



A new species of *Stenopsyche*, with descriptions of larvae and females of some species associated by gene sequences (Insecta: Trichoptera)

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Abstract

Twenty-seven individuals of *Stenopsyche* from An-hui, Shan-xi and Si-chuan provinces, China, were examined and their DNA (mtCOI) sequences were extracted and analyzed. The larva, male, and female of a new species, *S. huangshanensis* sp. nov., associated by mtCOI gene sequences, are described and illustrated. Larvae and adult females of 3 known species, *S. angustata* Martynov 1930, *S. navasi* Ulmer 1926, and *S. tienmushanensis* Hwang 1957, were successfully associated with their identifiable males; the larvae and females of *S. navasi* and *S. tienmushanensis* were described and illustrated for the first time, and the larva and female of *S. angustata* were re-described and re-illustrated. DNA from identifiable males of *Stenopsyche lotus* Weaver 1987 was also sequenced, but the larva and female of this species remain unknown. An unknown larva, not associated with an identifiable adult, was described and illustrated as *Stenopsyche* sp. 1. All the sequences were uploaded to GenBank. All specimens are deposited in the Insect Collection of Nanjing Agricultural University, Nanjing.

Key words: DNA, larval-adult association, Stenopsychidae, China

Introduction

Stenopsyche is the largest genus of Stenopsychidae, with 93 extant species and 1 fossil species. They are distributed mainly in the Oriental and East Palearctic Biogeographic Regions, with only 1 species occurring in the Afrotropical Region (Marlier 1950; Holzenthal *et al.* 2007, 2011; Morse 2015). Compared to the abundant known species described mainly from male genitalia, only a few females and larvae are distinguishable.

Stenopsyche maxima Martynov 1926, *S. cinerea* Navás 1930, *S. tibetana* Navás 1932, *S. chagyaba* Tian 1985, and *S. huangi* Tian 1985 were originally described based on females. The females of *S. apiguna* Schmid 1969 and *S. kodaikanalensis* Swegman & Coffman 1980 were figured and described in detail with their males in the original descriptions. Ismail *et al.* (1993) described the female of *S. siamensis* Martynov 1931. Hoang & Bae (2007) distinguished females of 4 *Stenopsyche* species that occurred in Vietnam: *S. angustata* Martynov 1930, *S. dakpri* Hoang & Bae 2007, *S. siamensis*, and *S. ulmeri* Navás 1932. Females of *S. griseipennis* McLachlan 1866, *S. pallidipennis* Martynov 1926, and *S. khasia* Kimmins 1958 were illustrated and described by Kimmins, (1958); those of *S. variabilis* Kimanski 1992, *S. marmorata* Navás 1920, and *S. coreana* (Kuwayama 1930) by Kumanski (1992); and those of *S. marmorata* and *S. pallens* Nozaki, Arefina & Hayashi 2008 by Nozaki *et al.* (2008). Many other authors listed females as allotypes when publishing new species, but they did not provide useful diagnostic characteristics for identifying females. In summary, to date, females of a total of 18 *Stenopsyche* species have been described.

Stenopsyche larvae also have been poorly studied. Larvae of only 9 species of *Stenopsyche* have been described, including *S. marmorata* (as *Stenopsyche griseipennis* McLachlan 1866) and *S. bergeri* Martynov 1926 by Lepneva (1964); *S. siamensis* by Ismail *et al.* (1996); *S. schmidi* Weaver 1987, *S. marmorata*, and *S. sauteri* (Ulmer 1907) by Kawai & Tanida (2005); *S. angustata*, *S. dakpri*, *S. ulmeri*, and 2 unknown species by Hoang & Bae (2007); *S. marmorata* (as *S. griseipennis*) and *S. sauteri* by Kawai (1950); *S. ochripennis* Albarda 1881 by Ulmer (1957); *S. angustata* by Dudgeon (1996); and *S. marmorata*, *S. sauteri*, and *S. schmidi* by Nozaki & Shimura (2015).

In this article, we describe 1 new species, *S. huangshanensis* sp. nov., with its larva and female; describe the female and larva of *S. navasi* Ulmer 1926, the female and larva of *S. tienmushanensis* Hwang 1957, and the larva of an unnamed *Stenopsyche* sp. 1; and re-describe the female and larva of *S. angustata*. These contributions bring to 94 the number of species of the genus, with females of 20 named species and larvae of 12 named species and 3 unnamed species described.

Material and methods

Sampling of specimens. A total of 38 specimens (16 males, 6 females and 16 larvae) were examined in this research. Twenty-seven individuals were used in barcoding sequences, including 12 adults (7 males and 5 females) and 15 larvae, collected from 2012 to 2013 in An-hui, Shan-xi and Si-chuan provinces, China (Table 1). Adult *Stenopsyche* were collected into 100% ethanol using pan traps with 15-w ultraviolet light bulbs. Larvae were collected using a D-frame aquatic net or by handpicking specimens off stones along the streams. Adult and larval specimens were then sorted and stored in 100% alcohol. Alcohol was changed 3 times for DNA sequencing within a week. All samples have been deposited in the Insect Collection, Nanjing Agricultural University.

Morphological study. Adults. For genitalia preparation, the male or female abdomen was cut from the body, as close to the basal region of the abdomen as possible. The separated abdomen with its terminal genitalia was cleared using a 10% solution of sodium hydroxide (NaOH) at 80°C temperature for about 20 minutes and then transferred into distilled water where the remaining NaOH was flushed. Then, the translucent abdomen was placed on a depression slide with 85% ethyl alcohol for examination. Genitalia structures were traced in pencil using a Nikon SMZ800 stereomicroscope equipped with a camera lucida. Original pencil drawings were scanned in Photoshop then placed as a template in Inkscape (Version 0.48) and inked digitally to produce illustrations. For each species, illustrations of male and female genitalia in lateral, dorsal, and ventral views were prepared.

Larvae. Larvae were examined with a Nikon SMZ800 microscope and sorted into morphospecies based on obvious morphological characters that have been used in caddisfly larval taxonomy, e.g., body size, width of the middle of the head capsule, shape, color patterns and spines. Character photos of larvae were taken using a Nikon Eclipse 80i microscope and Nis-Element D® software (Version 3.22.14). A series of photos at different focal distances were taken, then they were loaded into Zerene Stacker® (Version 1.02) and were stacked into an image with a greater depth of field. Plates were arranged using Adobe Photoshop®.

Terminology for male genitalia follows that of Weaver (1987), terminology for female genitalia follows that of Schmid (1969) and Nielsen (1980), and terminology for larvae follows that of Wiggins (1996).

DNA analysis. Right hind legs of 27 individuals (males, females, and larvae) were taken from bodies for DNA extractions. The extractions follow the animal tissue protocol of the DNeasy DNA extraction kit (Quiagen, Valencia, CA). Extracted DNA was then amplified for the 658 bp mtCOI region using polymerase chain reaction (PCR) with a 25µl reaction volume. This reaction was comprised of 14.7µl ddH₂O, 4µl 10×EasyTaq Buffer, 3µl dNTPs, 0.3µl EasyTaq 5U/µl, 1µl Primer 1, 1µl Primer 2, 1µl DNA. The PCR mix was preheated at 94°C for 3 min followed by 40 cycles of 94°C for 30 s, 53°C for 45 s, and 72°C for 60 s. After 10 min of final extension at 72°C, the products were maintained at 4°C (Zhou *et al.* 2007). The PCR primers are listed in Table 2. Each individual DNA fragment was sequenced from both directions. COI sequences were aligned using Sequencher 4.5 (Gene Codes Corporation, Ann Arbor, Michigan, USA). Phylograms were constructed independently from COI sequences using distance and neighbor-joining in Mega® 6.0. N-J parameters for phylograms as follows: Substitution Type: Nucleotide; Model/Method: Kimura 2-parameter model; Substitutions to include: Transitions + Transversions; Rates among Sites: Uniform rates; Gaps/Missing Data Treatment: Pairwise deletion.

Results

The phylogram constructed using Mega (Tamura *et al.* 2013) shows that 27 individuals have been divided into 6 groups; each group is a separate *Stenopsyche* species (Fig. 1). Thus, we successfully performed the life cycle associations (larvae, females, and males) of *S. angustata*, *S. huangshanensis* sp. nov., *S. navasi*, and *S. tienmushanensis*. We were unable to associate our male specimens of *S. lotus* with any female or larva. A larva of

an unknown *Stenopsyche* species was found (as *S. sp. 1*). The larvae and females of *S. navasi*, *S. tienmushanensis*, and *S. huangshanensis* **sp. nov.** are described and illustrated for the first time. A larva and female of *S. angustata* are re-described in detail and re-illustrated. A larva of *S. sp. 1* is described and illustrated for future associations. All molecular sequences were uploaded to GeneBank, with accession numbers as shown in Table 1.

TABLE 1. Specimens used in larva-female-male associations of *Stenopsyche* spp., with GenBank accession numbers for mtCOI sequences.

Sample ID	Species	Genbank accession (COI)	Life stage	Collection Site
LS000012	<i>S. angustata</i>	KM077456	Female	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000004	<i>S. angustata</i>	KM077457	Male	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000013	<i>S. angustata</i>	KM077458	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000014	<i>S. angustata</i>	KM077459	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000015	<i>S. angustata</i>	KM077460	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000016	<i>S. angustata</i>	KM077461	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000017	<i>S. angustata</i>	KM077462	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000018	<i>S. angustata</i>	KM077463	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000020	<i>S. angustata</i>	KM077464	Larva	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000031	<i>S. angustata</i>	KM077465	Larva	China, Shan-xi, Qin-shui County, Xia-chuan, Nv-ying Canyon
HS000013	<i>S. huangshanensis</i>	KM077466	Female	China, An-hui, Mt. Huang-shan, Tang-kou Town, Fu-xi Village, Long-tan Spring
HS000012	<i>S. huangshanensis</i>	KM077467	Male	China, An-hui, Mt. Huang-shan, Tang-kou Town, Fu-xi Village, Long-tan Spring
HS000018	<i>S. huangshanensis</i>	KM077468	Larva	China, An-hui, Mt. Huang-shan, Tang-kou Town, Fu-xi Village, Long-tan Spring
LS000025	<i>S. lotus</i>	KM077469	Male	China, Shan-xi, Qin-shui County, Xia-chuan, Nü-ying Canyon
LS000035	<i>S. lotus</i>	KM077470	Male	China, Shan-xi, Qin-shui County, Xia-chuan, Nü-ying Canyon
SC000050	<i>S. navasi</i>	KM077471	Female	China, Si-chuan, Mian-yang, Ping-wu County, Lao-he-gou, Da-pian-gou
SC000001	<i>S. navasi</i>	KM077472	Male	China, Si-chuan, Mian-yang, Ping-wu County, Lao-he-gou
SC000028	<i>S. navasi</i>	KM077473	Larva	China, Si-chuan, Mian-yang, Ping-wu County, Lao-he-gou, Xia-wa-fang
SC000029	<i>S. navasi</i>	KM077474	Larva	China, Si-chuan, Mian-yang, Ping-wu County, Lao-he-gou, Xia-wa-fang
JZ000007	<i>S. sp. 1</i>	KM077475	Larva	China, Si-chuan, Jiu-zhai-gou, Reed Sea
JZ000008	<i>S. sp. 1</i>	KM077476	Larva	China, Si-chuan, Jiu-zhai-gou, Reed Sea
JZ000009	<i>S. sp. 1</i>	KM077477	Larva	China, Si-chuan, Jiu-zhai-gou, Reed Sea
LS000002	<i>S. tienmushanensis</i>	KM077478	Female	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000005	<i>S. angustata</i>	KM077479	Male	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000009	<i>S. tienmushanensis</i>	KM077480	Female	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000008	<i>S. tienmushanensis</i>	KM077481	Male	China, Shan-xi, Yi-cheng County, Da-he Town, Da-he
LS000033	<i>S. tienmushanensis</i>	KM077482	Larva	China, Shan-xi, Qin-shui County, Xia-chuan, Nü-ying Canyon

TABLE 2. Polymerase chain reaction primers used to sequence mtCOI genes of *Stenopsyche* spp.

Primer	Sequence (5'to 3')	Reference
COI 1709Fs	TAATTGGAGGATTTGGAAATTG	Zhou <i>et al.</i> 2007
COI 2191R	CCYGGTAAAATTAATAAACTTC	Zhou <i>et al.</i> 2007
LCO1490	GGTCAACAAATCATAAAGATATTGG	Folmer <i>et al.</i> 1994
HCO2198	TAAACTTCAGGGTGACCAAAAATCA	Folmer <i>et al.</i> 1994

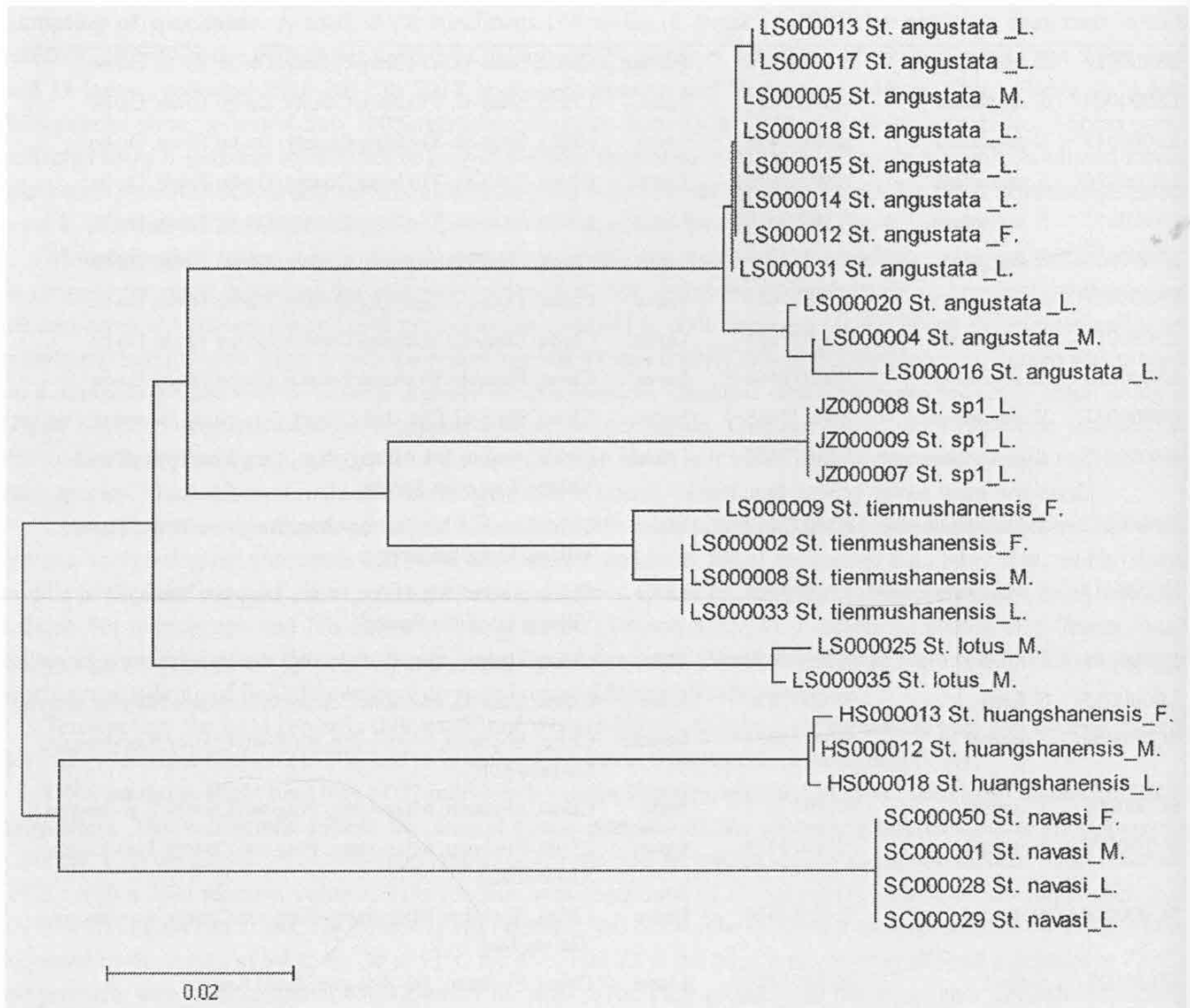


FIGURE 1. COI neighbor-joining diagram used to determine larval-female-male associations of Chinese *Stenopsyche* species.

***Stenopsyche huangshanensis* sp. nov.**

(Figs. 2–4)

Male. Body 22 mm. Length of each forewing 24 mm (n=1). Forewings light brown, each with many irregular light speckles in anterior part, and many long speckles in posterior part. Hind wings triangular and semi-transparent. *Male genitalia:* Abdominal segment IX annular; in lateral view ventral 1/3rd of pleuron IX strongly produced anterad and posterad with ventral margin long and dorsal margin short (transversely narrow in dorsal view), acute and curved anterad in lateral view; apicolateral angles digitate and curved slightly upward in lateral view, about half as long as preanal appendages. Preanal appendages elongate, setose, slightly sinuate and curved mesad in dorsal view. Segment X in dorsal view about 2/5ths as long as preanal appendages, each lateral margin with

incision near base, pair of subtriangular projections at mid-length with pair of small, barely noticeable, bristled processes on their posterior edges, apex with pair of divergent projections separated by concavity. Intermediate appendage small, button-like in dorsal view. Superior arms long, highly sclerotized, 3/5ths as long as preanal appendages, each with its distal 1/3rd curved outward in dorsal view and with apex obtuse; in lateral view distal 1/3rd curved downward. Inferior appendages subrectangular, about 3.6 times as long as wide and each with apex oblique in ventral view, longer mesally. Phallus with endothecal armature bearing many fine spines.

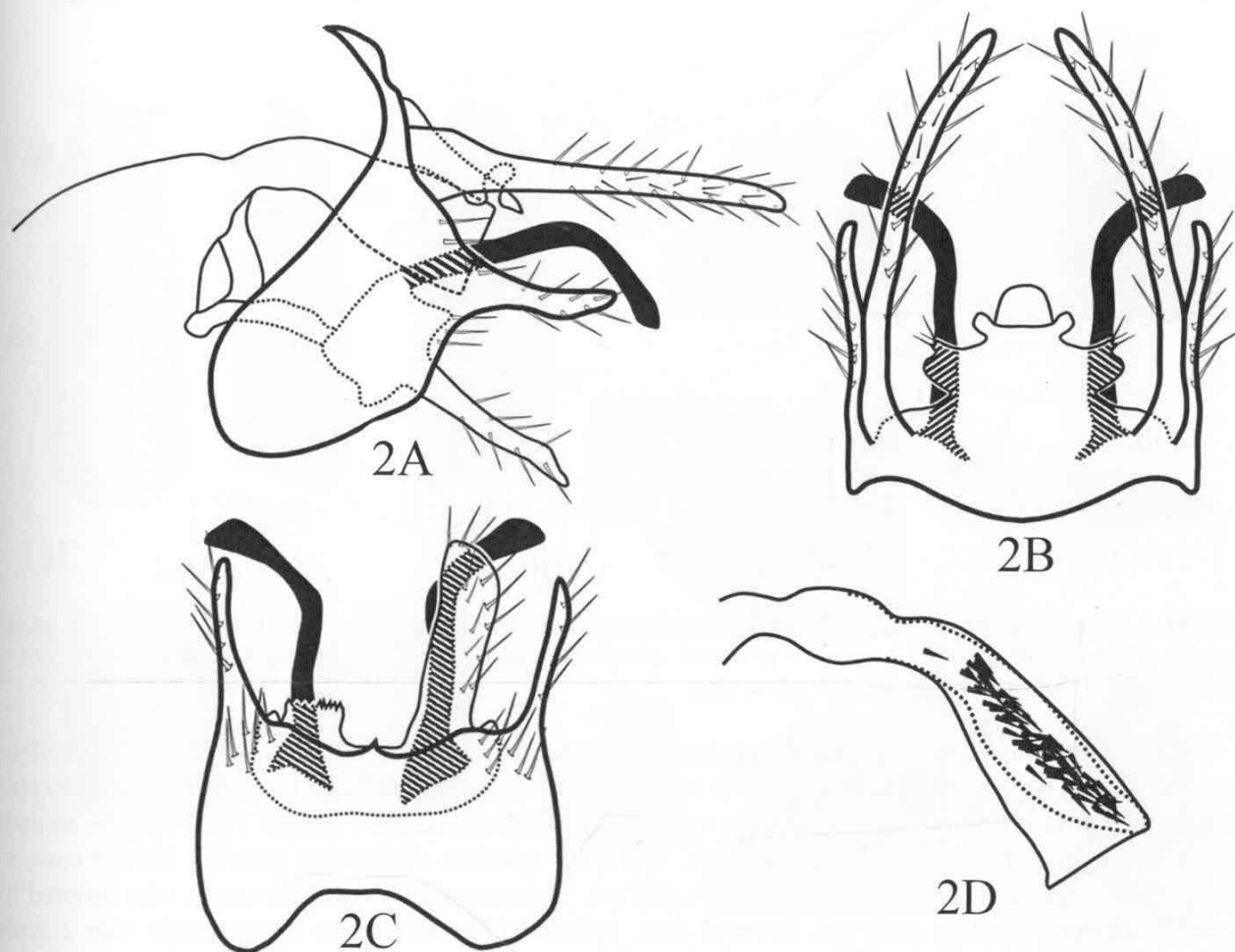


FIGURE 2. *Stenopsyche huangshanensis* sp. nov., male genitalia. 2A, left lateral; 2B, dorsal; 2C, ventral; 2D, phallus, left lateral.

Female. Length of each forewing 25 mm (n=1). Body yellowish brown. *Female genitalia:* Segment VIII in lateral view with sternum trapezoidal, setose ventrally and tergum oblique, trapezoidal; in dorsal view tergum subrectangular and in ventral view sternum with anterior margin slightly incised posteriorly and posterior margin bilobate. Segment IX sclerotized laterally, subrectangular in lateral view, membranous dorsally and ventrally, with transverse dorsal fold and with lateral apodemes extending internally anterad. Vulvar scale located ventrally, semicircular in lateral view, with posterolateral angle strongly setose; in ventral view with distal margin sinuate. Segment X membranous, with pair of setose longitudinal sclerites dorsolaterally oblong in dorsal view and bar-shaped in lateral view, another pair of setose longitudinal sclerites ventrolaterally about as long as dorsolateral sclerites; apex divided into pair of distal setose lobes, each bearing cercus. Cerci small, nipple-like. Processus spermathecae in lateral view irregular, posterior margin produced into small process.

Larva (5th instar). Body length 45 mm. Head and pronotum strongly sclerotized. *Head:* 6 mm long and 3 mm wide (n=2), in dorsal view subrectangular with basal and distal margins rounded. Ground color yellowish brown, with dark spots scattered over the whole head capsule, some of them connected to form short stripes. Eyes black, eye areas small, pale. Labrum stramineous, with pair of hair brushes at rounded anterior margin in dorsal view.

Clypeus yellow, but yellowish brown along anterior margin. Frontoclypeal apotome yellowish brown, with sparse dark dots and dark stripes. Mandibles dark brown, each with 4 apical teeth, only left mandible with mesal brush of stiff hairs. Mentum semicircular, posterior margin straight, apical margin with small tongue-shaped mesal process, each posterolateral angle with bristle. Anterior ventral apotome triangular, as broad as mentum, about 1/13th as long as ventral ecdysial line. Pair of #18 setae near posteroventral margin located posterior to base of ventral ecdysial line; distance from each seta to posteroventral margin shorter than distance of that seta to ventral ecdysial line ($d1:d2 = 1:1.6$).

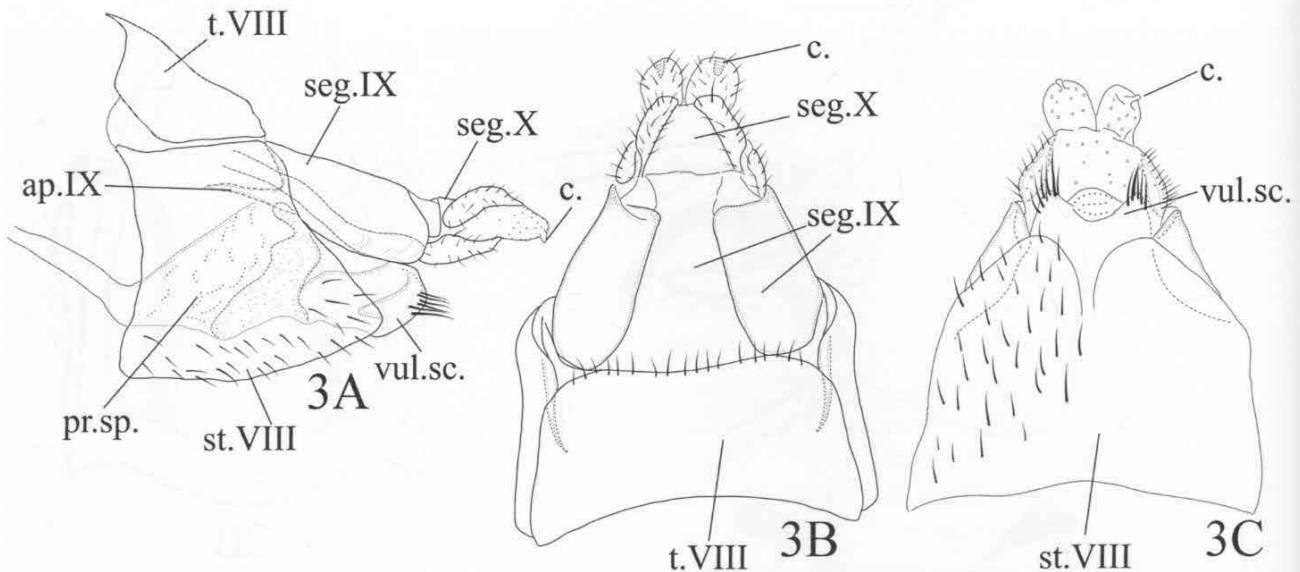


FIGURE 3. *Stenopsyche huangshanensis* sp. nov., female genitalia. 3A, left lateral; 3B, dorsal; 3C, ventral. ap.IX = lateral apodeme of segment IX; c. = cercus; pr.sp. = processus spermathecae; seg.IX = segment IX; seg.X = segment X; st.VIII = sternum VIII; t.VIII = tergum VIII; vul.sc. = vulvar scale.

Thorax: Pronotum heavily sclerotized, subrectangular in dorsal view, rounded ventrolaterally in lateral view, yellowish brown, dark spots on each side and in basal half near dorsal meson, large triangular dark spot located laterally just above episternum, anterior margin with scattered fine hairs and few bristles. Foretrochantin on each side in lateral view rhomboidal; episternum small, triangular; epimeron surrounding posterior base of coxa, in ventral view rectangular, with its anterior margin concave. Prosternum fused with pronotum, with inverted T-shaped black spot. Forelegs each with forecoxa short, cylindrical, in lateral view upper margin with 2 acute processes, basal process straight and with strong bristle at middle, distal process curved downwards; foretrochanter 2-jointed, basal joint short, distal one triangular; forefemur cylindrical, distal end thicker than base, with longitudinal carina from base to apex on outer side and longitudinal indentation on inner side; tibia slender, shorter than femur; tarsus slender, shorter than tibia, with row of hairs on inner side along lower margin; claw curved downward with small finger-like ventral process. Meso- and metanota membranous. Mesonotal setae arising in setal areas *sa1*, *sa2*, and *sa3*, each setal area with 1 seta. Mid- and hind legs nearly equal in length, same color patterns as foreleg, but coxae without teeth, each claw with small ventral process.

Abdomen: Almost uniformly broad, greenish grey in live specimens, brownish in alcohol, with scarce setae. Anal prolegs brown, stout, with few dark setae; claws hook-like.

Holotype male. CHINA, An-hui Province, Huang-shan County, Tang-kou Town, Fu-xi, 30°04'42"N, 118°09'00"E, alt. 614.3 m, 10 July 2013, by black light trap, Xu Ji-hua, Nie Chen-rui & Chen Dong-kai. Paratypes: Same data as holotype except alt. 639.0 m, 12 July 2013, 1 female, 3 larvae.

Diagnosis. The male genitalia of this new species are similar to those of *S. triangularis* Schmid 1959 from Shaan-xi, China, but differ from the latter in that (1) segment X has 2 pairs of processes (1 pair of processes in *S. triangularis*); (2) the superior arms are curved outward at an angle of 120° at 1/2 of the distance from the apex (the superior arms are curved outward at an angle of 80° at 1/3rd of the distance from the apex in *S. triangularis*). The female of the new species is similar to that of *S. angustata* in the genitalia, but differs from it in that (1) segments IX and X are visually separated by a fold (completely fused without a fold in *S. angustata*); (2) the dorsolateral

sclerites of segment X are about as long as the ventrolateral sclerites (the dorsolateral sclerites are longer than the ventrolateral sclerites in *S. angustata*); and (3) the processus spermathecae in lateral view has its posterior margin produced into a small process (the lower margin has a wide incision in *S. angustata*). The larva can be diagnosed from larvae of other *Stenopsyche* species by the distinctive punctate color pattern of the head, the curved distal process of each forecoxa, and the locations of the pair of #18 setae.

Etymology. The specific epithet is from the Chinese name of the type locality, Huang-shan County, An-hui Province.

Distributions. China (An-hui).

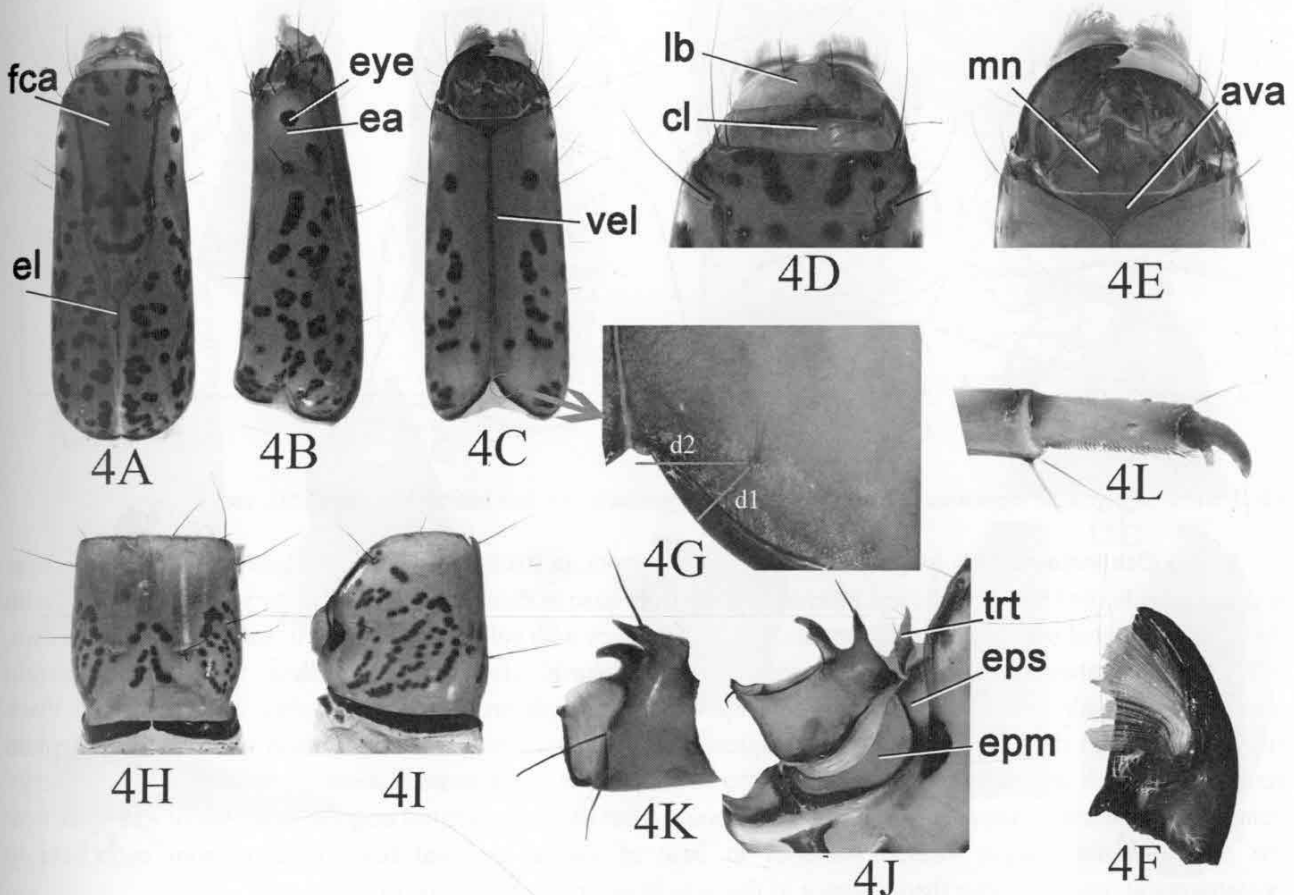


FIGURE 4. *Stenopsyche huangshanensis* sp. nov., larva. 4A–G, head: 4A, dorsal; 4B, left lateral; 4C, ventral; 4D, labrum and clypeus, dorsal; 4E, mandibles, mentum, and anterior ventral apotome, ventral; 4F, left mandible, ventral; 4G, pair of #18 setae, posteroventral. 4H–I, prothorax: 4H, dorsal; 4I, left lateral. 4J–L, foreleg and propleuron: 4J, left foretrochantin, episternum, and epimeron, left lateroventral; 4K, left forecoxa, left lateral; 4L, right tarsus and claw, right lateral.

***Stenopsyche angustata* Martynov 1930**

(Figs. 5–6)

Stenopsyche angustata Martynov 1930, 74–75, 109, textfigs. 15, 16; male; “W. China, Chin-Fu-San, 1909 (W.A. Maw)”; deposited in The Natural History Museum, London, United Kingdom. Larva and female described by Hoang & Bae 2007, 2–4, figs. 1a–h.

Male. Body length 17.6 mm. Length of each forewing 22.0 mm (n=5).

Female. Body length 20.0 mm. Length of each forewing 23 mm (n=2). Body yellowish brown. *Female genitalia*: Segment VIII in lateral view with tergum pentagonal and sternum trapezoidal; tergum in dorsal view somewhat bell-shaped, sternum in ventral view subrectangular, with posterior margin incised mesally. Segment IX slightly sclerotized, and somewhat fused with membranous segment X, in dorsal views segment IX widest at base

and then tapered, posterior margin rounded. Vulvar scale in ventral view rectangular, posterior margin produced distally into small process. Segment X membranous, with pair of setose longitudinal sclerites dorsolaterally semicircular in lateral view and triangular in dorsal view; another pair of setose longitudinal sclerites ventrolaterally triangular in lateral view, shorter than the dorsolateral sclerites; apex divided into pair of distal setose lobes, each bearing cercus. Cerci small, nipple-like. Processus spermathecae in lateral view irregular, posterolateral angle excised.

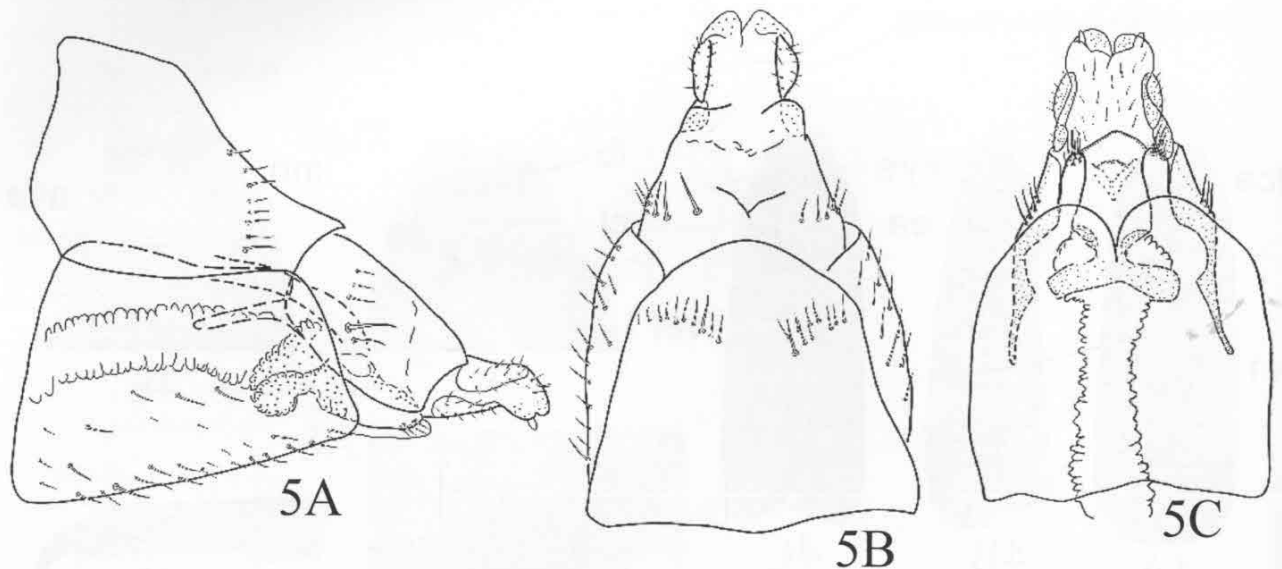


FIGURE 5. *Stenopsyche angustata* Martynov 1930, female genitalia. 5A, left lateral; 5B, dorsal; 5C, ventral.

Larva (5th instar). Body length 56 mm. Head and pronotum strongly sclerotized. *Head:* elongate, 6 mm long and 3 mm wide (n=8); in dorsal view tapered slightly from base to distal end. Ground color yellowish brown, with dark spots scattered over whole head capsule. Eyes black, each with yellow area around it. Labrum blackish brown, with 2 hair brushes at anterior membranous margin in dorsal view. Clypeus yellow, with anterior margin moderately smooth and round. Frontoclypeal apotome yellowish brown, with scattered black dots and black stripes. Mandibles dark brown, each with 4 apical teeth, left mandible with mesal brush of stiff hairs. Mentum semicircular, with anterior margin produced into small process, each posterolateral angle with bristle. Anterior ventral apotome triangular, as broad as mentum, about 1/10th as long as ventral ecdysial line. Pair of #18 setae near the posteroventral margin located posterior to base of ventral ecdysial line; distance from each seta to posteroventral margin shorter than distance of that seta to ventral ecdysial line ($d1:d2 = 1:2$).

Thorax: Pronotum strongly sclerotized, subrectangular in dorsal view, sinuate ventrolaterally in lateral view, ground color yellowish brown, with dark spots distributed in posterior half and lateral portions of pronotum and large black spot located just above insertion of each foreleg; anterior margin with scattered fine hairs and few bristles. Foretrochantins acute. Forelegs each having forecoxa with 2 small processes anteriorly, basal one straight, larger than apical one; apical tooth slightly curved; femur with 3 dark rings and black longitudinal stripe on outer side; tarsus with fringe hairs along lower margin from basal 1/3rd to apex; claw long and sharp, slightly curved downward with small finger-like ventral process. Mesonotum and metanotum membranous. Mesonotal setae arising in *sa1*, *sa2* and *sa3*, with 1 setae in each setal area. Mid- and hind legs nearly equal in length, same color patterns as forelegs, but coxae without teeth, each claw long and sharp, curved downward with small ventral process.

Abdomen: Almost uniformly broad, greenish grey in live specimens, brownish in alcohol, with scarce setae. Anal prolegs brown, stout, with few dark setae; claws hook-like.

Material examined. CHINA: Shan-xi Province, Yi-cheng County, Da-he Town, Da-he, alt. 1207.8 m, 35°27'14"N, 111°55'56"E, 13 Sept. 2013, light trap, collected by Sun Chang-hai, Xu Ji-hua & Wang Zi-wei; 5 males, 2 females. Same data except alt. 1180.8 m, 35°26'55"N, 111°55'56"E, 13 Sept. 2013, collected by Sun Chang-hai, Xu Ji-hua & Wang Zi-wei, 8 larvae.

Distribution. China (Fu-jian, Guang-dong, Gui-zhou, Guang-xi, Hong-kong, Hu-nan, Jiang-xi, Shaan-xi, Shan-xi, Si-chuan, Zhe-jiang), Vietnam.

Notes. The female genitalia of the species described in this article are slightly different from those of Vietnamese females (Hoang & Bae 2007). The vulvar scale of our females in ventral view has a posterior margin produced distally into a blunt process, but the vulvar scale of the Vietnamese female is incised distally. Larvae also show some variations in the color patterns of the frontoclypeal apotome and on the ventral surface of the head capsule.

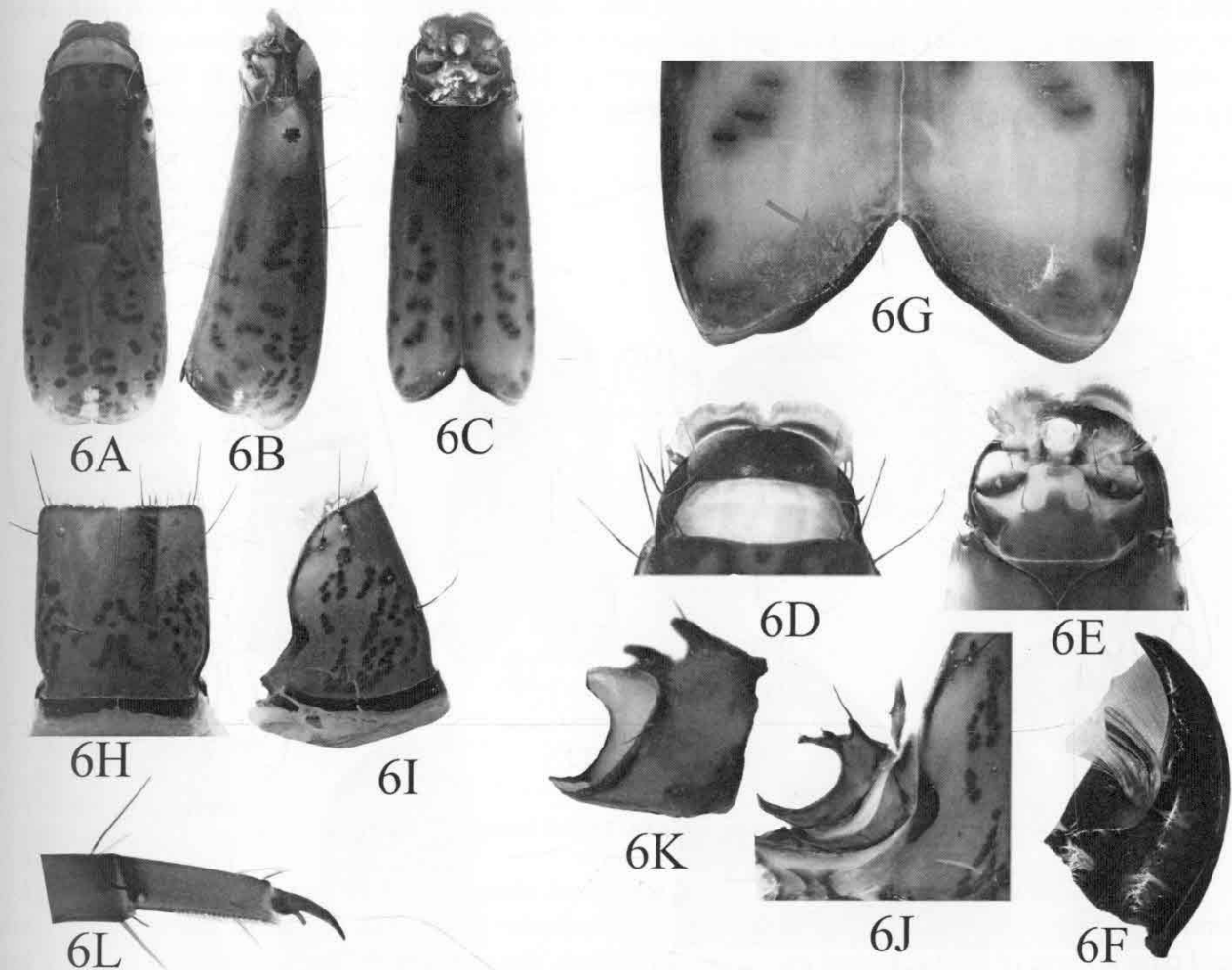


FIGURE 6. *Stenopsyche angustata* Martynov 1930, larva. 6A–F, head: 6A, dorsal; 6B, left lateral; 6C, ventral; 6D, labrum and clypeus, dorsal; 6E, mandibles, mentum, and anterior ventral apotome, ventral; 6F, left mandible, ventral, 6G, pair of #18 setae, posteroventral. 6H–I, prothorax: 6H, dorsal; 6I, left lateral. 6J–L, foreleg and propleuron: 6J, left foretrochantin, episternum and epimeron, left lateroventral; 6K, left forecoxa, left lateral; 6L, right tarsus and claw, right lateral.

***Stenopsyche navasi* Ulmer 1926**

(Figs. 7–8)

Stenopsyche navasi Ulmer 1926, 37–38, 41, textfigs. 22–23; male; “Tien Tsuen, China, von Herrn P. P. Longinos Navás 1907 erhalten. Heimat: China (Tient Tsuen [od. Tient Tschuen] in Schantung)”; deposited in the G. Ulmer collection (Zoological Museum Hamburg). Listed from China (Bei-jing, Hu-bei, Shan-xi, Si-chuan, Tian-jin, Tibet, Wu-nan, Yun-nan, Zhe-jiang) by Yang *et al.* 2005, 441–460.

Male. Body length 23.5 mm. Length of each forewing 26 mm (n=2). Forewings dark brown, each with many irregular light speckles in remigium, and light punctuation in vannal area. Hind wings triangular and semi-transparent.

Female. Length of each forewing 17 mm (n=1). Body yellowish brown. *Female genitalia:* Segment VIII strongly setose. Tergum IX subrectangular in lateral view and trapezoidal in dorsal view, fused with the basal

portion of segment X dorsally, separated lateroventrally. Vulvar scale rectangular, apex subtruncate in lateral view and rounded in ventral view. The basal portion of segment X sclerotized, ventrolateral margins produced into blunt triangular processes in lateral view, in dorsal view posterior margin straight; apical portion membranous, with a pair of oval sclerites dorsolaterally, apex divided into 2 pairs of lobes, each upper lobe in lateral view with apex bulging and slightly longer than lower one. Cerci oblong in lateral view, located between the upper and lower lobes, about as long as upper lobes. Processus spermathecae irregular, elongate, consisting of tube and trough in lateral view.

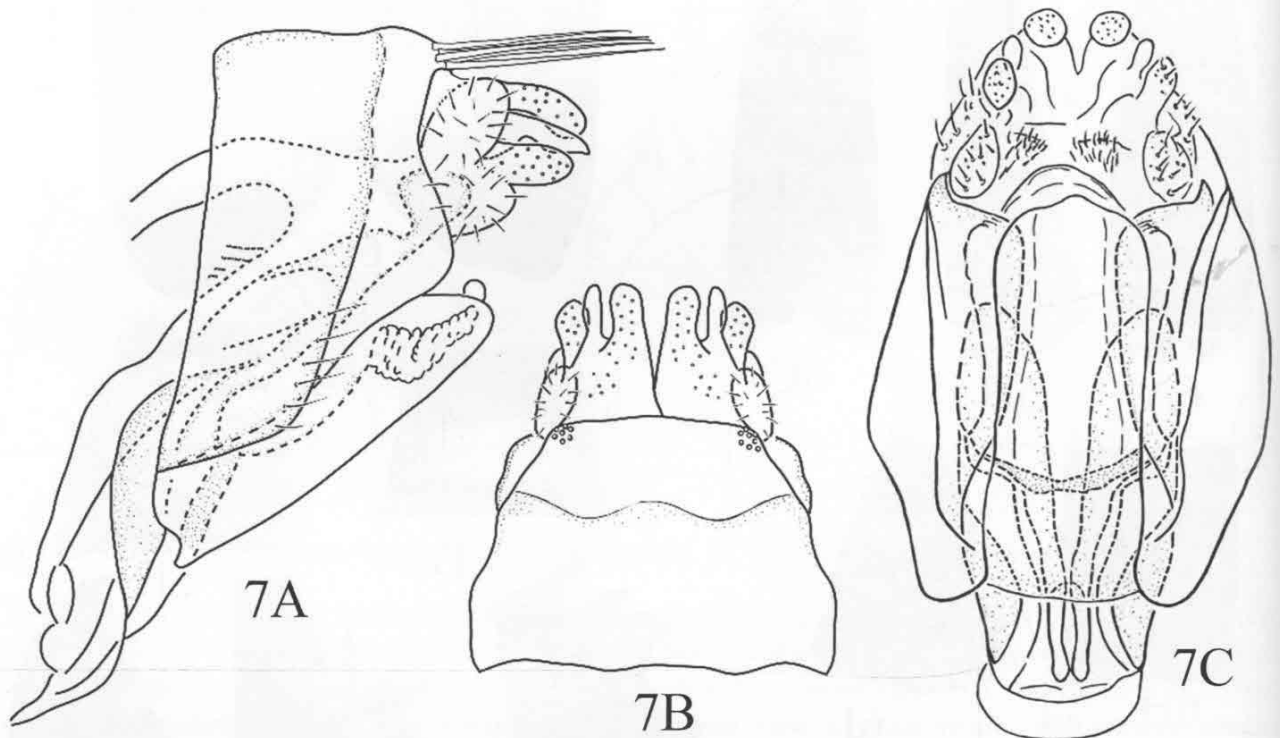


FIGURE 7. *Stenopsyche navasi* Ulmer 1926, female genitalia. 7A, left lateral; 7B, dorsal; 7C, ventral.

Larva (5th instar). Body length 44 mm. *Head:* sclerotized, elongate, 5.5 mm long and 1.5 mm wide (n=2), in dorsal view tapered slightly from base to distal end. Ground color brown, with black dots scattered over whole head capsule, some of them coalesced into stripes. Eyes black, eye areas yellow. Labrum light brown, with 2 hair brushes at anterior margin. Clypeus pale, with 3 paler longitudinal lines dividing clypeus into 4 subrectangular areas. Frontoclypeal apotome brown, with dark dots arranged closely in U-shaped line near margins; middle portion with scattered small dots. Lateral and ventral surfaces of head capsule brown, with scattered irregular short stripes composed of dark dots; ventrobasal area with pair of dark brown rounded areas at each side of ventral ecdysial line. Mandibles dark brown basally and black distally, each progressively narrower from base to apex in lateral view, apex with 4 apical teeth in ventral view, only left mandible with mesal brush of stiff hairs. Mentum semicircular, apex with tongue-like process, lateral margins each with seta. Anterior ventral apotome triangular, 1/8th as long as ventral ecdysial line. Pair of #18 setae near posteroventral margin with each seta located at center of dark brown circular spot and anterior to base of ventral ecdysial line; distance of each seta from posteroventral margin equal to distance of that setae to ventral ecdysial line ($d_1:d_2 = 1:1$).

Thorax: Pronotum strongly sclerotized, subrectangular in dorsal view, with sinuate ventrolateral margins in lateral view, yellowish brown, with -shaped pattern of dark brown dots at mesal basodorsal half and somewhat triangular pattern of dots laterally. Elongate black spot located just above insertion of each forecoxa; anterior margin fringed with fine hairs. Foretrochantins in ventrolateral view slender, sagitate, distal 1/3rd thicker than basal 2/3rds; each episternum small, bar-shaped; each epimeron surrounding base of forecoxa posteriorly, in ventral view rectangular, with its anterior margin concave. Forelegs each with forecoxa short cylindrical, in lateral view anterior margin with 1 large acute process, longer than forecoxa; foretrochanter 2-jointed, basal joint short, distal one triangular with inner apex produced into bristled process; femur cylindrical, progressively wider from base to apex

in lateral view, outer side with longitudinal carina and 3 dark brown rings above carina, inner side with longitudinal indentation; tibia and tarsus slender, progressively shorter, tarsus with row of hairs on inner side along lower margin from basal 1/5th to apex; claw curved downward with small finger-like ventral process at base. Mesonotum and metanotum membranous. Mesonotal setae arising in *sa1*, *sa2* and *sa3*, each with 1 seta. Middle and hind legs nearly equal in length, yellowish brown; femora slightly broader apically, punctate; claws bifid, hook-like.

Abdomen: Abdomen almost uniformly broad, greenish grey in live specimens, brownish in alcohol, with scarce setae. Anal prolegs brown, stout, with few dark setae; claws hook-like.

Materials examined. CHINA: Si-chuan Province, Mian-yang, Ping-wu County, Lao-he-gou, Da-pian-gou, alt. 1703.0 m, 104°43'18"N, 32°34'43"E, 24 May 2012, light trap, collected by Xu Ji-hua & Zhang Lian-bo, 2 males, 1 female. Same except Xia-wa-fang, alt. 1176 m, 104°43'18"N, 32°34'43"E, 26 May 2012, collected by Xu Ji-hua & Zhang Lian-bo, 2 larvae.

Distributions. China (Bei-jing, Hu-bei, Shaan-xi, Shan-dong, Si-chuan, Tian-jin, Yun-nan, Tibet, Zhe-jiang), Vietnam, Laos.

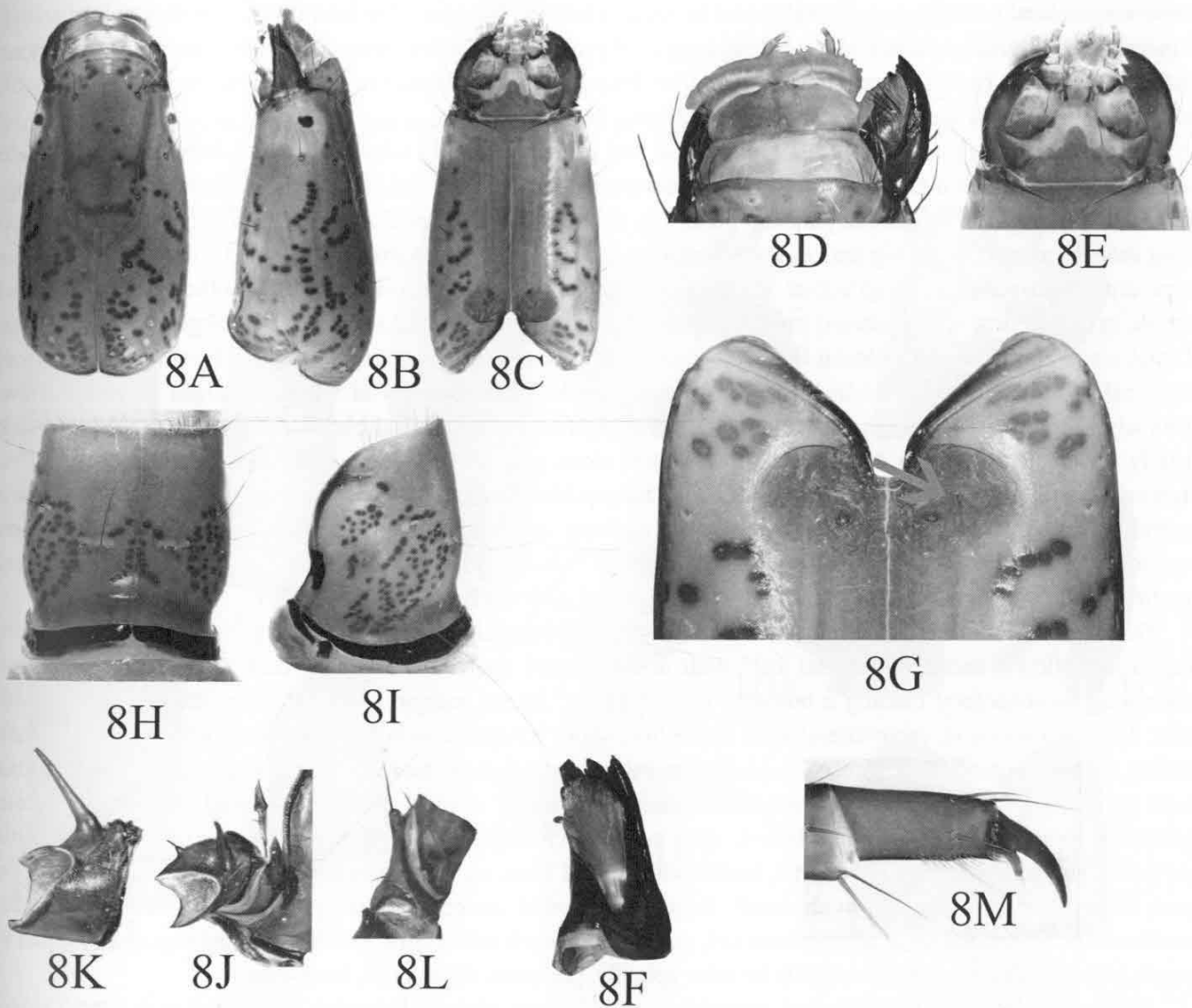


FIGURE 8. *Stenopsyche navasi* Ulmer 1926, larva. 8A–F, head: 8A, dorsal; 8B, left lateral; 8C, ventral; 8D, labrum and clypeus, dorsal; 8E, mandibles, mentum, and anterior ventral apotome, ventral; 8F, left mandible, ventral; 8G, pair of #18 setae, posteroventral. 8H–I, prothorax: 8H, dorsal; 8I, left lateral. 8J–M, foreleg and propleuron: 8J, left foretrochantin, episternum, and epimeron, left lateroventral; 8K, left forecoxa, left lateral; 8L, right tarsus and claw, right lateral. 8M, left mesotrochanter, anterior.

Stenopsyche tienmushanensis Hwang 1957

(Figs. 9–10)

Stenopsyche tienmushanensis Hwang 1957, 382–383, figs. 42–44; male; “Chekiang, Tienmushan, 1935, July 14. Coll. Hwang Ke-len; Chinese Science Col. Insect Res. Inst.” (translated from Chinese). Listed from China (An-hui, Guang-xi, Gui-zhou, Hai-nan, Hu-nan, Jiang-xi, Shaan-xi, Zhe-jiang) by Yang *et al.* 2005, 441–460; belonging in the *Stenophylax simplex* Species Group and 1st Subgroup [*Stenopsyche dentata* Subgroup] in China (Jiang-xi, Gui-zhou, Hai-nan, Shaan-xi, Sichuan, Zhe-jiang) according to Xu *et al.* 2014, 223–224, figs. 1, 3a–c.

Female. Length of each forewing 20 mm (n=2). Body yellowish brown. *Female genitalia:* Tergum VIII in lateral view with anterodorsal angle produced forward, in dorsal view trapezoidal, distal margin subtruncate; sternum VIII trapezoidal in lateral view, strongly setose ventrolaterally, subrectangular in ventral view. Segment IX sclerotized slightly, subrectangular in lateral view, with transverse dorsal fold and with lateral apodemes extending internally anterad; in dorsal view trapezoidal. Vulvar scale located ventrally, semicircular in lateral view, with posterolateral angle strongly setose; in ventral view distal margin convex and rounded. Segment X membranous, with pair of setose longitudinal sclerites dorsolaterally oval in dorsal view and bar-shaped in lateral view, another pair of setose rounded sclerites ventrolaterally about half as long as dorsolateral sclerites; apex divided into pair of distal setose lobes, each bearing cercus. Cerci small, nipple-like. Processus spermathecae in lateral view irregular, fused with vulvar scale, in ventral view tube-like with base bulging laterally.

Larva (5th instar). Body length 29 mm. Head and pronotum highly sclerotized, with distinct dark punctate pattern. *Head:* Length 4 mm, width 1 mm (n=2), subrectangular in dorsal and ventral views. Setae brown and long. Ground color brown, with distinct punctate pattern as follows: Frontoclypeal apotome with dark transverse stripe along anterior margin, and 4 big dark dots connected to it; 3 dark transverse stripes connected with the dark sinuous stripe along ecdysial line, longitudinal stripe connecting with aforementioned 3 stripes; other portion of head capsule in dorsal view with scattered irregular spots; in ventral view anterior and posterior margins dark, each side of thick stripe along ventral ecdysial line with sinuous stripe composed of 3 irregular spots. Eyes black, eye areas large, pale. Labrum black mesally and pale laterally, with 2 hair brushes at anterior margin in dorsal view. Frontoclypeus pale, with brown transverse line along anterior margin. Mandibles dark brown basally and black distally in lateral view, with 4 apical teeth in ventral view, only left mandible with mesal brush of stiff hairs. Mentum brown, oval; anterior margin dark, with tongue-like process, each lateral margin with seta. Anterior ventral apotome black, triangular, about 1/11th as long as ventral ecdysial line. Pair of #18 setae near posteroventral margin located anterior to base of ventral ecdysial line; distance from each seta to posteroventral margin slightly shorter than distance of that setae to ventral ecdysial line ($d1:d2 = 1:1.25$).

Thorax: Pronotum heavily sclerotized, narrowly subrectangular, yellowish brown, with distinct punctate pattern as follows: mesal basodorsal half with arrow-shaped spot, laterally with dark spots forming pattern resembling “a schoolboy chasing a butterfly in a meadow,” lateral margin black. Anterior margin fringed with setae. Foretrochantins in ventrolateral view spine-like, short. Episterna in lateral view somewhat triangular, dark brown; epimera surrounding forecoxae posterolaterally, posterolateral margins black. Legs each with forecoxa short cylindrical, in lateral view anterior margin with 2 short, conical processes curved downward. Femur cylindrical, progressively wider from base to apex in lateral view, with 3 dark brown rings near upper margin; tibia and tarsus slender, progressively shorter, tarsus with row of hairs on inner side along lower margin from base to apex; claw curved downward with small finger-like ventral process at base. Mesonotum and metanotum membranous. Mesonotal setae arising from *sa1*, *sa2* and *sa3*, each with 1 seta. Middle and hind legs nearly equal in length, yellowish brown; femora slightly broader apically, punctate; claws bifid, hook-like.

Abdomen: Almost uniformly broad, greenish grey in live specimens, brownish in alcohol, with scarce setae. Anal prolegs brown, stout, with few dark setae; claws hook-like.

Materials examined. CHINA, Shan-xi Province, Yi-cheng County, Da-he Town, Da-he, alt. 1207.8 m, 35°27'14"N, 111°55'56"E, 13 Sept. 2013, light trap, collected by Sun Chang-hai, Xu Ji-hua & Wang Zi-wei, 4 males, 2 females. Shan-xi Province, Qin-shui County, Xia-chuan, Nü-ying canyon, alt. 1532 m, 35°25'29"N, 112°0'36"E, 11 Sept. 2013, collected by Sun Chang-hai, Xu Ji-hua & Wang Zi-wei, 2 larvae.

Distribution. China (An-hui, Hai-nan, Hu-bei, Jiang-xi, Shaan-xi, Shan-xi, Guang-xi, Hu-nan, Gui-zhou, Zhe-jiang).

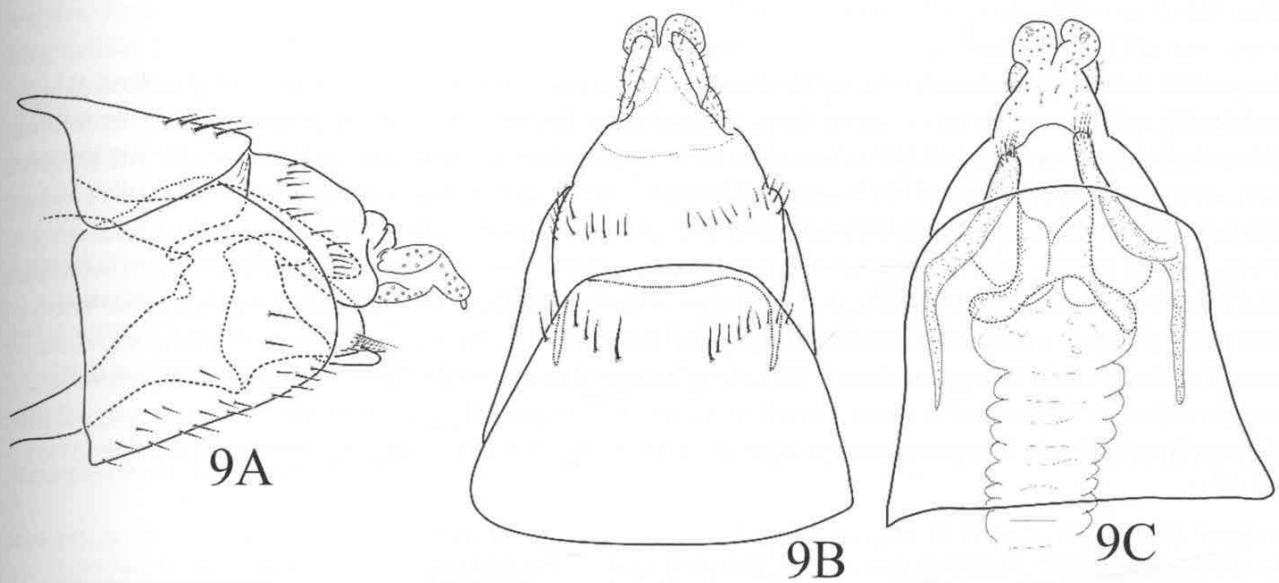


FIGURE 9. *Stenopsyche tienmushanensis* Hwang 1957, female genitalia. 9A, left lateral; 9B, dorsal; 9C, ventral.

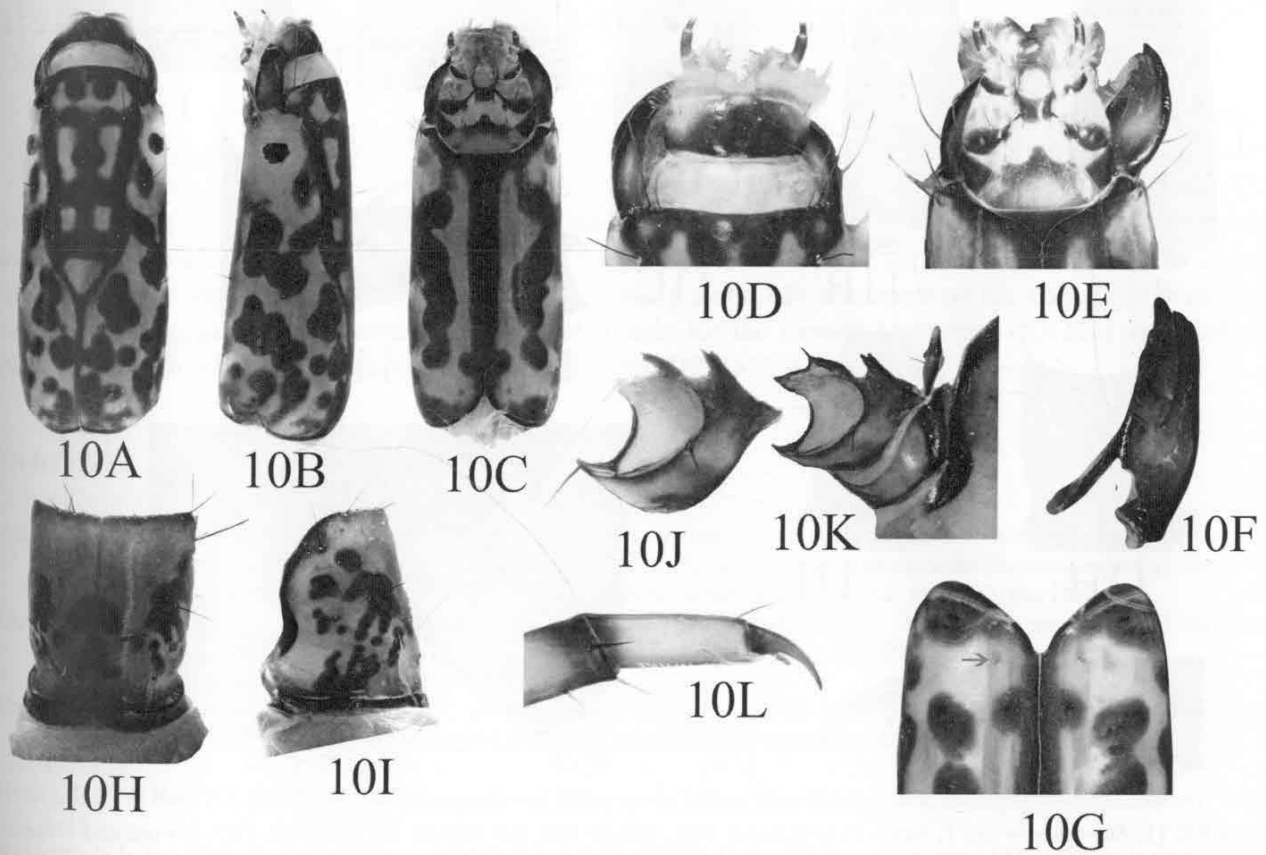


FIGURE 10. *Stenopsyche tienmushanensis* Hwang 1957, larva. 10A–G, head: 10A, dorsal; 10B, left lateral; 10C, ventral; 10D, labrum and clypeus, dorsal; 10E, mandibles, mentum, and anterior ventral apotome, ventral; 10F, left mandible, ventral; 10G, pair of #18 setae, posteroventral. 10H–I, prothorax: 10H, dorsal; 10I, left lateral. 10J–L, foreleg and propleuron: 10J, left foretrochantin, episternum, and epimeron, left lateroventral; 10K, left forecoxa, left lateral; 10L, right tarsus and claw, right lateral.

Stenopsyche sp. 1

(Fig. 11)

Larva (5th instar). Body length 43 mm. Head and pronotum strongly sclerotized. *Head:* length 5 mm, width 1.25 mm (n=3), subrectangular, setae brown, long. Ground color brown, with distinct punctate pattern as follows: frontoclypeal apotome with dark stripes and spots forming ghost face; other portions of head capsule with scattered dark spots or stripes of coalesced black dots, and dark stripe along ventral ecdysial line in ventral view. Eyes small, eye areas large, pale. Labrum dark brown mesally and light brown laterally, with 2 hair brushes at anterior margin. Frontoclypeus yellow, with 3 indistinct longitudinal pale lines separating 4 rectangular darker areas. Mandibles dark brown basally and black distally, in ventral view with 4 apical teeth, only left mandible with mesal brush of stiff hairs. Mentum semicircular, anterior margin with mesal tongue-like lobe, single seta on each side. Anterior ventral apotome black, triangular, about 1/8th as long as ventral ecdysial line. Pair of #18 setae near posteroventral margin with each seta located at center of dark brown triangular spot and posterior to base of ventral ecdysial line; distance from each seta to posteroventral margin shorter than distance of that setae to ventral ecdysial line ($d1:d2 = 1:1.67$).

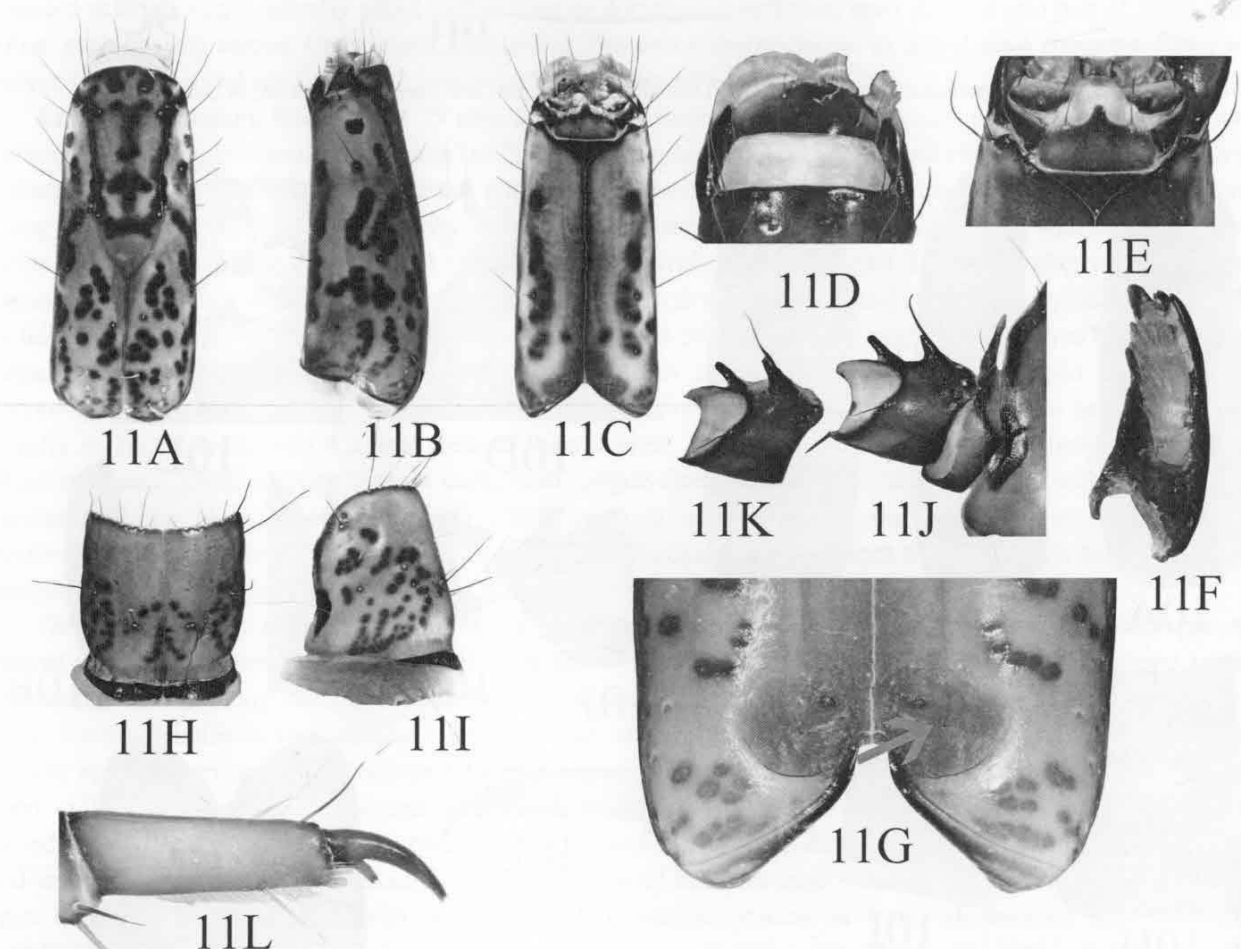


FIGURE 11. *Stenopsyche* sp. 1, larva. 11A–F, head: 11A, dorsal; 11B, left lateral; 11C, ventral; 11D, labrum and clypeus, dorsal; 11E, mandibles, mentum, and anterior ventral apotome, ventral; 11F, left mandible, ventral, 11G, pair of #18 setae, posteroventral. 11H–I, prothorax: 11H, dorsal; 11I, left lateral. 11J–L, foreleg and propleuron: 11J, left foretrochantin, episternum, and epimeron, left lateroventral; 11K, left forecoxa, left lateral; 11L, right tarsus and claw, right lateral.

Thorax: Pronotum heavily sclerotized, subrectangular in dorsal view, ventrolateral margin sinuous in lateral view, brown, mesal basodorsal portion with -shaped pattern of coalesced dark dots, laterally with semicircular pattern of dark dots; anterior half of each lateral margin with dark stripe connected with elongate black stripe just above insertion of forecoxa; anterior margin fringed with hairs. Foretrochantins in ventrolateral view rhomboid, long; episterna small, subtriangular in lateral view; epimera surrounding forecoxae posteriorly, in ventral view each rectangular, with its anterior margin concave, posterolateral margin black. Forelegs each with forecoxa short,

cylindrical, with 2 black conical processes at anterior margin in lateral view, basal process triangular and apical one slender. Femur cylindrical, progressively wider from base to apex in lateral view, outer side with dark brown longitudinal line and 3 dark brown rings above line, inner side with longitudinal indentation; tibia and tarsus slender, progressively shorter, tarsus with row of hairs on inner side along lower margin from basal 1/5th to apex; claw curved downward with small finger-like ventral process at base. Mesonotum and the metanotum membranous. Mesonotal setae arising in *sa1*, *sa2* and *sa3*, each with 1 seta. Middle and hind legs nearly equal in length, yellowish brown; femora slightly broader apically, punctate; claws bifid, hook-like.

Abdomen: Almost uniformly broad, greenish grey in live specimens, brownish in alcohol, with scarce setae. Anal prolegs brown, stout, with few dark setae; claws hook-like.

Materials examined. CHINA: Si-chuan Province, Jiu-zhai-gou County, Jiu-zhai-gou, reed sea, alt. 2299 m, 33°13'08"N, 103°54'39"E, 8 July 2013, collected by Wang Bei-xin & Zhang Jie, 3 larvae.

Distribution. China (Si-chuan).

Stenopsyche lotus Weaver 1987

Stenopsyche lotus Weaver 1987, 167–168, figs. 4A–C; male; "CHINA, Zhejiang, Tung-lu, 10 IV 1926, Mrs. Dora E. Wright"; deposited in the United States National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, USA.

Material examined. CHINA: Shan-xi Province, Qin-shui County, Xia-chuan, Nü-ying canyon, alt. 1532 m, 35°25'29"N, 112°0'36"E, 11 Sept. 2013, collected by Sun Chang-hai, Xu Ji-hua & Wang Zi-wei, 2 males.

Distribution. China (Shan-xi, Zhe-jiang).

Acknowledgements

We express our great appreciation to Dr. Takao Nozaki for his valuable review work and corrections on this manuscript. We are grateful to Dr. John C. Morse for his long term help and support in our research on aquatic insects. We also thank Prof. Vincent H. Resh for providing useful edit comments on the manuscript draft. This research was supported by Fundamental Research Funds for the Central University (KYZ201106), and the National Natural Science Foundation of China (NSFC, No. 412715125).

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