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Taxonomic Review of *Zavreliella* Kieffer from East Asia

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Yanmin Cao and Hongqu Tang (2017) Three species of the genus *Zavreliella* from East Asia are reviewed in this paper, including a new species, *Z. shidai* sp. n., based on associated pupae and males collected from Guangdong Province, China. The new species can be separated from other congeners by the uniquely banded wing and marked abdomen. The Japanese species *Z. inawaheia* Sasa, Kitami and Suzuki, 2001 is re-described based on the holotype. In addition, two additional records are added for *Z. marmorata* (v. d. Wulp). An emended generic diagnosis and keys to the known males from Asia are also provided.

Key words: *Zavreliella*, East Asia, Redescription, New species, Chironomidae.

BACKGROUND

The genus *Zavreliella* Kieffer was erected as a monotypic genus in 1920. Due to the high similarity to genus *Lauterborniella* Thienemann & Bause, species of *Zavreliella* were usually treated as a subgenus of *Lauterborniella* by several authors (Edwards 1929; Goetghebuer 1939; Albu 1980). The diagnosis of those above 2 genera remained unclear until three volumes of Holarctic keys had been published (Pinder and Reiss 1983, 1986; Cranston et al. 1989).

Reiss (1990) had reviewed this genus extensively, and synonymized numerous species names. Apart from that, there have been no other special papers about this genus published. To date, the genus includes 15 species worldwide (Reiss 1990; Sasa et al. 2001): 12 species in the Neotropical region, two each in the Holarctic region and the Oriental region, one each in the Afrotropical region and Australian region. In China, only one species, *Z. marmorata* (v. d. Wulp), had been reported from Hubei and Yunnan Provinces (Wang et al. 1977; Reiss 1990). Although some new species may be expected to occur in China, there have been no additional report by Chinese researchers for almost 40 years.

In this paper, a new species, *Z. shidai* sp. n., is described based on the male and pupae collected from China. The Japanese species *Z. inawaheia* is redescribed here based on the holotype and two additional records of *Z. marmorata* are noted here. In addition, the diagnosis of *Zavreliella* is emended, and the key to known males from Asia is given.

MATERIALS AND METHODS

Specimens examined were slide-mounted in Euparal. Morphological terminology and abbreviations follow Sæther (1980) and Cranston (2013). Measurements are given as ranges, with the number of observed specimens in parentheses if different from the number (n) stated at the beginning of the description. Line drawings were made by using a drawing tube attached to an Olympus BX43. All Chinese material is deposited in the Institute of Groundwater and Earth Science, Jinan University, Guangdong, China. The holotype of *Zavreliella inawaheia* is now housed in the

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National Museum of Nature and Science, Tsukuba, Japan (NSMT).

RESULTS

Systematics

Family Chironomidae Meigen, 1803
Subfamily Chironominae Macquart, 1838
Tribe Chironomini Macquart, 1838
Genus *Zavreliella* Kieffer, 1920
Type species by monotypy: *Chironomus clavatirus* Kieffer, 1913
[= *Chironomus marmoratus* v. d. Wulp, 1859]

Zavreliella shidai sp. n.

(Figs. 1-16, 21)
urn:lsid:zoobank.org:act:C5AA031B-6E2D-40BD-85F9-F77E09A1D2A0

Diagnosis: The male of the new species can be separated from others by the following combination: distinct abdominal markings and mottled wing; inferior volsella with the longitudinal suture laterally; superior volsella with two lateral setae on its inner margin. Pupa can be separated from others by the absence of distinct paired point patches on T II-VI, T VI with 4 LS-setae.

Description: Male (*n* = 1) (Figs. 1-9, Table 1)

Total length 3.5 mm. Wing length 1.7 mm. Total length/wing length 2.1. Wing length/length of front femur 1.8.

Coloration: Head and thorax brown to dark brown; wing with distinct dark spots (Fig. 1), a curved spot present in the anal cell; legs yellow with dark rings (Figs. 3, 4), color pattern of which are similar to those of North American population of *Z. marmorata* (Reiss 1990, figs. 1-2), but basal ring on fore tibia of this new species is distinctly narrower than that of the latter species. Abdomen medium brown, tergites II-VII each with dark saddle-shaped median elevation bearing a tuft of setae (Fig. 2).

Head: Temporals 10, uniserial, including 2 inner verticals, 5 outer verticals and 3 post orbitals. Frontal tubercle spindle-shaped, 23 μm in high and 13 μm wide in the middle. Frist antennal flagellomere dark brown, other flagellomeres yellow or pale brown, AR 1.5, ultimate flagellomere 683 μm long. Clypeus with 20 setae. Tentorium 150 μm long, 35 μm wide. Lengths of palpomeres 1-5 (in μm): 48, 31, 160, 150, 215.

Thorax: Antepronotums 0; acrostichals 6, beginning some distance from antepronotum, and running to the shallowly rounded tubercle; dorsocentrals 9, without scutal fossal setae anteriorly; humeral pit minute, but clear; prealars 3; scutellars 9.

Wings: VR 1.25. Brachiolum with 1 seta; R with 15, R_1 with 14, R_{4+5} with 22 setae.

Legs. Foretibia apically with curved spur, 50 μm long (Fig. 5); spur on mid-tibia 73 μm long, inner basal portion with 4-5 side teeth, combs consisting of 25 teeth (Fig. 6); spur on hind tibia 90 μm long, inner basal portion with 8-10 teeth, combs consisting of 40 teeth (Fig. 7). Lengths (in μm) and proportions of legs in table 1.

Abdomen: Numbers of setae on saddle-shaped dark areas in T II-VI: 30, 48, 40, 42, and 20 (Fig. 2).

Hypopygium (Figs. 8, 21): Anal tergite bands short, separated widely. Median anal tergite with 9 setae on each side. Anal point nearly parallel-sided and distally slightly rounded, 45 μm long. Superior volsella (Fig. 9) broadly digitiform, 40 μm long, with 4-5 setae on its dorsal and 2 long setae on its middle portion of inner margin. Basal lobe with hemispheric projection, dominant, clearly microtrichiose. Inferior volsella 120 μm long, with a distinct longitudinal suture laterally. Phallapodeme 90 μm long. Transverse sternapodeme 70 μm long, lateral sternapodeme 90 μm long. HR 1.0, HV 2.6.

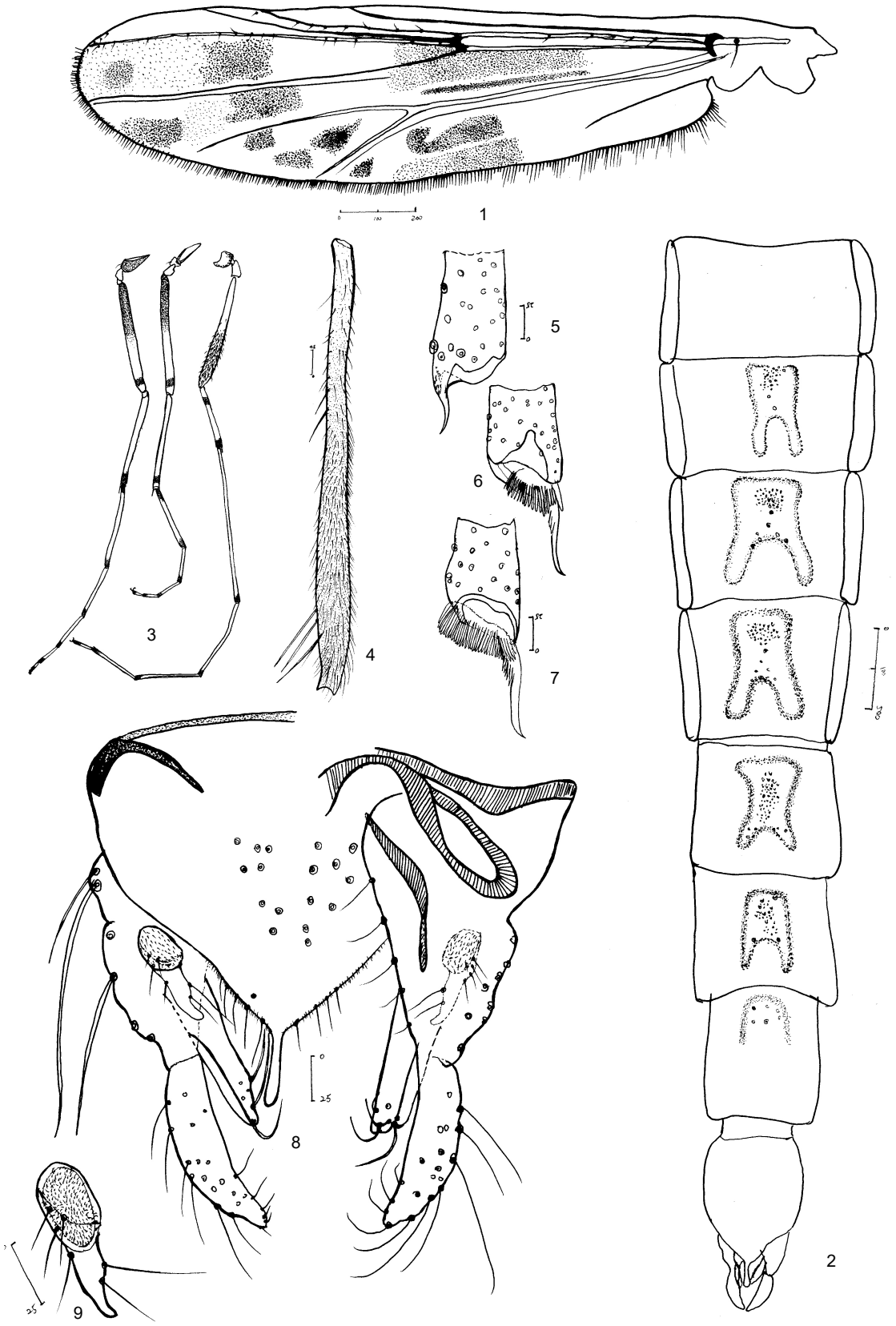
Pupa (*n* = 4) (Figs. 10-16):

Coloration: Largely yellow to pale brown. Abdominal spines and spinules darker than cuticle. Total length 3.9-5.0, 4.3 mm. Abdomen 3.1-4.0, 3.4 mm long.

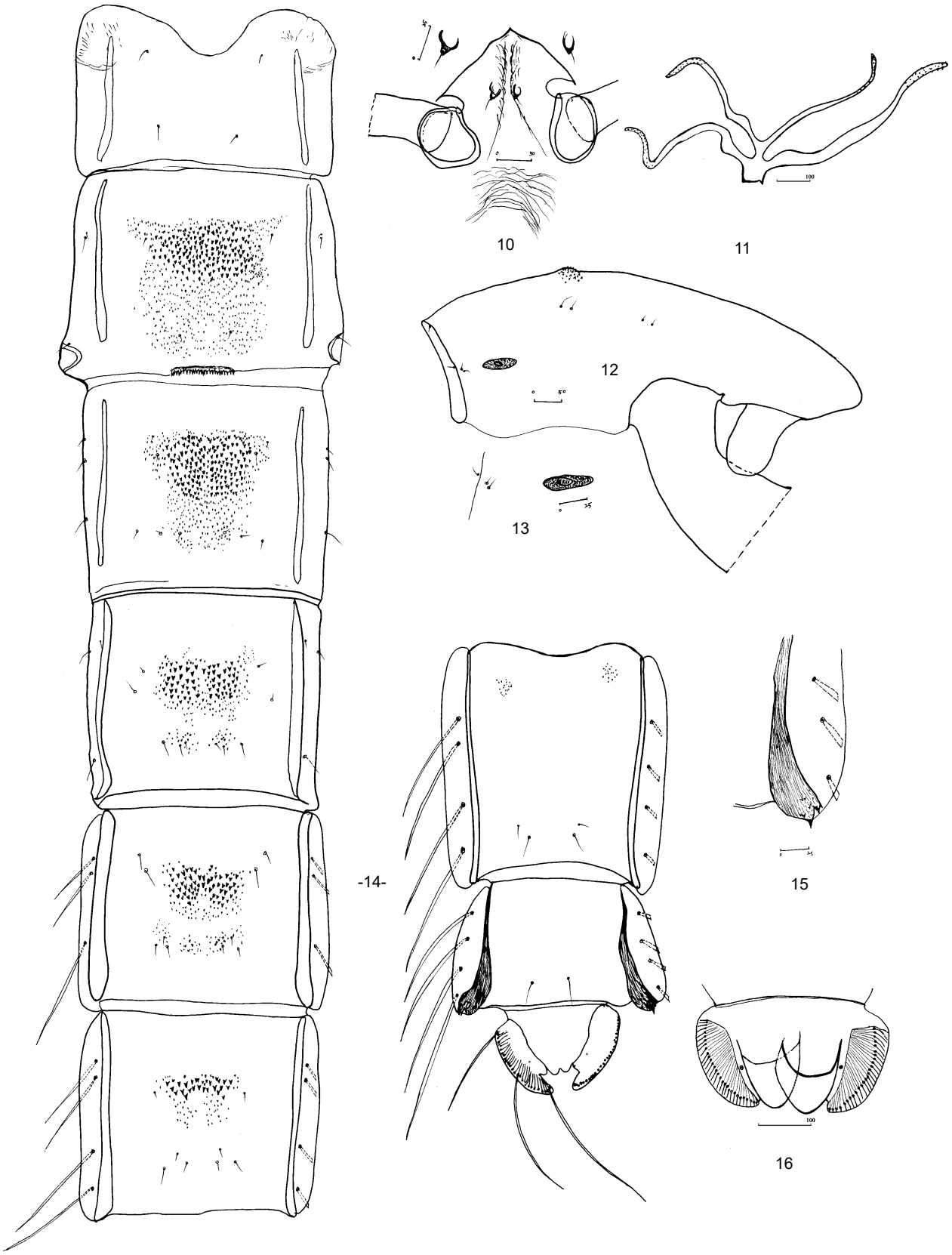
Cephalothorax: Cephalic tubercle small, conical, 10-12 μm wide and 5 μm high (Fig. 10). Frontal setae short, 10-12 μm long. Anteromedian thorax smooth, with a distinct tubercle. Thoracic horn with 4 branches, of which the basal two branches are slightly stronger than others (Fig.

Table 1. Lengths (μm) and proportions of legs of *Zavreliella shidai* sp. n., male

	P1	P2	P3
Fe	900	920	870
Ti	500	720	735
Ta1	1200	520	700
Ta2	650	270	430
Ta3	500	200	310
Ta4	400	120	180
Ta5	160	85	90
LR	2.40	0.72	0.95
SV	1.17	3.15	2.29
BV	1.52	3.20	2.28



Figs. 1-9. *Zavreliella shidai* sp. n., male. 1 wing 2 abdominal marking, dorsal view 3 legs, showing marking pattern 4 forefemur 5 foretibial apex 6 mid tibial apex 7 hind tibial apex 8 hypopygium 9 details of superior volsella.



Figs. 10-16. *Zavreliella shidai* sp. n., pupa. 10 frontal apotome, with details of cephalic tubercles in upper corners 11 thoracic horn 12 thorax 13 details of basal ring 14 tergites 15 anal comb of VIII 16 anal lobe, showing male sac.

11). Antepronotals 2. Precorneals minute, only 2 observed. Dorsocentrals divided into 2 groups, Dc 1 and Dc 2 *ca*. 40 μm long, slightly longer than those of Dc 3 and Dc 4 (Fig. 12). Basal ring flatly ellipse-shaped (Fig. 13).

Abdomen: Tergal paired point patches not clearly delimited. Tergite II-VI with obvious anterior transverse bands of points stronger than those of median and posterior patches. T I bare, T II-III with extensive spinules, subquadrate in outline, anterior spinules distinctly stronger than those of the posterior (Fig. 14). T IV-VI split into anteromedian patch and posterior patches, the anterior bands with somewhat of a tendency to separate into 2 sub-patches if only considering the stronger spines. T VII reduced into two anterolateral patches, T VIII bare. Conjunctive spinules between segments absent. Hook row on T II relatively weak, with 28-34, 32 hooks, occupying 0.3-0.4, 0.3 of tergal width. Vortex absent, pedes spurii B on segment II, weak. Comb of segment VIII composed of 1 larger and 2-3 small teeth, the longest spur 15-20, 18 μm (Fig. 15). Lateral taeniae of segments V-VIII: 3, 4, 4, 4. Anal lobe with 26-30, 29 taeniae. Male genitalia sac extending slightly past the distal margin of anal lobe (Fig. 16).

Material examined: Holotype. male with pupal exuviae. CHINA: Guangdong Province, Guangzhou City, Conghua District, Dongkeng Reservoir, 23-iii-2015 (emerged 02-iv-2015), coll. HQ Tang. Paratypes. 2 pupal exuviae, as holotype except 20-viii-2015; 1 pupal exuviae, as holotype except 27-vii-2015.

Etymology: Named after Prof. Shida Wang who first reported the related genus from China and contributed to elucidation of Chinese midge fauna.

Distribution: China (Guangdong Province)

Remarks: The pupa was collected from a small clean reservoir with several submerged macrophytes, and successfully reared to the adult stage. The adult undoubtedly belongs to the *Z. marmorata* group because the basal lateral lobe of superior volsella has a hemispherical microtrichiose projection, and the inferior volsella has a longitudinal suture laterally. The male most resembles that of *Z. marmorata* in the inferior volsella with long apical lobes and the digitiform superior volsella with two short setae along the inner margin, but differs from it in the hemispherical lateral lobe of superior volsella and the wing without any marking around the anal lobe. In *Z. marmorata*, the superior volsella has a weakly developed lateral lobe and the wing bears dark markings on the base of anal cell (Reiss 1990; Cranston et al. 1989).

The pupa is unique in the homogeneous spinulation on the abdominal tergites II-VI, while all the known pupae are armed with paired point patches on each of these tergites (Reiss 1990; Pinder and Reiss 1986).

***Zavreliella inawaheia* Sasa, Kitami & Suzuki, 2001**

(Figs. 17-19, 20)

Zavreliella sp. "inawaheia", Sasa, Kitami & Suzuki, 2000: 13.
Zavreliella inawaheia, Sasa, Kitami and Suzuki, 2001: 12; Yamamoto & Yamamoto, 2014: 343 (misspelled as *inwaheia*).

Diagnosis: *Z. inawaheia* differs from its congeners by the following combination: dark saddle-shaped markings on T II-VI; the insertion of 2 inner long setae of superior volsella more distally; apex of inferior volsella with a shallow cleft.

Redescription: Male (*n* = 1) (Figs. 17-19, Table 2). Total length 3.5 mm. Wing length 1.8 mm. Total length/wing length 2.0.

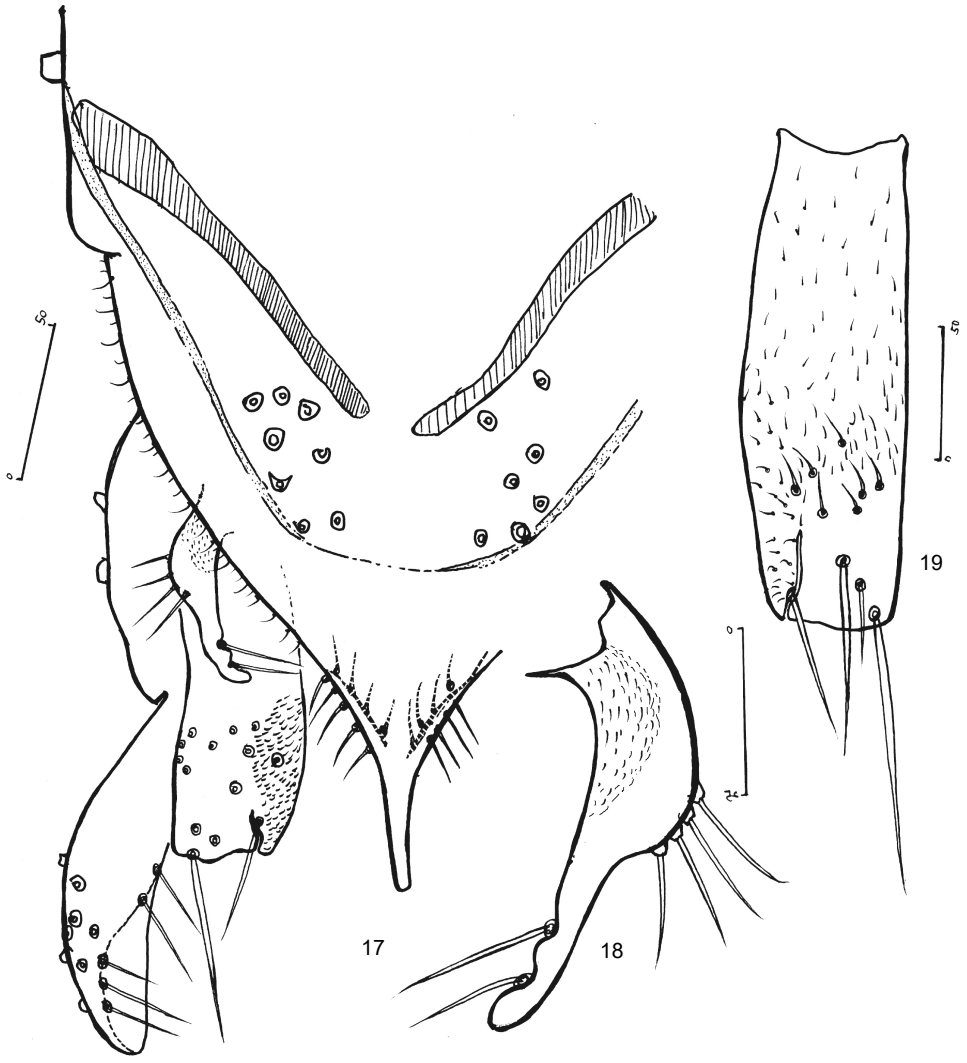
Coloration: Color pattern of legs and wing similar to previous species, abdomen terga II-VI also with distinct median dark markings in which numerous dark long setae are situated.

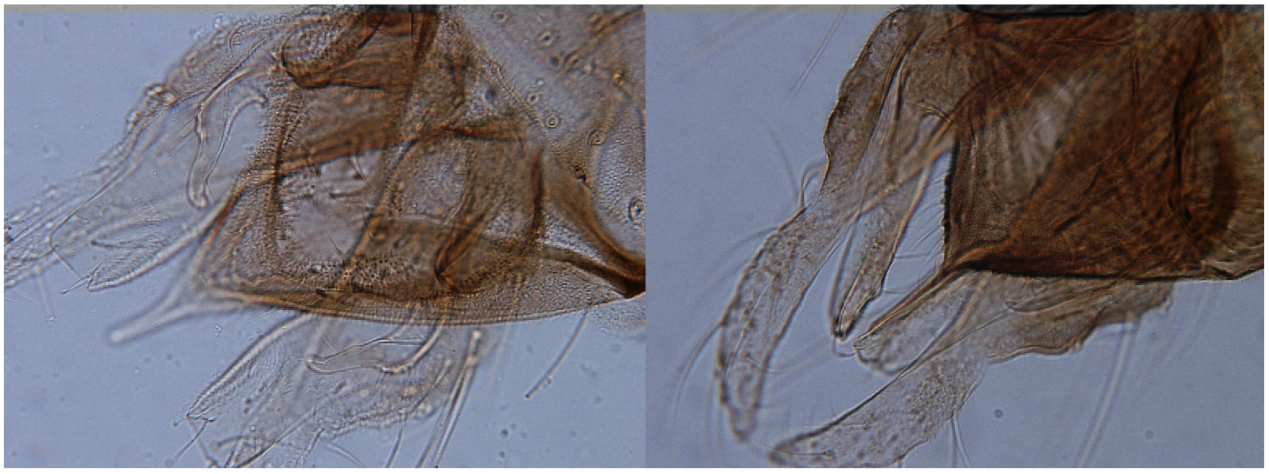
Head: Temporals 11, uniserial, including 5 inner and 6 outer verticals. Antenna with subapical seta, 15 μm long, AR 1.4, terminal flagellomere 657 μm long. Clypeus with 26 setae. Lengths of palpomeres 1-5 (in μm): 30, 38, 28, 195, 150, third palpomere with 6 strong setae.

Thorax: Antepronotums 0; acrostichals 10; dorsocentrals 10; prealars 4. Scutellum with 9

Table 2. Lengths (μm) and proportions of legs of *Zavreliella inawaheia* Sasa, Kitami & Suzuki, 2001, holotype ("-" means absent)

	P1	P2	P3
Fe	1142	914	888
Ti	508	760	787
Ta1	-	-	687
Ta2	-	-	253
Ta3	-	-	202
Ta4	-	-	121
Ta5	-	-	81
LR	-	-	0.87
SV	-	-	3.60
BV	-	-	2.44





20 21

Figs. 17-21. 17-20 *Zavreliella inawaheia* Sasa, Kitami & Suzuki, 2001, male. 17 hypopygium 18 details of superior volsella 19 details of inferior volsella 20 color photograph of hypopygium. 21 *Zavreliella shidai* sp. n. color photograph of male hypopygium.

setae, 4 of which are short.

Wings. VR 1.4. Brachiolum with 1 seta; R with 16, R_1 with 13-15, R_{4+5} with 28-32 setae.

Legs: Apex of fore tibia with an arcuate curved spur, 45 μm long; spur on mid-tibia 70 μm long, inner basal portion with 4-6 furrows; spur on hind tibia 110 μm long, inner basal portion with 6-8 teeth. Lengths (in μm) and proportions of legs in table 2.

Abdomen: T II-VI each with a medial bundle bearing strong dark setae, the seta number of each segment: 14, 16, 26, 14, and 11, TVII without distinct marking, with 4-5 dark long setae.

Hypopygium (Figs. 17, 20): Anal tergite band present. Median anal tergite with 8 setae on each side, posterior margin of T IX with 5 setae per side dorsally. Anal point nearly parallel-sided and slightly rounded distally, 45 μm long. Superior volsella (Fig. 18) broadly digitiform, 35 μm long, with 4 dorsolateral setae on its basal 1/2 and 2 long ventromedian setae on its subapical portion of inner margin. Basal lateral lobe present, clearly microtrichiose. Inferior volsella (Fig. 19) with a shallow notch and 3-4 strong setae apically. HR 1.5, HV 3.5.

Material examined: Holotype. male of *Z. inawaheia* (NSMT-I-Dip 5371 (No. 401: 015), JAPAN: Fukushima Prefecture, Lake Inawashiro, 06-vii-2000, coll. K Kitami.

Distribution: Japan (Fukushima Prefecture)

Remarks: The condition of the holotype is not so good; air bubbles and crystallization of mounting medium made it difficult to observe the wing pattern and the color pattern of abdomen. The fore- and middle tarsi are lost.

The species belongs to the *Z. marmorata* group, as the male has a flat microtrichiose lateral lobe in the superior volsella, and a shallow notch in the inferior volsellae. Yamamoto and Yamamoto (2014) pointed out that the species may be a junior synonym of *Z. marmorata* (Wulp) if observed correctly from the lateral view, but the male is distinct in having the apical cleft in the apex of inferior volsella. In *Z. marmorata*, the inferior volsella possesses a longitudinal suture laterally (Reiss 1990).

Zavreliella marmorata (v. d. Wulp, 1859)

Chironomus marmorata Wulp, 1859: 166.
Chironomus (*Lauterborniella*) *marmorata*: Edwards 1929: 405.
Lauterborniella (*Zavreliella*) *marmorata*: Goetghebuer 1939: 48; Wang 1977: 232.
Zavreliella marmorata: Lenz 1941: 55; Reiss 1990: 94; Ashe and Cranston 1991: 316. For other synonyms, see Reiss (1990: 91).

Diagnosis: *Z. marmorata* can be separated from others by the following combination: superior volsella with a weak lateral lobe and 2 subequal setae in the inner margin; gonostylus broad in the middle section.

Material examined: 1 male, Hubei Province, Jingzhou City, Hong Lake, 15-vii-2013, leg. Y.M. Cao; 1 female, 1 pupa, Guangdong Province, Guangzhou City, Liuxihe Reservoir, 03-x-2015, leg. H.Q. Tang.

Distribution: East Asia (China: Hubei, Guangdong and Yunnan Provinces), South Asia (India and Sri Lanka), South-East Asia (Indonesia), Europe and North America.

Remarks: In China, the species was previously known only from Hubei and Yunnan Provinces, and we now add a new record from Guangdong Province. This species will probably be found to have a broad distribution in China with further extensive survey.

Zavreliella sp.

(Figs. 22-26)

Diagnosis: The unnamed larva can be separated from others by the dark brown postmentum, and the ventromentum plate which is subequal to the mentum in width.

Description: Larva (*n* = 2)

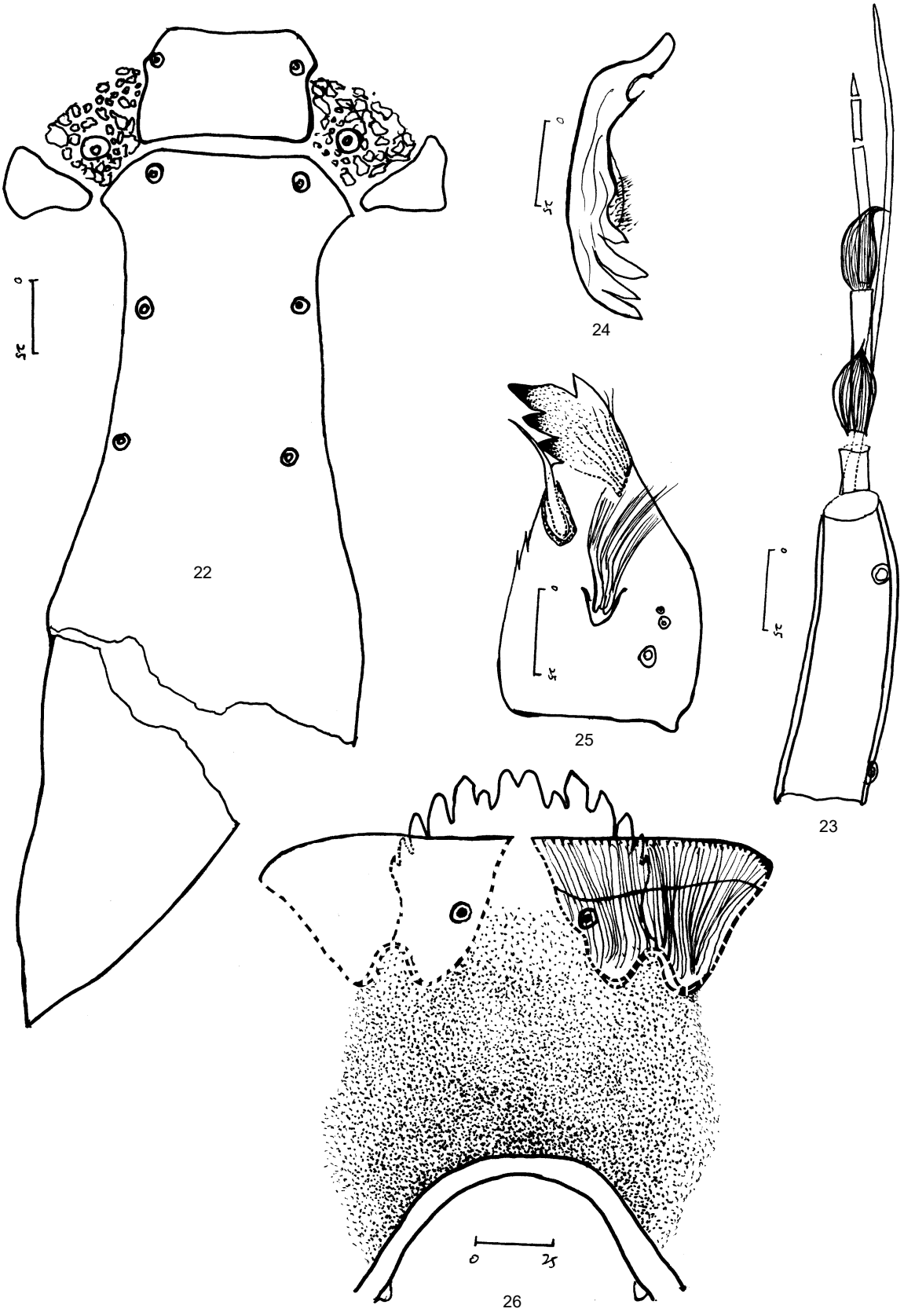
Total length 5.0-6.1 mm. Head capsule 350-360 μm long, 240-250 μm wide. Cephalic index 0.7.

Coloration: Head capsule yellow, with postmentum and postoccipital margin dark brown.

Dorsal surface of head (Fig. 22): Front-oclypeus with straight anterior margin, labral sclerite sub-rectangular, lateral sclerite 1 and 2 fragmentary, 3 complete.

Antenna (Fig. 23) : Total length 205-245 μm. Lengths of first to sixth segments (in μm): 98-113; 13-15; 30-50; 38-45; 8-13; 7.5; AR 0.8-0.9; first segment 3.7-4.0 times as long as basal width, ring organ located near the base 1/10. Antennal seta present at apical 1/5. Blade 115-150 μm long, extending beyond last flagellum, 1.2-1.3 times as long as flagellum. Lauterborn organ large, 15-20 μm long and 8-10 μm wide.

Labrum: SI plumose. Pecten epipharyngis consisting of 3 scales, lateral scales each with 5 teeth and median one with 4 teeth. Premandible 65-80 μm long, with 4 apical teeth, premandibular brush well developed (Fig. 24).



Figs. 22-26. *Zavreliella* sp., larva. 22 Dorsal surface sclerites 23 antenna 24 premandible 25 mandible 26 mentum.

Mandible (Fig. 25): 115-125 μm long, with 1 apical, 1 dorsal and 2 distinct inner teeth. Mola area pale, with 2 spines. Seta subdentalis reaching the first inner tooth.

Mentum (Fig. 26): 80-90, 85 μm wide, with 2 median and 6 lateral teeth, first laterals distinctly small and low, depressed slightly to the second laterals. The median two teeth 14-18, 16 μm wide. Ventromentum subequal to the mentum in width, with 32-46 striae. Ventromental plate ratio (W/H) 1.6-1.8, the inter-plates distance very narrow, 4.5-5.0 μm wide. Postmentum 120-140 μm long.

Body: Procercus 25-30 μm high, and 16-20 μm wide, bearing 6-7 long together with 1-2 slender and short setae; the long one 760-1050 μm long, the slender short one 500-650 μm long. Supraanal setae weak, 50-60 μm long.

Material examined: 2 larvae, CHINA: Guangdong Province, Guangzhou City, Conghua District, Dongkeng Reservoir, 18-iii-2014, coll. HQ Tang.

Distribution: China (Guangdong Province)

Remarks: The larva may be those of *Z. shidai* sp. n. since they are collected from the same site; no other congeners were found at the site. This larva resembles *Z. marmorata*, but can be separated from the latter by the heavily sclerotized postmentum.

DISCUSSION

The presently known Asian species of *Zavreliella* all belong to the *Z. marmorata* group. Most males can be separated by the extent of lateral lobe development on the superior volsella, and the arrangement and relative length of the inner margin setae. The inferior volsella of this group usually has a distinct suture laterally, but only a shallow cleft in the Japanese species *Z. inawaheia*. The unnamed larva in this paper closely resembles that of *Z. marmorata* in the shape of antenna and mentum, except for the coloration of postmentum. However, the pupa of *Z. shidai* deviates considerably from the conventional generic diagnosis of *Lauterborniella* and *Zavreliella* in the following combination: without well-defined paired point patches; T VI with 4 lateral taeniae. Those above combined characters also occur in genus *Kribiodorum* Kieffer, but the latter clearly with the conjunctive spinules in T III/IV/V, and absence of cephalic tubercles (Reiss 1982). The number of taeniae on tergite VI is usually 3 in genus *Zavreliella*, but 4 in genus *Lauterborniella*. The present new pupal type shows some intermediate status among above 3 genera. Since other pupae of Asian species is still unknown, it is unclear whether the similar type will be also found in other species.

CONCLUSIONS

Amendment to the diagnosis of the genus *Zavreliella* Kieffer. Male - Abdomen with pale or heavily darkened markings surrounding the seta tufts. Pupa - Paired point patches clearly or faintly present on tergites II-IV; tergite IV with 3 or 4 lateral taeniae. Larva - postmentum pale yellow or clearly dark brown.

Key to the known males of Asian *Zavreliella* species

1. Inferior volsella with 2 recognizable sections divided by a longitudinal suture 2
- Inferior volsella only with a shallow split distally ..... *Z. inawaheia* Sasa, Kitami and Suzuki, 2001 (East Asia: Japan)
2. Inner margin of superior volsella with 2 subequal ventromedian setae 3
- Inner margin of superior volsella with 1 long and 2 short ventromedian setae ..... *Z. cranstoni* Reiss, 1990 (Southeast Asia: Malaysia)
3. Abdominal segments with faint markings. Lateral lobe of superior volsella flat. Wing anal cell with 4-5 rectangular spots ..... *Z. marmorata* (v. d. Wulp, 1859) (widespread)
- Abdominal segments with dark brown markings. Lateral lobe of superior volsella hemispheric. Wing anal cell with only 3 spots, including a curved one ..... *Z. shidai* sp. n. (East Asia: China)

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