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LIFE HISTORY AND DESCRIPTIONS OF THE IMMATURE STAGES OF THE PLANTHOPPER *STENOCRANUS LAUTUS* (HOMOPTERA: DELPHACIDAE)

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Abstract.—The life history of *Stenocranus lautus* Van Duzee was studied in Missouri from April to November 1984, it was reared in the laboratory and the immature stages were described. *S. lautus* feeds and reproduces on *Carex lurida* Wahl., is bivoltine and apparently overwinters as eggs. Field collected adults kept on potted *C. lurida* in the laboratory laid eggs which hatched and were reared to adults. Durations of the five nymphal stadia were 5.4, 7.5, 16.0, 10.5 and 11.0 days, respectively. Nymphal instars differed in body size, number of pit-like sensoria, development of wingpads, number of metatibial and metatarsal spines, and shape and dentition of metatibial spurs.

Stenocranus lautus Van Duzee has been reported from most of eastern North America, including New Hampshire, New York, Maryland, Washington D.C., Virginia, North Carolina, Illinois and Kansas (Beamer, 1946a; Wilson and McPherson, 1980). *S. lautus* was described by Van Duzee (1897); an illustration of an adult was published by Metcalf (1923) and male genitalic features were described and illustrated by Beamer (1946a). No published information is available on the life history.

As is the case for the majority of planthopper species, very little is known about the life histories of the ca. 60 species of *Stenocranus* (O'Brien and Wilson, in press). Adults and nymphs feed on horsetails (Equisetaceae), grasses (Gramineae), and sedges (Cyperaceae) (Mochida and Okada, 1971). Information on the biology of several Palearctic species has been published. *S. minutus* (Fab.) feeds on *Dactylis glomerata* L. (Gramineae) (May, 1975), is monovoltine (Müller, 1958), overwinters as adults (Ossiannilsson, 1978) and is parasitized by a pipunculid fly (Diptera) (May, 1979). *S. major* (Kirschbaum) feeds on *Phalaris arundinaceae* L. (Gramineae) (Le Quesne, 1960), overwinters as an adult and has been reported as a pest of rice in Italy (Ossiannilsson, 1978). *S. gialovus* Asche and Hoch feeds on *P. aquatica* L. (Asche and Hoch, 1983), *S. matsumurai* Metcalf on *Equisetum arvense* L. (Equisetaceae) and *S. yasumatsui* Ishihara on *Carex* sp. (Cyperaceae) (Lee and Kwon, 1977, 1980).

The present study summarizes the life history of *S. lautus* at Pertle Springs, Johnson County, Missouri, provides information on laboratory rearing, descriptions and illustrations of immature stages and a key to nymphal instars.

MATERIALS AND METHODS

The field study was conducted at Racehorse Lake, Pertle Springs, Warrensburg, Johnson County, Missouri. In an attempt to collect overwintering stages of *S. lautus*, five 10-gallon plastic garbage bags of leaf litter and thatch from in and around the host plants, *Carex lurida* Wahl., were collected on April 15, 1984 and placed in a large modified Berlese funnel. Sweep net samples (50 sweeps/week) were taken twice per week from May 1 to November 15, 1984. The information recorded from these sweep samples included the number of individuals captured, gender of adults, and number of each nymphal instar. Some of the collected individuals were preserved in 70% isopropyl alcohol for measurements and description and some were returned alive to the laboratory for rearing (see below). Potential predators were collected in the field by sweeping and hand picking from the host plants. Feeding and oviposition sites were determined, in both field and laboratory studies, by observing individuals on the host plants.

The laboratory study was begun using an environmental chamber but, because of mechanical failure, the study was conducted in a laboratory where *C. lurida* plants were transplanted from the field site and grown in 16 cm diam. plastic pots. Two fluorescent bulbs on a 16L:8D timer were placed 8–10 cm over the tops of the pots. Room temperature could not be controlled but ranged from ca. 21 to 27°C during the course of the study. Field collected *S. lautus* adults were placed on potted *Carex* and allowed to feed and lay eggs. The insects remained on the plants despite the absence of a cover. After the eggs hatched, the immatures were removed by gently brushing them off the plant with a fine paintbrush and placing them on small, individual *Carex* plants each having 3–4 leaves and planted in 8 cm diam. plastic pots. Both eggs and newly hatched immatures were observed 5–6 times daily.

The information obtained from the laboratory study included number of eggs laid, feeding sites of immatures and adults, number surviving each stage, and length of each stadium. The descriptions and illustrations of the egg and each nymphal instar and a key to nymphal instars are based upon laboratory reared individuals.

The 5th instar is described in detail but only major differences are described for 4th through 1st instars. Measurements are given in mm as mean ± SD. Length was measured from apex of vertex to apex of abdomen, width across the widest part of the body, and thoracic length along the midline from the anterior margin of the pronotum to the posterior margin of the metanotum. Eggs were obtained by removing them from host plants by inserting a needle under each egg and teasing it free.

RESULTS AND DISCUSSION

Field study. No specimens were collected during April and May by either Berlese funnel or sweeping. First, 2nd and 3rd instar nymphs were collected from June 4 to 10; 4th and 5th instar nymphs from June 18 to July 2. Adult males were first collected on June 20 and females on June 25; both sexes were collected through July 25 (Fig. 1). Wax first appeared on the abdomens of females, signaling oviposition, on July 5. Unsuccessful attempts were made to locate eggs in the field. Second generation 1st instar nymphs were collected from August 1 to 6, 2nd from August 1 to 30, 3rd from August 1 to September 8, 4th from August 6 to September 19 and 5th from August 30 to September 21; adults were collected on August 23, but were not collected again until September 19. Wax first appeared on the abdomens of presumed second generation females on October 3. The last adult was collected on October 25 (Fig. 1). *S. lautus* is bivoltine and apparently overwinters as eggs. Evidence to support this

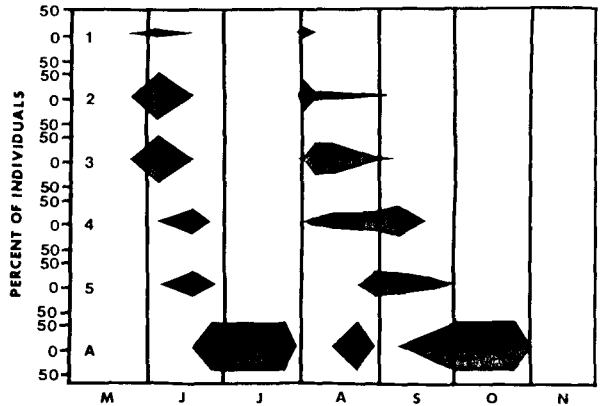

Fig. 1. Seasonal occurrence of *S. lautus* in Missouri. Number of individuals of each stage is expressed as percentage of total individuals of all stages collected per collection date (N_1 = 35, N_2 = 120, N_3 = 166, N_4 = 157, N_5 = 105, N_A = 77).

includes the absence of overwintering adults or immatures in the collected samples, the presence of early instar nymphs in the spring, and the presence of gravid females with oviposition wax in late fall. *S. lautus* differs from other species in the number of generations and overwintering stages. *S. minutus* is monovoltine (Müller, 1958) and *S. minutus* and *S. major* overwinter as adults (May, 1979; Ossiannilsson, 1978).

Feeding sites for adults were not detected in the field but nymphs were observed feeding ca. 4–6 cm above ground level on stems or along the midrib on the underside of leaves.

The spider *Zygoballus bettini* Peckham (Salticidae) was observed feeding on a late instar nymph: 16 other species of spiders, all potential predators collected at the study site are given by Calvert (1985).

Laboratory study. Wax-covered eggs were found inserted singly in horizontal rows on the leaves 9 cm up from the soil. Eggs hatched 16–21 days after being laid. Of 89 eggs laid, 85 hatched but 63 nymphs died during emergence. It took 67 days from the time the first egg was laid until the last adult ecdysis. The 22 surviving nymphs lived for different lengths of time but usually died during ecdysis; 15 died between 1st and 2nd nymphal instar, 3 between 2nd and 3rd, 2 between 3rd and 4th, and only 2 reached adult ecdysis (Table 1). The two individuals that reached adult emerged from their exuvia except for their hind legs; they died in this condition. The length of time from eclosion to ecdysis for these two individuals was 50 days. Durations of the nymphal stadia are given in Table 1. Adults were observed feeding on all emergent parts of the plants, but nymphs were always observed feeding below 7 cm.

Descriptions of nymphal instars. Fifth instar (Fig. 2). Length 2.7 ± 0.31; thoracic length 1.2 ± 0.08; width 1.3 ± 0.10. N = 6.

Table 1. Duration (in days) of the nymphal instars of *S. lautus*.

Nymphal instar	No. beginning	No. completing	Days	
			Range	Mean ± SD
1st	22	7	4–7	5.4 ± 1.3
2nd	7	4	7–8	7.5 ± 0.6
3rd	4	2	15–17	16.0 ± 1.4
4th	2	2	10–11	10.5 ± 0.7
5th	2	2	10–12	11.0 ± 1.4

Body reddish with white middorsal line extending from anterior end of vertex to posterior end of metanotum. Form elongate, subcylindrical, slightly flattened dorsoventrally, widest across mesothoracic wingpads.

Vertex subtriangular; posterior margin almost straight; narrowing anteriorly, lateral margins slightly convex in posterior ⅓. Frons yellowish to brownish with white longitudinal median line; subrectangular; border with clypeus slightly convex; lateral margins convex and carinate (outer carinae) and paralleled by second pair of carinae (inner carinae) which are continuous with lateral margins of vertex; area between inner carinae elevated; region between inner and outer carinae with 9 pits on each side; 8 pits between each outer carina and eye. Clypeus yellowish to brownish, narrowing distally, consisting of subconical basal postclypeus and cylindrical distal anteclypeus. Beak 3-segmented, cylindrical, segment 1 almost entirely hidden by

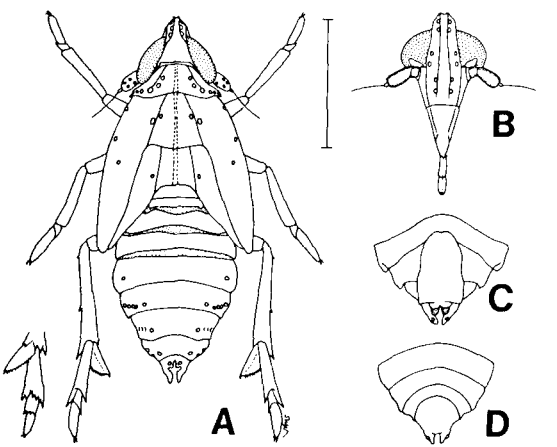

Fig. 2. *S. lautus* fifth instar. A. Habitus. B. Frontal view of head. C. Apical part of venter of female abdomen. D. Apical part of venter of male abdomen. Vertical bar = 1.0 mm.

anteclypeus, segment 2 ca. 1½× length of segment 3, segment 3 with black apex. Antennae 3-segmented; scape short, cylindrical; pedicel subcylindrical, 4× length of scape, with ca. 14–15 pit-like sensoria; flagellum bulbous basally, with elongate bristle-like extension distally, bulbous base ca. ⅙× length of pedicel. Eyes red.

Thoracic nota divided by middorsal line into three sets of plates. Pronotal plates subtriangular; anterior margin following posterior border of eye, posterior border sinuate; each plate with posterolaterally curving carina originating on anterior margin in median ⅓ and terminating on posterior margin in lateral ⅓; area between carinae elevated and subtriangular; row of 10 pits extending along anterolateral margin of carina to lateral border of plate (lateralmost pits not visible in dorsal view). Mesonotum with median length 1½× that of pronotum; subrectangular; elongate lobate wingpads extending to tips of metanotal wingpads; each plate with posterolaterally directed carina originating on anterior margin in median ¼ and terminating on posterior margin in lateral ½; area between carinae elevated and subtriangular; 2 pits near carina and 3 pits in lateral ⅓. Metanotum with median length ca. 1½× that of mesonotum; subrectangular, lobate wingpads extending to middle of 4th tergite; each plate with posterolaterally directed carina originating on anterior margin in median ¼ and terminating on posterior margin in median ⅓; 1 pit near middle of plate. Pro- and mesocoxae elongate and directed posteromedially; metacoxae fused to sternum. Metatrochanter short and subcylindrical. Pro- and mesofemora and tibia each with 2 ventral longitudinal rows of setae. Metatibia with 2 black-tipped spines on lateral aspect of shaft, an apical transverse row of 5 black-tipped spines on ventral aspect and a subtriangular, flattened movable spur with 12–13 teeth on posterior margin. Pro- and mesotarsi with 2 tarsomeres; tarsomere 1 wedge-shaped; tarsomere 2 subconical, ca. 3× length of tarsomere 1, with pair of apical claws and median membranous pulvillus. Metatarsi with 3 tarsomeres; tarsomere 1 with apical transverse row of 7 black-tipped spines; tarsomere 1 with apical transverse row of 7 black-tipped spines; tarsomere 2 cylindrical, ca. ¼× length of 1, with apical transverse row of 4 black-tipped spines on ventral aspect; tarsomere 3 subconical, ca. 1½× length of 2, with pair of apical claws and median pulvillus.

Abdomen 9 segmented; slightly flattened dorsoventrally, widest across 5th abdominal segment. Tergite 1 small, subtriangular; 2 subrectangular, 2⅓× width of 3; tergites 5–8 each with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect): tergite 5 with 1, 6 with 4–5, 7 with 5–6, 8 with 4–5. Segment 9 surrounding anus; with 3 pits; female with 1 pair of acute processes extending from juncture of sternites 8 and 9; males lacking processes.

Fourth instar (Fig. 3E). Length 1.8 ± 0.15; thoracic length 0.7 ± 0.03; width 0.9 ± 0.07. N = 7.

Frons with 7 pits between each outer carina and eye. Antennal pedicel with 9 sensoria; basal flagellum ¼× length of pedicel.

Pronotal plates each with 9 pits. Mesonotal wingpads shorter, covering ca. ⅔ of metanotal wingpad laterally. Metanotal median length subequal to that of mesonotum; carinae weaker; wingpad extending to tergite 3. Metatibial spur slightly smaller with 8–10 teeth on margin. Metatarsi with 2 tarsomeres; tarsomere 1 with apical transverse row of 6 black-tipped spines; tarsomere 2 subconical with 3 black-tipped spines in median portion of tarsomere.

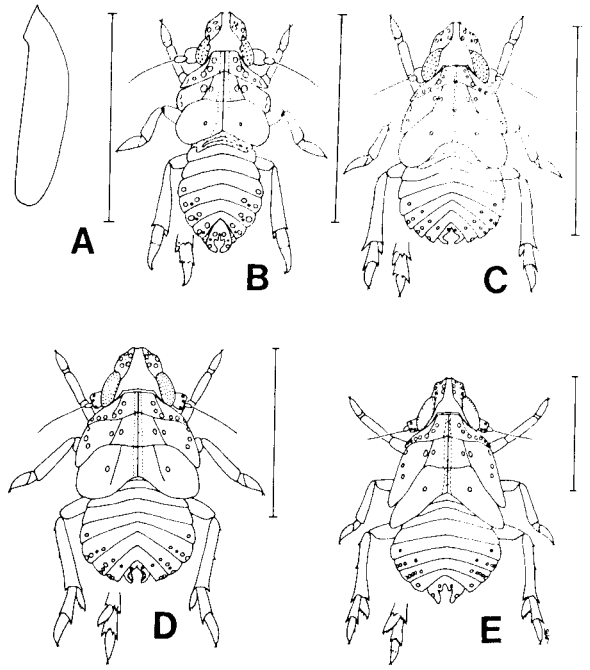

Fig. 3. *S. lautus* immature stages. A. Egg. B. First instar. C. Second instar. D. Third instar. E. Fourth instar. Vertical bar = 1.0 mm.

Abdominal tergites 5–8 with the following number of pits on either side of midline (lateralmost pits not visible in dorsal view due to curving on tergites onto ventral aspect): tergite 5 with 1, 6–7 each with 5, 7 with 5, 8 with 3–4.

Third instar (Fig. 3D). Length 1.3 ± 0.11; thoracic length 0.5 ± 0.03; width 0.6 ± 0.04. N = 10.

Frons with 5 pits between each outer carina and eye. Antennal pedicel with 4 sensoria; bulbous base of flagellum ca. 1½× length of pedicel.

Pronotal plates each with 8 pits. Mesonotal wingpad shorter covering ⅓ of metanotal wingpad laterally. Metanotal wingpad extending to juncture of tergites 2 and 3. Metatibial spur smaller; 4 apical teeth on margin. Metatarsomere 1 with apical transverse row of 5 black-tipped spines; tarsomere 2 without spines in middle.

Abdominal tergites 5–8 each with the following number of pits on either side of

midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect): tergite 5 with 1, 6–7 each with 4, 8 with 3.

Second instar (Fig. 3C). Length 1.0 ± 0.05; thoracic length 0.4 ± 0.04; width 0.4 ± 0.03. N = 10.

Frons with 3 pits between each outer carina and eye. Antennal pedicel lacking sensoria.

Pronotal plates each with 7 pits. Mesonotal plates each with 4 pits; wingpads undeveloped. Metanotal wingpads undeveloped. Metatibia with apical row of 3 black-tipped spines; spur smaller, ca. 2× length of longest metatibial spine, without marginal teeth, with black-tipped tooth at apex; metatarsomere 1 with 4 apical black-tipped spines.

Abdominal tergite 5 lacking pits, tergites 6–8 each with 3 pits on either side of midline (lateralmost pits not visible in dorsal view due to curving to tergites onto ventral aspect).

First instar (Fig. 3B). Length 0.8 ± 0.06; thoracic length 0.3 ± 0.06; width 0.3 ± 0.02. N = 10.

Bulbous base of antennal flagellum subequal in length to that of pedicel.

Pronotal plates each with 6 pits. Mesonotal plates each with 3 pits. Metanotal plates lacking pits. Metatibia apparently lacking spines on shaft.

Abdominal tergites 6–8 each with 2 pits on either side of midline (lateralmost pits not visible in dorsal view due to curving of tergites onto ventral aspect).

Egg (Fig. 3A). Length 0.97 ± 0.01; width 0.23 ± 0.01. N = 3.

Eggs laid singly; white; cylindrical flattened, ovoid in anterior ⅕; chorion translucent, smooth.

KEY TO *S. lautus* NYMPHAL INSTARS

1. Metatibial spur with marginal teeth; 5–8 pits between outer carina and eye; pit-like sensoria present on antennal pedicel (Figs. 2, 3D) 2
– Metatibial spur without marginal teeth; 3 pits between each outer carina and eye; antennal pedicel lacking pit-like sensoria; pit absent on abdominal tergite 5 (Fig. 3B, C) 4
2. Metatarsi with 3 tarsomeres; 8 pits between each outer carina and eye; mesonotal wingpads extending to or almost to apex of metanotal wingpads (Fig. 2) ...... 5th Instar
– Metatarsi with 2 tarsomeres (tarsomere 2 may be partially subdivided); 5–7 pits between each outer carina and eye; mesonotal wingpads not extending to apex of metanotal wingpads (Fig. 3D, E) 3
3. Metatarsomere 2 with 3 small spines in middle; 7 pits between each outer carina and eye; mesonotal wingpads covering ca. ⅔ of metanotal wingpads (Fig. 3E) ..... 4th Instar
– Metatarsomere 2 without spines; 5 pits between each outer carina and eye; mesonotal wingpads covering less than ⅔ of metanotal wingpads (Fig. 3D) .... 3rd Instar
4. Metatibia with 2 spines on shaft; abdominal tergites 6–8 each with 3 pits on either side (Fig. 3C) .... 2nd Instar
– Metatibia apparently lacking spines on shaft; abdominal tergites 6–8 each with 2 pits on either side (Fig. 3B) .... 1st Instar

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