KEY TO SEPARATE NATIVE AND QUARANTINE SIGNIFICANT SPECIES OF GELECHIIDAE FEEDING ON SOLANACEAE IN FLORIDA AND THE GULF COAST REGION

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Passoa (2007) illustrated identification characters of some exotic Lepidoptera of quarantine significance to the southern United States. As pointed out by Hodges (1998), little information exists on the immature stages of the Gelechioidea and very few vouchers document these life cycles. This lack of material prevented Passoa (2007) from treating the family Gelechiidae at the species level. Here we present a key to separate some native and quarantine significant species of Gelechiidae feeding on Solanaceae in Florida and the Gulf Coast Region. Identification of the pest species is often difficult; in particular, there is a need to distinguish *Tuta absoluta* from *Keiferia lycopersicella* (Povolny 1975: 392).

Larval terminology follows Stehr (1987). The definition of "outer tooth" (called an extra tooth by Benander 1937) follows Passoa (1985). This key is made for late instar larvae; early instars may not be identifiable. Characters used in the key were taken from Capps (1946), Keifer (1936, 1937), Povolny (1973), Schnitzler et al. (2012), USDA (1973) and Weisman (1986). A few discrepancies in the literature are discussed in the caveat section below. The characters in the couplets are ordered from the head to abdomen for ease of viewing. The number of teeth on the mandible is subject to wear, and the last (fifth) tooth is especially small and easily missed if worn.

Typically, gelechiid larvae are recognized by having the following combination of characters: a trisetose prespiracular group, L1 and L2 closely spaced below the spiracle on A3-6, a bisetose SV group on A1, a trisetose SV group on A3-6, and A9 with the D and SD setae each on a separate pinaculum (Capps 1946). In addition, the distance between L1 and A3 on the head is greater than the distance between A2 and A3 (Capps 1946, Stehr 1987), and at least SD1 and D1 are in a vertical line on A9 (Passoa 1995: 232). Other characters present in some, but not all Gelechiidae, are: mandible with an outer (extra) tooth, crochets divided into two groups, presence of an anal comb (Stehr 1987, Passoa 1995, Hodges 1998), and presence of a sclerotized collar on the abdominal prolegs (Carter and Kristensen 1998: 36). Fetz (1994) noted that the proleg size or crochet number may be reduced in some species. Nevertheless, recognition of gelechiid larvae remains difficult, even at the family level (Stehr 1987). For example, Carter and Kristensen (1998: 36) pointed out that both Gelechiidae and Oecophoridae have similar spacing of the of L1 and A3 setae. Our Couplet One should be regarded as a simplification to screen out larvae that are not typical gelechiids, and it is not designed to replace the above diagnosis.

A few attempts have been made to characterize subfamilies of larval gelechiids. Benander (1937) diagnosed Gelechiinae by having an outer tooth and/or anal comb. Not all Gelechiinae have an outer tooth (Peterson 1962: L15), and an anal comb is present or absent even within a single genus (e.g. *Chionodes*, Hodges 1999). According to Hodges (1998), an anal comb is usually absent in the Gelechiinae and often present in the Dichomeridinae, but even a tentative larval key to gelechiid subfamilies is not possible at this time.

Povolny (1991) compared chaetotaxy of the Gnorimoschemini to the Gelechiinae. He noted mature larvae of the Gnorimoschemini may lack some primary setae (e.g., reduction to one SV seta on A8 and A9); L1 and L2 are closely spaced on the prothorax; D1 and D2 are separated on T2 and T3; SD2 tends to be reduced on the abdomen; D1 and D2 are vertically arranged on A9; and SD1 of A9 is hairlike with a pigmented base. There is also a tendency for D1 to be anterodorsad of D2 on the abdominal segments of the Gelechiinae (Povolny 1991: plate 15) compared to a more vertical arrangement of these two setae in the Gnorimoschemini (Povolny 1991: plate 16). He further called attention the lateral arrangement of P1 and P2 on the head. Although this is unusual among oecophorid larvae (Passoa 1995: 249), variation in the P setae has not been studied in Gelechiidae. In fact, all these generalizations need modification based on studying a larger group of species. There was agreement with Capps (1946), MacKay (1972) and Weisman (1986) when Povolny (1991) stated that the "approximation of AF1 and AF2 is striking" in Gnorimoschemini. This character has been used to recognize solanaceous feeding gelechiids in several publications (e.g. Weisman 1986) and may be the best way to define taxa covered in this key.

Some caveats need to be emphasized.

- As is the case with almost any gelechioid study, numerous species wait to be described, and only a few life histories are well known. No doubt there are rare or locally common native species that we do not include in this key. Users need to be aware of the possibility of new records, in the host data and distribution, as well as the discovery of undescribed taxa. In particular, the two species (*Frumenta nundinella* and *Symmetrischema kendallorum*) are included in our study as adults but omitted from the larval key.
- Our focus was on New World species eating tomato, potato and weeds like *Solanum*. Some major pests of potential quarantine significance, for example *Scrobipalpa heliopa* (Lower), could not be included.
- *Keiferia lycopersicella* was considered a "superspecies" by Povolny (1973: 608) because of variation in wing pattern, wing color and adult body size. We have seen similar variation in the larvae. In particular, some specimens from Virginia lack the characteristic dark band on the posterior margin of the prothorax. These are either misidentified or represent another form or species. For the purpose of this key, we restrict *K. lycopersicella* to those specimens with the typical prothoracic shield coloration. Two characters to separate *Keiferia lycopersicella* from *Tuta absoluta* in the literature do not appear to be consistently valid: the presence or absence of a sclerotized prespiracular pinaculum (Gonzalez 1989, Sannino and Espinosa 2009) and the presence of a prothoracic dark band in *Tuta* only (ChemTica 2013). Thus, we do not use these characters in our key. Sibling species closely related to *K. lycopersicella* with similar larvae occur in Latin America (Pataki and Sierra Padiz 1989). They would be easily confused with *K. lycopersicella*, but none of them are known to be established in North America.

- *Keiferia gudmanella* and *Symmetrischema capsicum* were often confused in the literature (Povolny 1973). We follow Lee et al. (2009) who did not list *K. gudmanella* from the United States. Thus, *K. gudmanella* is excluded from our key to Gelechiidae feeding on Solanaceae in Florida and the Gulf Coast Region of the United States.
- Hodges (1969) synonymized *Keiferia peniculo* under *Keiferia glochinella*, but both species key out in separate places using Capps (1946: couplets 2 or 5). Either the larva of *K. glochinella* is morphologically variable, the two are not synonyms, or the material seen by Capps was partially misidentified. Based on adults, Hodges (1969) stated that Heinrich's concept of *K. peniculo* is the true *K. glochinella* and that the rest of the material in U.S. National Museum (where Capps studied) identified as *K. glochinella* is actually *Keiferia inconspicuella*. We have specimens collected from eggplant in Ohio associated with preserved pupae containing pharate adults (OSUC, FSCA). The genitalia from these pupae match *K. inconspicuella* using Hodges (1985). We used these dissections to identify the associated larvae as *K. inconspicuella*. The larval description of *Keiferia peniculo* by Capps (1946) could represent the true *Keiferia glochinella,* except that eggplant is not a known host of *K. glochinella*. We have used Capps (1946) in a general sense to tentatively place *K. glochinella* in the key without accepting morphological details. Larvae from Texas on *Solanum carolinense* could be either species.
- We follow Hodges and Becker (1990) who synonymized *S. tangolias* with *S. plaesiosema* and have used larval descriptions published under either name as one species. Keifer (1937: plate II: P7a) and Capps (1946: fig. 4) disagreed on the fusion of the thoracic D and SD pinacula in *Symmetrischema tangolias*. In addition, Keifer (1937:181) observed that *S. tangolias* illustrations of genitalia and larvae from Peru and New Zealand were slightly different from his California examples. The significance of this variation is unknown.
- Unpublished phylogenetic studies by several workers suggest that *Tuta absoluta* may be misplaced in *Tuta*. Being a well-known economic pest, we do not want to suggest a new combination without the proper documentation.
- Because the adult of *Keiferia altisolani* is very similar to several of our target species, we have included it in our adult and larval treatments even though it is not known from the eastern United States.

1. Prespiracular group trisetose; SV group on A1 bisetose; A1-8 with L1 and L2 closely spaced; A9 with at least SD1 and D1 in a vertical line and D2 on its own pinaculum... Gelechiidae

1'. Larva not agreeing with all of the above characters... not Gelechiidae

2. AF1 and AF2 usually closely spaced with AF2 closer to middle of front than the apex; mandible with 4-5 teeth on the cutting margin and an outer tooth; anal comb always absent; larva feeds on Solanaceae... 3

2'. AF1 and AF2 widely spaced with AF2 closer the apex of the front than the middle; number of teeth on mandible variable, often without an outer tooth; anal comb sometimes present; not feeding on Solanaceae... not Gelechiidae in this key

3. Prothoracic shield with a dark band on posterior margin... 4

3'. Prothoracic shield without a dark band on posterior margin... 5

4. Profile of the dorsum of A7 and A8 has blunt or pointed microgranules under high magnification (200-400x); abdomen sometimes with irregular bands or patches of pigmentation that are often pink or purple, which are visible in live larvae and sometimes preserved specimens... *Keiferia lycopersicella*

4'. Profile of the dorsum of A7 and A8 has microspines under high magnification (200-400x); abdomen never has irregular bands or patches of pigmentation in either live larvae or preserved specimens... *Tuta absoluta*

5. Diameter of SD1 pinaculum larger than the spiracle diameter on A3; mandible with 4 teeth on the cutting margin; L group bisetose on A9... 6

5'. Diameter of SD1 pinaculum smaller than the spiracle diameter on A3; mandible with 5 teeth on the cutting margin; L group trisetose on A9... 7

6. Outer tooth well developed; thoracic legs pigmented; SD1 on A9 hairlike; from Central and South America... *Tecia solanivora*

6'. Outer tooth poorly developed; thoracic legs pale; SD1 on A9 setiform; from the western United States... *Symmetrischema tangolias*

7. Head flattened and retracted; leaf miner or tier on *Solanum xanti* from California ... *Keiferia altisolani*

7'. Head variable, rounded or flattened; miner, tier or borer on pepper, eggplant, potato or other solanaceous hosts in the eastern United States, but if associated with *Solanum xanti* from California, then the head rounded and not retracted... 8

8. Thoracic legs pigmented; a line joining L1 and S2 is posterior to stemma one; L setae of A9 in a triangular arrangement... *Phthorimaea operculella*

8'. Thoracic legs pale, not pigmented; a line joining L1 and S2 either passes through or is posterior to stemma one; L setae of A9 in a vertical arrangement... 9

9. Head rounded, a line joining L1 and S2 touches or passes through stemma one; on pepper...

Symmetrischema capsicum

9'. Head flattened, a line joining L1 and S2 is usually posterior to stemma one; on eggplant or *Solanum carolinense*... 10

10. From Texas to the eastern United States, on eggplant or *Solanum carolinense*... *Keiferia inconspicuella*

10'. From Texas, New Mexico and California, on *Solanum carolinense*... *Keiferia glochinella*

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