



## Two new species and new record of *Amphinemura* (Plecoptera: Nemouridae) from northern China

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### Abstract

*Amphinemura changbaishana* sp. nov. and *Amphinemura qiliana* sp. nov. (Plecoptera: Nemouridae) are described and illustrated as two new stonefly species from northern China. Affinities of the new taxa with similar regional species of *Amphinemura* are discussed. *Amphinemura verrucosa* Zwick, 1973 is reported from China for the first time.

**Key words:** new species, *Amphinemura changbaishana*, *Amphinemura qiliana*, new record, *Amphinemura verrucosa*, stoneflies, Changbaishan, Qilian Mountains, northern China

### Introduction

*Amphinemura* is a large and widespread Amphinemurinae genus of the family Nemouridae with about 200 species known from the Holarctic and Oriental regions (DeWalt *et al.* 2019). Nearly half of these species are known from China. In the last two decades, new taxa have been added by Du & Wang (2007), Du *et al.* (2007), Ji & Du (2014), Ji *et al.* (2014), Li & Yang (2005, 2006, 2007, 2008a, b, c, d, e, 2011), Li *et al.* (2005), Li *et al.* (2013), Li *et al.* (2016), Li *et al.* (2017a, 2017b), Li *et al.* (2018a, 2018b), Mo *et al.* (2017, 2019), Shimizu (1997, 1998), Wang *et al.* (2006, 2007), Yang *et al.* (2005a, 2005b), and Zhu & Yang (2002, 2003). However, the diversity of *Amphinemura* in the vast area of northern China which belongs to the East Palearctic Region is still poorly studied (Yang *et al.* 2015). Currently, no records of *Amphinemura* are available from this region, whereas nine species, with three of these undetermined, are known from neighboring Korean Peninsula and Russia (Bae *et al.* 2011, Yoon & Aw 1988, Teslenko 2006, Teslenko 2015). Three species of *Amphinemura* are shared by the stonefly faunas of Korean Peninsula and the South of the Russian Far East, occurring in streams draining the Changbai Mountain ranges part of the Manchurian-Korean mountains.

In the present paper, two new species of *Amphinemura* are described from adult males: *Amphinemura qiliana* sp. nov., collected from the Daotang River, draining the Qilian Mountains of Qinghai Province of northwestern China, and *A. changbaishana* sp. nov. from Changbaishan Mountain of Jinlin Province of northeastern China. We also report *A. verrucosa* Zwick, 1973 from Changbaishan Mountain of Jinlin Province, a new species record for the stonefly fauna of China.

### Materials and methods

All adults were collected using light traps and were preserved in 75% ethanol. Abdomens of males were removed and soaked in 10% NaOH overnight, then rinsed with distilled water. Specimens were examined with the aid of a Leica M420 dissecting microscope and a compound microscope in transmitted light. The color illustrations were

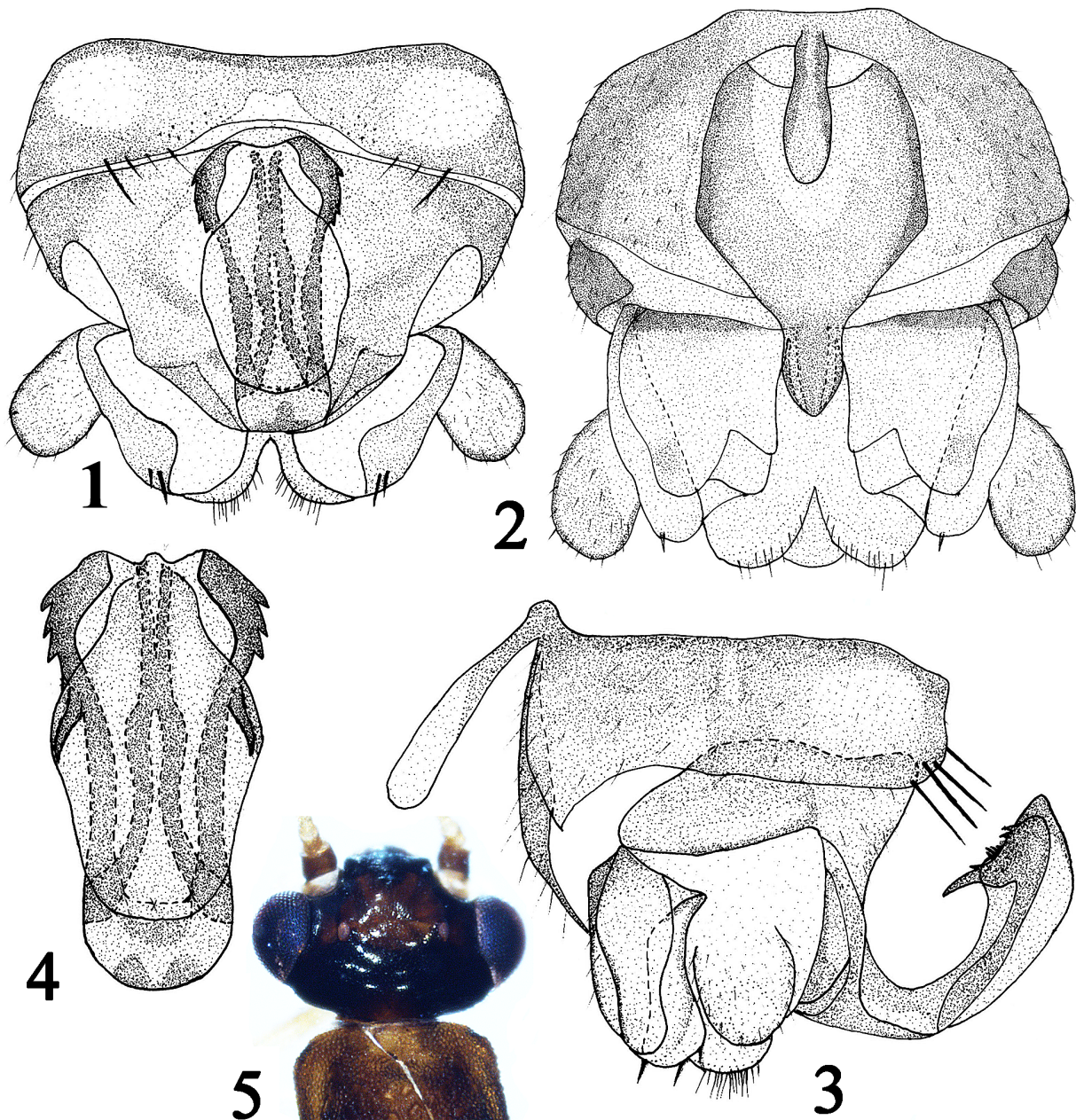
produced using a Leica S8APO, digital cameras (Nikon Coolpix 995 and Toup View 3.7), the stereomicroscope Olympus SZX16, digital camera Olympus DP74, and stacked using Helicon Focus software. The final illustrations were post-processed for contrast and brightness using Adobe® Photoshop® software. Morphological terminology follows Baumann (1975).

Holotypes and paratypes are deposited in the Entomological Museum of China Agricultural University, Beijing (CAU) and the Henan Institute of Science and Technology, Xinxiang (HIST), except one cleared paratype male of *A. qiliana* sp. nov. which is stored in the Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia (FSC EATB FEB RAS).

## Results and discussion

### *Amphinemura changbaishana* sp. nov.

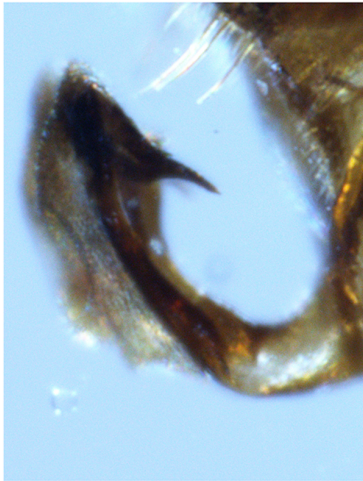
(Figs. 1–10)



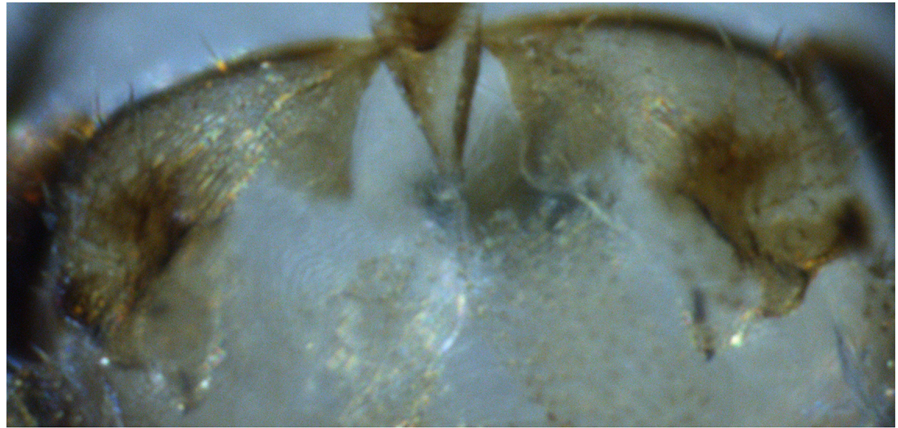
FIGURES 1–5. *Amphinemura changbaishana* sp. nov., male. 1. Terminalia, dorsal view. 2. Terminalia, ventral view. 3. Terminalia, lateral view. 4. Epiproct, dorsal view. 5. Head, dorsal view.



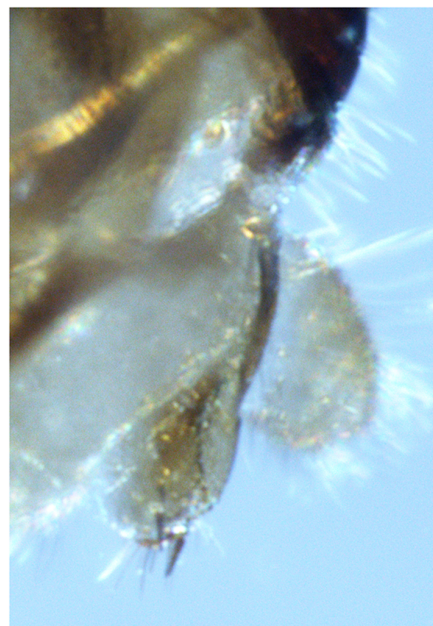
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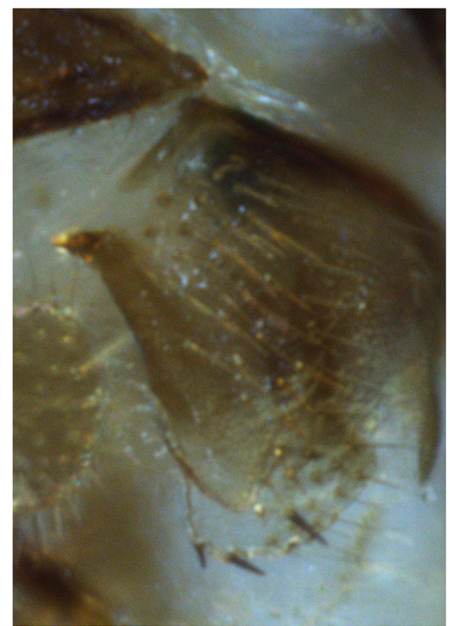
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**FIGURES 6–10.** *Amphinemura changbaishana* sp. nov., male. 6. Epiproct, dorsal view. 7. Epiproct, lateral view. 8. Paraprocts, caudal view. 9. Right paraproct, dorsal view. 10. Right paraproct, lateral view.

**Examined material.** Holotype male (CAU), CHINA: Jinlin Province, “scenic spot” on Changbaishan Mountain, 41°35' E 127°45', 6.VIII.2015, coll. Z. Kang. Paratype: 1 male (HIST), same locality and date as holotype.

**Description.** Adult habitus. General colour dark brown with light pattern. Head black except a heart-shaped brownish area covering the ocellar area; antennae light brown but pedicel and scape brown, compound eyes dark brown; head (Fig. 5) distinctly wider than pronotum; pronotum brown, surface distinctly coarse; legs yellowish brown.

**Male** (Figs. 1–4, 6–10). Forewing length ca. 6.5 mm. Tergum 9 sclerotized, the anterior margins more heavily, the posteromedial and anterolateral edges less; mid-posterior margin fringed with two paramedial groups of strong setae (Fig. 1). Vesicle of sternum 9 claviform, apical part swollen (Figs. 2 & 3). Hypoproct trapezoid in the basal half, with an obtuse angle in the middle of the outer edge, narrowed distally and terminates in a short tongue-shaped apex (Fig. 2). Tergum 10 darkly sclerotized, the anteromedian membranous concavity wider than the epiproct above it. Cercus short and conical, slightly longer than wide. Epiproct (Figs. 1, 3, 6–7): subrectangular with dark anterolateral serate expansions from caudal ends of which extends a pair of black prongs; dorsally sclerite covered with

robust sclerotized lateral bands; ventral sclerite strongly sclerotized, well visible by transparency after clearing, contour sinuous and medially slightly enlarged, anterior third with a ventral ridge with 4-5 stout black spines but in lateral view mostly hidden by the anterolateral prong (Fig. 3). Paraproct trilobed (Figs. 8–10): inner lobe a relatively large sclerotized triangular plate; median and outer lobes slightly longer than inner lobe; both sclerotized and claviform but the outer one more robust, apices convergent and with 3 black spines on the apical membrane (Figs. 8–10).

**Female.** Unknown.

**Remarks.** *Amphinemura changbaishana* is closely related to *A. denstigris* Zwick, 2010, *A. steinmanni* Zwick, 1973, and *A. rai* Ham & Lee, 1999, all originally described from the Korea Peninsula, sharing similar anterolateral epiproct prongs. Among these four species, *A. steinmanni* and the new species have only three paraproct spines, whereas *A. denstigris* and *A. rai* have numerous spines arranged in several rows; but epiproct of *A. steinmanni* differs greatly from *A. changbaishana*. By similarity in epiproct structure, *A. changbaishana* and *A. rai*, seems to be more closely related but can be easily separated by the paraprocts and also by details of epiproct. The anterolateral prongs of *A. rai* are located close to the middle line of the epiproct body, whereas the prongs in *A. changbaishana* are arranged along the lateral epiproct edges, both in dorsal and lateral views (Figs. 1, 3). Additionally, the basal portion of the lateral sclerites of the epiproct is more robust in *A. changbaishana* than in *A. rai*. Finally, the head pattern of *A. changbaishana* is distinctive with a large pale ocellar patch against the dark background which does not occur in the other related taxa mentioned above.

**Distribution.** China (Jilin Province).

**Etymology.** The specific name refers to Changbaishan the mountain system.

### *Amphinemura qiliana* sp. nov.

(Figs. 11–19)

**Examined material.** Holotype male, China: Qinghai Province, Qilian County, Arou Temple, Daotang River, 3150 m.a.s.l., 13.VII.2011, coll. W. Li (HIST). Paratypes, 1 male, same locality and date as holotype (HIST), 1 male (cleared and mounted), same locality and date as holotype (FSC EATB FEB).

**Description.** Adult habitus. Body length from tip of the head to the apex of abdomen, males, 4.0-4.5 mm, forewing length, males, 5.1-5.8 mm; wingspan, males, 11.2-12.6 mm. Head brown with U-shaped black band anterior of the anterior ocellus extending onto clypeus, lateral angles of the clypeus with rounded light-brown spot; M-line black and distinct (Fig. 11). A small rectangular black spot present on each inner side at the top of the epicranial suture in the antennal area. Interocellar area with a large light brown spot rounded posteriorly. A small semi-oval light brown spot present medially between posterior ocellus and the compound eye. Occiput covered by small black spots along the epicranial stem and behind each eye, extending to posterior ocelli. Pronotum light brown with rounded angles and X-shaped pattern consisting of small black spots which form a figure with sharp anterior angles and rounded posterior branches, posterior part of the pattern more pronounced (Fig. 11).

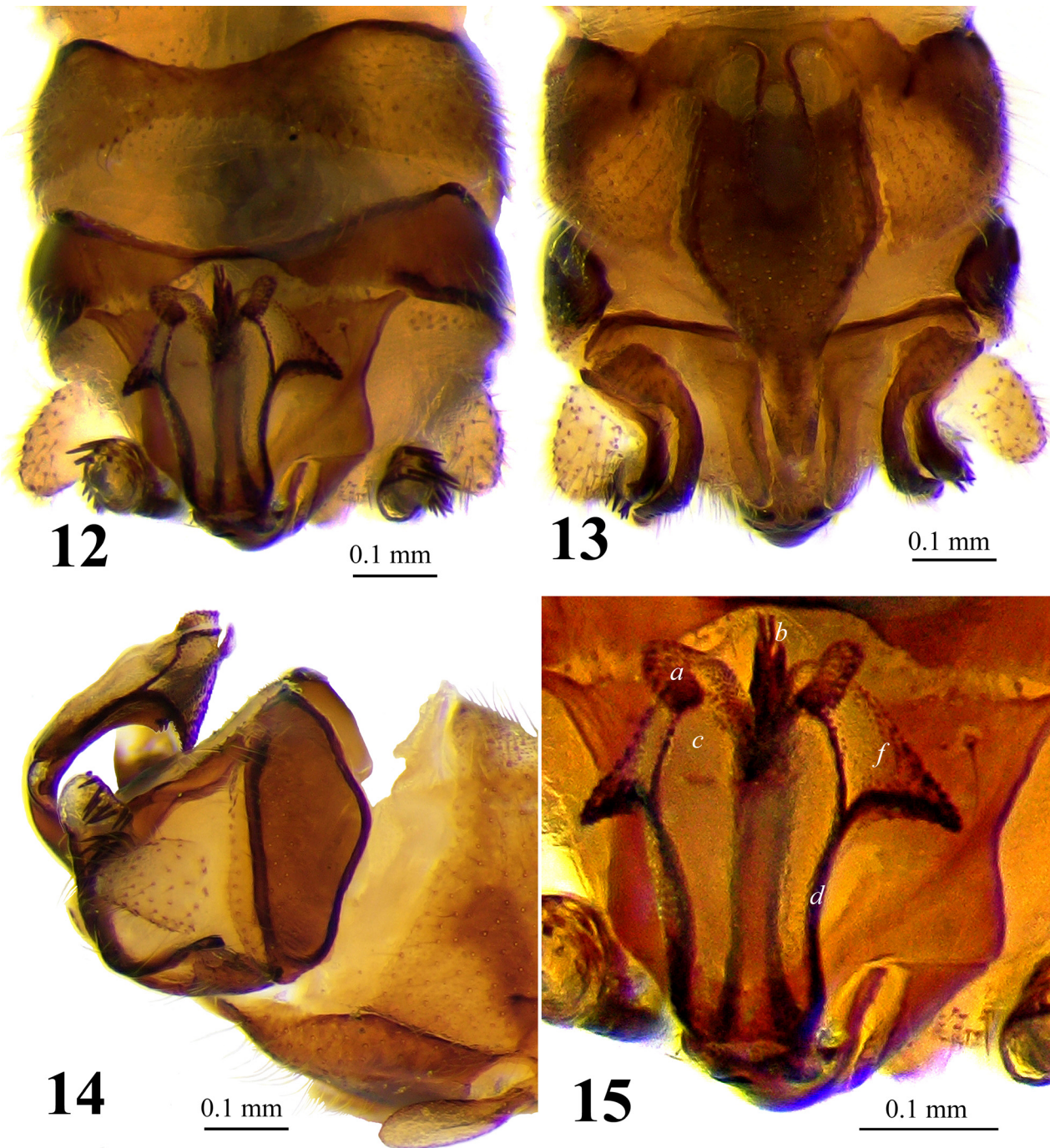
**Male.** Posterior margin of tergum 9 with notch and interrupted medially by a scattered fringe of long inwardly curved setae (Fig. 12). Subgenital plate of sternum 9 elongate, trapezoid in the first half anteriorly, with an obtuse angle in the middle of the outer edge, narrowed distally and terminating in a long rounded tongue-shaped extension; vesicle elongated, not reaching  $\frac{1}{2}$  length of the subgenital plate (Fig. 13). Tergum 10 medially forming a triangular sclerite plate with pointed anterior angles; two paramedial elongated leaf-shaped sclerites extend from the base of the epiproct to the triangular sclerite plate (Figs. 12, 15). Sternum 10 occupied by the broad bases of the paraprocts. Cerci membranous, oval, covered by hairs (Figs. 12–14). Paraprocts complex in ventral view: the inner paraproctal lobe elongated, less sclerotized than the other lobes, blade-like along medial edge (Figs. 13, 17); middle lobe large, elongate, and transverse at the base, mostly sclerotized at the inner edge and distally, extending first backward and then forward and up, curved dorsally; basally and along the inner edge with hairs (Figs. 13, 17). Dorsal face of the middle lobe apex a membranous rounded knob (Fig. 17), covered with a fringe of 6-8 long blunt black spines along the upper and rear face. Outer lobe is a narrow sclerite which bends outward and curves medially. Posterior branch of the outer lobe scoop shaped and slightly widened, its tip lies in the loop of the sclerite of the middle lobe, outer margin with 9-12 pointed black spines of the different size which are generally arranged in two rows (Fig. 17).

Epiproct in dorsal view lyre-shaped, narrowed at the base, widened and rounded anteriorly, with two anterolateral heavily sclerotized finger-shaped projections curved downward and densely covered with stout spicules (Fig.

15a); tip of the epiproct bifurcated (Fig. 12), consisting of thin tips of two ventral sclerites covered by fine spicules (Fig. 15b). Dorsum of the epiproct densely covered with fine spicules, surface divided by fine suture that anteriorly forms a shallow cleft separating two short membranous rounded lobes (Fig. 15c). Lateral arms (Fig. 15d) of the dorsal sclerite are long, narrow and darkly sclerotized, each lateral arm forks (Fig. 14) in the second half of length, the dorsal branch of the lateral arm extending to the base of anterolateral heavily sclerotized finger-shaped projection (Fig. 15a); the ventral branch of the lateral arm supporting lateral wing-shaped membranous lobe with an acute triangular apex directed obliquely downward, and covered with stout spicules especially densely on the posterior edge of the acute apex (Figs. 14, 15f, 16). In ventral view, the paired ventral sclerite heavily sclerotized, broad at the base, converge in the first ½ of their length, branched and narrowed towards the apex (Figs. 16, 15b). In lateral view, the ventral sclerite form keel-shaped ridges; each ridge bears 5 pairs of heavily sclerotized stout spines (Figs. 14, 16). Basal sclerites represented by two triangular sclerotized patches located at the basolateral margins of the epiproct (Figs. 12, 15).



FIGURE 11. *Amphinemura qiliana* sp. nov., male. head.



**FIGURES 12–15.** *Amphinemura qiliana* sp. n., male. 12. Abdominal tip, dorsal view. 13. Abdominal tip, ventral view. 14. Abdominal tip, lateral view. 15. Epiproct, cleared, dorsal view: *a*—anterolateral finger-shaped projection; *b*—apex of paired ventral sclerite; *c*—short membranous rounded lobe; *d*—lateral arm; *f*—lateral wing-shaped membranous lobe with an acute triangular apex.

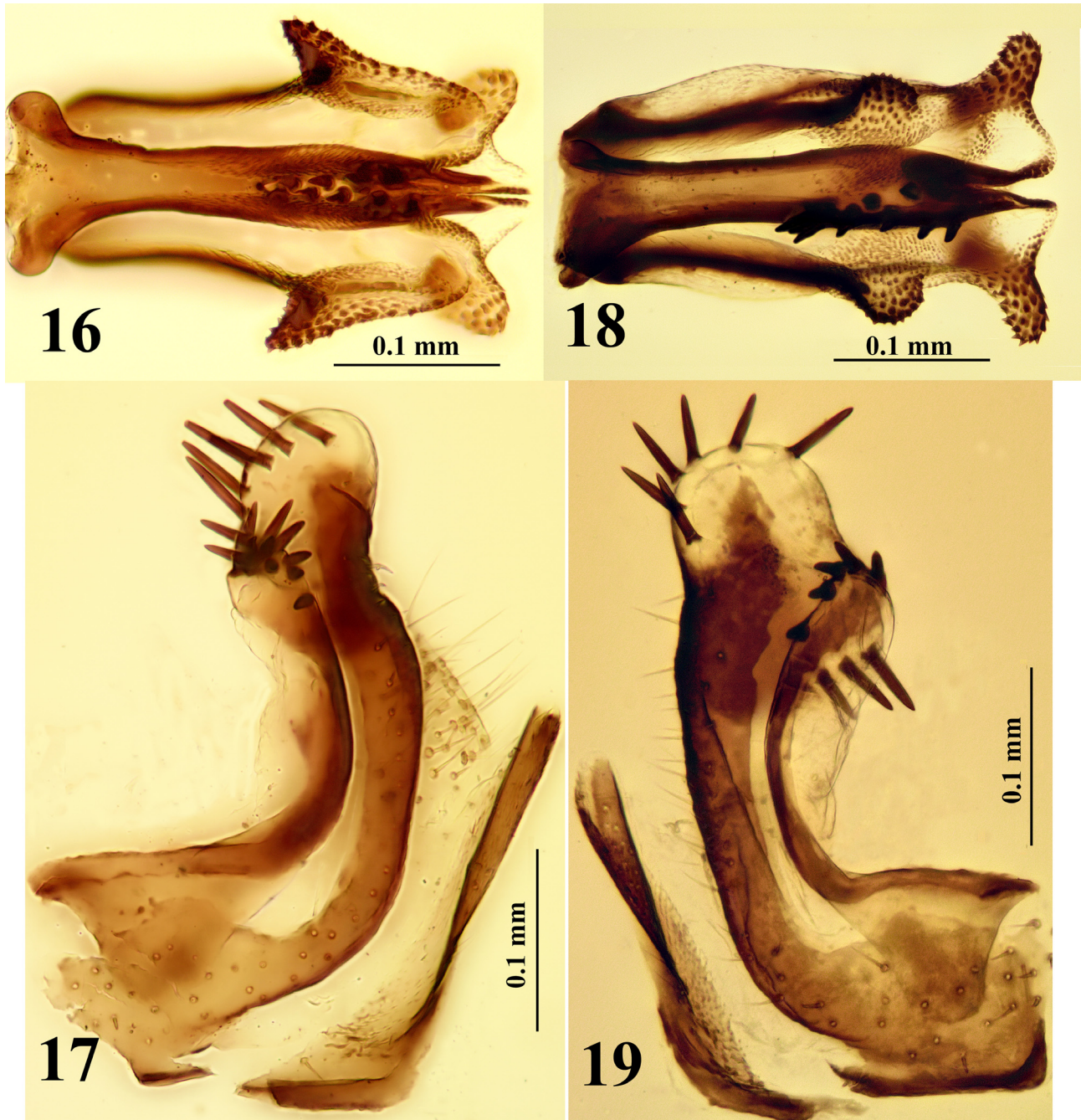
**Female.** Unknown.

**Remarks.** *Amphinemura qiliana* sp. n. appears to be closely related to *A. zwicki* Teslenko, 2015 (Teslenko 2015). Both species share the remarkable pair of anterolateral projections of the epiproct and the keel-shaped ventral sclerite with five pairs of stout spines. However, the anterolateral projection of *A. qiliana* is finger-like, longer than that of *A. zwicki* and curved dorsally downward; *A. zwicki* has bulbous projections directed towards each side of the bifurcated tip of the epiproct. *Amphinemura qiliana* can be also separated from *A. zwicki* by the shape of the lateral lobes of the epiproct which are wing-shaped with triangular apex directed obliquely downward and originating from the anterolateral apex of epiproct, longer than one third of epiproct. The lateral lobes of *A. zwicki* are bulbous,

rounded, and close to or covering partially the keel-shaped ridge of ventral sclerite (Fig. 18). Spines of the ventral sclerite of the epiproct of *A. qiliana* are short as compared to *A. zwicki*, which has long and pointed spines, especially at the base of keel (Fig. 18). Additional differences are the shape and number or location of the spines on the middle and outer paraproctal lobes: the middle paraproctal lobe of *A. zwicki* distally enlarged with spines on dorsal and ventral edges (Fig. 19) whereas the middle paraproctal lobe of *A. qiliana* is narrowed, shorter, and the spines located on dorsal edge. The outer lobe of *A. zwicki* has at most nine spines along the outer edge and *A. qiliana* bears 9-12 spines arranged in two rows (Fig. 17).

**Distribution.** The new species is known from the Daotang River, Qilian Mountains at 3,150 m.a.s.l. in north-western of China, straddling the border between Gansu and Qinghai provinces.

**Etymology.** The specific name *Amphinemura qiliana* refers to the type locality Qilian Mountains or Qilian County.



**FIGURES 16–19.** *Amphinemura qiliana*, sp. n., male, 16, 17. 16. Epiproct, cleared, ventral view. 17. Paraproctal lobes, cleared, ventral view. *Amphinemura zwicki*, male, 18, 19. 18. Epiproct, cleared, ventral view. 19. Paraproctal lobes, cleared, ventral view.

## *Amphinemura verrucosa* Zwick, 1973

**Examined material.** 1 female (CAU), the Northeastern China, Jinlin Province, scenic spot of Changbaishan Mountain, N 41°35' E 127°45', 6.VIII.2015, coll. Z. Kang.

**Remarks.** Known from Korea (Zwick 1973) and the South of the Russian Far East (Levanidova & Zhiltzova 1979). The only female examined for this study shows no notable differences from the original description and illustration of the female abdominal tip (Zwick 1973) and the associated male and female (Levanidova & Zhiltzova 1979). "Females are unmistakable because of a raised cone on the rear margin of sternum VII" (Zwick 2010). *Amphinemura verrucosa* is recorded for the stonefly fauna of China for the first time.

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