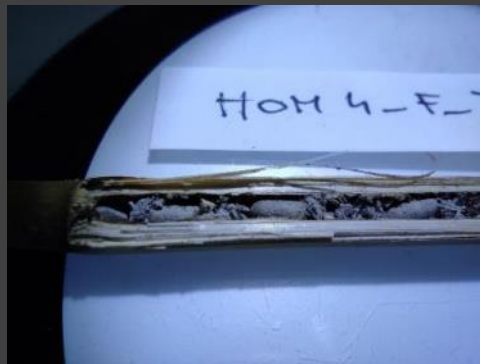


Trap nest identification guide



Supplementary material

This is a supplementary resource attributed to the following publications:

Protocols.io: *A step-by-step protocol and guide for cavity-nesting Hymenoptera sampling and data collection using trap nests*

Journal of Hymenoptera Research: *A standardised protocol for sampling cavity-nesting Hymenoptera using trap nests*

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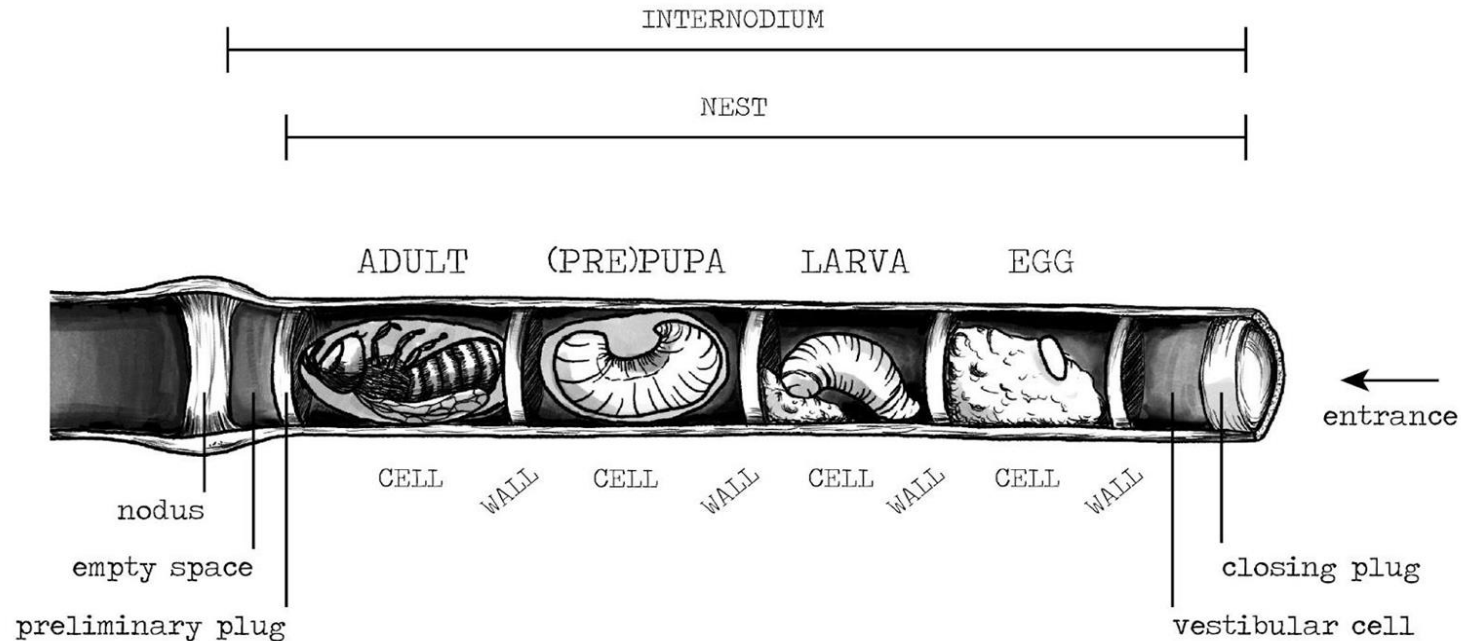
Trap nests

Foundational knowledge

- Trap nests consist of pre-drilled holes or bundles of hollow tubes, typically reed stems.
- These nests attract certain bee and wasp species, that build their nests in such cavities.
- Offspring are placed in brood cells that are separated by walls.

Taxa can differ in traits and other characteristics such as:

- Nest material
- Provisioned food source
- Nest diameter
- Overwintering form (larva or imago)
- Cocoon appearance
- Parasites and natural enemies



Trait table

Summary of nesting, developmental traits, and other characteristics of common trap nest inhabitants

	Family	Genus	Food	Nest material	Cocoon	Overwintering stage	Typical diameter of nest (mm)	Page number
Bees	Colletidae	<i>Hylaeus</i>	pollen	membrane	no	prepupa	2-5(-8)	5
	Megachilidae	<i>Anthidium</i>	pollen	plant hairs (cotton-like)	no	prepupa/ adult (imago)	4-10	8
		<i>Heriades</i>	pollen	resin	no	prepupa/ adult (imago)	3-5(-9)	9
		<i>Megachile</i>	pollen	leaf pieces, mud or resin	brown egg-like	prepupa/ adult (imago)	3-10	10
		<i>Osmia</i>	pollen	mud or leaf masticate	brown egg-like	adult (imago)	3-9	13
Wasps	Crabronidae	<i>Crossocerus</i>	flies (Diptera)	membrane	no	prepupa	6-7	17
		<i>Nitela</i>	barkflies (Psocoptera)	none	two-colored	prepupa	2-6(-8)	18
		<i>Passaloecus</i>	aphids (Aphidoidea)	membrane	no	prepupa	2-5(-8)	19
		<i>Psenulus</i>	aphids (Aphidoidea)	membrane	no	prepupa	2-5(-8)	20
		<i>Solierella</i>	true bugs (Heteroptera)	varied source of materials	mud	prepupa	2-6(-8)	21
		<i>Tracheliodes</i>	ants (Formicidae)	membrane	no	prepupa	7-8	22
		<i>Trypoxylon</i>	spiders (Araneae)	mud	black-capped bright biege	prepupa	2-6(-8)	23
	Pompilidae	<i>Agenioideus</i>	spiders (Araneae)	fluffy plant material	black-capped dark beige	prepupa	4-6 (3-8)	25
		<i>Auplopus</i>	spiders (Araneae)	mud	no	prepupa	4-10	26
		<i>Dipogon</i>	spiders (Araneae)	fluffy plant material	white	prepupa	4-6 (3-9)	27
	Vespiidae	Eumeninae*	caterpillars (Lepidoptera)	mud, membrane, leaf pieces	membranous	prepupa	2-9	29
	*e.g., <i>Alastor</i> , <i>Allodynerus</i> , <i>Ancistrocerus</i> , <i>Antepipona</i> , <i>Discoelius</i> , <i>Eumenes</i> , <i>Euodynerus</i> , <i>Leptochilus</i> , <i>Microdynerus</i> , <i>Parodontodynerus</i> , <i>Stenodynerus</i> and <i>Symmorphus</i>							
		Sphecidae	<i>Isodontia</i>	crickets (Oecanthinae)	grass	membranous	prepupa	7-10

Bees

Colletidae, *Hylaeus*

- *Hylaeus* (yellow-faced or masked bees) species nest in smaller diameter reed stems. Unlike most other solitary bees, they use a transparent, membrane-like secretion to separate brood cells instead of mud or plant material. Small, ribbed white or yellowish-white larvae are placed close together. Their provisioned food source is a viscous, glossy mixture of nectar and pollen. Since species-level identification is only possible once offspring have fully developed, these bees should be recorded at the genus level during processing, when they are usually only present in their larval stage.



Bihaly A.

Most frequently emerged species:

Hylaeus angustatus (Schenck, 1861)

Hylaeus cardioscapus Cockerell, 1924

Hylaeus communis Nylander, 1852

Hylaeus confusus Nylander, 1852

Hylaeus difformis (Eversmann, 1852)

Hylaeus gibbus Saunders, 1850

Hylaeus gracilicornis (Morawitz, 1867)

Hylaeus leptocephalus (Morawitz, 1870)

Hylaeus moricei (Friese, 1898)

Hylaeus punctulatissimus Smith, 1842

Hylaeus signatus (Panzer, 1798)

Hylaeus styriacus Förster, 1871

Hylaeus variegatus (Fabricius, 1798)



Bihaly A.

Hylaeus spp.



Photo : (C) Josef Dvorak www.holtholz.com/holtholz/ for BWVANS - Hylaeus communis, <https://bees.com/bee/collections/hylaeus-communis>



Bihaly Á.



Somay L.



Bihaly Á.

Megachilidae

- *Anthidium* (wool carder bees).....8
- *Heriades* (resin bees).....9
- *Megachile* (leafcutter bees)10
 - M. centuncularis*
 - M. ericetorum*
 - M. rotundata*
 - M. sculpturalis*
- *Osmia* (mason bees).....13
 - O. caerulescens*
 - O. rufa*

Anthidium s. l. spp.

- *Anthidium* (carder bees, wool carder bees or potter bees) species collect plant hairs (trichome) to build their brood cells. This gives the brood cells the appearance of being stuffed with cotton. These bees prefer medium to larger diameter reed stems for nesting. Since species-level identification is only possible once offspring have fully developed, these bees should be recorded at the genus level during processing, when they are usually only present in their larval stage.

Most frequently emerged species:

Anthidium florentinum (Fabricius, 1775)

Anthidium manicatum (Linnaeus, 1758)

Anthidium nanum Mocsáry, 1880

Anthidium septemspinosum Lepeletier, 1841



Photo : (C) Josef Dvorak www.biolib.cz for BWA&S - Anthidium manicatum



Heriades spp.

- *Heriades* (resin bees) species have cylindrical bodies and build their nests in small to medium-sized reed stems. The partition walls of the brood cells are typically made from resin, which helps distinguish their nests from other genera. These bees are small in size and relatively rare. Since species-level identification is only possible once offspring have fully developed, these bees should be recorded at the genus level during processing, when they are usually only present in their larval stage.



<https://portal.nature.cz/v/dnh/-/110809/>

Most frequently emerged species:

Heriades crenulata Nylander, 1856

Heriades rubicola Pérez, 1890

Heriades truncorum (Linnaeus, 1758)



Szabó K.

Megachile spp.

- A defining feature of this genus is the use of cut leaf pieces to construct brood cells, except for a few notable species, for example, *M. ericetorum* fills the entire reed cavity with mud, making the individual brood cells indistinguishable. In contrast, *M. sculpturalis* constructs its nests using resin and plant debris instead of leaves. Typically, the offspring are present in the larval stage during processing. *Megachile* (leafcutter bees) species can only be identified at the genus level during processing, except for the unique species mentioned above.



- Most frequently emerged species:

Megachile apicalis Spinola, 1808

Megachile centuncularis (Linnaeus, 1758)

*Megachile deceptor*a Pérez, 1890

Megachile ericetorum Lepeletier, 1841

Megachile leachella Curtis, 1828

Megachile ligniseca (Kirby, 1802)

Megachile maritima (Kirby, 1802)

Megachile pilidens Alfken, 1924

Megachile rotundata (Fabricius, 1787)

Megachile sculpturalis Smith, 1853

Megachile versicolor Smith, 1844

Megachile willughbiella (Kirby, 1802)



Megachile centuncularis

Megachile rotundata

- leaf walls, medium or large diameter nests



Megachile ericetorum

- mud nest and wall, medium or large diameter nests



Bihaly Á.



Bihaly Á.



Somay L.

Megachile sculpturalis

- resin and/or detritus walls, medium or large diameter nests, larvae in the cocoons



Sex dimorphism of *Megachile sculpturalis*: c As a protandric species, male larvae are positioned at the front in the nests and emerge earlier than females

Ruzzier E, Menchetti M, Borrolotti L, Seta M, Montemselhi E, Perkecion L (2020) Updated distribution of the invasive *Megachile sculpturalis* (Hymenoptera: Megachilidae) in Italy and its first record on a Mediterranean island. Biodiversity Data Journal 8: e57783. <https://doi.org/10.3897/BDJ.8.e57783>

Bihaly Á.

<https://media.springernature.com/full/springer-static/image/art%40%2862%2026-01729-x/Media040ipipb>

Osmia spp.

- The most commonly encountered species in the *Osmia* (mason bees) genus are *Osmia caerulescens* and *Osmia bicornis*. *O. caerulescens* construct their nests from chewed up and agglutinated plant material, while *O. bicornis* uses mud. *Osmia* species are active in early spring, so mature imagos are typically found in brood cells during processing. The imagos develop inside brown, matte, or slightly shiny cocoons.



Photo : Louise Hislop - *Osmia bicornis* pair showing size difference between male and female. Wylam, Northumberland, 24.5.09
<https://www.sciencephoto.com/library/Osmia-bicornis>

Most frequently emerged species:

Osmia aurulenta (Panzer, 1799)

Osmia bicornis (Linnaeus, 1758)

Osmia brevicornis (Fabricius, 1798)

Osmia caerulescens (Linnaeus, 1758)

Osmia cornuta (Latreille, 1805)

Osmia gallarum Spinola, 1808

Osmia leaiana (Kirby, 1802)

Osmia niveata (Fabricius, 1804)



Osmia bicornis (syn. *O. rufa*)

- mud walls, medium or large diameter nests, brown cocoon



Bihaly Á.



Bihaly Á.



Osmia caerulescens

- chopped plant walls, medium diameter

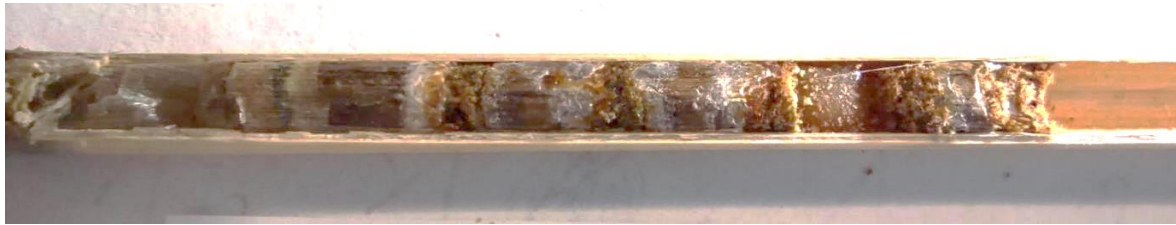


Photo : (C) Josef Dvorak www.biollo.cz for BWARS - *Osmia caerulescens*

<https://bears.com/bee/negachilidae/osmia-caerulescens>



Bihaly Á.



Wasps

Crabronidae

- *Crossocerus*.....17
- *Nitela*.....18
 - *Nitela spinolae*
- *Passaloecus*.....19
 - *Passaloecus gracilis*
- *Psenulus*.....20
 - *Psenulus pallipes*
- *Solierella*.....21
 - *S. compedita*
- *Tracheliodes*.....22
 - *Tracheliodes curvitaris*
- *Trypoxylon*.....23
 - *T. figulus*
 - *T. scutatum*
 - *T. attenuatum*

Crossocerus spp.

- *Crossocerus* wasps species do not construct complex nests, and their cell walls are membranous. Their prey consist of small flies from various families, including Ceratopogonidae, Mycetophilidae, Empididae, Pipunculidae, Dolichopodidae, Chloropidae, and Phoridae (Lomholdt, 1984). Species-level identification is only possible after the offspring have developed and requires expert analysis.



Ross Piper

Nitela spp.

- *Nitela* species construct small, egg-shaped, two-toned cocoons. Their prey consist of Psocoptera. These wasps are relatively rarely found in trap nests. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Photo: (C) Josef Dvorak www.biolib.cz for BWARS - Nitela borealis female

<https://bwars.com/wasp/carbonate/larvae/nitela-borealis>

Most frequently emerged species:

Nitela spinolae Latreille, 1809



Kabai M.

Passaloecus spp.

- *Passaloecus* (aphid-hunting wasps) nest in small-diameter reed stems and do not produce cocoons. Their larvae are yellow or orange and develop inside the nest, feeding on aphids provided by the adult wasps. These wasps are relatively rare. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Photo: i. (C) Josef Dvorak www.biolib.cz for BWARS - Passaloecus gracilis female



Kabai M.

Kabai M.

Most frequently emerged species:

Passaloecus borealis Dahlbom, 1844

Passaloecus corniger Shuckard, 1837

Passaloecus gracilis (Curtis, 1834)

Passaloecus insignis (Vander Linden, 1829)

Passaloecus singularis Dahlbom, 1844



Psenulus spp.

- *Psenulus* (aphid-hunting wasps) wasps feed their offspring aphids. The brood cell walls form a translucent membrane. Their larvae are yellow and do not produce cocoons. These wasps prefer small-diameter reed stems. Species-level identification is only possible after the offspring have developed and requires expert analysis.



<https://bwar5.com/wasp/crutch/index/pemphredoninae/psenulus-pallipes>

Most frequently emerged species:

Psenulus pallipes (Panzer, 1798)



Somay L.

Solierella spp.

- *Solierella* wasps do not build typical brood cells; instead, they accumulate various materials inside their nests. Among these materials, small solitary cocoons made of mud can be found, in which their offspring develop. They provision their larvae with true bugs, and other arthropods. Species-level identification is only possible after the offspring have developed and requires expert analysis.



<https://portal.nature.com/india/1.1424/>

Most frequently emerged species:

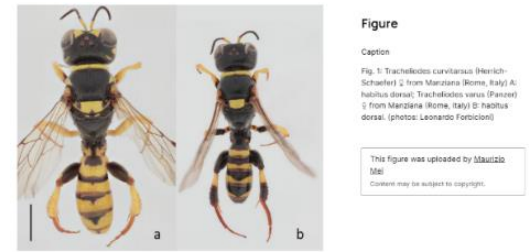
Solierella compedita (Piccioli, 1869)



Kabai M.

Tracheliodes spp.

- *Tracheliodes* wasps build nests with thin membranous walls separating the brood cells and sealing the entrance. The brood cells are filled with ants, which serve as the food source for their larvae. An unusually high number of ant prey have been observed in samples. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Figure

Caption

Fig. 1: *Tracheliodes curvitaris* (Herrich-Schaeffer) ♀ from Marziana (Borneo, Italy) A; *Tracheliodes varus* (Panzer) ♀ from Marziana (Borneo, Italy) B; habitus dorsal. (photos: Leonardo Forbicioni)

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Figure

Caption

Fig. 2: *Tracheliodes curvitaris* (Herrich-Schaeffer) ♀ from Marziana (Borneo, Italy), a: head and mesosoma lateral view; b: head and mesosoma lateral view; *Tracheliodes varus* (Panzer) ♀ from Marziana (Borneo, Italy), c: head frontal view; d: head and mesosoma lateral view. (photos by Leonardo Forbicioni)

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Most frequently emerged species:

Tracheliodes curvitaris (Herrich-Schaeffer, 1841)



Trypoxylon spp.

- The *Trypoxylon* (spider-hunting wasps) are one of the most common wasp genera found in trap nests. They nest in medium and small-diameter reed stems. Their beige, matte, elongated cocoons have a black "cap" at one end. These wasps hunt spiders and provision them as food for their offspring. The brood cell walls in their nests are made of mud. Species-level identification is only possible after the offspring have developed and requires expert analysis.



<https://bionus.com/wasp/crskondite/larvae/trypoxylon-figulus>

Most frequently emerged species:

Trypoxylon clavicerum Lepeletier de Saint Fargeau & Audinet-Serville, 1828

Trypoxylon attenuatum Smith, 1851

Trypoxylon figulus (Linnaeus, 1758)

Trypoxylon scutatum Chevrier, 1867



Bihaly Á.

Pompilidae

- *Agenioideus*.....25
 - Agenioideus cinctellus*
 - Agenioideus sericeus*
- *Auplopus*.....26
 - Auplopus carbonarius*
- *Dipogon*.....27
 - Dipogon bifasciatus*

Agenioideus spp.

- *Agenioideus* species construct hard, matte, drab or dark brown cocoons, with one end capped by a black cover. They build nests in medium-sized reed stems. Their nesting material resembles that of *Dipogon* species but is often looser and more similar to wood shavings. Their prey consist of spiders, and they are relatively common inhabitant of trap nests. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Most frequently emerged species:

Agenioideus cinctellus (Spinola, 1808)

Agenioideus sericeus (Vander Linden, 1827)



Auplopus spp.

- *Auplopus* (mud-nesting wasps) species create independent, wavy-surfaced brood cells made of mud. They provision the nests with spiders that serve as food for their offspring. Offspring are present in their larval form during processing. These brood cells can be constructed anywhere in a dry and secure location, meaning that cavities are not their exclusive nesting sites. These wasps are relatively rare. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Most frequently emerged species:

Auplopus carbonarius (Scopoli, 1763)

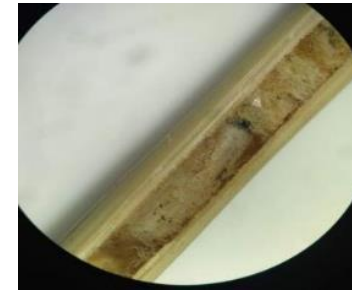


Dipogon spp.

- *Dipogon* (spider-hunting wasps) species collect spiders to feed their offspring. They construct loose cell walls from plant hairs, giving them a whitish, cotton-like appearance. The larvae are found inside white, silk-like cocoons. These wasps use small to medium-diameter reed stems and are relatively common in trap nests. Species-level identification is only possible after the offspring have developed and requires expert analysis.



Photo: (C) Josef Dvorak - www.biolib.cz for BWARS - Dipogon bifasciatus female



<https://bwars.com/wasp/pepiniade/pepiniade/dipogon-bifasciatus>

Bihaly Á.

Török E.

Bihaly Á.

27

Most frequently emerged species:

Dipogon bifasciatus (Geoffroy, 1785)



Eumeninae (Vespidae)

potter wasps or eumenid wasps

- Eumeninae.....29
 - Ancistrocerus*
 - Allodynerus*
 - Alastor*
 - Eumenes*
 - Euodynerus*
 - Microdynerus*
 - Stenodynerus*
 - Symmorphus*
 - Discoelius*.....31

Eumeninae spp.

- Eumeninae is a subfamily within the family Vespidae. They are a diverse group of solitary potter wasps, many of which exhibit similar nesting and provisioning behaviors. The eumenid wasps can only be identified at the species level by experts, therefore we recommend only recording them as Eumeninae during processing. They always build nests in medium-sized reed stems using mud to separate cells and to close the nests which contain yellow or white larvae. Their prey consist of small caterpillars and Chrysomelidae larvae.

Most frequently emerged species:

- Alastor mocsaryi* (André, 1884)
- Allodynerus delphinalis* Gir., 1866
- Allodynerus rossii* (Lepeletier, 1841)
- Discoelius zonalis* (Panzer, 1801)
- Euodynerus notatus* (Jurine, 1807)
- Euodynerus posticus* (Herrich-Schäffer, 1841)
- Euodynerus quadrifasciatus* (Fabricius, 1793)
- Leptochilus regulus* (de Saussure, 1856)
- Microdynerus timidus* (de Saussure, 1856)
- Rhynchalastor steckianus* (Schulthess, 1897)
- Stenodynerus chevrieranus* (de Saussure, 1856)
- Stenodynerus steckianus* (Schulthess, 1897)
- Symmorphus bifasciatus* (Linnaeus, 1761)
- Symmorphus crassicornis* (Panzer, 1796)
- Symmorphus murarius* (Linnaeus, 1758)



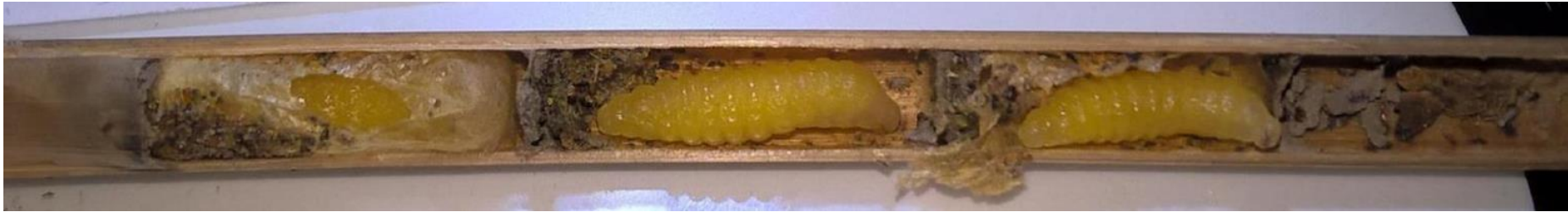
Eumeninae spp.



Ancistrocerus gazella (Panzer, 1798) (Kabai M.)



Eumenes lunulatus Fabricius (Bihaly Á.)



Symmorphus gracilis (Brulle, 1832) (Somay L.)



Microdynerus nugdunensis (de Saussure, 1856) (Somay L.)

Discoelius spp.

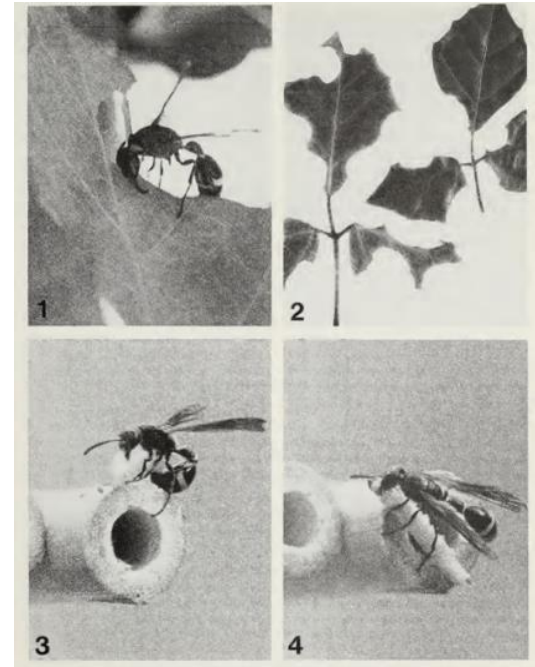
- *Discoelius* species prey on caterpillars. Most species construct nests from mud, but *Discoelius zonalis* lines the brood cells with leaves. These wasps build their nests in small to medium-sized reed stems or other suitable cavities. Species-level identification is only possible after the offspring have developed and requires expert analysis.

Most frequently emerged species:

Discoelius zonalis (Panzer, 1801)



Kabai M.



Veenedaal, R.L. and Piek, T., 1988. Predatory behaviour of *Discoelius zonalis* (Hymenoptera: Eumenidae). *Entomologische Berichten*, 48(1), pp.8-12.

Sphecidae

- Isodontia (grass-carrying wasps)

Isodontia species build nests in medium to large-diameter reed stems and use grass as their nesting material. The most notable species, *Isodontia mexicana*, the Mexican grass-carrying wasp, is a species belonging to the family Sphecidae. These wasps are large in size and prefer large reed stems for nesting. Their prey consist of crickets, particularly tree crickets (Oecanthinae). The large larvae with bent heads can be found inside translucent cocoons.



Isodontia mexicana (de Saussure, 1867)

Natural enemies

- Cleptoparasitic bees (cuckoo bees).....34
 - Megachilidae: *Coelioxys* spp., *Stelis* spp., *Hoplitis* spp.,
Lithurgus spp.
- Parasitoid wasps.....35
 - Cuckoo wasps (Chrysididae)
 - Sapyga quinquepunctata* (Sapygidae)
 - Monodontomerus* (Chalcidoidea)
 - Melittobia acasta* (Eulophidae)
 - Inchneumonidae (Terebrantes)
 - Gasteruptiidae (Gasteruptiidae)
- Dipteran parazitoids and kleptoparasites.....42
 - Tachinidae
 - Cacoxenus indagator*
- Nest parasitoid Coleopteran.....44
 - Trichodes apiarius* (Cleridae)
 - Megatoma undata* (Dermestidae)

Kleptoparasitic bees (cuckoo bees)

Megachilidae: *Coelioxys* spp., *Stelis* spp., *Hoplitis* spp., *Lithurgus* spp.

Cuckoo bees are kleptoparasitic members of the family Megachilidae that exclusively exploit the nests of other solitary bees. Unlike their host relatives, these bees do not collect pollen or build nests of their own. Instead, females infiltrate the brood cells of host bees typically during the provisioning or early sealing stage and lay their eggs beside or in place of the host's egg.

Genera such as *Coelioxys*, *Stelis*, *Hoplitis*, and *Lithurgus* are frequently encountered in trap nest studies. These cuckoo bees are found only in bee nests, never in wasp nests, and tend to parasitize closely related host species. For example, *Coelioxys* commonly targets *Megachile* species, while *Stelis* often parasitizes *Osmia* and *Heriades*.

The parasitic larvae typically hatch earlier than the host larva and either kill it directly or consume the provisioned food before the host can develop. As a result, only one offspring usually the cuckoo bee emerges from the parasitized cell.

During nest processing, cuckoo bee larvae or pupae can sometimes be identified based on their morphology, although definitive identification usually requires adult emergence. These species do not construct their own brood cells, and no distinct parasitic cocoon is produced in many cases, making their presence more difficult to detect without close inspection.

Coelioxys aurolimbatus Förster, 1853

Coelioxys echinatus Förster, 1853

Coelioxys inermis (Kirby, 1802)

Stelis breviscula (Nylander, 1848)

Stelis punctulatissima (Kirby, 1802)

Stelis signata (Latreille, 1809)



Hoplitis adunca (Panzer, 1798)



Chrysididae (cuckoo wasps)

Members of the family Chrysididae, commonly known as cuckoo wasps, are kleptoparasites or parasitoids that exploit the nests of solitary bees and wasps. These brightly colored, often metallic green or blue insects are known for their ability to infiltrate host nests and lay their eggs alongside or in place of the host's brood.

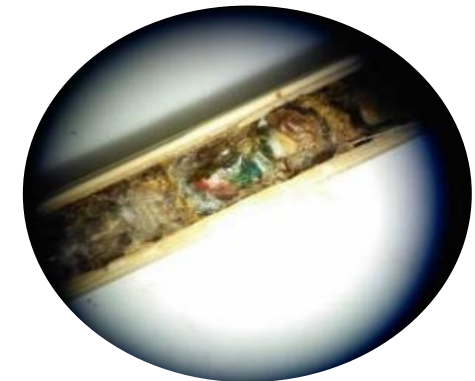
Chrysidid wasps are found in both bee and wasp nests, and their larvae either consume the host egg or larva directly, or outcompete it by feeding on the stored provisions. In some cases, they behave as true parasitoids, killing the host outright; in others, they function more as cleptoparasites.

During trap nest processing, the presence of chrysidid larvae or pupae is often indicated by their characteristic bell-shaped, membranous cocoons, which are thin, translucent, and sometimes lightly attached to the inner walls of the brood cell. These cocoons are distinctive and serve as a reliable indicator of chrysidid parasitism even when the adult wasps are not present.

Due to their cryptic lifestyle and the timing of their emergence, chrysidid species are often under-recorded in monitoring studies. However, their presence reflects important aspects of nest vulnerability and community-level parasitic interactions, especially in diverse solitary bee and wasp assemblages.



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Török E.

Kabai M.

Chrysididae (cuckoo wasps)

- Chrysidea disclusa* (Linsenmaier, 1959)
- Chrysis equestris* Dahlbom, 1854
- Chrysis fasciata* Olivier, 1790
- Chrysis fulgida* Linnaeus, 1761
- Chrysis gracillima* (Förster, 1853)
- Chrysis ignita* Linnaeus, 1761
- Chrysis indigotea* Dufour & Perris, 1840
- Chrysis interjecta* Du Buysson, 1895
- Chrysis iris* Christ, 1791
- Chrysis rutilans* Olivier, 1790
- Chrysis splendidula* Rossi, 1790
- Chrysura austriaca* (Fabricius, 1804)
- Chrysura dichroa* (Dahlbom, 1854)
- Hedychridium monochroum* Du Buysson, 1888
- Omalus biaccinctus* (Du Buysson, 1892)
- Omalus aeneus* (Fabricius, 1787)
- Pseudomalus auratus* (Linnaeus, 1758)
- Pseudomalus bogdanovi* (Radoszkowski, 1877)
- Pseudomalus pusillus* (Fabricius, 1804)
- Trichrysis cyanea* (Linnaeus, 1758)

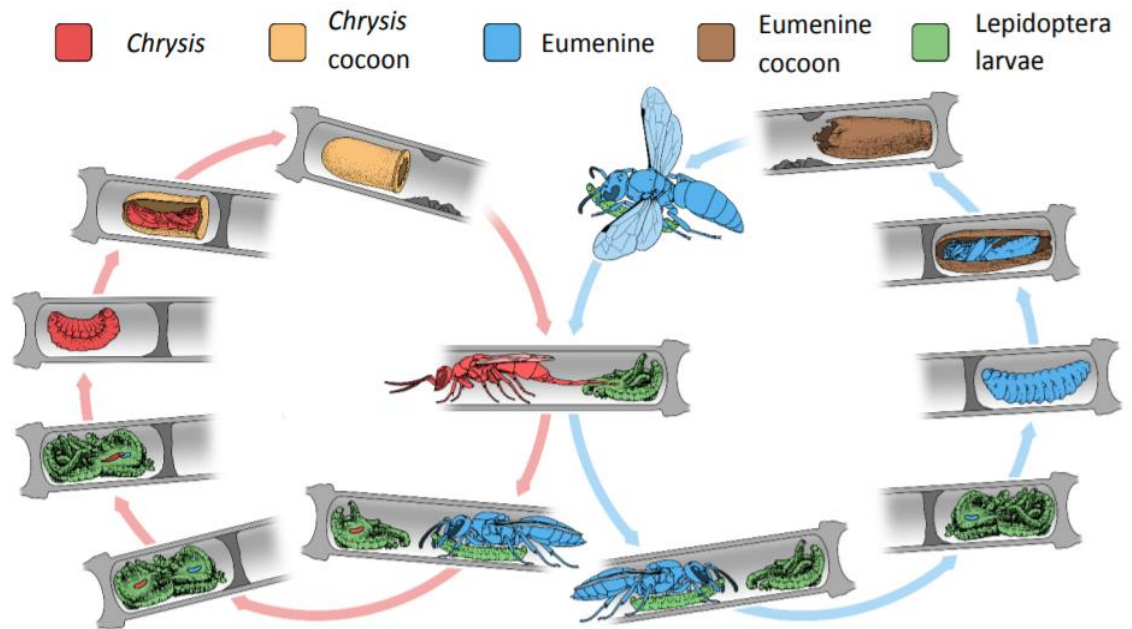
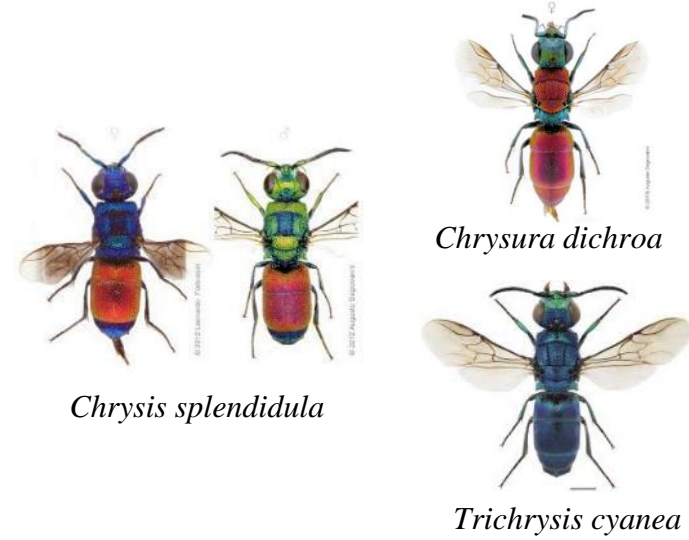


Figure 1. Life cycles of a kleptoparasitic cuckoo wasp of the genus *Chrysis* Linnaeus, 1761 and its potter wasp host (Vespidae: Eumeninae). Illustration by Alexander Berg.

Sapygidae:

Sapyga quinquepunctata (Fabricius, 1781)

Sapyga quinquepunctata is a kleptoparasitic wasp species belonging to the family Sapygidae. It primarily targets solitary bees, especially species of *Heriades* and *Osmia*, by laying its eggs into the host's brood cells during or shortly after nest construction.

The adult female can be recognized by its elongated black body and distinct white spots on the abdomen, which serve as a useful visual identification marker. Once the egg is laid, the developing *Sapyga* larva either consumes the bee egg or outcompetes the bee larva for the provided pollen-nectar provisions.

At the time of trap nest processing, *Sapyga* larvae or pupae may be found within the brood cells, typically enclosed in dark brown, shiny cocoons. These cocoons are slightly larger than those of most solitary bees and are often loosely fitted within the reed stem or cavity.

Sapyga quinquepunctata (Fabricius, 1781)
Sapygina decemguttata (Jurine, 1807)



Sapyga quinquepunctata



Calcidoidea:

Monodontomerus spp.



Figure 30. Adult female chalcid wasp, *Monodontomerus*, ovipositing in blue orchard bee cocoon. Note long ovipositor sheath at tip of the abdomen.



Figure 31. Infested blue orchard bee cocoon opened to show *Monodontomerus* larvae.

Species of the genus *Monodontomerus* are small chalcid wasps belonging to the superfamily Calcidoidea. They are common and effective parasitoids of solitary bees, particularly *Osmia* species. Frequently encountered species in trap nests include *Monodontomerus obscurus* Westwood, 1833 and *M. montivagus*, both known for their parasitic impact on cavity-nesting bee populations.

Females use their short but robust ovipositor to pierce the bee cocoon and lay approximately 10 eggs directly onto the bee prepupa or pupa. The developing *Monodontomerus* larvae (3–5 mm in length) consume most or all of the host tissue, resulting in the death of the developing bee. Several larvae often develop within a single host, a strategy known as gregarious parasitism.

During nest processing, their presence is typically indicated by multiple small larvae or pupae clustered around a decomposing or partially consumed bee pupa. In some cases, adult chalcid wasps may also be present, often emerging in large numbers from a single brood cell.

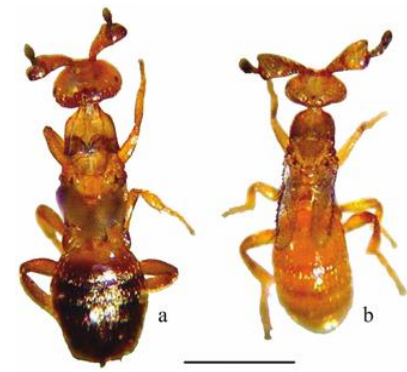
Calcidoidea, Eulophidae:

Melittobia acasta (Walker, 1839)

Melittobia species are minute eulophid wasps and a highly gregarious parasitoid known to infest a wide range of solitary bee and wasp species. It is one of the few parasitoids commonly found in both bee and wasp nests, indicating a broad host range and opportunistic parasitic strategy.

Females typically locate sealed brood cells and use their ovipositor to lay multiple eggs either on or near the host larva or prepupa. The developing *Melittobia* larvae feed externally, often in large groups, gradually consuming the host. As many as 20–50 individuals may develop within a single brood cell, depending on the size of the host.

During nest dissection, parasitised brood cells often contain clusters of tiny, pale larvae or numerous small, dark-coloured adult wasps. In many cases, the original host is almost entirely decomposed or no longer recognizable by the time *Melittobia* adults emerge.



male *Melittobia acasta* (right)
male *Melittobia australica* (left)



Ichneumonidae

Members of the family Ichneumonidae are highly diverse parasitoid wasps, many of which target the larvae or pupae of other insects. In trap nest studies, ichneumonid larvae are most frequently found in association with wasp nests.

These parasitoids typically lay their eggs into or onto the host larva within a sealed brood cell. The ichneumonid larva then develops by feeding on the host, eventually killing it. After completing development, the larva spins a thin, membranous cocoon within the brood cell a distinguishing feature often visible during nest dissection. These cocoons are delicate and translucent, sometimes loosely attached to the cell walls or lying free within the cell.

Due to the wide host range and cryptic behavior of many ichneumonid species, identification is usually limited to family level unless the offspring have fully developed. Their presence in trap nests is ecologically important, as it reflects parasitic pressure on solitary wasp populations and adds another trophic layer to the nest community structure.



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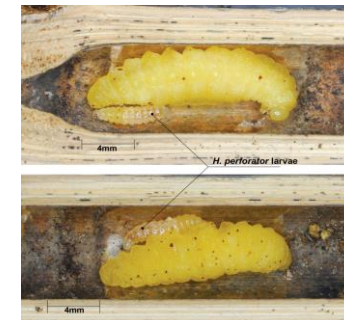
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Ichneumonidae, cocoon

Reid's Bluff Prairie, Houston County, Minnesota, USA

Size: 11 mm

December 29, 2013 peeled off the outside layers of the cocoon
(This is a case where I don't know if I should fill in the date or not.)



Brodd, G., & Barthelmy, C. 2012. JHR doi: 10.3897/jhr.24.1888

Gasteruptiidae

Members of the family Gasteruptiidae are specialised parasitoids that target the nests of solitary bees and wasps. The larvae develop within the brood cells of their hosts, typically consuming both the bee larva and its food provisions. They are most commonly associated with bee nests, such as those of *Heriades rubicola*, but have also been recorded in nests of mud-nesting wasps (*Pison* sp.) and species of *Hylaeus*.

Adult females are characterized by their elongated, slender bodies and a distinctive, needle-like ovipositor, which they use to lay eggs directly into the sealed brood cells of their hosts. Males and females may emerge from nests of varying structure and complexity, suggesting flexibility in host use.

The larvae are slim and elongate in shape, with fine dorsal hairs, which distinguish them from the more robust larvae of bees or kleptoparasitic flies. Gasteruptiid larvae are usually not numerous in a single nest, but even a single individual can result in the complete loss of the host offspring in the effected nest.

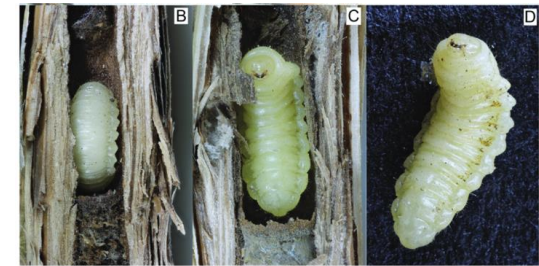


Figure 3. Nests with larvae of *Gasteruptia*. **A** Larva of *Gasteruptia nigrescens* in nest of *Heriades rubicola* (Hungary, Szeged, 2017) **B** Larva of *Gasteruptia nigrescens* in nest of *Heplitis leucomelana* (Czech Republic, Novozámecký fish pond, 2018) **C** Larva of *Gasteruptia phnigmatizola* in nest of *Hylaeus pectoralis* (Czech Republic, Novozámecký fish pond, 2018) **D** larva of *Gasteruptia phnigmatizola* extracted from nest of *Hylaeus pectoralis* (Czech Republic, Dubno, 2015).

Tachinidae

Larvae of the Tachinidae family are typically endoparasitoids of other insects, most often targeting caterpillars, beetle larvae, or other endopterygote hosts. However, some tachinid species have also been found developing in the brood cells of solitary bees or wasps, including *Anthidium* species, indicating a broader host range than traditionally assumed.

Tachinid larvae observed in trap nests may enter bee nests opportunistically or may be the result of direct parasitism, either of the bee larvae or of other nest-associated insects. Their phenology within bee nests is not fully understood, but they are considered true parasitoids, and their presence typically leads to the death of the host larva. During nest processing, they may appear as pale whitish or yellowish larvae, but in many cases they are already pupated, enclosed in small, brown, oval-shaped puparia resembling tiny eggs.

These puparia are often scattered within the brood cell or grouped together, sometimes with no remaining traces of the original host. Identification to family level is recommended unless the flies have fully developed.



Drosophilidae:

Cacoxenus indagator Loew, 1858

Cacoxenus indagator is a kleptoparasitic fly species commonly found in the nests of solitary bees, particularly those of the genus *Osmia*. Unlike true parasitoids or predators, *C. indagator* does not necessarily kill the developing bee larva. Instead, it lays its eggs in the brood cells, where its larvae compete with the bee offspring for the provisioned pollen and nectar.

As a result of this resource competition, it is possible for both the host bee and the kleptoparasitic fly larvae to develop successfully within the same cell, although the presence of *C. indagator* can reduce the fitness and size of the host.

During nest processing, numerous fly larvae can often be observed within affected cells, along with their characteristic spaghetti-like droppings, which serve as a useful visual indicator of infestation.

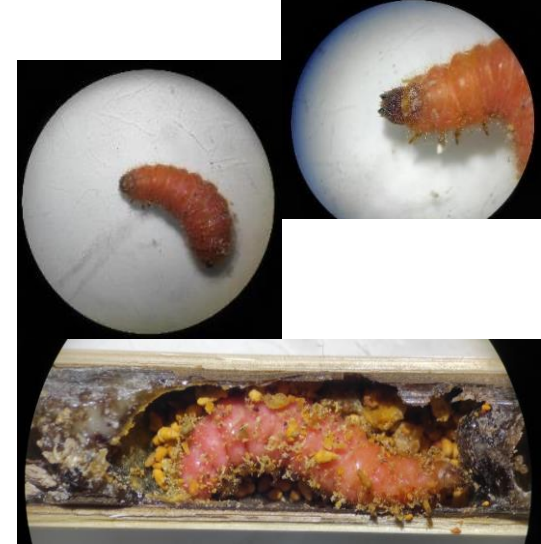


Cleridae:

Trichodes apiarius (Linnaeus, 1758)

Trichodes apiarius is a visually distinctive beetle species whose larvae are primarily associated with bee nests, although they may occasionally be found in wasp nests as well. The species is considered a kleptoparasite and predator, as its larvae feed on the developing brood of solitary bees. During nest processing, *T. apiarius* is often encountered in its larval stage, which is pinkish in colour.

The larvae are highly destructive and can consume multiple brood cells within a single nest, frequently leading to the complete loss of the nest's offspring.



Dermestidae

Dermestid beetles do not show specific nesting preferences and can be found in both bee and wasp nests. They are usually present in their larval stage during nest processing. These larvae primarily feed on organic waste materials within the nests, such as leftover pollen, dead insects, or decaying brood remains. They are scavengers rather than true nest parasites and do not directly cause the death of the developing bee or wasp offspring. Larvae are easily recognized by their elongated bodies covered in long, bristle-like hairs.

Most common species:

Megatoma undata (Linnaeus, 1758) (museum beetle)



Non-nesting species found in trap nest

- Chalcid Wasps = Chalcidoidea family (Hymenoptera, Chalcis, Terebrantes)
- Ants = Formicidae (Hymenoptera)
- Ladybugs = Coccinellidae (Coleoptera)
- Red bugs = Pyrrhocoridae (Heteroptera)



Pyrrhocoris apterus (wikipedia.org)



Chalcis biguttata (wikipedia.org)

Individuals belonging to these groups use reed stems as shelters or overwintering sites. They do not build nests inside, so they are not recorded nor classified into either of the two nesting groups ("bee" or "wasp"), even if they are bees or wasps. Instead, they are labeled as "other", and the "family" and "genus" columns are filled in as detailed as possible.

Notes

- The sources and authors of the images included in the guide are mentioned individually for each image. If no source is indicated, the image originates from a free-to-use online source.
- The list of Hymenoptera species provided in this guide is not exhaustive for cavity-nesting species in East-Central Europe; it includes only those collected between 2019 and 2025 in the Carpathian Basin.

This supplementary resource belongs to the following publications:

Protocols.io: A step-by-step protocol and guide for cavity-nesting Hymenoptera sampling and data collection using trap nests

Journal of Hymenoptera Research: A standardised protocol for sampling cavity-nesting Hymenoptera using trap nests

Reference: Józán, Zs. 2011: Checklist of Hungarian Sphecidae and Apidae species (Hymenoptera, Sphecidae and Apidae). – *Natura Somogyiensis* 19: 177-200.

<https://doi.org/10.24394/NatSom.2011.19.177>