Life History and Laboratory Rearing of *Sinea diadema* (Heteroptera: Reduviidae) with Descriptions of Immature Stages

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ABSTRACT The life history of the assassin bug *Sinea diadema* (F.) was studied in southern Illinois from February 2001 to November 2002, and the immature stages were described. The bug also was reared under controlled laboratory conditions. This bivoltine species occurs in herbaceous fields, often in association with leaves and stems of *Solidago missouriensis* Nuttall, and preys primarily on small bugs and beetles. It apparently overwinters as eggs. Nymphs emerged in mid-April and were found until mid-September. Adults were found from the third week of May until early October. The bug was reared in the laboratory on larval beet armyworm, *Spodoptera exigua* (Hübner), at 26 ± 3.0°C under a 16:8 (L:D) h photoperiod. The incubation period averaged 13.87 d; eyespots appeared in ≈7 d. The five stadia averaged 9.59, 7.80, 8.95, 11.80, and 12.97 d, respectively. Instars can be distinguished by differences in several anatomical features, including body length and width and progressive development of size, number, and pattern of spines.

KEY WORDS *Sinea diadema*, life history, laboratory rearing, descriptions, nymphs

THE FAMILY REDUVIIDAE, including the Phymatinae, occurs worldwide and contains ≈930 genera and 6,500 species (Schuh and Slater 1995). Approximately 50 genera and 200 species and subspecies occur in America north of Mexico (Froeschner 1988). One of the more common of these genera is *Sinea* Amyot and Serville.

Sinea is represented in America north of Mexico by 11 species (Froeschner 1988), 3 of which occur in Illinois [i.e., *S. complexa* Caudell, *S. diadema* (F.), and *S. spinipes* (Herrich-Schaeffer)] (Hagerty and McPherson 1999). Adults of this genus are recognized easily by the presence of ocelli, a quadrangular cell at the outer basal angle of the hemelytral membrane, a small lateral tubercle on the mesopleuron that projects over the posterior margin of the propleuron, front tibiae that are armed with prominent spines on the ventral surface, and front femora that are thickened, granulated, and spined, with a subapical spine dorsally (Blatchley 1926).

Sinea diadema ranges from Quebec, Nova Scotia, and Maine south to Florida and west to British Columbia and California (Froeschner 1988). It often is found in grassy (Hussey 1922a, Readio 1924, Blatchley 1926, Elkins 1951, Drew and Schaefer 1963) and weedy (Hussey 1922b, Readio 1924, Blatchley 1926, Froeschner 1944, Slater and Baranowski 1978) vegetation and prefers open, sunny areas (Readio 1927, Elkins 1951).

This species feeds on a wide variety of insects (Balduf and Slater 1943, Smith et al. 1943, Knowlton 1944, Gates and Peters 1962) including flies, bees (Readio 1924), and caterpillars (Torre-Bueno 1923, Knowlton and Harmston 1940). Specific examples include the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois); Mexican bean beetle, *Epilachna varivestis* Mulsant; fall cankerworm, *Alsophila pometaria* (Harris); spring cankerworm, *Paleacrita vernata* (Peck); stalk borer, *Papaipema nebris* (Guenée); western yellowstriped armyworm, *Spodoptera praefica* (Grote); European corn borer, *Ostrinia nubilalis* (Hübner); forage looper, *Caenurgina erechtea* (Cramer); birch leafminer, *Fenusa pusilla* (Lepeletier) (Thompson and Simmonds 1965); and boll weevil, *Anthonomus grandis grandis* Boheman (Whitcomb and Bell 1964).

Sinea diadema is bivoltine (Readio 1924, 1927; Balduf and Slater 1943) and overwinter as adults (Readio 1924, 1927) or eggs (Balduf and Slater 1943). It has been reared in the laboratory from egg to adult with limited success under unspecified conditions by Readio (1927), under controlled temperature and humidity by Balduf (1948), and under controlled temperature and photoperiod by Swadener and Yonke (1973). The egg (e.g., Barber 1923) and various instars (e.g., Readio 1924, 1927) have been briefly described.

In 1999, Hagerty and McPherson reported on a survey of the nonphymatine assassin bugs of southern Illinois, including *S. diadema.* They swept specimens

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of *S. diadema* from herbaceous vegetation in sunny areas (45 adults, 30 nymphs) and from grasses (25 adults, 19 nymphs) and handpicked others from goldenrod, *Solidago* sp. (3 adults). Adults were taken from 13 May to 20 October, but most were collected in June (26.0%, $n = 19$) and during September and October (69.9%, $n = 51$). Early instars (2 firsts, 7 seconds, 10 thirds) were collected from 13 May to 25 July, and later instars (21 fourths, 9 fifths) were collected from 13 May to 1 September. They felt these data, together with additional data from specimens housed in the Southern Illinois University Entomology Collection (SIUEC), suggested that *S. diadema* is bivoltine and overwinters as adults.

In 2001, we found three sites in southern Illinois that had populations in apparently sufficient numbers for a life history study. Each was an open herbaceous field with scattered trees that was surrounded by woodlands. Locations are as follows: Jackson Co., Chautauqua Road (N 37°43′00.4″, W 089°16′10.2″, ALT. 167.0 m), Striegel Road (N 37°44′16.7″, W 089°15′19.1″, ALT. 149.4 m); and Perry Co., DuQuoin State Fairgrounds (N 37°59′40.7″, W 089°13′35.0″, ALT. 161.5 m).

In this article, we present further information on the life history of *S. diadema* in the field and include information on laboratory rearing under controlled conditions and descriptions of the immature stages.

Materials and Methods

Life History

The field study of *S. diadema* was conducted from February 2001 to November 2002. During 2001, we determined the feasibility of the study and developed a synoptic collection. During 2002, counts of nymphs and adults and notes on the bugs' activities were taken weekly from early February to early November, before the bugs emerged from overwintering sites and after they became inactive, respectively. Specimens were collected by handpicking and sweeping and, during the early stages of the study, preserved in 70% EtOH and examined in the laboratory. Later, specimens, including nymphs that could be identified to instar, generally were released to prevent overcollecting. However, from 12 September to 17 October 2002, 11 females were brought to the laboratory and placed individually in ovipositional cages (described under Laboratory Rearing) to determine if they could deposit fertilized eggs at this time of year. Prey were collected and preserved in 70% EtOH. Potential overwintering sites (e.g., leaf litter) were examined from early February through early April 2001 and 2002. Data from the 2 yr (including preliminary data from 2001) were combined to gain a better understanding of the annual life cycle.

Laboratory Rearing

From late April to mid-June, *S. diadema* nymphs and adult males were collected from the field and used to establish a laboratory colony. From this colony, 13 pairs (including only virgin females) were selected and placed in ovipositional cages (one male and one female per cage); all reproduced. Each cage consisted of a 1-pt (≈0.47 liter) Mason jar with moistened filter paper on the bottom; it was closed with a disc of paper toweling and wire screening secured with the band of the 2-piece Mason jar lid. A strip of paper toweling (≈11.4 cm long and 6.0 cm wide), folded longitudinally in half with the free ends down to increase strength, was placed inside the jar to increase surface area for walking and absorption of excrement. A strip of cheesecloth (≈11.4 cm long and 6.0 cm wide), suspended inside the jar and secured at the upper end between the disc of paper toweling and screening, served as an ovipositional site.

The cages were examined daily for eggs, which were removed, placed on moistened filter paper on the bottom of a glass petri dish (≈9.0 cm diameter and 2.0 cm deep), and covered with the lid. Fecundity and fertility were based on total reproduction of the 13 pairs. However, of these eggs, the first 250 that hatched were used for determining incubation period and stadia.

Newly emerged first instars were placed on moistened filter paper in petri dishes prepared similarly to those for eggs, except that the inner rim of each dish bottom was coated with petroleum jelly to prevent the animals from escaping. This was not necessary for later instars because of their larger sizes. No more than one nymph was placed in a dish to prevent cannibalism.

Eggs, nymphs, and adults were kept in incubators maintained at 26 ± 3.0°C and a photoperiod of 16:8 (L:D) h (≈2,800 lux). Filter paper in the ovipositional cages and petri dishes was moistened daily. Nymphs were reared and adults maintained (including those in the original laboratory colony) on beet armyworm, *Spodoptera exigua* (Hübner).

Descriptions of Immature Stages

The description of the egg is based on 10 specimens deposited in the laboratory by field-collected females, and the description of each instar is based on 10 field-collected individuals. Eggs and nymphs were preserved in 70% EtOH. Drawings were made with a Wild MSA drawing tube (E. Leitz, Rockleigh, NJ); measurements (in mm) were made with an ocular micrometer. Scanning electron micrographs were used as aids in the descriptions of the egg and first instar.

Statistics

Averages are expressed as means ± SE; SEs of <0.005 are listed as 0.00.

Voucher Specimens

Selected samples of eggs and instars have been vouchered in the SIUEC.

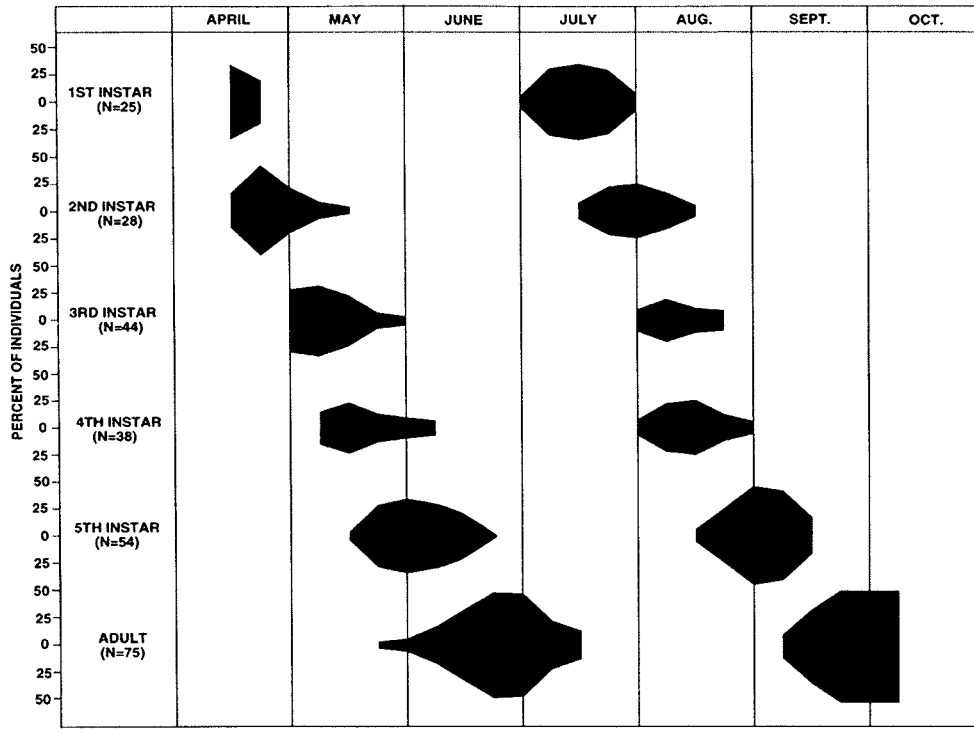


Fig. 1. Life cycle of *S. diadema* in the field. Percentage in each sample of individuals of each stage collected during the 2001–2002 seasons.

Results and Discussion

Life History

Sinea diadema apparently overwinters as eggs, although no eggs were found in the field. First instars were found from mid-April to the third week of April and during July, second instars from mid-April to mid-May and mid-July to mid-August, third instars during May and from early August to the third week of August, fourth instars from early May to early June and during August, fifth instars from mid-May to the third week of June and mid-August to mid-September, and adults from the third week of May to mid-July and early September to early October (Figs. 1 and 2). Copulation was observed on one occasion in early October on the leaves of *Solidago missouriensis* Nuttall.

As reported by Readio (1927) and Elkins (1951) and confirmed by Hagerty and McPherson (1999), this species prefers open sunny areas. Adults and nymphs were handpicked from leaves, stems, and/or flowers of poison ivy, *Toxicodendron radicans* L. (19 adults, 5 nymphs); goldenrod, *S. missouriensis* (12 adults, 9 nymphs); sheep's fescue, *Festuca ovina* L. (9 adults, 6 nymphs); common milfoil, *Achillea millefolium* L. (4 adults, 4 nymphs); late boneset, *Eupatorium serotinum* Michaux (5 adults, 2 nymphs); horse-weed, *Erigeron canadensis* L. (4 adults, 1 nymph); wild carrot, *Daucus carota* L. (3 adults); and ironweed, *Vernonia missurica* Rafinesque-Schmaltz (2 adults).

Sinea diadema fed on several small insects, most of which were bugs and beetles (Table 1). However, the data are so limited it is impossible to state whether or not these two orders are preferred.

As noted earlier, Readio (1924, 1927) and Balduf and Slater (1943) felt this species is bivoltine and overwinters as adults or eggs, respectively. Based on the peaks in abundance of nymphs and adults during the current study (Figs. 1 and 2), we also believe this species is bivoltine. However, the data do not support adults as the overwintering stage. The first individuals found in the spring of both years were nymphs, not adults. Also, copulation was observed in early October. Finally, of the 11 females brought to the laboratory from 12 September to 17 October 2002, 9 laid 679 eggs, 598 (88.1%) of which were fertile (females were preserved after first evidence of fertility). These data strongly suggest this species overwinters as eggs, thus supporting the conclusion of Balduf and Slater (1943).

Laboratory Rearing

As noted earlier, all 13 pairs reproduced. The number of eggs deposited averaged ≈361 per female (360.8 ± 41.09, range = 117–588, n = 4,690), with ≈90% fertility (323.8 ± 39.65, range = 117–578, n = 4,209). The ovipositional period was ≈41 d (40.7 ± 4.24, range = 20–72).

Eggs were laid in clusters (n = 433), generally in double rows, on the cheesecloth (n = 422), paper

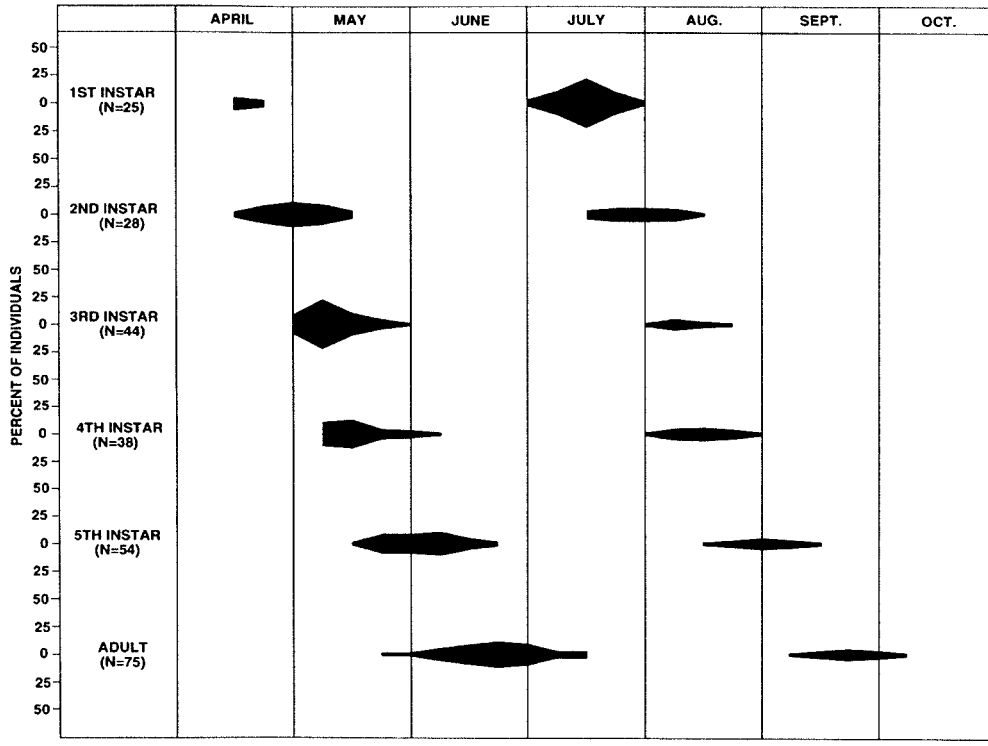


Fig. 2. Life cycle of *S. diadema* in the field. Percentage in each sample of total individuals of same stage collected during the 2001–2002 seasons.

toweling (n = 9), and sides of the cages (n = 2). Clusters averaged ≈11 eggs (10.9 ± 0.43, range = 1–27), which were brownish with a minutely, granulated chorion (Fig. 3) and glued to the substrate and each other. Each egg was capped by a reticulated operculum with most of the central area projecting as a distinct cone (Fig. 4). Red eyespots were visible after ≈7 d (range, 5–10, n = 351). For the 250 eggs used in laboratory rearing, the incubation period averaged 13.87 d (Table 2).

The first instar emerged through the cephalic end of the egg, pushing aside the operculum. It was reddish orange on emerging but darkened to its normal color within 2 h (n = 7).

Table 1. Feeding records of *S. diadema* in Jackson Co., southern Illinois, during 2001 and 2002

Taxon	No. of specimens
Heteroptera	
Miridae	
Lygus lineolaris (Palisot de Beauvois)[a]	1
Rhopalidae	
Arhyssus lateralis (Say)[a]	1
Neuroptera	
Chrysopidae	
Chrysoperla rufilabris Burmeister[b]	1
Coleoptera	
Chrysomelidae	
Brachypnoea sp.[a]	1
Diabrotica sp.[a]	1
Ophraea sp.[a]	1
Diptera	
Stratiomyidae	
Nemotelus kansensis Adams[a]	1

[a] Adult.
[b] Immature.

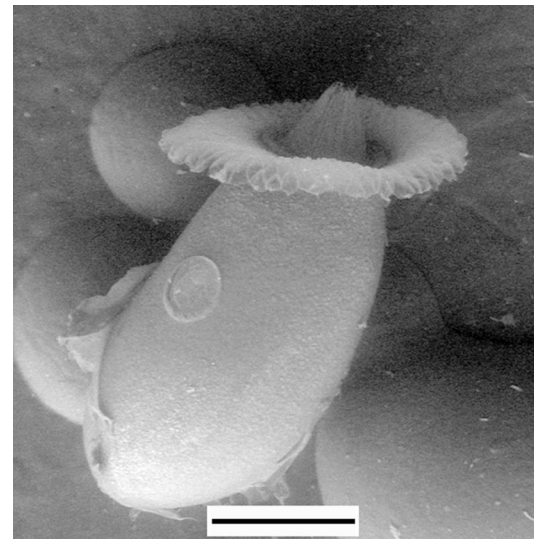


Fig. 3. Scanning electron micrograph of egg of *S. diadema* (scale bar = 0.4 mm).

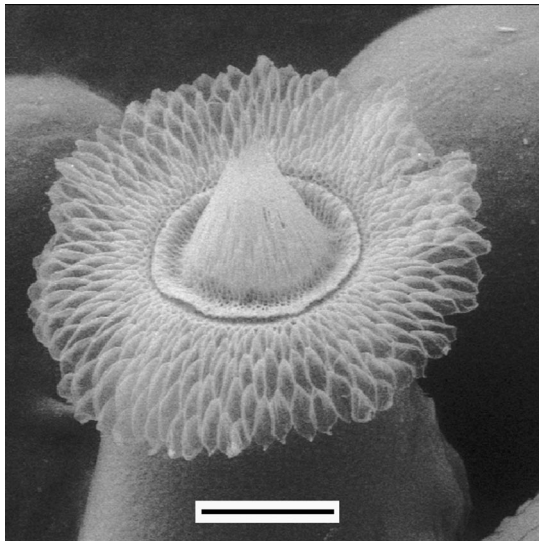


Fig. 4. Scanning electron micrograph of egg operculum and surrounding collar of *S. diadema* (scale bar = 0.25 mm).

The first, second, third, fourth, and fifth stadia averaged 9.59, 7.80, 8.95, 11.80, and 12.97 d, respectively. The total developmental period averaged 64.98 d (Table 2). Highest mortality occurred during the fifth stadium, resulting primarily from incomplete ecdysis.

Precopulatory behavior was observed in three pairs of adults. For two pairs, courtship began with head-to-head contact as both individuals sparred aggressively with their prothoracic legs. Often, the partners individually or together would then begin to nod, moving the tip of the beak forward and backward within the prosternal groove (stridulate?), antennate, and/or rotate the reflexed prothoracic legs in a circular jerky motion, one leg at a time. At this point, the partners might resume sparring. However, the male, instead, often would move to the side of the female while probing her with his beak. He then mounted her while still probing until he touched the junction of her head and pronotum; her resistance ceased almost immediately. At this time, his abdomen crossed hers diagonally. As he lowered the tip of his abdomen so that his genitalia came in contact with hers, he held his beak in the resting position (tip in prosternal groove), and copulation ensued. For the third pair, the female initiated copulation. She began by cleaning her antennae, then turned away from the male and thumped the substrate once with her abdomen, then again, and the male responded by thumping his abdomen once. Then, they alternated with each other, one thump at a time, twice more. Within 1 min, the male mounted her while probing with his beak until he touched the junction of her head and pronotum. She began cleaning her beak and antennae and continued until the male dismounted (<1 min). They recommenced alternate thumping and, within 1 min, the male remounted the female, and copulation proceeded as above. Mated pairs often were observed in copula repeatedly. Copulation ($n = 8$) sometimes continued for >45 min.

Table 2. Duration (in days) of each immature stage of *S. diadema* under controlled laboratory conditions

Stage	Number completing stadium	Range	Means ± SE	Cumulative mean age
Egg[a]	241	11–17	13.87 ± 0.07	13.87
Nymph				
First instar	201	6–17	9.59 ± 0.16	23.46
Second instar	193	5–18	7.80 ± 0.12	31.26
Third instar	191	5–14	8.95 ± 0.13	40.21
Fourth instar	184	6–23	11.80 ± 0.27	52.01
Fifth instar	156	6–31	12.97 ± 0.38	64.98

[a] 250 were used, 9 subsequently were eliminated because of mite infestation.

Various components of precopulatory and copulatory behavior have been reported by Readio (1927), for reduviids in general, and by Swadener and Yonke (1973), for *S. complexa* specifically, including the male placing the tip of his beak at the junction of the female's head and pronotum. They reported copulation lasting for "several hours" in reduviids and 30 min or less in *S. complexa*, respectively.

Descriptions of Immature Stages

Egg (Figs. 3 and 4). Length (overall), 1.64 ± 0.01; width at widest point (usually near middle), 0.69 ± 0.00; extensions of chorion forming collar, diameter of collar plus operculum, 1.12 ± 0.01. Egg curviform, comprised of egg proper (length, 1.43 ± 0.01) and operculum (length, 0.31 ± 0.00; diameter, 0.43 ± 0.00) (total length > than overall length because of curvature of egg). Eggs laid in double rows, brown, glued to substrate and each other. Chorion with irregular hexagonal reticulations. Operculum round, flat, outer rim with minute irregular reticulations, central area projecting as distinct cone; cone comprised of several scales that do not meet distally, resulting in tip that is bluntly rounded and open. Extensions of chorion (collar) compact on oviposition, expanding horizontally on drying to same plane as outer rim of operculum, minutely reticulated medially, more coarsely reticulated laterally, reticulations subrhomboidal.

Instars. The first instar is described in detail, but only major changes from previous instars are described for subsequent instars. Length is measured from the tip of the anteclypeus to the tip of abdomen; width is measured across the projecting posterior lobes of the metaepisterna. Additional measurements are given in Table 3.

The nymphal descriptions rely heavily on the development, number, and pattern of setigerous processes, which are important as diagnostic characters. As the nymphs mature, these processes develop from pustules through spinules to spines and become more numerous. On the dorsal surface, these processes are present as transverse rows that range from convex to concave. As these rows progressively become more numerous, their descriptions become more difficult

Table 3. Measurements (means ± SE, mm) of *S. diadema* instars

	Nymph				
	First instar	Second instar	Third instar	Fourth instar	Fifth instar
Body length[a]	2.33 ± 0.05	2.98 ± 0.07	4.54 ± 0.12	6.54 ± 0.15	9.58 ± 0.21
Head length[a]	0.83 ± 0.00	1.04 ± 0.01	1.38 ± 0.01	1.82 ± 0.03	2.31 ± 0.02
Anterior lobe	0.48 ± 0.01	0.56 ± 0.02	0.72 ± 0.01	0.94 ± 0.02	1.22 ± 0.01
Posterior lobe	0.38 ± 0.01	0.51 ± 0.01	0.71 ± 0.01	0.91 ± 0.02	1.25 ± 0.01
Width across eyes	0.41 ± 0.00	0.51 ± 0.01	0.66 ± 0.01	0.82 ± 0.01	1.03 ± 0.01
Synthlipsis	0.26 ± 0.00	0.33 ± 0.01	0.42 ± 0.00	0.53 ± 0.00	0.67 ± 0.01
Antennal segment lengths	2.22 ± 0.02	2.91 ± 0.03	3.86 ± 0.03	5.39 ± 0.08	7.21 ± 0.13
First	0.74 ± 0.01	1.02 ± 0.02	1.43 ± 0.01	2.00 ± 0.03	2.68 ± 0.13
Second	0.28 ± 0.01	0.39 ± 0.00	0.52 ± 0.01	0.77 ± 0.01	1.12 ± 0.01
Third	0.32 ± 0.00	0.46 ± 0.01	0.68 ± 0.01	1.07 ± 0.03	1.60 ± 0.02
Fourth	0.88 ± 0.02	1.04 ± 0.01	1.24 ± 0.01	1.55 ± 0.02	1.82 ± 0.01
Beak segment lengths	0.94 ± 0.00	1.17 ± 0.01	1.54 ± 0.01	2.06 ± 0.02	2.70 ± 0.03
First	0.34 ± 0.00	0.44 ± 0.01	0.58 ± 0.00	0.80 ± 0.01	1.12 ± 0.01
Second	0.38 ± 0.00	0.47 ± 0.01	0.64 ± 0.01	0.85 ± 0.01	1.10 ± 0.01
Third	0.22 ± 0.00	0.26 ± 0.00	0.32 ± 0.01	0.40 ± 0.00	0.48 ± 0.01
Notal lengths[b]					
Pronotum	0.32 ± 0.01	0.44 ± 0.01	0.62 ± 0.01	0.91 ± 0.02	1.27 ± 0.01
Mesonotum	0.17 ± 0.01	0.25 ± 0.01	0.38 ± 0.01	0.60 ± 0.01	1.18 ± 0.03
Metanotum	0.11 ± 0.01	0.13 ± 0.01	0.14 ± 0.01	0.16 ± 0.00	0.05 ± 0.01
Width across metaepisterna	0.56 ± 0.01	0.71 ± 0.02	0.92 ± 0.03	1.15 ± 0.04	1.69 ± 0.04
Abdominal length[b]	1.16 ± 0.04	1.52 ± 0.06	2.01 ± 0.08	2.67 ± 0.13	4.20 ± 0.26
Abdominal width[c]	0.89 ± 0.05	1.12 ± 0.06	1.54 ± 0.06	1.78 ± 0.11	2.60 ± 0.14
Leg lengths					
Procoxa	0.18 ± 0.00	0.25 ± 0.00	0.36 ± 0.00	0.55 ± 0.01	0.69 ± 0.01
Protrochanter	0.29 ± 0.01	0.34 ± 0.01	0.47 ± 0.01	0.59 ± 0.01	0.80 ± 0.01
Profemur	0.91 ± 0.01	1.22 ± 0.02	1.77 ± 0.02	2.39 ± 0.04	3.40 ± 0.02
Protibia	0.85 ± 0.01	1.12 ± 0.02	1.56 ± 0.02	2.09 ± 0.03	3.00 ± 0.02
Protarsal segments[d]	0.27 ± 0.00	0.32 ± 0.00	0.42 ± 0.01	0.55 ± 0.00	0.73 ± 0.01
First	0.04 ± 0.00	0.06 ± 0.00	0.08 ± 0.00	0.11 ± 0.00	0.12 ± 0.01
Second	0.26 ± 0.00	0.30 ± 0.00	0.40 ± 0.00	0.51 ± 0.01	0.68 ± 0.01
Mesocoxa	0.16 ± 0.00	0.21 ± 0.00	0.29 ± 0.00	0.41 ± 0.01	0.50 ± 0.01
Mesotrochanter	0.22 ± 0.00	0.29 ± 0.00	0.37 ± 0.01	0.50 ± 0.00	0.69 ± 0.01
Mesofemur	0.65 ± 0.01	0.80 ± 0.01	1.13 ± 0.01	1.59 ± 0.03	2.20 ± 0.01
Mesotibia	0.71 ± 0.01	0.88 ± 0.01	1.16 ± 0.01	1.65 ± 0.03	2.21 ± 0.02
Mesotarsal segments[d]	0.27 ± 0.00	0.32 ± 0.00	0.40 ± 0.00	0.54 ± 0.01	0.73 ± 0.01
First	0.04 ± 0.00	0.06 ± 0.00	0.07 ± 0.00	0.10 ± 0.00	0.12 ± 0.01
Second	0.26 ± 0.00	0.30 ± 0.00	0.39 ± 0.00	0.51 ± 0.01	0.69 ± 0.00
Metacoxa	0.16 ± 0.00	0.21 ± 0.00	0.28 ± 0.01	0.44 ± 0.01	0.52 ± 0.01
Metatrochanter	0.20 ± 0.00	0.27 ± 0.00	0.36 ± 0.00	0.49 ± 0.01	0.67 ± 0.01
Metafemur	0.70 ± 0.01	0.86 ± 0.01	1.25 ± 0.01	1.82 ± 0.02	2.32 ± 0.15
Metatibia	0.87 ± 0.01	1.06 ± 0.02	1.42 ± 0.02	1.96 ± 0.03	2.78 ± 0.11
Metatarsal segments[d]	0.28 ± 0.00	0.32 ± 0.00	0.42 ± 0.00	0.55 ± 0.00	0.77 ± 0.01
First	0.05 ± 0.01	0.06 ± 0.01	0.08 ± 0.00	0.10 ± 0.00	0.12 ± 0.00
Second	0.27 ± 0.00	0.31 ± 0.00	0.40 ± 0.00	0.52 ± 0.00	0.73 ± 0.00

Data based on 10 individuals per instar.
[a] Measured from tip of anteclypeus.
[b] Measured at midline.
[c] Measured across fifth tergum.
[d] Total length of segment measurements > than overall length because of curvature.

(i.e., rows often are more variable in later instars, and others are not present in earlier instars). However, the patterns on the head and pronotum are relatively constant. Thus, to facilitate descriptions of these patterns, we numbered the rows in the fifth instar and used these numbers as the basis for the descriptions in earlier instars (Fig. 5). Therefore, if an earlier instar lacked a particular row found in the fifth, the number was not mentioned.

First Instar (Fig. 6). Length, 2.33 ± 0.05; width, 0.56 ± 0.01. Body elongate-oval. General ground color of head (including beak), prothorax, sclerotized areas of meso- and metathoraces and medial plates of abdomen brown to dark brown; remainder of body whitish to dark gray, antennae generally yellow to yellowish brown, darkest basally; legs brownish basally, generally yellowish distally, prothoracic legs darker.

Head porrect, elongate, declivent apically, narrowed anteriorly to tip of tylus and posteriorly as short neck, tylus divided into short anteclypeus and longer postclypeus; color dark brown, ventral surface lighter. Antenniferous tubercles divergent apically, width of head across outer apical margins of tubercles subequal to synthlipsis. Transverse sulcus present, concave, continuing laterally to posterior margins of eyes, dividing head into anterior and posterior lobes; anterior lobe (to anteclypeus) ≈1.26 times length of posterior lobe; posterior lobe slightly elevated above anterior lobe; middorsal (ecdysial) line continuing from transverse sulcus to posterior margin of pronotum, becom-

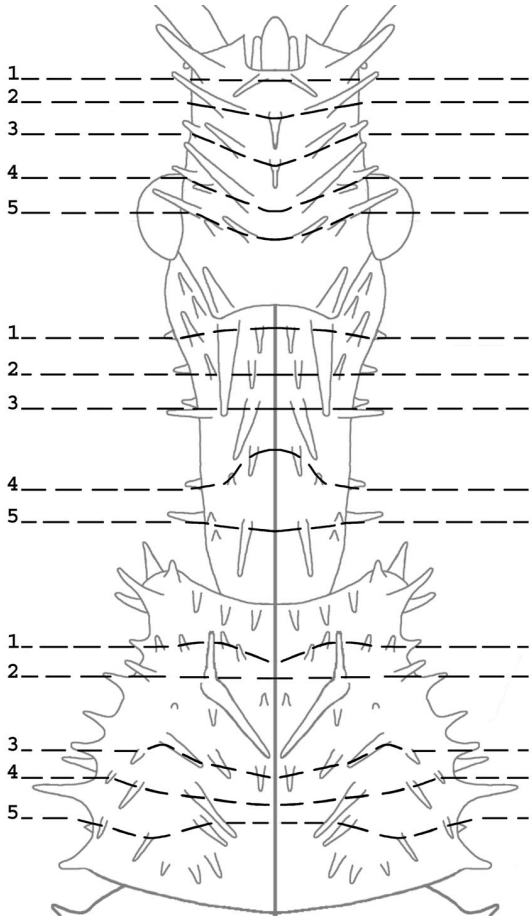


Fig. 5. Numbered rows of processes, head and prothorax, of fifth instar of *S. diadema.*

ing obscure in meso- and metanota. Anterior lobe with three straight rows of processes (i.e., rows 1, 2, and 4); row one with sublateral spine near base of each antenniferous tubercle; row two with pair of submedial pustules, approximately one-half distance from anterior margin of eye to basal medial margin of postclypeus; row four with pair of submedial pustules between eyes. Posterior lobe with four straight rows of processes (i.e., rows 1, 3, 4, and 5); rows 1, 4, and 5 each with submedial pair of pustules; row 3 with two pairs of pustules, one pair submedial, one pair sublateral; paired submedial pustules of all rows separated by decreasing distance posteriorly. Tylus greatly surpassing juga; juga short, reaching beyond distal margins of antenniferous tubercles, sloping lateroventrad. Labrum triangular, narrowing apically. Compound eyes red. Beak three-segmented, dark brown, tip fitting into prosternal, striated groove; total length ≈1.13 times length of head; segment two longest; segment three shortest, narrowing apically; ratio of beak segment lengths ≈1.55:1.73:1.00. Antennae four-segmented, filiform, generally yellowish to yellowish brown, whitish at intersegmental lines; total length ≈2.68 times length of head; segment one angulate basally, basal one-third dark brown; segments two and three shortest; segment four longest, rounded apically; ratio of antennal segment lengths ≈2.64:1.00:1.14:3.14.

Thorax brown to dark brown, ratio of notal lengths ≈2.91:1.55:1.00. Pronotum subhexagonal, narrowed anteriorly, widest in posterior one-third; anterior margin concave, posterior margin almost straight, lateral margins broadly sinuate; two rows of processes (i.e., rows 2 and 3); row 2 with pair of prominent submedial spines in anterior one-third, producing straight row; row 3 with two pairs of pustules, one pair submedial, one pair anterolateral, producing concave row; lateral margins each with two pustules, one subapical, one in posterior one-fourth. Mesonotum with two sclerotized subquadrate plates separated medially by membrane; each plate with prominent submedial spine and two pustules on lateral margin, one in anterior one-third, one in posterior one-half. Metanotum with two sclerotized subquadrate plates separated medially by membrane, anterolateral margins whitish; each plate with two pustules, one on medial margin, one midway on lateral margin. Pleura concolorous with sclerotized portions of nota; pro- and mesoepimera each with spiracle on posterior margin; proepisternum and epimeron, mesoepisternum and epimeron, and metaepisternum and epimeron usually with three and two, five and one, and three and zero pustules, respectively. Prosternum sclerotized with medial striated groove, meso- and metasterna primarily membranous; mesosternum ranging from whitish in anterior one-half, light brown in posterior one-half to grayish medially, whitish laterally; metasternum primarily whitish. Legs sparsely setose, particularly profemora. Prothoracic legs raptorial, elongate, spinose; generally brown to dark brown, tarsi yellow basally. Procoxae pyramiform, narrowing apically, brownish. Protrochanters elbowed, elongate, brownish. Profemora weakly fusiform, dark brown, ventral surface spinulate, with four longitudinal rows of spines anterodorsally, anteromedially, anteroventrally, and posteroventrally; anterodorsal row with four spines: spines increase in length distally, spine four (most distal) off-center and more dorsal in position; anteromedial row with three to four processes: only most distal process strongly developed as spine, remaining processes weakly developed as pustules; anteroventral row with four spines: spine one (proximal) shortest, three and four longest, subequal in length; posteroventral row with five spines: spines three and four longest; pustule on posterodorsal surface at base. Protibiae elongate, slender, tumescent and angulate apically, brown, ventral surface spinulate; two longitudinal rows of spines antero- and posteroventrally; anteroventral row with four prominent spines, spine one (proximal) shortest, remaining three subequal in length; posteroventral row with two prominent spines, subequal in length. Protarsi slender, yellowish proximally, brownish distally, two-segmented; segment one shortest, segment two terminating in two claws. Meso- and metathoracic legs similar in shape, elongate, longer than prothoracic legs, metathoracic legs longest. Meso- and metacoxae, trochanters, and tarsi (with claws) similar in color to

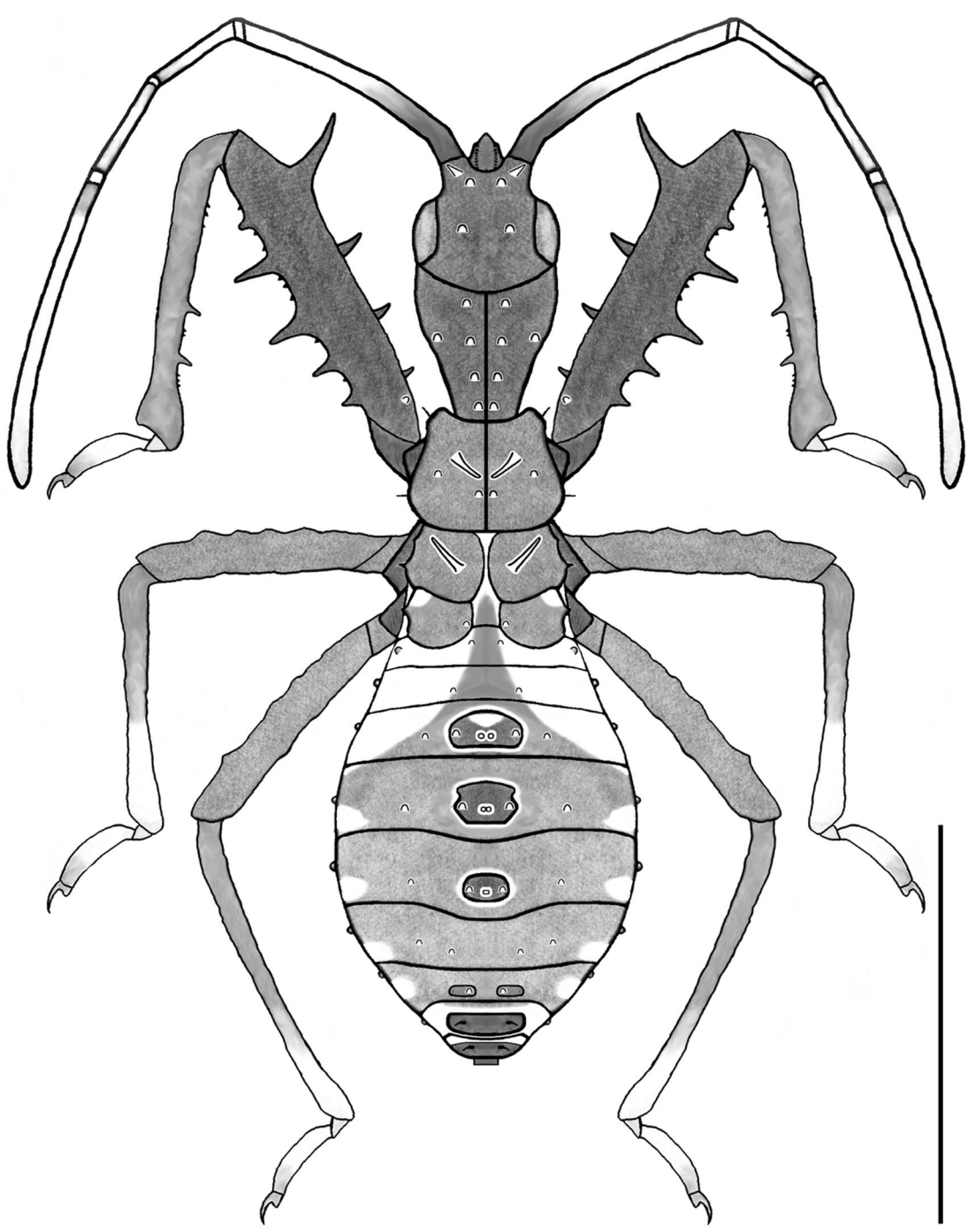


Fig. 6. First instar (general dorsal view) of *S. diadema* (scale bar = 1.0 mm).

prothoracic legs. Meso- and metafemora undulate, yellowish brown, distinctly narrower than profemora. Meso- and metatibiae brownish basally, yellowish distally.

Abdomen 10-segmented, ovate; terga 1–3 generally whitish with mediolongitudinal grayish stripe that expands to cover most of dorsal surface of terga 4–7 (or 8), lateral margins of terga 4–7 (or 8) alternated with grayish and whitish. Medial plates on terga 3, 4, 5, and 8; plates subquadrate to subrectangular, primarily brown; plate of tergum three with anteromedial whitish area; plates of terga 3–5 with whitish paired ostioles

in posterior one-half, those of 5 usually fused and forming slit. Paired medial plates often on tergum 7, shape variable; tergum 9 sclerotized in posterior two-thirds, membranous in anterior one-third; tergum 10 sclerotized. Terga 1, 2, 7, 8, and 9 with paired submedial pustules; terga 3–5 with two pairs of pustules: one pair submedial on/near lateral margins of medial plates, one pair one-half distance between midline and lateral margins (i.e., midpustules), producing straight row; tergum 6 with two pairs of pustules: one pair submedial, one pair one-half distance between midline and lateral margins (i.e., midpustules), producing weakly convex to concave row. Spiracles present on segments 1–8, peritremes brown; pair one dorsolateral, pairs 2–8 lateral; pairs 2–8 each followed by dorsoposterior pustule. Ventral surface generally whitish medially, grayish laterally in anterior one-half, grayish in posterior one-half; sparse setae present.

Second Instar (Fig. 7). Length, 2.98 ± 0.07; width, 0.71 ± 0.02. Color and color pattern similar to first instar, sclerotized areas of meso- and metathoraces and medial plates of abdomen brown; legs with color pattern unchanged to entirely brownish, prothoracic legs darker; processes more developed and numerous.

Head with transverse sulcus concave, weakly subangulate submedially; anterior lobe (to anteclypeus) ≈1.10 times length of posterior lobe; dark brown band evident just anterior to sulcus; ecdysial line now evident from sulcus to posterior margin of mesonotum; general color of head brown to dark brown, ventral surface lighter. Anterior lobe with four rows of processes (i.e., rows 1, 2, 4, and 5); row 1 with two pairs of processes: sublateral spine of first instar near base of each antenniferous tubercle more developed, additional pair of submedial pustules between these spines, still producing straight row; row 2 with three processes: paired submedial pustules of first instar now spines, additional pustule between bases of these spines, producing concave row; row 4 with two pairs of processes: submedial pustules of first instar now prominent spines, additional lateral pustule near anterior margin of each eye, producing concave row; row 5 (not present in first instar) with sublateral pustule near medial margin of each eye. Posterior lobe with four rows of processes (i.e., rows 1, 3, 4, and 5); row 1 with three pairs of processes: submedial pustules of first instar now prominent spines, two additional pairs of pustules present, one pair sublateral, one pair lateral, still producing straight row; rows 3 and 4 still with two and one pair of processes, respectively: all processes now spines, producing straight rows; row 5 with two pairs of processes: submedial pustules of first instar now spines, additional pair of lateral spines present, variable in position, sometimes more closely associated with row 4, producing straight to concave row. Beak ≈1.13 times length of head, ratio of beak segment lengths ≈1.69:1.81:1.00. Antennae with color pattern similar to first instar, generally lighter, ≈2.80 times length of head; ratio of antennal segment lengths ≈2.62:1.00:1.18:2.67.

Thorax brown, ratio of notal lengths ≈3.39:1.92:1.00. Pronotum with three rows of processes (i.e., rows 2, 3, and 4); row 2 still with one pair of prominent submedial spines: spines more developed, each with anterolateral spinule at base (i.e., weakly bifurcate), producing straight row; row 3 with two pairs of processes: submedial pustules more developed but still pustules, anterolateral pustules now spinules, still producing concave row; row 4 (not present in first instar) with pair of submedial spinules, producing straight row; lateral margins with pustules (2) of first instar now spinules. Mesonotum with two subquadrate plates of first instar now elongate medially, separated by medial membranous strip, prominent submedial spines larger; lateral margins whitish, pustules (2) of first instar now spines. Metanotum with two subquadrate plates of first instar now elongate posteromedially, medial margins weakly concave, lateral margins whitish; pustules on medial margins more developed but still pustules, those on lateral margins now spinules. Pleura with processes generally more numerous and developed, pustules of first instar now often spinules; proepisternum and epimeron, mesoepisternum and epimeron, and metaepisternum and epimeron usually with five and two, five and one, and four to five and zero processes, respectively. Prosternum lighter, meso- and metasterna with coloration similar to first instar. Legs more setose, particularly profemora. Prothoracic legs generally brown to dark brown, distal one-third to one-half of tibiae and all of tarsi yellowish to yellowish brown. Profemora brown to dark brown, ventral surface more spinulate; anteromedial row with five processes: only spine five (most distal) strongly developed, pustules (4) more evident than in first instar but still pustules; anteroventral row with five spines: spines one (proximal) and two shortest, subequal in length, spines 3, 4, and 5 longer, subequal in length; posteroventral row with five spines: spines 2, 3, and 4 longest; posterodorsal pustule of first instar at base now spinule. Protibiae brownish proximally, yellowish distally, ventral surface more spinulate; posteroventral row with three spines, basal spine ≈one-half length of distal two. Meso- and metafemora and tibiae infused with more yellow.

Abdomen with whitish areas of first instar now often yellowish, lateral margins of terga 4–7 (or 8) alternated with grayish and yellowish. Medial plate of tergum 3 subpentagonal; tergum 7 with medial plates smaller, often absent (as shown). Terga 1, 2, 7, 8, and 9 with paired pustules more evident but still pustules; terga 3–5 with two pairs of processes: submedial pustules on/near lateral margins of plates now prominent spines, midpustules now spinules, still producing straight row; tergum 6 with two pairs of processes: submedial pustules of first instar now prominent spines, midpustules unchanged, producing concave row. Spiracles 2–8 each with associated dorsoposterior pustule of first instar now spinule. Ventral surface with color pattern similar to first instar, more obscure; setae more numerous.

Third Instar (Fig. 8). Length, 4.54 ± 0.12; width, 0.92 ± 0.03. Color and color pattern similar to second instar, generally lighter; head and thorax yellowish

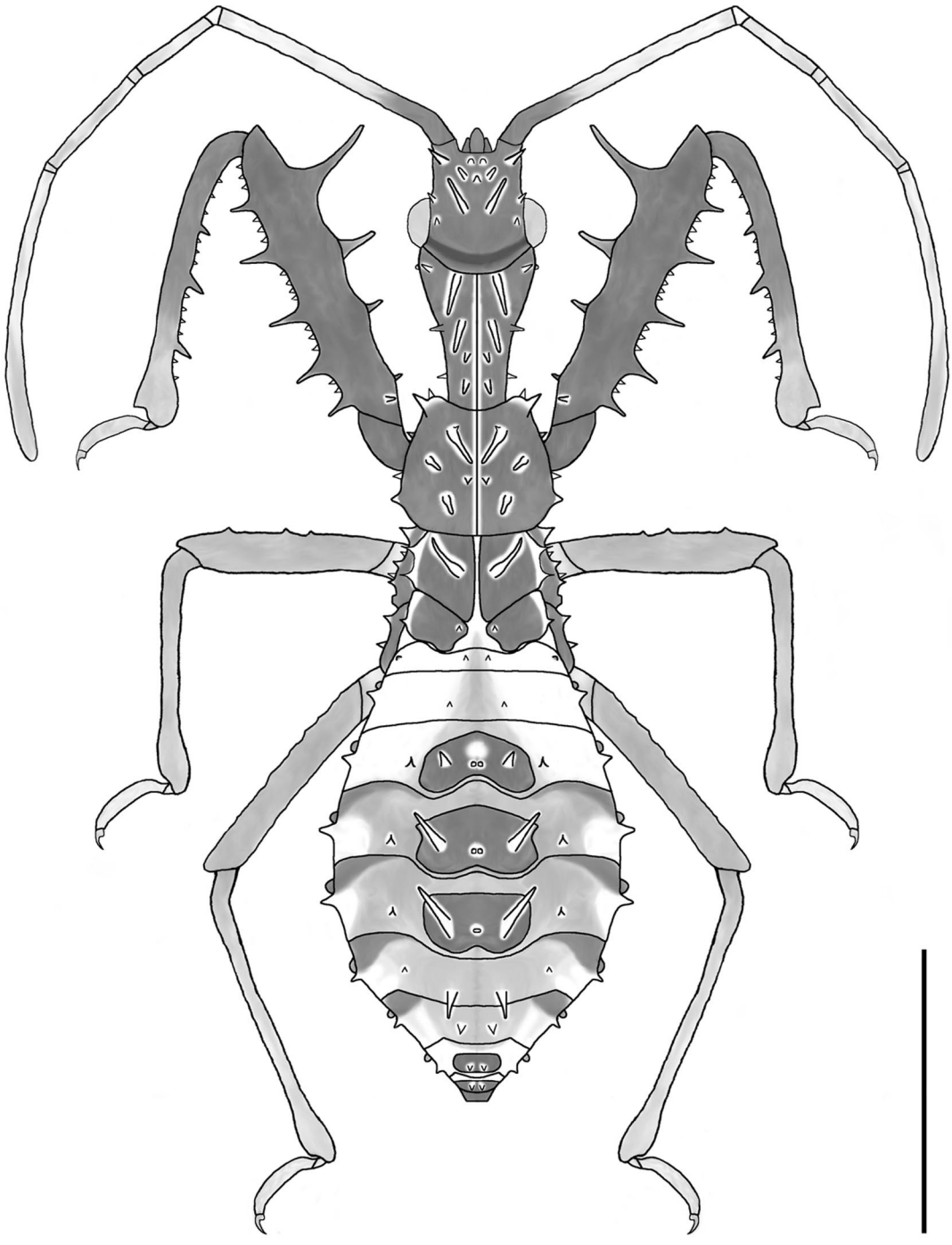


Fig. 7. Second instar (general dorsal view) of *S. diadema* (scale bar = 1.0 mm).

brown, yellow often associated with processes; processes more developed and numerous.

Head with transverse sulcus angulate submedially; anterior lobe (to anteclypeus) ≈1.01 times length of posterior lobe; dark brown band just anterior to sulcus more evident; ecdysial line more evident from sulcus to posterior margin of mesonotum; ventral surface lighter. Anterior lobe with five rows of processes (i.e., rows 1–5); row 1 still with two pairs of processes: submedial pustules now spinules, sublateral spine near base of each antenniferous tubercle larger, each with lateral pustule subbasally, producing straight row; row

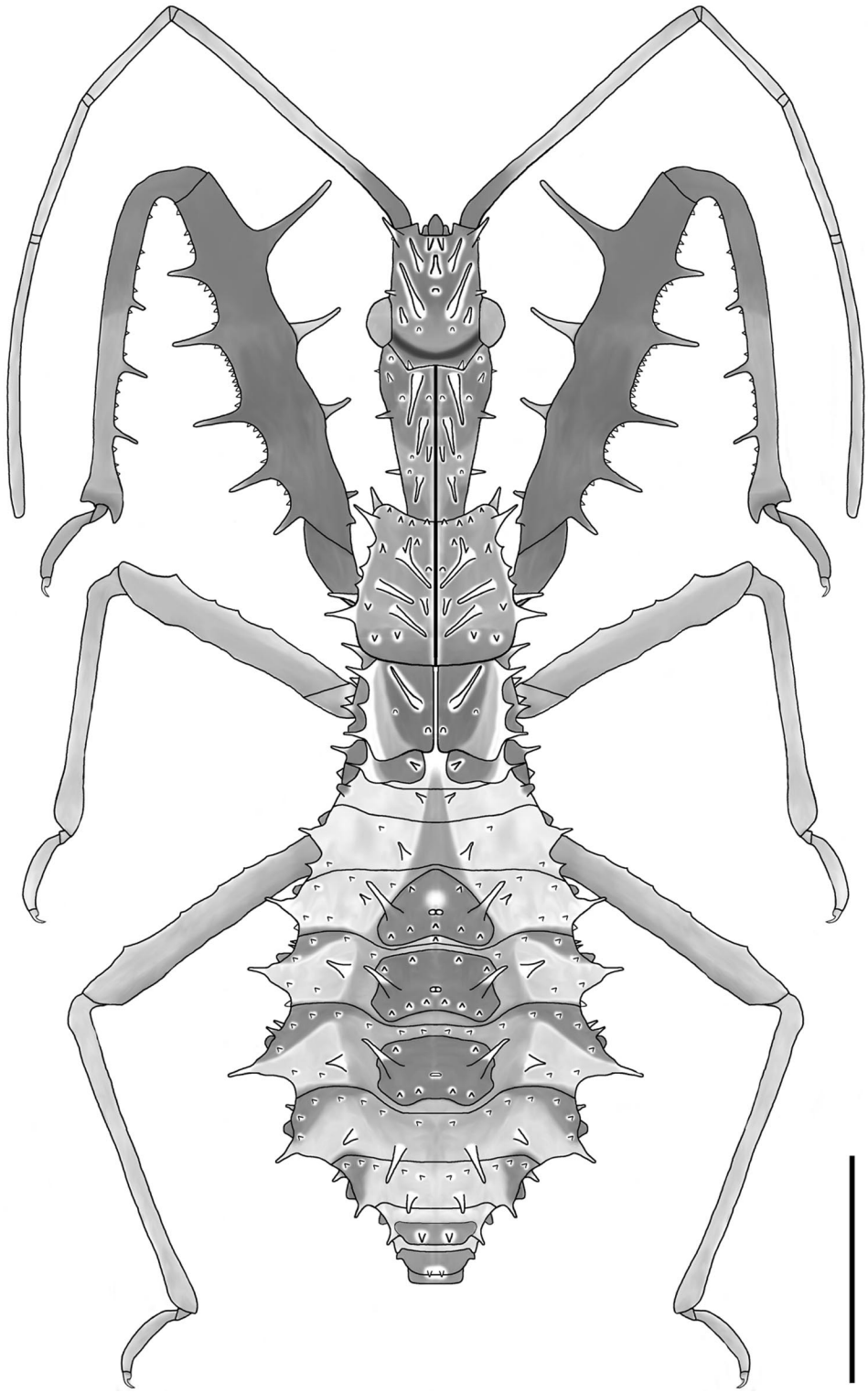


Fig. 8. Third instar (general dorsal view) of *S. diadema* (scale bar = 1.0 mm).

2 still with three processes: medial pustule now spinule, paired submedial spines unchanged, producing concave row; row 3 (not present in second instar) with one pustule midway between rows 2 and 4; row 4 still with two pairs of processes: prominent submedial spines unchanged, lateral pustules now spinules, producing concave row; row 5 with two pairs of processes: sublateral pustule of second instar near medial margin of each eye now spinule, additional submedial pair of pustules present, producing concave row; spinule now present in each submedial angle of transverse sulcus. Posterior lobe with five rows of processes (i.e., rows 1–5); row 1 still with three pairs of processes: prominent submedial spines unchanged, sublateral pustules now spinules, lateral pustules unchanged, producing straight row; row 2 (not present in second instar) with up to two pairs of pustules posterior to prominent submedial spines of row 1, one pair submedial, one pair one-half distance between midline and lateral margins (i.e., midpustules), producing straight row; row 3 still with two pairs of processes (spines): submedial and sublateral spines more developed, still producing straight row; row 4 with two pairs of processes: each submedial spine of second instar now associated with posterolateral pustule, producing convex row; row 5 with three pairs of processes: submedial and lateral spines unchanged, additional pustule anterolaterad of each submedial spine, producing concave row; often additional pustule posteromesad of each eye. Beak brownish to yellowish brown, ≈1.12 times length of head, ratio of beak segment lengths ≈1.81:2.00:1.00. Antennae with color pattern similar to second instar, generally lighter, ≈2.80 times length of head; ratio of antennal segment lengths ≈2.75:1.00:1.31:2.38.

Thorax brown, ratio of notal lengths ≈4.43:2.71:1.00. Pronotum with five rows of processes (i.e., rows 1–5); row 1 (not present in second instar) with pair of submedial pustules, producing straight row; row 2 with two pairs of processes: prominent submedial spines of second instar more developed, each with its anterolateral spinule at base now spine (i.e., strongly bifurcate), additional sublateral spinule each side, still producing straight row, each submedial bifurcate spine usually associated with posteromedial pustule, which is not included as part of row; row 3 with two pairs of processes: submedial pustules and anterolateral spinules of second instar now spines, still producing concave row; row 4 often with two pairs of processes: submedial spinules of second instar now spines, each usually associated with sublateral pustule, producing concave row; row 5 (not present in second instar) with two pairs of pustules: one pair one-half distance between midline and lateral margins (i.e., midpustules), one pair sublateral, producing weakly convex row; anterior margin of pronotum usually with straight row of three to four pairs of pustules; lateral margins with spinules (2) of second instar now spines, usually one to three additional pustules between these spines. Mesonotum with medial membranous strip reduced, prominent submedial spines larger, followed by two pairs of pustules/spinules; lateral margins whitish to yellowish, additional spinule midway between spines (2) of second instar; posterior margin strongly sinuate, wing pads evident, overlapping metanotum. Metanotal plates with medial pustules of second instar now spinules, lateral spinules now larger; lateral margins whitish to yellowish; posterior margin sinuate, wing pads evident but not as well developed as anterior pair. Pleura with processes generally more numerous and developed, processes of second instar now sometimes spines; proepisternum and epimeron, mesoepisternum and epimeron, and metaepisternum and epimeron usually with eight and five to seven, six to eight and one, and five to seven and zero processes, respectively. Pro-, meso-, and metasterna with coloration similar to second instar or mesosternum entirely whitish to brownish. Legs now granulate, particularly profemora. Prothoracic legs generally brown to dark brown. Profemora still brown to dark brown, with ventral surface more spinulate; anteromedial row with five processes: spine five (most distal) of second instar more developed, pustules (4) now spinules; anteroventral row with four spines: spine two of second instar lacking. Protibiae with color pattern similar to second instar, ventral surface more spinulate. Meso- and metathoracic legs with color pattern generally lighter.

Abdomen more spinose particularly on or near margins of terga 3–7 and medial plates of terga 3–5, usually more yellowish, color pattern more obscure. Medial plate of tergum 3 subtriangular, tergum 7 with medial plates absent. Terga 1, 2, 7, and 8 with paired pustules of second instar now spinules/spines, those of 9 unchanged; terga 3–5 still with two pairs of processes: paired prominent submedial spines on/near lateral margins of plates larger, midspinules larger, producing straight row; tergum 6 still with two pairs of processes: submedial spines unchanged, midpustules now spinules, producing concave row. Spiracles 2–8 with associated dorsoposterior spinules of second instar now spinules/spines. Ventral surface with color pattern similar to second instar, often more yellow; setae more numerous.

Fourth Instar (Fig. 9). Length, 6.54 ± 0.15; width, 1.15 ± 0.04. Color pattern similar to third instar, sclerotized portions of body generally lighter; remainder of body yellowish brown; processes more developed and numerous.

Head with anterior lobe (to anteclypeus) ≈1.03 times length of posterior lobe; dark brown band just anterior to transverse sulcus more evident; ventral surface with color similar to third instar. Anterior lobe with five rows of processes; row 1 with two pairs of spines: submedial spinules now spines, sublateral spine near base of each antenniferous tubercle larger, its lateral subbasal pustule unchanged, still producing straight row; row 2 still with three processes: medial spinule now spine, paired submedial spines unchanged, producing concave row; row 3 often with three to five processes: medial pustule of third instar now spinule/spine, two additional anterior pairs of pustules/spinules (if present), one pair submedial, one pair sublateral, producing concave row; row 4

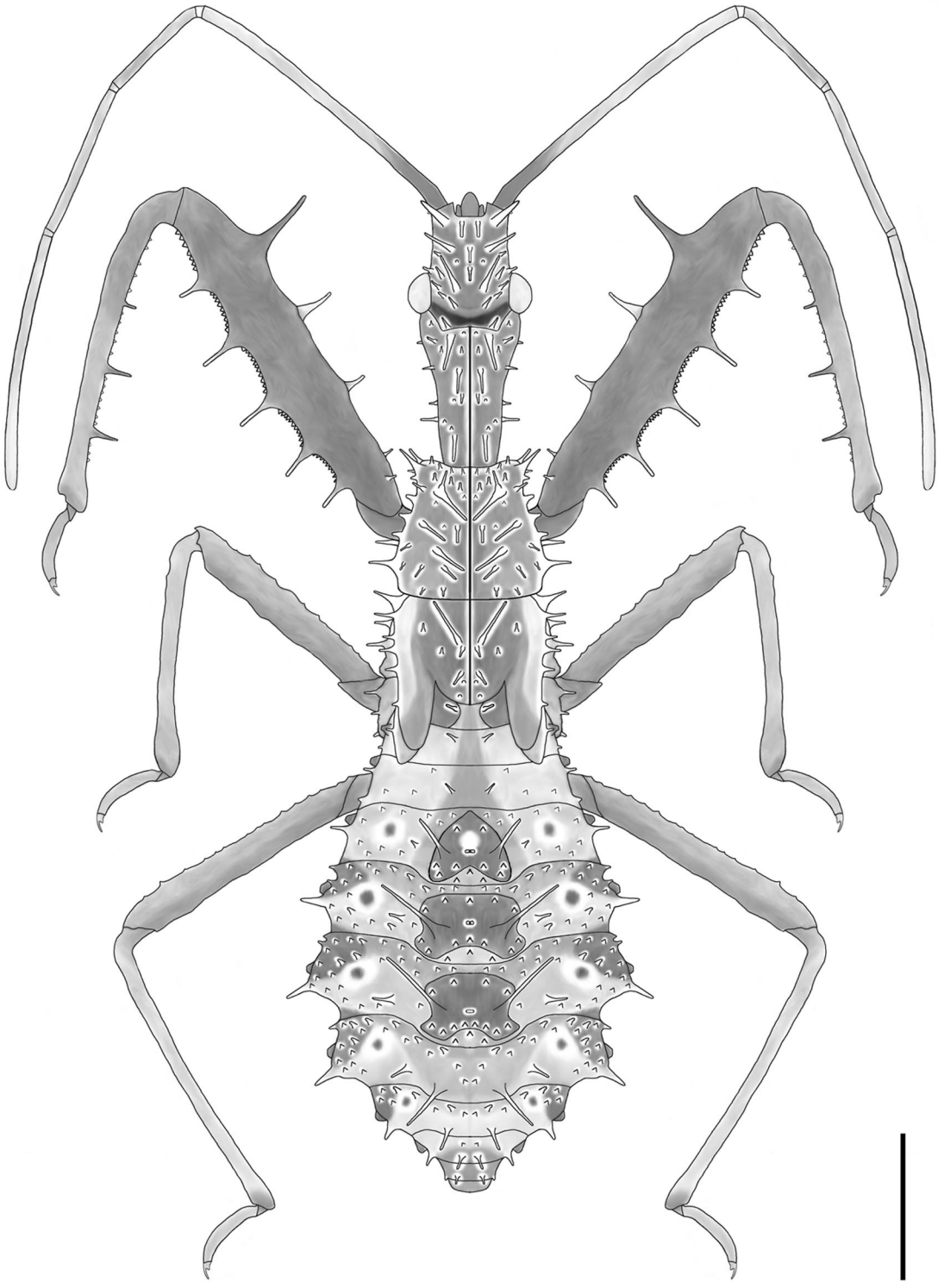


Fig. 9. Fourth instar (general dorsal view) of *S. diadema* (scale bar = 1.0 mm).

with three pairs of processes: prominent submedial spines and lateral spinules unchanged, additional pair of spinules present one-half distance between midline and lateral margins (i.e., midspinules), still producing concave row; row 5 with three pairs of processes: submedial pustules of third instar often now spinules, sublateral spinules unchanged, additional pair of pustules/spinules present one-half distance between midline and inner margin of eye (i.e., midpustules/midspinules), producing concave row; spinule in each submedial angle of transverse sulcus now spine. Posterior lobe with five rows of processes; row 1 with four pairs of processes: prominent submedial spines unchanged, sublateral spinules of third instar now spines, lateral pustules now spinules, often with additional pair of pustules anteromesad of prominent submedial spines, producing convex row; row 2 with paired submedial pustules and midpustules more developed but still pustules, still producing straight row; row 3 still with two pairs of processes (spines): submedial and sublateral spines unchanged, producing straight row; row 4 with three pairs of processes: submedial spines and posterolateral pustules unchanged, additional lateral spinule each side, still producing convex row; row 5 with three to four pairs of processes: submedial, anterolateral, and lateral pustules/spines of third instar more developed, often additional sublateral pustule each side, still producing concave row; pustule posteromesad of eye more developed. Beak ≈1.13 times length of head, ratio of beak segment lengths ≈2.00:2.13:1.00. Antennae with color pattern lighter, more obscure, ≈2.96 times length of head; ratio of antennal segment lengths ≈2.60:1.00:1.39:2.01.

Thorax brown, ratio of notal lengths ≈5.69:3.75:1.00. Pronotum with five rows of processes; row 1 with two to three pairs of processes: submedial pustules of third instar now spinules, one to two additional pairs of submedial to sublateral spinules present, producing concave row; row 2 still with two pairs of processes: submedial bifurcate spines and sublateral spinules more developed, producing straight row, row often associated with paired posteromedial and posterolateral pustules, which are not included as part of row; row 3 with three pairs of processes: submedial and anterolateral spines unchanged, additional pair of pustules present one-half distance between midline and lateral margins (i.e., midpustules), producing weakly concave row; row 4 with two pairs of processes: submedial spines and sublateral pustules more developed, still producing concave row; row 5 with three pairs of processes: midpustules and sublateral pustules of third instar now often spinules, additional sublateral spinule each side, producing weakly convex to concave row; anterior and lateral margins of pronotum with pustules of third instar now spinules; posterior margin with straight row of one to four pustules/spinules. Mesonotum with medial membranous strip reduced or absent, disc brownish, wing pads with anterolateral two-thirds yellowish, remainder brownish; prominent submedial spines of third instar larger, now associated with paired sublateral spinules (extremely variable) and followed by straight row of four pustules/spinules and three straight rows of paired pustules/spines; lateral margins with five to seven spinules/spines; posteromedial margin broadly rounded, wing pads overlapping tergum 1. Metanotal plates with medial processes more developed; wing pads evident, overlapping terga 1–2. Pleura with processes generally more numerous and developed; proepisternum and epimeron, mesoepisternum and epimeron, and metaepisternum and epimeron usually with 8–17 and 6–11, 8–14 and 1–2, and 7–14 and 0 processes, respectively. Sternum with coloration similar to third instar. Legs more granulate, particularly profemora. Prothoracic legs yellowish brown to brown; profemora yellowish brown to dark brown, ventral surface more spinulate; protibiae yellowish brown to brown, ventral surface more spinulate. Meso- and metathoracic legs with color pattern similar to third instar.

Abdomen more spinose, processes more developed, color pattern more obscure, terga 3–7 each with whitish circular area sublaterally, surrounded by pustules, each circle with central brownish spot. Medial plate of tergum three hexagonal. Ventral surface yellowish medially, mediolateral area marked with oblique brownish stripes, lateral margins brownish with brownish spot on sterna 2 (or 3) to 7; numerous pustules present.

Fifth Instar (Fig. 10). Length, 9.58 ± 0.21; width, 1.69 ± 0.04. Color pattern similar to fourth instar, generally with more yellow, processes more developed and numerous.

Head with anterior lobe (to anteclypeus) ≈0.98 times length of posterior lobe; dark brown band just anterior to transverse sulcus now black; ventral surface with color similar to fourth instar. Anterior lobe with five rows of processes; row 1 still with two pairs of spines: submedial spines larger, sublateral spine near base of each antenniferous tubercle unchanged, its lateral pustule near base more developed, sometimes bifurcate, producing straight row; row 2 with three processes (spines): medial and paired submedial spines more developed, still producing concave row; row 3 often still with three to five processes (pustules/spinules/spines): medial, paired submedial, and paired sublateral processes unchanged, producing concave row; row 4 still with three pairs of processes: prominent submedial spines larger, midspinules and lateral spinules unchanged, producing concave row; row 5 still with three pairs of processes (pustules/spinules/spines): all processes now spinules/spines, producing concave row; spine in each submedial angle of transverse sulcus larger. Posterior lobe with five rows of processes; row 1 still with four pairs of processes: anteromedial pustules of fourth instar now spinules, prominent submedial and sublateral spines and lateral spinules unchanged, producing convex row; row 2 with three pairs of processes: submedial pustules and midpustules of fourth instar now spinules, additional pair of lateral spinules present, still producing straight row; row 3 with three pairs of processes: submedial and sublateral spines of fourth instar larger, additional pair of lateral spinules present, still producing straight row; row 4 with three to four

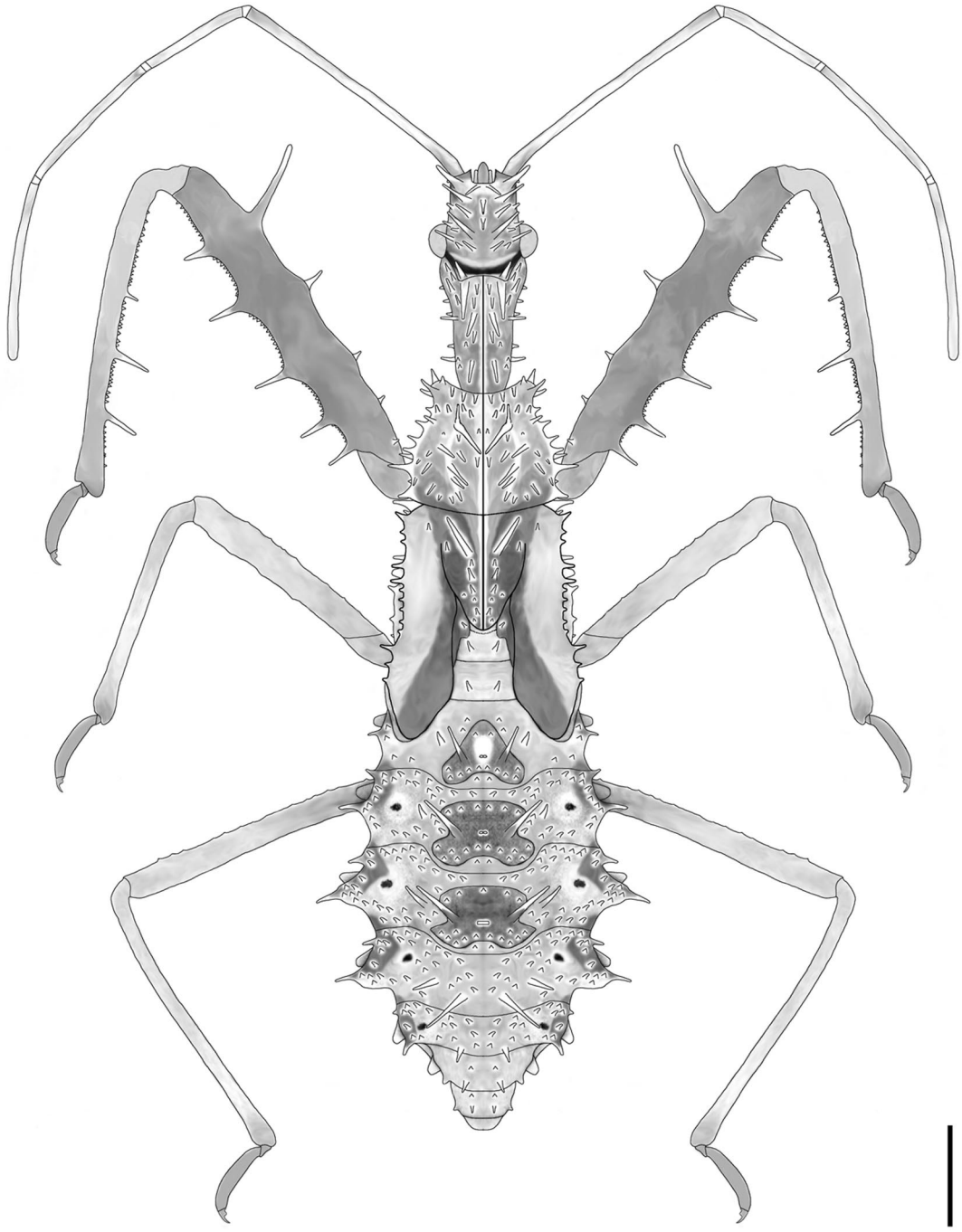
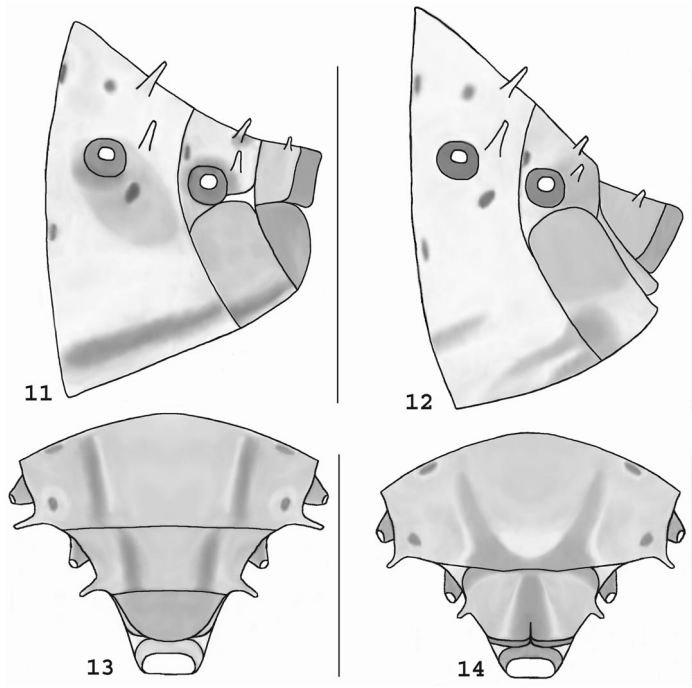


Fig. 10. Fifth instar (general dorsal view) of *S. diadema* (scale bar = 1.0 mm).

pairs of processes: submedial, posterolateral, and lateral processes unchanged, still producing convex row, occasionally row associated with additional pair of posteromedial pustules (not shown), producing irregular row; row 5 still with three to four pairs of processes: submedial, anterolateral, sublateral, and lateral pustules/spines unchanged, producing concave row; pustule posteromesad of eye of fourth instar now spinule, this spinule may be associated with additional posteromedial spinule. Beak ≈1.17 times length of head, ratio of beak segment lengths ≈2.33:2.29:1.00. Antennae with color pattern similar to fourth instar,



Figs. 11–14. Fifth instar (terminalia) of *S. diadema* (scale bars = 1.0 mm). 11. Male, lateral view. 12. Female, lateral view. 13. Male, ventroposterior view. 14. Female, ventroposterior view.

generally with more yellow, ≈3.12 times length of head; ratio of antennal segment lengths ≈2.39:1.00: 1.43:1.63.

Thorax brown, pronotum with pair of yellowish white, longitudinal curved lines; ratio of notal lengths ≈25.40:23.60:1.00. Pronotum with five rows of processes; row 1 with two to four pairs of spinules: submedial to sublateral processes unchanged, often with additional lateral spinule each side, producing irregular row; row 2 still with two pairs of processes: submedial and sublateral spinules/spines larger, producing straight row, row often associated with two to three pairs of posteromedial and posterolateral pustules, which are not included as part of row; row 3 with four pairs of processes: submedial and anterolateral spines unchanged, midpustules of fourth instar now spinules, often associated with additional lateral/posterolateral pustule/spinule each side, producing irregularly concave row; row 4 with two to three pairs of processes: submedial spines unchanged, sublateral pustules of fourth instar now spinules, often associated with additional lateral spinule each side, still producing concave row; row 5 still with three pairs of processes: midspinules now spinules/spines, two sublateral spinules each side unchanged, producing irregular row; anterior margin of pronotum with straight row of three to four pairs of spinules of fourth instar now spinules/spines; posterior margin weakly concave, with straight row of 4–10 spinules/spines near margin, each posterolateral corner of pronotum now prominent spine. Mesonotum with medial membranous area absent, disc brownish, wing pads with anterolateral 9/10 yellowish, remainder brownish; prominent submedial spines larger, followed by six weakly convex to concave rows of two to four processes; lateral margins more spinose; posteromedial area extended posteriorly, constricting metanotum, posteromedial margin narrowly rounded, wing pads more evident, overlapping tergum 3. Metanotum with wing pads almost completely covered by mesonotal wing pads, overlapping tergum 3. Pleura with processes generally more numerous and developed; proepisternum and epimeron, mesoepisternum and epimeron, and metaepisternum and epimeron usually with 8–21 and 6–14, 8–16 and 1–6, and 7–19 and 0 processes, respectively. Sternum with coloration similar to fourth instar. Legs more strongly and heavily granulate, particularly profemora. Prothoracic legs yellowish brown to brown; profemora yellowish brown to brown, ventral surface more spinulate; protibiae yellowish to brownish, ventral surface more spinulate. Meso- and metathoracic legs generally lighter.

Abdomen more spinose, processes more developed, color pattern more obscure. Terminal segments showing distinct sexual dimorphism: males (Figs. 11 and 13), sternum 8 unmodified, 9 noticeably swollen, particularly evident in lateral view; females (Figs. 12 and 14), sternum 8 divided medially in approximately posterior one-third, 9 not swollen, divided medially throughout entire length.

Diagnosis

The five instars are distinguished readily by characters in addition to body size and ratios of various measurements. All instars possess spines, which show progressive development in size, number, and pattern through the fifth instar. The first instar can be distinguished further by its lack of spines on the abdomen; spines are present on this tagma in later instars. The second instar differs from the third to fifth instars by the lack of wing pads; the later instars show progressive development of wing pads. Finally, the fifth instar shows distinct sexual dimorphism.

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