Identification of Nymphs of Midwestern Species and Instars of *Sinea* (Hemiptera: Heteroptera: Reduviidae: Harpactorinae)

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ABSTRACT The harpactorine reduviid genus *Sinea* is represented in the midwestern United States by three species: *Sinea complexa* Caudell, *Sinea diadema* (F.), and *Sinea spinipes* (Herrich-Schaeffer). Although the nymphs of these species have been described, no key has been developed for their identification. Here, we present a key to the nymphs of these taxa to the species and instar levels.

KEY WORDS *Sinea*, nymphal key, midwestern species, instars

The family Reduviidae, including the assassin bugs, ambush bugs, and threadlegged bugs, is represented in America north of Mexico by 11 subfamilies, 50 genera, and ≈200 species and subspecies (Froeschner 1988). Adults of these predaceous bugs are characterized by, among other features, large compound, protuberant eyes; usually a bilobed, cone-shaped head; a three- (rarely four)-segmented beak; and a stridulatory groove on the prosternum (Schuh and Slater 1995). In Illinois, they range in length from ≈7 mm (*Oncerotrachelus*) to 40 mm (*Emesaya* and *Arilus*) and vary in body shape from ovoid (Harpactorinae) to narrow and elongate (Emesinae) (Hagerty and McPherson 1999). There usually are five instars, although *Fitchia aptera* Stål (DeCoursey 1963) and *Melanolestes picipes* (Herrich-Schaeffer) (Readio 1927) reportedly have only four instars.

Taxonomic keys have been developed for the identification of various North America reduviid taxa. Fracker (1912) provided an early species key to North American Reduviidae, excluding the Phymatinae and Emesinae. Blatchley (1926) and Slater and Baranowski (1978) authored works on the biology of heteropteran taxa of eastern North America and North America (not comprehensive), respectively, and included species keys to the reduviids. Readio (1927) authored a monograph on the biology of North American Reduviidae (excluding the Phymatinae), and, as mentioned above, provided species keys; this monograph still stands as the authoritative work on this family north of Mexico.

Other works on Heteroptera have included species keys to reduviids within more limited geographical areas. These works include Torre-Bueno (1923) (excluding Phymatinae) and Parshley (1923) (Phymatinae) for Connecticut, Froeschner (1944) for Missouri, and Drew and Schaefer (1963) for Oklahoma.

The above-mentioned reduviid keys share one feature—all are for adult identification. Keys to immatures are almost nonexistent. The only key for nymphs of North America of which we are aware is that of Fracker and Usinger (1949) to genera. There apparently are no keys to species, although the eggs and nymphs of several reduviids have been described (Readio 1927; Swadener and Yonke 1973a,b,c, 1975; Bradshaw and McPherson 2002; Voss and McPherson 2003; Shurtz and McPherson 2005).

The harpactorine genus *Sinea* is represented in America north of Mexico by 11 species, three of which occur in the Midwest [i.e., *Sinea complexa* Caudell, *Sinea diadema* (F.), and *Sinea spinipes* (Herrich-Schaeffer)] (Froeschner 1988). The Midwest is defined here as Michigan and Ohio west to North Dakota, Nebraska, and Kansas.

In 1927, Readio briefly described the first–fifth instars of *S. diadema* (also published in 1924) and *S. spinipes*, which were of limited value. Almost 50 yr later, Swadener and Yonke (1973a) presented detailed descriptions of the five instars of *S. complexa*, but these descriptions could not be compared meaningfully with those of Readio (1927).

During 2001–2002, we conducted life history studies of *S. diadema* and *S. spinipes* in southern Illinois, reared both species in the laboratory under controlled conditions, and provided detailed descriptions of the five instars of each species (Voss and McPherson 2003, Shurtz and McPherson 2005). These instars are spinose and although this makes their descriptions more difficult, the spines provide excellent characters for distinguishing the nymphs of the two species and instars within each species. Furthermore, these same characters can be used to distinguish *S. complexa*.

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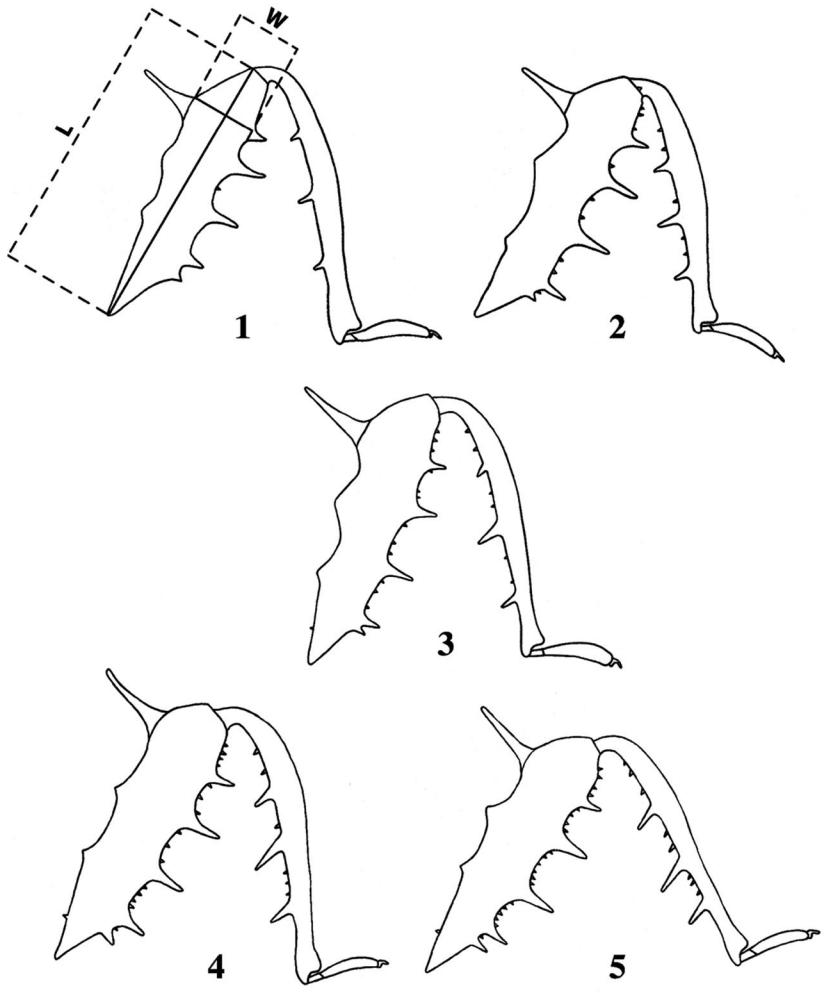


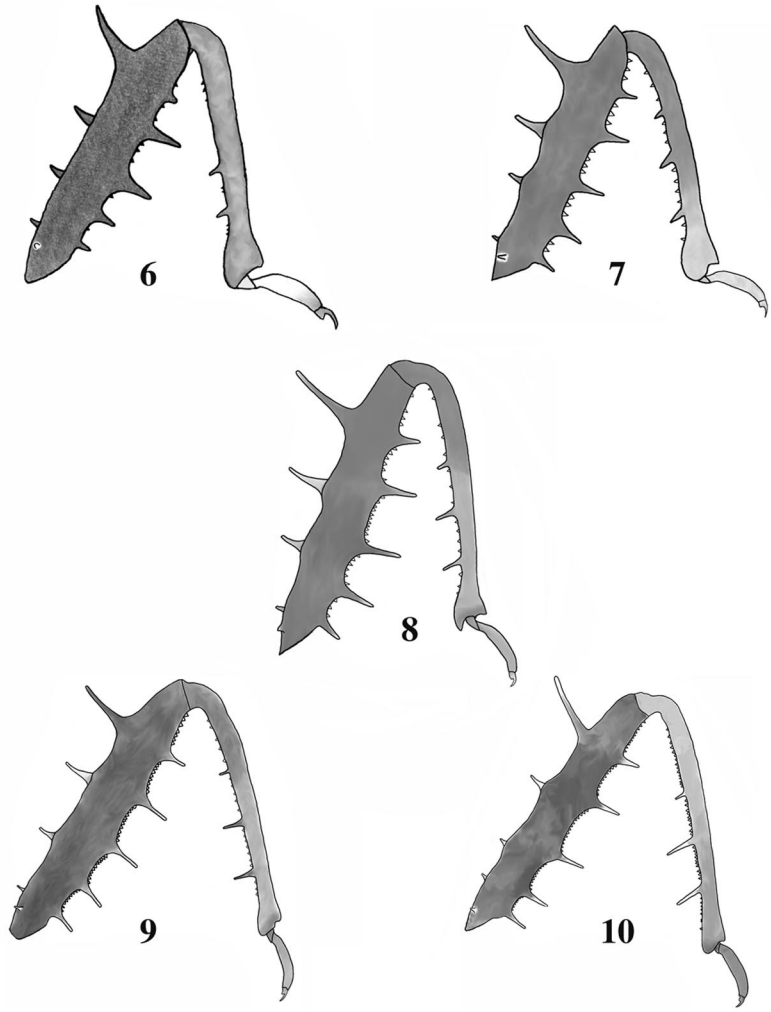
Figs. 1–5. Prothoracic leg, *S. complexa.* Posterior (outer) surface, base of femur to apex of tarsal claws. 1. First instar. 2. Second instar. 3. Third instar. 4. Fourth instar. 5. Fifth instar. L, length; W, width.

Here, we present information for distinguishing *Sinea* from other reduviids and a key to separate the instars within and between these three species.

Materials and Methods

Characters used in the key were based on nymphs collected during our studies of *S. diadema* and *S. spinipes* in southern Illinois and on nymphs of *S. complexa* collected in southern Illinois and Missouri. The nymphs of *S. diadema* were field-collected, whereas those of *S. spinipes* were laboratory-reared (first instars) and field-collected (first–fifth instars). Nymphs of *S. complexa* were laboratory-reared and field-collected and included those nymphs used by Swadener and Yonke (1973a) in their Missouri study, all of which were laboratory-reared. Field specimens of the three species were collected in southern Illinois. All specimens, including those from the Missouri study, were preserved in 70–75% ethanol.

Measurements are given as ranges and based on 10 specimens except as noted for *S. complexa:* third instar (five laboratory-reared and one field-collected), fourth instar (four laboratory-reared and zero field-collected). Profemoral length was measured along the posterior (=outer) surface (Fig. 1). Head width was measured across the eyes. Body length was measured in lateral view from the tip of the anteclypeus to the apex of the abdomen. Note that the body often is curved, especially in later instars. Therefore, for these individuals, the body was measured in sections, generally from the tip of the anteclypeus to the posterior margin of the metathorax and from the base to the apex of the abdomen, and the sections were summed. Although the characters selected for the key are relatively consistent, they should be used in conjunction with the original full descriptions in Voss and McPherson (2003) for *S. diadema*, Shurtz and McPherson (2005) for *S. spinipes*, and Swadener and Yonke (1973a) for *S. complexa.*

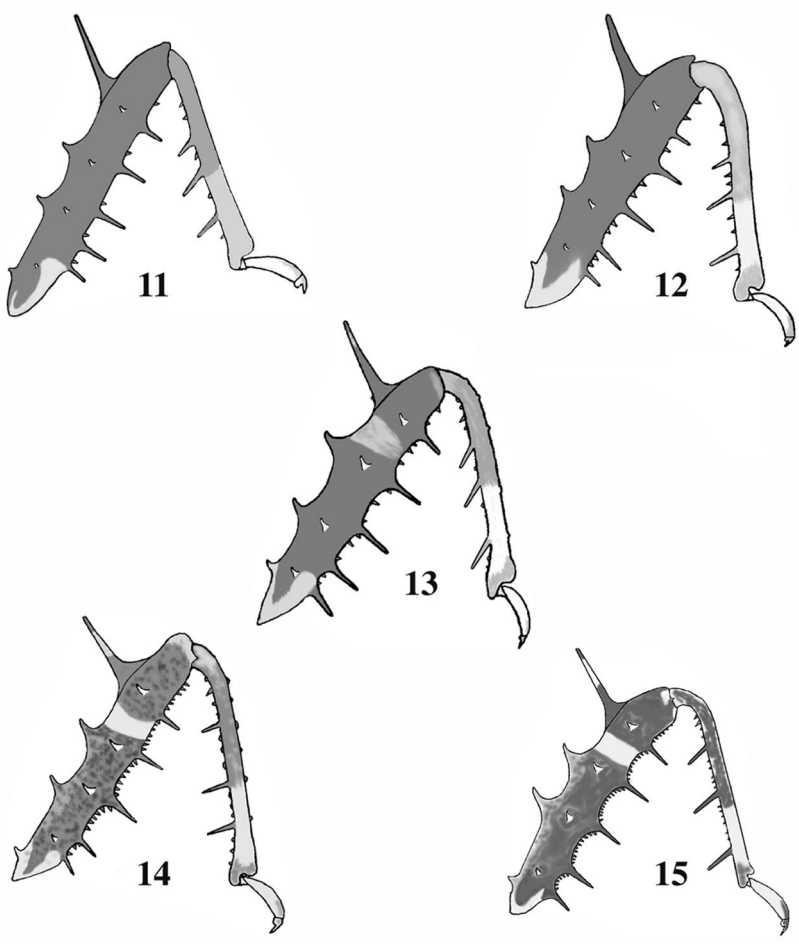


Figs. 6–10. Prothoracic leg, *S. diadema*, posterior (outer) surface, base of femur to apex of tarsal claws. 6. First instar. 7. Second instar. 8. Third instar. 9. Fourth instar. 10. Fifth instar (modified from Voss and McPherson 2003).

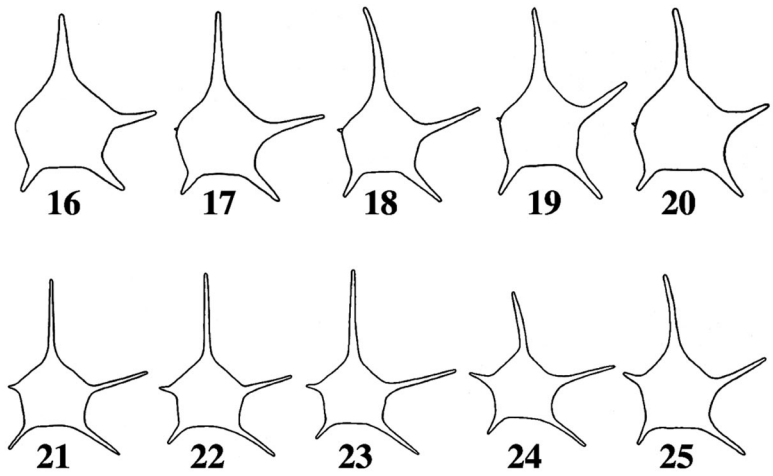
Identification. All instars of *S. complexa*, *S. diadema*, and *S. spinipes*, as a group, can be identified easily by the key of Fracker and Usinger (1949) to nymphs by several distinctive characters visible in dorsal and lateral views. These characters include (roughly in sequence given in Fracker and Usinger's key) the procoxae not more than twice as long as broad and not extending beyond the apex of the head; the second segment of beak cylindrical to slightly spindle-shaped, subequal to the length of the first (relative to third, which is distinctly shorter than the first or second segment); the first segment of antennae more than twice the length of the second; the protibiae not greatly swollen at the tip; the protarsi not retractile; the profemora armed with spines but lacking a pair of spines at the apex; and the protibiae armed with long spines. The last character separates *Sinea* from *Acholla*, which lacks protibial spines; otherwise, the two genera are similar in appearance.

Use of Key. Nymphs of the three *Sinea* species considered here, and presumably those of other congeneric species, are covered with setigerous processes that change in number, pattern, and structure during development. These changes are important diagnostic characters (Voss and McPherson 2003, Shurtz and McPherson 2005) but occur at varying rates during development, which must be incorporated into the key. These changes are discussed below.

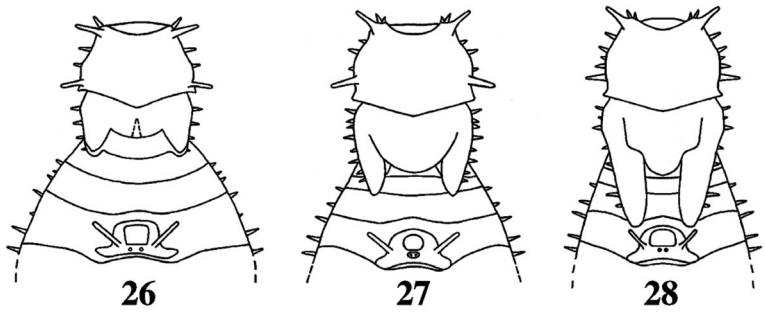
Characters most useful in any key to nymphs are those that vary little within, and provide good separation between, instars. For *Sinea*, the change in structure of the setigerous processes during development is valuable. These processes often begin as pustules in early instars and develop through spinules to spines in later instars. Their rate of transition from pustule to spine is relatively constant in most individuals; however, there are exceptions. For example, a particular pustule might first show up as a spinule in the third



Figs. 11–15. Prothoracic leg, *S. spinipes*, posterior (outer) surface, base of femur to apex of tarsal claws. 11. First instar. 12. Second instar. 13. Third instar. 14. Fourth instar. 15. Fifth instar (modified from Shurtz and McPherson 2005).



Figs. 16–25. Profemur, right leg, subapical cross-section, *S. diadema*. 16. First instar. 17. Second instar. 18. Third instar. 19. Fourth instar. 20. Fifth instar. Profemora, right leg, subapical cross-section. *S. spinipes*. 21. First instar. 22. Second instar. 23. Third instar. 24. Fourth instar. 25. Fifth instar.



Figs. 26–28. Wing pads, *S. complexa*. 26. Fourth instar. 27. Fifth instar (form 1). 28. Fifth instar (form 2).

instar in most individuals but in the second instar in some individuals. Compounding this problem is the designation of the process, itself, which is somewhat arbitrary. What is a pustule, spinule, or spine? What is the difference between a large pustule and a small spinule? A large spinule and a small spine? These problems, which result in some overlap of these characters between instars, necessitate broadening their descriptions within the keys (e.g., use of pustule/spinule, spinule/spine). Examples of the relative sizes of these processes in *Sinea* are shown in Figs. 32 and 40.

Another problem is that of asymmetrical development, particularly evident between corresponding processes on paired leg segments (e.g., left and right protibiae), both in actual rate of development (e.g., spinule on left protibia, spine on right) and in abnormal growth. Here, it is imperative that both segments be examined when using the key.

Finally, these insects, as do many other insects, show marked expansion of the abdomen during stadia, primarily resulting from feeding. Therefore, when measuring the lengths of animals for comparison with the ranges given in the key, a specimen should be selected that has fed, at least to some extent, and, therefore shows some expansion. Specimens that have molted recently or are bloated should not be used, or if they are used, they should be expected to fall outside the ranges given for the instars.

These precautions should be kept in mind when using the key. All characters should be considered rather than a single character. Used carefully and collectively, and in conjunction with the original descriptions, these keys should permit easy identification of both the species and instars.

Key to Immature Stages of Midwestern Species of *Sinea*[3,4,5]

1. Profemora stout, club-shaped, length along posterior (outer) surface ≈3.0–4.7× width at base of dorsal spine (Figs. 1–5), posteroventral surface with row of five spines from base of segment to opposite dorsal spine, spine 1 (basal) primarily yellowish to yellowish brown, spines 2–5 brownish, spine one short, toothlike, approximate to spine 2 (Figs. 1–5) *S. complexa* 3

1′. Profemora elongate, parallel-sided to fusiform, length along posterior (outer) surface ≈5.0–7.0× width at base of dorsal spine (Figs. 6–15), posteroventral surface also with row of five spines from base of segment to opposite dorsal spine, spine 1 (basal) brownish or with base partly yellowish, spines 2–5 brownish (spines 1–5 may be lighter in lighter specimens, particularly in fourth and fifth instars of *S. diadema*), spine 1 elongate (occasionally absent), not toothlike, not approximate to spine 2 (Figs. 6–15) 2

2. Profemora with subapical ringlet of four spines (anteroventral, anteromedial, dorsal, and posteroventral) (posterolateral pustule or tubercle may be present, particularly in older instars) (Figs. 16–20); protibiae with three or two (spine 1 may be absent) spines (intermediate spinules may be present) on posteroventral surface, if spine 1 present, then usually 1/2 or less length of spine 2, spine 2 usually shorter than or subequal to 3, occasionally distinctly longer in fourth and fifth instars (Figs. 6–10) *S. diadema* 7

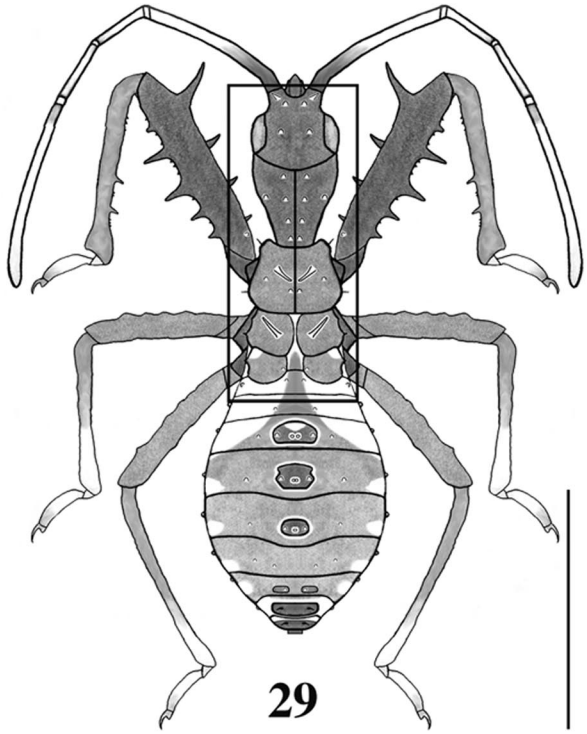
2′. Profemora with subapical ringlet of five spines (those mentioned above + posterolateral; posterolateral may be represented only by spinule) (Figs. 21–25); protibiae with three spines (intermediate spinules may be present) on posteroventral surface, spine 1 shortest, usually 2/3–3/4 length of spine 2, spine 2 subequal to distinctly longer than 3 (Figs. 11–15) *S. spinipes* 11

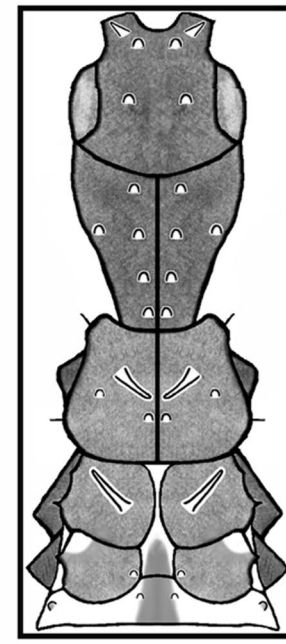
3. Dorsal surface of abdomen without spinules/spines, at most only with pustules (as in Figs. 29 and 39); profemora ≈0.65–0.85 mm in

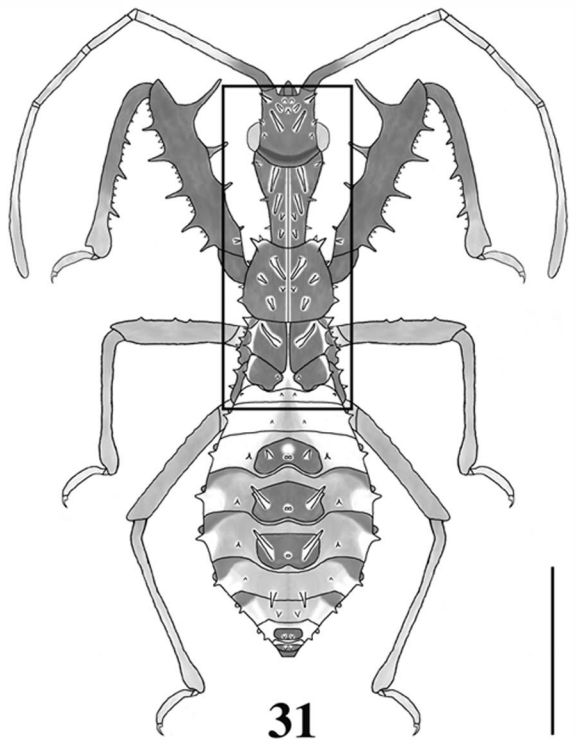
[3] References to anterior and posterior surfaces of profemora and protibiae (e.g., posteroventral) refer to inner and outer surfaces, respectively.

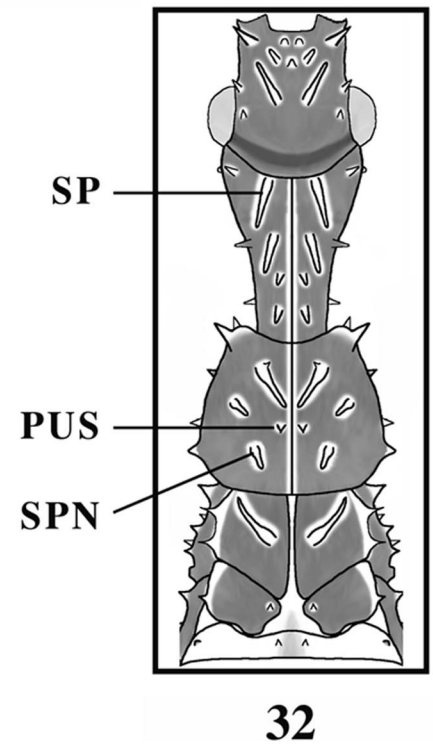
[4] Ratio of length to width of profemur is measured as shown in Fig. 1 (note, width does not include dorsal and ventral spines).

[5] Terga 3–5 can be identified by their medial plates, each of which encloses paired ostioles.









Figs. 29–32. Nymphs (general dorsal view and enlargement), *S. diadema* (scale bars = 1.0 mm). 29 and 30. First instar. 31 and 32. Second instar. PUS, pustule; SP, spine; SPN, spinule (modified from Voss and McPherson 2003).

length; head ≈0.38–0.43 mm in width; body ≈1.80–2.55 mm in length . . . . . first instar

3′. Dorsal surface of abdomen with paired spinules/spines, at least on medial plates of terga 3–5 (as in Figs. 31 and 41 and later instars); profemora ≈0.90 mm in length or longer; head ≈0.46 mm in width or wider; body ≈2.40 mm in length or longer 4

4. Dorsal surface of abdomen with paired spinules/spines usually not present posterior to tergum 5, occasionally with one pair of spinules on tergum 6; pronotum with paired spines in anterior 1/2 each with pustule/spinule subbasally; profemora ≈0.90–1.15 mm in length; head ≈0.46–0.51 mm in width; body ≈2.40–3.30 mm in length . . . . . second instar

4′. Dorsal surface of abdomen with paired spinules/spines posterior to tergum 5, usually on two or more additional terga; pronotum with paired spines in anterior 1/2 each with pustle/spinule/spine subbasally; profemora ≈1.15 mm in length or longer; head ≈0.56 mm in width or wider; body ≈3.25 mm in length or longer 5

5. Wing pads absent; head with pustule/spinule in each submedial angle of transverse suture (as in Figs. 34 and 44); pronotum with paired spines in anterior 1/2 each with pustule/spinule subbasally; profemora ≈1.15–1.40 mm in length; head ≈0.56–0.65 mm in width; body ≈3.25–4.10 mm in length . . . . . third instar

5′. Wing pads present (Figs. 26–28); head with spinule/spine in each submedial angle of transverse suture (as in Figs. 36 and 46); pronotum with paired spines in anterior 1/2 each with spinule/spine subbasally; profemora ≈1.45 mm in length or longer; head ≈0.67 mm in width or wider; body ≈4.10 mm in length or longer 6

6. Mesowing pads not completely overlapping metawing pads, often extending only to their base, the latter extending to abdominal tergum 1, not reaching tergum 2 (Fig. 26); profemora ≈1.45–1.75 mm in length; head ≈0.67–0.76 mm in width; body ≈4.10–5.35 mm in length; terminalia not clearly sexually dimorphic . . . . . fourth instar

6′. Mesowing pads completely overlapping metawings pads, wing pads, collectively, extending to at least anterior margin of tergum 2, occasionally reaching tergum 3 (Figs. 27 and 28); profemora ≈1.65–2.25 mm in length; head ≈0.78–0.93 mm in width; body ≈4.85–6.50 mm in length; terminalia clearly sexually dimorphic (as in Figs. 49–56) . . . . . fifth instar

7. Dorsal surface of head and prothorax each with one pair of spinules/spines (ignore pustules), those of head small, associated with antenniferous tubercles, those of pronotum prominent, in anterior 1/2 (Figs. 29 and 30); dorsal surface of abdomen without spinules/spines, at most only with pustules (Fig. 29); profemora ≈0.75–1.00 mm in length; head ≈0.40–0.42 mm in width; body ≈2.00–2.55 mm in length . . . . . first instar

7′. Dorsal surface of head and prothorax each with two or more rows of spinules/spines (Figs. 31–38); dorsal surface of abdomen with paired spinules/spines (Figs. 31 and 33, 35, 37); profemora ≈1.10 mm in length or longer; head ≈0.50 mm in width or wider; body ≈2.60 mm in length or longer 8

8. Head without spinule/spine in each submedial angle of transverse suture (Figs. 31 and 32); pronotum with paired spines in anterior 1/2 each with spinule subbasally (i.e., weakly bifurcate) (Figs. 31 and 32); profemora ≈1.10–1.40 mm in length; head ≈0.50–0.54 mm in width; body ≈2.60–3.60 mm in length . . . . . second instar

8′. Head with spinule/spine in each submedial angle of transverse suture (Figs. 33–38); pronotum with paired spines in anterior 1/2 each with spine subbasally (strongly bifurcate) (Figs. 33–38); profemora ≈1.60 mm in length or longer; head ≈62 mm in width or wider; body ≈4.00 mm in length or longer 9

9. Wing pads weakly developed (Figs. 33 and 34); profemora ≈1.60–2.00 mm in length; head ≈0.62–0.69 mm in width; body ≈4.00–5.25 mm in length . . . . . third instar

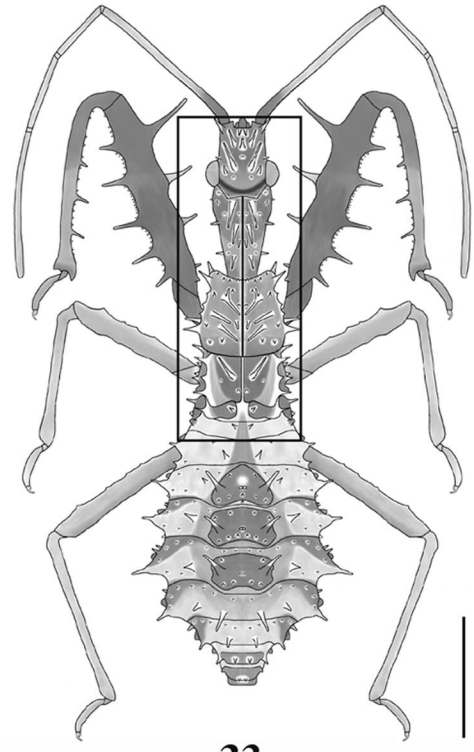
9′. Wing pads well developed (Figs. 35–38); profemora ≈2.20 mm in length or longer; head ≈0.80 mm in width or wider; body ≈5.60 mm in length or longer 10

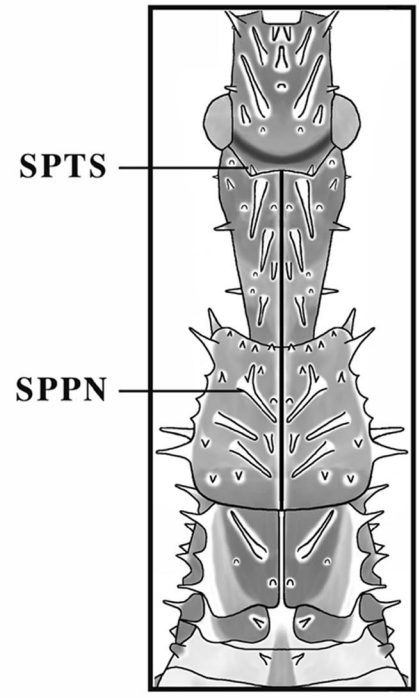
10. Wing pads overlapping abdominal terga 1 and 2 (Figs. 35 and 36); profemora ≈2.20–2.75 mm in length; head ≈0.80–0.86 mm in width; body ≈5.60–7.50 mm in length; terminalia not clearly sexually dimorphic . . . . . fourth instar

10′. Wing pads overlapping abdominal terga 3 and 4 (Figs. 37 and 38); profemora ≈3.00–3.60 mm in length; head ≈0.94–1.10 mm in width; body ≈8.50–11.00 mm in length; terminalia clearly sexually dimorphic (Figs. 49–52) . . . . . fifth instar

11. Dorsal surface of head and prothorax each with one pair of spinules/spines (ignore pustules), those of head small, associated with antenniferous tubercles, those of pronotum prominent, in anterior 1/2 (Figs. 39 and 40); dorsal surface of abdomen without spinules/spines, at most only with pustules (Fig. 39); profemora ≈0.80–1.10 mm in length; head ≈0.38–0.43 mm in width; body ≈2.25–3.00 mm in length . . . . . first instar

11′. Dorsal surface of head and prothorax each with two or more rows of spinules/spines (Figs. 41–48); dorsal surface of abdomen with paired spinules/spines (Figs. 41, 43, 45, and 47); profemora ≈1.25 mm in length





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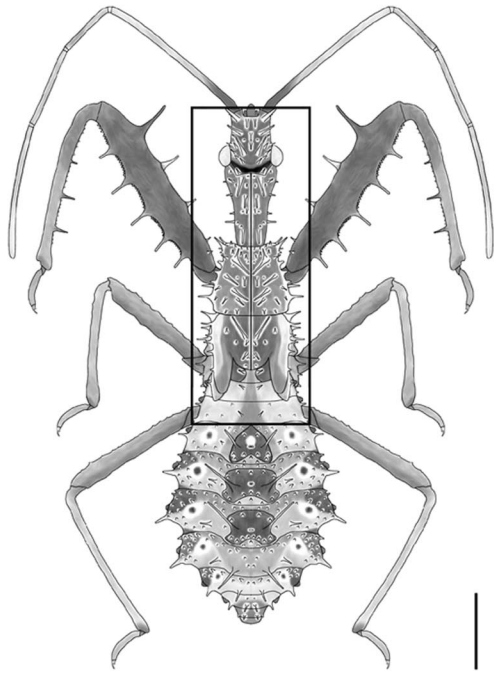

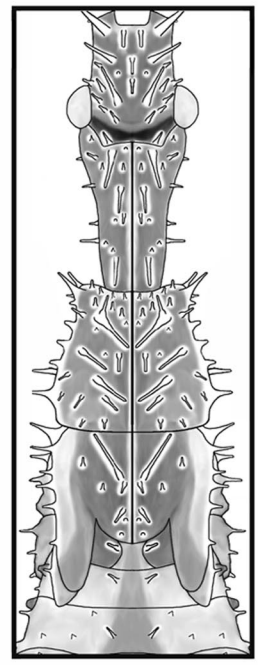

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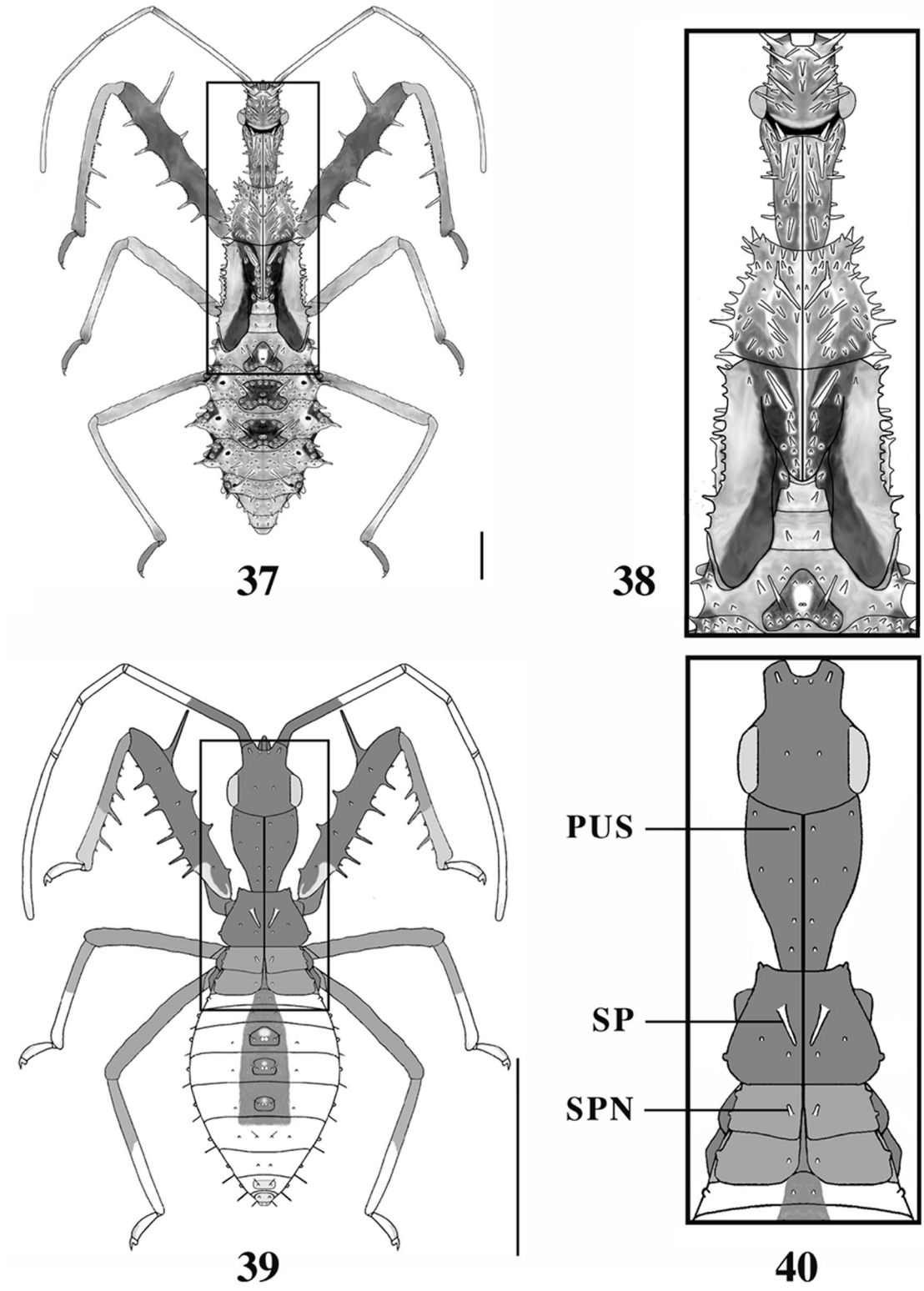
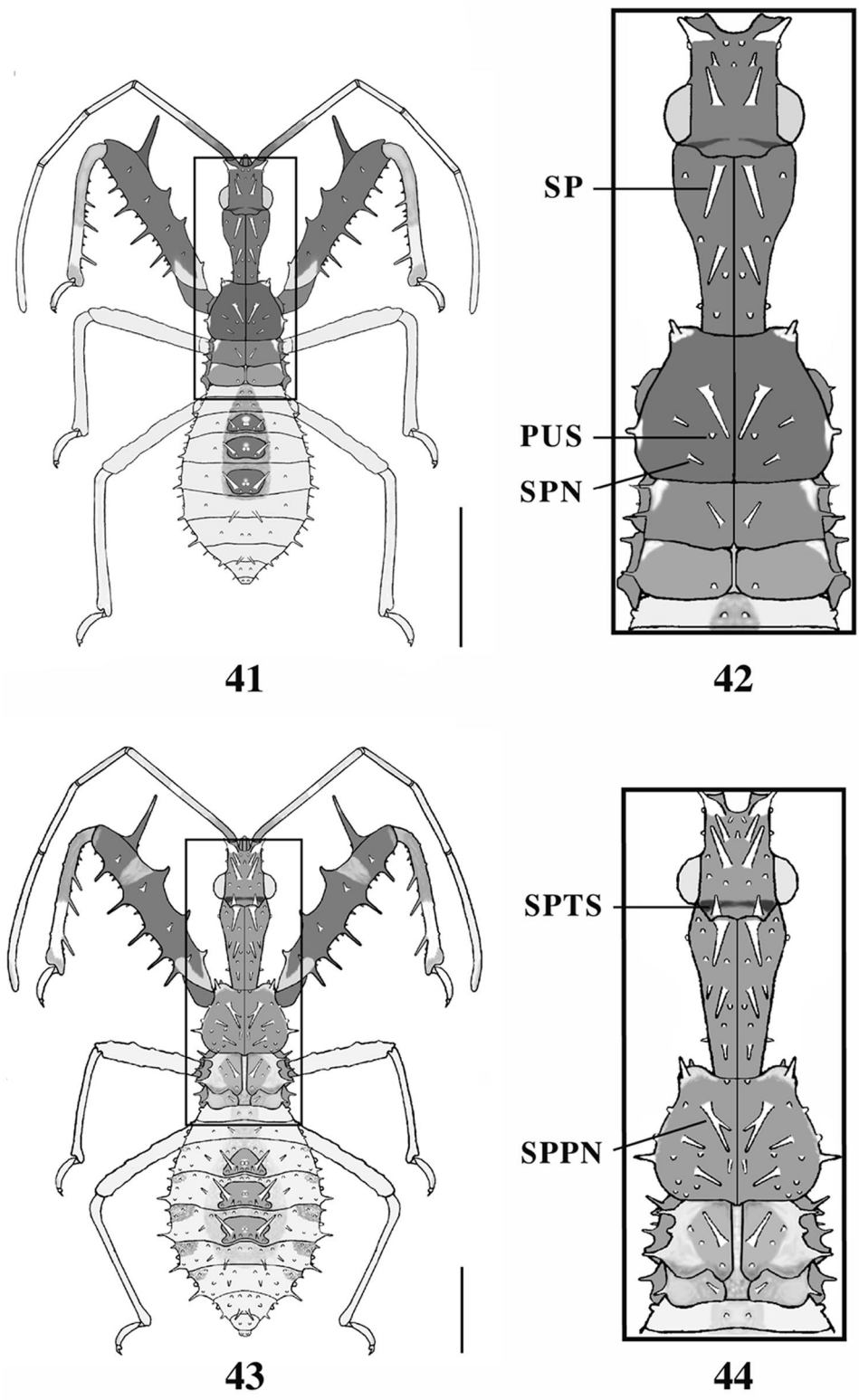
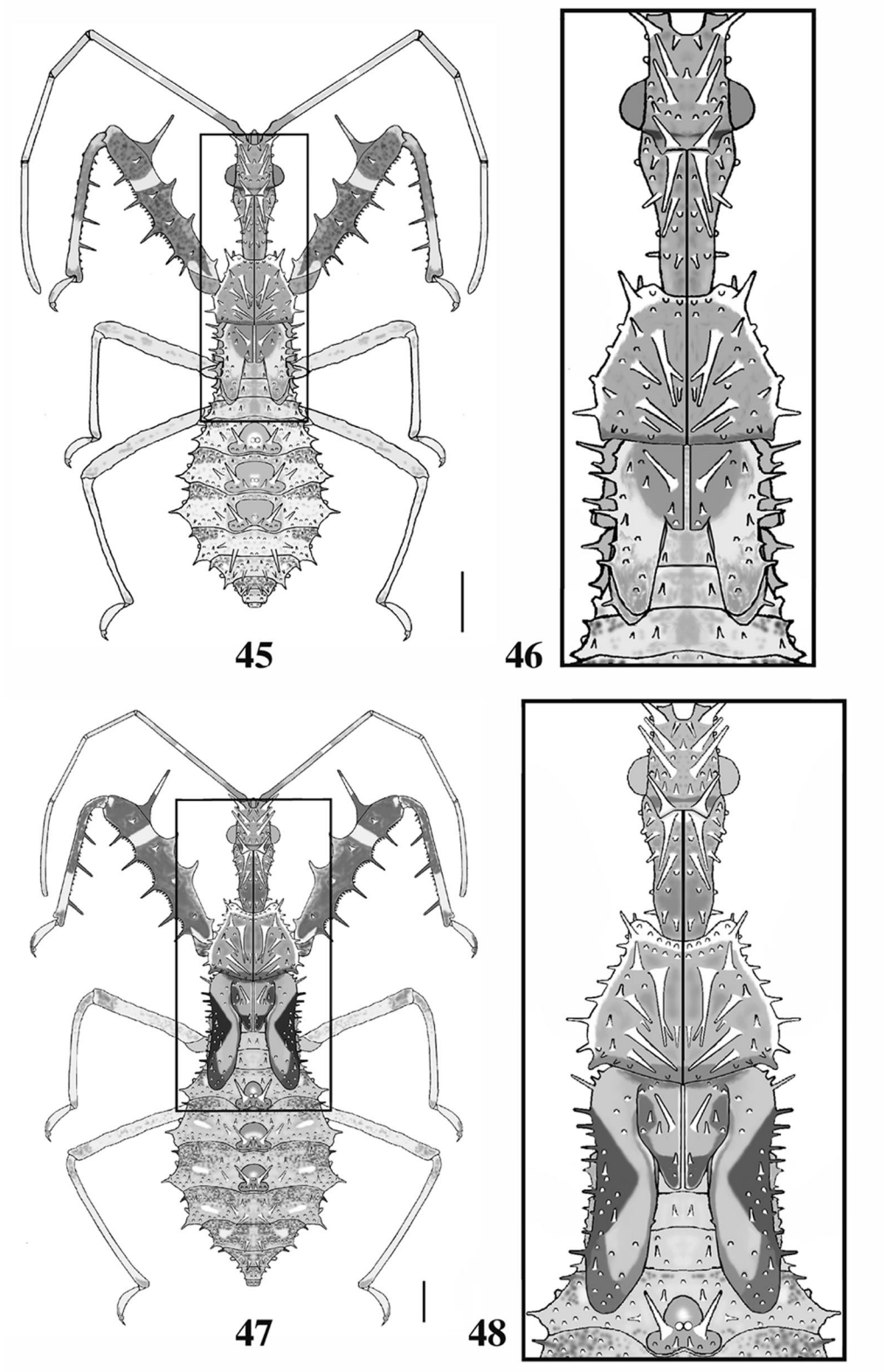
Figs. 33–36. Nymphs (general dorsal view and enlargement), *S. diadema* (scale bars = 1.0 mm). 33 and 34. Third instar. 35 and 36. Fourth instar. SPPN, spine, anterior 1/2 of pronotum; SPTS, spine, transverse suture, head (modified from Voss and McPherson 2003).



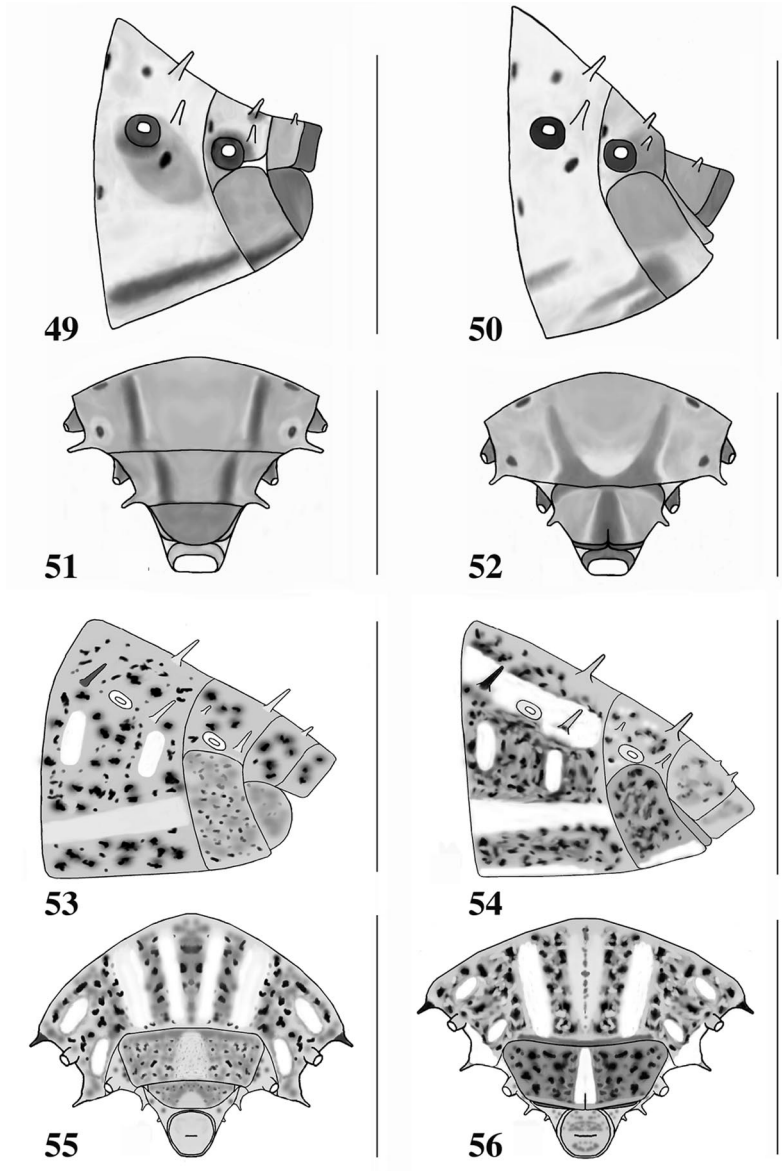
Figs. 37–40. Nymphs (general dorsal view and enlargement), *S. diadema* (scale bar = 1.0 mm). 37 and 38. Fifth instar. *S. spinipes* (scale bar = 1.0 mm). 39 and 40. First instar (modified from Voss and McPherson 2003 and Shurtz and McPherson 2005).



Figs. 41–44. Nymphs (general dorsal view and enlargement), *S. spinipes* (scale bars = 1.0 mm). 41 and 42. Second instar. 43 and 44. Third instar. PUS, pustule; SP, spine; SPN, spinule; SPPN, spine, anterior 1/2 of pronotum; SPTS, spine, transverse suture, head (modified from Shurtz and McPherson 2005).



Figs. 45–48. Nymphs (general dorsal view and enlargement), *S. spinipes* (scale bars = 1.0 mm). 45 and 46. Fourth instar. 47 and 48. Fifth instar (modified from Shurtz and McPherson 2005).



Figs. 49–56. Fifth instar (terminalia), *S. diadema* (scale bars = 1.0 mm). 49. Male, lateral view. 50. Female, lateral view. 51. Male, ventroposterior view. 52. Female, ventroposterior view. *S. spinipes* (scale bars = 1.0 mm). 53. Male, dorsolateral view. 54. Female, dorsolateral view. 55. Male, ventroposterior view. 56. Female, ventroposterior view (modified from Voss and McPherson 2003 and Shurtz and McPherson 2005).

or longer; head ≈0.48 mm in width or wider; body ≈3.20 mm in length or longer 12

12. Head without spinule/spine in each submedial angle of transverse suture (Figs. 41 and 42); pronotum with paired spines in anterior 1/2 each with pustule/spinule subbasally (i.e., weakly bifurcate) (Figs. 41 and 42); profemora ≈1.25–1.60 mm in length, without yellowish white to yellowish brown annulation in distal 1/3 (Fig. 12); head ≈0.48–0.56 mm in width; body ≈3.20–4.00 mm in length . . . . . second instar

12′. Head with spinule/spine in each submedial angle of transverse suture (Figs. 43–48); pronotum with paired spines in anterior 1/2 each strongly bifurcate, bifurcation progressively moving from subbasally to subapically in later instars (Figs. 43–48); profemora with yellowish white to yellowish brown annulation in distal 1/3 (fainter in lighter individuals) (Figs. 13–15, 43, 45, 47); pro-

femora ≈1.70 mm in length or longer; head ≈0.59 mm in width or wider; body ≈4.20 mm in length or longer 13

13. Wing pads of mesonotum weakly developed, those of metanotum weakly developed to not evident (Figs. 43 and 44); profemora ≈1.70–2.20 mm in length; head ≈0.59–0.67 mm in width; body ≈4.20–5.00 mm in length . . . . . third instar

13′. Wing pads well developed (Figs. 45–48); profemora ≈2.30 mm in length or longer; head ≈0.74 mm in width or wider; body ≈5.50 mm in length or longer 14

14. Wing pads overlapping abdominal terga 1 and 2 (Figs. 45 and 46); profemora ≈2.30–2.60 mm in length; head ≈0.74–0.85 mm in width; body ≈5.50–7.00 mm in length; terminalia often not clearly sexually dimorphic. . . . . fourth instar

14′. Wing pads overlapping abdominal terga 3 and 4 (Figs. 47 and 48); profemora ≈2.80–3.40 mm in length; head ≈0.92–1.07 mm in width; body ≈7.50–9.50 mm in length; terminalia clearly sexually dimorphic (Figs. 53–56) . . . . . fifth instar

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