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Trichoptera of Liaoning Province, People's Republic of China

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Abstract

The caddisfly fauna of Liaoning Province, in northeastern China, is one of the least known Trichoptera faunas in the People's Republic of China, with only 21 species (and 1 subspecies) of the 1253 Chinese species reported previously from this Province. A recent collection from Mt. Laopingding, Fencheng City, included 13 species, at least 9 of which are new species records for the Province, 3 are new species records for Palearctic China, and 2 others are new records for China. The species belong to 7 genera and 5 families which were not previously known from Liaoning. Variations in the male genitalia of *Hydropsyche orientalis* Martynov, 1934 and *H. simulans* Mosely, 1942 are discussed.

Key words: Caddisflies, fauna, Mt. Laopingding, Fencheng City, Apataniidae, Glossosomatidae, Goeridae, Odontoceridae, Sericostomatidae

Introduction

Liaoning Province in northeastern P.R. China is home to about 44 million people as of 2012, with about 2.5 million at a density of about 160 persons/km^2 in Dandong Prefecture as of 2010 (Wikipedia 2015a). Population density in Dandong's Fengcheng City is less (about 105 persons/km^2 as of 2003), thus impacting surface freshwater resources with pollution less than in other parts of the Prefecture. Average annual temperatures range -7.4°C–23.4°C, with average rainfall of 92 cm in summer-wet and winter-dry seasons, providing a cool, wet climate (Wikipedia 2015b) that commonly supports a diverse Palearctic caddisfly fauna. Nevertheless, only 21 species and 1 subspecies of Trichoptera have been reported so far from Liaoning Province (Table 1), representing only about 1% of the 1253 species presently known from China (Yang *et al.* 2016).

Material And Methods

During 15–29 May 2014, JkL used an aerial net to sweep adult caddisflies from riparian bushes along an unnamed river on Mt. Laopingding, Fencheng City, about 15 m from the river. The river is 2 km long and at the collection site (300 m AMSL) was 1–3 m wide and 30–200 cm deep with a rocky bottom. No significant human activity was observed along the river. The dried specimens were sent in paper triangles to JCM, who relaxed and pinned them. Abdomina were cleared overnight in 10% KOH, remaining soft tissue was removed in 80% EtOH, and genitalia were suspended in glycerin for observation and illustration. Voucher specimens from this collection are in the Department of Geological Sciences, Harbin Normal University, Harbin, Heilongjiang, P.R. China, and the Clemson University Arthropod Collection (CUAC), Clemson University, Clemson, South Carolina, USA.

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TABLE 1. Species of caddisflies (Trichoptera) reported previously from Liaoning Province, P.R. China (Yang *et al*. 2016). EP = East Palearctic Region, NA = North America, OL = Oriental Region, WP = West Palearctic Region.

Species	Chinese Provinces	Other Countries
HYDROBIOSIDAE		
Apsilochorema sutshanum Martynov 1934	EP: Liaoning	EP: Japan, Russia
HYDROPSYCHIDAE		
Cheumatopsyche chinensis Martynov 1930	EP: "Manchuria" (=Liaoning, Jilin, Heilongjiang Provinces, sometimes northeastern Inner Mongolia); OL: Anhui, Fujian, Guizhou, Hainan, Hubei, Hunan, Jiangsu, Sichuan, Yunnan, Zhejiang	OL: Laos
LEPTOCERIDAE		
Oecetis (*Oecetis*) *intima* McLachlan 1877	EP: Liaoning (Changai Island)	Widespread EP, NA, WP
Parasetodes aquilonius Yang & Morse 1997	EP: Hebei, Heilongjiang, Liaoning	EP: Mongolia, southern Russian Far East.
Setodes argentatus Matsumura 1906	EP: Heilongjiang, Jilin, Liaoning; OL: Guizhou, Jiangxi, Yunnan	EP: Japan, Korean Peninsula, southern Russian Far East
LIMNEPHILIDAE		
Limnephilus correptus McLachlan 1880	EP: Heilongjiang, Jilin, Liaoning; OL: Sichuan	EP: Korean Peninsula, Russian Far East
Limnephilus fuscovittatus Matsumura 1904	EP: Liaoning; OL: Sichuan	EP: Japan, eastern Russia
Nemotaulius mutatus (McLachlan 1872, in Selys-Longchamps & McLachlan 1872)	EP: Heilongjiang, Liaoning; OL: Sichuan, Tibet	EP: Japan; eastern Russia WP: eastern Europe
PHILOPOTAMIDAE		
Wormaldia niiensis Kobayashi 1985	EP: Liaoning	EP: Japan, Kazakhstan, Korean Peninsula, Russia (Far East)
PHRYGANEIDAE		
Agrypnia colorata Hagen 1873	EP: Heilongjiang, Jilin, Liaoning	EP: Mongolia, Russia; NA: Canada, USA WP: Finland, Norway, Sweden
Agrypnia czerskyi (Martynov 1924)	EP: Heilongjiang, Jilin, Liaoning	EP: Korean Peninsula, Mongolia, eastern Russia; WP: Finland, Sweden
Agrypnia picta Kolenati 1848	EP: Heilongjiang, Jilin, Liaoning, Qinghai, Tibet	EP: Japan, Korean Peninsula, Mongolia, Russia; WP: Finland, Germany, Sweden, Switzerland
Eubasilissa mandarina Schmid 1959	EP: Gansu, Henan, Liaoning, Shaanxi; OL: Sichuan	None

...Continued on next page

TABLE 1. (Continued)

Species	Chinese Provinces	Other Countries
Oligotricha lapponica (Hagen 1864)	EP: Heilongjiang, Jilin, Liaoning	EP: Korean Peninsula, Russia; NA: Canada, USA (Alaska) WP: Finland, Norway
Phryganea (*Colpomera*) *japonica* McLachlan 1866	EP: Heilongjiang, Jilin, Liaoning	EP: Japan, Korean Peninsula, Russia (Kuriles)
Phryganea (*Colpomera*) *sinensis* (McLachlan 1862)	EP: Heilongjiang, Jilin, Liaoning; OL: Shanghai, Yunnan	EP: Korean Peninsula; Russian Far East
Phryganea (*Phryganea*) *bipunctata* Retzius 1783	EP: Heilongjiang, Jilin, Liaoning	EP: Mongolia, Russia; WP: Germany, The Netherlands, Poland, Sweden, Yugoslavia
Semblis atrata (Gmelin 1789)	EP: Liaoning	EP: Mongolia, Russia; WP: Finland, Germany, Norway, Sweden
Semblis atrata chinganica Martynov 1907	EP: "Manchuria" (=Liaoning, Jilin, Heilongjiang Provinces, sometimes northeastern Inner Mongolia)	None
POLYCENTROPODIDAE		
Neucentropus mandjuricus Martynov 1907	EP: Manchuria" (= Liaoning, Jilin, Heilongjiang, sometimes northeastern Inner Mongolia); OL: Jiangsu, Jiangxi	EP: Japan, Mongolia, southern Russian Far East; OL: Vietnam
RHYACOPHILIDAE		
Rhyacophila vicina Botosaneanu 1970	EP: Liaoning	EP: Korea Peninsula, Russian Far East
STENOPSYCHIDAE		
Stenopsyche marmorata Navás 1920	EP: Beijing, Heilongjiang, Jiling, Liaoning, Shaanxi, Xinjiang; OL: Hubei, Sichuan	EP: Japan, Korean Peninsula, east Russia

Results

Thirteen species of Trichoptera were identified in the collected material, at least 9 of which are new records for Liaoning Province, including 3 of which are new records for Palearctic China and 2 others of which are new records for China (Table 2). Five families (Apataniidae Wallengren, Glossosomatidae Wallengren, Goeridae Ulmer, Odontoceridae Wallengren, and Sericostomatidae Stephens) and 7 genera (*Apatania* Kolenati, *Agapetus* Curtis, *Glossosoma* Curtis, *Goera* Stephens, *Hydropsyche* FJ Pictet, *Psilotreta* Banks, and *Gumaga* Tsuda) are reported for the first time for Liaoning Province.

We provide further details for two species of *Hydropsyche* that vary somewhat from specimens previously described.

TABLE 2. Species of caddisflies (Trichoptera) captured as follows: CHINA: Liaoning Province [Dandong Prefecture]; Mt. Laopingding, Fencheng City; 15 m from river, 300 m elev.; 15–29.v.2014, sweepnet, Li Jing-ke leg. ^ = new Liaoning record, + = new Palearctic Chinese record, * = new Chinese record; EP = East Palearctic Region, OL = Oriental Region, WP = West Palearctic Region.

Genera-species	Males	Females	Known Chinese Provinces (Yang *et al*. 2016)	Known Other Countries
APATANIIDAE				
+*Apatania sinensis* (Martynov 1914)	1		OL: Hubei	EP: Korea, Russian Far East
GLOSSOSOMATIDAE				
^*Agapetus* sp.		1	Widespread	Widespread

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TABLE 2. (Continued)

Genera-species	Males	Females	Known Chinese Provinces (Yang *et al*. 2016)	Known Other Countries
^*Glossosoma ussuricum* (Martynov 1934)	1	11	EP: Heilongjiang, Jilin	EP: Japan, Russian Far East, Siberia
GOERIDAE				
^*Goera interrogationis* Botosaneanu 1970	3		EP: Heilongjiang, Jilin	EP: Korea
**Goera parvula* Martynov 1935	2	6	None (new Chinese record)	EP: Korea, Russian Far East
HYDROBIOSIDAE				
Apsilochorema sutshanum Martynov 1934	6		EP: Liaoning	EP: Japan, Russian Far East
HYDROPSYCHIDAE				
^*Hydropsyche orientalis* Martynov 1934	1		EP: Heilongjiang, Jilin, Shaanxi, Xinjiang	EP: Russia, Japan, Korean Peninsula, Mongolia; WP
+*Hydropsyche simulata* Mosely 1942	3		OL: Anhui, Fujian, Guangdong, Guangxi, Jiangxi, Zhejiang	EP: Korean Peninsula; OL: Vietnam
^*Hydropsyche* spp.		37	Widespread	Widespread
ODONTOCERIDAE				
**Psilotreta falcula* Botosaneanu 1970	12	4	None (new Chinese record)	EP: Korea; Russian Far East
PHILOPOTAMIDAE				
Wormaldia niiensis Kobayashi 1985	13	1	EP: Liaoning	EP: Japan, Kazakhstan, Korea, Russian Far East
RHYACOPHILIDAE				
Rhyacophila vicina Botosaneanu 1970	1		EP: Liaoning	EP: Korea, Russian Far East
SERICOSTOMATIDAE				
+*Gumaga orientalis* (Martynov 1935)	3		OL: Fujian, Sichuan	EP: Japan, Korea, Russian Far East, Siberia
STENOPSYCHIDAE				
^*Stenopsyche marmorata* Navás 1920	3	14	EP: Beijing, Heilongjiang, Jilin, Shaanxi, Xinjiang; OL: Hubei, Sichuan	EP: Japan, Korea, Russia (Kuriles, Sakhalin, Far East), Korea; OL: Bhutan, India

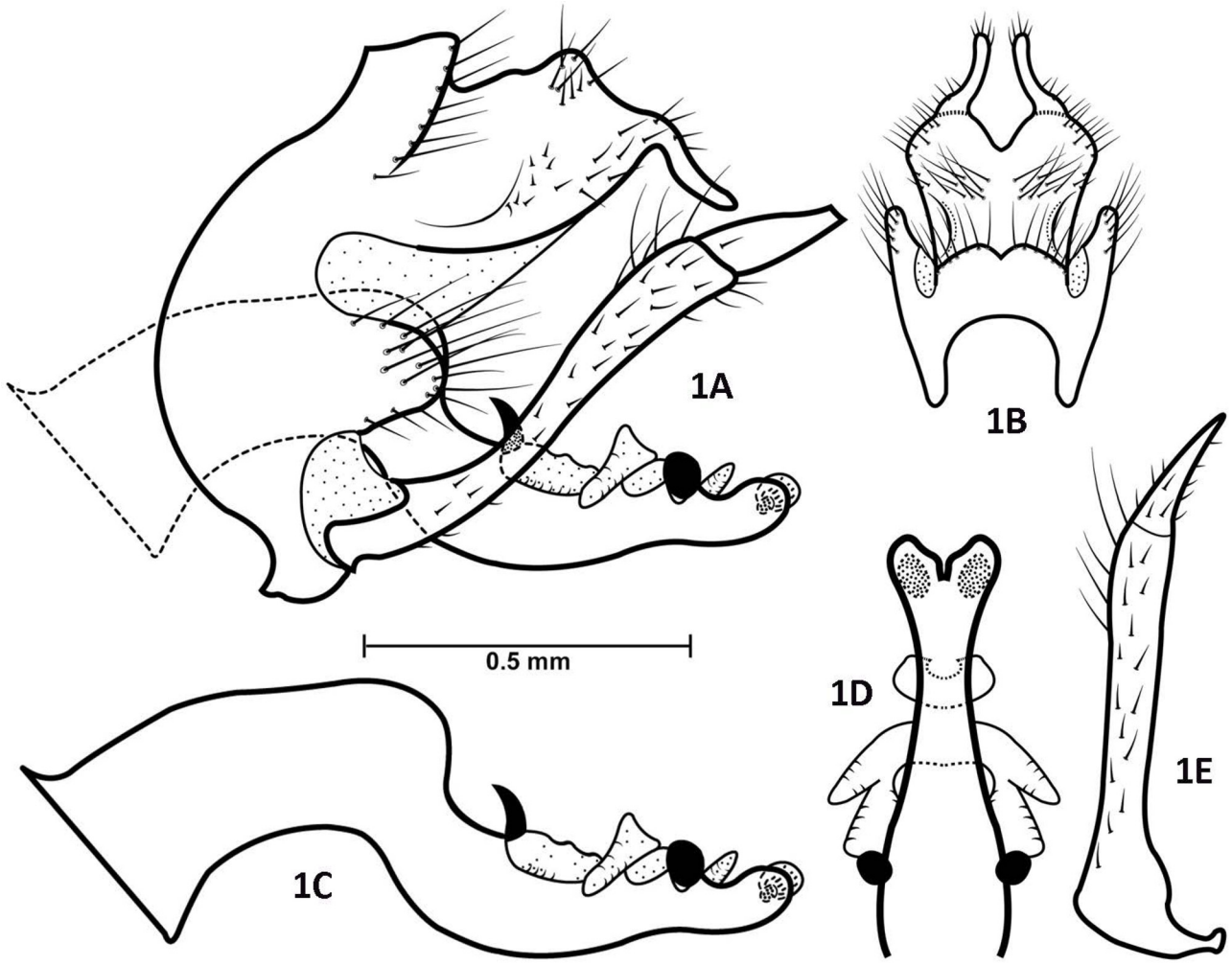
Hydropsyche orientalis Martynov, 1934
Figs. 1A–E

Hydropsyche nevae Ulmer, [nec Kolenati] 1907, 64 partim, figs. 91, 92 (male).

Hydropsyche orientalis Martynov, 1934, 276–277, 340, figs. 198a–c; holotype male from vicinity of Vinogradovka, in South Ussuri region [Far East Russia], deposited in the Russian Academy of Sciences, St. Petersburg, Russia. Botosaneanu 1970, 296, pl. 19 figs. 1–3 (male). Tanida 1982, 27. Tanida 1985, 179 (larva). Tanida 1986, 468, 470–473, figs. 1A–L (male, female, larva). Tanida 1991, 12 (synonymy). Tian *et al*. 1996, 102, figs. 173a–d (male). Ivanov 1997, 63, pl. 34 fig. 5, pl. 35 figs. 4, 12, pl. 36 figs. 6, 13 (male, female). Hur *et al*. 2000, 25–29, figs. 1–8 (larval instars 2–5, retreat, pupa, pupal case, male, female). Oláh & Johanson 2008, 129–130 (synonymy, new records). Additional references pertaining to biology and distribution provided by Morse (2015).

Hydropsyche ulmeri Tsuda, 1940 [nec Barnard], 26–27, 33 (male, female); 9 male, 10 female syntypes from 7 localities in Kyoto, Shiga, and Nagamo, Japan, deposited in Nara Women's University, Nara, but subsequently destroyed (T. Nozaki personal communication 1999). Tsuda 1942a, 231. Tsuda 1942b, 279–280. Tanida 1982, 27 (synonymized with *H. orientalis*). Tanida 1986, 470 (as synonym of *H. orientalis*).

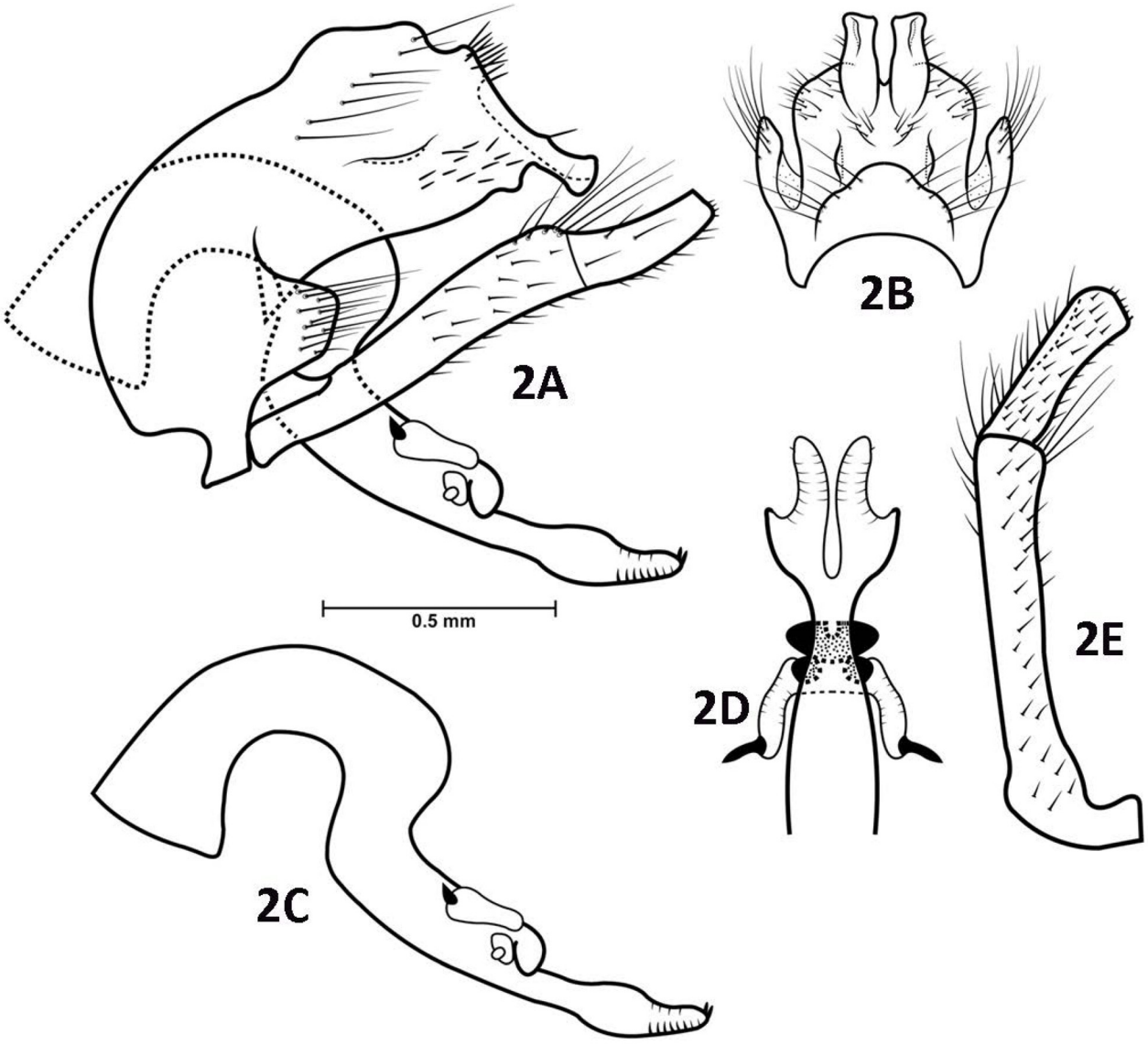
Hydropsyche tsudai Tani, 1977, 196, *nomen novum* for *Hydropsyche ulmeri* Tsuda. Tanida 1982, 27 (synonymized with *H. orientalis*). Tanida 1986, 470 (as synonym of *H. orientalis*).



FIGURES 1A–E. *Hydropsyche orientalis* Martynov 1934, male genitalia. 1A, left lateral; 1B, segments IX and X, dorsal; 1C, phallus, left lateral; 1D, phallus, ventral; 1E, left inferior appendage, caudoventral.

This common and widespread Palearctic species belongs to the *Hydropsyche annulata* Group (Malicky & Chantaramongkol 2000) or the *Hydropsyche newae* Species Clade (Oláh & Johanson 2008) and most closely resembles *H. newae* Kolenati, 1858 and *H. nevoides* Malicky & Chantaramongkol, 2000 in the general shape

of the male phallus and its armature. The inferior appendages are more sinuous and their apices are truncate and not acute in lateral view and the finger-like apices of tergum X are thicker and parallel apically in dorsal view, in contrast to the specimen illustrated by Ulmer (1907, as *H. nevae*) and referenced by Tsuda (1940). The apex of the phallus in our specimen is shorter and more rounded than illustrated by Martynov (1934). Also, the membranous arms of the parameres are longer and there is an additional pair of membranous lobes originating on the phallus dorsally before the phallotremal sclerites and projecting posterolaterad, not seen in Martynov's specimen (1934). In lateral view, the inferior appendages are less sinuous and the ventral margin of the phallus is concave for a shorter distance than in the specimen illustrated by Botosaneanu (1970, paratype from Vinogradovka, Ussuri, Russia). The male illustrated by Tanida (1986) is very similar to our specimen except that the middle of the phallus of our specimen is more strongly curved. The phallus of the male illustrated by Tian *et al*. (1996, from China) closely resembles that of Botosaneanu's specimen; the harpago of each inferior appendage of our specimen is shorter and more tapered than the harpagones of Tian *et al*. (1996). The inferior appendages of our specimen are more sinuous in lateral view and the paramere spines are shorter, stouter, and more nearly erect than those of the male specimen illustrated by Ivanov (1997, from Russia). Hur *et al*. (2000, from South Korea) provided no illustrations of male genitalia, but said "apical extensions of abdominal tergite X slender and widely departed each other, forming mesal rhombic structure"; however, the four sides of the space enclosed by these extensions in our specimen are not of equal length ("rhombic"), but instead have the distal portions longer, convergent, and apically parallel.



FIGURES 2A–E. *Hydropsyche simulata* Mosely 1942, male genitalia. 2A, left lateral; 2B, segments IX and X, dorsal; 2C, phallus, left lateral; 2D, phallus, ventral; 2E, left inferior appendage, caudoventral.

Hydropsyche simulata Mosely, 1942
Figs. 2A–E

Hydropsyche simulata Mosely, 1942, 350–351, 361, figs. 22–25; holotype male from vicinity of Foochow [Fuzhou, Fujian], China, deposited in The Natural History Museum, London, United Kingdom. Tian *et al*. 1996, 93, figs. 158a–d (male). Malicky & Chantaramongkol 2000, 812, pl. 25 (male, new records); Oláh & Johanson 2008, 142 (synonymy, new records).

Hydropsyche chekiangana Schmid, 1965, 141–142, pl. 5 figs. 7–10; holotype male from Wenchow [Wenzhou, Zhejiang], China. Tian *et al*. 1996, 93 (synonymized with *H. simulata*). Oláh & Johanson 2008, 142 (as synonym of *H. simulata*).

This primarily Oriental species (also previously reported from the Korean Peninsula) belongs to the *Hydropsyche annulata* Group (Malicky & Chantaramongkol 2000) or the *Hydropsyche simulata* Species Clade (Oláh & Johanson 2008). In lateral view, the inferior appendages of our specimens are more nearly straight than those of the holotype (Mosely 1942) or specimens illustrated by Tian *et al*. (1996, from China) or Malicky & Chantaramongkol (2000, from Henan or Zhejiang, China). In dorsal view the apical processes of tergum X are truncate in our specimens and those illustrated by Schmid (1965), Tian *et al.* (1996), and Malicky & Chantaramongkol (2000), not cleft as in the holotype (Mosely 1942). The dorsal or ventral profile of the phallus of our specimen has prominent subapicolateral shoulders that are inconspicuous in the specimens of Tian *et al.* (1996) and Malicky & Chantaramongkol (2000) and small in the holotype (Mosely 1942) and Schmid's (1965) specimen. In lateral view, the posterolateral margins of tergum X in our specimen are nearly straight on each side except for a small protrusion below the apical process and in caudal view each harpago is parallel-sided, rectangular; in all other illustrated specimens the posterolateral margin of tergum X is evenly rounded and the harpagones are broader apically than basally (Mosely 1942; Schmid 1965; Tian *et al.* 1996; Malicky & Chantaramongkol 2000).

Discussion

The caddisfly fauna of Liaoning Province now includes 30 species and 1 subspecies referable to 23 genera of 14 families (Tables 1, 2). These include an unidentified female of a species of *Agapetus* (Glossosomatidae). It is also possible that some of the female specimens of *Hydropsyche* are of additional species other than *H. orientalis* or *H. simulata*. This single 2-week collecting expedition in May increased the known fauna for the province by at least 30%.

Seventeen species and a subspecies in 12 genera of 4 families previously reported for Liaoning Province were not recovered in this investigation. The fact that 57% of the known fauna was not recovered indicates that the small sample period in one location was insufficient to represent the caddisfly flight season, habitat diversity, and range in the province.

The large proportion of new records for Liaoning Province is not surprising in consideration of the relatively small number of species reported previously from this province (Table 1). The province has more than 300 rivers and streams of various sizes. Most of them are slow-moving and broad, but those in the eastern portion of the province are clean and torrential (People's Government of Liaoning Province 2015), and are suitable habitats for caddisflies.

All 3 newly recorded species that had been reported previously in China only from the Oriental region and the 2 newly recorded species for China were known previously from East Palearctic locations outside of China. The number of species reported previously from the neighboring province of Hebei is 85 spp., Inner Mongolia 7 spp., and Jilin 27 spp. (Yang *et al*. 2016); the number from the Korean Peninsula is at least 132 spp. (Morse 2015). Clearly, additional research in Liaoning will add many more species to its fauna, most of which have been reported previously for the neighboring countries and Chinese provinces in the Palearctic Region.

Furthermore, refinements are needed to determine distributions of some northeastern Chinese species. For example, *Cheumatopsyche chinensis* Martynov 1930, *Semblis atrata chinganica* Martynov 1907, and *Neucentropus mandjuricus* Martynov 1907 were recorded as occurring in "Manchuria" and other parts of East Asia. Manchuria consists of the modern provinces of Liaoning, Jilin, Heilongjiang, and sometimes the northeastern portion of Inner Mongolia (Brummitt 2001; Britannica Concise Encyclopedia 2015). Yang *et al.*

(2016) considered these taxa to occur in Liaoning Province, but they may not actually live there. Further investigations should be performed to prove their distributions in Liaoning.

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