Interspecific Mouthpart Length Variation and Floral Visitation in the Parasitic Wasp Genus *Agathirsia* (Braconidae: Agathidinae)

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**ABSTRACT**  Carbohydrate energy sources are known to be important for many adult parasitic wasps. Floral visitation is commonly observed, and in many groups specialized mouthpart morphology is associated with deep nectar extraction. In parasitic wasps, there are few data examining the relationship between host plant use and the length of the mouthparts. In an effort to associate mouthpart length to nectar source, pollen was identified from museum specimens of selected species of *Agathirsia* (Hymenoptera: Braconidae). Despite drastic differences in glossa length, the pollen of several species of Asteraceae were commonly found on specimens of various species. We infer that increased feeding efficiency, as opposed to nectar access, is the adaptive value of elongate glossae in *Agathirsia*. Species with short mouthparts, however, exhibited a difference from both the medium and long mouthpart categories in pollen similarity. This suggests that members of *Agathirsia* with elongated mouthparts are more apt to visit certain flowers compared with short-tongued species. Males and females exhibited considerable overlap of their common nectar sources and displayed similar pollen richness. Pollen richness was higher in species in the medium length category compared with the short category, but these results are confounded by the fact that the medium-length specimens were on average larger bodied.

**KEY WORDS** mouthpart length, nectar feeding, parasitic wasps, Asteraceae

Parasitic wasps, including the generally smaller, non-aculeate taxa are common floral visitors (Jervis et al. 1993, 1996; Tooker and Hanks 2000). Mate- and host-searching behavior are seldom documented on flowers, and their occurrence on flowers is thought to be rare (Jervis et al. 1993). Likewise, documentation of active pollen consumption (i.e., not as a contaminant of liquid food) is exceptional for nonaculeate wasps (Jervis et al. 1993, Jervis 1998). Floral nectar feeding, however, has been observed regularly (Jervis et al. 1993, Patt et al. 1997) and is often associated with increased longevity and fecundity (Idris and Graffius 1995, 1997; reviewed in Jervis and Kidd 1986).

Most Hymenoptera possess short mouthparts that are capable of obtaining exposed liquid food. The most common feeding adaptation of parasitic wasps is the elongation of various mouthparts (Jervis 1998, Krenn et al. 2005). These are referred to as concealed nectar extraction apparatuses (CNEA) in Jervis (1998), wherein he describes seven functional types. Jervis (1998) also tabulates the taxonomic occurrence and independent appearance of parasitic wasp CNEA from the literature. A CNEA arose in several families but most often in the Ichneumonoidea (Ichneumonidae and Braconidae). At least one type of CNEA (usually at least three) occurs in five braconid subfamilies. Agathidinae braconids are well represented in the number of CNEA types and species.

There are three mouthpart types in *Agathirsia* (Pucci and Sharkey 2004) based on the categories of Jervis (1998). Most species are characterized by similarly lengthened galea and glossa (Jervis type I), which range from 0.2 to 1.8 mm in *Agathirsia*. Four species possess galea that are much shorter than the long, exposed, tube-forming glossa (Jervis type IV), which range from 2.1 to 5.5 mm. The third type (Jervis type VI) has apomorphic (derived) labial palps. *Agathirsia* contains only one rarely collected species of this type and is not treated in this study.

Species of Agathidinae are solitary koinobiont endoparasitoids of larval Lepidoptera (Sharkey 1997). The natural history of *Agathirsia* species is available only from their morphology, collection data, and the biology of closely related groups (Pucci and Sharkey 2004). Most of the 32 described species are collected from August through November and seem to be restricted to the southwestern United States and arid regions of Mexico. Most members seem to have wasp or bee mimetic coloration and/or setal pattern. All species contain dense setae on the glossa, and most specimens contain visible pollen, which together indicate floral nectar feeding. Based on those species...
with large numbers of collected individuals, there seems to be no marked sexual dimorphism.

The correlation between mouthpart length and feeding on flowers with relatively long corollas has been documented in various insect groups (Kevan and Baker 1983, Graenicher 1909, Gilbert and Jervis 1998), particularly bees where the association between tongue and corolla length has been documented in the field (Morse 1978, Harder 1988) and shown to be related to feeding efficiency (Inouye 1980; Harder 1983, 1985; Graham and Jones 1996). Nectar feeding has been shown to be most efficient when glossa length is at least equal to feeder (simulated corolla) length (Harder 1983). Likewise, field studies support the hypothesis that shorter tongued bees are more efficient than longer tongued bees on flowers with shorter corollas (Plowright and Plowright 1977, Ranta and Lundberg 1980). However, due to a greater propensity to feed from flowers with differing corolla lengths, longer tongued bees use a greater diversity of plant species as compared with co-occurring bee species with shorter tongues (Ranta and Lundberg 1980, Harder 1985, Borrell 2005).

The relationship between mouthpart variation and host plant use in parasitic wasps has not been investigated to the degree that it has in bees. The main purpose of our investigation was to establish whether glossa length in Agathirsia influences floral visitation. In particular, we sought to address the question, What is the benefit of possessing a long tongue for members of Agathirsia? Likely possibilities include 1) the ability to drink nectar from flowers with long corollas that would be otherwise inaccessible or 2) the ability to drink nectar faster than with short tongues. If only long-tongued Agathirsia are shown to visit flowers with relatively long corollas, the adaptive significance could be thought of in terms of access to nectar sources. Alternatively, if glossa length is not associated with corolla length, feeding efficiency is suggested as the driving force behind mouthpart evolution in Agathirsia.

Materials and Methods

Pollen was sampled from 122 museum specimens of 19 Agathirsia species. Specimens were chosen mainly to reflect a variety of species and glossal lengths as well as a variety of localities and dates (see Appendix). The long-glossa category refers to species with exposed, tube-forming glossae (Jervis type IV) in this article. Unfortunately, there were relatively few specimens available from this category \( (n = 15) \). The medium-glossa category consisted of species with glossae from 1 to 2 mm \( (n = 59) \), whereas the short-glossa category contained species with glossae <1 mm \( (n = 48) \). Partitioning of these latter two groups was arbitrary. Pollen richness was calculated as the mean of plant species per wasp specimen.

Specimens were used from the following collections: American Entomological Institute, American Museum of Natural History, California Academy of Sciences, Canadian National Collection of Insects, Los Angeles County Museum, Cook Arthropod Collection (Michigan State University), Snow Entomological Museum (University of Kansas), Texas A&M University Department of Entomology, U.S. National Museum, University of Arkansas Department of Entomology, Essig Museum of Entomology (University of California Berkley), and Bohart Museum of Entomology (University of California Davis).

A pin was used to transfer pollen from the specimens to 1.5-ml Eppendorf centrifuge tubes. Pollen was often attached to various body parts but was most abundant on the mouthparts. The pin was carefully cleaned after each use by rinsing with 95% ethanol and wiping with a clean paper towel. Part of each sample was placed onto a scanning electron microscope (SEM) stub for SEM analysis. The other portion of the sample was acetolyzed (Jones and Coppedge 1999) to remove the lipid layer surrounding the pollen grains. Acetolyzed pollen was viewed with light microscopy. Pollen was identified to the lowest taxonomic category possible. When identification to the species level was not feasible, a species code was designated so that pollen from conspecific plants could be recognized and tabulated for all wasp specimens. Pollen micrographs generated from this research are maintained as a part of the USDA–ARS, APMRU Pollen Reference Collection (College Station, TX).

The pollen assemblage between wasp groups was analyzed with PAST, version 1.94b (http://folk.uio.no/ohammer/past/). Analysis of similarity (ANOSIM) was used with the Jaccard similarity metric as the distance measure. ANOSIM is a multivariate, nonparametric test that compares distances between and within groups (Hammer et al. 2001). P values were based on 10,000 replicates of reconstructed group membership. A large number of uncommon pollen taxa have the potential to obscure our results. Therefore, ANOSIM was repeated several times with the rarest pollen taxa deleted each time.

Results

Approximately half of the 117 pollen taxa were members of Asteraceae (see Appendix). Furthermore, all but two of the 19 pollen taxa that were found on at least five wasp specimens are members of Asteraceae. In fact, wasps of all glossa lengths generally visited the same plant species (Table 1). Considering the pollen taxa that were counted from at least four wasp specimens, 11 of 24 were associated with all three mouthpart categories and accounted for 72% of the total pollen count. There were eight plant species that were associated only with the long tongue category, but these were based on only a single pollen grain.

The ANOSIM results, however, revealed some differences between mouthpart categories (Table 2). The pollen composition between the short and medium categories was significantly different regardless of the number of rare pollen taxa included. However, the composition between short versus long was significantly different only when the rarest pollen were excluded. There was not a significant difference between the me-
Table 1. Number of pollen grains of the most common taxa found on Agathirsia categorized by glossa length

| Family   | Scientific name/code | Shorta | Medium | Long  |
|----------|-----------------------|--------|--------|-------|
| Asteraceae | Aster sp. #1          | 12 (20) | 30 (20) | 3 (10) |
| Asteraceae | AST #80               | 4 (7)   | 21 (14) | 4 (14) |
| Asteraceae | Engelmannia pinnatifida | 3 (5) | 20 (13) | 5 (17) |
| Asteraceae | Helenium sp. #1       | 16 (27) | 10 (7) | 1 (3)  |
| Asteraceae | AST #5                | 3 (5)   | 17 (11) | 3 (10) |
| Asteraceae | AST #4                | 3 (5)   | 9 (6)  | 3 (10) |
| Asteraceae | Helianthus sp. #1      | 0 (0)   | 9 (6)  | 0 (0)  |
| Asteraceae | Viguiera sp. #1       | 1 (2)   | 6 (4)  | 2 (7)  |
| Asteraceae | AST #14               | 0 (0)   | 7 (5)  | 1 (3)  |
| Asteraceae | AST #10               | 0 (0)   | 5 (3)  | 3 (10) |
| Asteraceae | AST #15               | 1 (2)   | 4 (3)  | 2 (7)  |
| Malvaceae  | cf. Bastardia viscosa | 4 (7)   | 3 (2)  | 0 (0)  |
| Asteraceae | AST #7                | 4 (7)   | 2 (1)  | 0 (0)  |
| Asteraceae | Androsia sp. #1       | 2 (3)   | 2 (1)  | 2 (7)  |
| Asteraceae | Aster sp. #2          | 1 (2)   | 5 (3)  | 0 (0)  |
| Lamium     | Lamium sp. #1         | 6 (10)  | 0 (0)  | 0 (0)  |

a Percentage (rounded) of the total number of grains listed here per category is in parentheses. Short glossa wasps, n = 48; medium glossa, n = 59; and long glossa, n = 15.

Table 2. P values of ANOSIM similarity tests of the pollen types found on Agathirsia wasps by glossa length categories

| Min | SH vs. MD | SH vs. LG | MD vs. LG |
|-----|-----------|-----------|-----------|
| 1   | <0.0001   | 0.241     | 0.114     |
| 2   | <0.0001   | 0.164     | 0.258     |
| 3   | <0.0001   | 0.064     | 0.185     |
| 4   | <0.0001   | 0.015     | 0.026     |
| 5   | <0.0001   | 0.014     | 0.116     |
| 6   | <0.0001   | 0.003     | 0.110     |
| 7   | <0.0001   | 0.002     | 0.312     |
| 8   | <0.0001   | 0.001     | 0.299     |
| 9   | <0.0001   | 0.005     | 0.471     |
| 10  | 0.002     | 0.004     | 0.338     |

Min, minimum number of pollen grains to be included in the test; SH, short glossa (<1 mm); MD, medium glossa (1–2 mm); and LG, long glossa (>2 mm).

Table 3. Number of pollen grains of the most common pollen taxa (>5 occurrences) per sex

| Family   | Scientific name/code | Male   | Female   |
|----------|-----------------------|--------|----------|
| Asteraeae | Aster sp. #1          | 21     | 23       |
| Asteraeae | AST #60               | 15     | 13       |
| Asteraeae | Engelmannia pinnatifida | 10    | 17       |
| Asteraeae | Helenium sp. #1       | 8      | 17       |
| Asteraeae | AST #5                | 15     | 8        |
| Asteraeae | AST #4                | 7      | 8        |
| Asteraeae | Helianthus sp. #1      | 3      | 6        |
| Asteraeae | Viguiera sp. #1       | 3      | 6        |
| Asteraeae | AST #10               | 1      | 7        |
| Asteraeae | AST #20               | 3      | 5        |
| Malvaceae  | cf. Bastardia viscosa | 2      | 5        |
| Asteraeae | AST #15               | 1      | 5        |
| Asteraeae | Androsia sp. #1       | 3      | 3        |
| Asteraeae | Aster sp. #2          | 1      | 5        |

Table 4. P values of ANOSIM similarity tests of the pollen types found on Agathirsia wasps by sex

| Min | Male vs. female |
|-----|----------------|
| 1   | 0.119          |
| 2   | 0.075          |
| 3   | 0.066          |
| 4   | 0.053          |
| 5   | 0.074          |
| 6   | 0.161          |
| 7   | 0.155          |
| 8   | 0.191          |
| 9   | 0.281          |
| 10  | 0.262          |

Min, minimum number of pollen grains to be included in the test.
Despite probable differences of feeding efficiency based on differing corolla length to glossa length ratios (see Introduction), members of each mouthpart category commonly visited flowers of the same species. Regardless of this overlap in resource use, there was a difference in the pattern of plant use, i.e., the composition of the most favored host plants. The short-tongued group possessed pollen whose composition differed significantly from both the medium- and long-tongued groups. The occurrence of the single significant $P$ value in the medium versus long comparison (Table 2) is not considered to be indicative of a real difference between the groups. Indeed, randomization tests of our data sporadically produced significant $P$ values in ANOSIM, but never like the patterns associated with the short-tongued category (Table 2).

The methods used here did not measure the number of visits to each nectar source per wasp—resource partitioning therefore might further be reflected in the degree to which certain flowers are visited as has been noted for bees (Ranta and Lundberg 1980, Harder 1988, Borrell 2005). Also, the interaction of glossa length with other aspects of wasp morphology might be responsible for differences in flower choice. Harder (1985) found that the combination of several aspects of bumble bee ($Bombus$ spp.) morphology were better at predicting flower use than any one (including mouthpart length) alone. Similarly, Inoue and Kato (1992) found the length and width of bumble bee glossae are associated with flower visitation. Nevertheless, the hypothesis that species with short glossae are excluded from at least some of the common nectar sources of those with long glossae is not supported. Feeding efficiency is suggested as the adaptive value of elongated glossae. Although nectar source utilization in $Agathirsia$ needs to be confirmed in situ, these results indicate that caution should be used if morphology is used to ascribe nectar sources to nectar source.

Not all species of $Agathirsia$ were well represented in this study—there could very well be cases of diet specialization by some species or populations in certain habitats. Indeed, Harder (1985) found flower choice to be related to local nectar source richness and flower abundance for several species of bumble bees. Documentation of flower use for all species of $Agathirsia$ at specific localities is necessary to better understand their feeding ranges.

**Mouthpart Length and Diversity of Nectar Sources.** Unlike results from the bee literature (Ranta and Lundberg 1980, Harder 1985, Borrell 2005), $Agathirsia$ with the longest glossae did not have the highest diversity of pollen sources. The medium-length category had significantly higher pollen diversity than the short category, but this is confounded by a size difference between the groups. In bees, body size has been shown to be associated with flower choice (Harder 1985) and positively correlated with foraging efficiency (Harder 1983). Furthermore, larger bee species have been shown to forage over greater areas (Gathmann and Tscharntke 2002, Greenleaf et al. 2007). It should be stressed that our sampling method was not well suited for diversity measurement. These results are tentative, because the amount of pollen sampled from each specimen was not equal.

**Sex and Flower Visitation.** $Agathirsia$ males and females seem to have similar nectar-feeding behavior based on similar pollen richness and pollen taxa found for each sex. This suggests that males are not restricted to the emergence site as they are in some species of parasitic wasps (Hardy et al. 2007). This is consistent with the apparent lack of size-related sexual dimorphism in the genus. The ANOSIM results, however, are ambiguous due to the group of marginally significant results (Table 4). Further research at the species level is needed to establish whether there are differences of host use associated with sex.

The apparent similarity in feeding between the sexes is consistent with the view that nectar nourishment is used mainly for locomotion as opposed to egg production. This is contrary to some results in the literature. Based on the field observations of Jervis et al. (1993), most flower-visiting parasitic wasps exhibited nectar-feeding behavior, and female parasitic wasps were more common and diverse than males. Furthermore, Pollard (1967) (cited in Jervis et al. 1993) and van Emden (1963) found female ichneumonoid wasps were more likely to possess immature ovaries when collected near flowers as opposed to areas without flowers. Jervis et al. (1993), however, dissected several species of ichneumonoid females ($n = 44$) taken from flowers, and only one specimen was deemed relatively immature. The rest contained either a large proportion of mature eggs or had atrophied ovaries.

Morphological feeding specializations tend not to be sexually dimorphic in parasitoids despite differing ecological and physiological factors associated with sex (Gilbert and Jervis 1998). This contradiction may be explained by mouthpart morphology being coded principally by autosomal alleles (Gilbert and Jervis 1998).

In conclusion, we conclude that the advantage of elongate mouthparts in $Agathirsia$ is increased feeding efficiency on nectar from flowers with typical Asteraceae morphology, i.e., deep-lying nectar beneath tubular corollas. This may be realized by either feeding faster and/or attaining more nectar, on average, for each floral visit. Visitors with short mouthparts may only gain access to concealed nectar when it has accumulated to a relatively high level, whereas long-tongued visitors may attain nectar regardless of nectar level. This can be important for water and caloric intake. In fact, Gilbert and Jervis (1998) point out that many of the parasitic wasps with CNEA are from arid regions.

In addition to a decreased investment in mouthpart tissue, short mouthparts are advantageous by way of increased efficiency on food sources, such as honey-dew, host blood, and extra floral nectararies. This may result in a greater diversity of food sources being used. For example, tachinid flies with long mouthparts have been shown to concentrate on floral nectar, whereas those with shorter mouthparts generally used honey-dew and extra floral nectar in addition to floral nectar (Gilbert and Jervis 1998, analyzing data from Allen 1929). In fact, Bernstein and Jervis (2008) consider
exposed sources of sugar-rich food to be more common than concealed sources.

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### Appendix. Collection data and pollen list for the specimens used in this study

| Species and measurements* | collection site | Sex/collection date/pollen taxa* |
|---------------------------|-----------------|----------------------------------|
| Short-glossa species (<1 mm) |                 |                                  |
| *Agathirsia armandii* Pucci & Sharkey | glossa length = 0.57 mm; body length = 0.9 mm | m 21-viii-1963 AST #56, Aster sp. #1 |
| *Agathirsia asterephyila* Pucci & Sharkey | glossa length = 0.59 mm; body length = 0.93 mm | m 23-vii-1981 AST #50, Helenium sp. #1, Aster sp. #1 |
| *Agathirsia davidi* | | |
| *Agathirsia collini* | | |
| *Agathirsia capillata* Pucci & Sharkey | glossa length = 0.57 mm; body length = 7.6 mm | f 16-viii-1962 AST #47, Cirsiun sp. #1 |
| *Agathirsia testacea* | | |
| *Agathirsia rostrata* | | |
| *Agathirsia heleni* Pucci & Sharkey | glossa length = 0.53 mm; body length = 6.7 mm | f 8/ix-1948 AST #4, #28, Helenium sp. #1 |
| *Agathirsia davisii* Pucci & Sharkey | glossa length = 0.70 mm; body length = 8.2 mm | m 3-viii-1963 AST Eng. pinn. |
| *Agathirsia heleni* | | |
| *Agathirsia rostrate* | | |
| *Agathirsia testacea* | | |
| *Agathirsia testacea* | | |
| *Agathirsia testacea* | | |

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### Appendix. Continued

| Species and measurements<sup>+</sup>/collection site | Sex/collection date/pollen taxa<sup>+</sup> |
|-----------------------------------------------------|------------------------------------------|
| *Agathirsia trichosoma* (Cameron) — glossa length = 0.73 mm; body length = 10.3 mm | AST Helenium sp. #1, Aster sp. #1, Eng. pinn., *Helenium* sp. #1 |
| Morelos, nr. Guerra navas | m 1-ix-1974 | AST #7, #60, *Helenium* sp. #1 |
| Michoacan, Cotija | f 7/x-ix-1972 | AST #9, #60, *Helenium* sp. #1 |
| Michoacan, Cotija | m 14-ix-1975 | AST #6, #1, #10 |
| Guererro, nr. Ixcatepopan | m 13-ix-1982 | AST #7, Aster sp. #1 |

*Agathirsia cresoni* (Mues. & Walkley) — glossa length = 1.2 mm; body length = 10.5 mm

| Collection site | Sex/collection date/pollen taxa<sup>+</sup> |
|-----------------|------------------------------------------|
| Nuevo Leon, 32 km W Linares | m 5-x-1962 | AST #4, #5, #60, *Helenium* sp. #1, *Helenium* sp. #1, *Helianthus* sp. #1 |
| TX | m | #60 |
| Nuevo Leon, 32 km W Linares | f 5-x-1962 | AST #60, #2, *Helenium* sp. #1, #1, *Helenium* sp. #1 |
| TX | m | #60 |
| Nuevo Leon, 32 km W Linares | f 5-x-1962 | AST #60, #2, #60, *Aster* sp. #1, *Helenium* sp. #1 |
| TX, Uvalde Co., Garner St. Park | m 22-ix-1979 | AST #60, Aster sp. #1, *Symphyotrichum* sp. | Continued on following page
### Appendix. Continued

| Species and measurements<sup>a</sup>/collection site | Sex/collection date/pollen taxa<sup>b</sup> |
|---------------------------------------------------|------------------------------------------|
| Nuevo Leon, 41 mi. S Saltillo                      | f 7-ix-1962 AST *Aster* sp. #2, *Eupatorium* sp. #1, *Viguieria* sp.; MAL cf. Bast. vis. |
| Nuevo Leon, 41 mi. S Saltillo                      | f 7-ix-1962 AST #15, Eng. pinn., *Viguieria* sp. #1; SCR #20 |
| *Agathirsia michelei* Pucci & Sharkey – glossa length = 1.4 mm; body length = 5.2 mm | |
| Jalisco, nr. Encarnacion de Diaz                  | f 18-viii-1953 AST #61; FAB *Acacia angustissima*, Mimosa sp. #1 |
| *Agathirsia purkingsii* Pucci & Sharkey – glossa length = 1.4 mm; body length = 7.1 mm | |
| Jalisco, Zapotlanejo                              | f 3-x-1966 AST #4, Eng. pinn. |
| *Agathirsia sericans* (Westwood) – glossa length = 1.7 mm; body length = 10.5 mm | |
| Nayarit, Chapallile                               | m 1-x-1966 AST #20, *Lindheimera* sp. #1; ROS #11 |
| Nayarit, Ixtlan                                   | f 14-x-1968 AST #62, *Helenium* sp. #1 |
| Nayarit, Abucatlan                                 | m 14-ix-1970 AST #5, #7, #15, Eng. pinn., *Helenium* sp. #1, *Viguieria* sp. #1; COM #23; FAB #21 |
| Jalisco, nr. Magdalena                            | f 10-x-1975 APO *Amomia* sp.; AST Eng. pinn., *Viguieria* sp. #1 |
| Guerrero, nr. Taxco                                | m 16-ix-1976 AST #5, #62, HAM *Hamamelis* cf. *virginiana* |
| Mexico, nr. Toluca                                | m 17-viii-1954 AST #57, #58, RUT *Citrus* sp. #1 |
| Mexico, nr. Toluca                                | f 17-viii-1954 AST #5, #20, #60, *Ambrosia* sp., *Aster* sp. #1 |
| Michoacan, El Cangrejo                            | f 30-x-1987 AST #20, #48, *Lindheimera* sp. #1 |
| **Long-glossa species (>2 mm)**                   | |
| *Agathirsia longigladdia* Pucci & Sharkey – glossa length = 3.5 mm; body length = 7.4 mm | |
| Morelos, Cuernavaca                               | m 19/21-ix-1987 AST #20, #28 |
| *Agathirsia longilingua* Pucci & Sharkey – glossa | |
| Length = 4.6 mm; body length = 8.7 mm              | |
| Queretaro, nr. Queretaro                          | f 21-ix-1977 AST #4, #14, #20, #60, *Aster* sp. #1, Eng. pinn. |
| Queretaro, nr. Queretaro                          | f 21-ix-1977 AST Eng. pinn., *Viguieria* sp. #1 |
| Zacatecas, nr. Rio Grande                         | f 27-ix-1975 AST #4, #5, #41, #62, *Iva* sp. #1; FAB *Delaos* sp. #1; PIN #16 |
| Jalisco, San Fandía                               | f 24-ix-1963 ? 7b |
| *Agathirsia proxima* Westwood – glossa length = 3.5 mm; body length = 8.2 mm | |
| Morelos, Cuernavaca                               | m 8/10-ix-1987 AST #10, #11, #12, #60, *Ambrosia* sp. #1 |
| Morelos, Cuernavaca                               | m 8/10-ix-1987 AST #31, #64 |
| Morelos, Cuernavaca                               | f 8/10-ix-1987 AST #15 |
| Puebla, Chapulco                                  | m 4-xi-1991 AST #4, #5, FAB *Rhyynchosia* sp. #1 |
| Jalisco, Teocaltiche                               | f 25-ix-1975 AST #60, Eng. pinn. |
| Morelos, Cuernavaca                               | f 13/14-ix-1987 AST #20, #63, *Aster* sp. #1 |
| Morelos, Cuernavaca                               | m 13/14-ix-1987 AST #5, #11, *Viguieria* sp. |
| Zacatecas, nr. Rio Grande                         | f 27-ix-1975 AST #11, #15, *Ambrosia* sp. #1, Eng. pinn., *Helenium* sp. #1 |
| *Agathirsia rufula* Westwood – glossa length = 2.4 mm; body length = 7.5 mm | |
| Morelos, nr. Thayacapan                            | m 28-x-1991 AST #30, *Aster* sp. #1 |
| Distrito Federal                                  | m 11-x-1962 AST #60, Eng. pinn. |

<sup>a</sup> Measurements are medians for the species and are calculated from a more extensive set of specimens than what is presently listed.

<sup>b</sup> API, Apiaceae; APO, Apocynaceae; AST, Asteraceae; CAP, Caprifoliaceae; Cheno-Am, Chenopodiaceae-Amaranthus; CLU, Clusiaceae; COM, Commelinaceae; EUP, Euphorbiaceae; FAB, Fabaceae; HAM, Hamamelidaceae; HYD, Hydrangeaceae; LAM, Lamiaceae; MAL, Malvaceae; NYC, Nyctaginaceae; OLE, Oleaceae; PLA, Plantaginaceae; PNT, Platanaceae; PIN, Pinaceae; POA, Poaceae; POL, Polygonaceae; ROS, Rosaceae; RUB, Rubiaceae; RUT, Rutaceae; SAL, Salicaceae; SCR, Scrophulariaceae; SOL, Solanaceae; VER, Verbenaceae; ?, unknown; Eng. pinn., *Engelmannia pinnatifida*; Bast. vis., *Bastardia viscosa*.

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