tetralonia	1	1	0
Xylocopa	4	3	3
Colletidae	29	27	23
Colletes	5	2	2
Hylaeus	24	25	21
Halictidae	55	68	52
Dufourea	1	1	1
Halictus	14	13	9
Lasioglossum	31	43	33
Sphecodes	9	11	9
Megachilidae	47	56	37
Anthidium	2	2	2
Chelostoma	5	6	5
Coelioxys	4	5	4
Heriades	1	2	1
Hoplitis	3	4	2
Lithurgus	1	2	1
Megachile	10	13	11
Osmia	15	17	8
Pseudoanthidium	2	1	1
Stelis	3	3	1
Trachusa	1	1	1
Melittidae	4	5	4
Dasypoda	1	2	1
Macropis	1	1	1
Melitta	2	2	2
31	226	254	187

Note: Global data set: the number of species in our global analyses, that is, both the sequenced morphospecies from our inventory and the global sequences downloaded from BOLD. mPTP: the number of estimated species by the mPTP. ASAP: the number of estimated species by ASAP. The greenish and reddish shading marks the strength of higher and lower species estimates, respectively, by the two species delimitation methods as compared to the current taxonomic classification.

specimens (Čandek & Kuntner, 2015). The results of our raw dataset across bees show the lack of such a barcoding gap (Figure 2), but after curating the genetic distance matrix (pruning 6.25% of extreme values), we find a "universal" bee DNA barcoding gap between 6.5% and 9%. However, as our further analyses show, this likely represents an artefact and is not useful for general molecular identification of the vast diversity of wild bees. Namely, we show that all large bee genera have their own specific barcoding gaps (Figure 2). Again, we determined our "universal" and genus-specific barcoding gaps based on a carefully assembled and curated initial dataset and a careful elimination of extreme values. Therefore, our barcoding gap analyses reflect conservative estimates of probable mistakes in public repositories for these large bee genera.

For example, we argue that even if one undertakes a stringent procedure in compiling a dataset for various research topics (e.g., estimating the conservation status of a species or species richness of an area), a considerable amount of errors in many wild-pollinator clades are still expected. For example, we expect that 2%–4% of *Sphecodes* specimens, 2.3%–6.6% of *Bombus* specimens and 4.5%–9% of *Hylaeus* specimens, but less than 0.5% of *Megachile* specimens (Figure 2), are represented in public repositories with incongruent species identities. Furthermore, as we retained only sequences of the highest quality and reliability, the actual error rate in public molecular data repositories is likely higher. Thus, our results agree with previous studies (Gibbs, 2018), which indicate that bees, a hymenopteran clade originating ~125 million years ago and encompassing over 20,000 species (Cardinal, 2018), are too diverse to contain a single such DNA barcoding gap, at least using the *cox1* barcode.

Another interesting pattern is the seeming congruence of our species delimitation and barcoding gap analyses. Specifically, ASAP works by inferring a universal species threshold from the provided data (Puillandre et al., 2021). Therefore, as illustrated by our barcoding gap results that show genus-specific thresholds which are different to the universal bee threshold, ASAP is likely a method not suitable for species delimitation of a large and diverse group as wild bees. Instead of relying on sequence clustering, mPTP tries to detect the transition between intra-specific and inter-specific branches on a provided ultra-metric tree (Kapli et al., 2017). Because the intra- and inter-specific representation and diversities within and among different wild-bee clades are highly inconsistent, mPTP might be prone to oversplitting species. Of course, integrative taxonomic investigations of smaller clades will yield credible species hypotheses.

To arrive at protocols that allow for a sufficiently reliable molecular identification of wild bees, we suggest the following two steps to be undertaken. First, high-effort bee inventories, including DNA barcoding of all morphospecies, are needed in under-researched regions. These are often both under-funded and have high biodiversity indices. Therefore, funding agencies should prioritize research funding in such areas. Second, global molecular data repositories need to be strictly curated. Among several mistakes in current repositories are poor quality sequences that include stop codons, sequences of (clearly) misidentified taxa, as well as synonymized names and even spelling mistakes. We argue for active correction of existing sequences, even when the original data contributors are non-active and for cautious interpretation of results derived from datamining.

5 | CONCLUDING REMARKS

We provide a first high-effort wild bee inventory with DNA barcoding in a little-explored European region (south-central Europe and northern Balkan) and conduct Europe-wide analyses of the efficacy of morphology-based versus DNA barcoding-based identification of wild bees. One in six wild bees in our study was unreliably identified (disparity between morphological and molecular identifications). We argue this to be, in large part, due to taxonomic discrepancies, a lack of a general DNA barcoding gap across bees, considerable error rate in DNA barcoding data repositories and due to insufficient DNA barcoding efforts in entire geographical regions leading to inadequately sampled genetic diversity.

AUTHOR CONTRIBUTIONS

J. Š., M. G., K. Č. and D. K. conceived the study. B. K. and R. Š. carried out field sampling. B. K. and A. G. determined the bees. J. Š. carried out the DNA barcoding. J. Š., K. Č. and M. G. analysed the data. J. Š. prepared the first draft, while all authors jointly contributed to finishing the manuscript.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

All experimental data and DNA barcode identifiers (GenBank accession codes) are available in the manuscript.

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REFERENCES

Amiet, F., Herrmann, M., Müller, A., & Neumeyer, R. (2001). *APIDAE 3*. Centre suisse de cartographie de la faune (CSCF).

Amiet, F., Herrmann, M., Müller, A., & Neumeyer, R. (2004). *APIDAE 4*. Centre suisse de cartographie de la faune (CSCF).

Amiet, F., Herrmann, M., Müller, A., & Neumeyer, R. (2007). *APIDAE 5*. Centre suisse de cartographie de la faune (CSCF).

Amiet, F., Herrmann, M., Müller, A., & Neumeyer, R. (2010). *APIDAE 6*. Centre suisse de cartographie de la faune (CSCF).

Amiet, F., Müller, A., & Neumeyer, R. (1999). *APIDAE 2*. Centre suisse de cartographie de la faune (CSCF).

Amiet, F., Müller, A., & Praz, C. R. (2017). *APIDAE 1* (2nd ed.). Centre suisse de cartographie de la faune (CSCF).

Baena-Bejarano, N., Reina, C., Martínez-Revelo, D. E., Medina, C. A., Tovar, E., Uribe-Soto, S., Neita-Moreno, J. C., & Gonzalez, M. A. (2023). Taxonomic identification accuracy from BOLD and GenBank databases using over a thousand insect DNA barcodes from Colombia. *PLoS One*, *18*(4), e0277379. https://doi.org/10.1371/journal.pone.0277379

Barnosky, A. D., Hadly, E. A., Bascompte, J., Berlow, E. L., Brown, J. H., Fortelius, M., Getz, W. M., Harte, J., Hastings, A., Marquet, P. A., Martinez, N. D., Mooers, A., Roopnarine, P., Vermeij, G., Williams, J. W., Gillespie, R., Kitzes, J., Marshall, C., Matzke, N., … Smith, A. B. (2012). Approaching a state shift in Earth's biosphere. *Nature*, *486*(7401), 52–58. https://doi.org/10.1038/nature11018

Barrett, R. D. H., & Hebert, P. D. N. (2005). Identifying spiders through DNA barcodes. *Canadian Journal of Zoology*, *83*(3), 481–491. https://doi.org/10.1139/z05-024

Bleidorn, C., & Henze, K. (2021). A new primer pair for barcoding of bees (Hymenoptera: Anthophila) without amplifying the orthologous coxA gene of *Wolbachia* bacteria. *BMC Research Notes*, *14*(1), 1–6. https://doi.org/10.1186/s13104-021-05845-9

Čandek, K., & Kuntner, M. (2015). DNA barcoding gap: Reliable species identification over morphological and geographical scales. *Molecular Ecology Resources*, *15*(2), 268–277. https://doi.org/10.1111/1755-0998.12304

Cardinal, S. (2018). Bee (Hymenoptera: Apoidea: Anthophila) diversity through time. *Insect Biodiversity*, *II*, 851–867. https://doi.org/10.1002/9781118945582.ch28

Carolan, J. C., Murray, T. E., Fitzpatrick, Ú., Crossley, J., Schmidt, H., Cederberg, B., McNally, L., Paxton, R. J., Williams, P. H., & Brown, M. J. F. (2012). Colour patterns do not diagnose species: Quantitative evaluation of a DNA barcoded cryptic bumblebee complex. *PLoS One*, *7*(1), e29251. https://doi.org/10.1371/journal.pone.0029251

Collins, R. A., & Cruickshank, R. H. (2012). The seven deadly sins of DNA barcoding. *Molecular Ecology Resources*, *13*(6), 969–975. https://doi.org/10.1111/1755-0998.12046

Creedy, T. J., Norman, H., Tang, C. Q., Qing Chin, K., Andujar, C., Arribas, P., O'Connor, R. S., Carvell, C., Notton, D. G., & Vogler, A. P. (2020). A validated workflow for rapid taxonomic assignment and monitoring of a national fauna of bees (Apiformes) using high throughput DNA barcoding. *Molecular Ecology Resources*, *20*(1), 40–53. https://doi.org/10.1111/1755-0998.13056

deWaard, J. R., Ratnasingham, S., Zakharov, E. V., Borisenko, A. V., Steinke, D., Telfer, A. C., Perez, K. H. J., Sones, J. E., Young, M. R., Levesque-Beaudin, V., Sobel, C. N., Abrahamyan, A., Bessonov, K., Blagoev, G., deWaard, S. L., Ho, C., Ivanova, N. V., Layton, K. K. S., Lu, L., … Hebert, P. D. N. (2019). A reference library for Canadian invertebrates with 1.5 million barcodes, voucher specimens, and DNA samples. *Scientific Data*, *6*(1), 1–12. https://doi.org/10.1038/s41597-019-0320-2

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J. B., & Collen, B. (2014). Defaunation in the Anthropocene. *Science*, *345*(6195), 401–406. https://doi.org/10.1126/science.1251817

Folmer, O., Black, M., Hoeh, W., Lutz, R., & Vrijenhoek, R. (1994). DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, *3*(5), 294–299.

Gallai, N., Salles, J. M., Settele, J., & Vaissière, B. E. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, *68*(3), 810–821. https://doi.org/10.1016/j.ecolecon.2008.06.014

Gibbs, J. (2018). DNA barcoding a nightmare taxon: Assessing barcode index numbers and barcode gaps for sweat bees. *Genome*, *61*(1), 21–31. https://doi.org/10.1139/gen-2017-0096

Gill, R. J., Baldock, K. C. R., Brown, M. J. F., Cresswell, J. E., Dicks, L. V., Fountain, M. T., Garratt, M. P. D., Gough, L. A., Heard, M. S., Holland, J. M., Ollerton, J., Stone, G. N., Tang, C. Q., Vanbergen, A. J., Vogler, A. P., Woodward, G., Arce, A. N., Boatman, N. D., Brand-Hardy, R., … Potts, S. G. (2016). Protecting an ecosystem service: Approaches to understanding and mitigating threats to wild insect pollinators. *Advances in Ecological Research*, *54*, 135–206. https://doi.org/10.1016/bs.aecr.2015.10.007

Gogala, A. (2023). *Wild bees of Slovenia*. http://www2.pms-lj.si/andrej/bees.htm

Gueuning, M., Frey, J. E., & Praz, C. (2020). Ultraconserved yet informative for species delimitation: Ultraconserved elements resolve long-standing systematic enigma in Central European bees. *Molecular Ecology*, *29*(21), 4203–4220. https://doi.org/10.1111/mec.15629

Hebert, P. D. N., Cywinska, A., Ball, S. L., & DeWaard, J. R. (2003). Biological identifications through DNA barcodes. *Proceedings of the Royal Society B: Biological Sciences*, *270*(1512), 313–321. https://doi.org/10.1098/rspb.2002.2218

Hebert, P. D. N., Ratnasingham, S., & DeWaard, J. R. (2003). Barcoding animal life: Cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society B: Biological Sciences*, *270*(SUPPL. 1), 96–99. https://doi.org/10.1098/rsbl.2003.0025

Hebert, P. D. N., Stoeckle, M. Y., Zemlak, T. S., & Francis, C. M. (2004). Identification of birds through DNA barcodes. *PLoS Biology*, *2*(10), e312. https://doi.org/10.1371/journal.pbio.0020312

Herrera-Mesías, F., Bause, C., Ogan, S., Burger, H., Ayasse, M., Weigand, A. M., & Eltz, T. (2022). Double-blind validation of alternative wild bee identification techniques: DNA metabarcoding and in vivo determination in the field. *Journal of Hymenoptera Research*, *93*, 189–412. https://doi.org/10.3897/jhr.93.86723

Hopkins, G. W., & Freckleton, R. P. (2002). Declines in the numbers of amateur and professional taxonomists: Implications for conservation. *Animal Conservation*, *5*(3), 245–249. https://doi.org/10.1017/S1367943002002299

Hua, F., Wang, X., Zheng, X., Fisher, B., Wang, L., Zhu, J., Tang, Y., Yu, D. W., & Wilcove, D. S. (2016). Opportunities for biodiversity gains under the world's largest reforestation programme. *Nature Communications*, *7*, 12717. https://doi.org/10.1038/ncomms12717

Hubert, N., & Hanner, R. (2016). DNA barcoding, species delineation and taxonomy: A historical perspective. *DNA Barcodes*, *3*(1), 44–58. https://doi.org/10.1515/dna-2015-0006

Huelsenbeck, J. P., & Ronquist, F. (2001). MRBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics*, *17*(8), 754–755. https://doi.org/10.1093/bioinformatics/17.8.754

Kapli, P., Lutteropp, S., Zhang, J., Kobert, K., Pavlidis, P., Stamatakis, A., & Flouri, T. (2017). Multi-rate Poisson tree processes for single-locus species delimitation under maximum likelihood and Markov chain Monte Carlo. *Bioinformatics*, *33*(11), 1630–1638. https://doi.org/10.1093/bioinformatics/btx025

Kimura, M. (1980). A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution*, *16*, 111–120. https://doi.org/10.1007/BF01731581

Krehenwinkel, H., Pomerantz, A., Henderson, J. B., Kennedy, S. R., Lim, J. Y., Swamy, V., Shoobridge, J. D., Graham, N., Patel, N. H., Gillespie, R. G., & Prost, S. (2019). Nanopore sequencing of long ribosomal DNA amplicons enables portable and simple biodiversity assessments with high phylogenetic resolution across broad taxonomic scale. *GigaScience*, *8*(5), 1–16. https://doi.org/10.1093/gigascience/giz006

Kumar, S., Stecher, G., Li, M., Knyaz, C., & Tamura, K. (2018). MEGA X: Molecular evolutionary genetics analysis across computing platforms. *Molecular Biology and Evolution*, *35*(6), 1547–1549. https://doi.org/10.1093/molbev/msy096

Leclercq, N., Marshall, L., Caruso, G., Shiel, K., Weekers, T., Carvalheiro, L. G., Dathe, H. H., Kuhlmann, M., Michez, D., Potts, S. G., Rasmont, P., Roberts, S. P. M., Smagghe, G., Vandamme, P., & Vereecken, N. J. (2023). European bee diversity: Taxonomic and phylogenetic patterns. *Journal of Biogeography*, *50*(7), 1244–1256. https://doi.org/10.1111/jbi.14614

Lister, B. C., & Garcia, A. (2018). Climate-driven declines in arthropod abundance restructure a rainforest food web. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(44), E10397–E10406. https://doi.org/10.1073/pnas.1722477115

Magnacca, K. N., & Brown, M. J. F. (2012). DNA barcoding a regional fauna: Irish solitary bees. *Molecular Ecology Resources*, *12*(6), 990–998. https://doi.org/10.1111/1755-0998.12001

McKendrick, L., Provan, J., Fitzpatrick, Ú., Brown, M. J. F., Murray, T. E., Stolle, E., & Paxton, R. J. (2017). Microsatellite analysis supports the existence of three cryptic species within the bumble bee *Bombus lucorum* sensu lato. *Conservation Genetics*, *18*(3), 573–584. https://doi.org/10.1007/s10592-017-0965-3

Meier, R., Shiyang, K., Vaidya, G., & Ng, P. K. L. (2006). DNA barcoding and taxonomy in diptera: A tale of high intraspecific variability and low identification success. *Systematic Biology*, *55*(5), 715–728. https://doi.org/10.1080/10635150600969864

Meier, R., Zhang, G., & Ali, F. (2008). The use of mean instead of smallest interspecific distances exaggerates the size of the "barcoding gap" and leads to misidentification. *Systematic Biology*, *57*(5), 809–813. https://doi.org/10.1080/10635150802406343

Meiklejohn, K. A., Damaso, N., & Robertson, J. M. (2019). Assessment of BOLD and GenBank – Their accuracy and reliability for the identification of biological materials. *PLoS One*, *14*(6), e0217084. https://doi.org/10.1371/journal.pone.0217084

Meyer, C. P., & Paulay, G. (2005). DNA barcoding: Error rates based on comprehensive sampling. *PLoS Biology*, *3*(12), e422. https://doi.org/10.1371/journal.pbio.0030422

Miller, M. A., Pfeiffer, W., & Schwartz, T. (2010). *Creating the CIPRES science gateway for inference of large phylogenetic trees*. In 2010 Gateway Computing Environments Workshop (GCE). https://doi.org/10.1109/GCE.2010.5676129

Nieto, A., Roberts, S. P. M., Kemp, J., Rasmont, P., Kuhlmann, M., García Criado, M., Biesmeijer, J. C., Bogusch, P., Dathe, H. H., De la Rúa, P., De Meulemeester, T., Dehon, M., Dewulf, A., Ortiz-Sánchez, F. J., Lhomme, P., Pauly, A., Potts, S. G., Praz, C., Quaranta, M., … Michez, D. (2014). *European red list of bees*. IUCN Global Species Programme. https://doi.org/10.2779/77003

Packer, L., & Ruz, L. (2017). DNA barcoding the bees (Hymenoptera: Apoidea) of Chile: Species discovery in a reasonably well known bee fauna with the description of a new species of *Lonchopria* (Colletidae). *Genome*, *60*(5), 414–430. https://doi.org/10.1139/gen-2016-0071@gen-iblf.issue0

Page, T. J., Choy, S. C., & Hughes, J. M. (2005). The taxonomic feedback loop: Symbiosis of morphology and molecules. *Biology Letters*, *1*(2), 139–142. https://doi.org/10.1098/rsbl.2005.0298

Phillips, J. D., Gillis, D. J., & Hanner, R. H. (2019). Incomplete estimates of genetic diversity within species: Implications for DNA barcoding.

Ecology and Evolution, 9(5), 2996–3010. https://doi.org/10.1002/ece3.4757
Phillips, J. D., Gillis, D. J., & Hanner, R. H. (2022). Lack of statistical rigor in DNA barcoding likely invalidates the presence of a true species' barcode gap. *Frontiers in Ecology and Evolution*, *10*, 859099. https://doi.org/10.3389/fevo.2022.859099
Potts, S., Biesmeijer, K., Bommarco, R., Breeze, T., Carvalheiro, L., Franzén, M., González-Varo, J. P., Holzschuh, A., Kleijn, D., Klein, A.-M., Kunin, B., Lecocq, T., Lundin, O., Michez, D., Neumann, P., Nieto, A., Penev, L., Rasmont, P., Ratamäki, O., … Schweiger, O. (2015). *Status and trends of European pollinators. Key findings of the STEP project*. Pensoft Publishers.
Potts, S. G., Dauber, J., Hochkirch, A., Oteman, B., Roy, D. B., Ahnre, K., Biesmeijer, K., Breeze, T., Carvell, C., Ferreira, C., Fitzpatrick, Ú., Isaac, N. J. B., Kuussaari, M., Ljubomirov, T., Maes, J., Ngo, H., Pardo, A., Polce, C., Marino, Q., … Vujic, A. (2021). *Proposal for an EU pollinator monitoring scheme*. Publications Office of the European Union. https://doi.org/10.2760/881843
Praz, C., Genoud, D., Vaucher, K., Bénon, D., Monks, J., & Wood, T. J. (2022). Unexpected levels of cryptic diversity in European bees of the genus *Andrena* subgenus *Taeniandrena* (Hymenoptera, Andrenidae): Implications for conservation. *Journal of Hymenoptera Research*, *91*, 375–428. https://doi.org/10.3897/JHR.91.82761
Puillandre, N., Brouillet, S., & Achaz, G. (2021). ASAP: Assemble species by automatic partitioning. *Molecular Ecology Resources*, *21*(2), 609–620. https://doi.org/10.1111/1755-0998.13281
Ratnasingham, S., & Hebert, P. D. N. (2007). BOLD: The barcode of life data system (www.barcodinglife.org). *Molecular Ecology Notes*, *7*(3), 355–364. https://doi.org/10.1111/j.1471-8286.2006.01678.x
Ratnasingham, S., & Hebert, P. D. N. (2013). A DNA-based registry for all animal species: The barcode index number (BIN) system. *PLoS One*, *8*(7), e66213. https://doi.org/10.1371/journal.pone.0066213
Schmidt, S., Schmid-Egger, C., Morinière, J., Haszprunar, G., & Hebert, P. D. N. (2015). DNA barcoding largely supports 250 years of classical taxonomy: Identifications for Central European bees (Hymenoptera, Apoidea partim). *Molecular Ecology Resources*, *15*(4), 985–1000. https://doi.org/10.1111/1755-0998.12363
Sheffield, C. S., Hebert, P. D. N., Kevan, P. G., & Packer, L. (2009). DNA barcoding a regional bee (Hymenoptera: Apoidea) fauna and its potential for ecological studies. *Molecular Ecology Resources*, *9*(S1), 196–207. https://doi.org/10.1111/j.1755-0998.2009.02645.x
Sheffield, C. S., Heron, J., Gibbs, J., Onuferko, T. M., Oram, R., Best, L., Desilva, N., Dumesh, S., Pindar, A., & Rowe, G. (2017). Contribution of DNA barcoding to the study of the bees (Hymenoptera: Apoidea) of Canada: Progress to date. *Canadian Entomologist*, *149*(6), 736–754. https://doi.org/10.4039/tce.2017.49
Šilc, U., Vreš, B., Čelik, T., & Gregorič, M. (2020). Biodiversity of Slovenia. In D. Perko, R. Ciglič, & M. Zorn (Eds.), *The geography of Slovenia. World regional geography book series* (pp. 109–124). Springer. https://doi.org/10.1007/978-3-030-14066-3_7
Steffan-Dewenter, I., Potts, S. G., Packer, L., & Ghazoul, J. (2005). Pollinator diversity and crop pollination services are at risk. *Trends in Ecology & Evolution*, *20*(12), 651–652. https://doi.org/10.1016/j.tree.2005.09.004
Stoeckle, M. Y., & Thaler, D. S. (2014). DNA barcoding works in practice but not in (neutral) theory. *PLoS One*, *9*(7), e100755. https://doi.org/10.1371/journal.pone.0100755
Tamura, K., Stecher, G., & Kumar, S. (2021). MEGA11: Molecular evolutionary genetics analysis version 11. *Molecular Biology and Evolution*, *38*(7), 3022–3027. https://doi.org/10.1093/molbev/msab120
Vanbergen, A. J., Garratt, M. P., Vanbergen, A. J., Baude, M., Biesmeijer, J. C., Britton, N. F., Brown, M. J. F., Brown, M., Bryden, J., Budge, G. E., Bull, J. C., Carvell, C., Challinor, A. J., Connolly, C. N., Evans, D. J., Feil, E. J., Garratt, M. P., Greco, M. K., Heard, M. S., … Wright, G. A. (2013). Threats to an ecosystem service: Pressures on pollinators. *Frontiers in Ecology and the Environment*, *11*(5), 251–259. https://doi.org/10.1890/120126
Vanbergen, A. J., Heard, M. S., Breeze, T., Potts, S. G., & Hanley, N. (2014). *Status and value of pollinators and pollination services. A report to the Department for environment, food and rural affairs (Defra)*. Department for Environment, Food and Rural Affairs.
Villalta, I., Ledet, R., Baude, M., Genoud, D., Bouget, C., Cornillon, M., Moreau, S., Courtial, B., & Lopez-Vaamonde, C. (2021). A DNA barcode-based survey of wild urban bees in the Loire Valley, France. *Scientific Reports*, *11*, 4770. https://doi.org/10.1038/s41598-021-83631-0
Wheeler, Q. D., Raven, P. H., & Wilson, E. O. (2004). Taxonomy: Impediment or expedient? *Science*, *303*(5656), 285. https://doi.org/10.1126/science.303.5656.285
Williams, P. H., & Osborne, J. L. (2009). Bumblebee vulnerability and conservation world-wide. *Apidologie*, *40*(3), 367–387. https://doi.org/10.1051/apido/2009025
Wu, H. Y., Chan, K. T., But, G. W. C., & Shaw, P. C. (2021). Assessing the reliability of medicinal dendrobium sequences in GenBank for botanical species identification. *Scientific Reports*, *11*, 3439. https://doi.org/10.1038/s41598-021-82385-z
Zhang, H.-G., Lv, M.-H., Yi, W.-B., Zhu, W.-B., & Bu, W.-J. (2017). Species diversity can be overestimated by a fixed empirical threshold: Insights from DNA barcoding of the genus *Cletus* (Hemiptera: Coreidae) and the meta-analysis of COI data from previous phylogeographical studies. *Molecular Ecology Resources*, *17*(2), 314–323. https://doi.org/10.1111/1755-0998.12571

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX 1

Collection details of specimens sequenced in this study in the following order: species-level identification based on morphological determination, sex, locality details (town, country, coordinates), collector, legator, internal specimen code, and GenBank accession number.

Andrenidae, *Andrena apicata*, female, Mengeš, Slovenia, 46.1824 N 14.5478 E, 05-May-2020, Pibernik M., Koderman B., GOK04-20-05-05_PR_1, OR179542.

Andrenidae, *Andrena bicolor*, female, Mengeš, Slovenia, 46.1969 N 14.5259 E, 01-Apr-2020, Pibernik M., Koderman B., GOK05-20-04-01_KR_1, OR179540.

Andrenidae, *Andrena bicolor*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 01-Apr-2020, Šturm R., Koderman B., LJB05-20-04-01_KR_1, OR179597.

Andrenidae, *Andrena bucephala*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 21-May-2020, Šturm R., Koderman B., CJE06-20-05-21_KB_1, OR179328.

Andrenidae, *Andrena carantonica*, female, Cerknica, Slovenia, 45.7588 N 14.3621 E, 10-Jun-2020, Šturm R., Koderman B., CJE03-20-06-10_KB_2, OR179329.

Andrenidae, *Andrena chrysosceles*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 21-May-2020, Šturm R., Koderman B., CJE06-20-05-21_KR_1, OR179330.

Andrenidae, *Andrena curvungula*, female, Cerknica, Slovenia, 45.7279 N 14.4042 E, 10-Jun-2020, Šturm R., Koderman B., CJE08-20-06-10_KM_1, OR179331.

Andrenidae, *Andrena dorsata*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 22-Jul-2020, Šturm R., Koderman B., CEK10-20-07-22_KR_2, OR179285.

Andrenidae, *Andrena flavipes*, female, Ig, Slovenia, 45.9706 N 14.5492 E, 21-May-2020, Šturm R., Koderman B., LJB08-20-05-21_KR_1, OR179412.

Andrenidae, *Andrena floricola*, female, Mengeš, Slovenia, 46.1511 N 14.5726 E, 05-May-2020, Pibernik M., Koderman B., GOK03-20-05-05_KB_1, OR179543.

Andrenidae, *Andrena fulvago*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 10-Jun-2020, Šturm R., Koderman B., CJE01-20-06-10_KR_2, OR179333.

Andrenidae, *Andrena fulvago*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 20-Jul-2020, Šturm R., Koderman B., LJB05-20-07-20_KB_1, OR179598.

Andrenidae, *Andrena fulvago*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 30-Jun-2020, Koderman B., Koderman B., LJU02-20-06-30_KR_2, OR179470.

Andrenidae, *Andrena fulvata*, female, Cerknica, Slovenia, 45.7688 N 14.4004 E, 06-May-2020, Šturm R., Koderman B., CJE10-20-05-06_KM_1, OR179381.

Andrenidae, *Andrena fulvata*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 01-Apr-2020, Šturm R., Koderman B., LJB01-20-04-01_KR_3, OR179599.

Andrenidae, *Andrena fulvida*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 10-Jun-2020, Šturm R., Koderman B., CJE01-20-06-10_KR_1, OR179335.

Andrenidae, *Andrena fulvida*, female, Cerknica, Slovenia, 45.7568 N 14.3626 E, 21-May-2020, Šturm R., Koderman B., CJE04-20-05-21_KR_2, OR179332.

Andrenidae, *Andrena gravida*, male, Celje, Slovenia, 46.2357 N 15.2323 E, 04-Jul-2020, Šturm R., Koderman B., CEK03-20-07-04_KM_3, OR179286.

Andrenidae, *Andrena gravida*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 01-Apr-2020, Šturm R., Koderman B., LJB02-20-04-01_KR_1, OR179600.

Andrenidae, *Andrena haemorrhoa*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 21-May-2020, Šturm R., Koderman B., CJE02-20-05-21_PR_1, OR179336.

Andrenidae, *Andrena hattorfiana*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 10-Aug-2020, Šturm R., Koderman B., CEK07-20-08-10_PM_1, OR179284.

Andrenidae, *Andrena hattorfiana*, male, Cerknica, Slovenia, 45.7795 N 14.3599 E, 21-May-2020, Šturm R., Koderman B., CJE02-20-05-21_PM_1, OR179337.

Andrenidae, *Andrena hattorfiana*, female, Mengeš, Slovenia, 46.1824 N 14.5478 E, 30-Jun-2020, Pibernik M., Koderman B., GOK04-20-06-30_KM_1, OR179505.

Andrenidae, *Andrena helvola*, male, Ig, Slovenia, 45.9635 N 14.5168 E, 02-Jun-2020, Šturm R., Koderman B., LJB05-20-06-02_PM_8, OR179539.

Andrenidae, *Andrena hesperia*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 02-Jun-2020, Šturm R., Koderman B., LJB01-20-06-02_KR_3, OR179465.

Andrenidae, *Andrena humilis*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_KB_2, OR179338.

Andrenidae, *Andrena humilis*, male, Ig, Slovenia, 45.9635 N 14.5168 E, 21-May-2020, Šturm R., Koderman B., LJB05-20-05-21_KB_1, OR179635.

Andrenidae, *Andrena labialis*, male, Mengeš, Slovenia, 46.1947 N 14.5127 E, 16-Jun-2020, Pibernik M., Koderman B., GOK06-20-06-16_KM_1, OR179506.

Andrenidae, *Andrena lathyri*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 08-Jul-2020, Šturm R., Koderman B., LJB01-20-07-08_KM_2, OR179601.

Andrenidae, *Andrena minutula*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 05-May-2020, Šturm R., Koderman B., CEK02-20-05-05_PR_1, OR179588.

Andrenidae, *Andrena minutula*, female, Cerknica, Slovenia, 45.7568 N 14.3626 E, 21-May-2020, Šturm R., Koderman B., CJE04-20-05-21_KB_2, OR179339.

Andrenidae, *Andrena minutula*, female, Mengeš, Slovenia, 46.1585 N 14.4932 E, 01-Apr-2020, Pibernik M., Koderman B., GOK07-20-04-01_KR_1, OR179545.

Andrenidae, *Andrena minutula*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 01-Apr-2020, Šturm R., Koderman B., LJB01-20-04-01_KR_1, OR179602.

Andrenidae, *Andrena minutula*, male, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 27-May-2020, Koderman B., Koderman B., LJU05-20-05-27_KB_1, OR179428.

Andrenidae, *Andrena minutuloides*, male, Cerknica, Slovenia, 45.7251 N 14.4028 E, 10-Jun-2020, Šturm R., Koderman B., CJE07-20-06-10_KR_4, OR179341.

Andrenidae, *Andrena minutuloides*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 22-Jun-2020, Šturm R., Koderman B., LJB04-20-06-22_KR_9, OR179603.

Andrenidae, *Andrena nitida*, female, Ljubljana, Slovenia, 46.1019 N 14.4503 E, 30-Jun-2020, Koderman B., Koderman B., LJU09-20-06-30_PM_1, OR179469.

Andrenidae, *Andrena ovatula*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 26-May-2020, Pibernik M., Koderman B., GOK08-20-05-26_PM_3, OR179537.

Andrenidae, *Andrena pandellei*, female, Celje, Slovenia, 46.2440 N 15.2254 E, 20-May-2020, Šturm R., Koderman B., CEK04-20-05-20_KB_1, OR179593.

Andrenidae, *Andrena paucisquama*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_KB_1, OR179340.

Andrenidae, *Andrena paucisquama*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_KB_4, OR179327.

Andrenidae, *Andrena rosae*, male, Mengeš, Slovenia, 46.1947 N 14.5127 E, 13-Jul-2020, Pibernik M., Koderman B., GOK06-20-07-13_PM_1, OR179541.

Andrenidae, *Panurgus banksianus*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 30-Jun-2020, Koderman B., Koderman B., LJU02-20-06-30_KR_1, OR179500.

Andrenidae, *Panurgus calcaratus*, male, Mengeš, Slovenia, 46.1947 N 14.5127 E, 27-Jul-2020, Pibernik M., Koderman B., GOK06-20-07-27_KR_2, OR179544.

Andrenidae, *Panurgus calcaratus*, male, Ljubljana, Slovenia, 46.0523 N 14.4790 E, 30-Jun-2020, Koderman B., Koderman B., LJU03-20-06-30_KR_1, OR179501.

Apidae, *Amegilla quadrifasciata*, male, Kranj, Slovenia, 46.2697 N 14.3872 E, 30-Jun-2020, Pibernik M., Koderman B., GOK09-20-06-30_PM_1, OR179504.

Apidae, *Anthophora aestivalis*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 22-Jun-2020, Šturm R., Koderman B., CEK10-20-06-22_PM_1, OR179280.

Apidae, *Anthophora furcata*, male, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_PM_5, OR179342.

Apidae, *Anthophora furcata*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 27-Jul-2020, Koderman B., Koderman B., LJU02-20-07-27_PM_2, OR179473.

Apidae, *Anthophora plumipes*, female, Celje, Slovenia, 46.2899 N 15.2953 E, 05-May-2020, Šturm R., Koderman B., CEK08-20-05-05_PM_7, OR179283.

Apidae, *Anthophora retusa*, male, Celje, Slovenia, 46.2988 N 15.2464 E, 05-May-2020, Šturm R., Koderman B., CEK10-20-05-05_PM_2, OR179282.

Apidae, *Bombus argillaceus*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 02-Jun-2020, Šturm R., Koderman B., LJB05-20-06-02_PM_1, OR179528.

Apidae, *Bombus bohemicus*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 15-Sep-2020, Šturm R., Koderman B., CJE01-20-09-15_PM_5, OR179382.

Apidae, *Bombus hortorum*, male, Celje, Slovenia, 46.2440 N 15.2254 E, 20-May-2020, Šturm R., Koderman B., CEK04-20-05-20_PM_4, OR179322.

Apidae, *Bombus hortorum*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_PM_3, OR179343.

Apidae, *Bombus hortorum*, female, Kranj, Slovenia, 46.2697 N 14.3872 E, 26-May-2020, Pibernik M., Koderman B., GOK09-20-05-26_PM_1, OR179507.

Apidae, *Bombus hortorum*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 21-May-2020, Šturm R., Koderman B., LJB02-20-05-21_PM_3, OR179585.

Apidae, *Bombus hortorum*, female, Ig, Slovenia, 45.9706 N 14.5492 E, 21-May-2020, Šturm R., Koderman B., LJB08-20-05-21_PM_1, OR179401.

Apidae, *Bombus hortorum*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 27-May-2020, Koderman B., Koderman B., LJU01-20-05-27_KM_1, OR179430.

Apidae, *Bombus humilis*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 11-Jun-2020, Šturm R., Koderman B., CEK03-20-06-11_PM_13, OR179319.

Apidae, *Bombus humilis*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 20-May-2020, Šturm R., Koderman B., CEK10-20-05-20_PM_3, OR179321.

Apidae, *Bombus humilis*, male, Cerknica, Slovenia, 45.7727 N 14.3976 E, 02-Sep-2020, Šturm R., Koderman B., CJE09-20-09-02_PM_3, OR179383.

Apidae, *Bombus humilis*, female, Mengeš, Slovenia, 46.1947 N 14.5127 E, 05-May-2020, Pibernik M., Koderman B., GOK06-20-05-05_PM_1, OR179546.

Apidae, *Bombus hypnorum*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_PM_9, OR179344.

Apidae, *Bombus hypnorum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 16-Jun-2020, Pibernik M., Koderman B., GOK01-20-06-16_PM_2, OR179508.

Apidae, *Bombus hypnorum*, male, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 13-Jul-2020, Koderman B., Koderman B., LJU01-20-07-13_PM_1, OR179474.

Apidae, *Bombus lapidarius*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 20-May-2020, Šturm R., Koderman B., CEK03-20-05-20_PM_2, OR179590.

Apidae, *Bombus lapidarius*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 06-May-2020, Šturm R., Koderman B., CJE02-20-05-06_PM_1, OR179384.

Apidae, *Bombus lapidarius*, female, Kranj, Slovenia, 46.2697 N 14.3872 E, 27-Jul-2020, Pibernik M., Koderman B., GOK09-20-07-27_PM_19, OR179547.

Apidae, *Bombus lapidarius*, female, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 13-Jul-2020, Koderman B., Koderman B., LJU05-20-07-13_PM_3, OR179476.

Apidae, *Bombus lapidarius*, male, Ljubljana, Slovenia, 46.0851 N 14.4692 E, 21-Sep-2020, Koderman B., Koderman B., LJU10-20-09-21_PM_2, OR179477.

Apidae, *Bombus lucorum*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 22-Jun-2020, Šturm R., Koderman B., CEK02-20-06-22_PR_1, OR179307.

Apidae, *Bombus lucorum*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_KM_2, OR179346.

Apidae, *Bombus pascuorum*, female, Celje, Slovenia, 46.2306 N 15.1840 E, 05-May-2020, Šturm R., Koderman B., CEK06-20-05-05_PM_1, OR179326.

Apidae, *Bombus pascuorum*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 10-Jun-2020, Šturm R., Koderman B., CJE06-20-06-10_PM_1, OR179347.

Apidae, *Bombus pascuorum*, female, Mengeš, Slovenia, 46.1947 N 14.5127 E, 26-May-2020, Pibernik M., Koderman B., GOK06-20-05-26_PM_2, OR179511.

Apidae, *Bombus pascuorum*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 02-Jun-2020, Šturm R., Koderman B., LJB03-20-06-02_KR_3, OR179509.

Apidae, *Bombus pascuorum*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 27-May-2020, Koderman B., Koderman B., LJU01-20-05-27_PM_1, OR179432.

Apidae, *Bombus pratorum*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 11-Jun-2020, Šturm R., Koderman B., CEK10-20-06-11_PM_2, OR179320.

Apidae, *Bombus pratorum*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_PM_5, OR179348.

Apidae, *Bombus pratorum*, female, Kranj, Slovenia, 46.2658 N 14.4166 E, 05-May-2020, Pibernik M., Koderman B., GOK10-20-05-05_PM_1, OR179548.

Apidae, *Bombus pratorum*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 21-May-2020, Šturm R., Koderman B., LJB01-20-05-21_PM_3, OR179323.

Apidae, *Bombus ruderarius*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 22-Jun-2020, Šturm R., Koderman B., LJB07-20-06-22_PR_1, OR179579.

Apidae, *Bombus sylvarum*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 20-May-2020, Šturm R., Koderman B., CEK10-20-05-20_PM_2, OR179325.

Apidae, *Bombus sylvarum*, female, Cerknica, Slovenia, 45.7688 N 14.4004 E, 24-Apr-2020, Šturm R., Koderman B., CJE10-20-04-24_KB_1, OR179385.

Apidae, *Bombus sylvarum*, female, Kranj, Slovenia, 46.2697 N 14.3872 E, 26-May-2020, Pibernik M., Koderman B., GOK09-20-05-26_PM_3, OR179512.

Apidae, *Bombus sylvarum*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 02-Jun-2020, Šturm R., Koderman B., LJB02-20-06-02_PM_1, OR179475.

Apidae, *Bombus sylvarum*, female, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 13-Jul-2020, Koderman B., Koderman B., LJU07-20-07-13_PM_4, OR179478.

Apidae, *Bombus terrestris*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 22-Jun-2020, Šturm R., Koderman B., CEK02-20-06-22_KR_9, OR179324.

Apidae, *Bombus terrestris*, male, Cerknica, Slovenia, 45.7503 N 14.3641 E, 02-Sep-2020, Šturm R., Koderman B., CJE05-20-09-02_PM_2, OR179386.

Apidae, *Bombus terrestris*, female, Mengeš, Slovenia, 46.1824 N 14.5478 E, 26-May-2020, Pibernik M., Koderman B., GOK04-20-05-26_KM_1, OR179510.

Apidae, *Bombus terrestris*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 01-Apr-2020, Pibernik M., Koderman B., GOK08-20-04-01_KM_1, OR179549.

Apidae, *Bombus terrestris*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 02-Jun-2020, Šturm R., Koderman B., LJB10-20-06-02_KB_1, OR179571.

Apidae, *Bombus terrestris*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 27-May-2020, Koderman B., Koderman B., LJU02-20-05-27_PM_2, OR179431.

Apidae, *Bombus terrestris*, female, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 27-May-2020, Koderman B., Koderman B., LJU07-20-05-27_PM_1, OR179434.

Apidae, *Ceratina chalybea*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 10-Jun-2020, Šturm R., Koderman B., CJE06-20-06-10_KM_1, OR179349.

Apidae, *Ceratina chalybea*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 22-Jun-2020, Šturm R., Koderman B., LJB03-20-06-22_PM_1, OR179576.

Apidae, *Ceratina cucurbitina*, male, Borovnica, Slovenia, 45.9511 N 14.3490 E, 02-Jun-2020, Šturm R., Koderman B., LJB02-20-06-02_KB_1, OR179486.

Apidae, *Ceratina cyanea*, female, Celje, Slovenia, 46.3095 N 15.2892 E, 22-Jun-2020, Šturm R., Koderman B., CEK09-20-06-22_KM_1, OR179315.

Apidae, *Ceratina cyanea*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_KB_5, OR179350.

Apidae, *Ceratina cyanea*, female, Kranj, Slovenia, 46.2658 N 14.4166 E, 16-Sep-2020, Pibernik M., Koderman B., GOK10-20-09-16_PR_1, OR179551.

Apidae, *Ceratina cyanea*, male, Ig, Slovenia, 45.9772 N 14.5645 E, 22-Jun-2020, Šturm R., Koderman B., LJB10-20-06-22_KM_3, OR179582.

Apidae, *Ceratina cyanea*, female, Ljubljana, Slovenia, 46.1019 N 14.4503 E, 27-Jul-2020, Koderman B., Koderman B., LJU09-20-07-27_KR_4, OR179479.

Apidae, *Epeoloides coecutiens*, male, Cerknica, Slovenia, 45.7279 N 14.4042 E, 06-Aug-2020, Šturm R., Koderman B., CJE08-20-08-06_KB_3, OR179426.

Apidae, *Eucera longicornis*, male, Cerknica, Slovenia, 45.7568 N 14.3626 E, 10-Jun-2020, Šturm R., Koderman B., CJE04-20-06-10_PM_3, OR179351.

Apidae, *Nomada armata*, male, Mengeš, Slovenia, 46.1511 N 14.5726 E, 16-Jun-2020, Pibernik M., Koderman B., GOK03-20-06-16_KM_3, OR179535.

Apidae, *Nomada flavoguttata*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 21-May-2020, Šturm R., Koderman B., CJE05-20-05-21_KB_3, OR179375.

Apidae, *Nomada hirtipes*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 27-May-2020, Koderman B., Koderman B., LJU01-20-05-27_KM_3, OR179463.

Apidae, *Nomada integra*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 23-Jun-2020, Šturm R., Koderman B., CJE01-20-06-23_KR_2, OR179420.

Apidae, *Tetralonia malvae*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 04-Jul-2020, Šturm R., Koderman B., CEK03-20-07-04_PM_1, OR179309.

Apidae, *Xylocopa iris*, female, Cerknica, Slovenia, 45.7688 N 14.4004 E, 23-Jun-2020, Šturm R., Koderman B., CJE10-20-06-23_PM_2, OR179424.

Apidae, *Xylocopa valga*, female, Celje, Slovenia, 46.2637 N 15.0697 E, 22-Jun-2020, Šturm R., Koderman B., CEK01-20-06-22_PM_7, OR179318.

Apidae, *Xylocopa valga*, male, Cerknica, Slovenia, 45.7727 N 14.3976 E, 23-Jun-2020, Šturm R., Koderman B., CJE09-20-06-23_PM_4, OR179425.

Apidae, *Xylocopa valga*, female, Mengeš, Slovenia, 46.1392 N 14.5751 E, 05-May-2020, Pibernik M., Koderman B., GOK02-20-05-05_PM_1, OR179570.

Apidae, *Xylocopa valga*, female, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 30-Jun-2020, Koderman B., Koderman B., LJU06-20-06-30_PM_2, OR179502.

Apidae, *Xylocopa violacea*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 20-May-2020, Šturm R., Koderman B., CEK03-20-05-20_PM_1, OR179317.

Apidae, *Xylocopa violacea*, male, Cerknica, Slovenia, 45.7588 N 14.3621 E, 21-May-2020, Šturm R., Koderman B., CJE03-20-05-21_PM_1, OR179380.

Apidae, *Xylocopa violacea*, female, Mengeš, Slovenia, 46.1969 N 14.5259 E, 26-May-2020, Pibernik M., Koderman B., GOK05-20-05-26_PM_6, OR179538.

Apidae, *Xylocopa violacea*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 21-May-2020, Šturm R., Koderman B., LJB01-20-05-21_PM_1, OR179606.

Colletidae, *Colletes daviesanus*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 13-Jul-2020, Pibernik M., Koderman B., GOK01-20-07-13_PM_3, OR179556.

Colletidae, *Colletes hederae*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 16-Sep-2020, Pibernik M., Koderman B., GOK01-20-09-16_KM_1, OR179555.

Colletidae, *Hylaeus angustatus*, female, Celje, Slovenia, 46.2484 N 15.2153 E, 22-Jul-2020, Šturm R., Koderman B., CEK05-20-07-22_PM_13, OR179289.

Colletidae, *Hylaeus angustatus*, female, Cerknica, Slovenia, 45.7568 N 14.3626 E, 21-May-2020, Šturm R., Koderman B., CJE04-20-05-21_KR_5, OR179354.

Colletidae, *Hylaeus brevicornis*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 02-Sep-2020, Šturm R., Koderman B., CJE01-20-09-02_KB_3, OR179399.

Colletidae, *Hylaeus brevicornis*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 19-Jun-2020, Koderman B., Koderman B., LJU01-20-06-19_KB_1, OR179440.

Colletidae, *Hylaeus clypearis*, female, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 21-Sep-2020, Koderman B., Koderman B., LJU06-20-09-21_KB_1, OR179488.

Colletidae, *Hylaeus communis*, male, Celje, Slovenia, 46.2641 N 15.0574 E, 05-May-2020, Šturm R., Koderman B., CEK02-20-05-05_PM_2, OR179296.

Colletidae, *Hylaeus communis*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_PM_4, OR179355.

Colletidae, *Hylaeus communis*, female, Mengeš, Slovenia, 46.1947 N 14.5127 E, 27-Jul-2020, Pibernik M., Koderman B., GOK06-20-07-27_PM_2, OR179552.

Colletidae, *Hylaeus communis*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 06-Aug-2020, Šturm R., Koderman B., LJB05-20-08-06_KM_6, OR179610.

Colletidae, *Hylaeus communis*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 13-Jul-2020, Koderman B., Koderman B., LJU02-20-07-13_KB_16, OR179485.

Colletidae, *Hylaeus communis*, male, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 19-Jun-2020, Koderman B., Koderman B., LJU07-20-06-19_KR_1, OR179441.

Colletidae, *Hylaeus confusus*, female, Celje, Slovenia, 46.3095 N 15.2892 E, 05-May-2020, Šturm R., Koderman B., CEK09-20-05-05_KM_2, OR179295.

Colletidae, *Hylaeus confusus*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 10-Jun-2020, Šturm R., Koderman B., CJE06-20-06-10_PM_4, OR179357.

Colletidae, *Hylaeus confusus*, female, Mengeš, Slovenia, 46.1585 N 14.4932 E, 11-Aug-2020, Pibernik M., Koderman B., GOK07-20-08-11_PM_2, OR179553.

Colletidae, *Hylaeus confusus*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 21-May-2020, Šturm R., Koderman B., LJB01-20-05-21_KR_3, OR179312.

Colletidae, *Hylaeus confusus*, male, Borovnica, Slovenia, 45.9457 N 14.3703 E, 21-May-2020, Šturm R., Koderman B., LJB04-20-05-21_KR_2, OR179356.

Colletidae, *Hylaeus cornutus*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 19-Aug-2020, Šturm R., Koderman B., LJB07-20-08-19_KB_1, OR179611.

Colletidae, *Hylaeus difformis*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 08-Jul-2020, Šturm R., Koderman B., CJE01-20-07-08_PM_1, OR179400.

Colletidae, Hylaeus *dilatatus*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 21-Aug-2020, Šturm R., Koderman B., CEK02-20-08-21_KM_2, OR179287.

Colletidae, *Hylaeus dilatatus*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 04-Jul-2020, Šturm R., Koderman B., CEK03-20-07-04_KR_4, OR179293.

Colletidae, *Hylaeus dilatatus*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 06-Aug-2020, Šturm R., Koderman B., CJE01-20-08-06_KR_5, OR179402.

Colletidae, *Hylaeus dilatatus*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 21-May-2020, Šturm R., Koderman B., LJB07-20-05-21_KM_2, OR179626.

Colletidae, *Hylaeus dilatatus*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 26-Aug-2020, Koderman B., Koderman B., LJU02-20-08-26_KR_3, OR179489.

Colletidae, *Hylaeus gibbus*, male, Ljubljana, Slovenia, 46.0851 N 14.4692 E, 13-Jul-2020, Koderman B., Koderman B., LJU10-20-07-13_KB_5, OR179491.

Colletidae, *Hylaeus gredleri*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 08-Jul-2020, Šturm R., Koderman B., CJE01-20-07-08_KB_1, OR179404.

Colletidae, *Hylaeus gredleri*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 08-Jul-2020, Šturm R., Koderman B., LJB07-20-07-08_KB_1, OR179612.

Colletidae, *Hylaeus gredleri*, female, Ljubljana, Slovenia, 46.1019 N 14.4503 E, 13-Jul-2020, Koderman B., Koderman B., LJU09-20-07-13_KR_3, OR179490.

Colletidae, *Hylaeus hyalinatus*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 08-Sep-2020, Šturm R., Koderman B., CEK07-20-09-08_KM_2, OR179306.

Colletidae, *Hylaeus hyalinatus*, female, Celje, Slovenia, 46.3095 N 15.2892 E, 04-Jul-2020, Šturm R., Koderman B., CEK09-20-07-04_KR_4, OR179291.

Colletidae, *Hylaeus hyalinatus*, male, Cerknica, Slovenia, 45.7568 N 14.3626 E, 19-Aug-2020, Šturm R., Koderman B., CJE04-20-08-19_KB_2, OR179405.

Colletidae, *Hylaeus hyalinatus*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 06-Aug-2020, Šturm R., Koderman B., LJB04-20-08-06_KB_1, OR179586.

Colletidae, *Hylaeus hyalinatus*, male, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 19-Jun-2020, Koderman B., Koderman B., LJU02-20-06-19_KB_3, OR179443.

Colletidae, *Hylaeus hyalinatus*, female, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 27-May-2020, Koderman B., Koderman B., LJU06-20-05-27_KR_2, OR179442.

Colletidae, *Hylaeus hyalinatus*, male, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 11-Aug-2020, Koderman B., Koderman B., LJU06-20-08-11_KB_5, OR179492.

Colletidae, *Hylaeus incongruus*, male, Celje, Slovenia, 46.2899 N 15.2953 E, 22-Jul-2020, Šturm R., Koderman B., CEK08-20-07-22_KR_4, OR179288.

Colletidae, *Hylaeus incongruus*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 06-Aug-2020, Šturm R., Koderman B., CJE05-20-08-06_KB_2, OR179403.

Colletidae, *Hylaeus intermedius*, male, Borovnica, Slovenia, 45.9457 N 14.3703 E, 06-Aug-2020, Šturm R., Koderman B., LJB04-20-08-06_KB_2, OR179584.

Colletidae, *Hylaeus leptocephalus*, male, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 19-Jun-2020, Koderman B., Koderman B., LJU05-20-06-19_KR_5, OR179448.

Colletidae, *Hylaeus moricei*, male, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 19-Jun-2020, Koderman B., Koderman B., LJU04-20-06-19_KR_6, OR179445.

Colletidae, *Hylaeus nigritus*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 11-Jun-2020, Šturm R., Koderman B., CEK10-20-06-11_KR_6, OR179294.

Colletidae, *Hylaeus nigritus*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 13-Jul-2020, Pibernik M., Koderman B., GOK01-20-07-13_KR_1, OR179554.

Colletidae, *Hylaeus nigritus*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 02-Jun-2020, Šturm R., Koderman B., LJB04-20-06-02_PM_2, OR179517.

Colletidae, *Hylaeus nigritus*, female, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 19-Jun-2020, Koderman B., Koderman B., LJU04-20-06-19_KR_1, OR179446.

Colletidae, *Hylaeus pfankuchi*, female, Cerknica, Slovenia, 45.7251 N 14.4028 E, 10-Jun-2020, Šturm R., Koderman B., CJE07-20-06-10_KR_5, OR179358.

Colletidae, *Hylaeus punctatus*, female, Cerknica, Slovenia, 45.7727 N 14.3976 E, 19-Aug-2020, Šturm R., Koderman B., CJE09-20-08-19_KR_1, OR179406.

Colletidae, *Hylaeus punctatus*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 19-Jun-2020, Koderman B., Koderman B., LJU02-20-06-19_KB_2, OR179447.

Colletidae, *Hylaeus sinuatus*, male, Borovnica, Slovenia, 45.9457 N 14.3703 E, 22-Jun-2020, Šturm R., Koderman B., LJB04-20-06-22_KR_1, OR179577.

Colletidae, *Hylaeus sinuatus*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 11-Aug-2020, Koderman B., Koderman B., LJU01-20-08-11_KR_2, OR179493.

Colletidae, *Hylaeus styriacus*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 04-Jul-2020, Šturm R., Koderman B., CEK07-20-07-04_KB_3, OR179292.

Colletidae, *Hylaeus styriacus*, male, Cerknica, Slovenia, 45.7727 N 14.3976 E, 08-Jul-2020, Šturm R., Koderman B., CJE09-20-07-08_KR_1, OR179407.

Halictidae, *Dufourea dentiventris*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 02-Sep-2020, Šturm R., Koderman B., CJE06-20-09-02_KM_3, OR179395.

Halictidae, *Halictus gavarnicus*, female, Celje, Slovenia, 46.2637 N 15.0697 E, 22-Jul-2020, Šturm R., Koderman B., CEK01-20-07-22_KM_1, OR179273.

Halictidae, *Halictus langobardicus*, male, Celje, Slovenia, 46.2549 N 15.2645 E, 10-Aug-2020, Šturm R., Koderman B., CEK07-20-08-10_KM_1, OR179271.

Halictidae, *Halictus langobardicus*, male, Borovnica, Slovenia, 45.9457 N 14.3703 E, 19-Aug-2020, Šturm R., Koderman B., LJB04-20-08-19_KM_1, OR179607.

Halictidae, *Halictus langobardicus*, male, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 11-Aug-2020, Koderman B., Koderman B., LJU01-20-08-11_PM_3, OR179481.

Halictidae, *Halictus maculatus*, female, Celje, Slovenia, 46.2899 N 15.2953 E, 05-May-2020, Šturm R., Koderman B., CEK08-20-05-05_KR_1, OR179275.

Halictidae, *Halictus maculatus*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 02-Jun-2020, Šturm R., Koderman B., LJB01-20-06-02_KR_2, OR179454.

Halictidae, *Halictus maculatus*, male, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 19-Jun-2020, Koderman B., Koderman B., LJU04-20-06-19_PR_1, OR179437.

Halictidae, *Halictus scabiosae*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 05-May-2020, Šturm R., Koderman B., CEK03-20-05-05_KM_1, OR179589.

Halictidae, *Halictus scabiosae*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_PM_1, OR179513.

Halictidae, *Halictus seladonius*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 20-May-2020, Šturm R., Koderman B., CEK07-20-05-20_KB_1, OR179594.

Halictidae, *Halictus sexcinctus*, female, Celje, Slovenia, 46.2440 N 15.2254 E, 20-May-2020, Šturm R., Koderman B., CEK04-20-05-20_KR_1, OR179592.

Halictidae, *Halictus sexcinctus*, female, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 27-May-2020, Koderman B., Koderman B., LJU05-20-05-27_PM_1, OR179438.

Halictidae, *Halictus simplex*, male, Celje, Slovenia, 46.2306 N 15.1840 E, 21-Aug-2020, Šturm R., Koderman B., CEK06-20-08-21_KM_1, OR179272.

Halictidae, *Halictus simplex*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 06-Aug-2020, Šturm R., Koderman B., CJE01-20-08-06_KR_3, OR179396.

Halictidae, *Halictus simplex*, male, Mengeš, Slovenia, 46.1455 N 14.5540 E, 27-Jul-2020, Pibernik M., Koderman B., GOK01-20-07-27_KR_1, OR179565.

Halictidae, *Halictus simplex*, male, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 26-Aug-2020, Koderman B., Koderman B., LJU01-20-08-26_KM_1, OR179482.

Halictidae, *Halictus smaragdulus*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 06-Aug-2020, Šturm R., Koderman B., LJB02-20-08-06_KR_1, OR179608.

Halictidae, *Halictus subauratus*, female, Cerknica, Slovenia, 45.7568 N 14.3626 E, 21-May-2020, Šturm R., Koderman B., CJE04-20-05-21_KR_3, OR179352.

Halictidae, *Halictus subauratus*, female, Ig, Slovenia, 45.9706 N 14.5492 E, 22-Jun-2020, Šturm R., Koderman B., LJB08-20-06-22_PM_1, OR179580.

Halictidae, *Halictus subauratus*, female, Ljubljana, Slovenia, 46.0851 N 14.4692 E, 27-May-2020, Koderman B., Koderman B., LJU10-20-05-27_KR_1, OR179439.

Halictidae, *Halictus tumulorum*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 20-May-2020, Šturm R., Koderman B., CEK10-20-05-20_KM_1, OR179274.

Halictidae, *Halictus tumulorum*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_PM_1, OR179353.

Halictidae, *Halictus tumulorum*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 26-May-2020, Pibernik M., Koderman B., GOK08-20-05-26_KR_4, OR179514.

Halictidae, *Halictus tumulorum*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 30-Jun-2020, Pibernik M., Koderman B., GOK08-20-06-30_PR_1, OR179564.

Halictidae, *Halictus tumulorum*, female, Ig, Slovenia, 45.9730 N 14.5573 E, 21-May-2020, Šturm R., Koderman B., LJB09-20-05-21_PM_1, OR179423.

Halictidae, *Halictus tumulorum*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 13-Jul-2020, Koderman B., Koderman B., LJU01-20-07-13_PM_3, OR179483.

Halictidae, *Lasioglossum albipes*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 05-May-2020, Šturm R., Koderman B., CEK03-20-05-05_KM_2, OR179620.

Halictidae, *Lasioglossum albipes*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 21-May-2020, Šturm R., Koderman B., CJE02-20-05-21_KM_1, OR179359.

Halictidae, *Lasioglossum albipes*, female, Cerknica, Slovenia, 45.7588 N 14.3621 E, 06-May-2020, Šturm R., Koderman B., CJE03-20-05-06_PM_1, OR179408.

Halictidae, *Lasioglossum albipes*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 06-Aug-2020, Šturm R., Koderman B., LJB03-20-08-06_PM_1, OR179583.

Halictidae, *Lasioglossum angusticeps*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_KB_3, OR179360.

Halictidae, *Lasioglossum bluethgeni*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 11-Jun-2020, Šturm R., Koderman B., CEK07-20-06-11_KB_3, OR179278.

Halictidae, *Lasioglossum bluethgeni*, female, Cerknica, Slovenia, 45.7588 N 14.3621 E, 10-Jun-2020, Šturm R., Koderman B., CJE03-20-06-10_KB_3, OR179361.

Halictidae, *Lasioglossum bluethgeni*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 22-Jun-2020, Šturm R., Koderman B., LJB05-20-06-22_KM_1, OR179578.

Halictidae, *Lasioglossum bluethgeni*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 19-Jun-2020, Koderman B., Koderman B., LJU01-20-06-19_KM_1, OR179450.

Halictidae, *Lasioglossum buccale*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 11-Jun-2020, Šturm R., Koderman B., CEK07-20-06-11_PR_1, OR179279.

Halictidae, *Lasioglossum calceatum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_KB_1, OR179515.

Halictidae, *Lasioglossum calceatum*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 16-Jun-2020, Pibernik M., Koderman B., GOK08-20-06-16_KB_2, OR179516.

Halictidae, *Lasioglossum calceatum*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 21-May-2020, Šturm R., Koderman B., LJB04-20-05-21_KR_1, OR179345.

Halictidae, *Lasioglossum calceatum*, female, Ljubljana, Slovenia, 46.0523 N 14.4790 E, 19-Jun-2020, Koderman B., Koderman B., LJU03-20-06-19_KR_3, OR179449.

Halictidae, *Lasioglossum calceatum*, female, Ljubljana, Slovenia, 46.1019 N 14.4503 E, 19-Jun-2020, Koderman B., Koderman B., LJU09-20-06-19_KR_1, OR179451.

Halictidae, *Lasioglossum costulatum*, male, Cerknica, Slovenia, 45.7795 N 14.3599 E, 19-Aug-2020, Šturm R., Koderman B., CJE02-20-08-19_KM_1, OR179409.

Halictidae, *Lasioglossum costulatum*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 21-May-2020, Šturm R., Koderman B., LJB02-20-05-21_PM_1, OR179301.

Halictidae, *Lasioglossum crassepunctatum*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 11-Jun-2020, Šturm R., Koderman B., CEK07-20-06-11_KM_4, OR179629.

Halictidae, *Lasioglossum discum*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 20-May-2020, Šturm R., Koderman B., CEK07-20-05-20_KM_1, OR179633.

Halictidae, *Lasioglossum discum*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 02-Jun-2020, Šturm R., Koderman B., LJB10-20-06-02_PM_1, OR179573.

Halictidae, *Lasioglossum fulvicorne*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 22-Jul-2020, Šturm R., Koderman B., CEK10-20-07-22_PM_1, OR179277.

Halictidae, *Lasioglossum fulvicorne*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 08-Jul-2020, Šturm R., Koderman B., CJE05-20-07-08_PM_28, OR179414.

Halictidae, *Lasioglossum fulvicorne*, female, Cerknica, Slovenia, 45.7279 N 14.4042 E, 10-Jun-2020, Šturm R., Koderman B., CJE08-20-06-10_KR_4, OR179362.

Halictidae, *Lasioglossum fulvicorne*, female, Kranj, Slovenia, 46.2697 N 14.3872 E, 16-Jun-2020, Pibernik M., Koderman B., GOK09-20-06-16_KB_2, OR179519.

Halictidae, *Lasioglossum fulvicorne*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 02-Jun-2020, Šturm R., Koderman B., LJB10-20-06-02_KB_2, OR179572.

Halictidae, *Lasioglossum fulvicorne*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 30-Jun-2020, Koderman B., Koderman B., LJU01-20-06-30_KM_1, OR179495.

Halictidae, *Lasioglossum glabriusculum*, female, Celje, Slovenia, 46.2484 N 15.2153 E, 05-May-2020, Šturm R., Koderman B., CEK05-20-05-05_KM_1, OR179621.

Halictidae, *Lasioglossum glabriusculum*, female, Cerknica, Slovenia, 45.7688 N 14.4004 E, 15-Sep-2020, Šturm R., Koderman B., CJE10-20-09-15_PM_5, OR179410.

Halictidae, *Lasioglossum glabriusculum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_KM_4, OR179521.

Halictidae, *Lasioglossum glabriusculum*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 21-May-2020, Šturm R., Koderman B., LJB10-20-05-21_KM_2, OR179444.

Halictidae, *Lasioglossum glabriusculum*, female, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 27-May-2020, Koderman B., Koderman B., LJU07-20-05-27_PM_4, OR179452.

Halictidae, *Lasioglossum laevigatum*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 21-May-2020, Šturm R., Koderman B., CJE02-20-05-21_KR_1, OR179363.

Halictidae, *Lasioglossum laticeps*, female, Celje, Slovenia, 46.3095 N 15.2892 E, 05-May-2020, Šturm R., Koderman B., CEK09-20-05-05_KB_1, OR179619.

Halictidae, *Lasioglossum laticeps*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 08-Jul-2020, Šturm R., Koderman B., CJE06-20-07-08_KB_1, OR179411.

Halictidae, *Lasioglossum laticeps*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 16-Jun-2020, Pibernik M., Koderman B., GOK01-20-06-16_KR_4, OR179523.

Halictidae, *Lasioglossum laticeps*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 19-Jun-2020, Koderman B., Koderman B., LJU01-20-06-19_KR_3, OR179453.

Halictidae, *Lasioglossum lativentre*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 11-Jun-2020, Šturm R., Koderman B., CEK02-20-06-11_KB_4, OR179628.

Halictidae, *Lasioglossum lativentre*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 19-Aug-2020, Šturm R., Koderman B., CJE01-20-08-19_KM_2, OR179413.

Halictidae, *Lasioglossum lativentre*, female, Mengeš, Slovenia, 46.1969 N 14.5259 E, 26-May-2020, Pibernik M., Koderman B., GOK05-20-05-26_KR_4, OR179524.

Halictidae, *Lasioglossum lativentre*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 21-May-2020, Šturm R., Koderman B., LJB02-20-05-21_PR_2, OR179290.

Halictidae, *Lasioglossum lativentre*, female, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 19-Jun-2020, Koderman B., Koderman B., LJU07-20-06-19_KB_1, OR179455.

Halictidae, *Lasioglossum leucozonium*, female, Celje, Slovenia, 46.2306 N 15.1840 E, 05-May-2020, Šturm R., Koderman B., CEK06-20-05-05_PR_1, OR179624.

Halictidae, *Lasioglossum leucozonium*, female, Cerknica, Slovenia, 45.7727 N 14.3976 E, 10-Jun-2020, Šturm R., Koderman B., CJE09-20-06-10_KR_2, OR179364.

Halictidae, *Lasioglossum leucozonium*, female, Mengeš, Slovenia, 46.1969 N 14.5259 E, 16-Jun-2020, Pibernik M., Koderman B., GOK05-20-06-16_KR_6, OR179522.

Halictidae, *Lasioglossum leucozonium*, female, Mengeš, Slovenia, 46.1585 N 14.4932 E, 26-May-2020, Pibernik M., Koderman B., GOK07-20-05-26_KM_1, OR179525.

Halictidae, *Lasioglossum leucozonium*, female, Ig, Slovenia, 45.9401 N 14.5524 E, 21-May-2020, Šturm R., Koderman B., LJB06-20-05-21_KR_1, OR179390.

Halictidae, *Lasioglossum leucozonium*, female, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 27-May-2020, Koderman B., Koderman B., LJU04-20-05-27_KR_3, OR179456.

Halictidae, *Lasioglossum lineare*, female, Celje, Slovenia, 46.2637 N 15.0697 E, 22-Jun-2020, Šturm R., Koderman B., CEK01-20-06-22_KM_1, OR179276.

Halictidae, *Lasioglossum lineare*, female, Mengeš, Slovenia, 46.1392 N 14.5751 E, 16-Jun-2020, Pibernik M., Koderman B., GOK02-20-06-16_KB_2, OR179518.

Halictidae, *Lasioglossum lineare*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 08-Jul-2020, Šturm R., Koderman B., LJB04-20-07-08_KM_2, OR179614.

Halictidae, *Lasioglossum lineare*, female, Ljubljana, Slovenia, 46.1100 N 14.4632 E, 30-Jun-2020, Koderman B., Koderman B., LJU08-20-06-30_PR_1, OR179494.

Halictidae, *Lasioglossum majus*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_KR_1, OR179365.

Halictidae, *Lasioglossum majus*, female, Mengeš, Slovenia, 46.1824 N 14.5478 E, 16-Jun-2020, Pibernik M., Koderman B., GOK04-20-06-16_PR_1, OR179526.

Halictidae, *Lasioglossum malachurum*, female, Celje, Slovenia, 46.2899 N 15.2953 E, 04-Jul-2020, Šturm R., Koderman B., CEK08-20-07-04_PR_1, OR179623.

Halictidae, *Lasioglossum malachurum*, female, Mengeš, Slovenia, 46.1511 N 14.5726 E, 16-Jun-2020, Pibernik M., Koderman B., GOK03-20-06-16_KR_2, OR179527.

Halictidae, *Lasioglossum morio*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 11-Jun-2020, Šturm R., Koderman B., CEK03-20-06-11_KB_2, OR179632.

Halictidae, *Lasioglossum morio*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_PM_4, OR179366.

Halictidae, *Lasioglossum morio*, female, Mengeš, Slovenia, 46.1392 N 14.5751 E, 26-May-2020, Pibernik M., Koderman B., GOK02-20-05-26_KB_1, OR179529.

Halictidae, *Lasioglossum morio*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 21-May-2020, Šturm R., Koderman B., LJB03-20-05-21_KM_1, OR179334.

Halictidae, *Lasioglossum morio*, female, Ljubljana, Slovenia, 46.0511 N 14.4708 E, 19-Jun-2020, Koderman B., Koderman B., LJU01-20-06-19_KM_3, OR179458.

Halictidae, *Lasioglossum nigripes*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 11-Jun-2020, Šturm R., Koderman B., CEK10-20-06-11_KR_2, OR179630.

Halictidae, *Lasioglossum nigripes*, female, Cerknica, Slovenia, 45.7251 N 14.4028 E, 06-Aug-2020, Šturm R., Koderman B., CJE07-20-08-06_KB_1, OR179415.

Halictidae, *Lasioglossum nigripes*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 22-Jun-2020, Šturm R., Koderman B., LJB03-20-06-22_KB_1, OR179615.

Halictidae, *Lasioglossum nitidulum*, female, Celje, Slovenia, 46.3095 N 15.2892 E, 11-Jun-2020, Šturm R., Koderman B., CEK09-20-06-11_KR_2, OR179631.

Halictidae, *Lasioglossum nitidulum*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_KB_6, OR179368.

Halictidae, *Lasioglossum nitidulum*, female, Ljubljana, Slovenia, 46.1100 N 14.4632 E, 19-Jun-2020, Koderman B., Koderman B., LJU08-20-06-19_KR_2, OR179459.

Halictidae, *Lasioglossum parvulum*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 21-May-2020, Šturm R., Koderman B., CJE05-20-05-21_KM_3, OR179372.

Halictidae, *Lasioglossum parvulum*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 21-May-2020, Šturm R., Koderman B., CJE05-20-05-21_PR_1, OR179369.

Halictidae, *Lasioglossum pauxillum*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 05-May-2020, Šturm R., Koderman B., CEK03-20-05-05_KR_4, OR179627.

Halictidae, *Lasioglossum pauxillum*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 21-May-2020, Šturm R., Koderman B., CJE01-20-05-21_KR_1, OR179370.

Halictidae, *Lasioglossum pauxillum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_KR_3, OR179530.

Halictidae, *Lasioglossum pauxillum*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 21-May-2020, Šturm R., Koderman B., LJB05-20-05-21_KR_1, OR179378.

Halictidae, *Lasioglossum pauxillum*, female, Ig, Slovenia, 45.9635 N 14.5168 E, 21-May-2020, Šturm R., Koderman B., LJB05-20-05-21_KR_2, OR179379.

Halictidae, *Lasioglossum pauxillum*, female, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 19-Jun-2020, Koderman B., Koderman B., LJU05-20-06-19_KR_6, OR179457.

Halictidae, *Lasioglossum politum*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 05-May-2020, Šturm R., Koderman B., CEK03-20-05-05_KM_3, OR179622.

Halictidae, *Lasioglossum politum*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 10-Jun-2020, Šturm R., Koderman B., CJE02-20-06-10_KB_5, OR179371.

Halictidae, *Lasioglossum politum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_KB_2, OR179531.

Halictidae, *Lasioglossum politum*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 21-May-2020, Šturm R., Koderman B., LJB04-20-05-21_KB_1, OR179574.

Halictidae, *Lasioglossum politum*, female, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 27-May-2020, Koderman B., Koderman B., LJU04-20-05-27_KR_5, OR179460.

Halictidae, *Lasioglossum punctatissimum*, female, Mengeš, Slovenia, 46.1392 N 14.5751 E, 16-Jun-2020, Pibernik M., Koderman B., GOK02-20-06-16_KB_3, OR179520.

Halictidae, *Lasioglossum puncticolle*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 22-Jun-2020, Šturm R., Koderman B., LJB01-20-06-22_PR_3, OR179575.

Halictidae, *Lasioglossum villosulum*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 05-May-2020, Šturm R., Koderman B., CEK02-20-05-05_KR_1, OR179625.

Halictidae, *Lasioglossum villosulum*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 21-May-2020, Šturm R., Koderman B., LJB04-20-05-21_KR_3, OR179367.

Halictidae, *Lasioglossum villosulum*, female, Ljubljana, Slovenia, 46.0851 N 14.4692 E, 21-Sep-2020, Koderman B., Koderman B., LJU10-20-09-21_KR_1, OR179497.

Halictidae, *Lasioglossum zonulum*, female, Celje, Slovenia, 46.2899 N 15.2953 E, 05-May-2020, Šturm R., Koderman B., CEK08-20-05-05_KB_1, OR179634.

Halictidae, *Lasioglossum zonulum*, female, Cerknica, Slovenia, 45.7279 N 14.4042 E, 21-May-2020, Šturm R., Koderman B., CJE08-20-05-21_KB_1, OR179373.

Halictidae, *Lasioglossum zonulum*, female, Mengeš, Slovenia, 46.1455 N 14.5540 E, 26-May-2020, Pibernik M., Koderman B., GOK01-20-05-26_PM_2, OR179532.

Halictidae, *Lasioglossum zonulum*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 21-May-2020, Šturm R., Koderman B., LJB03-20-05-21_KR_1, OR179487.

Halictidae, *Lasioglossum zonulum*, female, Ig, Slovenia, 45.9706 N 14.5492 E, 19-Aug-2020, Šturm R., Koderman B., LJB08-20-08-19_PM_3, OR179613.

Halictidae, *Lasioglossum zonulum*, female, Ljubljana, Slovenia, 46.1100 N 14.4632 E, 27-May-2020, Koderman B., Koderman B., LJU08-20-05-27_PR_1, OR179461.

Halictidae, *Sphecodes ephippius*, male, Mengeš, Slovenia, 46.1585 N 14.4932 E, 13-Jul-2020, Pibernik M., Koderman B., GOK07-20-07-13_KB_1, OR179568.

Halictidae, *Sphecodes geoffrellus*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_KR_13, OR179376.

Halictidae, *Sphecodes monilicornis*, female, Ljubljana, Slovenia, 46.1100 N 14.4632 E, 19-Jun-2020, Koderman B., Koderman B., LJU08-20-06-19_PM_4, OR179468.

Halictidae, *Sphecodes niger*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 16-Apr-2020, Šturm R., Koderman B., LJB03-20-04-16_KB_1, OR179617.

Halictidae, *Sphecodes niger*, male, Ljubljana, Slovenia, 46.1100 N 14.4632 E, 11-Aug-2020, Koderman B., Koderman B., LJU08-20-08-11_KB_1, OR179496.

Halictidae, *Sphecodes pellucidus*, female, Cerknica, Slovenia, 45.7279 N 14.4042 E, 10-Jun-2020, Šturm R., Koderman B., CJE08-20-06-10_KR_3, OR179377.

Halictidae, *Sphecodes puncticeps*, female, Mengeš, Slovenia, 46.1585 N 14.4932 E, 26-May-2020, Pibernik M., Koderman B., GOK07-20-05-26_PR_2, OR179536.

Megachilidae, *Anthidium manicatum*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 19-Aug-2020, Šturm R., Koderman B., LJB07-20-08-19_KM_1, OR179604.

Megachilidae, *Anthidium manicatum*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 26-Aug-2020, Koderman B., Koderman B., LJU02-20-08-26_PM_1, OR179471.

Megachilidae, *Anthidium oblongatum*, male, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 26-Aug-2020, Koderman B., Koderman B., LJU06-20-08-26_PM_2, OR179472.

Megachilidae, *Chelostoma campanularum*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 06-Aug-2020, Šturm R., Koderman B., CJE05-20-08-06_KR_8, OR179387.

Megachilidae, *Chelostoma campanularum*, female, Borovnica, Slovenia, 45.9457 N 14.3703 E, 08-Jul-2020, Šturm R., Koderman B., LJB04-20-07-08_PM_2, OR179605.

Megachilidae, *Chelostoma emarginatum*, male, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 27-May-2020, Koderman B., Koderman B., LJU04-20-05-27_KR_4, OR179435.

Megachilidae, *Chelostoma florisomne*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 11-Jun-2020, Šturm R., Koderman B., CEK10-20-06-11_KR_3, OR179316.

Megachilidae, *Chelostoma florisomne*, female, Borovnica, Slovenia, 45.9452 N 14.3359 E, 21-May-2020, Šturm R., Koderman B., LJB01-20-05-21_KR_2, OR179616.

Megachilidae, *Chelostoma foveolatum*, male, Cerknica, Slovenia, 45.7503 N 14.3641 E, 20-Jul-2020, Šturm R., Koderman B., CJE05-20-07-20_KR_1, OR179388.

Megachilidae, *Chelostoma rapunculi*, male, Borovnica, Slovenia, 45.9452 N 14.3359 E, 21-May-2020, Šturm R., Koderman B., LJB01-20-05-21_PM_4, OR179596.

Megachilidae, *Chelostoma rapunculi*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 20-May-2020, Šturm R., Koderman B., CEK02-20-05-20_PM_7, OR179297.

Megachilidae, *Chelostoma rapunculi*, female, Ljubljana, Slovenia, 46.0851 N 14.4692 E, 27-May-2020, Koderman B., Koderman B., LJU10-20-05-27_PM_1, OR179436.

Megachilidae, *Coelioxys alata*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 19-Aug-2020, Šturm R., Koderman B., CJE01-20-08-19_KB_2, OR179391.

Megachilidae, *Coelioxys alata*, male, Cerknica, Slovenia, 45.7793 N 14.3290 E, 19-Aug-2020, Šturm R., Koderman B., CJE01-20-08-19_PM_8, OR179393.

Megachilidae, *Coelioxys alata*, female, Cerknica, Slovenia, 45.7568 N 14.3626 E, 15-Sep-2020, Šturm R., Koderman B., CJE04-20-09-15_PM_6, OR179389.

Megachilidae, *Coelioxys aurolimbatus*, female, Borovnica, Slovenia, 45.9303 N 14.3491 E, 08-Jul-2020, Šturm R., Koderman B., LJB03-20-07-08_PM_1, OR179587.

Megachilidae, *Coelioxys inermis*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 20-Jul-2020, Šturm R., Koderman B., CJE06-20-07-20_PM_32, OR179392.

Megachilidae, *Heriades truncorum*, male, Celje, Slovenia, 46.2641 N 15.0574 E, 22-Jun-2020, Šturm R., Koderman B., CEK02-20-06-22_KB_1, OR179298.

Megachilidae, *Heriades truncorum*, female, Cerknica, Slovenia, 45.7795 N 14.3599 E, 06-Aug-2020, Šturm R., Koderman B., CJE02-20-08-06_KR_1, OR179397.

Megachilidae, *Heriades truncorum*, female, Mengeš, Slovenia, 46.1947 N 14.5127 E, 13-Jul-2020, Pibernik M., Koderman B., GOK06-20-07-13_KR_1, OR179563.

Megachilidae, *Heriades truncorum*, male, Ig, Slovenia, 45.9730 N 14.5573 E, 22-Jun-2020, Šturm R., Koderman B., LJB09-20-06-22_KR_1, OR179581.

Megachilidae, *Heriades truncorum*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 13-Jul-2020, Koderman B., Koderman B., LJU02-20-07-13_KR_8, OR179484.

Megachilidae, *Hoplitis adunca*, male, Celje, Slovenia, 46.2357 N 15.2323 E, 20-May-2020, Šturm R., Koderman B., CEK03-20-05-20_PM_8, OR179299.

Megachilidae, *Hoplitis adunca*, male, Celje, Slovenia, 46.2357 N 15.2323 E, 20-May-2020, Šturm R., Koderman B., CEK03-20-05-20_PM_8, OR179591.

Megachilidae, *Hoplitis claviventris*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 19-Aug-2020, Šturm R., Koderman B., LJB10-20-08-19_PM_1, OR179609.

Megachilidae, *Hoplitis leucomelana*, male, Celje, Slovenia, 46.2306 N 15.1840 E, 11-Jun-2020, Šturm R., Koderman B., CEK06-20-06-11_PM_5, OR179300.

Megachilidae, *Hoplitis leucomelana*, female, Cerknica, Slovenia, 45.7793 N 14.3290 E, 08-Jul-2020, Šturm R., Koderman B., CJE01-20-07-08_PM_3, OR179398.

Megachilidae, *Hoplitis leucomelana*, female, Ig, Slovenia, 45.9632 N 14.5438 E, 02-Jun-2020, Šturm R., Koderman B., LJB07-20-06-02_PM_1, OR179550.

Megachilidae, *Lithurgus chrysurus*, male, Celje, Slovenia, 46.2484 N 15.2153 E, 22-Jul-2020, Šturm R., Koderman B., CEK05-20-07-22_KR_1, OR179595.

Megachilidae, *Lithurgus chrysurus*, female, Mengeš, Slovenia, 46.1511 N 14.5726 E, 27-Jul-2020, Pibernik M., Koderman B., GOK03-20-07-27_PM_3, OR179566.

Megachilidae, *Lithurgus chrysurus*, female, Ig, Slovenia, 45.9772 N 14.5645 E, 19-Aug-2020, Šturm R., Koderman B., LJB10-20-08-19_PM_2, OR179618.

Megachilidae, *Megachile alpicola*, female, Cerknica, Slovenia, 45.7251 N 14.4028 E, 08-Jul-2020, Šturm R., Koderman B., CJE07-20-07-08_KR_1, OR179417.

Megachilidae, *Megachile apicalis*, male, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 30-Jun-2020, Koderman B., Koderman B., LJU04-20-06-30_KB_1, OR179499.

Megachilidae, *Megachile centuncularis*, female, Celje, Slovenia, 46.2306 N 15.1840 E, 20-May-2020, Šturm R., Koderman B., CEK06-20-05-20_KR_1, OR179313.

Megachilidae, *Megachile centuncularis*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 10-Jun-2020, Šturm R., Koderman B., CJE05-20-06-10_KR_3, OR179374.

Megachilidae, *Megachile centuncularis*, female, Mengeš, Slovenia, 46.1947 N 14.5127 E, 11-Aug-2020, Pibernik M., Koderman B., GOK06-20-08-11_PM_4, OR179558.

Megachilidae, *Megachile centuncularis*, female, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 27-May-2020, Koderman B., Koderman B., LJU04-20-05-27_KB_1, OR179462.

Megachilidae, *Megachile circumcincta*, female, Celje, Slovenia, 46.2306 N 15.1840 E, 11-Jun-2020, Šturm R., Koderman B., CEK06-20-06-11_PM_8, OR179311.

Megachilidae, *Megachile ericetorum*, male, Celje, Slovenia, 46.2357 N 15.2323 E, 04-Jul-2020, Šturm R., Koderman B., CEK03-20-07-04_KR_1, OR179310.

Megachilidae, *Megachile ericetorum*, male, Mengeš, Slovenia, 46.1585 N 14.4932 E, 30-Jun-2020, Pibernik M., Koderman B., GOK07-20-06-30_KM_2, OR179533.

Megachilidae, *Megachile ligniseca*, female, Celje, Slovenia, 46.2637 N 15.0697 E, 21-Sep-2020, Šturm R., Koderman B., CEK01-20-09-21_PM_1, OR179314.

Megachilidae, *Megachile ligniseca*, male, Cerknica, Slovenia, 45.7471 N 14.3646 E, 08-Jul-2020, Šturm R., Koderman B., CJE06-20-07-08_PM_1, OR179418.

Megachilidae, *Megachile ligniseca*, female, Kranj, Slovenia, 46.2697 N 14.3872 E, 27-Jul-2020, Pibernik M., Koderman B., GOK09-20-07-27_PM_18, OR179559.

Megachilidae, *Megachile melanopyga*, female, Mengeš, Slovenia, 46.1969 N 14.5259 E, 30-Jun-2020, Pibernik M., Koderman B., GOK05-20-06-30_PM_1, OR179534.

Megachilidae, *Megachile pilicrus*, female, Mengeš, Slovenia, 46.1824 N 14.5478 E, 26-Aug-2020, Pibernik M., Koderman B., GOK04-20-08-26_PM_5, OR179560.

Megachilidae, *Megachile versicolor*, female, Ig, Slovenia, 45.9730 N 14.5573 E, 21-May-2020, Šturm R., Koderman B., LJB09-20-05-21_KM_1, OR179433.

Megachilidae, *Osmia bicolor*, female, Celje, Slovenia, 46.2357 N 15.2323 E, 11-Jun-2020, Šturm R., Koderman B., CEK03-20-06-11_PM_1, OR179304.

Megachilidae, *Osmia bicolor*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 21-May-2020, Šturm R., Koderman B., LJB02-20-05-21_PR_1, OR179281.

Megachilidae, *Osmia bicornis*, female, Celje, Slovenia, 46.2549 N 15.2645 E, 05-May-2020, Šturm R., Koderman B., CEK07-20-05-05_PM_2, OR179305.

Megachilidae, *Osmia bicornis*, female, Mengeš, Slovenia, 46.1585 N 14.4932 E, 05-May-2020, Pibernik M., Koderman B., GOK07-20-05-05_PR_1, OR179567.

Megachilidae, *Osmia bicornis*, female, Borovnica, Slovenia, 45.9511 N 14.3490 E, 02-Jun-2020, Šturm R., Koderman B., LJB02-20-06-02_PR_1, OR179498.

Megachilidae, *Osmia bicornis*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 27-May-2020, Koderman B., Koderman B., LJU02-20-05-27_PR_1, OR179464.

Megachilidae, *Osmia bidentata*, female, Celje, Slovenia, 46.2988 N 15.2464 E, 04-Jul-2020, Šturm R., Koderman B., CEK10-20-07-04_PM_1, OR179303.

Megachilidae, *Osmia caerulescens*, female, Celje, Slovenia, 46.2641 N 15.0574 E, 22-Jul-2020, Šturm R., Koderman B., CEK02-20-07-22_PM_3, OR179302.

Megachilidae, *Osmia caerulescens*, male, Ljubljana, Slovenia, 46.0609 N 14.5191 E, 19-Jun-2020, Koderman B., Koderman B., LJU05-20-06-19_KB_2, OR179466.

Megachilidae, *Osmia leaiana*, male, Cerknica, Slovenia, 45.7795 N 14.3599 E, 23-Jun-2020, Šturm R., Koderman B., CJE02-20-06-23_KB_2, OR179421.

Megachilidae, *Osmia mustelina*, female, Ljubljana, Slovenia, 46.0904 N 14.5065 E, 27-May-2020, Koderman B., Koderman B., LJU07-20-05-27_PM_3, OR179467.

Megachilidae, *Osmia niveata*, male, Ig, Slovenia, 45.9730 N 14.5573 E, 02-Jun-2020, Šturm R., Koderman B., LJB09-20-06-02_KR_1, OR179561.

Megachilidae, *Pseudoanthidium nanum*, female, Ljubljana, Slovenia, 46.0437 N 14.4791 E, 27-May-2020, Koderman B., Koderman B., LJU02-20-05-27_KR_3, OR179429.

Megachilidae, *Stelis breviuscula*, female, Cerknica, Slovenia, 45.7471 N 14.3646 E, 20-Jul-2020, Šturm R., Koderman B., CJE06-20-07-20_KR_3, OR179422.

Megachilidae, *Stelis breviuscula*, male, Mengeš, Slovenia, 46.1969 N 14.5259 E, 13-Jul-2020, Pibernik M., Koderman B., GOK05-20-07-13_KB_3, OR179569.

Megachilidae, *Stelis breviuscula*, male, Ljubljana, Slovenia, 46.0388 N 14.5147 E, 13-Jul-2020, Koderman B., Koderman B., LJU04-20-07-13_KR_3, OR179503.

Megachilidae, *Trachusa byssina*, male, Cerknica, Slovenia, 45.7795 N 14.3599 E, 08-Jul-2020, Šturm R., Koderman B., CJE02-20-07-08_KM_2, OR179427.

Melittidae, *Dasypoda hirtipes*, female, Cerknica, Slovenia, 45.7727 N 14.3976 E, 20-Jul-2020, Šturm R., Koderman B., CJE09-20-07-20_PM_6, OR179394.

Melittidae, *Dasypoda hirtipes*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 13-Jul-2020, Pibernik M., Koderman B., GOK08-20-07-13_PM_1, OR179557.

Melittidae, *Dasypoda hirtipes*, female, Ljubljana, Slovenia, 46.0713 N 14.5402 E, 13-Jul-2020, Koderman B., Koderman B., LJU06-20-07-13_KM_1, OR179480.

Melittidae, *Macropis europaea*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 06-Aug-2020, Šturm R., Koderman B., CJE05-20-08-06_KM_4, OR179416.

Melittidae, *Melitta haemorrhoidalis*, female, Cerknica, Slovenia, 45.7503 N 14.3641 E, 20-Jul-2020, Šturm R., Koderman B., CJE05-20-07-20_KM_4, OR179419.

Melittidae, *Melitta leporina*, male, Celje, Slovenia, 46.2306 N 15.1840 E, 22-Jul-2020, Šturm R., Koderman B., CEK06-20-07-22_KM_1, OR179308.

Melittidae, *Melitta leporina*, female, Kranj, Slovenia, 46.2564 N 14.3613 E, 27-Jul-2020, Pibernik M., Koderman B., GOK08-20-07-27_PM_1, OR179562.

APPENDIX 2

Comparison of morphological (Morpho ID) and molecular (BOLD ID: species best hit) identifications for all specimens in this study, with molecular identification reliability (BOLD ID: best-hit ident) and less reliable but still over 95% identical molecular identifications (BOLD ID: other close hits (≥95%)). When a sequence blasted to more than one species with equal probability, or there was no hit above 95% ident, we deemed the species undetermined using molecular identification ("sp." values).

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
GOK04-20-05-05_PR_1	Andrenidae	*Andrena*	*apicata*	*apicata*	98.6	*mitis, batava, helvola*	Yes
GOK05-20-04-01_KR_1	Andrenidae	*Andrena*	*bicolor*	*bicolor*	100.0	n/a	Yes
LJB05-20-04-01_KR_1	Andrenidae	*Andrena*	*bicolor*	*bicolor*	100.0	n/a	Yes
CJE06-20-05-21_KB_1	Andrenidae	*Andrena*	*bucephala*	*bucephala*	100.0	n/a	Yes
CJE03-20-06-10_KB_2	Andrenidae	*Andrena*	*carantonica*	sp.	100.0	*carantonica, trimmerana, rosae*	No
CJE06-20-05-21_KR_1	Andrenidae	*Andrena*	*chrysosceles*	*chrysosceles*	100.0	n/a	Yes
CJE08-20-06-10_KM_1	Andrenidae	*Andrena*	*curvungula*	sp.	89.6	n/a	No
CEK10-20-07-22_KR_2	Andrenidae	*Andrena*	*dorsata*	*dorsata*	100.0	n/a	Yes
LJB08-20-05-21_KR_1	Andrenidae	*Andrena*	*flavipes*	*flavipes*	100.0	*nitida, limata, assimilis, thoracica*	Yes
GOK03-20-05-05_KB_1	Andrenidae	*Andrena*	*floricola*	sp.	91.2	n/a	No
CJE01-20-06-10_KR_2	Andrenidae	*Andrena*	*fulvago*	sp.	100.0	*fulvago, ruficrus, dorsata, fulva*	No
LJB05-20-07-20_KB_1	Andrenidae	*Andrena*	*fulvago*	*fulvago*	100.0	*dorsata, ruficrus, fulva*	Yes
LJU02-20-06-30_KR_2	Andrenidae	*Andrena*	*fulvago*	sp.	100.0	*ruficrus, dorsata, fulvago, fulva*	No
CJE10-20-05-06_KM_1	Andrenidae	*Andrena*	*fulvata*	*fulvata*	100.0	n/a	Yes
LJB01-20-04-01_KR_3	Andrenidae	*Andrena*	*fulvata*	*fulvata*	100.0	n/a	Yes
CJE01-20-06-10_KR_1	Andrenidae	*Andrena*	*fulvida*	*fulvida*	99.7	n/a	Yes
CJE04-20-05-21_KR_2	Andrenidae	*Andrena*	*fulvida*	*fulvida*	99.9	n/a	Yes
CEK03-20-07-04_KM_3	Andrenidae	*Andrena*	*gravida*	sp.	100.0	*flavipes, chrysopyga*	No
LJB02-20-04-01_KR_1	Andrenidae	*Andrena*	*gravida*	sp.	99.8	*flavipes, chrysopyga*	No
CJE02-20-05-21_PR_1	Andrenidae	*Andrena*	*haemorrhoa*	*haemorrhoa*	100.0	n/a	Yes
CEK07-20-08-10_PM_1	Andrenidae	*Andrena*	*hattorfiana*	*hattorfiana*	99.8	n/a	Yes
CJE02-20-05-21_PM_1	Andrenidae	*Andrena*	*hattorfiana*	*hattorfiana*	100.0	n/a	Yes
GOK04-20-06-30_KM_1	Andrenidae	*Andrena*	*hattorfiana*	*hattorfiana*	99.0	n/a	Yes
LJB05-20-06-02_PM_8	Andrenidae	*Andrena*	*helvola*	*fucata*	98.4	n/a	No
LJB01-20-06-02_KR_3	Andrenidae	*Andrena*	*hesperia*	*hesperia*	97.1	n/a	Yes
CJE02-20-06-10_KB_2	Andrenidae	*Andrena*	*humilis*	*humilis*	100.0	n/a	Yes
LJB05-20-05-21_KB_1	Andrenidae	*Andrena*	*humilis*	sp.	93.9	n/a	No
GOK06-20-06-16_KM_1	Andrenidae	*Andrena*	*labialis*	*labialis*	100.0	n/a	Yes
LJB01-20-07-08_KM_2	Andrenidae	*Andrena*	*lathyri*	*lathyri*	99.8	n/a	Yes
CEK02-20-05-05_PR_1	Andrenidae	*Andrena*	*minutula*	*minutula*	100.0	*subopaca*	Yes
CJE04-20-05-21_KB_2	Andrenidae	*Andrena*	*minutula*	*minutula*	100.0	n/a	Yes
GOK07-20-04-01_KR_1	Andrenidae	*Andrena*	*minutula*	*minutula*	100.0	n/a	Yes
LJB01-20-04-01_KR_1	Andrenidae	*Andrena*	*minutula*	*minutula*	99.8	*subopaca*	Yes
LJU05-20-05-27_KB_1	Andrenidae	*Andrena*	*minutula*	*minutula*	99.9	n/a	Yes
CJE07-20-06-10_KR_4	Andrenidae	*Andrena*	*minutuloides*	*minutuloides*	99.7	*nanula, pauxilla, anthrisci, alfkenella, corssubalpina*	Yes
LJB04-20-06-22_KR_9	Andrenidae	*Andrena*	*minutuloides*	sp.	99.5	*minutula, minutuloides, nanula, corssubalpina, pauxilla, anthrisci, alfkenella*	No
LJU09-20-06-30_PM_1	Andrenidae	*Andrena*	*nitida*	sp.	100.0	*limata, nitida, assimilis, thoracica, galica*	No

(Continues)

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
GOK08-20-05-26_PM_3	Andrenidae	*Andrena*	*ovatula*	*ovatula*	98.6	n/a	Yes
CEK04-20-05-20_KB_1	Andrenidae	*Andrena*	*pandellei*	*pandellei*	99.4	n/a	Yes
CJE01-20-05-21_KB_1	Andrenidae	*Andrena*	*paucisquama*	*paucisquama*	98.3	n/a	Yes
CJE01-20-05-21_KB_4	Andrenidae	*Andrena*	*paucisquama*	*paucisquama*	100.0	n/a	Yes
GOK06-20-07-13_PM_1	Andrenidae	*Andrena*	*rosae*	*rosae*	99.9	*trimmerana, rosae, carantonica*	Yes
LJU02-20-06-30_KR_1	Andrenidae	*Panurgus*	*banksianus*	*banksianus*	100.0	n/a	Yes
GOK06-20-07-27_KR_2	Andrenidae	*Panurgus*	*calcaratus*	*calcaratus*	100.0	n/a	Yes
LJU03-20-06-30_KR_1	Andrenidae	*Panurgus*	*calcaratus*	*calcaratus*	100.0	n/a	Yes
GOK09-20-06-30_PM_1	Apidae	*Amegilla*	*quadrifasciata*	*quadrifasciata*	100.0	n/a	Yes
CEK10-20-06-22_PM_1	Apidae	*Anthophora*	*aestivalis*	*aestivalis*	100.0	n/a	Yes
CJE05-20-06-10_PM_5	Apidae	*Anthophora*	*furcata*	*furcata*	100.0	n/a	Yes
LJU02-20-07-27_PM_2	Apidae	*Anthophora*	*furcata*	*furcata*	100.0	n/a	Yes
CEK08-20-05-05_PM_7	Apidae	*Anthophora*	*plumipes*	*salviae*	100.0	*crinipes*	No
CEK10-20-05-05_PM_2	Apidae	*Anthophora*	*retusa*	*retusa*	100.0	n/a	Yes
LJB05-20-06-02_PM_1	Apidae	*Bombus*	*argillaceus*	*argillaceus*	100.0	n/a	Yes
CJE01-20-09-15_PM_5	Apidae	*Bombus*	*bohemicus*	sp.	100.0	*bohemicus, ashtoni, flavidus*	No
CEK04-20-05-20_PM_4	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
CJE02-20-06-10_PM_3	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
GOK09-20-05-26_PM_1	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
LJB02-20-05-21_PM_3	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
LJB08-20-05-21_PM_1	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
LJU01-20-05-27_KM_1	Apidae	*Bombus*	*hortorum*	*hortorum*	100.0	n/a	Yes
CEK03-20-06-11_PM_13	Apidae	*Bombus*	*humilis*	*humilis*	100.0	*incertus, pascuorum, ruderarius, longipes, deuteronymus, flavobarbatus, anachoreta*	Yes
CEK10-20-05-20_PM_3	Apidae	*Bombus*	*humilis*	*humilis*	99.8	*pascuorum, ruderarius, deuteronymus, lapidarius, sylvarum, anachoreta*	Yes
CJE09-20-09-02_PM_3	Apidae	*Bombus*	*humilis*	*humilis*	100.0	*pascuorum, deuteronymus, flavobartatus, ruderarius*	Yes
GOK06-20-05-05_PM_1	Apidae	*Bombus*	*humilis*	*humilis*	100.0	*pascuorum*	Yes
CJE05-20-06-10_PM_9	Apidae	*Bombus*	*hypnorum*	*hypnorum*	100.0	n/a	Yes
GOK01-20-06-16_PM_2	Apidae	*Bombus*	*hypnorum*	*hypnorum*	100.0	n/a	Yes
LJU01-20-07-13_PM_1	Apidae	*Bombus*	*hypnorum*	*hypnorum*	100.0	n/a	Yes
CEK03-20-05-20_PM_2	Apidae	*Bombus*	*lapidarius*	sp.	100.0	*lapidarius, lucorum*	No
CJE02-20-05-06_PM_1	Apidae	*Bombus*	*lapidarius*	*lapidarius*	100.0	n/a	Yes
GOK09-20-07-27_PM_19	Apidae	*Bombus*	*lapidarius*	*lapidarius*	100.0	*lucorum*	Yes
LJU05-20-07-13_PM_3	Apidae	*Bombus*	*lapidarius*	sp.	100.0	*lapidarius, lucorum*	No
LJU10-20-09-21_PM_2	Apidae	*Bombus*	*lapidarius*	*lapidarius*	100.0	*lucorum*	Yes
CEK02-20-06-22_PR_1	Apidae	*Bombus*	*lucorum*	*terrestris*	100.0	n/a	No
CJE05-20-06-10_KM_2	Apidae	*Bombus*	*lucorum*	*lucorum*	100.0	n/a	Yes
CEK06-20-05-05_PM_1	Apidae	*Bombus*	*pascuorum*	*pascuorum*	100.0	*incertus, flavobarbatus*	Yes
CJE06-20-06-10_PM_1	Apidae	*Bombus*	*pascuorum*	*pascuorum*	100.0	n/a	Yes
GOK06-20-05-26_PM_2	Apidae	*Bombus*	*pascuorum*	*pascuorum*	100.0	*bohemicus*	Yes
LJB03-20-06-02_KR_3	Apidae	*Bombus*	*pascuorum*	*pascuorum*	99.8	*bohemicus*	Yes
LJU01-20-05-27_PM_1	Apidae	*Bombus*	*pascuorum*	sp.	100.0	*pascuorum, humilis*	No
CEK10-20-06-11_PM_2	Apidae	*Bombus*	*pratorum*	*pratorum*	100.0	*haematurus, soroeensis*	Yes

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
CJE02-20-06-10_PM_5	Apidae	*Bombus*	*pratorum*	*pratorum*	100.0	*haematurus, soroeensis*	Yes
GOK10-20-05-05_PM_1	Apidae	*Bombus*	*pratorum*	*pratorum*	100.0	*haematurus, soroeensis*	Yes
LJB01-20-05-21_PM_3	Apidae	*Bombus*	*pratorum*	sp.	100.0	*pratorum, haematurus, soroeensis*	No
LJB07-20-06-22_PR_1	Apidae	*Bombus*	*ruderarius*	sp.	100.0	*ruderarius, sylvarum, lapidarius, veteranus, humilis, deuteronymus*	No
CEK10-20-05-20_PM_2	Apidae	*Bombus*	*sylvarum*	*sylvarum*	99.7	*pascuorum*	Yes
CJE10-20-04-24_KB_1	Apidae	*Bombus*	*sylvarum*	*sylvarum*	100.0	*veteranus, pascuorum*	Yes
GOK09-20-05-26_PM_3	Apidae	*Bombus*	*sylvarum*	*sylvarum*	100.0	*pascuorum*	Yes
LJB02-20-06-02_PM_1	Apidae	*Bombus*	*sylvarum*	*sylvarum*	100.0	*pascuorum, veteranus, ruderarius, lapidarius*	Yes
LJU07-20-07-13_PM_4	Apidae	*Bombus*	*sylvarum*	*sylvarum*	100.0	*pascuorum*	Yes
CEK02-20-06-22_KR_9	Apidae	*Bombus*	*terrestris*	*lucorum*	100.0	n/a	No
CJE05-20-09-02_PM_2	Apidae	*Bombus*	*terrestris*	*terrestris*	100.0	n/a	Yes
GOK04-20-05-26_KM_1	Apidae	*Bombus*	*terrestris*	sp.	100.0	*lucorum, terrestris, magnus, maderensis*	No
GOK08-20-04-01_KM_1	Apidae	*Bombus*	*terrestris*	sp.	100.0	*lucorum, terrestris, magnus, maderensis*	No
LJB10-20-06-02_KB_1	Apidae	*Bombus*	*terrestris*	*terrestris*	100.0	*lucorum, magnus, maderensis*	Yes
LJU02-20-05-27_PM_2	Apidae	*Bombus*	*terrestris*	*terrestris*	100.0	*lucorum, maderensis, magnus*	Yes
LJU07-20-05-27_PM_1	Apidae	*Bombus*	*terrestris*	sp.	100.0	*lucorum, terrestris, magnus, maderensis*	No
CJE06-20-06-10_KM_1	Apidae	*Ceratina*	*chalybea*	*chalybea*	100.0	n/a	Yes
LJB03-20-06-22_PM_1	Apidae	*Ceratina*	*chalybea*	*chalybea*	99.9	n/a	Yes
LJB02-20-06-02_KB_1	Apidae	*Ceratina*	*cucurbitina*	*cucurbitina*	100.0	n/a	Yes
CEK09-20-06-22_KM_1	Apidae	*Ceratina*	*cyanea*	*cyanea*	100.0	*mocsaryi*	Yes
CJE01-20-05-21_KB_5	Apidae	*Ceratina*	*cyanea*	*cyanea*	100.0	*mocsaryi*	Yes
GOK10-20-09-16_PR_1	Apidae	*Ceratina*	*cyanea*	*cyanea*	99.9	*mocsaryi*	Yes
LJB10-20-06-22_KM_3	Apidae	*Ceratina*	*cyanea*	*cyanea*	100.0	*mocsaryi*	Yes
LJU09-20-07-27_KR_4	Apidae	*Ceratina*	*cyanea*	*cyanea*	99.9	*mocsaryi*	Yes
CEK02-20-05-20_PM_7	Apidae	*Chelostoma*	*rapunculi*	*rapunculi*	100.0	n/a	Yes
CJE08-20-08-06_KB_3	Apidae	*Epeoloides*	*coecutiens*	*coecutiens*	100.0	n/a	Yes
CJE04-20-06-10_PM_3	Apidae	*Eucera*	*longicornis*	*longicornis*	100.0	*sociabilis, nigrescens, caspica, proxima*	Yes
GOK03-20-06-16_KM_3	Apidae	*Nomada*	*armata*	*armata*	100.0	n/a	Yes
CJE05-20-05-21_KB_3	Apidae	*Nomada*	*flavoguttata*	*flavoguttata*	100.0	n/a	Yes
LJU01-20-05-27_KM_3	Apidae	*Nomada*	*hirtipes*	*hirtipes*	100.0	*depressa, integerrima, gracilis, valida, glabella, tormentillae, panzeri, flava, leucophthalma, armatella, ferruginata*	Yes
CJE01-20-06-23_KR_2	Apidae	*Nomada*	*integra*	*fabriciana*	99.9	*hispanica, opaca, gransassoi, rostrata*	No
CEK03-20-07-04_PM_1	Apidae	*Tetralonia*	*malvae*	*malvae*	100.0	n/a	Yes
CJE10-20-06-23_PM_2	Apidae	*Xylocopa*	*iris*	*iris*	100.0	n/a	Yes
CEK01-20-06-22_PM_7	Apidae	*Xylocopa*	*valga*	*valga*	99.5	*dissimilis, nasalis*	Yes
CJE09-20-06-23_PM_4	Apidae	*Xylocopa*	*valga*	*valga*	100.0	*dissimilis, nasalis*	Yes
GOK02-20-05-05_PM_1	Apidae	*Xylocopa*	*valga*	*valga*	100.0	*valga, dissimilis, nasalis*	Yes
LJU06-20-06-30_PM_2	Apidae	*Xylocopa*	*valga*	*valga*	99.5	*dissimilis, nasalis*	Yes
CEK03-20-05-20_PM_1	Apidae	*Xylocopa*	*violacea*	*violacea*	100.0	n/a	Yes

(Continues)

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
CJE03-20-05-21_PM_1	Apidae	*Xylocopa*	*violacea*	*violacea*	100.0	n/a	Yes
GOK05-20-05-26_PM_6	Apidae	*Xylocopa*	*violacea*	*violacea*	100.0	n/a	Yes
LJB01-20-05-21_PM_1	Apidae	*Xylocopa*	*violacea*	*violacea*	99.8	n/a	Yes
GOK01-20-07-13_PM_3	Colletidae	*Colletes*	*daviesanus*	sp.	100.0	*daviesanus, tuberculatus*	No
GOK01-20-09-16_KM_1	Colletidae	*Colletes*	*hederae*	sp.	99.8	*succinctus, hederae, intricans, brevigena, halophilus*	No
CEK05-20-07-22_PM_13	Colletidae	*Hylaeus*	*angustatus*	*communis*	100.0	n/a	No
CJE04-20-05-21_KR_5	Colletidae	*Hylaeus*	*angustatus*	*angustatus*	100.0	*brevicornis*	Yes
CJE01-20-09-02_KB_3	Colletidae	*Hylaeus*	*brevicornis*	*brevicornis*	99.5	*glacialis, intermedius, gredleri, imparilis*	Yes
LJU01-20-06-19_KB_1	Colletidae	*Hylaeus*	*brevicornis*	*brevicornis*	99.7	*glacialis, intermedius, gredleri*	Yes
LJU06-20-09-21_KB_1	Colletidae	*Hylaeus*	*clypearis*	*clypearis*	100.0	n/a	Yes
CEK02-20-05-05_PM_2	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
CJE05-20-06-10_PM_4	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
GOK06-20-07-27_PM_2	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
LJB05-20-08-06_KM_6	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
LJU02-20-07-13_KB_16	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
LJU07-20-06-19_KR_1	Colletidae	*Hylaeus*	*communis*	*communis*	100.0	n/a	Yes
CEK09-20-05-05_KM_2	Colletidae	*Hylaeus*	*confusus*	*confusus*	100.0	n/a	Yes
CJE06-20-06-10_PM_4	Colletidae	*Hylaeus*	*confusus*	*confusus*	100.0	n/a	Yes
GOK07-20-08-11_PM_2	Colletidae	*Hylaeus*	*confusus*	*confusus*	100.0	n/a	Yes
LJB01-20-05-21_KR_3	Colletidae	*Hylaeus*	*confusus*	*confusus*	100.0	*confusus*	Yes
LJB04-20-05-21_KR_2	Colletidae	*Hylaeus*	*confusus*	*confusus*	100.0	n/a	Yes
LJB07-20-08-19_KB_1	Colletidae	*Hylaeus*	*cornutus*	*cornutus*	99.7	n/a	Yes
CJE01-20-07-08_PM_1	Colletidae	*Hylaeus*	*difformis*	*difformis*	100.0	n/a	Yes
CEK02-20-08-21_KM_2	Colletidae	*Hylaeus*	*dilatatus*	*dilatatus*	100.0	n/a	Yes
CEK03-20-07-04_KR_4	Colletidae	*Hylaeus*	*dilatatus*	*dilatatus*	99.8	*annularis*	Yes
CJE01-20-08-06_KR_5	Colletidae	*Hylaeus*	*dilatatus*	sp.	100.0	*annularis*	No
LJB07-20-05-21_KM_2	Colletidae	*Hylaeus*	*dilatatus*	*dilatatus*	99.9	*annularis*	Yes
LJU02-20-08-26_KR_3	Colletidae	*Hylaeus*	*dilatatus*	*dilatatus*	99.8	*annularis*	Yes
LJU10-20-07-13_KB_5	Colletidae	*Hylaeus*	*gibbus*	*confusus*	100.0	n/a	No
CJE01-20-07-08_KB_1	Colletidae	*Hylaeus*	*gredleri*	*gredleri*	100.0	*punctatus, intermedius, kahri*	Yes
LJB07-20-07-08_KB_1	Colletidae	*Hylaeus*	*gredleri*	*gredleri*	100.0	*punctatus, intermedius, kahri*	Yes
LJU09-20-07-13_KR_3	Colletidae	*Hylaeus*	*gredleri*	*intermedius*	100.0	*kahri*	No
CEK07-20-09-08_KM_2	Colletidae	*Hylaeus*	*hyalinatus*	*hyalinatus*	100.0	*alpinus*	Yes
CEK09-20-07-04_KR_4	Colletidae	*Hylaeus*	*hyalinatus*	*hyalinatus*	100.0	*alpinus*	Yes
CJE04-20-08-19_KB_2	Colletidae	*Hylaeus*	*hyalinatus*	sp.	100.0	*hyalinatus, alpinus*	No
LJB04-20-08-06_KB_1	Colletidae	*Hylaeus*	*hyalinatus*	sp.	100.0	*alpinus, hyalinatus*	No
LJU02-20-06-19_KB_3	Colletidae	*Hylaeus*	*hyalinatus*	sp.	100.0	*alpinus, hyalinatus*	No
LJU06-20-05-27_KR_2	Colletidae	*Hylaeus*	*hyalinatus*	sp.	100.0	*alpinus, hyalinatus*	No
LJU06-20-08-11_KB_5	Colletidae	*Hylaeus*	*hyalinatus*	sp.	100.0	*alpinus, hyalinatus*	No
CEK08-20-07-22_KR_4	Colletidae	*Hylaeus*	*incongruus*	sp.	100.0	*gibbus, confusus, incongruus, pictus*	No
CJE05-20-08-06_KB_2	Colletidae	*Hylaeus*	*incongruus*	*incongruus*	100.0	*gibbus, confusus, pictus*	Yes
LJB04-20-08-06_KB_2	Colletidae	*Hylaeus*	*intermedius*	*kahri*	99.8	*gredleri, intermedius, punctatus*	No
LJU05-20-06-19_KR_5	Colletidae	*Hylaeus*	*leptocephalus*	*leptocephalus*	100.0	n/a	Yes
LJU04-20-06-19_KR_6	Colletidae	*Hylaeus*	*moricei*	*moricei*	100.0	n/a	Yes
CEK10-20-06-11_KR_6	Colletidae	*Hylaeus*	*nigritus*	*nigritus*	99.8	n/a	Yes

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
GOK01-20-07-13_KR_1	Colletidae	*Hylaeus*	*nigritus*	*nigritus*	99.9	n/a	Yes
LJB04-20-06-02_PM_2	Colletidae	*Hylaeus*	*nigritus*	*nigritus*	99.8	n/a	Yes
LJU04-20-06-19_KR_1	Colletidae	*Hylaeus*	*nigritus*	*nigritus*	99.9	n/a	Yes
CJE07-20-06-10_KR_5	Colletidae	*Hylaeus*	*pfankuchi*	*rinki*	98.8	*pfankuchi*	No
CJE09-20-08-19_KR_1	Colletidae	*Hylaeus*	*punctatus*	sp.	100.0	*gredleri, punctatus*	No
LJU02-20-06-19_KB_2	Colletidae	*Hylaeus*	*punctatus*	sp.	100.0	*gredleri, punctatus*	No
LJB04-20-06-22_KR_1	Colletidae	*Hylaeus*	*sinuatus*	*sinuatus*	100.0	n/a	Yes
LJU01-20-08-11_KR_2	Colletidae	*Hylaeus*	*sinuatus*	*sinuatus*	100.0	n/a	Yes
CEK07-20-07-04_KB_3	Colletidae	*Hylaeus*	*styriacus*	*styriacus*	99.9	n/a	Yes
CJE09-20-07-08_KR_1	Colletidae	*Hylaeus*	*styriacus*	*styriacus*	98.9	n/a	Yes
CJE06-20-09-02_KM_3	Halictidae	*Dufourea*	*dentiventris*	*dentiventris*	100.0	n/a	Yes
CEK01-20-07-22_KM_1	Halictidae	*Halictus*	*gavarnicus*	*confusus*	97.5	*tumulorum, alpinus, gavarnicus*	No
CEK07-20-08-10_KM_1	Halictidae	*Halictus*	*langobardicus*	*langobardicus*	99.8	n/a	Yes
LJB04-20-08-19_KM_1	Halictidae	*Halictus*	*langobardicus*	*compressus*	99.9	*simplex, quadripartitus, langobardicus, crenicornis*	No
LJU01-20-08-11_PM_3	Halictidae	*Halictus*	*langobardicus*	*langobardicus*	99.6	*simplex*	Yes
CEK08-20-05-05_KR_1	Halictidae	*Halictus*	*maculatus*	*maculatus*	98.5	n/a	Yes
LJB01-20-06-02_KR_2	Halictidae	*Halictus*	*maculatus*	*maculatus*	99.2	*pseudomaculatus*	Yes
LJU04-20-06-19_PR_1	Halictidae	*Halictus*	*maculatus*	*maculatus*	99.2	*pseudomaculatus*	Yes
CEK03-20-05-05_KM_1	Halictidae	*Halictus*	*scabiosae*	*scabiosae*	100.0	n/a	Yes
GOK01-20-05-26_PM_1	Halictidae	*Halictus*	*scabiosae*	*scabiosae*	100.0	n/a	Yes
CEK07-20-05-20_KB_1	Halictidae	*Halictus*	*seladonius*	*seladonicus*	97.5	*semitectus, seladonius, subauratus*	Yes
CEK04-20-05-20_KR_1	Halictidae	*Halictus*	*sexcinctus*	*sexcinctus*	100.0	n/a	Yes
LJU05-20-05-27_PM_1	Halictidae	*Halictus*	*sexcinctus*	*sexcinctus*	100.0	n/a	Yes
CEK06-20-08-21_KM_1	Halictidae	*Halictus*	*simplex*	sp.	100.0	*simplex, compressus, crenicornis, langobardicus*	No
CJE01-20-08-06_KR_3	Halictidae	*Halictus*	*simplex*	sp.	100.0	*simplex, compressus, crenicornis, langobardicus*	No
GOK01-20-07-27_KR_1	Halictidae	*Halictus*	*simplex*	*simplex*	100.0	*compressus, crenicornis, langobardicus*	Yes
LJU01-20-08-26_KM_1	Halictidae	*Halictus*	*simplex*	*simplex*	100.0	*compressus, crenicornis, langobardicus*	Yes
LJB02-20-08-06_KR_1	Halictidae	*Halictus*	*smaragdulus*	*subauratus*	100.0	*tumulorum*	No
CJE04-20-05-21_KR_3	Halictidae	*Halictus*	*subauratus*	*subauratus*	100.0	*tumulorum*	Yes
LJB08-20-06-22_PM_1	Halictidae	*Halictus*	*subauratus*	*subauratus*	100.0	*tumulorum*	Yes
LJU10-20-05-27_KR_1	Halictidae	*Halictus*	*subauratus*	*subauratus*	100.0	*tumulorum*	Yes
CEK10-20-05-20_KM_1	Halictidae	*Halictus*	*tumulorum*	*confusus*	97.5	*tumulorum*	No
CJE01-20-05-21_PM_1	Halictidae	*Halictus*	*tumulorum*	*tumulorum*	99.5	*confusus*	Yes
GOK08-20-05-26_KR_4	Halictidae	*Halictus*	*tumulorum*	*tumulorum*	99.8	*confusus*	Yes
GOK08-20-06-30_PR_1	Halictidae	*Halictus*	*tumulorum*	*tumulorum*	100.0	*confusus*	Yes
LJB09-20-05-21_PM_1	Halictidae	*Halictus*	*tumulorum*	*tumulorum*	100.0	*confusus*	Yes
LJU01-20-07-13_PM_3	Halictidae	*Halictus*	*tumulorum*	*tumulorum*	99.8	*confusus*	Yes
CEK03-20-05-05_KM_2	Halictidae	*Lasioglossum*	*albipes*	*calceatum*	100.0	*albipes*	No
CJE02-20-05-21_KM_1	Halictidae	*Lasioglossum*	*albipes*	*albipes*	99.4	*calceatum, duplex*	Yes
CJE03-20-05-06_PM_1	Halictidae	*Lasioglossum*	*albipes*	*albipes*	99.5	*calceatum*	Yes

(Continues)

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
LJB03-20-08-06_PM_1	Halictidae	*Lasioglossum*	*albipes*	*albipes*	100.0	*calceatum, duplex*	Yes
CJE02-20-06-10_KB_3	Halictidae	*Lasioglossum*	*angusticeps*	*angusticeps*	99.9	*punctatissimum*	Yes
CEK07-20-06-11_KB_3	Halictidae	*Lasioglossum*	*bluethgeni*	*bluethgeni*	99.9	n/a	Yes
CJE03-20-06-10_KB_3	Halictidae	*Lasioglossum*	*bluethgeni*	*bluethgeni*	100.0	n/a	Yes
LJB05-20-06-22_KM_1	Halictidae	*Lasioglossum*	*bluethgeni*	*bluethgeni*	100.0	n/a	Yes
LJU01-20-06-19_KM_1	Halictidae	*Lasioglossum*	*bluethgeni*	*bluethgeni*	99.9	n/a	Yes
CEK07-20-06-11_PR_1	Halictidae	*Lasioglossum*	*buccale*	*buccale*	100.0	n/a	Yes
GOK01-20-05-26_KB_1	Halictidae	*Lasioglossum*	*calceatum*	*calceatum*	100.0	n/a	Yes
GOK08-20-06-16_KB_2	Halictidae	*Lasioglossum*	*calceatum*	*calceatum*	100.0	*albipes*	Yes
LJB04-20-05-21_KR_1	Halictidae	*Lasioglossum*	*calceatum*	*calceatum*	100.0	n/a	Yes
LJU03-20-06-19_KR_3	Halictidae	*Lasioglossum*	*calceatum*	*calceatum*	100.0	*albipes*	Yes
LJU09-20-06-19_KR_1	Halictidae	*Lasioglossum*	*calceatum*	*calceatum*	100.0	*albipes*	Yes
CJE02-20-08-19_KM_1	Halictidae	*Lasioglossum*	*costulatum*	*costulatum*	100.0	n/a	Yes
LJB02-20-05-21_PM_1	Halictidae	*Lasioglossum*	*costulatum*	*costulatum*	100.0	n/a	Yes
CEK07-20-06-11_KM_4	Halictidae	*Lasioglossum*	*crassepunctatum*	*crassepunctatum*	99.8	n/a	Yes
CEK07-20-05-20_KM_1	Halictidae	*Lasioglossum*	*discum*	*discum*	100.0	n/a	Yes
LJB10-20-06-02_PM_1	Halictidae	*Lasioglossum*	*discum*	*discum*	100.0	n/a	Yes
CEK10-20-07-22_PM_1	Halictidae	*Lasioglossum*	*fulvicorne*	*fulvicorne*	99.7	n/a	Yes
CJE05-20-07-08_PM_28	Halictidae	*Lasioglossum*	*fulvicorne*	*subfulvicorne*	99.8	*fulvicorne*	No
CJE08-20-06-10_KR_4	Halictidae	*Lasioglossum*	*fulvicorne*	*fulvicorne*	99.4	*subfulvicorne*	Yes
GOK09-20-06-16_KB_2	Halictidae	*Lasioglossum*	*fulvicorne*	*fulvicorne*	100.0	*subfulvicorne*	Yes
LJB10-20-06-02_KB_2	Halictidae	*Lasioglossum*	*fulvicorne*	*crassepunctatum*	100.0	n/a	No
LJU01-20-06-30_KM_1	Halictidae	*Lasioglossum*	*fulvicorne*	*pauxillum*	100.0	n/a	No
CEK05-20-05-05_KM_1	Halictidae	*Lasioglossum*	*glabriusculum*	*glabriusculum*	99.8	n/a	Yes
CJE10-20-09-15_PM_5	Halictidae	*Lasioglossum*	*glabriusculum*	*glabriusculum*	99.8	n/a	Yes
GOK01-20-05-26_KM_4	Halictidae	*Lasioglossum*	*glabriusculum*	*glabriusculum*	99.7	n/a	Yes
LJB10-20-05-21_KM_2	Halictidae	*Lasioglossum*	*glabriusculum*	*glabriusculum*	99.8	n/a	Yes
LJU07-20-05-27_PM_4	Halictidae	*Lasioglossum*	*glabriusculum*	*glabriusculum*	99.7	n/a	Yes
CJE02-20-05-21_KR_1	Halictidae	*Lasioglossum*	*laevigatum*	*laevigatum*	99.7	n/a	Yes
CEK09-20-05-05_KB_1	Halictidae	*Lasioglossum*	*laticeps*	*laticeps*	98.6	n/a	Yes
CJE06-20-07-08_KB_1	Halictidae	*Lasioglossum*	*laticeps*	*laticeps*	100.0	n/a	Yes
GOK01-20-06-16_KR_4	Halictidae	*Lasioglossum*	*laticeps*	*laticeps*	98.6	n/a	Yes
LJU01-20-06-19_KR_3	Halictidae	*Lasioglossum*	*laticeps*	*laticeps*	100.0	n/a	Yes
CEK02-20-06-11_KB_4	Halictidae	*Lasioglossum*	*lativentre*	*lativentre*	99.9	n/a	Yes
CJE01-20-08-19_KM_2	Halictidae	*Lasioglossum*	*lativentre*	*lativentre*	99.9	n/a	Yes
GOK05-20-05-26_KR_4	Halictidae	*Lasioglossum*	*lativentre*	*lativentre*	100.0	n/a	Yes
LJB02-20-05-21_PR_2	Halictidae	*Lasioglossum*	*lativentre*	*lativentre*	100.0	n/a	Yes
LJU07-20-06-19_KB_1	Halictidae	*Lasioglossum*	*lativentre*	*lativentre*	100.0	n/a	Yes
CEK06-20-05-05_PR_1	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	100.0	n/a	Yes
CJE09-20-06-10_KR_2	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	100.0	n/a	Yes
GOK05-20-06-16_KR_6	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	100.0	n/a	Yes
GOK07-20-05-26_KM_1	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	100.0	n/a	Yes
LJB06-20-05-21_KR_1	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	98.6	n/a	Yes
LJU04-20-05-27_KR_3	Halictidae	*Lasioglossum*	*leucozonium*	*leucozonium*	100.0	n/a	Yes
CEK01-20-06-22_KM_1	Halictidae	*Lasioglossum*	*lineare*	*lineare*	100.0	n/a	Yes
GOK02-20-06-16_KB_2	Halictidae	*Lasioglossum*	*lineare*	*lineare*	100.0	n/a	Yes
LJB04-20-07-08_KM_2	Halictidae	*Lasioglossum*	*lineare*	*lineare*	100.0	n/a	Yes
LJU08-20-06-30_PR_1	Halictidae	*Lasioglossum*	*lineare*	*lineare*	100.0	n/a	Yes

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APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
CJE02-20-06-10_KR_1	Halictidae	*Lasioglossum*	*majus*	*majus*	99.8	*zonulum*	Yes
GOK04-20-06-16_PR_1	Halictidae	*Lasioglossum*	*majus*	*majus*	99.9	*zonulum*	Yes
CEK08-20-07-04_PR_1	Halictidae	*Lasioglossum*	*malachurum*	*malachurum*	100.0	n/a	Yes
GOK03-20-06-16_KR_2	Halictidae	*Lasioglossum*	*malachurum*	*malachurum*	100.0	n/a	Yes
CEK03-20-06-11_KB_2	Halictidae	*Lasioglossum*	*morio*	*morio*	100.0	*leucozonium*	Yes
CJE01-20-05-21_PM_4	Halictidae	*Lasioglossum*	*morio*	*morio*	100.0	n/a	Yes
GOK02-20-05-26_KB_1	Halictidae	*Lasioglossum*	*morio*	*morio*	100.0	*leucozonium*	Yes
LJB03-20-05-21_KM_1	Halictidae	*Lasioglossum*	*morio*	*morio*	100.0	n/a	Yes
LJU01-20-06-19_KM_3	Halictidae	*Lasioglossum*	*morio*	*morio*	100.0	*leucozonium*	Yes
CEK10-20-06-11_KR_2	Halictidae	*Lasioglossum*	*nigripes*	*nigripes*	100.0	n/a	Yes
CJE07-20-08-06_KB_1	Halictidae	*Lasioglossum*	*nigripes*	*nigripes*	100.0	n/a	Yes
LJB03-20-06-22_KB_1	Halictidae	*Lasioglossum*	*nigripes*	*nigripes*	100.0	n/a	Yes
CEK09-20-06-11_KR_2	Halictidae	*Lasioglossum*	*nitidulum*	*nitidulum*	99.7	*smeathmanellum*	Yes
CJE01-20-05-21_KB_6	Halictidae	*Lasioglossum*	*nitidulum*	*nitidulum*	100.0	*smeathmanellum*	Yes
LJU08-20-06-19_KR_2	Halictidae	*Lasioglossum*	*nitidulum*	*nitidulum*	100.0	*smeathmanellum*	Yes
CJE05-20-05-21_KM_3	Halictidae	*Lasioglossum*	*parvulum*	*parvulum*	99.9	*nitidiusculum*	Yes
CJE05-20-05-21_PR_1	Halictidae	*Lasioglossum*	*parvulum*	*parvulum*	100.0	*nitidiusculum*	Yes
CEK03-20-05-05_KR_4	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	100.0	n/a	Yes
CJE01-20-05-21_KR_1	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	99.3	*transitorium*	Yes
GOK01-20-05-26_KR_3	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	100.0	n/a	Yes
LJB05-20-05-21_KR_1	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	99.2	n/a	Yes
LJB05-20-05-21_KR_2	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	100.0	n/a	Yes
LJU05-20-06-19_KR_6	Halictidae	*Lasioglossum*	*pauxillum*	*pauxillum*	100.0	n/a	Yes
CEK03-20-05-05_KM_3	Halictidae	*Lasioglossum*	*politum*	*politum*	99.8	n/a	Yes
CJE02-20-06-10_KB_5	Halictidae	*Lasioglossum*	*politum*	*politum*	100.0	n/a	Yes
GOK01-20-05-26_KB_2	Halictidae	*Lasioglossum*	*politum*	*politum*	100.0	n/a	Yes
LJB04-20-05-21_KB_1	Halictidae	*Lasioglossum*	*politum*	*politum*	99.8	n/a	Yes
LJU04-20-05-27_KR_5	Halictidae	*Lasioglossum*	*politum*	*politum*	100.0	n/a	Yes
GOK02-20-06-16_KB_3	Halictidae	*Lasioglossum*	*punctatissimum*	*punctatissimum*	99.2	n/a	Yes
LJB01-20-06-22_PR_3	Halictidae	*Lasioglossum*	*puncticolle*	*puncticolle*	100.0	*corvinum, villosulum, birkmanni, transpositum*	Yes
CEK02-20-05-05_KR_1	Halictidae	*Lasioglossum*	*villosulum*	*villosulum*	100.0	n/a	Yes
LJB04-20-05-21_KR_3	Halictidae	*Lasioglossum*	*villosulum*	*villosulum*	100.0	*lineare*	Yes
LJU10-20-09-21_KR_1	Halictidae	*Lasioglossum*	*villosulum*	*villosulum*	100.0	*lineare, hikosana*	Yes
CEK08-20-05-05_KB_1	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
CJE08-20-05-21_KB_1	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
GOK01-20-05-26_PM_2	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
LJB03-20-05-21_KR_1	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
LJB08-20-08-19_PM_3	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
LJU08-20-05-27_PR_1	Halictidae	*Lasioglossum*	*zonulum*	*zonulum*	100.0	n/a	Yes
GOK07-20-07-13_KB_1	Halictidae	*Sphecodes*	*ephippius*	*ephippius*	100.0	*miniatus*	Yes
CJE05-20-06-10_KR_13	Halictidae	*Sphecodes*	*geoffrellus*	*geoffrellus*	100.0	*miniatus*	Yes
LJU08-20-06-19_PM_4	Halictidae	*Sphecodes*	*monilicornis*	*monilicornis*	100.0	*reticulatus, cephalotes*	Yes
LJB03-20-04-16_KB_1	Halictidae	*Sphecodes*	*niger*	*niger*	100.0	n/a	Yes
LJU08-20-08-11_KB_1	Halictidae	*Sphecodes*	*niger*	*niger*	100.0	n/a	Yes
CJE08-20-06-10_KR_3	Halictidae	*Sphecodes*	*pellucidus*	sp.	95.5	*scabricollis*	No
GOK07-20-05-26_PR_2	Halictidae	*Sphecodes*	*puncticeps*	*puncticeps*	100.0	n/a	Yes
LJB07-20-08-19_KM_1	Megachilidae	*Anthidium*	*manicatum*	*manicatum*	100.0	n/a	Yes

(Continues)

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
LJU02-20-08-26_PM_1	Megachilidae	*Anthidium*	*manicatum*	*manicatum*	100.0	n/a	Yes
LJU06-20-08-26_PM_2	Megachilidae	*Anthidium*	*oblongatum*	*oblongatum*	100.0	n/a	Yes
CJE05-20-08-06_KR_8	Megachilidae	*Chelostoma*	*campanularum*	*campanularum*	99.6	n/a	Yes
LJB04-20-07-08_PM_2	Megachilidae	*Chelostoma*	*campanularum*	*campanularum*	99.6	n/a	Yes
LJU04-20-05-27_KR_4	Megachilidae	*Chelostoma*	*emarginatum*	*emarginatum*	100.0	n/a	Yes
CEK10-20-06-11_KR_3	Megachilidae	*Chelostoma*	*florisomne*	*florisomne*	100.0	n/a	Yes
LJB01-20-05-21_KR_2	Megachilidae	*Chelostoma*	*florisomne*	*florisomne*	100.0	n/a	Yes
CJE05-20-07-20_KR_1	Megachilidae	*Chelostoma*	*foveolatum*	*foveolatum*	99.1	n/a	Yes
LJB01-20-05-21_PM_4	Megachilidae	*Chelostoma*	*rapunculi*	*rapunculi*	99.7	*campanularum*	Yes
LJU10-20-05-27_PM_1	Megachilidae	*Chelostoma*	*rapunculi*	sp.	100.0	*rapunculi, campanularum*	No
CJE01-20-08-19_KB_2	Megachilidae	*Coelioxys*	*alata*	*alata*	100.0	n/a	Yes
CJE01-20-08-19_PM_8	Megachilidae	*Coelioxys*	*alata*	*alata*	100.0	n/a	Yes
CJE04-20-09-15_PM_6	Megachilidae	*Coelioxys*	*alata*	*alata*	99.9	n/a	Yes
LJB03-20-07-08_PM_1	Megachilidae	*Coelioxys*	*aurolimbatus*	*aurolimbatus*	100.0	n/a	Yes
CJE06-20-07-20_PM_32	Megachilidae	*Coelioxys*	*inermis*	*inermis*	100.0	*elongata*	Yes
CEK02-20-06-22_KB_1	Megachilidae	*Heriades*	*truncorum*	*truncorum*	100.0	n/a	Yes
CJE02-20-08-06_KR_1	Megachilidae	*Heriades*	*truncorum*	*truncorum*	100.0	n/a	Yes
GOK06-20-07-13_KR_1	Megachilidae	*Heriades*	*truncorum*	*truncorum*	100.0	n/a	Yes
LJB09-20-06-22_KR_1	Megachilidae	*Heriades*	*truncorum*	*truncorum*	100.0	n/a	Yes
LJU02-20-07-13_KR_8	Megachilidae	*Heriades*	*truncorum*	*truncorum*	100.0	n/a	Yes
CEK03-20-05-20_PM_8	Megachilidae	*Hoplitis*	*adunca*	*adunca*	100.0	n/a	Yes
CEK03-20-05-20_PM_8	Megachilidae	*Hoplitis*	*adunca*	*adunca*	100.0	n/a	Yes
LJB10-20-08-19_PM_1	Megachilidae	*Hoplitis*	*claviventris*	*claviventris*	100.0	*Osmia claviventris*	Yes
CEK06-20-06-11_PM_5	Megachilidae	*Hoplitis*	*leucomelana*	*leucomelana*	100.0	n/a	Yes
CJE01-20-07-08_PM_3	Megachilidae	*Hoplitis*	*leucomelana*	*leucomelana*	100.0	n/a	Yes
LJB07-20-06-02_PM_1	Megachilidae	*Hoplitis*	*leucomelana*	*leucomelana*	100.0	n/a	Yes
CEK05-20-07-22_KR_1	Megachilidae	*Lithurgus*	*chrysurus*	*chrysurus*	99.8	n/a	Yes
GOK03-20-07-27_PM_3	Megachilidae	*Lithurgus*	*chrysurus*	*chrysurus*	99.8	n/a	Yes
LJB10-20-08-19_PM_2	Megachilidae	*Lithurgus*	*chrysurus*	*chrysurus*	99.8	n/a	Yes
CJE07-20-07-08_KR_1	Megachilidae	*Megachile*	*alpicola*	*alpicola*	100.0	*versicolor*	Yes
LJU04-20-06-30_KB_1	Megachilidae	*Megachile*	*apicalis*	*apicalis*	98.0	*argentata*	Yes
CEK06-20-05-20_KR_1	Megachilidae	*Megachile*	*centuncularis*	*centuncularis*	100.0	*ligniseca, pilicrus*	Yes
CJE05-20-06-10_KR_3	Megachilidae	*Megachile*	*centuncularis*	*centuncularis*	100.0	*ligniseca, pilicrus*	Yes
GOK06-20-08-11_PM_4	Megachilidae	*Megachile*	*centuncularis*	sp.	100.0	*centuncularis, ligniseca, pilicrus*	No
LJU04-20-05-27_KB_1	Megachilidae	*Megachile*	*centuncularis*	*centuncularis*	100.0	*ligniseca, pilicrus*	Yes
CEK06-20-06-11_PM_8	Megachilidae	*Megachile*	*circumcincta*	*circumcincta*	100.0	n/a	Yes
CEK03-20-07-04_KR_1	Megachilidae	*Megachile*	*ericetorum*	*ericetorum*	100.0	n/a	Yes
GOK07-20-06-30_KM_2	Megachilidae	*Megachile*	*ericetorum*	*ericetorum*	99.9	n/a	Yes
CEK01-20-09-21_PM_1	Megachilidae	*Megachile*	*ligniseca*	*ligniseca*	99.7	n/a	Yes
CJE06-20-07-08_PM_1	Megachilidae	*Megachile*	*ligniseca*	*ligniseca*	100.0	n/a	Yes
GOK09-20-07-27_PM_18	Megachilidae	*Megachile*	*ligniseca*	*ligniseca*	100.0	n/a	Yes
GOK05-20-06-30_PM_1	Megachilidae	*Megachile*	*melanopyga*	*ericetorum*	100.0	n/a	No
GOK04-20-08-26_PM_5	Megachilidae	*Megachile*	*pilicrus*	*pilicrus*	99.2	n/a	Yes
LJB09-20-05-21_KM_1	Megachilidae	*Megachile*	*versicolor*	sp.	100.0	*centuncularis, ligniseca, versicolor, pyrenaea*	No
CEK03-20-06-11_PM_1	Megachilidae	*Osmia*	*bicolor*	sp.	98.0	*bicolor, inermis*	No
LJB02-20-05-21_PR_1	Megachilidae	*Osmia*	*bicolor*	*bicolor*	99.7	*inermis*	Yes

APPENDIX 2 (Continued)

Specimen code	Morpho ID:Family	Morpho ID:Genus	Morpho ID:Species	BOLD ID:Species best hit	BOLD ID:Best hit ident (%)	BOLD ID:Other close hits (≥95%)	Confirmed species ID?
CEK07-20-05-05_PM_2	Megachilidae	*Osmia*	*bicornis*	*bicornis*	100.0	*pedicornis, ariadne*	Yes
GOK07-20-05-05_PR_1	Megachilidae	*Osmia*	*bicornis*	*bicornis*	100.0	*pedicornis, ariadne, opima, cornifrons, tricornis, cerinthidis, taurus*	Yes
LJB02-20-06-02_PR_1	Megachilidae	*Osmia*	*bicornis*	*bicornis*	100.0	*pedicornis, ariadne, opima, cornifrons, tricornis, cerinthidis, taurus*	Yes
LJU02-20-05-27_PR_1	Megachilidae	*Osmia*	*bicornis*	*bicornis*	100.0	*pedicornis, ariadne, opima, cornifrons, tricornis, cerinthidis, taurus*	Yes
CEK10-20-07-04_PM_1	Megachilidae	*Osmia*	*bidentata*	*bidentata*	100.0	n/a	Yes
CEK02-20-07-22_PM_3	Megachilidae	*Osmia*	*caerulescens*	*caerulescens*	100.0	n/a	Yes
LJU05-20-06-19_KB_2	Megachilidae	*Osmia*	*caerulescens*	*caerulescens*	100.0	n/a	Yes
CJE02-20-06-23_KB_2	Megachilidae	*Osmia*	*leaiana*	*leaiana*	99.9	*nasoproducta*	Yes
LJU07-20-05-27_PM_3	Megachilidae	*Osmia*	*mustelina*	*mustelina*	99.9	*emarginata*	Yes
LJB09-20-06-02_KR_1	Megachilidae	*Osmia*	*niveata*	sp.	100.0	*niveata, brevicornis*	No
LJU02-20-05-27_KR_3	Megachilidae	*Pseudoanthidium*	*nanum*	sp.	100.0	*lituratum, nanum, scapulare, palestinicum*	No
CJE06-20-07-20_KR_3	Megachilidae	*Stelis*	*breviuscula*	sp.	99.9	*odontopyga, breviuscula, phaeoptera*	No
GOK05-20-07-13_KB_3	Megachilidae	*Stelis*	*breviuscula*	sp.	99.9	*odontopyga, breviuscula, phaeoptera*	No
LJU04-20-07-13_KR_3	Megachilidae	*Stelis*	*breviuscula*	sp.	99.7	*odontopyga, breviuscula, phaeoptera, simillima, murina, franconica*	No
CJE02-20-07-08_KM_2	Megachilidae	*Trachusa*	*byssina*	*byssina*	98.6	n/a	Yes
CJE09-20-07-20_PM_6	Melittidae	*Dasypoda*	*hirtipes*	*hirtipes*	99.9	n/a	Yes
GOK08-20-07-13_PM_1	Melittidae	*Dasypoda*	*hirtipes*	*hirtipes*	99.6	n/a	Yes
LJU06-20-07-13_KM_1	Melittidae	*Dasypoda*	*hirtipes*	*hirtipes*	98.5	n/a	Yes
CJE05-20-08-06_KM_4	Melittidae	*Macropis*	*europaea*	*europaea*	100.0	n/a	Yes
CJE05-20-07-20_KM_4	Melittidae	*Melitta*	*haemorrhoidalis*	*haemorrhoidalis*	99.2	n/a	Yes
CEK06-20-07-22_KM_1	Melittidae	*Melitta*	*leporina*	*leporina*	99.4	n/a	Yes
GOK08-20-07-27_PM_1	Melittidae	*Melitta*	*leporina*	*leporina*	99.9	n/a	Yes