

Delphacid Planthoppers *Sogatella kolophon* and *Delphacodes idonea* (Homoptera: Delphacidae): Descriptions of Immature Stages and Notes on Biology

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ABSTRACT Planthoppers *Sogatella kolophon* (Kirkaldy) and *Delphacodes idonea* Beamer were reared on torpedo grass, *Panicum repens* L., in the laboratory. Egg incubation periods averaged 11.0 and 10.0 d for *S. kolophon* and *D. idonea*, respectively. Total nymph periods were 20.3 d for *S. kolophon* and 16.8 d for *D. idonea*. Adult longevity for *S. kolophon* and *D. idonea* was 18.4 and 9.4 d, respectively. Immature stages of both species are described and illustrated and a key is provided to separate instars.

KEY WORDS Delphacidae, biology, immature morphology

RECENTLY WE found two species of delphacid planthoppers, *Sogatella kolophon* (Kirkaldy) and *Delphacodes idonea* Beamer, feeding on torpedo grass, *Panicum repens* L. Torpedo grass is one of the most serious weeds of plantations, fruits, and field crops in the tropics and subtropics (Holm et al. 1977). Because a number of planthopper species are vectors of plant pathogens (Conti 1985), these delphacids may be a source of biological control for this serious weed.

S. kolophon has been reported from Australia, Pacific islands, Southeast Asia, Atlantic islands, Central and South America, Caribbean islands, and West Africa (Fennah 1949, 1956, 1957, 1963, 1967a,b, 1978; Caldwell & Martorell 1951; Mochida & Okada 1971; S.W.W., unpublished data). Fennah (1963) recognized four subspecies of *S. kolophon*; one of these, *S. kolophon meridiana* (Beamer), has been recorded from the following localities in the United States: Florida, Texas, Kentucky, Missouri, Mississippi, Louisiana, and Georgia (Beamer 1952, Giri & Freytag 1983b; S.W.W., unpublished data). *S. kolophon* has been reported feeding on wheat, *Triticum aestivum* L.; oats, *Avena sativa* L.; carrots, *Daucus carota* L.; carpet grass, *Axonopus compressus* (Spartz) Beauv.; barnyard grass, *Echinochloa crusgalli* (L.) Beauv.; goose grass, *Eleusine indica* (L.) Gaertn.; pangola grass, *Digitaria decumbens* Stent; rice, *Oryza sativa* L.; and para grass, *Panicum purpurascens* Raddi, as well as tree ferns, *Dicksonia* sp., and trumpet lilies, *Lilium longiflorum* var. *eximium* Hort. (Fennah 1963, Mochida & Okada 1971, Ghauri 1980, Giri & Freytag 1983b). *S. kolophon* has been shown to transmit viruses of corn, *Zea mays* L., and barley, *Hordeum vulgare* L. (Greber 1982), and is the agent of dry bud rot of young coconut palms (Julia & Mariau 1982).

Other members of the genus *Sogatella* have drawn considerable attention because of their importance as plant pests. *Sogatella furcifera* (Horvath) is a pest of rice and much attention has been directed toward the resistance of rice cultivars to its feeding (Ammar et al. 1980, Saxena & Khan 1984, Heinrichs & Rapusas 1985, Wu & Khush 1985). *S. furcifera* is also a vector of pangola stunt virus (Bisessar 1966) and is a pest of millet *Setaria italica* (L.) Beauv., and corn (Pathak 1975). *Sogatella suzeensis* (Matsumura) [= *S. vibu* (Haupt)] is a pest of a number of cereals and is a vector of viruses of corn (Ammar 1977).

As is the case with most delphacids, little is known about the biology of the ca. 120 species of *Delphacodes* reported in the United States. Stoner & Gustin (1980) and Giri & Freytag (1983a) provided life-history information and host-plant records for *Delphacodes campestris* (Van Duzee) and *Delphacodes luteola* (Van Duzee), respectively. Wilson (1985) described the immature stages of *Delphacodes bellicosa* Muir and Giri & Freytag (1983b) reported the occurrence of eight *Delphacodes* spp. in Kentucky. Beamer (1947) reported *D. idonea* from Florida and described adults. Otherwise no information is available for this delphacid.

In the present study we summarize the biology of *S. kolophon* and *D. idonea* and their relationship with torpedo grass in South Florida, and include information on laboratory rearing, descriptions and illustrations of immature stages, and provide a key to the five instars.

Materials and Methods

Descriptions of Immatures. Descriptions and illustrations of the egg and each instar and a key to instars are based upon laboratory-reared individuals preserved in 75% ethyl alcohol.

The fifth instar is described in detail but only major differences are described for first through

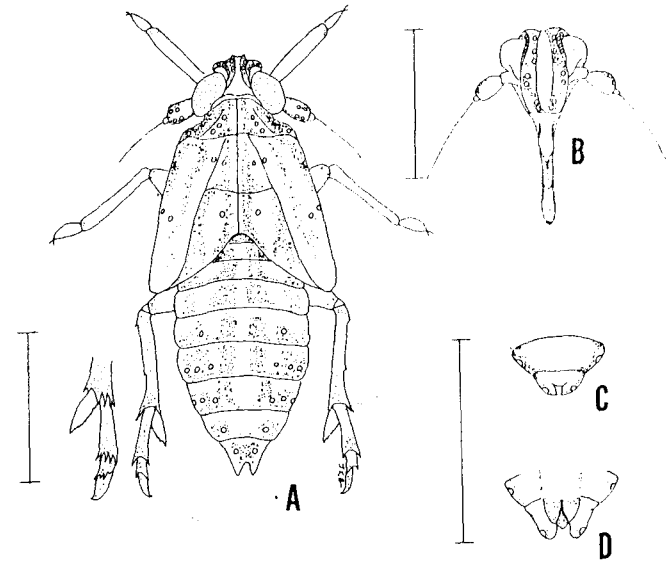


Fig. 1. *S. kolophon* fifth instar: (A) habitus, (B) frontal view of head, (C) apical part of venter of male abdomen, (D) apical part of venter of female abdomen. Vertical bars = 1.0 mm.

fourth instars. 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 inserting a needle under each egg and teasing it free from the host plant.

Biology of *S. kolophon* and *D. idonea*. Weekly sweeps of two pure stands of torpedo grass located in Fort Lauderdale, Fla., were made from November 1985 to February 1986. Laboratory colonies of *S. kolophon* and *D. idonea* were established by placing wild adults in cylindrical butyrate cages on separate pots of torpedo grass (Tsai 1975). Both colonies were kept at 26.7°C with a 12:12 (L:D) photoperiod and allowed to lay eggs. Upon hatching, the immatures were removed from the plant and placed in culture tubes (2.5 cm diameter) containing a fresh stem and leaves. The culture-tube opening was covered with parafilm. Plant tissue was replaced every 3 d or when required. Dead insects were replaced to obtain adequate numbers completing each molt. Daily observations of nymphs were made and dates of molts recorded.

Results and Discussion

Descriptions of Immatures. The nymphs of *S. kolophon* and *D. idonea* are very similar and can

be separated reliably only as fifth instars. In fifth-instar *S. kolophon* the length of the vertex is ca. 1.5-fold its width at the base, the gena bears two small pits, and the tibial spur has 16-18 teeth. In *D. idonea* the length of the vertex is subequal to its width, the gena bears three pits, and the hind tibial spur has 10-12 teeth.

Sogatella kolophon

Fifth Instar (Fig. 1). Length 2.19 ± 0.16 mm; thoracic length 0.75 ± 0.07 mm; width 1.02 ± 0.07 mm; $n = 15$.

Form elongate, subcylindrical, slightly flattened dorsoventrally, widest across mesothoracic wingpads. Body mottled light gray to brown and cream on dorsum with white middorsal line extending from anterior end of pronotum to posterior end of abdomen. Venter and legs cream.

Vertex quadrate, length subequal to width at base, posterior margin almost straight; carina on each side extending anteromedially from posterolateral corner and continuing onto frons as inner carina. Frons subrectangular; widest near middle, width ca. 0.7 length; carinate lateral margins convex, these outer carinae extending from vertex to near clypeal border and paralleled by pair of inner carinae; 9 pits between each inner and outer carina and 4 pits between each outer carina and eye.

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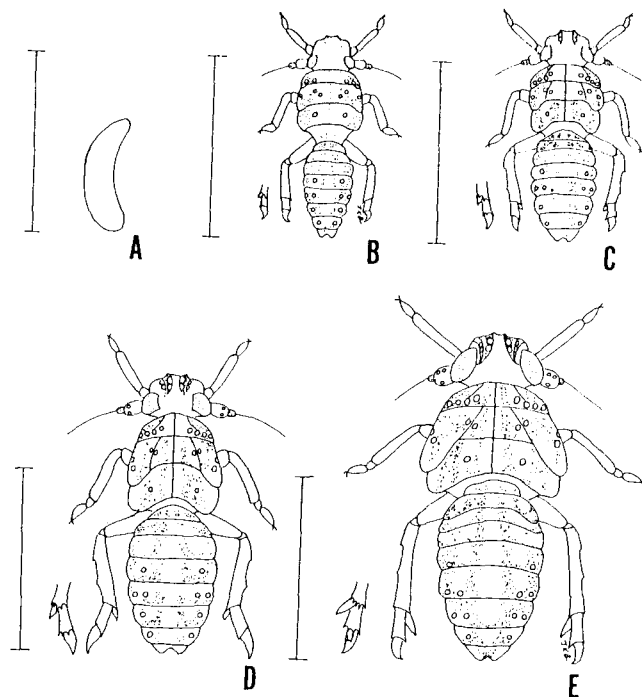


Fig. 2. *S. kolophon* immature stages: (A) egg, (B) first instar, (C) second instar, (D) third instar, (E) fourth instar. Vertical bars = 1.0 mm.

Gena with 2 small pits. Clypeus narrowing distally, consisting of subconical basal postclypeus and cylindrical distal anteclypeus. Beak 3-segmented, segment 1 obscured by anteclypeus, lengths of segments 2 and 3 subequal; apex of segment 3 black. Eyes red. Antennae 3-segmented; scape short, cylindrical; pedicel subcylindrical, ca. 3-fold length of scape, with ca. 10–12 pitlike sensoria; flagellum bulbous basally, with elongate, bristlelike extension distally, bulbous base ca. 0.2 length of pedicel.

Thoracic nota divided by middorsal line into 3 pairs of plates. Pronotal plates subrectangular, appearing triangular in dorsal view; anterior margin following posterior border of eye, posterior border sinuate; each plate with oblique posterolaterally directed carina originating on anterior margin in median $\frac{1}{2}$ and terminating near posterior margin in lateral $\frac{1}{2}$, row of 7 pits extending posterolaterally from inner margin of carina to lateral border of plate (lateralmost pits not visible in dorsal view). Mesonotal length ca. 1.5- to 2-fold that of pronotum; wingpads in macropter elongate lobate, extending to, or nearly to, tips of metanotal wing-

pads; brachypters with wingpads like those of fourth instars (as in *Megamelus davis* Van Duzee; see Wilson & McPherson [1981]); each plate with posterolaterally directed carina originating on anterior margin in median $\frac{1}{2}$ and terminating on posterior margin in lateral $\frac{1}{2}$; 2 pits on either side of carina and 3 pits in lateral $\frac{1}{2}$. Metanotal median length ca. 0.75 that of mesonotum; each plate bearing an elongate lobate wingpad extending to 4th tergite; weak longitudinal carina originating on anterior margin in median $\frac{1}{2}$ and terminating in posterior margin in median $\frac{1}{2}$; 1 pit just lateral to carina. Pro- and mesocoxae elongate, posteromedially directed; metacoxae fused to sternum. Metatrochanter subcylindrical. Metatibia with 2 black-tipped spines on lateral aspect of shaft, an apical transverse row of 5 black-tipped spines on plantar surface, and a subtriangular, flattened movable spur with row of 16–18 teeth on lateral margin. Pro- and mesotarsi with 2 tarsomeres; tarsomere 1 wedge-shaped; tarsomere 2 subconical, curved, and with pair of apical claws and median membranous pulvillus. Metatarsi with 3 tarso-

meres; tarsomere 1 cylindrical with apical transverse row of 7 black-tipped spines on plantar surface; tarsomere 2 cylindrical, with apical transverse row of 4 black-tipped spines on plantar surface; tarsomere 3 subconical, similar to terminal tarsomere of other legs.

Abdomen 9 segmented; slightly flattened dorsoventrally, widest across segment 4 or 5. Tergite 1 reduced, tergites 5–8 each with the following number of pits on either side of midline (lateralmost pits not always visible in dorsal view because of curving of tergites onto ventral aspect): tergite 5 with 1 pit, 6–8 each with 3 pits. Segment 9 surrounding anus, with 3 pits on each side; female with 1 pair of acute processes extending caudally from juncture of sternite 8 and segment 9; males lacking processes.

Fourth Instar (Fig. 2E). Length 1.74 ± 0.21 mm; thoracic length 0.57 ± 0.06 mm; width 0.74 ± 0.07 mm; $n = 15$.

Gena lacking pits. Antennal pedicel with 7–9 sensoria.

Mesonotal wingpad ca. 0.7 length of metanotal wingpad. Metanotal wingpad extending to 3rd tergite. Metatibia with 4 spines on plantar surface, spur slightly smaller with row of 7–9 teeth on lateral aspect. Metatarsi with 2 tarsomeres; tarsomere 1 with 6 spines on plantar surface; tarsomere 2 subconical with 3 small black-tipped spines in middle on plantar surface.

Third Instar (Fig. 2D). Length 1.20 ± 0.13 mm; thoracic length 0.38 ± 0.05 mm; width 0.47 ± 0.07 mm; $n = 15$.

Antennal pedicel with 4–6 sensoria; bulbous base of flagellum ca. 0.5 length of pedicel.

Pronotal plates each with 6 pits. Mesonotal wingpad shorter, covering $\frac{1}{2}$ metanotal wingpad laterally. Metatibial spur smaller; 3 teeth on margin. Metatarsomere 1 with apical transverse row of 5 black-tipped spines on plantar surface; tarsomere 2 without spines in middle.

Second Instar (Fig. 2C). Length 1.10 ± 0.13 mm; thoracic length 0.33 ± 0.03 mm; width 0.36 ± 0.05 mm; $n = 15$.

Antennal pedicel with 2 sensoria. Frons with 3 pits between each outer carina and eye. Mesonotum with 2 pits on either side of carinae and 2 pits in lateral $\frac{1}{2}$. Meso- and metanotal wingpads undeveloped. Metatibial spur smaller, lacking lateral teeth, with black-tipped tooth at apex.

First Instar (Fig. 2B). Length 0.83 ± 0.07 mm; thoracic length 0.24 ± 0.02 mm; width 0.26 ± 0.12 mm; $n = 15$.

Body cream colored, mottling absent or obscure. Antennal pedicel lacking sensoria.

Metatibia lacking spines on shaft; spur greatly reduced, slightly longer than longest metatibial spine, with black-tipped tooth at apex.

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

Egg (Fig. 2A). Length 0.69 ± 0.03 mm; width 0.17 ± 0.03 mm; $n = 5$. Eggs laid singly; white; cylindrical; chorion translucent, smooth.

Delphacodes idonea

Fifth Instar (Fig. 3). Length 2.26 ± 0.25 mm; thoracic length 0.74 ± 0.08 mm; width 1.01 ± 0.10 mm; $n = 15$.

Form elongate, subcylindrical, slightly flattened dorsoventrally, widest across mesothoracic wingpads. Body mottled light gray to brown and cream in color on dorsum with white middorsal line extending from anterior end of pronotum to posterior end of abdomen. Venter and legs cream in color.

Vertex quadrate, length ca. 1.5 width at base, posterior margin slightly convex, carina on each side extending anteromedially from posterior $\frac{1}{2}$ and continuing onto frons as inner carina. Frons subrectangular; widest near middle, width ca. 0.75 length; carinate lateral margins convex, these outer carinae extending from vertex to near clypeal border and paralleled by pair of inner carinae; 9 pits between each inner and outer carina and 4 pits between each outer carina and eye. Gena with longitudinal row of 3 small pits. Clypeus narrowing distally, consisting of subconical basal postclypeus and cylindrical distal anteclypeus. Beak 3-segmented, segment 1 obscured by anteclypeus, lengths of segments 2 and 3 subequal; apex of segment 3 black. Eyes red. Antennae 3-segmented; scape short, cylindrical; pedicel subcylindrical, ca. 2-fold length of scape, with ca. 10–12 pitlike sensoria; flagellum bulbous basally, with elongate, bristlelike extension distally, bulbous base ca. 0.25 length of pedicel.

Thoracic nota divided by middorsal line into 3 pairs of plates. Pronotal plates subrectangular, appearing triangular in dorsal view; anterior margin following posterior border of eye, posterior border sinuate; each plate with oblique posterolaterally directed carina originating on anterior margin in median $\frac{1}{2}$ and terminating near posterior margin in lateral $\frac{1}{2}$, row of 7 pits extending posterolaterally from inner margin of carina to lateral border of plate (lateralmost pits not visible in dorsal view). Mesonotal median length ca. 1.5 that of pronotum; wingpads in macropter elongate lobate, extending to, or nearly to, tips of metanotal wingpads; brachypters with wingpads like those of fourth instars (as in *M. davis* Van Duzee; see Wilson & McPherson [1981]); each plate with posterolaterally directed carina originating on anterior margin in median $\frac{1}{2}$ and terminating on posterior margin in lateral $\frac{1}{2}$; 2 pits on either side of carina and 3 pits in lateral $\frac{1}{2}$. Metanotal median length ca. 0.75-fold that of mesonotum; each plate bearing an elongate lobate wingpad extending to 3rd tergite; weak longitudinal carina originating on anterior margin in median $\frac{1}{2}$ and terminating in posterior margin near middle; 1 pit just lateral to carina. Pro- and me-

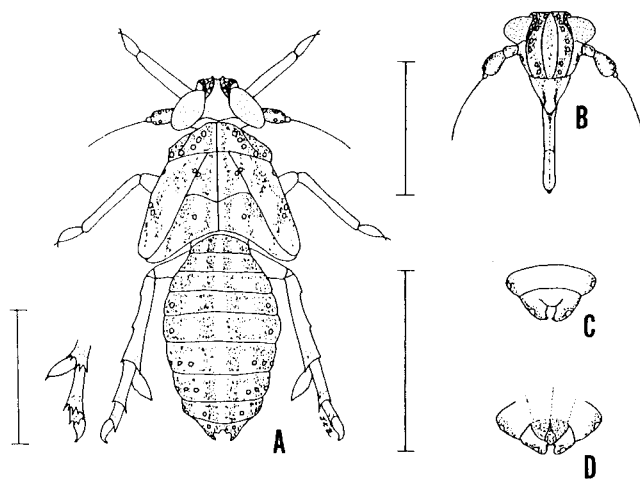


Fig. 3. *D. idonea* fifth instar: (A) habitus, (B) frontal view of head, (C) apical part of venter of male abdomen, (D) apical part of venter of female abdomen. Vertical bars = 1.0 mm.

socoxae elongate, posteromedially directed; metacoxae fused to sternum. Metatrochanter subcylindrical. Metatibia with 2 black-tipped spines on lateral aspect of shaft, an apical transverse row of 5 black-tipped spines on plantar surface, and a subtriangular, flattened movable spur with row of 10–12 teeth on lateral margin. Pro- and mesotarsi with 2 tarsomeres; tarsomere 1 wedge-shaped; tarsomere 2 subconical, curved, and with pair of apical claws and median membranous pulvillus. Metatarsi with 3 tarsomeres; tarsomere 1 cylindrical with apical transverse row of 7 black-tipped spines on plantar surface; tarsomere 2 cylindrical, with apical transverse row of 4 black-tipped spines on plantar surface; tarsomere 3 subconical, similar to terminal tarsomere of other legs.

Abdomen 9 segmented; slightly flattened dorsoventrally, widest across segment 4 or 5. Tergite 1 reduced, tergites 5–8 each with the following number of pits on either side of midline (lateral-most pits not always visible in dorsal view because of curving of tergites onto ventral aspect): tergite 5 with 1 pit, 6–8 each with 3 pits. Segment 9 surrounding anus; with 3 pits on each side; female with 1 pair of acute processes extending caudally from juncture of sternite 8 and segment 9; males lacking processes.

Fourth Instar (Fig. 4E). Length 1.71 ± 0.19 mm; thoracic length 0.56 ± 0.05 mm; width 0.72 ± 0.10 mm; $n = 15$.

Gena lacking pits. Antennal pedicel with 7–9 sensoria.

Mesonotal wingpad ca. 0.7 length of metanotal wingpad. Metanotal wingpad extending to 2nd

tergite. Metatibia with 4 spines on plantar surface, spur slightly smaller, with row of 6–8 teeth on lateral aspect. Metatarsi with 2 tarsomeres; tarsomere 1 with 6 spines on plantar surface; tarsomere 2 subconical, with 3 small black-tipped spines in middle on plantar surface.

Third Instar (Fig. 4D). Length 1.40 ± 0.15 mm; thoracic length 0.45 ± 0.04 mm; width 0.51 ± 0.03 mm; $n = 15$.

Antennal pedicel with 4–6 sensoria; bulbous base of flagellum ca. 0.3 length of pedicel.

Pronotal plates each with 6 pits. Mesonotal wingpad shorter, covering $\frac{1}{2}$ metanotal wingpad laterally. Metatibial spur smaller; 3 teeth on margin. Metatarsomere 1 with apical transverse row of 5 black-tipped spines on plantar surface; tarsomere 2 without spines in middle.

Second Instar (Fig. 4C). Length 1.16 ± 0.07 mm; thoracic length 0.36 ± 0.03 mm; width 0.39 ± 0.02 mm; $n = 15$.

Antennal pedicel with 2 sensoria. Frons with 2 pits between each outer carina and eye. Mesonotum with 2 pits on either side of carinae and 2 pits on lateral $\frac{1}{2}$. Meso- and metanotal wingpads undeveloped. Metatibial spur smaller, lacking lateral teeth, with black-tipped tooth at apex.

First Instar (Fig. 4B). Length 0.95 ± 0.11 mm; thoracic length 0.28 ± 0.04 mm; width 0.29 ± 0.03 mm; $n = 15$.

Antennal pedicel lacking sensoria.

Metatibia lacking spines on shaft; spur greatly reduced, slightly longer than longest metatibial spine, with black-tipped tooth at apex.

Abdominal tergites with pits obscure, tergites 6–

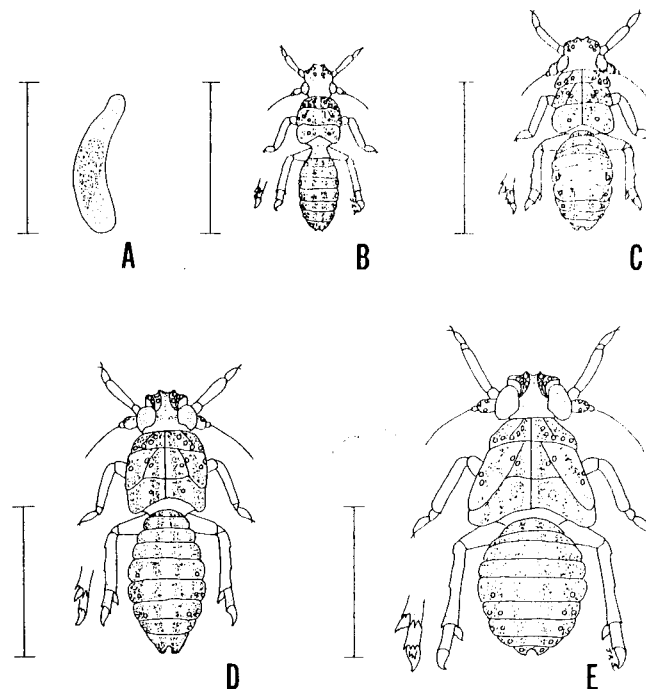


Fig. 4. (*D. idonea* immature stages: (A) egg, (B) first instar, (C) second instar, (D) third instar, (E) fourth instar. Vertical bars = 1.0 mm.

8 each with 2 pits on either side of midline (lateral-most pits not visible in dorsal view because of curving of tergites onto ventral aspect).

Egg (Fig. 4A). Length 0.88 ± 0.02 mm; width 0.25 ± 0.02 mm; $n = 5$. Eggs laid singly; white; cylindrical; chorion translucent, smooth.

Key to *S. kolophon* and *D. idonea* Instars

1. Metatibial spur with marginal teeth; 4 pits between outer carina and eye; antennal pedicel with more than 3 pitlike sensoria present (Fig. 1, 2 D and E, 3, and 4 D and E) 2
Metatibial spur without marginal teeth; 2–3 pits between outer carina and eye; antennal pedicel with 0–2 pitlike sensoria (Fig. 2 B and C and 4 B and C) 4
2. Metatarsi with 3 tarsomeres; mesonotal wingpads extending to or almost to apex of metanotal wingpads (Fig. 1 and 3) fifth instar

Metatarsi with 2 tarsomeres (tarsomere 2 may be partially subdivided); mesonotal wingpads not extending to apex of metanotal wingpads (Fig. 2 D and E and 4 D and E) 3

3. Metatarsomere 2 with 3 small spines in middle; mesonotal wingpads covering ca. $\frac{3}{4}$ of metanotal wingpads (Fig. 2 E and 4 E) fourth instar

Metatarsomere 2 without spines; mesonotal wingpads covering $< \frac{3}{4}$ of metanotal wingpads (Fig. 2 D and 4 D) third instar

4. Metatibia with 2 spines on shaft; antennal pedicel with 2 pitlike sensoria; tergites 6–8 each with 3 pits on either side (Fig. 2 C and 4 C) second instar
Metatibia lacking spines on shaft; antennal pedicel lacking pitlike sensoria; tergites 6–8 each with 2 pits on either side (Fig. 2 B and 4 B) first instar

Biology of *S. kolophon* and *D. idonea*. Our observations of oviposition site and incubation pe-

Table 1. Duration (in days) of instars of *S. kolophan* and *D. idonea*

Instar	<i>S. kolophan</i>				<i>D. idonea</i>			
	No. beginning	No. completing	Days		No. beginning	No. completing	Days	
			Range	$\bar{x} \pm SD$			Range	$\bar{x} \pm SD$
First	22	16	3-7	4.6 \pm 0.96	29	29	1-6	3.8 \pm 1.18
Second	26	24	2-6	3.7 \pm 0.88	30	28	1-4	2.5 \pm 0.75
Third	26	26	2-4	3.8 \pm 0.67	35	29	1-6	3.0 \pm 1.21
Fourth	31	28	2-6	3.8 \pm 0.83	36	30	1-6	3.2 \pm 0.96
Fifth	28	28	2-8	4.9 \pm 1.22	31	25	2-9	4.4 \pm 1.29

riod were similar to those described for *D. luteola* and *D. campestris* by Giri & Freytag (1983a) and Stoner & Gustin (1980). Eggs were inserted singly into leaf and sheath tissue in transverse rows of three to five eggs for *S. kolophan* and single eggs for *D. idonea*. Eggs hatched 10-12 d and 8-12 d after being laid by *S. kolophan* and *D. idonea*, respectively. Durations of the nymphal stadia for *S. kolophan* and *D. idonea* are given in Table 1. Duration of nymph development and adult longevity of *S. kolophan* were 20.3 \pm 0.91 and 18.4 \pm 7.30 d, respectively, which were comparable with those of *S. furcifera* (Ammar et al. 1980). The nymph development time and adult longevity of *D. idonea* were 16.8 \pm 1.08 and 9.4 \pm 5.0 d, respectively, which were considerably shorter than those reported for *D. luteola* (Giri & Freytag 1983a) and *D. campestris* (Stoner & Gustin 1980).

Our field observations have revealed that *S. kolophan* and *D. idonea* shared the same host. However, we never observed any large number of the insects associated with any one plant during 1985-86. Certain torpedo grasses infested with these two insects often exhibited the effect of stunting and mosaiclike symptoms. In light of the fact that *S. kolophan* transmitted a rhabdovirus of maize (Greber 1982), it would be of great interest to explore the possibilities of whether this insect would also transmit another economically important rhabdovirus, maize mosaic virus (Bradfute & Tsai 1983) or if it would transmit a disease agent to torpedo grass that could be used as a biocontrol agent. Research aimed at these aspects is currently being undertaken in our laboratory in Fort Lauderdale.

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