KEY TO FREQUENTLY NAMED LEPIDOPTERAN LARVAE INTERCEPTED, OR POTENTIALLY ENCOUNTERED, AT US PORTS

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This key is designed to identify the most frequently named Lepidoptera at United States ports of entry as of 2013. Because many species cannot be named (early instars or poorly studied groups), it is not a given that this key has all the most frequently intercepted taxa. Some genera may regularly intercepted but unrecognized. The huge variety of early instar Noctuidae/Erebidae is a good example of this problem. There are many other taxa in this category. Trade patterns are constantly changing over time, users should expect a need to delete or add species to this key in the future.

Good comprehensive larval keys exist (Carter and Kristensen 1998, Stehr 1987) but as a rule they are too long and complicated for the volume of material we get in APHIS. Also, they rarely go past family. This key is a compromise between the need to for precision and speed. Thus, a good collection and detailed understanding of larval morphology is assumed and required. All of the references cited in the LepIntercept fact sheets need to be part of any port library. This document serves as a blanket recommendation for their purchase or copying costs from the APHIS Lepidoptera specialist to any port needing a justification. This key assumes eventual full access to the appropriate literature. Getting this information needs to be a priority for ports frequently intercepting larval Lepidoptera. Many of the copyrighted books are never going to be "on-line" and go out of print relatively fast. Aggressive hassle free purchasing is a must for any serious identifier having to deal with Lepidoptera.

Weisman (1974, 1986) and the Pest ID System – previously called PIN, PINET) database were consulted to select species for this key. Additions were made based on the experience of the author. For every species in LepIntercept, we include a diagnosis and reference the appropriate data sheet. To increase taxon coverage, several other categories have been added. Some species are commonly seen at the ports but were outside the scope of our study (not in the top 80%). They are mentioned to point identifiers in the right direction. When there is a relatively easy diagnosis, it is included. A third category is composed of major pests not commonly intercepted, but serious enough to warrant inclusion in the key. This usually involved consulting the Pests Not Known to Occur in the United States (PNKTO) series and the Off Shore Pest Information System list for Lepidoptera (http://www.aphis.usda.gov/plant_health/safeguarding/ downloads/ 2011/OffshorePestInformationSystemPestListProject.pdf). Studies on quarantine Lepidoptera have produced new species and novel morphological characters. United States ports do not just intercept "common species". Some rare larvae, if they would cause confusion, are added. Very distinctive larvae are also sometimes included. With a few exceptions, if a genus or species is mentioned, identifiers can expect these taxa can be recognized with morphology. Pupae are rarely intercepted but are included in this key if they have been found in significant numbers over several years.

Unlike traditional taxonomic keys to a given category (genus, species, etc.), this key mixes family to species identifications and adds "possibly" or "usually" or "probably" if needed. These warnings emphasize the importance of confirming the identification with additional literature, morphology and host/origin data. Many of the taxa categorized as "probably" or "usually" could be confirmed with more effort but their diagnosis was too complicated to include as a bullet statement. They appear in the index with a question mark. This key suggests other possibilities where better identifications are often possible for areas with more complete literature. Thus, the key stops at Sphingidae, but one should not assume that no larval sphingid can ever be identified. Rather, there was no common pattern of species that could be suggested.

Do not forward specimens to specialists with no data (origin unknown and no host) because these contribute nothing to the Pest ID database unless the pest is especially significant (e.g., a high ranking OPIS species). Those missing parts (head or abdomen) should also be held because the chance of getting a good identification on such material is slim.

The following works (and references within them) have been consulted freely to construct this key: Weisman (1974, 1986), Epstein (1996), Stehr (1987), Passoa (2007), Kristensen (1998) and Schnitzler et al. (2012). The pyraloid section was based on Weisman (1974, 1986, 1987), Passoa (1985, 2007), Solis (2011 revision) and Hayden et al. (2013). The Noctuoidea was modified from Weisman (1986), Crumb (1956), Miller (1991), and Passoa (2007). The Tortricidae key was authored by Todd Gilligan. Consult Gilligan and Epstein (2012) for interactive identification keys covering additional tortricid species of quarantine significance. The Gelechiidae species list and index is by Jim Young. All the references in the fact sheets and numerous unpublished APHIS training aids were also consulted.

No attempts were made to place the taxa in phylogenetic order nor were characters studied to decide the best way to organize the key. Families were eliminated one by one based on how easy the taxon was to define or how common the species are at the ports. The organization generally follows Weisman (1986) and aims for an almost equal number of couplets. Better versions and schemes with illustrations are already being considered and tested for the future. Classification of the Lepidoptera follows Nieukerken et al. (2011).

Characters ordered from head to anal shield without regard to importance. Terms are defined in Stehr (1987). The most obvious terminology change from Weisman (1986) is that stemmata is used in lieu of ocelli. This key does not have any "escape couplets" (for example, none of the above) except in Noctuidae/Erebidae. Therefore it is important not to force an answer. If nothing fits, it is likely the identifier has a species not covered by this key. The characters used to identify the included taxa are often suitable for situations outside the ports. If *Spodoptera frugiperda* is suspected in corn from North America, the key and fact sheets can help confirm or refute the identification. The reverse is not true. Keys for intercepted Lepidoptera are not designed to identify random unknown larvae outside the ports. This situation was pointed out by Solis (2011) and it still remains a valid warning. Be careful when only a host and scientific name is given without a diagnosis. This is a good place to start but there usually are other possibilities. Where it has been studied (pyraloids and Noctuidae), it is painfully obvious that early instar larvae often will not key to species correctly. Thus, most early instar larvae should not be forwarded to specialists because morphological identification is not possible at this time.

If there are questions, do not just pop the larva in the mail and expect a specialist to read long notes or guess at the issue. Instead, take a photograph of the structure and email it. This allows for mutual viewing of the segment in question and almost always will lead to a fast clarification. Some Lepidoptera are urticating, port identifiers need to point this out to less experienced inspectors. The caterpillar fauna of Japan, Australia, Europe, Canada and North America are best known. Africa is the least studied. Asia and Latin America are partially documented. This should be kept in mind when deciding to forward a specimen to a specialist. No effort was made to repeat large sections of keys that required no changes. Pierids on crucifers, tineids and phycitines on stored products, and New World *Spodoptera* are some examples.

This key points out significant problems in identification of quarantine Lepidoptera and summarizes the "state of the art." Nearly all these problems could be overcome with time to carefully study specimens using a large series of known larvae in all the instars. Worldwide, quarantine workers feel pressured to get enough time outside their identification load and collections almost always lack the needed material. It is wrong to conclude "larvae can't be identified"; results come after resources are allocated. Systematics is no different from any other scientific endeavor in this regard.

There are many caveats to this key. Most serious, few interception records are based on barcoded larvae or are associated with reared adults. Their hosts are never vouchered and many plant identifications are not made by trained botanists. Origins can be misleading because of shipping changes in transit. All of these factors must be remembered when analyzing Lepidoptera intercepted at ports of entry. The reliability of any association is based on repetition. The more times a species is found on a given host from a given pathway, the more likely that association is real and valid.

Given a very short time frame, a large series of specimens could not be examined. There was no time to carefully cite literature for all the facts presented. No effort was made to separate literature records from recent or past interception data for species not covered in the fact sheets. The Pest ID database provides the most up to date listing of hosts and orgins. No effort was made to duplicate this data with additional indices or lists although interception data was critically evaluated for species covered in the fact sheets. Nevertheless, it is expected that this key will produce a correct identification for a large majority of Lepidoptera intercepted at United States ports when used in combination with the fact sheets. The Systematic Entomology Laboratory deserves credit for producing the taxonomic monographs fundamental to any key. APHIS port identifiers answered questions, took pictures and donated specimens. Hopefully this key repays their efforts and patience. Any further comments or corrections are welcome.

1. Body with numerous secondary setae or scoli, hiding most of the primary setae 2

Secondary setae can be spinelike (e.g. Arctiinae) or in arranged in tufts (e.g. Lymantriinae). Occasionally the secondary setae are minute and the larva appears smooth even though the body is covered with hairs (e.g. Papilionidae). Scoli are sometimes present. Some Arctiinae erebids, such as *Utethesia* on *Crotolaria*, are an exception. They best fit here because the bisetose L 3 group on A1-8 can be conisidered secondary setae in a regular pattern, even though the covering is sparse. Minute spinules on the skin do not count as secondary setae (Heliothinae, etc.).

1'. Body without numerous short secondary setae or scoli, primary setae evident 12

Some gelechioids have secondary setae on the prothoracic shield (Peleopodidae). A genus of sod webworms has scattered secondary setae on the anal prolegs. *Anarsia* has secondary setae on the anal shield. Also, a few families have one or two "extra setae" (Cossidae, Thyatiridae, some Tortricidae, seta X of the Notodontidae and a few Noctuidae). All these examples should be ignored for this couplet.

2. Head usually much larger than prothorax, body widest at middle; lenticles present; crochets biordinal or triordinal in a laterally elongated circle.........HESPERIIDAE

Two of the three hesperiid subfamilies have a "neck". All subfamilies have lenticles. Minno (1994) has a larval key to some New World pest species. APHIS is most likely to see *U. proteus*. From at least 1989 or earlier, the maguey worm *Aegiale hesperiaris* (or more rarely, *Agathymus* sp.) is no longer the most common worm in bottles of tequila. Instead these are being replaced with the cossid *Comadia* (see couplet 49, Brickey and Gorharn 1989) Some hesperiid species have an anal fork. The abdominal segments are indistinctly annulated. Distribution: worldwide.

- head black and read; yellow subdorsal stripes in living larvae; beans, Latin America...*Urbanus proteus*

2'. Head equal to the diameter of prothorax or much smaller, sometimes retracted and hidden; body sometimes sluglike; lenticles usually absent; crochets in a mesoseries..3

Some African Saturniidae have lenticles, for example, the mopane or mopani worm.

3. Body with 6-8 annulets per segment; A8 with a dorsal horn or button.................... SPHINGIDAE

Although Sphingidae are the most commonly intercepted larva with a horn, other families can have this character including the Bombycidae, a few Notodontidae and Endromidae. Very rarely, sphingid larvae have A8 completely unmodified. Except for a few pest species, and certain countries where good picture books exist, sphingid larvae are normally identified to family. It is rare to get large mature sphingid larvae, most are early instars. *Erinnyis* and *Hyles* are two genera likely to be intercepted. Distribution: worldwide.

3'. Body lacks annulets or has no more than six if present; dorsal horn on A8 absent...4

4. Head sometimes retracted and hidden, body sluglike 5

If you inject or boil the larva to preserve it, the head may evert on some slug caterpillars (see drawings in Stehr 1987 for Lycaenidae). APHIS does not commonly intercept megalopygid or zygaenid larvae. Limacodidae and Lycaenidae are the most common slug caterpillars at the ports. The larva on *Thryptomene* needs to be reared or barcoded, the family identification is unclear.

- verrucae present, uniordinal crochets in a mesoseries, inconspicuous slitlike gland near the spiracles of A2 and A7, some with a gland above the prothoracic coxa; anal comb present or absent; Mexico... Zygaenidae
- A2 and A7 lack glands by the spiracles; body marked with several longitudinal stripes; feeds on *Euonymous* .... *Pryeria sinica*
- *Thryptomene*, Australia ....unknown, either Lacturidae or Zygaenidae
- a fleshy protuberance (spiracular sensilla or spiracular spur) present near the spiracles on the prothorax and A2-8; prolegs on A2-7; crochets on A3-6 or less commonly A2 to A7; New World.. Megalopygidae

4'. Head obvious from above, body cylindrical 6

5. Head retracted and hidden; larva with spiny scoli, hairy tubercles or verrucae, rarely with gelatinous tubercles (some Asian species); crochets absent ......LIMACODIDAE

- The lack of crochets in limacodids distinguishes them from Lacturidae, Megalopygidae and Lycaenidae that share the same slug-like body form but have crochets on the prolegs on A3-6. Most identifications will be left at the family level. Distribution: worldwide.
- dorsal scoli white with red in middle of abdomen; Hawaii, various plants..... *Darna pallivitta*

5'. Head often retracted and hidden; crochets in mesoseries interrupted at center by spatulate lobe..LYCAENIDAE

Most lycaenids cannot be named past family unless they are from pineapple, pomegrantes, beans or New World cycads. Distribution: worldwide.

- honey gland present on A7; living larvae bright red; no modified or star shaped setae on body; from pineapple in Latin America............................... *Strymon* (see data sheet)
- pomegranates ....possibly *Virochola*
- New World cycads.. *Eumaeus*
- beans, Mexico ....possibly *Everes comyntas* or *Strymon melinus*
- head not black, beans, Old World ....possibly *Lampides boeticus*
- from *Pelargonium*, Europe or South Africa .... possibly *Cacyreus marshalli*

6. Osmeterium present; the metathorax may be enlarged; transverse body stripes and/or an eyespot may be present; some have fleshy filaments.....................PAPILIONIDAE

The osmeterium is not always everted in some preserved specimens. When in doubt, inject the larva with alcohol through the anus to try and extend the gland or look for a slit on the prothoracic dorsum that is the exit hole for the osmeterium. Early instar papillionids often have short scoli and are sometimes confused with Saturniidae. They are normally identified to family unless they are mature larva from Europe or Asia. *Papilio demoleus* is present in the Caribbean Region and poses a threat to North America. The African species, *Papilio demodocus*, also from citrus, is almost morphologically identical to *Papilio demoleus*.

- early instars with spiny scoli and a white mid-abdominal saddle; mature larva smooth with a black or white intersegmental markings between T2 and T3, another between A1 and A2, and a slanted lateral line on A4 and A5; anterior margin of prothorax and A9 with paired small tubercles; last abdominal segments never totally pure white; on citrus and relatives in the Caribbean ....possibly *Papilio demoleus*

6'. Osmeterium absent; metathorax and coloration not as above 7

7. Abdominal segments two through six divided into five, or usually six, annulets; crochets in continuous, usually triordinal, mesoseries, sometimes with an extra short series of crochets parallel to the larger band .... PIERIDAE

There are two types of pierid larvae. One group has short secondary setae and small chalazae. Other species have large chalazae mixed with smaller setae. Existing keys to *Pieris* often depend on color characters that rapidly lost in preserved larvae. Pest species feed on crucifers or legumes. Distribution: worldwide.

- on crucifers............................*Leptophobia aripa*, *Pieris* (*brassicae*, *rapae*) or *Ascia monuste*
- girdle present; transverse row of black dots on abdominal dorsum; containers from Europe ....possibly pupae of *Pieris brassicae*

7'. Abdominal segments two through six not divided into annulets; crochets lacking an extra short series of crochets parallel to the larger band..8

8. Middorsal glands present A6 and A7..LYMANTRIINAE (EREBIDAE)

Although most lymantriines have glands on A6 and A7, one Indian species apparent has lacks glands, a few species have only a single gland on A6, and in rare cases six gland slits may be present (Gardner 1941, Kitching and Rawlins 1998). There are no morphological methods to tell gypsy moth strains apart but Wallner et al. (1994) suggested discriminant analyses of larval head colors. I do not know if this is practical. Pogue and Schaefer (2007) reviewed some selected *Lymantria* species and included a key to first instar larvae. Traxler (1977) studied the morphology of the European gypsy moth larva in detail with a scanning electron microscope. Pupae of *Orgyia leucostigma plagiata* can only be identified if the larval exuvium is present to determine head color. Distribution: worldwide.

- head with two thick longitudinal stripes; dorsal verrucae spiny, without hairbrushes, tufts or flattened white setae; prothorax with a pair of lateral projecting verrucae; on trees or shrubs, usually not conifers; northeastern United States .... *Lymantria dispar* (European strain)
- Pupa with dense dorsal abdominal setal tufts; the ground color sexually dimorphic (males light brown, females dark brown black); larval cast skin with the head brownish, not red or yellow, and with no trace of a setal tuft on A2 or red verrucae on the abdomen; origin has to be Nova Scotia and only from balsam fir around Christmas (late December).. *Orgyia leucostigma plagiata*

8'. Middorsal glands absent A6 and A7 9

9. Larva with barbed secondary setae and heteroideous crochets; if crochets are homoideous, then the mandible has a large molar lobe .... ARCTIINAE (EREBIDAE)

Some Arctiinae have only a few scattered secondary setae on the L3 group of A1-8 that can be easily missed. Injecting the larvae, or boiling the specimen, helps to extend the prolegs making the crochets easier to see. The molar lobe of footman moths was illustrated by Stehr (1987). Species identification of *Utetheisa* depends on origin. Distribution: worldwide.

- head pattern with two black bands; setae yellow to brown to orange, on crops from Mexico and Central America .... often *Estigmene acrea*
- hairy pupae on bananas .... usually Ctenuchinae
- black and orange, on *Crotolaria* ....*Utetheisa*

9'. Secondary setae not barbed; crochets are homoideous and a large molar lobe is absent..10

10. Scoli absent .... VARIOUS FAMILIES

This is a collection of microlepidoptera and macrolepidoptera with secondary setae. Lecithocerid mandibular drawings show a large black tip; this may indicate they are sclerotized more heavily than normal, but this could not be evaluated without actual specimens. Pterophorid larvae on *Scabiosa* from Europe may be in the genus *Stenoptilia*, but no comparative material is available for comparison. *Sphenarches anisodactylus* is intercepted on pigeon pea from the Caribbean region. This couplet also includes noctuoids covered with secondary setae. As with the osmeterium, the prothoracic gland may not be visible in all preserved specimens; if it appears to be absent, double check by looking for a slit between the prothoracic legs. Any of these noctuids be could confused with Arctiinae. They are not frequently intercepted.

- mandible with a sclerotized tip on the first tooth; with verrucae and both sclerotized rings and a pore associated with SD1 on A8 .... Lecithoceridae

- SD1 not modified on A1-8, apple, coconut, *Protea* ....Agonoxenidae
- anal point present; larva brown to gray to partially orange; with retractable tufts of steel blue to black hairs on T2 and T3; pine, Old World................................. *Dendrolimus*
- larvae covered with secondary setae that may be normal, spinelike, clubbed or curved; prespiracular pinaculum trisetose when secondary setae reduced; prolegs long and slender, crochets in uniordinal penellipse; cut flowers, Mexico, Europe ....Pterophoridae
- prothoracic gland present; crochets uniordinal; prolegs well developed on A3-6 ....Acronictinae, Pantheinae
- prolegs only on A4-6 .... Nolidae (part)
- P2 high on head near vertex, distance between P2 less than distance separating P1; mandible of mature larva with no scissorial teeth; stipital lobe present; two MD setae present on A1.. Notodontidae (part)

10'. Scoli present, either simple or branched 11

11. Stemmata not uniform in size or location; head angulate, sometimes with long scoli; middorsal scoli sometimes present on A7 but not A9; last abdominal segment may be forked; crochets uniordinal to triordinal, but usually triordinal...NYMPHALIDAE

Nymphalid larvae are highly diverse but APHIS rarely intercepts anything except young larvae from herbaceous plants in Mexico. They are often confused with Saturniidae. It is likely they are all in the Nymphalinae.

11'. Stemmata uniform in size and location; head smooth, without scoli; middorsal scoli sometimes present on A9 but not A7; last abdominal segment never forked; crochets biordinal ....SATURNIIDAE

Saturniids are mostly intercepted as part of a Smuggling Interdiction and Trade Compliance (SITC) Program project. These usually involve eggs or pupae as these two stages are the ones commonly transported. It is very rare to find a mature larva intercepted at the ports. Pupae from China are common, often in large numbers. Distribution: worldwide.

- with sustenores (paired projections on the last segment); exported from England but native to Asia...*Attacus*
- with a brain window; metathoracic wing with a tubercle; cremaster with very short stout spines; in baggage from China.. *Antheraea*

12. Caterpillars living in a tent or case of plant or animal matter .... VARIOUS FAMILIES

Do not confuse tent makers with leaf webbers. Many microlepidoptera make a web on a leaf. Tent makers in this couplet enclose at least several leaves and often a part of a branch. New World Psychidae can sometimes be identified as can tineids from stored products. Do not discard the case; it is critical to accurate identifications past family. There is also scattered literature on Coleophoridae and Acentropinae immatures. A few gelechioid families also live in cases but except for *Coleophora* we do not expect to intercept them. The same is true for tent caterpillars. Case makers and tent caterpillars are so obvious that infested hosts are unlikely to be exported. Unless noted otherwise, groups are distributed worldwide.

- prespiracular group fused with prothoracic shield; prothoracic spiracle, if oval, is lying horizontal; SV group of T2 and T3 bisetose; case made mostly of plant material such as leaves and twigs ....Psychidae
- larva often with six or less stemmata; three (rarely two) L setae on T1; L setae on A1-8 widely separated; crochets may be surrounded by a band of cuticular spines; case does not include much plant material if any at all .... Tineidae
- aquatic larvae, gills present or absent, case of plant fragments ....Acentropinae
- from Chile on asparagus (not the true host), less commonly intercepted in recent years; case smooth, not wrinkled, with a triangular rear portion ....*Coleophora verzurella*
- Hawaii .... possibly *Hyposmocoma*
- V1 setae on head macroscopic, half as long as P2; most often cherry, apple or *Euonymus*, Canada and Europe .... *Yponomeuta sp*
- large gregarious macrolepidoptera in a tent, pine or hardwoods;
    - mandible with secondary setae, Old World .... *Thaumetopoea*
    - with anal point; New & Old World.. *Malacosoma*

12'. Caterpillars not living in a case of plant or animal matter..13

13. Caterpillars living in a leaf mine ....various families

There are numerous characters on leaf mines that help identifications: the shape (blotch or serpentine), the location (upper or underside) and the frass pattern if present. Thus, one should never submit a leaf miner without the associated pressed mine. At least preserve the mine in the vial with the larva. Good host data is also critical. APHIS rarely intercepts leaf miners, this seems strange, perhaps inspectors don't recognize them. Or it is not properly noted on the APHIS form 309. Beside leaves, mines also occur on bark and fruit. Pupal clusters of *Leucoptera malifoliella* are sporadically intercepted from Europe or the Middle East, sometimes in large numbers. The tiny smooth white cocoons on apple are often X-shaped. Gracillariids have hypermetamorphic development, there is a sap feeding early instar and a later tissue feeding form. The family is easily recognized by the presence of prolegs on A3-5, however, early instars have no prolegs and a few genera do have well developed prolegs on A6. Very rarely, prolegs are present on A2-6 (Davis 1994 and references within).

- in supermarkets, on citrus (esp. oranges) from California...*Marmara*
- *Opuntia,* Mexico .... *Marmara opuntiella*
- Serpentine miner on citrus with central frass tract, mature larva with two thin anal “tails” (absent in prepupa)...*Phyllocnistis citrella*
- on litchi or logan, Asia... usually Gracillariidae
- various woody plants, Europe, Mexico... possibly *Phyllonorycter*
- L1 of T3 and A1-2 on lateral projections; mines almost circular, if backlighted, frass is seen in arcs or concentric circles; fruit trees, Europe .... *Leucoptera malifoliella*
- linear, irregular blotch mines, often with a darker area inside; horse chestnut, Europe ....*Cameraria ohridella*

13'. Caterpillars not living in a leaf mine 14

14. Abdominal prolegs absent on A6.. most GRACILLARIIDAE

Most gracillariids are leaf miners and will key out in couplet 13. A few bore in fruit and would not be considered leaf miners.

- in fruit of litichi or logan, Asia except Australia ....*Conopomorpha*
- in fruit of litichi from Australia .... *Conopomorpha* or *Acrocercops*

14'. Abdominal prolegs present on A6 15

15. Abdominal prolegs present only on A6 and A10....................................... most GEOMETRIDAE

A few geometrids have vestigial abdominal prolegs on A3-5 or just A5. African species can have well developed prolegs on A3-6. In spite of this being one of the largest families of Lepidoptera, hardly any larvae go past family. A simple rearing project would cheaply clarify the most common Mexican interceptions from corn or raspberry. Specimens from Canadian blueberry sometimes can be identified. Submit only mature larva with bright colors or atypical morphology. There are no keys except for Canada and a picture book from Australia.

- Skin granulose; setae spatulate .... Sterrhinae (*Idaea* authority was cancelled)

15'. Prolegs present on other abdominal segments in addition to A6 and A10..................................16

16. Four setae in the prespiracular group of the prothorax .... *Langsdorfia*

APHIS has not yet intercepted *Langsdorfia*, but the larva will not key correctly in any published work because of the extra seta on the L group of the prothorax. It bores in stems through Latin America and is economically important at times in Central and South America.

16'. Less than four setae in the prespiracular group of the prothorax 17

17. Less than three setae in the prespiracular group of the prothorax 18

17'. Three setae in the prespiracular group of the prothorax 47

18. Apparently only one seta in the prespiracular group of the prothorax .... NOCTUIDAE

Various genera of noctuids have an apparently unisetose prespiracular group on the prothorax. *Sesamia* and *Busseola* are difficult to separate as larvae but *Busseola* does not occur in Europe. Setal angles are a key feature for African stem borers so identification requires an eyepiece goniometer. This is a special eyepiece for measuring angles like a protractor. APHIS has regularly intercepted *Sesamia* from chestnuts even though it is not a recorded host of this species.

- Europe, artichoke ....*Gortyna*
- Africa, corn .... *Sesamia* and *Busseola*
- Europe, corn and chestnuts ....*Sesamia*

18'. Two setae in the prespiracular group of the prothorax...19

Most caterpillars intercepted by APHIS with a bisetose prespiracular group and the L setae closely spaced belong to the Pyraloidea. More rarely they are Carposinidae. However, when the world fauna is considered, a wide range of other Lepidoptera have this chaetotaxy. Any of them could potentially be confused with the Pyraloidea. Examples of a bisetose prespiracular group are found in larvae of the Tineidae (Scardiinae), Gelechioidea (Momphidae) Yponomeutoidea (almost all Glyphipterigidae, a few Yponomeutidae, Ypsolophidae), Tortricidae, Copromorphoidea, Choreutidae (Millieriinae), Epermeniidae, Alucitidae, Thyrididae, Hyblaeidae, Tineodidae, and Brachodidae.

- Iris, Japan .... *Monochroa* (adult reared, formally misidentified as Momphidae)
- on Onagraceae, in stems or seeds ....probably a true Momphidae

19. Setae L1 and L2 of abdominal segments 3 to 6 close together below the spiracle, often on the same pinaculum..20

19'. Setae L1 and L2 of abdominal segments 3 to 6 widely separated, either both L setae below the spiracle or one behind the spiracle (Noctuoidea, part)....................................34

20. Four subventral setae present on abdominal segments 3 to 6 ..........................CARPOSINIDAE

The submental flaps mentioned by Stehr (1987) are not obvious in the few specimens of this family APHIS has intercepted.

- in fruit of *Malus* or *Crataegus*, Canada, Japan ....*Carposina*

20' Three subventral setae present on abdominal segments 3 to 6..............................PYRALOIDEA

Compared to other large families of Lepidoptera (Noctuidae, Erebidae, Tortricidae and Geometridae), the larger pyraloid subfamilies are relatively well defined and most authors use the same characters to define the subfamilies. Because chaetotaxy of the Schoenobiinae is difficult to study, it is easiest to look for their membranous sac, and if it is absent, eliminate this subfamily as a choice before evaluating anything else.

- With membranous sac anterior to prothoracic coxae; no sclerotized pinacula; borers in rice or semi-aquatic plants; Latin America, Asia ....Schoenobiinae

21. A sclerotized ring is present around at least SD1 on A8 or the L group of A9 is trisetose (Pyralidae)...22

APHIS intercepts the Chrysauginae, Epipaschiinae, Galleriinae, Phycitinae and Pyralinae. Sclerotized rings are sometimes hard to see. When in doubt, look for a tiny sclerotized bar called a "neural connection" at the setal base or make a slide of the cuticle and examine the pinacula with a compound microscope. Either the sclerotized rings or L setae on A9 can be used to separate Pyralidae from Crambidae. If the presence of rings is ambiguous, count the L setae. Distribution: worldwide.

- sclerotized rings on SD1 or D2 of the metathorax.................................... many Chrysauginae
- sclerotized rings on D2 of the mesothorax ....*Hypotia*

21'. All segments lack a sclerotized ring and the L group on A9 is unisetose (Crambidae)...25

Some specimens of Pyraustinae and Spilomelinae have pigmentation on the body pinacula that resembles a ring because the center is pale. It will be clear that these are not the true sclerotized rings of the Pyralidae because of their location and number. Those crambids with a bisetose L group on A9 (Acentropinae, Schoenobiinae) were discussed above. The organization of this key by the reduced abdominal SD pinacula or the SV group on A1 is under study. More obvious characters (extra pinacula present or prothoracic shield pattern) are currently favored because identifiers will remember them easier.

22. Sclerotized ring present around SD1 of the mesothorax...................................... most Phycitinae

Phycitines have a sclerotized SD1 ring on the mesothorax, both the mesothorax and A8, or on the mosothorax and at least partial rings on A1-8. More rarely sclerotized rings are absent on all body segments (*Etiella* is a common example). They can be either leaf rollers, stem borers, seed feeders or stored product pests. Identification of other species of stored product pests are given by Solis (2011) or Weisman (1987) and are not repeated here. Sibling species of *C. cactorum* occur in Peru and Argentina. *Hypsipyla robusta* occurs on Meliaceae in the Old World. Other species of *Etiella* are found in Asia. No morphological information useful for identification is present for any of these species. Distribution: worldwide.

- body pinacula not pigmented; cuticle not strongly granulated; front extends from 2/3 to 3/4 the distance to the epicranial notch; D setae in a horizontal line on A1-7 and L setae of A1 in a vertical line; in stored products or a scavenger outdoors in warm climates; cosmopolitan.. *Plodia interpunctella* (see data sheet)
- body pinacula pigmented; cuticle not strongly granulated; front extends only 1/2 the distance to the epicranial notch; D setae in a horizontal line on A1-7; SD2 separated from the spiracle by the horizontal diameter of the spiracle; D2 of A1-7 is two to two and a half times the length of D1; in stored products or a scavenger outdoors in warmer climates; cosmopolitan .... *Cadra cautella* (see data sheet)
- sclerotized rings around SD1 of A1-7 in an arc or crescent shape and well separated from the setal base; sclerotized ring around SD1 of A8 usually complete; SD2 is separated from the spiracle of A8 by at least two times the spiracle's diameter; anal shield with SD1 closer to D1 than L1, Mediterranean Europe, North Africa, parts of Asia, sibling species in tropical America .... *Apomyelois ceratoniae* (see data sheet)
- stored products .... possibly another *Cadra* or *Ephestia* (includes *Anagasta*)
- complete or partial ring fragments on A1-7, in field or stored products..*Amyelois transitella* (New World) or *Mussidia* (Africa)
- prespiracular group and spiracle fused to prothoracic shield in late instars, unfused in early instars; dried fruit; tropic and subtropical regions.. mature *Cryptoblabes*
- head with pale areas around the setal bases; body coloration characteristic, the anterior portions of A1-8 with a series of alternating pale white and gray-green bands; prothorax with a characteristic posterior extension of the prespiracular group; usually on grasses and legumes, New World ....*Elasmopalpus lignosellus*
- prothoracic shield with characteristic pattern of two curved broken middorsal lines and a triangular or curved spot posterior to XD2; mandible with an inner tooth; SD1 seta of the mesothorax 1.5 times as long as the SD1 seta on the metathorax; D1 1/4 the length of D2 on A1; legumes, New World ....*Fundella pellucens*
- head with thick genal dash; lateral margins of prothoracic shield black; rings complete on mesothorax and A8, usually on Asteraceae, United States to Central America ....*Homoeosoma*
- hypopharyngeal complex with a series of blades; D2 posteroventrad of D1 on A1-7; body pinacula large and pigmented; SV group of A9 unisetose; Meliaceae, New World tropics .... *Hypsipyla grandella*
- early instar larvae are white; later instars with black head and prothoracic shield; orange to red larva transversely banded with black bands or spots; SV group bisetose on A7 and A8; *Opuntia*, New World, Australia, south Africa and Hawaii ....mature *Cactoblastis cactorum*

- mandible with an inner tooth on the first molar ridge and three scissorial teeth; body dark; skin granulated; D setae of A1-7 in a horizontal line; L1 and L2 in a vertical line on A3; corn and sorghum, Mexico, Central America ....*Moodna bisinuella*
- prothoracic shield with a characteristic pattern of dark pigmentation, lightly marked specimens have a single dark patch posterior to the SD1 seta, darkly pigmented specimens have two such patches, one posterior to the SD1 seta, the other ventrad of D2; no inner tooth on mandible; D2 posteroventrad of D1; legumes, West Indies to Brazil ....*Ancylostomia stercorea*
- cuticle dark and granulose with obvious tonofibrillary platelets; pineapple, Cuba .... *Ribua*

22'. Sclerotized ring absent on SD1 of the mesothorax...23

23. Sclerotized ring present around SD1 of A1 .... most Galleriinae

Galleriinae divide up into several groups based on larval morphology. Sometimes there are less than six stemmata and the SV group of T2 and T3 is bisetose. Other genera have six stemmata and the SV group of T2 and T3 is unisetose. The prespiracular group and prothoracic shield can be fused. A few taxa have no sclerotized ring around SD1 of A1. Most interceptions are from stored products or seed pods. However, the wax moth is sometimes imported as pet food under permit requiring confirmation by port inspectors. Sclerotized rings can be faint or obvious in Galleriinae.

- prespiracular and prothoracic shields fused; pineapple, Latin America..*Alpheias conspirata, Genopaschia protomis*
- six stemmata present; peritreme of spiracles thickened on posterior margin; sclerotized rings around seta SD1 on abdominal segments 1 and 8 not complete; D1 and D2 pinacula on abdominal segments not pigmented; stored products, cosmopolitan ....*Corcyra cephalonica*
- six stemmata present; peritreme of spiracles uniform in thickness; sclerotized rings around seta SD1 on abdominal segments 1 and 8 complete; D1 and D2 pinacula on abdominal segments pigmented; stored products, cosmopolitan ....*Paralipsa gularis*
- four stemmata present; SV group of T2 and T3 bisetose ....*Galleria mellonella*
- Prespiracular shield of prothorax extending below and behind the spiracle; legume pods, tropical regions .... *Trachylepidia fructicassiella*

23'. Sclerotized ring absent around SD1 of A1 24

24. Sclerotized rings absent on all body segments ....Phycitinae, Chrysauginae

- early instars have a solid black prothoracic shield; later instars have a a characteristic pattern of four groups of dark spots on the prothoracic shield, two lateral and two middorsal at the anterior and posterior ends; legumes.. *Etiella zinckenella* (New World), *Etiella* sp. (Old World)
- in *Crescentia* fruit, tropical America ....*Bonchis munitalis*

24'. Sclerotized ring present on A8...Epipaschiinae, Pyralinae

Most intercepted Pyralinae are stored products pests. There is no sclerotized ring on A9 (misprint in some literature). *Pyralis farinalis* is the most common species but scattered records from crops exist for *P. manihotalis*. There are no morphological descriptions for *P. manihotalis*.

Epipaschiinae includes several pests of avocado but these are leaf feeders not likely to be seen because APHIS usually only imports only fruit. *Phidotricha erigens* is recorded from diverse plants but reared adults are most often from castor bean, corn and sorghum. *Pococera gelidalis* could be easily confused with *P. erigens* on *Mimosa pigra*, at least in Mexico and Honduras.

- First and sometimes the second molar ridge with an inner tooth; XD2 equidistant from SD1 and XD1; body with dark bands; tropical America castor bean, corn, sorghum .... *Phidotricha erigens*
- *Mimosa piga*, Mexico and Honduras ....Epipaschiinae
- Four stemmata; A9 with SV group uinsetose; abdomen light colored; stored products, nearly cosmopolitan .... *Pyralis prob. farinalis*
- Six stemmata; A9 with SV group bisetose; abdomen dark chocolate; stored products, nearly cosmopolitan .... *Aglossa*

25. Mesothorax and metathorax with a single extra pinacula behind the dorsal setae or V1 of A9 twice as far apart as V1 on A10; most often stem borers in rice, reeds, corn, sorgum, sugarcane and grasses .... Crambinae

The pinaculum behind the dorsal setae on the mesothorax and metathorax is usually called an extra pinaculum. Other names are pinaculum without setae, non-setal bearing plate or secondary pinaculum. They may be faint or conspicuous. When these pinacula are absent or so faint that the larva must be cleared and slide mounted, it is better to stop at Crambinae unless the SV setal number or experience at the port suggests a better identification. Species identification of *Chilo* or *Diatraea* is very difficult and any pink or light colored stripes often fade rapidly in alcohol. Head and body color can be an important character, suggesting it is worth the effort to photograph larvae with a phone or cheap camera before preservation if a species name is critical. At the very least, when doing baggage interceptions from Mexico, be sure to get an exact locality for any corn or sugarcane *Diatraea*. The sclerotized patch of tonofibrillary platelets is anterior to the prothoracic coxae in many *Diatraea* was illustrated by Parada et al. (2007: fig. 7). Early instar Crambinae may be found on leaves or outside stems until they mature and become borers.

- prespiracular group not extending behind the prothoracic spiracle; SV group unisetose on mesothorax and metathorax; Mexico..*Eoreuma loftini*
- prespiracular group extending below and behind the prothoracic spiracle; SV group unisetose on mesothorax and metathorax; may have a tonofibrillary platelet behind the spiracle on A3-6; Latin America .... *Crambus* genus complex
- prothoracic shield has dark contrasting tonofibrillary platelets on anterior and posterior margin, those on the anal shield also dark and contrasting but with no obvious pattern; SV group bisetose on mesothorax and metathorax; no contrasting patch of tonofibrillary platelets anterior to the prothoracic coxae; quarantine species from Old World ....*Chilo sp.* (*partellus, supressalis, zonellus*)

- prothoracic shield lacks dark and contrasting tonofibrillary platelets on both the anterior and posterior margin, anal shield with faint or no platelets, or if present, in a transverse line; SV group bisetose on mesothorax and metathorax; sometimes a sclerotized patch of tonofibrillary platelets is anterior to the prothoracic coxae; corn or sugarcane New World pest species of *Diatraea* (see data sheets and the Keys page on LepIntercept)

25'. Mesothorax and metathorax with two extra pinacula behind the dorsal setae or extra pinacula absent; V1 on A10 twice as far apart as V1 on A9; larvae are borers or leaf rollers on a wide variety of hosts 26

Extra pinacula are also found on the abdomen of some crambids (e.g. *Conogethes*).

26. V1 pinaculum on A3-6 round; on Brassicaceae (Glapyriinae)...27

The latest concept of the Glapyriinae includes the Evergestiinae. Only a few of the potential pests APHIS could potentially intercept from this subfamily are included in this key.

26'. V1 pinaculum on A3-6 bandlike, rectangular or oval; on a wide range of hosts (Spilomelinae/Pyraustinae complex)..28

Not all members of the Spilomelinae/Pyraustinae complex have the bandlike or rectangular V pinacula on A3-6, but those that have these pinacula rounded do not feed on Brassicaceae**.**

27. A tonofibrillary platelet in a sclerotized pit is present posterior to SD1 on A3-6; D1 longer than D2; D and SD pinacula not conical; prothoracic shield unmarked ....*Hellula*

As with Crambinae, pink stripes can often fade rapidly in alcohol. It would be better to define *Hellula* with some morphological characters. The tonofibrillary platelet in a sclerotized pit posterior to SD1 on A3-6 is found in some *Crambus*, European Pyraustinae and *Hellula*. Its actual distribution or phylogenetic significance has not been studied. Usually D2 is longer than D1 in most Lepidoptera, *Hellula* is unusual in having the reverse. Orgin can help with species identification. *Hellula rogatalis* is North American; *H. undalis* is an Old World species and *H. phidilealis* occurs from the southern United States to parts of South America and Hawaii. *Crocidolomia pavonana* is just one of many pyraloids that may key out at this point so be careful of Asian interceptions on Brassicaceae**.**

27'. No tonofibrillary platelet in a sclerotized pit present posterior to SD1 on A3-6; D2 longer than D1; D and SD pinacula conical; prothoracic shield sometimes mottled...*Evergestis*

There are several species of *Evergestis* that will key out here. *Evergestis rimosalis* from the New World has a mottled prothoracic shield, black conical D and SD pinacula and a characteristic pattern of cross stripes (hence the common name, cross striped cabbageworm). The D and SD pinacula of *E. forficalis* from Europe are conical but pale but only the SD pinacula are pigmented. There is no cross striped pattern and the SV group of T2 and T3 is bisetose.

28. Mesothorax and metathorax with a pair extra pinacula behind the dorsal setae .... Spilomelinae (part)

Several genera of Spilomelinae and have a pair of extra pinacula behind the dorsal setae of the last two thoracic segments. Although literature sometimes shows these pinacula on *Sceliodes* or *Pyrausta*, we could not confirm this in the specimens we examined. *Conogethes* is a complex of species, our diagnosis is based on specimens from Japan. Sometimes the two extra dorsal thoracic pinacula of *Conogethes* almost fuse. The presence of a hairlike SD1 seta is unusual.

- prespiracular group of the prothorax extends below and behind the spiracle; A1-7 with one to three extra pinacula posterior to the spiracle; sweet potato only .... *Megastes* (Latin America), *Omphisa* (Old World)
- prespiracular group of the prothorax does not extend behind spiracle; mandible with two inner teeth and an outer "tooth" (lobe); front not reaching the epicranial notch; SD1 pinacula of A2 and A7 not reduced; no extra pinacula without setae on the abdomen; in pods or flowers of legumes, tropical regions .... *Maruca vitrata* (see data sheet)
- prespiracular group of the prothorax extends below and behind the spiracle; extra pinacula on mesothorax and metathorax below L3; one extra pinacula behind the L1 and L2 setae on A1-7; SD1 on A9 hairlike; young larvae with no pinacula; traditionally from peach, pine, castor bean, Asia .... *Conogethes*

28'. Mesothorax and metathorax lack an pair extra pinacula behind the dorsal setae 29

29. SV group of A1 unisetose on at least one side; D1 pinacula of A2-8 often contains a pale or dark spot; only on Solanaceae (Spilomelinae, part)... *Leucinodes* group

This taxon was discussed by Hayden et al. (2013). See the fact sheets for *Neoleucinodes* and *Leucinodes*. The SV group of A1 is unstable, but usually unisetose. It is better to trust the origins over morphology if the identification is in doubt

- body pinacula pigmented, S1 posterior of a line connecting stemmata 2 and 3; Old World .... *Leucinodes orbinalis*
- stemma 1 and stemma 2 closely spaced; S1 is touching or anterior to a vertical line connecting stemmata 2 and 3; prothoracic shield without spots or faintly mottled at most; body pinacula pale; SD1 pinacula on A2 and A7 not reduced; SD2 seta and pinaculum on A3-6 inconspicuous; SD1 anterior or anterodorsad of the spiracle on A8 and the host is a cultivated species of *Solanum* .... *Neoleucinodes elegantalis*

29'. SV group of A1 bisetose or trisetose; on various hosts including Solanaceae.............................30

30. Prothoracic shield with a dark spot posterior to XD2...................................... **Spilomelinae (part)**

This group includes species with at least one spot on the prothoracic shield posterior of XD2. Many other larvae not covered by this key likely will have this character. The submentum of *L. integra* has a large seta in a depression, but as noted by Keifer (1937), the significance has not been documented. The position of the mesothoracic setae varies, but the homology (what to name them) is not clear. None of the three species below have SD1 reduced on A2 or A7 except *O. indicata*

- prespiracular group of the prothorax on a nearly crescent-shaped pinaculum; prothoracic shield with a dark and sharply defined spot; D setae of mesothorax on the same pinaculum; the top mesothoracic SD seta is anterior of the bottom one; body pinacula unpigmented; SV group is bisetose on A1; crochets in a complete or nearly complete biordinal circle; Solanaceae, New World......... *Lineodes integra*
- prothoracic shield mottled with a pair of black dots; D setae of mesothorax on the same pinaculum; the top mesothoracic SD seta is posterior of the bottom one; SD pinaculum of the mesothorax, and sometimes the metathorax, pigmented; SV group of A1 bisetose; herbaceous crops and weeds, cosmopolitan .... *Spoladea recurvalis*
- front extends less than 1/2 the distance to the epicranial notch; mandible triangular in shape and usually without teeth (one to three small teeth may be present); SV group bisetose on A1; legumes, subtropical regions .... *Omiodes indicata*
- prespiracular pinaculum of the prothorax oval; D setae of mesothorax on separate pinaculum; the top mesothoracic SD seta is posterior of the bottom one; crochets in a complete circle, triordinal mesally and uniordinal laterally; polyphagous, cosmopolitan .... *Udea*

30'. Prothoracic shield lacks a dark spot posterior to XD2 31

31. Prothoracic shield with partial solid dark shading up to the D2 seta ....Spilomelinae (part)

This group includes two species with a partially dark prothoracic shield. As pointed out by Hayden et al. (2013), *R. periusalis* is another example using red/pink coloration for identification is limited because this pigment fades in preserved pyraloid larvae.

- prothoracic shield shaded with black almost to the D1 seta; SV group of A1 bisetose; D1 pinaculum on the abdominal segments with a black spot anterodorsad to the D1 seta; D2 pinacula on A8 not fused; southern U.S. to Brazil, Solanaceae .... *Rhectocraspeda periusalis*
- prespiracular pinaculum of the prothorax surrounds the spiracle; black shading of prothoracic shield extends to the D2 seta; D and SD pinacula of mesothorax fused; SV group of A1 trisetose; New World, herbaceous crops and weeds ....*Herpetogramma bipunctalis*

31'. Prothoracic shield lacks partial dark shading up to the D setae, either the prothoracic shield is patterned differently or is completely dark 32

32. Mesothoracic D and SD pinacula fused .... *Herpetogramma* (part)

This group includes species of *Herpetogramma* with a pale prothoracic shield. Two of them, *Herpetogramma licarsisalis* and *Herpetogramma phaeopteralis*, are pests of grasses. Not all early instars of at least some species have the mesothoracic D and SD pinacula fused (Passoa 1985: 112).

32'. Mesothoracic D and SD pinacula separate 33

33. Head capsule with a shield like extension over base of antenna; or prespiracular group of the prothorax extends below and behind spiracle to fuse with the posteroventral corner of the prothoracic shield; or a tonofibrillary platelet in a sclerotized pit is present posterior to SD1 on A3-6 .... misc. Pyraustinae

This couplet separates a few miscellaneous Pyraustinae from the remaining Spilomelinae. *Ostrinia* is a complex of species that is especially hard to identify to species outside North America. The extension of the prothoracic shield in *Achyra* is sometimes lightly sclerotized and hard to see. Identification of *Pyrausta* is restricted to plants in the Lamiaceae pending a better larval characterization of the genus.

- head capsule with a shield like extension over base of antenna, wide range of herbaceous hosts, especially corn and pepper........................*Ostrinia nubilalis* (Europe, North America), *Ostrinia furnacalis* (Asia)
- prespiracular group of the prothorax extends below and behind spiracle to fuse with the posteroventral corner of the prothoracic shield............*Achyra rantalis* (North America), *Achyra bifidalis* (Latin America)
- mesothorax and metathorax with the MD and MSD setae on pigmented pinacula; SD1 pinacula of A2 and A7 not reduced; a tonofibrillary platelet in a sclerotized pit is present posterior to SD1 on A3-6; Canada, Europe, on Lamiaceae ....*Pyrausta*

33'. Head capsule lacks a shield like extension over base of antenna and the prespiracular group of the prothorax does not fuse with the prothoracic shield and a tonofibrillary platelet in a sclerotized pit is absent posterior to SD1 on A3-6 ....(Spilomelinae, Cybalomiinae, part)

This group includes miscellaneous species of Spilomelinae, some of which are frequently intercepted. *Hendecasis duplifascialis*, a member of the Cybalomiinae, also keys out here. *Nomophila* is a complex of species that, except for Europe and North America, have poorly known immatures. The same is true for *Diaphania* in Latin America.

- XD2 equidistant from SD1 and XD1; thoracic pinacula not darkly pigmented; SV group on A1 trisetose; crochets of A3-6 biordinal; bores in buds of jasmine from Asia .... *Hendecasis duplifascialis* (see data sheet)
- XD2 closer to SD1 than XD1; one SD seta on T2 and T3 hairlike; SV pinacula of T2 and T3 notched anteriorly; SV group trisetose on A1; SD pinacula reduced on A2 and A7; anal shield lacks pigmented patches; polyphagous on herbaceous plants but especially on peppers, cut flowers, sometimes saprophagous, southern Europe, Middle East and Africa ....*Duponchelia fovealis*
- XD2 closer to SD1 than XD1; SV group trisetose on A1; SD pinacula reduced on A2 and A7; anal shield with pigmented patches; polyphagous on herbaceous plants..*Nomophila nearctica* (North America), *Nomophila noctuella* (Europe, North Africa)
- genal spot present; mandible with inner teeth, three scissorial teeth and smaller ones on the cutting margin; prespiracular group of prothorax extends below the spiracle; SV group of A1 trisetose; abdominal crochets in a mesal penellipse; SD1 on A8 rectangular; cactus, Mexico .... *Loxomorpha flavidissimalis*

- genal spot absent; mandible with an outer tooth; SV group bisetose on A1; crochets of A3-6 in a mesal penellipse; usually on *Mormordica* or cucurbits, ... *Diaphania hyalinata-indica* complex (see data sheet)
- early instars with pigmented pinacula and a thick dark oval mark on the prothoracic shield, later instars with pale pinacula and an unmarked prothoracic shield; genal spot present; no outer tooth on the mandible; no black spot posterior to the SD2 seta on the prothorax; SV group of A1 bisetose; crochets of A3-6 in a mesal penellipse; D1 longer than D2 on A1-7, D2 is longer than D1 on A8... *Diaphania nitidalis* (see data sheet)

34. At least D2 and L1 of T2 and T3 with fleshy filaments having a single terminal spine; SV group of thorax bisetose; on *Abelmoschus* or *Hibiscus*, southern Europe, Middle East or Africa ....*Earias*

Species identification should not be attempted unless the specimen is from India or Central Africa on cotton. *Earias* is one of the most frequently misidentified caterpillars until the new identifier learns the characters and host/orgin.

34'. Dorsum of larvae without spiny fleshy filaments; SV group of thorax variable...........................35

Noctuoid larval family identification is at best challenging. For the moment, an attempt is made to at least mention all the taxa as painfully unsatisfactory it may be to characterize them. Without an ability to separate these families, the most accurate approach is to drop back to Noctuiodea instead of guessing at a probable answer. Unfortunately, this would hurt the resolution of the Pest ID database and make it pointless to consult. Practically speaking, APHIS has to make an educated guess and live with wrong answers at times. When the larva is from Anacardiaceae, and the crochets are heteroideous, the larva is most likely to be in the Eutellidae. Oenosandridae are rare and distinctive. All Notodontidae are difficult to separate from all Noctuidae. No single character defines all larval Nolidae. There is no set of characters to separate all Noctuidae from all Erebidae. Separation of these two families is discussed in the "escape couplets". Identifiers should expect numerous exceptions although many common species will key out properly.

- spinneret blunt, depressed medially with lateral lobes; mandible with a retinaculum; prothoracic gland present; SV group bisetose or trisetose on A1; prolegs with lateral fleshy lobes and heteroideous or homoideous crochets; most often on sweetgum or Anacardiaceae .... possibly Euteliidae
- no prothoracic gland; secondary setae in small clusters not covering the body; single MD seta on T3; less than 3 SV setae on A3-6; crochets biserial; only *Eucalyptus* from Australia .... Oenosandridae
- P2 high on head near vertex, distance between P2 less than distance separating P1; mandible of mature larva with no scissorial teeth; stipital lobe present; two MD setae present on A1; seta X (or verruca) present near anterolateral corner of anal shield; maxillae with stipital lobes; head is often striped with two closely spaced parallel bands of different colors and the vertex may be pointed; fleshy humps on the abdominal dorsum or a small knob on A8 may be present;

many species rest with their body arched upward and the stemapoda held erect off the substrate.. Notodontidae (part)

- dorsum with very long setae; F setae well above frontal pores ....possibly Nolidae

35. Prolegs reduced or absent on A3 and/or A4 compared to A5 and A6 (Noctuidae/Erebidae complex, part)...36

For nearly 100 years the Noctuidae adult classification by Hampson was rigidly followed without regard to the input of larval characters. Now molecular studies change the classification immediately. As a result, there is no easy to use larval subfamily key for Noctuidae or Erebidae, and for most tropical regions, there is nothing comprehensive for species identification. Dissection of the mouthparts is needed for many groups. Realistically, it is impossible to identify early or middle instars, which unfortunately is the bulk of what APHIS intercepts in Noctuoidea. Given these constraints, the goal of APHIS should be to name the pests that represent the most serious risk and separate them from species we have in the US, while identifying the rest of the unknowns to the family level unless they are unusual. That is the goal for this section.

35'. Prolegs of A3-A6 all equal in size...38

Be sure to check the anterior prolegs carefully because in some Erebinae the reduction is slight. Early instars of some subfamilies (e.g. Noctuinae) have reduced prolegs but in later instars the proleg size becomes more equal. Therefore, this key will not work with early instars if the proleg size is reduced. These are best identified only to family or Erebidae/Noctuidae unless they are Plusiinae which can be recognized by their biordinal crochets.

36. Seta V1 on A1 and A2 modified into a ringlike structure......................................Erebinae (part)

This taxa was named Group I of the Catocalinae by Crumb (1956). *Melipotis* is the most commonly intercepted genus. Be sure to check for the ringlike seta on both A1 and A2. If four rings are seen, you can be sure this modification is present. Setae that fall out of their socket are easily confused with the ringlike setae.

36'. Seta V1 on A1 and A2 minute but normal in form, not ringlike 37

37. Crochets biordinal or rarely weakly biserial ....Plusiinae

The tribe Abrostolini contains larvae with fully developed prolegs on A3-6 but APHIS apparently does not intercept them. They often feed on Urticaceae, at least in Europe and North America.

New World Plusiinae with vestigial prolegs on A3 and A4, and SD1 hairlike on A9, can be placed in the tribe Argyrogrammatini. However, identification to species is usually not worth the effort for Latin American interceptions.

Cornutiplusia circumflexa has variable genitalia and a larva almost identical to *Autographa gamma* except for minor differences in the size and number of hypopharyngeal blades. Origin is not a help because their ranges overlap and both are polyphagous quarantine significant pests. In the New World, *Autographa gamma* (Greenland) can be only be separated from *Autographa californica* (U.S., Baja California and Canada) by knowing the origin.

There are no larval characters to separate species of *Chrysodeixis* in Asia or *Pseudoplusia includens* from *C. chalcites* in Canada.

- vestigial prolegs present on A3 and A4; SD1 hairlike on A9; molar ridges continue to the scissorial teeth; D and SD setae equally spaced on T2 and T3; texture of cuticle smooth to slightly granular depending on the magnification; ten ridges present on the raduloid; highly polyphagous, New World, Hawaii, North Africa, Middle East or Europe..*Trichoplusia ni* (see data sheet)
- head with setal bases dark, genal spot usually present; subdorsal area with pigmented SD1 pinacula and a white stripe in living larvae; thoracic legs black or green; vestigial prolegs present on abdominal segments 3 and 4; SD1 hairlike on A9; mesothoracic D setae almost touch; two molar ridges do not reach the scissorial teeth; pinacula not surrounded by ring of minute black spicules; polyphagous
    - Hawaii .... *Chrysodeixis eriosoma*
    - Europe, Africa, Middle East ....*Chrysodeixis chalcites*
    - Asia ....*Chrysodeixis* spp.
    - Canada .... *Chrysodeixis (Pseudoplusia) includens* or *C. chalcites*
- head with setal bases dark, genal spot usually present; subdorsal area with pigmented SD1 pinacula and a white stripe in living larvae; thoracic legs black or green; vestigial prolegs present on abdominal segments 3 and 4; SD1 hairlike on A9; diameter of pigmented area on SD1 pinacula of A1-7 equal to or larger than the diameter of the spiracle; sometimes with thoracic legs and all body pinacula dark; raduloid with 10 ridges; polyphagous, North America (except Canada) and Latin America ....*Pseudoplusia includens* (typical dark forms)
- Vestigial prolegs present on abdominal segments 3 and 4; SD1 hairlike on A9; setal bases of head and epicranium similar in color; with 23 ridges on raduloid; polyphagous, subtropical and tropical regions of New World ....*Ctenoplusia oxygramma*
- prolegs completely absent on abdominal segments 3 and 4; SD1 on A9 thin but setaform; A2 with the SV1 and SV2 pinacula separated; ventral setae surrounded by a ring of black spicules; mandible ribs continue to cutting margin; polyphagous; throughout the New World .... *Rachiplusia* spp
- prolegs completely absent on abdominal segments 3 and 4; SD1 on A9 thin but setaform; pinacula of setae SV1 and SV2 fused on abdominal segments 2 to 4; adfrontal area with thin oblique vertical dash; genal dash present or absent; inner face of mandible black in late instars, most abdominal setae pale in late instars; minute ring of microspines surround lower body pinacula, most pronounced in early instars ....*Autographa gamma* and very likely some *Cornutiplusia circumflexa*
- prolegs completely absent on abdominal segments 3 and 4; SD1 on A9 thin but setaform; A1 with bisetose SV group; A2 with the SV1 and SV2 pinacula at least partially fused; cuticle covered with long spinules, the dorsal ones white and the lateral ones black; ventral abdominal pinacula not ringed with black spicules; polyphagous, North and Central America to Costa Rica ....*Megalographa biloba*

- prolegs completely absent on abdominal segments 3 and 4; SD1 on A9 thin but setaform; A1 with bisetose SV group; A2 with the SV1 and SV2 pinacula at least partially fused; cuticle covered minute granules; ventral pinacula ringed with small black spinules; polyphagous, western United States to Baja California and maybe northern Mexico .... *Autographa californica*

37'. Crochets clearly uniordinal and uniserial .... miscellaneous Erebidae/Noctuidae

This couplet includes the loopers and semiloopers that are not Plusiinae. The most likely subfamilies are Acontiinae (Noctuidae) and Erebinae (Erebidae). *Achaea janata* is common in tropical regions and was intercepted on *Euphorbia* from Hawaii. *Plusia* also keys out here because it has uniordinal crochets, an exception for the subfamily. *Anticarsia gemmatalis*, which feeds on legumes and especially soybean, would key out here.

38. Cuticle rough and spiny 39

Use about 100 to 200 power on a stereoscope to evaluate the cuticle texture. A very common mistake is to assume all noctuids with a spiny cuticle must be in the Heliothinae. In fact, both the Erebidae and Noctuidae contain species with a spiny cuticle.

38'. Cuticle smooth or granular, not spiny 40

39. Prothoracic L setae arranged horizontally or in a slanted line; more often feeding on fruits or flowers than leaves ....late instar Heliothinae

The horizontal arrangement of the prothoracic setae is a distinctive character of the Heliothinae. Unfortunately, it is not present in the early instars. Early instar Heliothinae often look different from the mature larva as well.

There are no known characters to separate *Helicoverpa armigera* from *Helicoverpa zea* in Brazil. Identification of *H. armigera* in the Old World is equally difficult. The guide below for *H. armigera*, *assulta* and *puntigera* is to help select samples for barcoding more than for making quarantine decisions. A more detailed key for *armigera* suspects is available on the Keys page of LepIntercept, but in spite of being more detailed, it is still provisional. Like the Plusiinae, APHIS wastes much time and effort cataloging pointless repeated interceptions of the Central American species on the same crops year after year. Each one requires mandible dissection or looking at the pinacula under high power. Worse yet, unknown *H. armigera* infestations in the New World would be identified as *H. zea* resulting in specialists screening for a target that will never be recognized with morphology. A general Heliothinae key is available on the Keys page on LepIntercept, but the document badly needs to be updated and hopefully will be the subject of its own identification tool in the future. For now, a better policy is to identify all New World Heliothinae to subfamily except for *H. zea* that could be randomly barcoded. All Brazilian *H. zea* interceptions should be considered *H. armigera* suspects.

- D setae of A1-8 inserted on large conical chalazae, those of A1, A2 or A8 often larger than the rest; body color highly variable, but usually with lines and stripes and sometimes a black bar joining the D setae of A1 or A2 (saddle marking); if the setal bases are small, then the mandible has a minute tooth on the inner rib and no large retinaculum (*H. armigera* suspect, see data sheet)

- microspines uniformly covering body; Old World, on Solanaceae.. usually *H. assulta*
- three rows of body microspines; spiracles brown; prothoracic setae dark; no saddle marking on A1 or A2; polyphagous, Australia .... probably *H. puntigera*
- three rows of body microspines; spiracles black or brown; prothoracic setae pale; with black bar (saddle marking) connecting the D setae on A1 or A2; polyphagous, Old World (sibling species in Africa), Brazil .... probably *H. armigera*

- mandible with a large retinaculum, sometimes reduced to a thin ridge or groove; at least half of the dorsal pinacula of A1, A2 and A8 covered with microspines; conical pinacula, if present, are only on A1, A2 and A8; color and pattern highly variable; host range wide,
  - Central America, Caribbean, Guyana, Suriname, French Guiana and Hawaii .... *C.* virescens (see data sheet)
  - rest of South America .... *Chloridea* sp.
  - Chile .... Heliothinae
- at least half of the dorsal pinacula of A1, A2 and A8 covered with microspines; SD1 and L1 setal bases of A4 connected to each other by a band of microspines (sometimes barely so) and both are much larger than the diameter of the spiracle; feeds primarily on *Physalis*, only rarely on *Solanum*.................... *Heliothis subflexa*
- mandible lacks a retinaculum or at most has a trace of a small tooth; dorsal pinacula of A1, A2 and A8 lacks microspines or have only a few around the edges; conical pinacula, if present, are only on A1, A2 and A8; color and pattern highly variable; host range wide but generally not associated with *Physalis*,
  - Central America, Caribbean, Ecuador, Colombia, Venezuela and Hawaii .... *H. zea* (see data sheet)
  - rest of South America .... (*Helicoverpa* sp.)

39'. Prothoracic L setae arranged vertically ....various Noctuidae/Erebidae

This is the common condition for most noctuids and seems not to vary by instar. Below are three examples of non-Heliothinae taxa with a spiny cuticle that are occasionally intercepted. Plusiinae also have a spiny cuticle, but they are easily recognized to subfamily using the characters noted above. The spiny cutworm from Chile has been called "*Agrotis lutescens*" or *Feltia malfida* but it needs to reared and carefully identified.

- SD1 hairlike on A9; Chile only ....*Agrotis/Feltia* complex
- at least dorsal setae stout and faintly clubbed; cosmopolitan .... Herminiinae (part)
- head often large for size of body, may be bicolored; prothoracic SV group trisetose; body pinacula conical, often with a pale center giving the impression of "rings"; some dorsal or subdorsal setae very long; prepupa pale; various plants, Mexico ....*Litoprosopus*

40. Head with a characteristic thick longitudinal band; dorsal spots onA2 usually present; pineapple, Central America and northern South America ....*Elaphria* "*nucicolora*"

The pupa and larva of *Elaphria nucicolora* are frequently intercepted in association with pineapple. Although there is some larval color variation, a few rearings and dissected genitalia from pupae have always been this species. Literature and web photos show a thin light middorsal stripe. The intercepted *Elaphria* fauna needs study; quotes are used around the species name to suggest further confirmation.

40'. Larva lacks both a thick longitudinal band and dorsal spots on A2; host and origins vary 41

Many noctuid/erebid larvae have a thick head band but these lack spots on A2 and/or an association with pineapple.

41. Mesothorax and metathorax lack a minute tonofibrillary platelet connected to the SD setae by a sclerotized bar 42

41'. Mesothorax and metathorax with at least SD1 (and sometimes SD2 as well) connected to a minute tonofibrillary platelet by a sclerotized bar 43

The thickness of the bar may vary and sometimes this structure is in a shallow pit.

42. Adfrontal area reaches epicranial notch; mandible without a retinaculum; spinneret wider than long; SD2 of T2 and T3, and SD1 of A9, all hairlike and set in a dark area resembling a very thick setal base; cuticle with course granules, often conical and irregular in size; polyphagous, cosmopolitan .... *Agrotis/Feltia* complex

Feltia subterranea is the most easily recognized member of this group. Some *Agrotis ipsilon* can be identified from Europe or Canada. Other unknown species are best left at genus or subfamily. Most of these larvae tend to avoid woody plants. The identification is more accurate if the host is an economically important crop.

- Largest granules on dorsum point backwards toward the rear of the body; various hosts, Mexico .... *Feltia subterranea*

42'. Adfrontal area, mandible and spinneret variable; SD2 of T2 and T3, and SD1 of A9, if hairlike not set in a dark area resembling a very thick setal base; cuticle lacks course granules,; polyphagous, cosmopolitan.. Noctuidae/Erebidae complex

These larvae may possess one or more, but not all, of the characters defining the *Agrotis*/*Feltia* complex. After the Plusiinae are eliminated as a possibility, if desired, a port identifier can make an educated guess and put the results in the comment section of PPQ form 309. Do not forward difficult examples (SD1 of intermediate thickness) or poorly preserved specimens to specialists. APHIS gets too many noctuid/erebid interceptions to spend hours with each find, but the below may help in special cases.

- spinneret with silk pore concealed by apical flaps (illustrated by Crumb 1956: plate 3 I-R); SV group trisetose on A1 and SD1 setaform on A9 ......possibly Erebidae
- spinneret with the silk pore open apically (illustrated by Crumb 1956: plate 2); SV group bisetose on A1 and SD1 setaform on A9 .... possibly Noctuidae
- spinneret with the silk pore dorsally grooved, wider than long or fringed (illustrated by Crumb 1956: plate 2); SV group bisetose on A1 and SD1 hairlike on A9 .... possibly Noctuinae (including Hadeninae)

43. Head with adfrontal area outlined in white forming an inverted "Y"; mandible with four scissorial teeth and no retinaculum; SD1 on T2 and T3 connected to the associated tonofibrillary platelet by a minute sclerotized bar; SV group bisetose on A1; lateral spot often present on the mesothorax or A1 and body setae short, most not much longer than the vertical height of the spiracle on A8 ....*Spodoptera* spp.

Larval *Spodoptera* are hard to define morphologically but they do present a characteristic appearance. Many Latin American pests also occur in the United States. Consult Passoa (1991, 2011) for New World species not mentioned below. The key by Pogue (2002) has the advantage of using preserved larvae without a need for origin. Two Old World species (*S. litura* and *S. littoralis*) are quarantine significant and very variable in color. The *Spodoptera* key on the Keys page on LepIntercept gives guidelines for their separation, but it is not possible to correctly identify all the atypical color forms. Origin helps as the two are mostly allopatric. Young larvae cannot go past genus except for *S. litura* on orchids from Thailand.

- small larvae defined by the swollen thorax ....*Spodoptera* sp.
- orchids, Thailand.. *S. litura* (see data sheet)
- ground color green to yellow brown to dark blue gray; subdorsal area often not contrasting with paler dorsum; middorsal line often obvious; spiracular stripe often interrupted on A1 by a black band or spot; dorsal triangles, if present, are on all abdominal segments, A1 and A8, A7 and A8 or just A8 and most of them usually have an apical white dot; abdominal spiracles usually with a large black dot dorsally and a white spot posteriorly; from Middle East to Asia on a wide range of hosts .... *S. litura* (see data sheet)
- ground color a shade of chocolate brown to steel gray to dark olive green; subdorsal area usually strongly contrasting with paler dorsum; middorsal line usually faint or absent; spiracular stripe not interrupted on A1 by a black band or spot; dorsal triangles, if present, are on all abdominal segments, A1 and A8, A7 and A8 or just A8 and in most cases lack an apical white dot; sometimes a white spot is present posterior to the abdominal spiracles, more rarely with a dorsal black dot; from Europe to Africa to the Middle East on a wide range of hosts ....*S. littoralis* (see data sheet)
- mesothoracic lateral dark spot normally present near SD1; large lateral spot on A1 absent; dorsum often contrasting with the darker subdorsal area and colored with an irregular series of white dots and broken lines, more rarely a series of paired thin black dashes are present; cosmopolitan, polyphagous ...*S. exigua* (see data sheet)
- Dorsal abdominal pinacula larger than diameter of spiracles on A1-7, these pinacula either conspicuous, especially on A8 and A9 (brown or black color forms) or pale (green form); abdominal segments with a granulated texture under a magnification of 25x or greater.................................. *S. frugiperda* (see data sheet)

43'. Mesothorax and metathorax with both SD1 and SD2 connected to a minute tonofibrillary platelet by a sclerotized bar; adfrontal area of head often not white; larva lacks a swollen thorax or lateral dark spot on the mesothorax or A1 44

44. Spinneret with apical spinules; spiracles black; four to eight yellow middorsal spots usually present, sometimes also with a W-shaped mark on A8; polyphagous, cosmopolitan .... *Peridroma saucia*

The presence of yellow middorsal spots is diagnostic for *P. saucia* but they can be faint or absent. This species often occurs with *Copitarsia* and would be a common non-target in *Copitarsia* larval surveys. Color forms of *P. saucia* without any dorsal spots will be hard to identify without dissecting the mouthparts. There are sibling species in Chile, Argentina and Hawaii.

44'. Spinneret lacks apical spinules; spiracle color variable; yellow middorsal spots absent; W-shaped mark sometime present on A8 45

45. Spinneret rounded or with a medial depression; labial palpi with last segment much shorter than basal segment; mature larvae with white body setae, paired dorsal dashes or triangles, lateral red spots, or no markings; young larvae with a mottled head, dark setae, reduced prolegs on A3 and A4 and a green dorsum faintly striped with white; cut flowers and vegetables most often from Mexico, northern South America and Chile, rarer in Central America except for Guatemala ....*Copitarsia* sp. (see data sheet)

Early instars of *Copitarsia* are easily confused with *S. exigua.* There are several color forms of *Copitarsia* depending on the instar or species. Specialists don't agree on species limits and the literature is filled with synonyms that are no longer considered valid names. There is one species in Mexico and Central America (but see the data sheet for details)

- Mexico and Central America ....*Copitarsia decolora*

45'. Mandible and spinneret variable; labial palpi with last two segments longer than one third the length of the basal segment; coloration, hosts and origins variable...46

46. Mandible with a large retinaculum; spinneret about four times longer than wide; last segment of labial palpi about as long as the basal segment; sixteen stout spinelike blades present on the hypopharyngeal complex; abdominal prolegs with a lateral sclerotized plate; normal (dark) form with a black patch surrounding spiracles of A1-8; green form with thick white spiracular stripe extending from the head to the anal prolegs, passing through the spiracles of A1-7 but below the larger spiracle of A8; polyphagous, Old World origins only ....*Mamestra brassicae* (see data sheet)

It is a common mistake is to assume any noctuid larva with a retinaculum is *M. brassicae*; in fact, many species of noctuids have this structure. The spinneret of *M. brassicae* is four times longer than wide and the last segment of the labial palpi is about as long as the basal segment. Several North American larvae look like *M. brassicae* (e.g., *Orthosia rubescens*). Numerous noctuid larvae have a broad white spiracular stripe passing from the thorax to the anal prolegs.
Early instars of *M. brassicae* have pigmented body pinacula and a margined prothoracic shield enclosing two black dots. There is no retinaculum on the mandible.
This pest is difficult to recognize unless the color pattern is present and the mouthparts are dissected.

46'. No black patch surrounds the spiracles of A1-8 or no thick white spiracular stripe from the head to the anal prolegs is present; if this coloration is seen, then mouthparts not as above; worldwide on many hosts .... Noctuidae

This couplet was added so that unknown larvae will not be forced into *Copitarsia* or *M. brassicae* because the key "dead-ends" into these two choices. As in couplet 42, the same choices and guidelines apply.

- spinneret with silk pore concealed by apical flaps (illustrated by Crumb 1956: plate 3 I-R); SV group trisetose on A1 and SD1 setaform on A9 ....possibly Erebidae
- spinneret with the silk pore open apically (illustrated by Crumb 1956: plate 2); SV group bisetose on A1 and SD1 setaform on A9 .... possibly Noctuidae
- spinneret with the silk pore dorsally grooved, wider than long or fringed (illustrated by Crumb 1956: plate 2); SV group bisetose on A1 and SD1 hairlike on A9 .... possibly Noctuinae (including Hadeninae)

47. D2 of A9 on a single pinaculum, or if on separate pinacula, then the D2 setae are closer to each other than each D2 seta is to D1 below it; D1 and SD1 of A9 sometimes on the same pinaculum; SD1 on A9 never hairlike; anal comb, if present, with straight teeth ....Tortricidae

Currently, the family Tortricidae includes three subfamilies: Tortricinae, Olethreutinae, and Chlidanotinae. Among the Tortricinae, most pest species are in the Archipini, usually as external feeders (leaf rollers). The Olethreutinae contain many pest species in the Grapholitini that feed internally in fruits or stems. Chlidanotinae larvae are poorly known; most bore in twigs, fruits or seeds. The former family "Cochylidae" is a tribe of the Tortricinae (Cochylini) and is no longer recognized as a separate family.

Larval tortricids are normally recognized by having the prespiracular group trisetose (but see couplet 19), L1 and L2 on A1-8 closely spaced, the abdominal crochets in a circle or ellipse, and the D2 setae on A9 joined on the same pinaculum (called a saddle pinaculum by Gilligan and Epstein 2012). When D2 are on separate pinacula, or the pinacula are faint, tortricids are recognized by the D2 setae being more closely spaced to each other than to their corresponding D1 setae. Only a few tortricids have the D2 setae widely spaced. SD1 on A9 is never hairlike in Tortricidae, although this character state is commonly seen in Gelechioidea. Most Olethreutinae, and some Tortricinae, have D1 and SD1 of A9 joined on the same pinaculum. This is an unusual arrangement as well. Unfortunately, numerous exceptions prevent reliable separation of tortricid subfamilies in the larval stage. A better approach is to classify them into phenetic groups or "types" as proposed by Brown (2011). A modified version of his key by Todd Gilligan is available on the Keys page on LepIntercept.

47'. D2 of A9 on separate pinacula or each D2 seta closer to their corresponding D1 seta than to the other D2; D1 and SD1 of A9 not joined on the same pinaculum; SD1 on A9 sometimes hairlike; anal comb often absent, if present, teeth are straight or curved...48

This couplet leads to those frequently intercepted microlepidoptera with a trisetose prespiracular group (Gelechioidea, Yponomeutoidea and Tineidae). The anal comb is generally absent except for Gelechiidae and some other rarely seen Gelechioidea. Gelechioids have straight or curved teeth whereas the teeth are always straight in Tortricidae. A few microlepidoptera (Choreutidae and Gelechioidea) have the D2 setae joined on A9 but they differ from Tortricidae in other ways.

48. Submentum with a large oval pit; A1-8 often with a sclerotized ring around SD1; live or decayed plant material, cosmopolitan...BLASTOBASIDAE, OECOPHORINAE (*Endrosis*)

Two generalizations on blastobasids require modification. First, there are other Gelechioidea with submental pits or similar structures. One source of confusion is with Oecophorinae, particularly those found under bark. Another is with *Endrosis* from stored products. Xyloryctidae from Australia have a pit although it is not clear if this structure is homologous with the Blastobasidae.
The second generalization is that blastobasids are always scavengers. There are sugarcane pests and species intercepted from fresh fruit. The food habits of this family require further study.
There are no keys to blastobasid larvae, but New World interceptions from yucca pods can be named if the larvae are large. Sometimes blastobasids from acorns, coffee or sugarcane can also be identified. Otherwise leave them at the family level. Note in the comments if sclerotized rings are present on A1-8 (these are also found in Xylorytidae and a few other gelechioids).

- head with six stemmata, SD1 rings present or absent on A1-8, living and dead plants, cosmopolitan...Blastobasidae
- two stemmata present, SD1 rings absent, stored grains, bulbs, cosmopolitan...*Endrosis sarcitrella*

48'. Submentum lacks a large oval pit; A1-8 lacks a sclerotized ring around SD1; various hosts, cosmopolitan...49

49. L1 and L2 of A1-8 closely spaced, often on the same pinaculum..50

This group includes Gelechioidea, Argyresthiidae, Cossidae, Sesiidae and Castniidae. Minet (1991) illustrated certain sensory pits on the head that appear unique to cossids and its relatives. In addition, he noted most sesiids, and some cossids and castniids, have an oblique line on the prothoracic shield between the D setae. Another characteristic of these borers (Cossidae, Sesiidae and Castniidae) is that the cuticular microspines are not distributed uniformly (Minet 1991), this is unusual. Stehr (1987) noted that SD2 is usually caudal to SD1 on the prothorax in Cossidae; this distinguishes cossids from most sesiids. *Paysandisia archon* is the most likely species of castniid to be intercepted from Europe but there are many other species of this family in Latin America. *Chilecomadia* are imported into the United States under the name butterworms.

- dorsum with spined areas on A1-8; no crochets; palms, banana, Latin America..... Castniidae
- dorsum with oval spined area; prolegs absent but may have spines or a few crochets; palms, Europe, Brazil and temperate South America................. *Paysandisia archon*
- one extra setae behind spiracle on A1-8; crochets biordinal; Europe .... *Cossus cossus*
- several extra setae mostly above spiracle on A1-8; crochets uniordinal; garlic or onions, Italy, the Middle East ....*Dyspessa*
- prothorax smooth; no secondary setae in subdorsal area of A1-8; Canada possibly *Prionoxystus robinae*

- rugose area of prothoracic shield with an anterior triangular patch of microspines; cosmopolitan.. *Zeuzera*
- rugose area of prothoracic shield with blunt projections covering almost all of posterior portion; reed mat from Europe .... *Phragmatoecia castaneae*
- anal shield with pointed horn; bottles of mezcal from Mexico .... *Comadia*
- crochets in transverse band; faint slanted line on prothorax borers in woody plants...Sesiidae
- squash, Mexico .... *Melittia*

49'. L1 and L2 of A1-8 widely spaced, not on the same pinaculum (Yponomeutoidea & Tineidae) 52

50. Prothoracic shield with SD2 slightly behind a line connecting SD1 and XD2; crochets uniordinal; A9 with setae D1, D2, and SD1 on common pinaculum; on *Sorbus* or *Malus* ....*Argyresthia conjugella*

Weisman (1986) thought the position of SD2 on the prothoracic shield might help define the Argyresthiidae, but according to the drawings in Stehr (1987), the position of SD2 varies among species in this family. *Argyresthia pruniella* or *Argyresthia eugeniella* (West Indies, guava) might key out here too but larvae of either were not available.

50'. Prothoracic shield with SD2 far behind line connecting SD1 and XD2; crochets variable; A9 with setae D1, D2, and SD1 not on common pinaculum; various hosts 51

51. SV group of A1 bisetose; at least D1 and SD1 in a vertical line and D2 on its own pinaculum, either dorsad or posterodorsad of D1; anal comb sometimes present .... most Gelechiidae

Other characters present in some, but not all Gelechiidae, are: mandible with an outer (extra) tooth, crochets divided into two groups, and presence of a sclerotized collar on the abdominal prolegs. A few species have D1 anteroventrad of D2 on A9, but this is not common. SD1 on A9 is either hairlike or setaform. There is a great need to evaluate many gelechiid interceptions and decide which names can be accepted without rearing or barcoding as neither of these procedures seem possible in the near future. We present a conservative list below. For solanaceous feeding gelechiids, consult the dichotomous key in Hayden et al. (2013) for additional species and characters. A simplified version of that key is presented below.

- abdominal prolegs rudimentary with only 2 to 4 crochets; in stored products only; cosmopolitan but rarely intercepted as larvae .... *Sitotroga cerealella*
- prothorax with prespiracular shield enclosing the spiracle, lateral setae in a linear arrangement; crochets of anal prolegs interrupted at center; anal shield with secondary setae at the posterior margin; anal comb present; host restricted to stone fruits, Canada, Europe, Middle East, North Africa and possibly localized areas of Asia, ... *Anarsia lineatella*
- head with adfrontal setae widely separated, AF2 at level of apex of front, no genal spot present; mandible with three large well defined sissorial teeth plus one smaller reduced tooth with a rounded tip on the cutting margin; prothoracic shield frequently with a crescent shaped marking; SD1 on A9 reduced and

setaform, not hairlike; prolegs with greater than ten crochets in a uniordinal penellipse; cotton, okra, and other malvaceous plants, India, Egypt, Latin America.. *Pectinophora gossypiella*

- head dark brown and typically reticulated, adfrontal setae widely separated, AF2 at level of apex of front; prespiracular group of prothorax not sclerotized; thorax with dark pigmentation; anal comb present; from unknown whole leaf spices, *Gnetium, Pterocarpus* and Malvaceae, Africa ..... Dichomerinae
- head with adfrontal setae widely separated, AF2 at level of apex of front; prespiracular group of prothorax strongly sclerotized; thorax lacks dark pigmentation;; mature larva with yellow to light brown setae; anal comb present; on an unknown whole leaf spice, *Gnetum africanum, Erythrina bereroana, Piper* and Malvaceae, Africa ....*Dichomeris spp.*
- head with adfrontal setae close together, AF2 well below apex of front; line joining setae Ll and S2 tangent to or passing through stemma one; thoracic legs pale; lateral setae of A9 in a nearly vertical line; *Capsicum* and *Solanum*, New World .... probably *Symmetrischema spp.*
- head with adfrontal setae close together, AF2 well below apex of front; all L setae of T1 joined on a single sclerotized, sometimes faint, pinaculum; crochets in a pennelipse, SD1 of A9 hairlike; solanaceous plants, New World .... *Keiferia sp.*
- head with adfrontal setae close together, AF2 well below apex of front; all L setae of T1 on separate pinacula; *Solanum, Capsicum, Datura, Nicotiana*, Europe, Northern Africa, South America ....*Tuta absoluta*
- head with adfrontal setae close together, AF2 well below apex of front; L group usually bisetose on A9, occasionally trisetose on one side; mandible triangular with three teeth and the mandibular setal bases in a diagonal line; D1 and D2 pinacula of mesothorax joined; SD1 on A9 variable; crochets on A3-6 mostly uniordinal; potatoes only ....*Tecia solanivora*
- head with adfrontal setae close together, AF2 well below apex of front; mandible with four to five teeth, outer surface of mandible with basal ridge above the condyles (best viewed ventrally), the mandibular setal bases arranged vertically; thoracic legs pigmented; L group trisetose on A9, the L setae in a triangular arrangement; SD1 on A9 thin and hair-like; in field or stored potatoes, cosmopolitan ....*Phthorimaea operculella*

51'. SV group of A1 variable; if bisetose then D1 and SD1 not in a vertical line; D2 variable; anal comb absent...................................MISCELLANEOUS GELECHIOIDEA

Separation of all larval Gelechiidae from all Cosmopterigidae is virtually impossible and there is no set of characters to define larval Oecophoridae (in the sense of Weisman 1986). Stathmopodidae and Batrachedridae are two more families that may be common, but are difficult to recognize even to family. Elachistidae is a diverse group that can only be defined in the pupal stage. We can identify some pests but interceptions of Gelechioidea from poorly studied regions like South America, Africa and most of Asia can hardly be placed to family, especially if not associated with economically important plants. They are usually dumped into Oecophoridae for lack of a better placement. Another option is to just leave them at superfamily Gelechioidea. The interceptions from *Brunia* fit this category, they are named either Gelechiidae or Oecophoridae but

no one knows the correct name for sure without rearing or barcoding (assuming there is even a barcode match for our species).
New World *Anatrachyntis* (used to be called *Pyroderces* or *Sathrobrota*) are common but the two species cannot be told apart. Pest lists favor *Anatrachyntis rileyi*, but this may just be an artifact of *A. badia* being poorly known. Some Old World species are still in *Pyroderces*, but there is no morphological informtion on their larvae. *Anatrachyntis* also occur in Europe.
Do not confuse *Stenoma catenifer* with the tortricid *Cryptophasma* (also in avocado seeds from Mexico). Many Stenomatinae tie avocado leaves, most of them poorly known.

- larva with pore and sclerotized ring associated with SD1 on A1-8, scavangers, Old World ....Autostichidae
- *Brunia*, Africa .... Gelechiidae or Oecophoridae
- mesothoracic leg large and clublike, blueberry, Canada .... Chimabachidae
- prothoracic shield with secondary setae on anterior margin or D2 of T3 with a sclerotized ring, Asia, Latin America .... Peleopodidae
- Apiaceae, artichoke, pupae (if present) have lateral condyles, Europe and Middle East .... Elachistidae
- D1 anterodorsad of D2 and SD1 on A9; SD1 of A9 setaform..............poss. Cosmopterigidae
- larva with few or no crochets, stem borer, Europe .... Pterolonchidae
- SD1 pinaculum of A8 anterior to spiracle; SD1 and D1 are joined on A9; pineapple and other plants, New World, Europe ....*Anatrachyntis* (*rileyi* or *badia*)
- prothorax with large prespiracular shield extending below the spiracle; SV group on A1 bisetose; A1-8 with SD1 and SD2 on the same pinaculum; crochets triordinal, in a complete circle; A8 with L3 above L1 and L2; A9 with D setae on same pinaculum; avocado fruit, Latin America .... *Stenoma catenifer*
- D2, D1 SD1 on A9 in a vertical line; *Annona*, Latin America .... *Cerconota anonella*
- head with four apparent stemmata, stored products .... *Hofmannophila pseudospratella*

52. Pinaculum of SD1 touching or enclosing spiracle on A1-8; crochets of A3-6 in a uniordinal circle enclosing a short longitudinal series of crochets; Canada, *Allium* ....*Acrolepiopsis assectella*

According to Stehr (1987), larvae of the Acrolepiidae can be recognized in North America by having SD1 of A1-8 anterodorsad of the spiracle, L2 anteroventrad of L1 on A1-8 with both L setae on the same pinaculum, only six setae on each side of A9 and uniordinal to weakly multiserial (a few extra crochets are located inside the circle) crochets on short prolegs.
Three species of Acrolepiidae are recorded from *Allium* by Gaedike (1997). They are: *A. assectella*, *A. sapporensis*, and *A. betulella*. The record for *A. assectella* in Hawaii actually refers to *A. sapporensis* (Gaedike 1997). Nevertheless, it is still helpful to consult Zimmerman’s summary of the literature. In Europe and Russia, *A.* assectella can be confused with *A. betulella*. Although it seems confusing that *A. betulella* should feed on *Allium ursinum* and not *Betula* (birch), this situation arose because *A. ursinella* was synonymized under *A. betulella* (Gaedike 1997) which is an older more valid name. *Acrolepiopsis sapporensis* occurs from Mongolia to Japan, and was introduced into Hawaii (Gaedike 1997). Specimens of *A. sapporensis* were

labelled *A. assectella* and distributed to all the APHIS ports as part of the Pests Not Known to Occur [in the U.S.] (PNKTO) project. Thus, APHIS identifers need to find these specimens (usually marked with a red label) and change the identification from *A. assectella* to *A. sapporensis*. It appears all these examples were collected in Hawaii before the distinction between *assectella* and *sapporensis* was known. If this series included larvae, contact Steven Passoa. Thus, interceptions from Canada can be identified as *A. assectella* and those from Hawaii are *A. sapporensis*. Other orgins can go to genus *Acrolepiopsis* as long as the host is *Allium*.

52'. Pinaculum of seta SD1 on A1-8 not touching or enclosing spiracle; crochets in circle or ellipse without enclosing series of crochets 53

53. Crochets of abdominal proleg in a biserial circle; seta L3 missing on A9 .... PLUTELLIDAE and PRAYDIDAE

There are three pest species of *Prays*: *citri*, (citrus, southern Europe), *endocarpa* (citrus, Asia) and *oleae* (olive leaves or fruit, southern Europe). *Prays* has been in Plutellidae, Yponomeutidae and currently its own family, Praydidae.

- prothoracic and anal shields spotted; body setae dark and thick; AFa absent; seven setae on A9 with D, SD and L setae all widely separated, SD1 hairlike; anal prolegs longer than broad, with few crochets; Brassicaceae and Capparidaceae, cosmopolitan .... *Plutella xylostella*
- A9 with dorsal and subdorsal setae on one continuous pinaculum, the L setae on another pinaculum; SD1 not hairlike; anal prolegs short with many crochets ... *Prays* spp.

53'. Crochets of abdominal prolegs in a uniserial circle or ellipse, rows of very small spinules may be present on the prolegs anterior and/or posterior to the crochets; seta L3 usually present on abdominal segment 9 ....TINEIDAE

We can easily recognize Acrolophinae to subfamily and the genus *Opogona*. If the larvae are from stored products, and slide mounted, the key by Hinton (1956) can be tried. The head may need to be cleared and slide mounted to tell how many stemmata are present. Identification of tineids associated with green plants is difficult because so little is known about the larval morphology of anything except the pest species. L3 is missing on A9 in *Tineola*, but this species makes a case and would key out in couplet 12.

- Head with six stemmata; prespiracular shield surrounds spiracle and is at least partially fused to prothoracic shield; hypostoma (postgena) in broad contact; abdominal prolegs with space between the spinules and crochets .... *Acrolophus*
- head with two stemmata; prespiracular shield surrounds spriacle but is not fused to prothoracic shield; abdominal prolegs without space between the spinules and crochets .... *Opogona sacchari*

This key was produced and distributed as part of LepIntercept. Please cite as follows:

Passoa, S. C. 2014. Key to frequently named lepidopteran larvae intercepted, or potentially encountered, at U.S. ports, 35 pp. *In*: Gilligan, T. M. and S. C. Passoa. LepIntercept, An identification resource for intercepted Lepidoptera larvae. Identification Technology Program (ITP), USDA/APHIS/PPQ/S&T, Fort Collins, CO. [accessed at www.lepintercept.org].

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