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The Taxonomy and Biology of *Strauzia* (Diptera: Tephritidae)

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The North American genus *Strauzia* is revised. Five new species are included with keys to adults of the 12 known species. Host plant, important larval characteristics, and life cycle information are given for 11 of the species. The evolution of the genus is discussed and 14 host plants are reported. All species bore in the stems of Asteraceae, pupariate in the crown area or in the soil, and are univoltine.

INDEX DESCRIPTORS: Tephritidae, *Strauzia*, Sunflower maggot, Taxonomy

The importance of sunflower, *Helianthus annuus* L., as a crop has caused an increased interest in the sunflower maggot, *Strauzia longipennis* (Wiedemann), as a pest. All species of *Strauzia* whose biology is known, bore in the stems of Asteraceae during the larval stage, feeding on the parenchyma. This mode of feeding does not greatly harm the plant, but apparently reduces seed production by high winds, coming at the crucial time when seed-heads are maturing, may cause considerable stem breakage and seed loss (Caesar, 1924).

The taxonomy of the genus was revised by Steyskal (1986) without the benefit of biological data or larval morphology. He discussed the relationship of this genus to other tephritids.

Knowledge of larval morphology, mating behavior in nature, pupariation, and host plant data adds greatly to the understanding of this genus. Only Phillips (1946) has studied the larvae.

The *Helianthus* host plants of *Strauzia* are undergoing changes with many polyploid species and species that hybridize (Heiser, 1969). Heiser (1969) has divided the *Helianthus* into three sections. In the first section where all species are annuals with n = 17 chromosomes, only *H. annuus* is a host plant. No hosts have been reported among the eight species of section two having n = 17. In section three eight of 29 species serve as host to *Strauzia*. All of these having n = 34 or n = 51. The status of *Strauzia* spp. attacking *Helianthus forskii* Raf. (n = 34) and *H. strumosus* L. (n = 34, 51) has not been satisfactorily determined. *Strauzia* species occurring in the Southwest have not been adequately studied or collected; this is especially true of *S.* *mutiphennis*, *S. longipennis*, and *S. vittigera*.

**MATERIAL AND METHODS**

This study was based on the examination of more than 3,000 specimens from North America. A list of institutions from which specimens were borrowed is given by Stoltzfus, (1977).

Immature specimens were cleared in potassium hydroxide and studied in glycerin. Drawings were made by use of an ocular grid. Measurements that were made of the genitalia and head and the terminology used are discussed by Stoltzfus (1977). Measurements involving less than 10 specimens are so noted in the text.

Plant names were checked against those used by Van Brugger (1976) and Heiser (1969). Dr. Charles Heiser, Department of Biology, Indiana University, identified species of *Helianthus*; other plants were identified by the author.

Numerous field observations were made of courtship, oviposition, and mating. Only identifications of fly species made in the field at distances of 60 cm or less were reported.

**Genus *Strauzia***

*Strauzia* Robineau-Desvoidy, 1830. 718.

There is considerable difference between the sexes of *Strauzia* both in wing pattern and development of enlarged fronto-orbital bristles. The intergrading wing pattern and the natal darkening have been principal causes of taxonomic confusion in the genus.

The main contributions to the taxonomy of *Strauzia* were made by Loew (1873), who described seven varieties, and by Steyskal (1986). Phillips (1923), provided a key to the seven varieties of Loew. Steyskal (1986) described three new species, raised four varieties to new status as species, and synonymized three other varieties of Loew (1873) with *S.* *longipennis*. Host plants were given for all but one of the new species. Novak (1977) and Wasbauer (1972) also have reported host plants all of which, except for *S. longipennis*, have been derived from my rearing records. Steyskal (1986) also discussed morphological terminology of the postabdomen. Biological information needed to identify sibling species was not available to him, nor did he use subimaginal characteristics.

The taxonomic keys of Steyskal (1986) are difficult to use and in some cases misleading. I find several characters of no value in separating species due to their great variability. The postocellar setae and the pigmentation of subscostral cell vary too widely in my specimens to be diagnostic. The size and shape of the rasper teeth, the shape and color of the spermatotheca, and the shape and color of the preterminal vesicles also are of no diagnostic use. The orientation of the spicules of *S. perfecta* (Stoltzfus, 1986, p. 115, Fig. 10) as illustrated are not as they are in my specimens, which are oblique to horizontal.

Due to Steyskal's reliance on these variable characters and the addition of five new species included in this paper I have provided a key to species.

*Strauzia* may be distinguished from other North American Tephritidae by the following combination of characters: 1) third antennal segment not more than half the length of the face, 2) oral margin anterior to genal bristle lacking well-developed bristles, 3) only one pair of upper fronto-orbitals, 4) width of front equal to 5/6 width of head, head higher than long, 5) proboscis not geniculate, 6) presural bristle present, 7) humeral bristle present, 8) dorsal-central bristles close to a transverse line between the supra-alar, 9) scutellum neither swollen nor polished, bearing two pairs of bristles, 10) wings long, narrow, not reticulate, 11) Cu2 bent at near right angle, closing anal cell with an elongate point approximately length of anal cell before posterior wing margin, 12) claspers as long as width of epandrium, 13) preseptal setae similar in size and conical, 14) puparium shining light yellow, integument very hard, 15) third instar larva with anterior spiracles bearing 18-65 papillae, posterior spiracular disc with 28-60 hair-like interspiracular processes, spiracular slits elongated (Figs. 1-5).

The larval characteristics of all species are very similar. No consistent differences were noted except for the number of papillae on the anterior spiracles; therefore, only the description of one species, *S. perfecta*, is given.
Table 1. Host Plants of *Strauzia*

<table>
<thead>
<tr>
<th>Species</th>
<th>Host Plant</th>
<th>Pupation Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>arculata</td>
<td>Helianthus grosseserratus</td>
<td>crown</td>
</tr>
<tr>
<td>giganteus</td>
<td>H. giganteus</td>
<td>upper root</td>
</tr>
<tr>
<td>intermedia</td>
<td>Rudbeckia laciniata</td>
<td>crown</td>
</tr>
<tr>
<td>longipennis</td>
<td>H. annua</td>
<td>soil</td>
</tr>
<tr>
<td>longitudinalis</td>
<td>D. decapetalis</td>
<td>root, soil</td>
</tr>
<tr>
<td>noctipennis</td>
<td>H. grosseserratus</td>
<td>soil</td>
</tr>
<tr>
<td>perfecta</td>
<td>Ambrosia trifida</td>
<td>soil</td>
</tr>
<tr>
<td>rugosum</td>
<td>Eupatorium rugosum</td>
<td>soil</td>
</tr>
<tr>
<td>stolzflus</td>
<td>unknown</td>
<td>unknown</td>
</tr>
<tr>
<td>uvedalia</td>
<td>Smallanthus uvedalia</td>
<td>soil</td>
</tr>
<tr>
<td>verbesinae</td>
<td>Verbesina occidentalis</td>
<td>upper root</td>
</tr>
<tr>
<td>vittigera</td>
<td>H. hirsutus</td>
<td>upper root</td>
</tr>
<tr>
<td>tuberosus</td>
<td>H. tuberosus</td>
<td>upper root</td>
</tr>
<tr>
<td>unknown species</td>
<td>H. maximiliani (Guthrie Co., LA)</td>
<td></td>
</tr>
<tr>
<td>unknown species</td>
<td>H. mollis (reported from Joliet, IL)</td>
<td></td>
</tr>
<tr>
<td>unknown species</td>
<td>H. stramosus</td>
<td>upper root</td>
</tr>
</tbody>
</table>

General Biology

Adults emerge in late May and in June, with peak emergence occurring in early June in central Iowa. Adult males are usually found on the upper leaves of their host plant patrolling a leaf or resting on the under surface. Intruders are chased away by wing movements or short forward thrusts of the body.

Male territoriality reduces interference with courtship if a female should alight on its plant. The female is usually observed walking around, apparently searching for suitable oviposition sites in the upper two or three internodes of the taller host plants. Eggs are inserted into the parenchyma of an internode sufficiently deep for the egg to be completely protected. As the plant grows and new internodes occur, more eggs are laid in the stem. In some species few eggs develop into mature larvae, possibly due to intraspecific competition. In *H. tuberosus* where only one to three larvae reach maturity, as many as seven eggs were found. In smaller host plants of 10 mm diameter or less, only a single larva usually reaches the puparium stage. In other species most eggs laid may develop to mature larvae. In a large stalk of *Ambrosia trifida* L. (Wadsworth, Ohio), 30 larvae were found, most of which were third instar.

No differences in courtship were observed between seven of the 12 species in which mating was seen. Courtship is short and may last only two or three seconds if the female is receptive. Male and female usually approach face to face within a few centimeters, the male then leaps over the head of the female and lands on her abdomen. Wing and body movements may be involved in attracting the female. Alternately one wing is extended perpendicular to the body and oriented vertically; lateral movements of the body and bobbing may accompany wing displays. A complete sequence of wing and body motions may last 10 seconds, but copulation may ensue without such displays. Copulation may last for several hours. Flies in tandem are frequently observed in nature. A pair of *S. vittigera* kept in a baby food jar were observed mating each morning for eight days.

Adult numbers decrease by late June and most species are gone for the year by early July, but a specimen of *S. perfecta* was taken on August 12 in Ames, Iowa. All species are univoltine.

Larvae tunnel in the pith parenchyma of the host, moving up and down the stem and doing considerable damage in some plants (Brink, 1922). The economic damage to sunflower stalks is discussed by Westdal and Barrett (1955, 1960, 1962).

Pupariation occurs in the soil, in the crown area, or an upper root. The pupa forms in the spring several weeks prior to adult emergence. When pupariation occurs in the stalks, an emergence tunnel is made by the third instar. The actions of fungi and bacteria appear to help to decompose the stems sufficiently to allow emergence of the adults.

In species pupating in soil, exit holes have been observed up to 25 cm from the ground and the larva then falls to the ground, burrowing into the soil to pupariate in the upper 3-6 cm of soil. In a few cases, larvae that normally pupate in the stem burrowed down through the crown and entered the soil. This may be the normal path of egressing for *S. longitudinalis*.

Table 2. Measurements of *Strauzia*

<table>
<thead>
<tr>
<th>Species</th>
<th>Aculeus angle (°)</th>
<th>Fronto-facial angle (°)</th>
<th># Papillae ant. spiracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>arculata</td>
<td>40-46</td>
<td>67-79</td>
<td>18-24</td>
</tr>
<tr>
<td>giganteus</td>
<td>53-60</td>
<td>74-86</td>
<td>21-26</td>
</tr>
<tr>
<td>intermedia</td>
<td>42-48</td>
<td>82-88</td>
<td>44-67</td>
</tr>
<tr>
<td>longipennis</td>
<td>51-60</td>
<td>83-91</td>
<td>27-37</td>
</tr>
<tr>
<td>longitudinalis</td>
<td>52-65</td>
<td>85-90</td>
<td>19-27</td>
</tr>
<tr>
<td>noctipennis</td>
<td>42-47</td>
<td>84-92</td>
<td>21-22</td>
</tr>
<tr>
<td>perfecta</td>
<td>58-64</td>
<td>86-94</td>
<td>23-33</td>
</tr>
<tr>
<td>rugosum</td>
<td>46-54</td>
<td>82-89</td>
<td>28-33</td>
</tr>
<tr>
<td>stolzflus</td>
<td>52-57</td>
<td>84-93</td>
<td>27-38</td>
</tr>
<tr>
<td>uvedalia</td>
<td>53-60</td>
<td>74-86</td>
<td>21-26</td>
</tr>
<tr>
<td>verbesinae</td>
<td>41-55</td>
<td>76-90</td>
<td>23-35</td>
</tr>
</tbody>
</table>

Table 3. Life Cycle Data of *Strauzia*

<table>
<thead>
<tr>
<th>Species</th>
<th>Spring Emergence-Disappearance</th>
<th>Pupariation</th>
</tr>
</thead>
<tbody>
<tr>
<td>arcul</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gigan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>longp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>longt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>notti</td>
<td></td>
<td></td>
</tr>
<tr>
<td>perfe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ruggs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>uveda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>verbe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vitti</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Only three adults were collected, one June 13 and two June 25; all other data represent ten or more observations.

**EVOLUTION**

The relationship of *Strauzia* to other tephritids was discussed by Steyskal (1986). *Strauzia* species have only recently diverged as evidenced by the lack of consistent morphological differences and by their similar life history patterns.

A general trend occurs toward loss of pigmentation on the thoracic dorson and pleura, increased sexual dimorphism, and a reduced number of papillae on the anterior spiracles of the third instar and puparium. The genitalia of derived species have a more rounded clasper distally, the aculeus of the ovipositor expanded into "ears" or the margins concave just before the tip. Pupariation in the soil rather than the crown or root seems to be a trend. Coalescing of the wing pattern in the male occurs in the derived species.

*S. intermedia* appears to be ancestral due to considerable pigmentation, variable number of incrassated lower fronto-orbital bristles (fio), as well as numerous papillae in the immature stages. The ancestral
Biology of Strauzia

The role of courtship patterns as isolating mechanisms has not been determined, as no differences in courtship behavior has been observed between species. Dimorphism of the sexes would seem to suggest some role, however.

Sixty-eight mating pairs have been observed in nature involving the following species: *S. arnalditata*, *S. longispennis*, *S. longitudinalis*, *S. noctisopennis*, *S. perfetta*, *S. verbesinae* and *S. vittigera*. None of these copulating pairs were hybrids. In areas where these mating pairs were observed, there were host plants of other species of *Strauzia* within 10 meters.

Competitive mating experiments in the laboratory conducted in 8 dram vials and in baby food jars resulted in hybrid mating pairs. In 55 experiments with 2 different species, 13 resulted in hybrid mating pairs.

The lack of interbreeding in the field must be due at least partly to initiation of courtship only on the host plant. Bush (1969) and Berlocher (1984) discussed the contribution of host plant selection to speciation.

**KEY TO THE SPECIES OF STRAUZIA**

**MALES**

1. Scutellum with lateral brown to black spots (Fig. 16) .................. 2
2. Wing pattern normal (Fig. 40, 50, 55) ........................................ 5
3. Pretarsus and last tarsomere dark brown, mesonotum with pair of longitudinal dark brown stripes between the acrosticals and a second pair on the dorsoventrals (Fig. 16) .................. 4
4. Lower fronto-orbital bristles swollen and truncate (Fig. 7) ................. intermedia
5. Pleura with blackish areas on the meron, anepimeron, anepisternum, katepisternum; mesonotum with alar, dorsoventral and submesal stripes, abdominal tergites each with lateral dark spots ............................................................ stelsiisi
Lighter species, meron sometimes with a spot; lacking submesal stripes; only first and second abdominal tergites clearly marked with spots ............................................................ gigantei
6. Mesonotum without longitudinal stripes; surstyli without a lateral lobe (Fig. 18) ............................................................... verbesinae
7. Mesonotum with dark brown mesonotal stripes at least partly present; surstyli with a lateral lobe (Fig. 19) ............................................................ vittigera n. status
7. Mesonotum with definite dorsoventral stripes at least posterior to suture 8
8. Mesonotum with reddish pattern, without longitudinal dark brown stripes ............................................................ arnalditata
9. Mesonotum with well defined stripes, wings with hyaline area between cross veins interrupted before reaching costa (Fig. 38); fronto-facial angle acute (Fig. 7) ............................................................ arnalditata
10. Mesonotum sometimes with incomplete stripe; wing pattern normal, or with coalesced longitudinal pattern (Figs. 51-53) ............................................................ vittigera n. status
11. Wing with pattern coalesced into a dark brown to black longitudinal stripe covering much of the wing .................. 13

**FEMALES**

1. Scutellum with dark brown to black spots at corners .................. 2
2. Mesonotum with dark stripes at least posterior to suture ............................................................ perfetta
3. Wing pattern with hyaline area between crossveins not reaching the costa (Fig. 38); body light yellow ............................................................ arnalditata
4. Mesonotum with only dorsoventral stripe, which sometimes fades out before the suture. Pleura usually lacking dark brown areas ............................................................ vittigera n. status
5. Pretarsus and last tarsomere blackish; dark brown to blackish areas on meron, anepisternum, anepimeron, katepisternum and abdominal tergites. Aeculeus with long point (Fig. 22) ............................................................ intermedia
Blackish areas only on pretarsus and tip of last tarsomere; aeculeus broader (Fig. 21) ............................................................ 6
6. Pleural areas, except meron, normal body color; only second abdominal tergite with dark brown areas ............................................................ gigantei
Meron, anepimeron, anepisternum, katepisternum with dark areas; abdominal tergites with dark areas. Mesonotum with alar, submesal and dorsoventral stripes ............................................................ stelsiisi
7. Aeculeus with "ears" (lateral, preapical angulations, Fig. 29); fronto-facial angle acute (Fig. 7) ............................................................ verbesinae
Aeculeus lacking ears; fronto-facial angle near 90 degree ............................................................ 8
8. Body reddish to yellowish brown, aeculeus narrower at preapical angle than the egg guide below (Fig. 25); wing pattern normal or modified as in *S. arnalditata* (Fig. 38). Body large, mesonotum dark brown, western species ............................................................ noctisopennis n. sp.
Body lighter, normal yellowish brown; wings normal; metanotum variable ............................................................ 9
9. Small, 6.5 mm or less; metanotum without darkening; wing rounded apically (Fig. 50); aeculeus narrowed at preapical angle (Fig. 27); eastern species ............................................................ roguani n. sp.
Mostly larger; metanotum variable; aeculeus slightly expanded at
Figs. 1-6. Structures of third instar larva and egg. Fig. 1. *Struzia perfecta* third instar. Fig. 2. *S. perfecta* larval head. Fig. 3. *S. perfecta* anterior spiracle. Fig. 4. *S. vittigera* posterior spiracular disc. Fig. 5. *S. perfecta* cephalopharyngeal skeleton. Fig. 6. *S. perfecta* egg. Ap, anal plate; ASp, anterior spiracle; IP, interspiracular process; Mh, mouth hook; S, sensilla; SpP, spiracular plate; SS, stigmatic slit; StS, stigmatic scar; Tr, trabeculae.
Figs. 7-19. Head, thorax and postabdomen. Fig. 7. Head, male, of *S. vittigera*. Fig. 8. Postabdomen of *S. verbesinae* posterior view. Fig. 9. Clasper, *S. arculata*. Fig. 10. Clasper, *S. gigantei*. Fig. 11. Head, female, *S. uvedaliae*. Fig. 12. Clasper, *S. intermedia*. Fig. 13. Clasper, *S. longipennis*. Fig. 14. Clasper, *S. longitudinalis*. Fig. 15. Clasper, *S. noctipennis*. Fig. 16. Basic pattern of notal stripes. Fig. 17. Clasper, *S. perfecta*. Fig. 18. *S. verbesinae*. Fig. 19. Clasper, *S. vittigera*. AD, anterior dorsocentral stripe; AL, dorsocentral bristle; AS, anterior submesal spot; DB, alar stripe; DS, dorsocentral stripe; EP, epandrium; FF, frontofacial angle; LS, lateral scutellar spot; OC, outer clasper; PR, proctiger; SS, surstylus; SSS, submesal stripe.
Figs. 20-31. Aculeus of ovipositor. Fig. 20. *S. arculata*. Fig. 21. *S. gigantei*. Fig. 22. *S. intermedia*. Fig. 23. *S. longipennis*. Fig. 24. *S. longitudinalis*. Fig. 25. *S. noctipennis*. Fig. 26. *S. perfecta*. Fig. 27. *S. rugosum*. Fig. 28. *S. uvedaliae*. Fig. 29. *S. verbesinae*. Fig. 30. *S. vittigera* from *H. hirsutus*. Fig. 31. *S. vittigera* (from *H. strumosus*). Figs. 32-35. Spermathecae. Fig. 32. *S. arculata*. Fig. 33. *S. noctipennis*. Fig. 34. *S. uvedaliae*. Fig. 35. *S. vittigera*. Fig. 36. Aedeagus of *S. arculata*. Fig. 37. Aedeagus of *S. noctipennis*. 
Figs. 38-54. Wings. Fig. 38. *S. arculata* female. Fig. 39. *S. gigantei* female. Fig. 40. *S. intermedia* male. Fig. 41, 42. *S. longipennis* males. Fig. 43, 44. *S. longitudinalis* male and female. Figs. 45-47. *S. noctipennis* males. Fig. 48. *S. perfecta* female. Fig. 49. *S. uredalkae* male. Fig. 50. *S. rugatum* female. Fig. 51-53. *S. vittigera* males. Fig. 54. *S. vittigera* female.

preapical margin (Figs. 23, 24); eastern or western species ................................................................. 10

10. Metanotum and ovipositor normal body color; aculeus with preapical angle definite, not rounded, margins toward tip straight (Fig. 28) ................................................................. *sinalaque* n. sp.

Metanotum and ovipositor usually darkened; aculeus preapical angle rounded, margins toward tip often concave ................................................................. 11

11. Eastern woodland species; wings long, posterior margin near apex often concave; bristle at end of first costal break weak; metanotum with dark brown at least basally ................................................................. *longitudinalis* n. status

Wide distribution, open or ecotonal areas; wings normal shape; bristle at end of first costal break nearly as long as at second costal break; metanotum normal to darkened laterally and basally ................................................................. *longipennis*

**SPECIES**

_Strauzia arculata_ Steyskal, 1986.

**Diagnosis.** The well defined notal stripes extending the full length of the notum, the light yellow color, the acute frontofacial angle and
the pattern of the wing (Fig. 38) distinguish this species.

Distribution. Ill., la., Kan. The specimens from other areas listed by Steyskal (1986) may be S. noctipennis. The host record from Helianthus annuus is in error.

Biology. This species infests Helianthus grosseserratus Martens. Adults were collected from June 4 to August 1 in central Iowa. Courtship, mating, oviposition and larval feeding behavior were similar to other species of Strauzia. Usually only one puparium per plant was found, but three were found in one case. In a sample of 71 host plants examined on June 8, three contained empty pupal cases of emerged adults and 25 had unemerged pupae. Pupariation occurred in the crown and adult emergence exits were within two inches of the soil surface.

No lodging due to stem damage from larval feeding was observed. Strauzia gigantea Steyskal, 1986.

Diagnosis. The dark brown pretarsus and distal end of the last tarsomere along with the dark areas on the meron set this species apart from most others. The lack of enlarged lfo bristles in the male and less darkening of the pleura and notum will distinguish it from S. intermedia. This species is similar to S. stolzfpisi but has less darkened area, especially on the nota and pleura.

The number of papillae on the anterior spiracles (39-49), is greater than other species except S. intermedia.

Distribution. Ohio, Michigan.

Biology. Emergence from the host plant. H. giganteus L., occurred by May 27; by mid-June no adults were found in Kent, Ohio. In larger stems of the host (1.5 mm or more), more than one larva was found. By September 18, larvae appeared fully developed and left the plant, exiting through holes about 30 cm above the soil, dropping to the ground, and pupariating in the upper few centimeters of soil. Infestation is high for larger stems, 38 of 124 host plants examined on June 8, three contained empty pupal cases of this species. In areas where host plants of other Strauzia were growing within a meter of H. annuus other species were not found to infest this plant. In three different localities (Harrisonburg, Virginia, Wads­worth, Ohio, Ames and Oskaloosa, Iowa), close proximity of host plants for different species did not result in rearings on other hosts.

Up to 30 larvae may be found infesting a single host. Pupariation occurred in the soil with larval exit holes above ground. This species emerged later than most Strauzia, usually after June 1 in Iowa, and left the stalk to pupariate in the soil earlier, by September 1, 1987 in Iowa (Table 3).

Strauzia intermedia Steyskal, 1986.

Diagnosis. Blackish to dark brown areas occur on the last tarsomere, pretarsus, meron, metanotum, pleural areas and margins of the abdominal tergites. An extra pair of longitudinal alar stripes (Fig. 16) are present. This is the darkest species in the genus. Wings of males and females are similar (Fig. 40); the males often have 5-7 slightly enlarged lfo bristles.

Distribution. Ontario to Manitoba south to Kansas and North Carolina.

Biology. This is the earliest species to emerge in the spring (Table 3). It has been collected from early May to mid-June, bur I collected no adults later than May 26 for 1987 and 1988 in Iowa. Immatures develop rapidly, seven puparia and 11 larvae were taken in Boone Co., Iowa on July 28. This is the earliest date for pupariation of any of the species (Table 3). One to five puparia may be found in the crown area of the host Rudbeckia laciniata L.

 Strauzia longipennis (Wiedemann), 1830. Sensu stricta.

Diagnosis. The concept of the species included here is only of those individuals from the host plant H. annuus. This concept corresponds to the concept of S. longipennis var. typica of Loew, 1873. The males from the annual sunflower are easily distinguished by the "F" pattern at the apex of the wing which is separated from the remainder of the wing at least posteriorly. Females are hard to separate from S. longitudinalis, S. noctipennis, S. rugosum and S. undulatae, without host data. The wings of S. longitudinalis are longer and tend to have a concave margin posteriorly near the apex, and the metanotum is more pigmented. S. noctipennis is more reddish; this is very evident in live specimens. S. rugosum is smaller, 6.5 mm or less for females and 5.5 mm for males; the metanotum is usually light yellow. S. undulatae has less darkening of the tip of the ovipositor sheath and the aculeus has straight margins and an abrupt angle at the ears, while in S. longipennis this angle is rounded (Fig. 23), making the margins of the tip concave.

The surstylus has a broad inner lobe near the tip (Fig. 13), and lacks any lateral lobe as in S. noctipennis.

The larvae have 27-37 papillae on the anterior spiricle (Table 2).

Distribution. Ontario to Manitoba south to Kansas and North Carolina.

Biology. H. annuus is the only host plant from which I have reared this species. In areas where host plants of other Strauzia were growing within a meter of H. annuus other species were not found to infest this plant. In three different localities (Harrisonburg, Virginia, Wads­worth, Ohio, Ames and Oskaloosa, Iowa), close proximity of host plants for different species did not result in rearings on other hosts.

Up to 30 larvae may be found infesting a single host. Pupariation occurred in the soil with larval exit holes above ground. This species emerged later than most Strauzia, usually after June 1 in Iowa, and left the stalk to pupariate in the soil earlier, by September 1, 1987 in Iowa (Table 3).

Strauzia longitudinalis (Loew), 1873. New Status.

Strauzia longipennis var. longitudinalis (Loew), 1873: 240-241, description.

Diagnosis. This species has very long wings (Fig. 24). The posterior margin near the apex is concave in the male and to a lesser extent in the female. In some males the wing pattern is coalesced into a long dark brown stripe. Such males, if they are small enough, are difficult to distinguish from S. rugosum. The postscutellum is generally darker brown than in S. longipennis, and the "F" pattern is continuous with the basal pattern in males. The general body color is the normal light yellow for the genus; there are no natal stripes and the corners of the scutellum have dark spots. The angle of the aculeus tip is wide with the lateral angle rounded.

The surstylus (Fig. 14) is not as broad as in S. longipennis.

The larvae have 17-27 papillae on the anterior spiracles, the smallest number for any species (Table 2).

The type specimen is 5.5 mm long. Head with frontotemporal angle 90 degrees, 4 enlarged lfo, 1 genal bristle.

Wings 6.6 mm long, 2.0 mm wide, with coalesced pattern, costal cell spot well defined (Figs. 41, 42).

Genitalia with proctiger only slightly darkened, clasper with 3 bristles apically, 8 medial; surstyli bent at 90 degrees (Fig. 13).


Biology. H. decapetalus L. is the host. Adults have been collected from May 22 to June 16 in Kent, Ohio. Usually only one puparium occurs per plant. Occasionally the larvae tunnel so far below the crown to pupate that they leave the root and pupariate in the soil. Larval development is slow; for example, as late as October 23, 1969, 30 larvae and only three puparia were collected in Kent, Ohio.

This species was synonymized by Steyskal (1986). The long larval development period, reduced anterior spiracles, habit of tunneling deep into the tap root to pupariate, different host plant affinities, and wing pattern of the male all support the separation of this species from S. longipennis.

Strauzia noctipennis New Species.

Description. Body yellowish brown to reddish brown. Head squarish in silhouette, lfo in male enlarged and truncate. Body length of male 5.8-8.0 mm, female 6.0-8.1 mm.

Thorax with notum reddish brown, distinct stripes. Scutellum with dark spots at corners. Metanotum reddish brown to dark brown.
Pluria lacking definite darkened areas.

Wings (Figs. 45-47), modified and variable in both sexes; males often with a very dark broad coalesced pattern, female with normal pattern, sometimes with hyaline band between crossveins not reaching the costa. Wing length for males 5.2-7.8 mm, width 1.7-2.2 mm; in females length 5.6-7.6 mm, width 2.0-2.5 mm.

Genitalia of male with epandrium darkened laterally, surstyli normal, 3-4 bristles apically (Fig. 15), aedeagus large; female with tip of ovipositor dark brown, aculeus with egg guide wider than remainder of aculeus and visible from above (Fig. 25).

Anterior spiracle of larva with 21-26 papillae.


Material Examined. 272 specimens.

Distribution. Wisconsin, Alberta, Oregon and south to Indiana and New Mexico.

Biology. This species has been reared from puparia collected from the crown area of *H. graciletorum*. However, most flies reared were collected as puparia from the soil around this plant. Adults were collected from May 22 to mid-July in central Iowa. Larval exit holes can be found by early September.

*Strauzia perfecta* Steyskal, 1986.

Diagnosis. The only character needed to delineate *S. perfecta* is the lack of dark spots on the corners of the scutellum. Other characters included "ears" along the lateral margin of the aculeus, generally light color, and wings of both sexes similar (Fig. 48).

Larval Description. Third instar (Fig. 1) length 10.6 mm, width 1.8 mm, yellow to whitish. Spinules small, inconspicuous. Head with 10-12 closely ranked spinules dorsally, 5-10 ventrally caudal to mouth, three to four rows just posterior to anterior spiracles and next six intersegmental areas dorsally. Broad intersegmental areas of spinules on first to sixth abdominal segments ventrally.

Head with antenna two-segmented, basal segment twice as long, distal segment half the diameter and bearing a rim distally. Ventral sensilla as long as antenna, bearing a subicular rim distally in which 4-6 post-like sensoria project.

Cephalopharyngeal skeleton (Fig. 5) 1.33 mm long, dark, and bearing a tooth along ventral aspect of the mouth hooks.

Anterior spiracle (Fig. 3) dark yellow, bearing a dorsal lobe twice as long as ventral lobe, with 23-33 papillae.

Each segment bearing sensillae scattered along anterior margin; thoracic segments with up to 24 and abdominal segments with 12-18 (Fig. 2).

Posterior spiracular disc (Fig. 4) bearing four pair of tubercules around edge, ventral pair of tubercules each with three sensillae, others with one. Stigmatic slits with trabeulae extending to near middle of slits. Four groups of interspiracular processes having 8-22 hair-like extensions; the processes may be branched two or three times and extend beyond the borders of the stigmatic plate.

The puparium is glossy yellow and slightly dorsoventrally flattened.

The egg (Fig. 6) is 1.8-1.5 mm long by 0.21-0.27 mm wide and bears a nuple on the micropylar end. It is shining white and no reticulation or other markings are evident.

Distribution. Ontario west to South Dakota and south to New Mexico and North Carolina.

Biology. This species is very numerous where large stands of its host plant *Ambrosia trifida* L. occur. Stems two centimeters or larger may have 30 larvae infesting them, completely tunneling the pith and parenchyma tissues of the lower stem.

This is the latest species to emerge (Table 3); it can be collected from June 8 to July 30. It is univoltine like other *Strauzia* and pupariates in the soil.

*Strauzia rugosum* New Species.

Description. Body yellow, small, male 4.5-5.5 mm, female 5.5-6.5 mm. Head with fio truncate, and enlarged. Thorax with dark spots at corners of scutellum, metanotum light yellow, no notal stripes or pleural darkenings.

Wing pattern (Fig. 50) in female normal, rounded apically, length 2.5-2.6 mm; male with very long narrow wings 5.2-7.0 mm, width 1.2 mm to 1.8 mm (only nine males and eight females measured). Male wing pattern always coalesced into a narrow longitudinal band that is not as dark as other species.

Genitalia; male with epandrium darkened laterally, surstyli short; female with ovipositor normal length, darkened distally, aculeus (Fig. 27) similar to *S. vittigera*.

Anterior spiracles of third instar with 28-33 papillae. Puparium smallest of all species, 4.8 mm long and 1.9 mm wide.

Holotype. Female, 2 miles south, Wadsworth, Ohio, Stoltzfus (USNM). This specimen was collected November 7, 1965 as a puparium from soil near *Eupatorium rugosum* Houtt. After two months on peat moss in a refrigerator to break diapause it was held at room temperature. It emerged Feb. 10, 1966.

Material examined. Nine males, eight females.

Distribution. Ohio, Virginia and West Virginia.

Biology. Adults were collected from May 16 to June 4 in mesophytic woods where the host plant *Eupatorium rugosum* occurs. Immature larvae were taken as late as October 10 in Medina Co., Ohio, but by November 7 only puparia were found. Pupariation occurs in the soil.

*Strauzia stoltzfusi* Steyskal, 1986.

Diagnosis. This species has extensive darkened areas including two or three pair of notal stripes, but lacks dark pretarsal and tarsal segments. I have seen only the type and nothing is known of the biology.

*Strauzia uvedalii* New Species.

Description. Body yellow to yellowish brown, large species male 5.1-6.1 mm; female 6.2-7.3 mm. Head outline squarish in silhouette (Fig. 11), two small, three large fio bristles swollen in male. Thorax with notum only slightly more reddish brown, stripes lacking, metanotum light brown, corners of scutellum with spots. Other areas lacking distinctive markings.

Wing of male (Fig. 49) with "F" pattern darker and broader than normal, arms of "F" pattern fused. Wing pattern of female normal.

Genitalia of female with lateral margins of aculeus (Fig. 34) straight near tip, angle broad (Table 2). Ovipositor sheath blackened at tip. Male with surstly (Fig. 15) slightly enlarged apically. Epandrium darkened laterally.

Third instar with 28-33 anterior spiracles.


Material Examined. Ten males, six females.

Distribution. Maryland, North Carolina and Virginia.

Biology. Adults were collected only between June 13-25. Larvae leave the host plant, *Smallanthus uvedalii* (L.), to pupariate in the soil. Many larvae of different sizes were collected on September 1, none of which were developed enough to pupariate. By November no larvae were found.

*Strauzia verbascinae* Steyskal, 1986.

Diagnosis. The scutellum bears basilateral spots, the fronto facial angle is acute and the notum lacks stripes. The female is easily identified by the ears of the aculeus (Fig. 29). The male is harder to identify. It lacks specialized wing pattern, has short surstly (Fig. 18).
and is less than 5.5 mm.

Distribution: Va., Md., Tenn., and Ky.

Biology. The host, Verbesina occidentalis (L.) Walt., usually grows in dryer mesophytic thickets or openings. Adults were numerous where the host plant was abundant. Adults were collected from May 12 to June 11 in northwestern Virginia. By October all larvae had pupariated in the stems with usually only one puparium per plant.

Strauzia vittigera (Loew), 1873. New Status.

Description. Body length of type 6.5 mm, wing 6.0 by 1.75 mm. Frontotial angle 134 degrees. Scutellum lateral spots distinct; 1/3 of metanotum with light medial “V” pattern. Abdomen with lateral aspects of segments 1-4 slightly darker. Wing pattern complete, stigma not darkened, costal cell with faint spot.

Epyandrium darkened laterally. Left surstylus angled 47 degrees, 4 bristles apically, angle with a small lobe laterally.

A single pair of natal stripes extending both anterior and posterior to the transverse suture, in most specimens, distinguishes this species from other Strauzia except S. arculata. The metanotum is dark laterally and ventrally, the frontotial angle is acute, the wing pattern is coalesced in about half of the males (Figs. 51-53).

Genitalia of male with a small lateral lobe opposite the prensisetae on the lateral border of the clasper (Fig. 19). The female aculeus (Fig. 30) has parallel margins except near the tip where it angles sharply without concavity to the point. These characteristics along with the chronistic differences and host selection serve to separate this species from S. longipennis where it was placed by Steyskal (1986).

Holotype. Male, Nebraska, Heyden collector, Loew Coll. 13287 (MCZ). Paratype, female, Nebraska, Heyden collector, Loew Coll. 13287 (MCZ).

Material Examined. 764 specimens.

Distribution. Ontario west to Montana and south to Virginia and Arizona.

Biology. The host plants are Helianthus hirsutus Raf., and H. tuberosus L. Host plants assigned by Steyskal, (1986) to S. longipennis belong here except for Smallanthus undulae which belongs to Strauzia undulae and Agarathon altissima which is in error (personal communication with collector).

Adults were collected from May 15 to July 21 in northeastern Ohio. Many eggs are laid in the upper internodes of developing stems, e.g., 10 in one stem. Usually only a single puparium, sometimes two, are found in the upper root or crown area. Exit holes at ground level were found plugged with plant fibers and excrement. In central Iowa pupariation occurred in late September or early October.

The flies reared from H. tuberosus are quite variable in pigmentation of the thorax and the wing pattern in the male. All specimens reared from H. hirsutus had a normal wing pattern, well defined natal stripes, both anterior and posterior to the transverse suture and were generally less than 5.5 mm in body length.

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LITERATURE CITED


