

New Species and Previously Undescribed Larvae of North American Ephemeroptera¹

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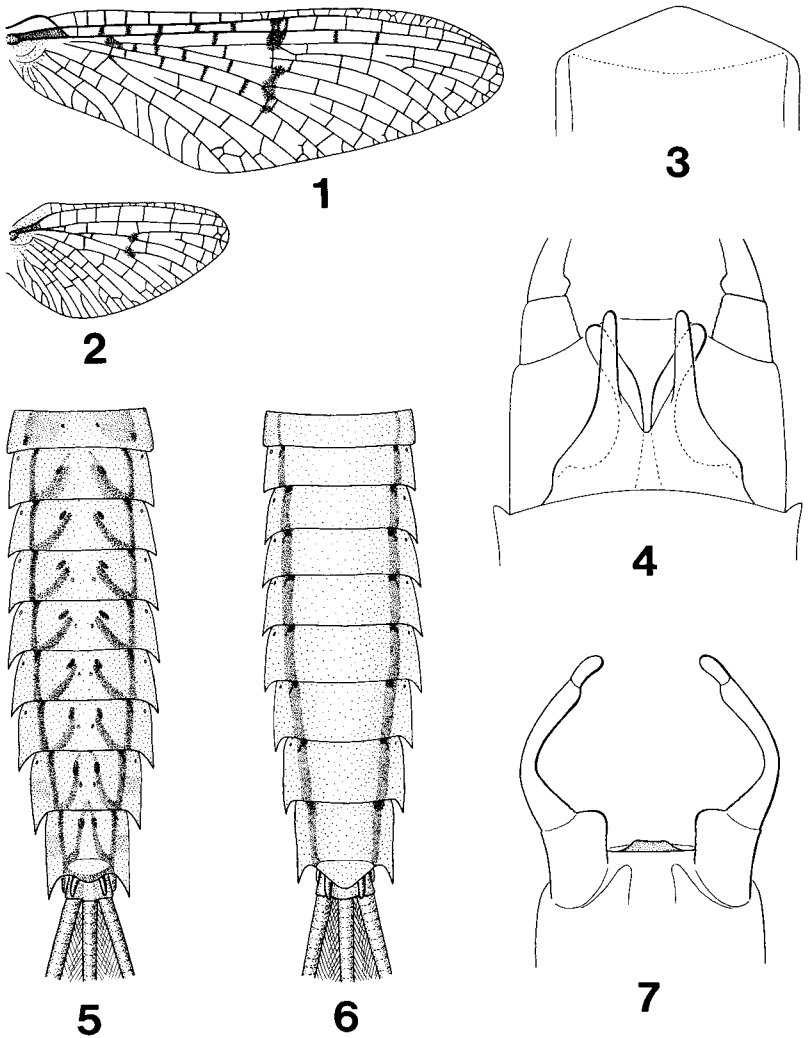
ABSTRACT: Adults and larvae of *Siphonurus minnoi* sp. n. and *Pseudocloeon cestum* sp. n. are described, and the larvae of *Siphonurus typicus* (Eaton) and *Isonychia sicca* (Walsh) are described for the first time. Distributional and habitat information for the species are included.

Recent field studies and rearing experiments carried out in Indiana and other states have lead to the discovery of new species and previously unknown larvae of mayflies. Herein we describe adult and larval stages of new species of *Siphonurus* (Siphonuridae) and *Pseudocloeon* (Baetidae), and give the first larval descriptions of *Siphonurus typicus* (Eaton) and *Isonychia sicca* (Walsh) (Oligoneuriidae).

Siphonurus minnoi new species (Figs. 1-5)

ADULT MALE: Length of body 13-14 mm, fore wing 11.5-12 mm. Head pale except for dark reddish-brown transverse band on frontal shelf immediately below eyes; base of ocelli dark reddish-brown; antennal scape and flagellum light brown. Thorax with pronotum dark brown, bordered with white laterally; mesonotum and metanotum yellow-brown; thoracic pleura and coxae marked with highly contrasting areas of dark reddish-brown, yellow-brown, and white. Fore legs light brown; middle and hind legs pale; all tarsal joints dark brown. Fore wings (Fig. 1) hyaline except basal membrane area between Sc and R₁ dark brown, two large dark brown spots in bullar region and crossveins basad of bullar region bordered with dark brown shading; all veins dark brown; stigmatic crossveins partially anastomosed. Hind wings (Fig. 2) hyaline except two dark brown spots in radial sector (sometimes fused to form a single spot); all veins dark brown. Abdomen dorsally with segments 1-7 light brown with paired dark brown submedian spots near middle of segments and lateral dark brown triangular patches in distal half of segments (the submedian spots and lateral triangles frequently coalesce); lateral borders of segments 8 and 9 white in anterior

¹ Purdue University Agricultural Experiment Station Journal Series No. 8493.
Received for publication 13 April 1981.



Figs. 1-7. 1-5. *Siphonurus minnoi*—1, fore wing, 2, hind wing, 3, ♀ subanal plate, 4, ♂ genitalia, dorsal, 5, larval abdomen, ventral. 6. *S. typicus* larval abdomen, ventral, 7. *Pseudocloeon cestum* ♂ genitalia, ventral.

half and light brown in posterior half; segment 10 white except for light brown median stripe. Ventral abdomen pale with dark reddish-brown markings as follows: segment 1 with broad inverted U-shaped mark covering entire anterior half of segment; segment 2 with broad inverted U-shaped mark covering all of anterior half of segment except anterolateral corners;

segments 3–6 with long, narrow, oblique dashes (occasionally extended and joined anteriorly to form complete inverted “V”) and with pale yellow-brown spot anterolateral of oblique dashes; segments 7 and 8 with marks forming complete, narrow, inverted “U” and with paired submedian pale yellow-brown spots more evident than on preceding segments; segment 9 pale yellow medially and with two broad longitudinal dark brown stripes. Genitalia (Fig. 4) mostly tan; penes simple, lacking any spination, dorsal lobes subparallel, ventral lobes curved outward. Cerci light brown basally, becoming paler distally, all segments banded with dark brown in basal third.

ADULT FEMALE: Length of body 13.5–14.5 mm, fore wings 12–13 mm. Markings similar to male with the following exceptions: dorsally, abdominal segments paler tan, and dark submedian spots and posterolateral triangles more distinct; ventrally, abdominal segment 7 with dark marks forming a broad inverted “U,” segment 8 with two parallel longitudinal stripes, and segment 9 with oblique dashes joined to form an inverted “V”; apex of subanal plate (Fig. 3) broadly triangular, sides straight and tip bluntly pointed.

LARVA: Length of body 11–13 mm, caudal filaments 5–7 mm. Head, thorax, and dorsal abdomen generally mottled brown on pale yellow ground color. Legs generally pale; femora with brown bands at base and slightly distad of middle; tibiae with brown band at base; tarsi with brown bands at base and apex. Abdominal trachea black and conspicuous. Gills double on segments 1 and 2 only. Ventrally, abdominal segments (Fig. 5) pale yellow with submedian brown spots and oblique dashes similar to adult pattern, and longitudinal brown stripes extending length of abdomen near base of lateral expansions (frequently reduced to short dashes in immature specimens and some females). Caudal filaments with brown bands slightly distad of middle and at apex.

HOLOTYPE: Adult ♂ (reared)—Indiana: Perry Co., Poison Cr., ca. 5 mi NW of Derby, IV-24-1976, A. V. Provonsha and M. Minno, deposited in Entomological Research Collection, Purdue University (PU).

PARATYPES: 5 adult ♂♂, 23 adult ♀♀ (reared with associated cast larval skins) and 10 larvae—same data as holotype (except 13 ♀♀ collected V-15-1975); 1 adult ♂, 1 adult ♀, 1 larva—same data as holotype, deposited in United States National Museum; 3 adult ♂♂, 9 adult ♀♀—Missouri: Christian Co., Finley R., W. Linden, IV-13-1979, D. M. Sullivan, deposited in Southwest Missouri State University collection (SMSU); 22 adult ♂♂, 15 adult ♀♀, same data as previous except collected V-9-1980 (3 ♂♂ and 3 ♀♀ deposited PU, 5 ♂♂ and ♀♀ deposited in University of Utah Collection (UU), 14 ♂♂ and 7 ♀♀ deposited SMSU); 1 adult ♂, 5 larvae—MO: Texas Co., Big Piney R. nr Houston, V-17-1980, D. M. Sullivan, deposited SMSU; 2 adult ♂♂, 2 adult ♀♀ (reared), 31 larvae—MO: Christian Co., Finley R.,

ject county rd. NM, ca. 5 mi SW Seymore, V-28-1980, D. M. Sullivan (adults and 17 larvae deposited SMSU, 4 larvae deposited PU, 10 larvae deposited UU; 1 adult ♂, 1 adult ♀—same data as previous (except collected VI-5-1980), deposited SMSU.

The adults of *S. minnoi* resemble those of the western species *S. spectabilis* Traver, which also possess oblique dashes or complete U-shaped marks on the ventral abdomen, banded cerci, and dark shading on the wings. In *S. spectabilis*, however, there is a single brown pigmented area in the bullar region of the fore wings, the hind wings of the male are completely shaded with orange or amber, the male genitalia are significantly different (see Traver, 1934), and the female subanal plate extends to a long point rather than a short, bluntly triangular one as in *S. minnoi*. *Siphonurus marshalli* Traver also possesses shading in the fore wings, but the hind wings are tinged with amber or coffee-brown and lack any spot in the radial sector; also the abdominal segments lack prominent U-shaped marks ventrally. The head and thorax of both *S. spectabilis* and *S. marshalli* are mostly dark brown as opposed to the yellow-brown of *S. minnoi*. Several other species of *Siphonurus* possess oblique dashes or U-shaped markings ventrally on the abdomen, but they lack the dark spots on the fore and hind wings.

The combination of longitudinal lateral stripes and oblique dashes on the ventral abdomen will distinguish *S. minnoi* larvae from the other known *Siphonurus* larvae that also have double gills only on abdominal segments 1 and 2 and dark bands at the midlength of the caudal filaments. Female and immature larvae that lack distinct ventral markings may be difficult to distinguish from other species of *Siphonurus*.

Poison Creek, the type locality, is a small, rocky-bottomed, spring-fed stream in the unglaciated area of southern Indiana. All larvae were taken from pools containing dense layers of leaf detritus.

Siphonurus typicus (Eaton)

(Fig. 6)

LARVA: Length of body 13–14 mm, caudal filaments 6–7 mm. Head, thorax, and dorsal abdomen generally mottled brown on pale yellow ground color. Legs pale; femora with brown spot at base and broad preapical band; base of tibiae and tarsi marked with brown. Gills double on abdominal segments 1 and 2 only. Ventrally, abdominal segments (Fig. 6) with longitudinal brown stripes near base of lateral expansions (indistinct on younger individuals and some females), and paired submedian spots occasionally present on posterior segments of females (spots on segments 8 and 9, when present, may be extended anteriorly as oblique pale brown dashes).

MATERIAL EXAMINED: 26 larvae, 29 larval cast skins from reared speci-

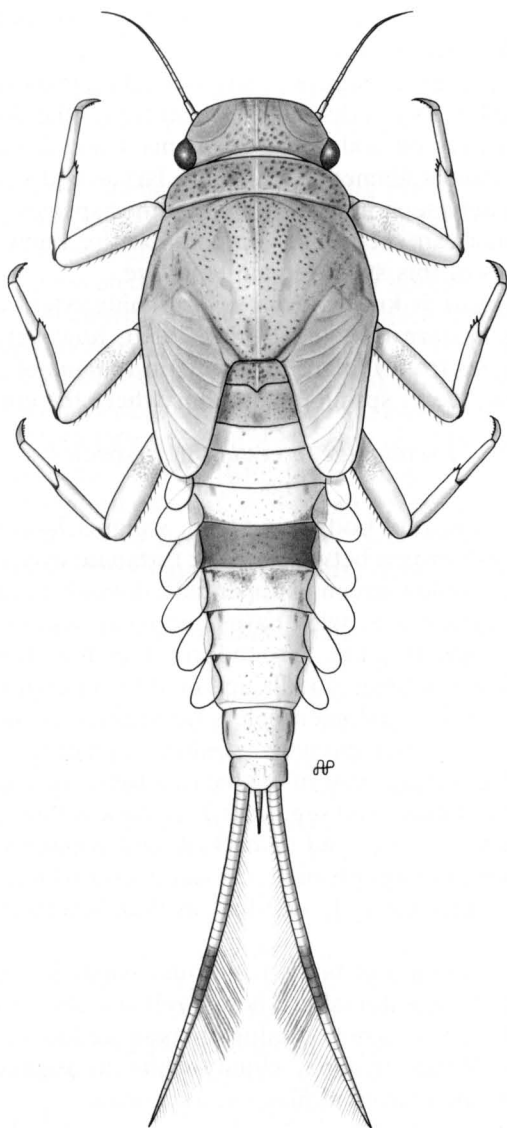


Fig. 8. *Pseudocloeon cestum* larva, dorsal.

mens—Indiana: Scott Co., small stream 1 mi E Blocher at St. rd. 56 and Co. rd. 1400W. V-18-1978, A. V. Provonsha and D. Bloodgood; 8 larvae—IN: Monroe Co., Bryant Cr., Morgan Monroe St. Forest. V-24-1978, M. Minno and D. Bloodgood; 18 larvae, Cushman, Massachusetts, May, 1952,

G. F. Edmunds, Jr. All specimens deposited in Entomological Research Collection, Purdue University.

The longitudinal stripes and lack of any submedial markings on the ventral abdomen of male larvae will distinguish them from other known larvae that have double gills only on abdominal segments 1 and 2 and banding at the midlength of the caudal filaments. Immature larvae and some female larvae cannot be adequately separated from many other species. Since only 10 of the 18 North American species of *Siphonurus* are known as larvae, comparative diagnoses of this stage remain tentative.

Siphonurus typicus is known from several midwestern and northeastern states as well as eastern Canada (Burks, 1953); however, this is the first report of the species from Indiana. Habitats in Indiana of *S. typicus* larvae are small, shallow, clear, spring-fed streams where the current is slow.

Pseudocloeon cestum new species
(Figs. 7, 8)

ADULT MALE: Length of body 4–4.5 mm, wings 3.7–4 mm. Head mostly dark brown, reddish-brown between ocelli; turbinate eyes reddish-brown in basal half of stock, yellow-green in upper half, dorsally reddish-brown. Thorax dark brown, lighter near wing bases and most sutures. Wings hyaline, cloudy-white in stigmatic area. Ground color of legs white; fore femora entirely with diffuse red tinge; middle and hind femora with diffuse red tinge in distal third. Dorsally, abdomen pale with segment 1 tinged with diffuse red, segments 2–4 with red spiracular dashes, segments 3 and 4 with large diffuse red blotch covering most of medial two-thirds of segments, segments 5 and 6 with faint red tinge, and segments 7–10 dark yellow-ocher. Ventrally, abdominal segments 1–6 pale and unmarked, and segments 7–9 white. Genitalia (Fig. 7) white, forceps strongly curved. Cerci white, vestigial median terminal filament approximately one-half median length of abdominal segment 10.

ADULT FEMALE: Length of body 3.5–4 mm, wings 3.5–4 mm. Head pale with diffuse reddish tinge dorsally. Thorax yellow-ocher. Legs pale; femora tinged with pale yellow-ocher. Abdomen pale yellow-ocher and lacking darker markings. Wings hyaline, cloudy-white in stigmatic areas. Cerci white, vestigial median terminal filament as in male.

LARVA (Fig. 8): Length of body 3.5–4.5 mm, cerci 1.7–2.1 mm. Antennae relatively short, approximately as long as length of head. Head and dorsal thorax yellow-ocher to light brown, frequently marked with diffuse red and brown speckling; thorax pale ventrally. Legs pale; femora with faint reddish-brown band near middle, small black spot at base, and row of short setae on dorsal (outside) edge; tibiae and tarsi with small black spot at base. Abdominal segment 5 uniformly dark brown dorsally and ventrally; all other segments pale, paired submedial brown spots dorsally on segments 2–9; brown or reddish-brown speckles usually present on most abdominal seg-

ments dorsally, most conspicuous on segment 6 (speckles occasionally found ventrally, especially on segments 4, 8, and 9 of female larvae). Gills lack apparent tracheation. Cerci pale with dark band slightly beyond middle. Vestigial median filament as long as median length of abdominal segment 10.

HOLOTYPE: Larva—Indiana: Benton Co., Big Pine Cr. 4 mi E Atkinson, VIII-5-1976, M. Minno and B. Bacon, deposited in Entomological Research Collection, Purdue University.

PARATYPES: (All deposited at PU except when noted) 3 adult ♂♂, 4 adult ♀♀ (reared with associated cast larval skins) and 8 larvae—same data as holotype; 6 larvae—Indiana: Benton Co., Mud Cr. at St. rd. 71, 2.5 mi N Freeland Park, V-25-1976, A. V. Provonsha and M. Minno; 2 adult ♂♂, 3 adult ♀♀ (reared with associated cast larval skins)—same data as previous except collected VII-14-1976; 1 adult ♂, 1 adult ♀, 2 larvae—same data as previous except collected VIII-4-1976; 2 subimago ♂♂, 2 subimago ♀♀ (reared with associated larval cast skins) and 15 larvae—IN: Union Co., East Fork White Water R. at Brownsville, V-15-1974, A. V. Provonsha and L. Dersch; 3 larvae—same data as previous, deposited in United States National Museum.

OTHER MATERIAL EXAMINED: 1 larva—Indiana: Benton Co., Sugar Cr. 7 mi E Milford, Illinois, VII-12-1961, C. Moye; 6 larvae—IN: Benton Co., Sugar Cr. at State Line rd. ca. 3 mi NW Freeland Park, V-25-1976, A. V. Provonsha and M. Minno; 1 larva—IN: Bartholomew Co., Haw Cr. at Rocky Ford rd., Columbus, VI-15-1978, M. Minno and J. H. Hollis; 1 larva—IN: Brown Co, Bean Blossom Cr. 1 mi S Bean Blossom, VI-19-1972, W. P. McCafferty et al. 1 larva—IN: Fayette Co., Williams Cr. at St. rd. 121, .5 mi N Nultown, V-15-1974, A. V. Provonsha and L. Dersch; 4 larvae—IN: Fountain Co., East Fork Coal Cr. at U.S. Hwy 41, 13 mi S Attica, VI-1-1973, W. P. McCafferty and A. V. Provonsha; 1 larva—IN: Hendricks Co., Mill Cr., U.S. Hwy 40 at Stilesville, VII-27-1978, A. V. Provonsha and D. Bloodgood; 1 subimago ♀ (reared with associated larval cast skin) and 5 larvae—IN: Hendricks Co., White Lick Cr. at Magnetic Springs, VII-27-1978, A. V. Provonsha and D. Bloodgood; 1 larva—IN: Tippecanoe Co., Wabash R. at W. Lafayette, V-22-1980, A. V. Provonsha et al.; 1 adult ♀ (reared with associated larval cast skin) and 3 larvae—IN: Tippecanoe Co., Little Wea Cr. at Foresman Hull Mill, W. Eli Lilly, VI-14-1978, M. Minno et al.; 17 larvae—Illinois: Vermillion Co., Sugar Cr. at State Line rd. ca. 3 mi NW Freeland Park, Indiana, V-25-1978, M. Minno and D. Bloodgood; 1 larva—Arkansas: Montgomery Co., Ouachita R. at Rocky Shoals Boat Camp at U.S. Hwy 270, VI-1-1974, W. P. McCafferty et al.

Moriwara and McCafferty (1979) indicated that North American *Pseudocloeon* were most likely derived monophyletically from the *lapponicus* group of the genus *Baetis*. Although some authors (e.g., Keffermüller, 1979) would choose to no longer recognize *Pseudocloeon* as a valid genus because

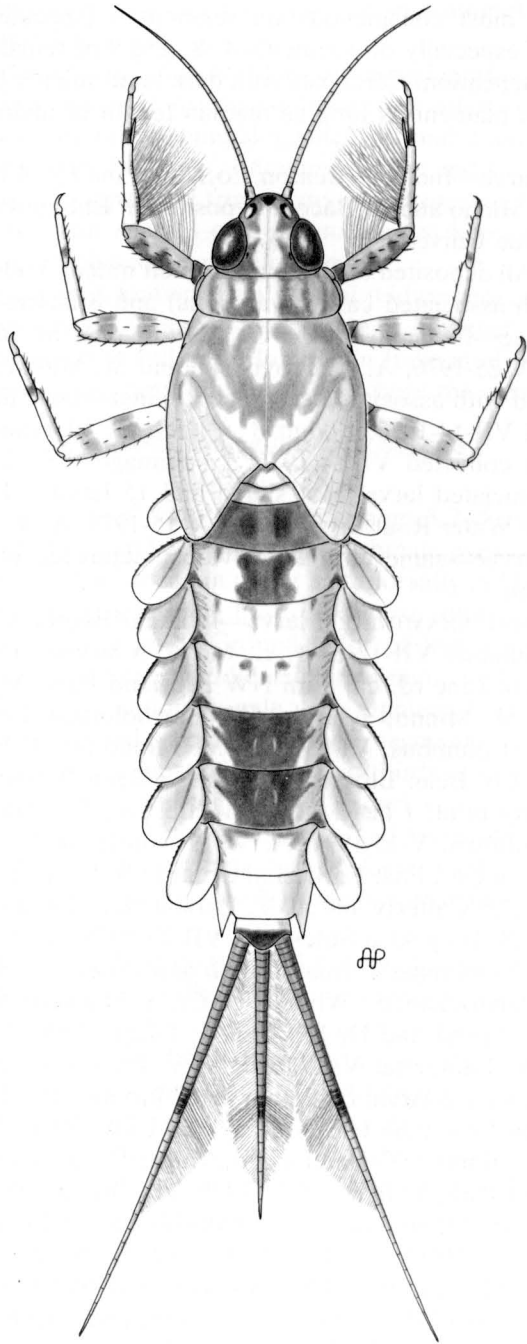


Fig. 9. *Isonychia sicca* larva, dorsal.

of apparent polyphyly in other parts of the world, we believe the distinction between *Baetis* and *Pseudocloeon* in North America remains practical. Possible future nomenclatural changes will depend on more specific phylogenetic information and on whether the species from Java, for which *Pseudocloeon* was established, is congeneric with the North American species (Edmunds et al., 1976).

The adult males of many *Pseudocloeon* species possess some red markings on the abdomen, usually in the form of small, paired, submedian spots or lateral blotches. In *P. cestum* males, the large red blotch that covers most of dorsal abdominal segments 3 and 4 and that extends as shading on segments 5 and 6 distinguishes this species from other *Pseudocloeon*. No characters were found that adequately separate the females of *P. cestum* from all other *Pseudocloeon* females.

Among known North American *Pseudocloeon* larvae, the speckled appearance of the head and thorax and the uniformly brown band completely encircling abdominal segment 5 on an otherwise basically pale abdomen will distinguish *P. cestum*. Also, the cerci of *P. cestum* larvae are much shorter than those of other *Pseudocloeon* we have examined, and the antennae are exceptionally short for baetid larvae in general.

Because larvae of *P. cestum* were commonly and abundantly encountered in collections from throughout Indiana, we had initially assumed they were of a known species. Rearing experiments proved otherwise. Larvae apparently have a somewhat restricted habitat, which may account for their being overlooked by some previous workers. All, including those from Illinois and Arkansas, were taken from fine pea gravel in shallow waters (3–35 cm) of small to moderate sized third and fourth order streams with slow to moderate currents.

Unfortunately, when adults of *Pseudocloeon* are placed in alcohol red markings soon disappear, making accurate identifications difficult if not impossible. This led Daggy (1945) to recommend that adults be pinned. This recommendation, however, is not followed by most workers, and most collections of adults are of little use for species comparisons. For this reason and because larvae of *P. cestum* are so distinctive, we have selected a mature larva as the holotype rather than one of the reared adult males. As pointed out by Edmunds and Allen (1966), this action is not only appropriate, but for many mayfly groups may be preferred since the larvae are longer lived, are more frequently encountered, and often possess more distinctive specific characters than adults. All adults of *P. cestum* in our possession were reared and placed in alcohol with their associated cast skins.

Isonychia sicca (Walsh)
(Fig. 9)

LARVA: Length of body 11–13.5 mm, caudal filaments 5–7 mm. General color light yellow-brown with darker brown markings as follows: Head

mostly medium brown with pale yellow median stripe. Pronotum mostly brown with pale median stripe, usually also with one or two submedian pale stripes. Thorax mottled brown with large pale anteromedian area, paired submedian pale spots anterior to mesoscutellum, mesoscutellar area pale. Legs pale with dark spot at apex of trochanter; femora with small spot at base, large band at middle and near apex; fore femora darker than middle and hind femora; fore tibiae usually lacking bands; middle and hind tibiae with indistinct band near middle; all tarsi with band in basal third; double row of short spines on basal half of tibiae and tarsi. Dorsally, abdomen with segment 1 variously pale or brown; segments 2, 6, and 7 mostly chestnut brown, darker brown medially, lateral borders pale; segment 3 chestnut brown in median third, dark brown near midline, pale laterally; segments 4, 5, 8, and 9 mostly pale yellow-brown; segment 10 brown in posterior half; pale median stripe usually apparent on most segments. Gills with cloudy purplish blotch. Ventrally, abdomen pale with paired lateral brown spots usually present on all segments but most distinct on posterior segments. Tails dark brown at base, light brown or yellow-brown distally and with narrow brown band near middle.

MATERIAL EXAMINED: 36 larvae, 2 larval cast skins from reared specimens—Indiana; Posey Co., Wabash R. at Old Dam nr New Harmony, VIII-12-1974, A. V. Provonsha, L. Dersch; 10 larvae—IN: Posey Co., Wabash R. at New Harmony, VI-24-1980, W. P. McCafferty et al.; 5 larvae—IN: Gibson Co., White R. at Cunningham's Ferry, 5 mi NW Patoka, VII-11-1973, W. P. McCafferty and A. V. Provonsha; 19 larvae—same data as previous except collected VII-20-1977; 9 larvae—IN: Martin Co., E. Fork White R. at Hindostan Falls Pub. Fish. Site, VI-20, 21-1974, A. V. Provonsha and L. Dersch; 17 larvae—IN: Martin Co., E. Fork White R. at Shoals, VII-2-1979, A. V. Provonsha and D. Bloodgood.

Very few larvae of *Isonychia* have been adequately described, and workers have generally found it difficult to specifically characterize larvae that are known. Three subspecies of *I. sicca* are currently recognized in North America. The larvae described herein are assignable to *I. sicca sicca*. Larvae in our possession, believed to be those of *I. sicca campestris* McDunnough from the Green River, Sweetwater Co., Wyoming, have markings more typical of other known *Isonychia* larvae. If this association is correct, it raises some question as to the validity of the subspecific ranking of *I. s. campestris*. We do not know if subspecific differences exist for *I. sicca manca* Eaton.

To our knowledge no description of the larva of *I. sicca* has been published prior to this time. Interestingly, however, three larval figures (lateral whole views in pen and ink) labeled *Chirotenetes siccus* (Fig. 72 in Needham, 1920), *I. sicca* (Plate 36, c in Needham et al., 1935), and *I. sicca* (Fig. 254 in Burks, 1953) have been published. No written description or authen-

tication, however, are included in any of these publications. The drawings in Needham (1920) and Needham et al. (1935) are the same, and the figure in Burks (1953) appears to have been redrawn from the former. Moreover, all of these figures lack any indication of the rather distinctive markings described herein; it remains doubtful if they were drawn from true *I. sicca* larvae.

Many larval structural and color characters are intraspecifically variable for the *Isonychia* species we have examined, making it difficult to find consistent characters of taxonomic value. Nevertheless, the abdominal color pattern of *I. sicca*, although somewhat variable, is distinctive enough to separate it from other known *Isonychia* larvae. The straight apical spur of the fore tibiae and the double row of short spines on the middle and hind tibiae and tarsi may also prove to be of some diagnostic value.

All *I. sicca* larvae taken in Indiana are from large rivers and were taken on rocky substrates with moderate to fast currents. They have often been taken in association with the larvae of *I. bicolor*.

Acknowledgments

We thank Steven L. Jensen for providing us with the Missouri specimens of *S. minnoi* and George F. Edmunds, Jr. for the Massachusetts specimens of *S. typicus*.

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