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(Hymenoptera: Pompilidae: Pepsinae: Pepsini)

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Analysis of potential host spider(s) of *Pepsis elegans* Lepeletier (Hymenoptera: Pompilidae: Pepsinae: Pepsini)

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Abstract. Five families of spiders (Araneae: Araneomorphae, Mygalomorphae) are reviewed and analyzed as potential hosts of *Pepsis elegans* Lepeletier (Hymenoptera: Pompilidae: Pepsinae: Pepsini). Lycosidae and Atypidae were the least likely host families, after analysis, with Euctenizidae, Antrodiaetidae, and Halonoproctidae as more likely host families. Species of *Ummidia* Thorell (Halonoproctidae) and *Eucteniza relata* (O. P.-Cambridge) (Euctenizidae) were the most likely host genera and species of *P. elegans* based on mygalomorph relationship, equivalent size, and morphological, geographical, ecological, and biological attributes. Smaller sized genera and species of Euctenizidae and *Antrodiaetus* Ausserer (Antrodiaetidae) were less likely host possibilities.

Key words. Lycosidae, Atypidae, Euctenizidae, Antrodiaetidae, Halonoproctidae.

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Introduction

Pepsis elegans Lepeletier (Hymenoptera: Pompilidae: Pepsinae: Pepsini) is the only “tarantula hawk-wasp” from east of the Mississippi River where tarantulas (Araneae: Mygalomorphae: Theraphosidae: *Aphonopelma* Pocock) are absent except in East Baton Rouge Parish, LA (Fig. 1). Since tarantulas are unavailable for capture in that region, what are other possible host spiders of *P. elegans*? Despite 963 specimen and online photograph records of *P. elegans*, only 60 (6.2%) indicated females searching on the ground. The host spider and nesting behavior of *P. elegans* remain unknown. This implies the host spider, its burrow and trapdoor are cryptic and secluded. Females of *P. elegans* average ~25 mm in body length. Potential host spiders in this size range in the eastern U. S. include burrowing wolf spiders (Lycosidae), purse-web spiders (Atypidae), and trapdoor spiders (Antrodiaetidae, Euctenizidae, Halonoproctidae). Size equivalence between spider wasp and host spider is important in successful spider capture (Kurczewski and Kiernan 2015). *Pepsis elegans* females often have dried mud on the forewings and body indicating they have been underground in moist fine-grained soil, as in a burrow. They are active at night like other *Pepsis* Fabricius species (Williams 1956; Cazier and Mortenson 1964). Criteria for successful spider wasp-host spider association include Mygalomorphae relationship, geographic sympatry, habitat coexistence, seasonal synchrony, and equivalent abundance (Kurczewski 2023). Spider burrow and trapdoor structure and dimensions are important.

Materials and Methods

This paper is based predominantly on a thorough review of the literature of the genus *Pepsis* and the infraorder Mygalomorphae during 2022–2026. Much of the information presented is factual or likely factual. Important papers from the literature search are by Atkinson (1886), Williams (1928, 1956), Jenks (1938), Cazier and Mortenson (1964), Coyle (1971, 1981), Gertsch and Platnick (1980), Gillaspay (1990), Bond and Coyle (1995), Bond and Opell (2002), Bond and Platnick (2007), Bond and Godwin (2013), Hardy (2018), Stevenson and Godwin (2020), Godwin and Bond (2021), Layton (2021), Kurczewski et al. (2021, 2024), Kurczewski and West (2022), and Kurczewski (2023, 2025). Measurements for taxa provided in the Results section represent total body length (in mm).



Figure 1. *Pepsis elegans* Lepeletier, female. Photograph © Thomas Shahan.

Results

Lycosidae. Females of several species of Lycosidae (wolf spiders) are geographically sympatric, open burrow-dwelling, nocturnally active, and large enough to be considered potential host species of *P. elegans*—*Hogna carolinensis* (Walckenaer) (22–35 mm), *Tigrosa aspersa* (Hentz) (~25 mm), and *T. grandis* (Banks) (<31 mm). However, Lycosidae host records are absent for the 12 North American *Pepsis* species, of which all specialize on tarantulas (Theraphosidae) (Williams 1956; Cazier and Mortenson 1964; Kurczewski et al. 2000a, b; 2022, 2024). *Pepsis* species may instinctively capture only Mygalomorphae. Lycosidae belong to the infraorder Araneomorphae. *Pepsis mexicana* Lucas females (16–34 mm; Vardy 2000), a species slightly larger than *P. elegans* (16–28 mm; Vardy 2005), avoided wolf spiders when introduced to them in captivity because of their smaller size, visual acuity, maneuverability, speed, ferocity, and alertness (Williams 1956). Wolf spiders are the usual target of smaller, faster pompilid species in the genera *Entypus* Dahlbom (Pompilidae: Pepsinae: Pepsini) and *Tachypompilus* Ashmead (Pompilidae: Pompilinae: Pompilini) (Kurczewski et al. 2020a, b; 2022). Lycosid habitats such as grasslands, prairies, meadows, agricultural fields, pastures, and woodland edges—are different from the open woodland of *P. elegans* (Kurczewski 2025). Many of the lycosid habitat types are anthropogenic, not native. Despite some species being large enough, Lycosidae can probably be eliminated as potential hosts for *P. elegans*.

Atypidae. The purse-web spiders *Sphodros niger* (Hentz) and *S. rufipes* (Latreille) (Atypidae) are relatively large (25–29 mm) and common in the eastern U. S. (Gertsch and Platnick 1980; Hoffman 2010). Their combined geographic distribution largely overlaps that of *Pepsis elegans*. *Sphodros* Walckenaer females build sturdy silk and soil tubular retreats into the ground at the base of a tree and some species extend the tubes vertically 30 cm or more up the side of the tree trunk (Gertsch and Platnick 1980). *Sphodros niger* often builds the above ground portion of its silken tube horizontally through leaf litter on or near the ground surface. The European spider wasp *Aporus* (*Aporus*) *unicolor* Spinola (Pompilidae: Pompilinae: Aporini) cuts open the silken tubular retreat of a related

purse-web spider genus, *Atypus* (Araneae: Mygalomorphae: Atypidae), with its mandibles, widens the tear with its protarsal claws, and gains access to the spider inside (Early 2013). Species of *Aporus* are structurally modified for such parasitoid activity by having a flat, triangular-shaped head with strong mandibles, enlarged pronotum, and swollen profemora with added musculature. *Pepsis elegans* has no such structural modifications for attacking and capturing purse-web spiders in their retreats. *Pepsis elegans* females often have dried mud on the forewings and body indicating they have been underground in moist fine-grained soil, not in a purse-web. *Sphodros* species probably should not be considered as potential host spiders for *P. elegans*.

Euctenizidae. *Myrmekiaphila* Atkinson (Euctenizidae) has 12 species in the central and eastern U. S. (Bond and Platnick 2007). The geographic distribution of this genus matches that of *P. elegans* except it does not occur in Kansas, Missouri, Illinois, Indiana, Ohio, Pennsylvania, Maryland, and eastern Virginia. *Myrmekiaphila* species live in woodland, grasslands, and arid regions. They construct subterranean, silk-lined burrows covered by a silk and soil trapdoor. Several *Myrmekiaphila* species, including *M. comstocki* Bishop and Crosby (Fig. 2) and *M. foliata* Atkinson, excavate lateral side burrows off the main burrow and seal them with silken cork and soil partitions (Atkinson 1886). Such barriers may prevent or make difficult entry by potential predators and parasitoids. Nonetheless, *Calopompilus heiligbrodtii* (Cresson) (Pompilidae: Pepsinae: Pepsini), a slightly smaller species than *P. elegans*, captured *Myrmekiaphila comstocki* (Euctenizidae), adult or subadult females, in Texas (Kurczewski et al. 2020b).

Priocnemis (Priocnemissus) nigripes (Cresson) (Hymenoptera: Pepsinae: Pepsini), a species smaller than *P. elegans*, captured the trapdoor spider *M. comstocki* in Arkansas, and used the spider's own burrow as a nest (Kurczewski and West 2022). *Myrmekiaphila comstocki* is usually nocturnal; however, males wander on the ground surface during daylight and females hunt from their open trapdoors at all hours (Hardy 2018). The exterior covering of the trapdoor of *M. comstocki* is camouflaged, containing soil and plant material or moss attached to the silk. *Myrmekiaphila comstocki* burrows were 6–33 cm deep at one locality in Arkansas (Hardy 2018). Trapdoors were closed or open with spiders visible in the entrance depending on the weather conditions.

Psorthaspis legata (Cresson) (Pompilidae: Pompilinae: Aporini), a much smaller spider wasp than *P. elegans*, immobilized a *Myrmekiaphila foliata*, subadult male or juvenile, and deposited it in its own burrow in Georgia (Kurczewski and West 2022). *Psorthaspis legata* captured an *M. comstocki*, subadult female, in Texas (Kurczewski and West 2022). Larger species of *Myrmekiaphila* should probably be considered potential host spiders of smaller females of *P. elegans* in areas of their coexistence.

Eucteniza relata (O. P.-Cambridge) (Euctenizidae) is the commonest trapdoor spider in central and southern Texas (Bond and Godwin 2013) (Fig. 3). Females of *E. relata* are 25–28 mm in body length, the same size as *P. elegans*. *Eucteniza relata* excavates a tubular subterranean burrow with a cork-like, hinged lid composed of silk and soil, in which they sit to ambush passing prey (Fig. 3). The burrow is lined with silk and is 7–25 cm in depth (Bond and Opell 2002). *Eucteniza relata* is a possible host species of *P. elegans* in eastern Texas, where they coexist, as it is the presumed host spider of the related *P. cerberus* Lucas and its hybrid with *P. elegans* (Hurd 1952), *P. novitia* Banks (Gillaspy 1990). *Calopompilus heiligbrodtii*, slightly smaller than *P. elegans*, twice captured *Eucteniza relata*, adult males, in Texas (Kurczewski et al. 2020; Kurczewski and West in prep.).

Antrodiaetidae. *Antrodiaetus* species (Antrodiaetidae) are found commonly throughout much of the eastern U. S. They are rare or absent in Oklahoma, Texas, Arkansas, Louisiana, Florida, and the Atlantic Coastal Plain (Coyle 1971; Stevenson and Godwin 2020). *Antrodiaetus unicolor* (Hentz) complex (Fig. 5), the most abundant mygalomorph spider throughout much of the eastern U. S. (Coyle 1971), occurs from Michigan, Ontario, New York, and Vermont to Missouri, extreme northern Arkansas (1 record), Alabama, and Georgia. Adult females are somewhat smaller (13–22 mm; Coyle 1971) than *Pepsis elegans* (16–28 mm; Vardy 2005), although some females can attain a body length of 28 mm. *Antrodiaetus* species live in humid, cool, dense forests with sloped loamy soils (Coyle 1971). They construct tubular, quasi-vertical, silk-lined burrows widened just below the entrance and at the bottom (Coyle 1971). The silk lining of the burrow extends above the soil surface forming an inward-collapsed flexible collar composed of silk, excavated soil, and plant debris. The spider collapses the collar by pulling inward from inside its burrow, producing a folding in the middle like two half circles. Coyle (1971) reported an unidentified pompilid wasp cocoon in Missouri in a “medium-sized” *Antrodiaetus stygius* Coyle burrow. Coyle (pers. comm.) indicated the body length of this spider was approximately 13–15 mm. *Priocnemis (Priocnemissus)*



Figures 2–5. Potential host spiders of *Pepsis elegans*. 2) *Myrmekiaphila comstocki* Bishop and Crosby. Photograph © Bryan E. Reynolds. 3) *Eucteniza relata* (O. P.-Cambridge). Photograph © Stephen P. Holloway. 4) *Ummidia audouini* (Lucas). Photograph © Scott Zona. 5) *Antrodiaetus unicolor* (Hentz) complex. Photograph © Marshal Hedin and Fred Coyle.

nigripes (Pompilidae: Pepsinae: Pepsini), a smaller species than *P. elegans*, captured an *Antrodiaetus* sp. (Antrodiaetidae), subadult female, in Missouri (Kurczewski and West in prep.). *Priocnemis* (*Priocnemissus*) *minorata* Banks, a smaller species than *P. elegans*, immobilized an *Antrodiaetus unicolor* (Hentz) or *A. robustus* (Simon), immature male, in Pennsylvania (Kurczewski and West 2022). *Anoplius* (*Lophopompilus*) *carolina* (Banks), a smaller species than *P. elegans*, captured an *Antrodiaetus unicolor* complex, subadult male, in Massachusetts (Kurczewski and West 2022). Based on these examples, *Antrodiaetus* species may be slightly below the acceptable host size range of *Pepsis elegans*, except for smaller wasps.

Halonoproctidae. *Ummidia* Thorell are relatively large spiders that construct silk-lined burrows with hinged trapdoors (Bond and Coyle 1995). Their burrows are often close together, covered with plant litter, and camouflaged (Coyle 1981; Bond and Coyle 1995). Although *Ummidia* trapdoors are wafer-like, they are stiff enough to not collapse inward when the spider occupant underneath inserts its chelicerae and pulls the door tight against the lip of the opening (Coyle, pers. comm.). *Ummidia audouini* (Lucas) is larger (~25–35 mm) than other congeners in the eastern U. S., more closely approximating tarantulas in size and appearance (Godwin and Bond 2021) (Fig. 4). *Ummidia audouini* is the heaviest native spider in the southeastern U. S. while *P. elegans* is the largest spider wasp in that region. *Pepsis elegans* and the genus *Ummidia* have nearly identical geographic location maps (Hurd 1952; Godwin and Bond 2021; Kurczewski 2023). *Pepsis elegans* habitat, mesic open woodland, resembles *Ummidia* burrowing habitat (Godwin, pers. comm.). Females of *Ummidia* often spend their entire lives inside their burrows and never wander far from the entrance. They are nocturnally accessible in their entrance holding the trapdoor slightly ajar, waiting in the darkness to ambush unsuspecting prey (Kurczewski 2023). Females of *P. elegans*, like other *Pepsis* species, are active at night (Williams 1956; Cazier and Mortenson 1964), allowing for potential nocturnal capture. Males of *Ummidia* wander across the ground surface in search of females mainly in June–July when females of *P. elegans* are nesting. The wasp's host-searching is possibly synchronized with the spiders' mating activities when the males and females are accessible and vulnerable. Females of *Ummidia* exhibit defensive behavior against enemies attempting to enter their burrow. The spider grasps the inner surface of the trapdoor with its chelicerae, pedipalp claws, and first and second pairs of legs while anchoring itself solidly against the burrow walls (Coyle 1981).

Psorthaspis mariae (Cresson), a smaller species than *P. elegans*, paralyzed an *Ummidia audouini*, juvenile, then dragged it into its own burrow in Georgia (Kurczewski and West 2022). Similar host spider capture was observed with an *Ummidia audouini* in Mississippi, although the large black wasp was not identified (Layton 2021). *Ummidia* is a possible host spider genus for *P. elegans* because of size equivalence, geographic sympatry, habitat coexistence, seasonal synchrony, relative abundance, and seclusive burrow habitation (Kurczewski 2023). The only impediment for capture of *Ummidia* is the stiff trapdoor and ability of the spider to hold it shut from inside its burrow.

Summary and Discussion

In nearly every reported capture of a Nearctic mygalomorph spider, the spider wasp entered and chased the spider from its burrow, forcefully grasped it from its entrance with her mandibles, or lured it onto the ground surface (Williams 1928; Kurczewski et al. 2020, 2021, 2022b, 2023, 2024; Kurczewski and West 2022). The wasp often lifted the trapdoor using its mandibles, legs, and/or pronotum, partly entered the burrow, and alerted the spider to her presence. There is a single example of *Psorthaspis planata* (Fox) (Aporini), after being introduced artificially to a California trapdoor spider in captivity [*Bothriocyrtum californicum* (O. P.-Cambridge)], capturing and ovipositing on its abdomen in its burrow (Jenks 1938). *Pepsis elegans* does not have the structural modifications of pompilid species in the tribe Aporini that capture Mygalomorphae, except for enlarged genae for added mandibular musculature (Kurczewski et al. 2024). Whether or not the wasp lifts and fits through the trapdoor, removes the trapdoor, or chews through it with its mandibles is unknown in most species. The simplest and least dangerous manner to capture the spider is to lure it from its burrow onto the ground surface where the wasp has a distinct advantage in quickness and maneuverability.

Based on what is known about their size, morphology, geography, ecology, biology, and burrow and trapdoor structure and dimensions, four genera in three families of Mygalomorphae in the eastern U. S. can be considered potential host spiders of *Pepsis elegans*: *Myrmekiaphila* (Euctenizidae); *Eucteniza relata* (Euctenizidae); *Antrodiaetus* (Antrodiaetidae); and *Ummidia* (Halonoproctidae). Some genera of Mygalomorphae are more likely host spiders of *P. elegans* than other genera based on size equivalency, geographic sympatry, habitat coexistence, and burrow and trapdoor structure and dimensions. Several species of Pompilidae are reported to capture more than one family or genus of trapdoor spider (Kurczewski and West 2022), and this is a possibility with *P. elegans*. The potential host spiders for *P. elegans* are summarized below.

***Myrmekiaphila comstocki*, *M. foliata* (Euctenizidae).** The combined geographic distribution of the 12 *Myrmekiaphila* species is sympatric with that of *P. elegans*, except in the upper central U. S. and Mid-Atlantic States. Species of *Myrmekiaphila* are slightly smaller than other spiders being considered as hosts of *P. elegans*. *Myrmekiaphila comstocki* and *M. foliata* excavate side burrows off the main burrow and seal them with silk and soil partitions (Atkinson 1886), preventing or making entry by potential predators and parasitoids more difficult. Smaller females of *P. elegans* might capture *Myrmekiaphila comstocki* and *M. foliata*.

***Eucteniza relata* (Euctenizidae).** *Eucteniza relata* is one of the largest potential mygalomorph within the geographic range of *Pepsis elegans*. However, the wasp and spider are sympatric only in eastern Texas (Bond and Godwin 2013; Kurczewski 2023). The habitat of *E. relata* is primarily desert and tropical dry forest (Bond and Godwin 2013), whereas that of *P. elegans* is mesic, open, predominantly oak-hickory woodland (Kurczewski 2025). The burrow of *E. relata* is similar in architecture and dimensions to that of *Ummidia audouini* (Kurczewski et al. 2024). *Eucteniza relata* should be considered as a possible host spider of *P. elegans* where the two species coexist.

***Antrodiaetus unicolor* complex (Antrodiaetidae).** The species in this complex are usually slightly smaller than other spiders considered as hosts of *P. elegans*, although some individuals are as large as 28 mm. The geographic distribution of *Antrodiaetus* species overlaps that of *P. elegans* except in the south-central U. S., Gulf and Atlantic Coastal Plains (Coyle 1971; Stevenson and Godwin 2020). *Antrodiaetus* species are found in humid, cool, dense forests with loamy soils (Coyle 1971), whereas *P. elegans* inhabits open, predominantly oak-hickory woodland (Kurczewski 2025). The burrows of *Antrodiaetus* extend above the soil surface as an inward-collapsed flexible collar of silk, excavated soil, and plant debris. The spider from inside its burrow collapses the collar by pulling inward, producing a folding in the middle like two half circles. Such a trapdoor should provide easier access to a predator or parasitoid than the solid doors of Euctenizidae and Halonoproctidae.

***Ummidia audouini*, *U. spp.* (Halonoproctidae).** *Ummidia audouini* is the heaviest native mygalomorph spider while *P. elegans* is the largest spider wasp in the southeastern U. S. *Pepsis elegans* and the genus *Ummidia* have almost identical geographic location maps (Hurd 1952; Godwin and Bond 2021; Kurczewski 2023). *Pepsis elegans* habitat, mesic open woodland, resembles *Ummidia* habitat (Godwin, pers. comm.). Females of *Ummidia* are nocturnally accessible in their entrances holding the trapdoor slightly ajar, waiting in the darkness to ambush unsuspecting prey (Kurczewski 2023). Females of *P. elegans* are active at night, enabling the potential for capture of the spider. Females of *Ummidia* exhibit defensive behavior against enemies attempting to enter their burrow by grasping the inner surface of the trapdoor with their chelicerae, pedipalp claws, and first and second pairs of legs while anchoring themselves solidly against the burrow walls (Coyle 1981).

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