

THE NEARCTIC BUDWORMS OF THE LEPIDOPTEROUS GENUS HELIOTHIS

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Larvae of the genus *Heliothis* Ochsenheimer have a marked fondness for the buds, young leaves, and developing fruits of plants and for this reason have been given the name of budworms. The best-known species is the corn earworm, bollworm, or false tobacco budworm (*Heliothis obsoleta* Fabricius). According to Bishopp,¹ the damage caused by this species may be conservatively estimated at \$30,000,000 annually. Another important species is the tobacco budworm (*Heliothis virescens* Fabricius), which is a well-known pest of tobacco.

No satisfactory means of distinguishing the species of larvae in this genus has been provided up to the present, since coloration has been depended upon for this purpose and the coloration is extremely variable. Structural characters are provided here by which the species may be positively determined.

GENERIC CHARACTERS

Examination of the four species of *Heliothis* larvae described in the following pages has disclosed the following characters common to the group, which may be considered provisionally as generic characters. It will be noted that the skin is clothed with minute spinules; setae IV and V on the prothorax are in a horizontal plane; and the third joint of the labial palpus is but little if any longer than the second. This combination of characters will serve to distinguish this group from any other larvae known to the writer.

White or yellowish, usually broken, longitudinal lines on the body middorsally, dorsed to setigerous tubercle I, between tubercles I and II, and at the upper margin of the suprspiracular area. Skin clothed with minute spinules. Setigerous tubercles IV and V on the prothorax (on prespiracular shield) in a horizontal plane (fig. 14). Spinneret long and slender, about 5 times or more as long as the median breadth and tapering somewhat toward the apex (fig. 6). Labial palpus with the third segment but little if any longer than the second segment (fig. 5). Blade of the maxillulae with

¹ Bishopp, F. C. The Bollworm or Corn Earworm. Farmers' Bull. 872, U. S. Dept. Agr., p. 3, 1922.

about 9 to 12 flat, toothlike processes on the free margin. Setigerous tubercles of body as in figure 14.

Head setae and punctures as follows: A2 nearer to A3 than to A1; A2 much nearer to Aa than to A1 but often scarcely twice as near; A2 somewhat nearer to A1 than to Pa; Aa twice as near to A2 as to Pa or more; P1 decidedly nearer to Adf2 than to Adf1; P1 somewhat above the level of Adf2; Pa, Aa, and A2 not in a straight line; interspace A2-Aa equalling or slightly less than P1-Pa; Adf2 much nearer to P1 than to P2; Pb about twice as near to P2 as to P1; Adf2 above the apex of the front; P2, P1, and Adf1 approximately in a straight line; Adfa distinctly nearer to Adf2 than to Adf1; O1 posterior to the line connecting the centers of ocelli IV and VI; Oa less than the ocellar width removed from ocellus VI and nearer to the ocellus than to O3; G1 approximately equidistant from SO3 and O3; Ga nearer to G1 than to O3; G1 much nearer to Ga than to SO3; G1 minute.

KEY TO THE SPECIES

1. Dorsal setigerous tubercles (I and II) on abdominal segments 1, 2, and 8 set with the minute spinules with which the skin is clothed. Each mandible usually with a large basal process on the oral face (fig. 9) and with no produced margin along the first ventral rib. Line connecting the bases of setae A3 and O2 passing through ocellus I near the center (fig. 12).

virescens Fabricius.

Dorsal setigerous tubercles (I and II) on abdominal segments 1, 2, and 8 without spinules. Each mandible with a produced margin along the first ventral rib and without a basal process (fig. 10). Line connecting the bases of setae A3 and O2 passing posterior to ocellus I or tangent to its posterodorsal margin (fig. 2)..... 2.

2. Setigerous tubercles I, II, and III strongly conical and conspicuously large on all abdominal segments. Dark submedian arcs of head very broad, covering all of the head posteriorly..... *phloxiphaga* Grote and Robinson.

Setigerous tubercles I, II, and III not strongly conical and never conspicuously large except on abdominal segments 1, 2, and 8. Dark submedian arcs absent on the head..... *obsoleta* Fabricius.

DESCRIPTION OF LARVAE

HELIOTHIS OBSOLETA Fabricius

The following distinctive characters of this larva may be noted:
All instars after the second.—Dorsal setigerous tubercles (I and II) on abdominal segments 1, 2, and 8 not set with the spinules with which the skin is clothed, except that rarely there may be a few spinules at the base of the tubercles in adult larvae. Tubercle I on the above segments somewhat larger than II but not conspicuously so. Tubercles not conspicuously conical.

Fifth instar larva.—Head 2.2–2.6 mm. broad.

Adult (sixth instar) larva.—Head 3.3–3.5 mm. broad. A produced margin along the first ventral rib of mandible but no basal process (fig. 10). Spiracles on abdominal segments 1 to 7, 0.222 mm. broad,

which is near the average height of the corresponding spiracles in *virescens* Fabricius (fig. 8). Seta A3 usually distinctly more than the width of the ocellus removed from ocellus II (fig. 2). Line connecting the insertions of setae A3 and O2 passing posterior to ocellus I or tangent to its postero-dorsal margin (fig. 2). Head marked, if at all, with brown freckles and sometimes with white reticulation. No dark submedian arcs.

Body about 0.33 mm. long and 5.5 mm. broad; abdominal segments 1 to 4 of about equal width, the body tapering both anteriorly and posteriorly from these; the skin set closely with small, retrorse, spine-like granules which are white in the pale lines, dark elsewhere dorsally, and pale on the venter; general color varying from red, maroon, orange, yellow, and green to dark fuscous, often green dorsally with a stripe including the pale middorsal line and the supraspiracular area dark. Broken white or yellowish longitudinal lines, often obscure in their relationships, occur as follows: middorsally, bordering the fuscous middorsal stripe, through setigerous tubercle I, between tubercles I and II, through tubercle II, ventrad of II, and several very indefinite in the supraspiracular area. A strong yellow or pale line or narrow stripe margining the supraspiracular area ventrally. Venter tending to be white medially. Spiracles in the subspiracular stripe, black with yellow centres. Setigerous tubercles large and often somewhat conical, I somewhat larger than II on abdominal segments 1, 2, and 8 but not conspicuously so; the tubercles without spinules excepting rarely a few at base. Cervical shield usually with the lateral margins infuscated. Anal shield concolorous with adjacent parts. Head of the general body color, often flecked with brown and sometimes reticulate with white, without fuscous submedian arcs or recitulation. Claw of legs with the base broadly angulate (fig. 4).

Labial palus with the segments in the proportional length of 18, 3, and 4, the basal segment with a long acutely conical papilla apically (fig. 5). Spinneret nearly 6 times as long as the median breadth, tapering toward the truncate apex (fig. 6). Mandible as in Figure 10, the first ventral rib usually produced inward into a thin lobe near the base, or the produced margin may extend along most of the length of the rib. Anterior half of hypopharynx clothed sparsely with very short, stout spines, heavier postero-laterally; lobes of the maxillulae clothed with extremely fine hairs; blade of the maxillulae with about 12 flat, triangular, toothlike processes on the free margin.

Head setae and punctures as follows: A2 distinctly nearer to A1 than to Pa; Aa slightly nearer to A3 than to A2; A3 slightly more than the ocellar width removed from ocellus II; Pa, Aa, and A3 not in a straight line; ocellus VI distinctly nearer to O1 than to O3; O2 nearer to A3 than to L1; O2 slightly nearer to A3 than to O1; L1 distinctly

nearer to La than to O2; SOa usually slightly nearer to SO2 than to SO3; SO3 distinctly nearer to O3 than to G1.

Material.—Described from a large number of larvae from various sources.

Distribution.—This species is widely distributed over the world and is found in nearly all parts of the United States.

Food plants.—The larva is a general feeder. We have not attempted to make a comprehensive list of food plants but have taken larvae feeding on the following: Cotton bolls, ears of corn, buds of corn, tobacco leaves, buds and seed capsules, tomato fruits, peppers, *Physalis*, species, sassafras, rose shoots, beans, and okra.

HELIOTHIS VIRESCENS Fabricius

This larva has the following distinguishing characters:

All instars after the second.—Dorsal setigerous tubercles (I and II) on abdominal segments 1, 2, and 8 set with the minute spinules with which the skin is clothed. Tubercle I on the above abdominal segments usually conspicuously larger than II.

Fifth instar larva.—Head 1.7–2 mm. broad.

Adult (sixth instar) larva.—Head 2.6–3 mm. broad. Each mandible usually with a large basal process on its oral face. Spiracles on abdominal segments 1 to 7, 0.244 mm. high, which is near the average width of the corresponding spiracles in *obsoleta* Fabricius (fig. 7). Seta A3 usually distinctly less than the width of the ocellus removed from ocellus II (fig. 12). Line connecting the insertions of setae A3 and O2 passing through ocellus I near the center (fig. 12). Head marked, if at all, with brown freckles and sometimes with white reticulation. No dark submedian arcs.

Body about 28 mm. long and 4 mm. broad; first four abdominal segments of about equal width, the body tapering both anteriorly and posteriorly from these; skin set closely with small, short, retrorse spinelike granules which are white on the pale lines, dark elsewhere dorsally, and pale ventrally; general color often green with the venter tending to be white medially and with little infuscation, but varying to reddish and maroon with infuscation more or less developed bordering the middorsal pale line and in the supraspiracular area. Broken white or yellowish longitudinal lines usually present as follows: Middorsally, flanking the middorsal line, dorsal to setigerous tubercle I, through tubercle I, between tubercles I and II, through tubercle II, bordering the supraspiracular area above, and a pair in the supraspiracular area submedially. The supraspiracular area is often scarcely differentiated in color from the dorsum but may be more or less intensely infuscated, especially on the dorsal half. Spiracles set well within the subspiracular pale stripe, black with brown centers. Setigerous tubercles large and somewhat conical, I much larger than II on abdominal segments 1, 2, and 8, less

disparity in size elsewhere, both tubercles clothed with spinules especially on the above abdominal segments, color variable, often green with dark tips. Cervical shield usually green flecked with white, the lateral margins sometimes infuscated. Anal shield concolorous with adjacent parts. Head of the general coloration, sometimes with pale brown tessellation and occasionally reticulated with white, no fuscous submedian arcs or reticulation. Claw of legs with the base broadly angulate. Length of segments of labial palpus in the proportion of 16, 4, and 4, the basal segments with a long acutely conical papilla apically. Spinneret about seven times as long as the median breadth, tapering toward the truncate apex. Mandible as in Figure 9, usually with a broad, convex part on the oral face, produced from the base and along the first ventral rib with the broad, often serrate, apex toward the cutting margin of the mandible. Anterior half of hypopharynx clothed sparsely with very short stout spines, heavier postero-laterally; lobes of the maxillulae clothed with extremely fine hairs; blade of the maxillulae with about 12 flat, triangular, toothlike processes on the free margin.

Head setae and punctures as follows: A2 equidistant from A1 and A3, or nearer to A3; Aa slightly nearer to A3 than to A2; A3 less than the ocellar width removed from ocellus II; Pa, Aa, and A3 not in a straight line; Pb scarcely twice as near to P2 as to P1; ocellus VI nearer to O1 than to O3; O2 nearer to A3 than to L1; O2 approximately equidistant from A3 and O1; L1 distinctly nearer to La than to O2; SOa nearer to SO2 than to SO3; SO3 distinctly nearer to O3 than to G1.

Material.—Described from a large number of larvae from Clarks-ville, Tenn., and Quincy, Fla.

Distribution.—Moths have been seen from Virginia, Tennessee, Colorado, California, North Carolina, Florida, Louisiana, and Mexico.

Food plants.—The known food plants include tobacco buds, leaves, and seed capsules, *Physalis viscosa*, *Rhexia virginica*, *Linaria canadensis*, okra, *Geranium*, and *Ageratum*.

HELIOTHIS PHLOXIPHAGA Grote and Robinson

The following distinctive characters of this larve may be noted:

Dorsal setigerous tubercles (I and II) on abdominal segments 1, 2, and 8 not set with the spinules with which the skin is clothed. Tubercle I but very slightly larger than II on the above abdominal segments. Tubercles I, II, and III strongly elevated, conical, on all abdominal segments. Head 2.2–2.5 mm. broad (probably fifth instar). Each mandible with a slight produced margin along the first ventral rib and without a basal process. Spiracles on abdominal segments 1 to 7, 0.22 mm. broad. Seta A3 distinctly more than the width of the ocellus removed from ocellus II. Line connecting the

insertions of setae A3 and O2 passing posterior to ocellus I. Head with conspicuous dark submedian arcs and with some dark reticulation.

Body about 30 mm. long and 4.5 mm. broad, broadest through abdominal segments 2, 3, 4, and 5 and tapering both anteriorly and posteriorly from these; skin set with small, retrorse, spinelike granules which are pale in the pale lines, dark elsewhere dorsally, and pale ventrally, interspersed in dark areas with dark rounded granules; general color green with much infuscation. Longitudinal area between tubercles I occupied by a dark stripe, except for the pale marginal lines and pale flecks representing the middorsal line. The area included between the pale longitudinal line dorsad of tubercle I and the stronger pale line ventrad of tubercle II, dark but much flecked with pale. Below this and including tubercle III a dark longitudinal stripe more distinct than the others and flecked with pale. Spiracles black, included within the pale subspiracular stripe. Venter pale with the setigerous tubercles black as elsewhere. Setigerous tubercles I, II, and III distinctly strongly conical on all abdominal segments, and somewhat larger on abdominal segments 1, 2, and 8. Cervical shield margined laterally with fuscous. Head with but little dark reticulation, the median black arcs very broad, covering the head posteriorly. Claws of legs with the base angulate.

Labial palpus with the segments in the proportionate length of 18, 2, and 3. Spinneret about six times as long as the median breadth, cylindrical. Mandible with only a slight produced margin along the first ventral rib and without a basal process. Blade of the maxillulae with about 11 oblong toothlike projections on the free margin.

In the immature larva setigerous tubercles I and II on the abdomen are remarkably large and conical, the entire head is blackish, and the cervical shield is pale with black lateral margins.

Head setae and punctures as follows: A2 twice as near to A3 as to A1; A2 twice as near to Aa as to A1; A2 slightly nearer to A1 than to Pa; Aa slightly nearer to A3 than to A2; A3 distinctly more than the width of the ocellus removed from ocellus II; Pa, Aa, and A3 approximately in a straight line; ocellus VI distinctly nearer to O1 than to O3; L1 much nearer to La than to O2.

Material.—Described from one mature (?) alcoholic larva and one mature (?) and one immature inflated larva, all in the collections of the United States National Museum. The inflated larvae are labelled "No. 976. Dyar and Caudell Collectors."

Distribution.—Moths have been seen from Texas, Colorado, Utah, and California.

Food plants.—The recorded food plants include: Alfalfa, phlox, grasses, and *Grindilia squarrosa*.

HELIOTHIS CYSTIPHORA Wallengren

This larva is not included in the preceding key to species but may be distinguished by the following characters:

Body gradually decreasing in width from the metathorax posteriorly. Head strongly freckled with dark brown and fuscous, without fuscous arcs or reticulation. Venter with three white lines particularly evident on the first two abdominal segments. Claw of the leg with a long acute basal tooth.

Head 3 mm. broad. Each mandible with a large acute basal tooth on the first ventral rib. Seta A3 not more than the width of the ocellus removed from ocellus II. Line connecting the insertions of setae A3 and O2 passing through ocellus I. Setigerous tubercles of abdomen occasionally with a few spinules.

Body about 25 mm. long and 3.5 mm. broad; skin set closely with small, short, retrorse, spinelike granules; general color apparently grayish with fuscous stripes. A narrow middorsal fuscous stripe including the broken white middorsal line and bordered by white lines. Longitudinal white lines above and below setigerous tubercle I and ventrad of II, this last the strongest. From ventrad of II and including III a fuscous stripe. Spiracles well within the broad pale subspiracular band which extends to tubercle V. Venter with 3 white lines, particularly evident on the first two abdominal segments. Cervical shield strongly bordered with fuscous laterally.

Second joint of labial palpus as long as the third. Spinneret long and slender, five times as long as the median breadth. Mandible with five teeth, with a large acute process on the first ventral rib basally. Anterior half of hypopharynx clothed uniformly with short stout spines of almost uniform size both laterally and medially; blade of maxillulae with about 9 toothlike processes on the free margin.

Head setae and punctures as follows: A2 approximately equidistant from A1 and A3; A2 at least twice as near to A1 as to Pa; Aa equidistant from A2 and A3; Aa three times as near to A2 as to Pa; A3 not more than the width of the ocellus from ocellus II; P1 much above the level of the apex of the front and decidedly nearer to Adf2 than to Adf1; Pa, Aa and A3 not in a straight line; interspace A2-Aa about half P1-Pa; Pb about twice as near to P2 as to P1; Adfa somewhat nearer to Adf2 than to Adf1; ocellus VI equidistant from O1 and O3 or nearer to O3; O2 equidistant from A3 and O1 or nearer to A3; O2 distinctly nearer to A3 than to L1; L1 three times as near to La as to O2; SOa approximately equidistant from SO2 and SO3; SO3 approximately equidistant from G1 and O3

Material.—Described from 4 mature (?) and 2 immature alcoholic larvae in the United States National Museum collection.

Distribution.—The larvae are from the Galapagos Islands, William Beebe collector. The writer knows nothing of the further distribution of this species.

Food plants.—Unknown.

EXPLANATION OF PLATE

- A¹, A², A³, A^a, A^b—Anterior setae and punctures of epicranium.
 Adf¹, Adf², Adf^a—Adfrontal setae and puncture of epicranium.
 E¹, E²—Epistomal setae.
 F¹, F^a—Frontal seta and puncture.
 G¹, G^a—Genal seta and puncture of epicranium.
 L¹, L^a—Lateral seta and puncture of epicranium.
 O¹, O², O³, O^a—Ocellar setae and puncture of epicranium.
 P¹, P², P^a, P^b—Posterior setae and punctures of epicranium.
 SO¹, SO², SO³, SO^a—Subocellar setae and puncture of epicranium.
 X—Ultraposterior setae and punctures of epicranium.

1. *Heliiothis obsoleta*: Head capsule, dorsal view, showing arrangement of setae and punctures.
2. *Heliiothis obsoleta*: Head capsule, lateral view, showing arrangement of setae and punctures.
3. *Heliiothis obsoleta*: Head capsule, ventral view of left side, showing arrangement of setae and punctures.
4. *Heliiothis obsoleta*: Claw of leg, lateral view.
5. *Heliiothis obsoleta*: Labial palpus.
6. *Heliiothis virescens*: Spinneret, ventral view.
7. *Heliiothis virescens*: Spiracle on third abdominal segment.
8. *Heliiothis obsoleta*: Spiracle on third abdominal segment.
9. *Heliiothis virescens*: Oral face of left mandible.
10. *Heliiothis obsoleta*: Oral face of left mandible.
11. *Heliiothis virescens*: Head capsule, dorsal view, showing arrangement of setae and punctures.
12. *Heliiothis virescens*: Head capsule, lateral view, showing arrangement of setae and punctures.
13. *Heliiothis virescens*: Head capsule, ventral view of left side, showing arrangement of setae and punctures.
14. *Heliiothis virescens*: Setal map of first and second thoracic and first, third, seventh, eighth, and ninth abdominal segments.





Crumb, S. E. 1926. "The Nearctic budworms of the lepidopterous genus *Heliothis*." *Proceedings of the United States National Museum* 68(2617), 1–8.
<https://doi.org/10.5479/si.00963801.68-2617.1>.

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DOI: <https://doi.org/10.5479/si.00963801.68-2617.1>

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