

REDESCRIPTIONS OF THE LARVAL STAGES OF
HEMEROBIUS STIGMA STEPHENS
(NEUROPTERA: HEMEROBIIDAE)

GARY L. MILLER¹ AND PARIS L. LAMBDIN
Department of Entomology and Plant Pathology
University of Tennessee, Knoxville, TN 37901 USA

ABSTRACT

The larval instars of *Hemerobius stigma* Stephens are redescribed and illustrated. The presence of empodia distinguishes first instars. Second instars have fewer setae on the tenth abdominal segment than third instars. A key is provided to separate instars.

RESUME

Los estadios larvales de *Hemerobius stigma* Stephens son descritos e ilustrados. La presencia de "empodia" distingue los primeros estadios. Segundos estadios tienen menos setas en el décimo segmento abdominal que los terceros estadios. Una clave es dada para separar los estadios.

Species of *Hemerobius* are considered important biocontrol agents of soft-bodied insects, and they are potentially useful in the integrated control of pest populations (New 1975), especially at lower temperatures (Garland 1978b, 1980; Neuenschwander and Hagen 1980). Identification of *Hemerobius* spp. is based primarily on adult morphology (MacLeod and Stange 1981). Larval descriptions have either been too brief to separate species of the genus (e.g. Smith 1923, Killington 1937), or failed to reveal sufficient characters to identify instars of a particular species (Withycombe 1923). In general, first instars of all hemerobiids may be distinguished by the presence of empodia, but few characters have been identified as useful in distinguishing second and third instars. This lack of detailed larval descriptions of *Hemerobius* has hampered life history investigations (Smith 1923).

Hemerobius stigma Stephens is widespread throughout Europe, and is one of the most common species of Neuroptera in the British Isles (Killington 1937). Carpenter (1940) considered *H. stigmaterus* Fitch the most widely distributed species of *Hemerobius* in the Nearctic Region. Due to similarities of adult genitalia, Tjeder (1960) synonymized *H. stigmaterus* with *H. stigma*, and compiled a list of synonyms. Variability in the aedeagus prompted Nakahara (1965) to suggest further studies before establishing synonymy of the 2 species. However, most workers accept *H. stigma* as the senior synonym.

The vagueness of previous larval descriptions (Withycombe 1922, 1923; Smith 1923, Laidlaw 1936, Killington 1937), coupled with the unresolved taxonomic status of *H. stigmaterus*, has presented a problem in properly

¹Present address: Dept. of Zoology-Entomology, Auburn University, Auburn, AL 36830 USA.

assessing the biocontrol program for the balsam woolly adelgid (*Adelges piceae*) in Canada (Garland 1978a). During the 1930's, Palearctic *H. stigma* was released but never recovered. This species could have been confused with the Nearctic taxon, *H. stigmaterus*, before the 2 species were synonymized (Garland 1978a).

The eggs were adequately described by several investigators (Smith 1922, Withycombe 1922, Miller and Lambdin 1982). The latter indicated that comparative studies were needed on related species to determine if morphological features of the egg may be diagnostic at the species level.

Because of the potential importance of *H. stigma* as a biocontrol agent in forest management programs, and the unresolved taxonomic problem of this species, the larval instars are redescribed and illustrated. Special attention has been given to those structures that may be of diagnostic value for comparison with larval stages of other *Hemerobius* species.

Larvae obtained from a laboratory colony of *H. stigma* at University of Tennessee, Knoxville were preserved and mounted on slides as described by Wilkey (1962). Setal numbers are given for each half of the body. Measurements for the larval stages were recorded in micrometers (μm) with averages followed by ranges in parentheses.

DESCRIPTION

Third instar (Fig. 1a) (n=10): Length 6,450 μm (4,600-7,200), width at metathorax 1,230 μm (860-1,440).

Head: length 549 μm (435-600), width 495 μm (480-525). Head prognathous (Fig. 1b), y-shaped ecdysial suture terminates at base of mandibles; frons deltoid, with 4 pair of setae. Genae with 4 setae in oblique row, 3 tacklike setae and a campaniform sensillum on posterior margin of sclerite, 2 setae on lateral margin near 3 ocelli, and 2 setae on venter. Antenna 3-segmented; scape 97 μm (90-120) long, 90 μm (75-105) wide; pedicel 63 μm (60-69) long, 54 μm (42-60) wide; flagellum 531 μm (510-555) long, with 4 pair of tacklike setae (Fig. 1g) and a long apical seta. Maxilla with 2 longitudinal rows of 6 (6-9) long setae; 4 (3-4) short setae on outer margin, 2 long setae on inner margin, and 6 (6-8) tacklike setae apically. Submentum with 3 lateral setae, prementum with 2 ventral setae. Labial palpus 3-segmented: 1 pair of long setae, 1 tacklike seta and a sensory pore on segment I; 1 pair of setae and 2 sensilla on segment II; a cirlet of 18-20 spines at apex, and a sensillum on anterior 1/3 of flagellum.

Thorax: divided into 2 subequal annulets (Fig. 1d); integument covered with minute spinules. *Prothorax*: Dorsum of anterior annulet with 3 setae in transverse row; venter with 3 tacklike setae on anterolateral margin and 3 long, needlelike setae in transverse row on each side. Dorsum of posterior annulet with 3 tacklike setae on anterolateral margin; 3 long setae on lateral margin, 4 long setae in transverse row anteriorly, and 3 long submedial setae. Pair of submedial kidney-shaped sclerites, dorsum of each with 1 long seta and 1 spinelike seta on anterior margin and a long medial seta; venter with 3 tacklike setae on anterolateral margin and 6 (4-6) longer setae arranged in 2 oblique rows in submedial area. *Mesothorax*: Dorsum of anterior annulet with a transverse row of 5 long setae and a lateral spiracle; venter with a short seta. Dorsum of posterior annulet with a tacklike seta on anteromedial margin, 3 long setae on lateral margin and

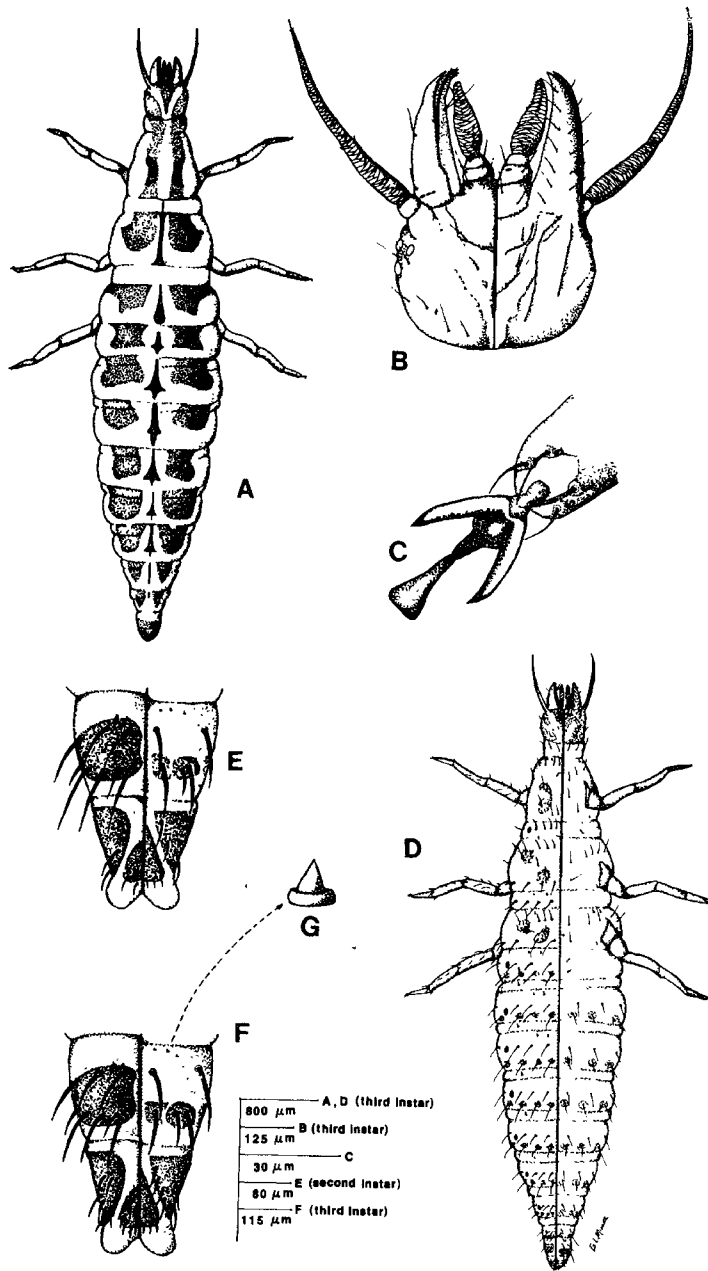


Fig. 1. *Hemerobius stigma* Stephens larvae: a) dorsum of third instar, b) dorsoventral head region of third instar, c) tarsus of first instar, d) dorsoventral view of chaetotaxy for third instar, e) 9th and 10th abdominal segments of first and second instars, f) 9th and 10th abdominal segments of third instar, g) tacklike seta.

3 setae in transverse row anteriorly; anterior submarginal chalaza with 2 long and 1 spinelike setae; 1 long submedial seta and 2 marginal setae; and a posterior rounded sclerite with 1 long and 1 tacklike seta; venter with a circulet of 4 long setae on anterolateral margin, 2 long setae medially and 1 tacklike seta on submargin of posterior annulet. *Metathorax*: Dorsum of anterior annulet with 4 long setae in transverse row and 2 tacklike setae on submargin; venter with microspines only. Dorsum of posterior annulet same as on mesothorax, but only 1 long seta on posterolateral margin; venter with same pattern as mesothorax except 2 spinelike setae on anteromedial margin.

Abdomen (Fig. 1d): 10-segmented, each segment membranous, divided into 2 subequal annulets except segment I with 1 annulet; each annulet with numerous microspinules. Dorsum of segment I with marginal spiracle, 2 tacklike setae and a transverse row of 4 long setae anteriorly; 4 chalazae posteriorly located, setal arrangement from lateral margin to midline is 1,2,1,2 alternating spinelike and needlelike; venter with 2 spinelike submedial setae. Dorsal anterior annulets of segments II-VII with a submarginal tacklike seta on each half; venter with microspinules only. Dorsal posterior annulets of segments II-VII same as segment I; venter with transverse row of 3 long setae anteriorly and a transverse row of long setae arranged 2,1,1 from lateral margin to midline posteriorly. Dorsal anterior annulet of segment VIII with submarginal tacklike seta; posterior annulet same as above except anteriorly with 3 long setae and posteriorly the 3 chalazae with setal arrangement from lateral margin to midline 2,1,2. Venter of posterior annulet with 3 tacklike and 1 long medial setae, and 1 long seta on anterolateral margin; transverse row of chalazae with setae arranged 2, 1 from margin to midline posteriorly. Segment IX (Fig. 1f) with same setal pattern as segment VIII, but more heavily sclerotized and without lateral spiracles. Segment X without setae on anterior annulet, but with a lateral and medial sclerotized plate on posterior annulet; lateral plate with 9 (8-9) long setae on lateral, medial and posterior margins of sclerite; medial sclerite deltoid with 14 (12-16) spinelike setae. Ventrally, no setae on anterior annulet; posterior annulet with 2 sclerites, lateral sclerite with oblique row of 7 long setae; medial deltoid sclerite with transverse row of 6 long setae on posterior margin.

SECOND INSTAR

Larvae (n=10) differ from third instars as follows: Length 3,660 μm (3,060-4,840); width at metathorax 680 μm (580-900). *Head* (Fig. 1b): length 369 μm (339-384), width 381 μm (366-390). Antennal scape 75 μm (60-90) long, 63 μm (54-72) wide; pedicel 42 μm (36-51) long, 42 μm (36-45) wide; flagellum 405 μm (375-429) long. *Thorax: Prothorax*: Posterior annulet on venter with an additional tacklike seta on anterolateral margin. *Mesothorax*: Anterior annulet on venter with only a tacklike seta on anterior submargin. *Abdomen*: Posterior annulet of segment X (Fig. 1e) (36-45) wide; flagellum 405 μm (375-429) long. *Thorax: Prothorax*: Posterior margin, a dorsal deltoid sclerite with a longitudinal row of 4 pairs of long setae, and ventrally with lateral sclerite possessing 3 long setae in oblique row on posterior margin.

FIRST INSTAR

Larvae (n=10) differ from other instars as follows: Length 2,440 μm (1,440-3,200), width at metathorax 460 μm (200-600). *Head*: length 288 μm (219-360), width 315 μm (270-375); antennal scape 57 μm (30-62) long, 54 μm (36-81) wide, pedicel 39 μm (27-45) long, 39 μm (33-45) wide; flagellum 339 μm (330-357) long. Tarsi (Fig. 1c) with trumpet-shaped empodia. *Thorax: Prothorax*: Dorsum and venter of anterior annulet without transverse row of setae. Dorsum of posterior annulet lacking anterior transverse row of setae, only 1 long seta on posterolateral margin; venter with a tacklike seta on posterior submargin only. *Mesothorax*: Dorsal anterior annulet lacking transverse row of setae; venter with only a tacklike seta on posterior submargin. Dorsum of posterior annulet lacking anterior transverse row of setae, with 1 long seta on posterolateral margin; venter with 2 tacklike setae on anterolateral margin, 1 long medial seta and 1 spinelike seta on posterior submargin. *Metathorax*: Dorsum of anterior annulet lacking transverse row of setae; venter with a tacklike seta on posterior submargin. Dorsum of posterior annulet lacking anterior transverse row of setae; venter with 2 tacklike setae on anterolateral margin, 1 long medial seta and 1 spinelike seta on posterior submargin. *Abdomen*: Posterior annulet of segment X with 2 long setae in oblique row on posterior margin of dorsolateral sclerite, medial deltoid sclerite with a longitudinal row of 4 pairs of long setae; venter with lateral sclerite possessing 3 long setae in oblique row on posterior margin.

KEY TO THE LARVAL INSTARS

1. Tarsi with trumpet-shaped empodia first instar
Tarsi without empodia 2
2. Posterior annulet of segment X with 2 long setae in oblique row on medial margin of dorsolateral plates; lateral sclerite on venter with 3 long setae in oblique row on posterior margin second instar
Posterior annulet of segment X with 8-9 long setae on medial and posterior margins of dorsal and lateral plates; lateral sclerite on venter with 7 long setae in oblique row on posterior margin - third instar

The body and head capsule sizes are not consistent characters to rely on because of the size overlap among instars. The presence of empodia on first instars and the difference in chaetotaxy of the tenth abdominal segments between the second and third instars are primary characteristics that readily distinguish the immature stages of *H. stigma*. Accordingly, we differ from Withycombe's (1923) belief that chaetotaxy probably would not provide useful taxonomic characters. Indeed, a close examination of other species may reveal setae that could be compared to differentiate all species of Hemerobiidae on the basis of their immature stages.

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