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NOCTUIDAE - *Helicoverpa armigera* (Hübner)

Taxonomy

Noctuoidea: Noctuidae: Heliothinae: *Helicoverpa armigera* (Hübner)

Common names: cotton bollworm, Old World bollworm, scarce bordered straw

Synonyms: *Heliothis armigera*, *H. obsoleta*, *H. pulverosa*, *H. uniformis*, *H. armiger*

Prior to the mid-20th century, the name *armigera* was often used to refer to *H. zea* in the New World. See the Detailed Information tab for specifics.

Larval diagnosis (Summary)

- 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
- If setal bases are small, then the mandible has a minute tooth on the inner rib and no large retinaculum
- Larvae of *H. armigera* are difficult to separate from those of other species of *Helicoverpa* (*H. assulta, H. puntigera*); see the detailed larval diagnosis for more information.
- There are no consistent morphological characters that can be used to separate the larvae of *H. armigera* and *H. zea*.

Host/origin information

Helicoverpa armigera is highly polyphagous and has been recorded feeding on plants in more than 45 families. Larvae are intercepted on a variety of hosts from many locations. The origins and hosts listed here are the most common combinations; however, it is possible that larvae may be intercepted on any host originating from within this species' recorded distribution.

Origin	Host(s)
India	*Tagetes*
Israel	various
Kenya	various
Netherlands	*Bupleurum*, *Leucospermum*, *Ornithogalum*, *Veronica*
Zimbabwe	various

Recorded distribution

Helicoverpa armigera is widely distributed throughout the Old World (Africa, Asia, Europe), Australasia, and Oceania. It has recently been discovered in Brazil (Czepak et al. 2013).

Identification authority (Summary)

Larvae of *H. armigera* are usually intercepted from locations in the Old World. In the New World, *H. armigera* has only been recorded from Brazil. See the Detailed Information tab for specific identification recommendations for various regions.

Pest characterization

(Based on Cavey 2001, Venette et al. 2003)

- Taxonomy: **Medium.** Species identification is often difficult.
- Distribution: **High.** *Helicoverpa armigera* is not present in the U.S.
- Potential Impact: **High.** This species is a serious threat to agriculture and the environment.

This ranking characterizes *H. armigera* as quarantine significant.

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Fig. 1: Late instar larva, lateral view


Fig. 2: Late instar larva, dorsal view


Fig. 3: Late instar larva, lateral view


Fig. 4: Late instar larva, dorsal view


Fig. 5: Mid- to late instar larva, lateral view


Fig. 6: Mid- to late instar larva, dorsal view

Fig. 7: Mid-instar larva, lateral view


Fig. 8: Early instar larva, lateral view

Larval diagnosis (Detailed)

Prior to the mid-20th century, the name *armigera* was often used to refer to *H. zea* in the New World. Only in 1955 were the two names considered separate species and *H. zea* used for the New World populations. Based on *Heliothis* being considered masculine, the species name was shortened to "*H. armiger*" to be in agreement with the gender of the genus. This is not currently followed. Consult King (1994) for a discussion of these points.

In spite of the pest status of *H. armigera*, there appears to be few detailed larval morphological studies with complete setal maps of the mature larva (e.g., Kirkpatrick 1961, Chu et al. 1965, Thakar and Srivastava 1983, Sri et al. 2010). Toguebaye and Couilloud (1982) studied the first instar of *H. amigera* in detail. Various, often conflicted diagnoses, have been published; the major ones are reviewed here organized by geographical regions. Although complicated, listing the suite of characters used to identify *H. armigera* will result in a better understanding of morphological variation and provide backup characters that might be useful in doubtful cases. Neither Weisman (1986) nor Venette et al. (2003) treated larval identification of *H. armigera* at United States ports; there is certainly a need to address this topic in some detail.

Hardwick (1965) presented a morphometric key to *Helicoverpa* larvae based on origins. For Australia, he noted *H. armigera* usually had spiracles with dark brown rims and a central light or medium brown area. There was often orange shading around the D and SD pinacula, but no orange spot. The vertical diameter of SD1 on A7 was equal or less than the diameter of the corresponding spiracle in *H. armigera* from Australia (Kirkpatrick 1961). Bejakovich and Dugdale (1998), working in New Zealand, noted *H. armigera* has three longitudinal bands of microspines: one on the dorsal midline, one between D2 and L2 and a final one between L1 and L3. In addition, the rim of the spiracle is black in all instars, the microspines have a broad round base, the cuticle appears "cobblestoned" between the spines and microspines are present below SD1 on A1-8. Matthews (1999: figs. 415, 416) illustrated the cuticle texture of *H. armigera* on A1 and A9 with scanning electron micrographs. He noted late instar *H. armigera* often have "saddle markings" (enlarged pinacula connected by a black bar) on A1 and A2. These tend to be absent in *H. punctigera* (Matthews 1999: plate 21). Another difference is prothoracic setae behind the head. These tend to be pale in *H. armigera* but dark in *H. puntigera.* Hosts can also provide a clue. *Helicoverpa punctigera* is not as common on members of the grass family as is *H. armigera* (Department of Primary Industries and Fisheries 2005).

Chu et al. (1965), studying *Helicoverpa* in China, noted that *H. armigera* and *H. assulta* both have a small inner mandibular tooth. *Helicoverpa armigera* has cone shaped pinacula on A1 and A8 and more spines near the dorsal line on A1 and A8 than *H. assulta*. The spines of *H. armigera* are pointed, easy to see "inside the legs" and the head has P1 slightly higher than AF2. Gardner (1946) put *H. armigera* in his A IV group noting that these species have a trisetose SV group on A2, a bisetose SV group on A7, SD1 on A8 directly above the spiracle and microspines becoming hairlike ventrally. Gardner (1946) did not find an inner tooth on the mandible of *H. armigera*. Yoshimatsu (2002), working in Japan, illustrated the mandibles of both *H. armigera* and *H. assulta*. They were nearly identical but *H. armigera* was said to have microspines on the anal shield that are lacking in *H. assulta*. In addition, the diameter of the SD1 pinacula on A7 is about equal to the spiracle length in *H. armigera*. The SD1 pinacula on A7 in *H. assulta* is much larger, about 1.4-2 times the length of the spiracle. There are also minor differences in spiracle sizes on A7 compared to A8 between these species.

Hardwick (1965) used measurements and ratios to separate *H. armigera* from *H. assulta* in Africa without other morphological details. Ahola and Silvonen (2005) gave a detailed description of the mouthparts of *H. armigera*, but no keys to related species in northern Europe. Beck (1999: 291-293) did provide a key to European Heliothinae. He illustrated the chaetotaxy of the first abdominal segment, noted the D pinacula of A1 and A8 are joined by a black bar and that the D pinacula of A1 are relatively large and closely spaced (Beck 1999: 501b, Beck 2000: 174). He illustrated the mandible of *H. armigera* with a small inner tooth (Beck 1999: 512c). Sannino et al. (1993) included *H. armigera* in his study of Lepidoptera associated with tobacco. He called attention to the sinuate striations and well developed pinacula in *H. armigera*.

Given the documented larval variation in North American species of *Chloridea*, *Heliothis*, and *Helicoverpa*, we have little or no confidence in morphological identification of larval *H. armigera* in some parts of its range. Neunzig (1969: figs 9-12) showed that the pinacula height of both *H. zea* and *C. virescens* varies according to age within an instar. As a larva grows, the cuticle tightens which tends to stretch and shrink the pinacula. Obviously, it becomes hard to trust pinacula size as a key character, although several authors cite conical pinacula as a feature of *H. armigera*. Another problem is mandible wear. *Chloridea virescens* can have a well developed inner tooth or just a scar (Neunzig 1969: figs 6, 7). This may explain why some authors see a tooth on *H. armigera* while others do not.

Unfortunately, the quarantine significance of *H. armigera* forces us to evaluate conflicting literature and attempt a diagnosis. In New Zealand, the black spiracles and three bands of microspines will separate *H. armigera* from *H. puntigera* (with brown spiracles) and *H. assulta* (with microspines not in obvious bands) (Bejakovich and Dugdale 1998: 10, 11). Kirkpatrick (1961) was unable to separate *H. armigera* from *H. punctigera* in Australia, and given doubt about the spiracular color of *H. armigera* being black or brown in areas outside of New Zealand, it is better to stop at genus for interceptions in Australia. Color characters (saddle markings, etc.) will be a clue but are not definitive. Yamaskaki et al (2009: Fig. 1) illustrated four color forms of *H. armigera*: completely green, green with stripes, brown and black. This helps document at least some of the expected variation for this pest.

For European interceptions, when present, large conical pinacula will separate *H. armigera* from related genera of Heliothinae, but not all specimens are expected to show this character. Perhaps scattered spines on the distal region of the hypopharyngeal complex (Ahola and Silvonen 2005: fig. 1106) is the most distinctive mouthpart character for *H. armigera* in northern Europe. The final problem is separating *H. armigera* from *H. assulta*. *Helicoverpa assulta* is normally associated only with only Solanaceae (but see Mathews 1999: 117, 118) whereas *H. armigera* is polyphagous. Differences in cuticular texture will separate the two species on solanaceous hosts. Sannino et al (1996) compared *H. peltigera* to *H. armigera* and noted major differences in the larval mandibles.


Fig. 9: Early instar larva, lateral view


Fig. 10: Mid-instar


Fig. 11: Head, thorax

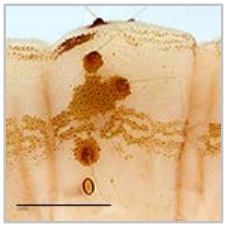


Fig. 12: Pinacula on A1

Fig. 13: Crochets


Fig. 14: Head (cleared)


Fig. 15: Hypo. complex


Fig. 16: Hypopharyngeal complex, dorsal view


Fig. 17: Mandible


Fig. 18: Mandible

Identification authority (Detailed)

Helicoverpa armigera was first reported as established in Brazil in early 2013 in the states of Goias, Bahia, and Mato Grosso (Czepak et al. 2013). It has since been reported from the Distrito Federal and the southern state of Parana (Specht et al. 2013, Tay et al. 2013). This is the first instance of this important pest establishing in the New World. Because we have not identified any morphological characters to reliably separate *H. zea* from *H. armigera*, interceptions from Brazil will require molecular methods. There is also occasional evidence of Old World cargo or produce being shipped through Mexico to the United States. This is another potential pathway for introduction of *H. armigera* into the New World.

A second problem area is Australia and New Zealand. Do not identify *H. armigera* to species in Australia and do so in New Zealand only with caution using well preserved mature larva. *Helicoverpa puntigera* is restricted to Australia, or occasionally New Zealand where it does not overwinter (Bejakovich and Dugdale 1998: 52), and therefore it is not a consideration when identifying *H. armigera* from other regions.

For quarantine purposes, it may be best to assume *H. assulta* eats only Solanaceae until more records from other plant families are published from regions outside of Australia. Therefore, we can assume *Helicoverpa* interceptions from non-solanaceous plants are more likely to be *H. armigera* than *H. assulta*. Body color is another clue. Hardwick (1965:28) stated that *H. assulta* is primarily a green larva whereas *H. armigera* tends to be darkly colored. This difference between the two species was illustrated by Li et al. (2013) along with other morphological characters needing confirmation (crochet pattern) or clarification (prothoracic chaetotaxy). Therefore, green larvae on Solanaceae from the Old World need to be examined carefully as *H. assulta* suspects instead of rapidly confirming them as *H. armigera*.

Identification of *H. armigera* from Europe and Northern Africa is relatively straightforward. Heliothis nubigera is the only species almost colored like *H. armigera* (Beck 1999-2000, Ahola and Silvonen 2005) from this region. The literature is good and sibling species like *H. assulta* do not occur in those regions. Netherlands vegetables are assumed to be grown in country, other host are of uncertain origin and therefore it is best not to attempt a species identification for *Helicoverpa* from this pathway. Sibling species of *Helicoverpa* in Central Africa prevent recognition of *H. armigera* in that part of the world.

Key to the identification of *Helicoverpa armigera* suspects intercepted at U.S. ports of entry

Identification guide to larval Heliothinae (Lepidoptera: Noctuidae) of quarantine significance

Because larvae of *H. armigera* are difficult to identify to species, many are likely listed in PestID under "*Helicoverpa* spp."

Origin records

Helicoverpa armigera has been intercepted from the following locations:

Albania, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Cape Verde, China, Egypt, Eritrea, France, Gambia, Germany, Ghana, Guatemala, Hong Kong, India, Iraq, Israel, Italy, Japan, Jordan, Kenya, Lebanon, Malaysia, Mali, Morocco, Mozambique, Netherlands, New Zealand, Nigeria, Pakistan, Palestinian Territory, Philippines, Portugal, Senegal, South Africa, South Korea, Spain, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom of Great Britain and N. Ireland, Yugoslavia, Zimbabwe

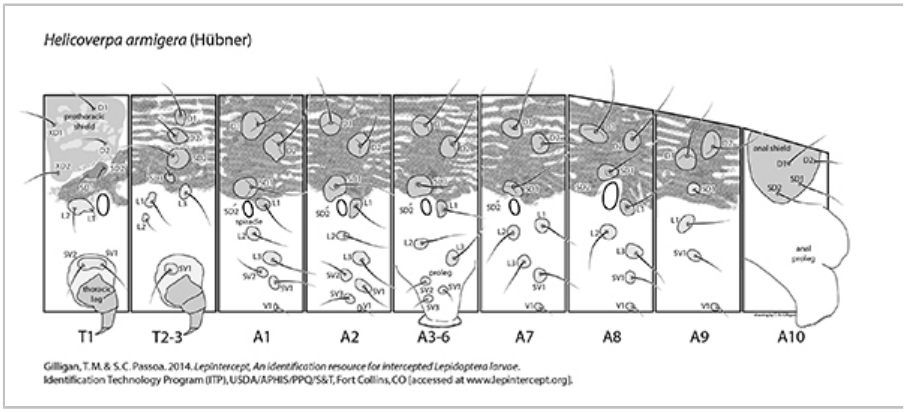
Records from Guatemala needs confirmation and likely represent misidentifications.

Host records

Helicoverpa armigera has been intercepted on the following hosts:

Abelmoschus esculentus, *Achillea*, *Allium*, *Amaranthus*, *Ammi*, *Anemone coronaria*, *Anemone*, *Anethum*, *Anigozanthos*, *Antirrhinum*, *Artemisia*, *Asclepias*, *Asclepias tuberosa*, *Asparagus*, *Aster*, *Astilbe*, *Astrantia*, *Bellis*, *Bouvardia*, *Brassica oleracea*, *Brassica oleracea* var. *acephala*, *Brassica rapa*, *Brassica*, *Brunia*, *Bupleurum griffithii*, *Bupleurum*, *Cajanus cajan*, *Calendula*, *Capsicum annuum*, *Capsicum*, *Carthamus*, *Celosia*, *Cestrum*, *Chamelaucium*, *Chrysanthemum*, *Cicer arietinum*, *Cicer*, *Cichorium intybus*, *Citrus*, *Clematis*, *Coriandrum sativum*, *Cosmos*, *Craspedia*, *Cucurbita*, Cucurbitaceae, *Cynara scolymus*, *Dahlia*, *Delphinium*, *Dendrobium*, *Dianthus*, *Echinops*, *Eryngium*, *Eustoma grandiflorum*, *Eustoma*, Fabaceae, *Fragaria*, *Gentiana*, *Gerbera*, *Gladiolus*, *Gomphrena*, *Grevillea*, *Gypsophila*, *Helianthus*, *Hibiscus*, *Hydrangea*, *Hypericum*, *Jasminum sambac*, *Jasminum*, *Lablab purpureus*, *Lathyrus sativus*, *Leucadendron*, *Leucospermum cordifolium*, *Leucospermum*, *Limonium*, *Lippia graveolens*, *Lippia*, *Lisianthus*, *Lysianthus*, *Lysimachia*, *Malus*, Malvaceae, *Matricaria*, *Mentha longifolia*, *Mentha*, *Minthostachys*, *Moluccella*, *Musa*, *Nerium*, *Ocimum basilicum*, *Ocimum*, *Oleaceae*, *Oncidium*, *Origanum majorana*, *Origanum*, *Origanum vulgare*, *Ornithogalum arabicum*, *Ornithogalum*, *Oxypetalum*, *Phaseolus coccineus*, *Phaseolus*, *Pisum sativum*, *Pisum*, *Polianthes tuberosa*, *Polyanthus*, *Protea*, *Ranunculus*, *Rosa*, *Rosmarinus officinalis*, *Rosmarinus*, *Rudbeckia*, *Salvia officinalis*, *Salvia*, *Satureja hortensis*, *Satureja*, *Scabiosa*, *Setaria italica*, Solanaceae, *Solanum aethiopicum*, *Solanum melongena*, *Solanum*, *Statice*, *Tagetes erecta*, *Tagetes*, *Tetrapleura*, *Thymus citriodorus*, *Thymus*, *Thymus vulgaris*, *Trachelium*, *Tuberosa*, *Tulipa*, *Vernonia amygdalina*, *Veronica*, *Zea mays*

Setal map



Helicoverpa armigera setal map

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