

New species of *Limnophyes* Eaton (Diptera, Chironomidae) from China and synonymy of *L. fuscipygmus* Tokunaga, 1940

Wenbin Liu¹, Cong Zhao¹, Fanqing Kong², Chuncai Yan¹, Xinhua Wang³

1 Tianjin Key Laboratory of Conservation and Utilization of Animal Diversity, Tianjin Normal University, Tianjin, 300387, China **2** Ecological Environment Monitoring and Scientific Research Center of Haihe River Basin and Beihai Sea Area, Ministry of Ecological Environment, Tianjin, 300170, China **3** College of Life Science, Nankai University, Tianjin 300071, China

Corresponding author: Chuncai Yan (skycc@tjnu.edu.cn)

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Abstract

Two new species, *L. minerus* Liu & Yan, **sp. nov.** and *L. subtilus* Liu & Yan, **sp. nov.** are described and illustrated as adult males. *Limnophyes minimus* (Meigen, 1818) is assigned as a senior synonym of *L. minerus* Tokunaga, 1940. A key to males of *Limnophyes* from China is presented.

Keywords

Identification key, morphology, synonymy, systematics, taxonomy

Introduction

Limnophyes was erected by Eaton (1875) with *Limnophyes pusillus* Eaton, 1875 as type species. Sæther (1990a, b) reviewed the Holarctic, Afrotropical and Neotropical members of this genus. Subsequently, the genus in different life stages and geographical areas were studied by a number of authors (Wang 2000; Chaudhuri et al. 2001; Langton and Moubayed 2001; Yamamoto 2004; Makarchenko et al. 2005; Mendes et al. 2007;

Murray 2007; Makarchenko and Makarchenko 2011; Moubayed 2011; Pinho and Andersen 2015; Song et al. 2020). To date, the genus comprises more than 90 species recorded worldwide (Ashe and O'Connor 2012; Song et al. 2020). However, although 28 species of *Limnophyes* have been recorded in Japan, only four of these are widespread Holarctic species. Most likely, many of the remaining Japanese names are synonymous with names from other regions, and a revision is desirable (Przhiboro and Sæther 2007).

To date, 16 species of the genus from China were described or recorded including two larvae, *L. pentaplastus* (Kieffer, 1921) and *L. pumilio* (Holmgren, 1869) (Wang and Sæther 1993; Wang 1997; Wang 2000; Song et al. 2020).

In this study we describe two new species of *Limnophyes* from Oriental China as male adults, provide a key to the known adult males of the genus from China, and suggest that *L. fuscipygmus* Tokunaga, 1940 from China be considered a synonym of *L. minimus* (Meigen, 1818).

Methods and material

The morphological nomenclature follows Sæther (1980). The material examined was mounted on slides following the procedure outlined by Sæther (1969). All samples have been stored in 85% ethanol prior to preparation. Color is described as observed in specimens mounted in Canada balsam on slides. Measurements are given as ranges followed by the arithmetic mean when four or more species were measured, followed by the number of specimens measured (*N*) in parentheses. All types are deposited in the College of Life Sciences, Nankai University, China (BDN).

Abbreviations used in text as follows: AR, antennal ratio = length of ultimate flagellomere/combined lengths of flagellomeres one to penultimate; fe, femur; HR, hypopygium ratio = gonocoxite length/gonostylus length; HV, hypopygium value = body length/gonostylus length \times 10; LR, leg ratio = tarsomere length/tibia length; LR₁, tarsomere I length/tibia length; p1–3, Legs (1–fore, 2–mid, 3–hind); R, Radius; R₁, Radius 1; R₄₊₅, Radius four and five; Cu₂, the second Cubitus; Ta1–5, tarsomeres 1–5; Ti, tibia; VR, ratio of length of Cu/length of M; BV, Length of (femur + tibia + ta1) / length of (ta2 + ta3 + ta4 + ta5); SV, Length of (femur + tibia) / length of ta; BR, longest seta on tarsomere 1/minimum width of tarsomere 1.

Taxonomy

Limnophyes minerus Liu & Yan, sp. nov.

<http://zoobank.org/559838A7-DBA7-4578-8408-841097D8A54F>

Figs 1–4

Type material. *Holotype* male (BDN No. 13105), CHINA: Sichuan Province, Kangding County, Wasi River, 30.051°N, 101.964°E, 3124 m a.s.l., light trap, 15.vi.1996,

X. Wang. **Paratype:** 1 male, Sichuan Province, Daocheng County, Sangdui Town, 29.038°N, 100.297°E, 3447 m a.s.l., sweep net, 11.vi.1996, X. Wang; 1 male, Hubei Province, Wufeng County, Houhe River, 30.199°N, 110.675°E, 1723 m a.s.l., sweep net, 1.vii.1997, B. Ji.

Diagnostic characters. The species can be separated from other members of the genus by having minute inferior volsella, virga consisting of one tapering spine, no lanceolate setae, and AR 0.24–0.27.

Etymology. From the Latin, *minerus*, minute or tiny, referring to the reduced inferior volsella, adjective in the nominative singular.

Description. Male ($N = 3$).

Total length 1.68–1.80 mm. Wing length 0.95–1.25 mm. Total length / wing length 1.44–1.76. Wing length / length of profemur 2.57–3.20.

Coloration. Head and thorax dark brown. Abdomen and legs brown. Wing nearly transparent.

Head. Antenna with 13 flagellomeres. AR 0.24–0.27. Ultimate flagellomere 79–98 μm long. Temporal setae 4–5, including 1 inner vertical, 1–3 outer verticals and 1–2 postorbitals. Clypeus with 10–21 setae. Tentorium 110–120 μm long, 14–18 μm wide. Palpomere lengths (in μm): 17–20, 22–25, 42–55, 35–52, 79–95. Length ratio of palpomeres 5/3 1.73–1.91.

Wing (Fig. 1). Anal lobe reduced. VR 1.22–1.30. Brachiolum with one seta. R with 1–3 setae. Costal extension 40–50 μm long. Squama with 2–4 setae.

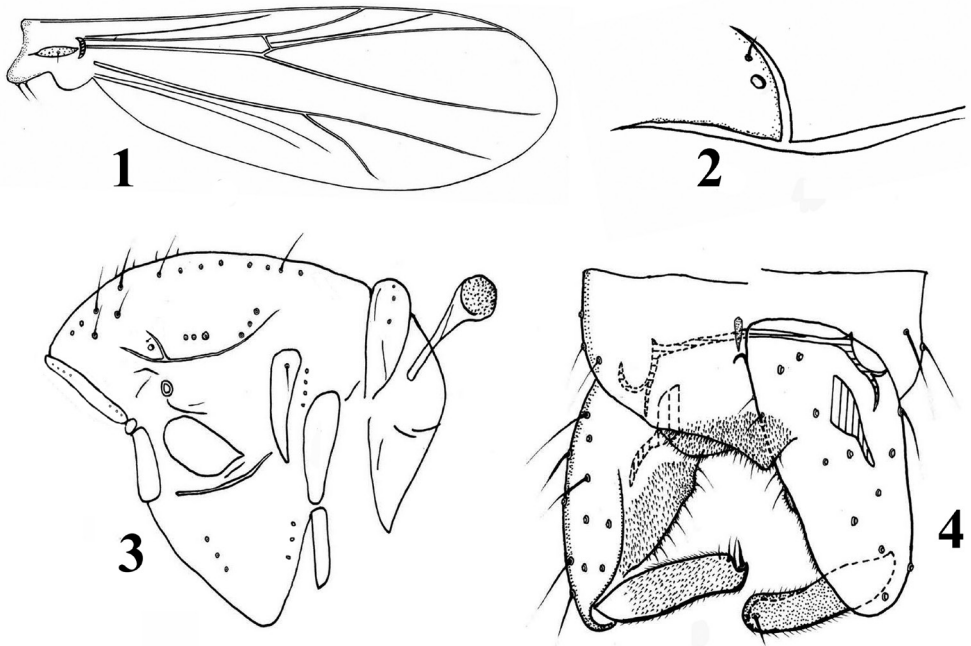
Thorax (Figs 2, 3). Anteprenotum with 2–4 median setae, and 2–3 lateral setae. Humeral pit (Fig. 3) small, with sclerotized anterior margin. Dorsocentrals 14–16, with 0–1 non-lanceolate humeral, and 14–15 non-lanceolate dorsocentrals. Preepisternum with 3 setae in anterior and posterior respectively. Acrostichals 4, prealars 4–5, supraalar 1, posterior anepisternum II with 3–4 setae, epimeron II with 4 setae, median anepisternum II with one seta; scutellum with 9 setae.

Legs ($N = 2$). Spur of fore tibia 33–37 μm long, of mid tibia 17–23 μm and 13–18 μm long, of hind tibia 37–38 μm and 13–15 μm long. Setae of tibial comb 28–30 μm long, comb with 11 teeth. Width at apex of fore tibia 25–26 μm , of mid tibia 24–25 μm , of hind tibia 30 μm . Lengths and proportions of legs in Table 1.

Hypopygium (Fig. 4). “Anal point” bluntly triangular, with 8–13 weak setae. Laterosternite IX with 2–3 setae. Phallapodeme 25–32 μm long; transverse sternapodeme 63–75 μm long. Virga 17–19 μm long, consisting of one tapering spine. Gonocoxite

Table 1. Lengths (in μm) and proportions of leg segments of male *L. minerus* Liu & Yan, sp. nov. ($N = 3$).

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄
P	310–390	430–510	220–240	130–140	80–95	45–50
P ₁ ^l	380–420	370–470	150–200	85–100	40–60	40–45
P ₃	390–450	420–510	230–280	110–120	95–130	50
	ta ₅	LR	BV	SV	BR	
P ₁	45–60	0.47–0.52	3.20–3.34	3.36–3.75	2.20–2.25	
P ₂	35–50	0.43–0.47	3.92–5.45	4.45–5.00	2.00–2.33	
P ₃	45–60	0.55–0.56	3.41–3.47	3.43–3.52	2.50–2.67	



Figures 1–4. *Limnophyes minerus* Liu & Yan, sp. nov., male **1** wing **2** humeral area of the thorax **3** thorax **4** hypopygium.

113–125 μm long. Inferior volsella minute. Gonostylus 65–73 μm long, with pointed crista dorsalis. Megaseta 10–16 μm long. HR 1.55–1.89, HV 2.58–2.73.

Remarks. The new species can be separated from other members of the genus by having a minute inferior volsella. The characters of the new species closely resemble *L. ninae* Sæther, 1975 (Sæther 1975, 1990a). However, the new species differs from the latter on the basis of following characters: (1) the humeral pit of the new species lacking lanceolate prescutellars, whereas in *L. ninae* the humeral pit has lanceolate setae inside the margin; (2) virga consisting of three spines with the median much shorter in *L. ninae*, whereas the new species has a single virga; (3) the AR of new species (0.24–0.27) is much lower than in *L. ninae* (0.62–0.77).

Distribution. The new species was collected in a subtropical mountain area in Hubei and Sichuan Provinces in Oriental China.

Limnophyes minimus (Meigen, 1818)

Chironomus minimus Meigen, 1818: 47.

Limnophyes pusillus Eaton, 1875: 60; Goetghebuer 1932: 196; 1940–50: 140; Brundin 1947: 83.

Spaniotoma (Limnophyes) pusilla (Eaton); Edwards, 1929: 355.

Limnophyes minimus (Meigen); Goetghebuer 1932: 108, 1940–50: 137.

Limnophyes interruptus Goetghebuer, 1938: 463.

Limnophyes immucronatus Sæther, 1969: 103.

Limnophyes hudsoni Sæther, 1975: 1032.

Limnophyes natalensis (Kieffer); Freeman 1957: 344, pro parte, (misidentified)

Limnophyes minimus (Meigen); Sæther 1990: 59; Wang and Sæther 1993: 216; Wang 2000: 636; Yamamoto 2004: 46; Makarchenko et al. 2005: 403, 2011: 115, Langton and Pinder 2007: 114.

Limnophyes fuscipygmus Wang, 2000: 636, nec Tokunaga, 1940: 287 syn. nov.

Material examined. Fujian Province, Fuzhou Agricultural University Campus, sweep net, 5 males, 22.iv.1993, W. Bu; Fujian Province, Nanping County, Maodi Town, sweep net, 4 males, 22.ix.2002, Z. Liu; Fujian Province, Shanghang County, Mt. Buyun, light trap, 5 males, 6.v.1993, W. Bu; Fujian Province, Wuyishan Natural Reserve Area, light trap, 31 males, 25.iv.1993, W. Bu; Guangxi Autonomous Region, Jinxiu County, Luoxiang Town, sweep net, 2 males, 9.vi.1990, X. Wang; Guangxi Autonomous Region, Longsheng County, sweep net, 5 males, 24.v.1990, X. Wang; Guizhou Province, Daozhen County, Dashahe Natural Reserve Area, sweep net, 1 male, 22.v.2004, H. Tang; Guizhou Province, Daozhen County, Xiaoshahe River, sweep net, 1 male, 25.v.2004, H. Tang; Hebei Province, Chengde City, Beidai River, sweep net, 1 male, viii.1986, X. Wang; Hebei Province, Chengde City, Saihanba Forest Park, sweep net, 1 male, 15.vii.2001, Y. Guo; Henan Province, Luanchuan County, Longyuwan Park, sweep net, 1 male, 13.vii.1996, J. Li; Henan Province, Baiyunshan Forest Farm, sweep net, 3 males, 16.vii.1996, J. Li; Henan Province, Song County, Baiyunshan Forest Farm, sweep net, 3 males, 16.vii.1996, J. Li; Hubei Province, Hefeng County, Mt. Fenshui, light trap, 3 males, 16.vii.1997, B. Ji; Hubei Province, Lifeng County, Houhe River, sweep net, 2 males, 30.vi.1997, B. Ji; Hubei Province, Lichuan County, Mt. Xingdou, sweep net, 3 males, 30.vi.1997, B. Ji; Hubei Province, Xianfeng County, Pingbaying Park, sweep net, 3 males, 25.vi.1997, B. Ji; Jiangxi Province, Poyang Lake, sweep net, 4 males, 12.vi.2004, C. Yan; Jiangxi Province, Yifeng County, Mt. Gongshan, sweep net, 2 males, 8.vi.2004, C. Yan; Jiangxi Province, Wuyishan Natural Reserve Area, light trap, 2 males, 13.vi.2004, C. Yan; Ningxia Autonomous Region, Mt. Liupan, Erlonghe Forest Farm, sweep net, 6 males, 7.viii.1987, X. Wang; Shanxi Province, Ningshan County, Huoditang Forest Farm, sweep net, 2 males, 12.viii.1994, W. Bu; Sichuan Province, Ganzi City, Yajiang River, light trap, 2 males, 14.vi.1996, X. Wang; Sichuan Province, Kangding City, Wasi River, light trap, 2 males, 15.vi.1996, X. Wang; Sichuan Province, Litang County, Zhaisang Region, sweep net, 2 males, 11.vi.1996, X. Wang; Sichuan Province, Mt. Emei, sweep net, 1 male, 17.v.1987, X. Wang; Xizang Autonomous Region, Xiazayu County, sweep net, 2 males, 24.iv.1988, C. Deng; Xizang Autonomous Region, Shigatse City, Zhangmu Town, sweep net, 6 males, 18.ix.1987, C. Deng; Yunnan Province, Fumin County, Daying Town, sweep net, 1 male, 1.vi.1996, X. Wang; Yunnan Province, Wuding County, Mashan Town, sweep net, 1 male, 1.vi.1996, X. Wang; Zhejiang Province, Baishanzu Natural Reserve

Area, light trap, 2 males, 18.iv.1994, H. Zou; Zhejiang Province, Tianmushan Natural Reserve Area, light trap, 1 male, 17.viii.1999, H. Zou.

Remarks. *Limnophyes minimus* (Meigen, 1818) is one of the dominant species of *Limnophyes* in China. Of all the specimens examined, some variation can be found. One specimen from Guangxi Province had a strongly reduced anal lobe, antenna with 10 segments, and LR_1 of 0.59, i.e., outside the range of 0.45–0.55. Two specimens from Sichuan and Yunnan provinces have AR 0.20 and 0.30, both lower than the minimum value of Sæther's description (AR 0.48). One specimen from Fujian Province had 9-segmented antenna, and high length ratio of palpomeres 5/3 (2.11).

Tokunaga (1940) described the species *L. fuscipygmus* based on materials from Taiwan Province, China. The holotype specimen of *L. fuscipygmus* mainly agrees with the description of *L. minimus* by Sæther (1975: 1032, figs 2–4), especially the characters of humeral pit, anal point, inferior volsella, and gonostylus. Consequently, it must be considered a junior synonym of *L. minimus*.

Distribution. The species is widespread, and it has been recorded in all the six Chinese geographical regions. It occurs both in Palaearctic and Oriental China.

***Limnophyes subtilus* Liu & Yan, sp. nov.**

<http://zoobank.org/56360531-A0B1-4140-8CB9-711A0E6672C7>

Figs 5–8

Type material. *Holotype* male (BDN No. 12222), CHINA: Sichuan Province, Daocheng County, Daocheng River, 29.112°N, 100.146°E, 2492 m a.s.l., sweep net, 11.vi.1996, X. Wang. *Paratype*: 5 males, as holotype.

Diagnostic characters. The new species can be separated from other members of the genus by having 9–21 lanceolate humerals, 7–9 lanceolate prescutellars, megaseta hair-like, virga very slender, and anal lobe moderately developed.

Etymology. From the Latin, *subtilus*, thin, slender, referring to the shape of the virga, adjective in the nominative singular.

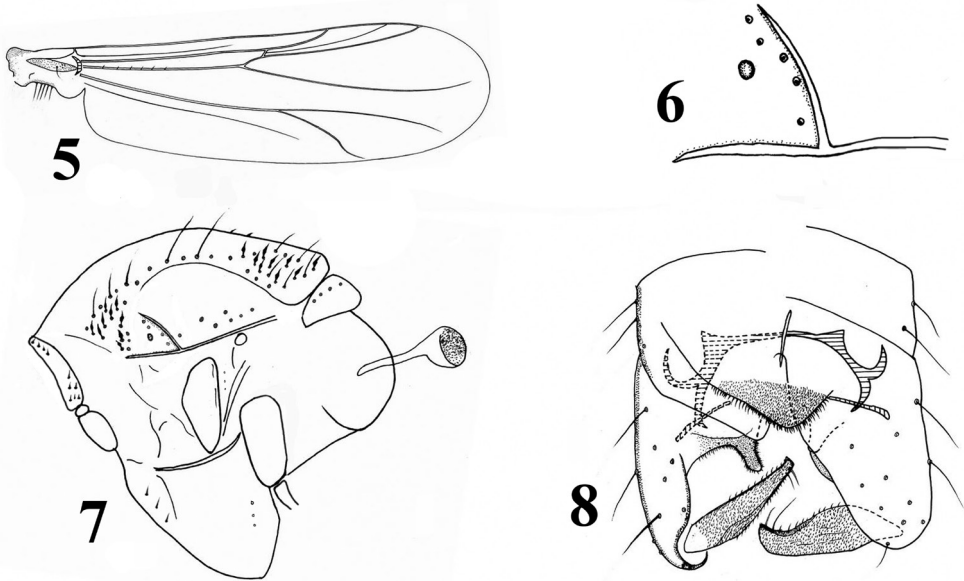
Description. Male ($N = 6$).

Total length 2.53–2.83, 2.67 mm. Wing length 1.56–1.73, 1.63 mm. Total length / wing length 1.54–1.74, 1.64. Wing length / length of profemur 2.97–3.16, 3.05.

Coloration. Head, thorax and legs dark brown. Abdomen yellowish brown. Wing nearly transparent.

Head. Antenna with 13 flagellomeres. AR 0.76–0.88, 0.83. Ultimate flagellomere 295–330, 310 μm long. Temporal setae 5–7, 6, including 1 inner vertical, 2 outer verticals and 2–4, 3 postorbitals. Clypeus with 14–18, 16 setae. Tentorium 132–140, 136 μm long, 22 μm wide. Palpomere lengths (in μm): 25–31, 28; 40–45, 43; 79–95, 86; 78–90, 85; 120–128, 125. Length ratio of palpomeres 5/3 1.26–1.62, 1.44.

Wing (Fig. 5). Anal lobe moderately developed. VR 1.20–1.29, 1.26. Brachiolium with one seta. R with 5–6, 5 setae. Costal extension 22–40, 31 μm long. Squama with 6–8, 7 setae.



Figures 5–8. *Limnophyes subtilis* Liu & Yan, sp. nov., male **5** wing **6** humeral area of the thorax **7** thorax **8** hypopygium.

Table 2. Lengths (in μm) and proportions of leg segments of male *L. subtilis* Liu & Yan, sp. nov. ($N = 6$).

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄
P ₁	540–580, 560	690–730, 712	340–360, 352	200–230, 215	130–140, 132	80–90, 87
P ₂	590–620, 602	620–650, 632	270–290, 280	170–180, 178	120	60–80, 72
P ₃	590–630, 605	730–760, 745	420–440, 432	220	190–200, 192	95–100, 98
	ta ₅	LR	BV	SV	BR	
P ₁	80	0.49	3.04–3.25, 3.20	3.61–3.64, 3.62	1.84–2.00, 1.88	
P ₂	55–70, 64	0.44–0.45, 0.44	3.47–3.55, 3.49	4.38–4.48, 4.41	2.50	
P ₃	80	0.55–0.60, 0.58	2.97–3.05, 3.02	3.13–3.16, 3.14	2.00–2.60, 2.38	

Thorax (Figs 6, 7). Antepronotum with 3–4, 4 median and 4–6, 5 lateral setae. Humeral pit (Fig. 7) rounded, with sclerotized posterior margin. Dorsocentrals 43–47, 45, including 9–21, 14 lanceolate humerals, 6–10, 8 non-lanceolate humerals, 14–19, 15 other non-lanceolate dorsocentrals, and 7–9, 8 lanceolate prescutellars. Preepisternum with 2–3, 3 setae in anterior row, and posterior with 3 setae. Acrostichals 2–6, 5; prealars 4–10, 7; supraalar 1; posterior anepisternum II with 2–4, 3 setae; epimeron II with 3 setae; scutellum with 6–9, 8 setae.

Legs. Spur of fore tibia 44 μm , of mid tibia 17–19, 18 μm and 14–18, 16 μm long, of hind tibia 37–45, 41 μm and 13–22, 17 μm long. Tibial comb 42–45, 44 μm long, comb with 13 teeth. Width at apex of fore tibia 31–40, 35 μm , of mid tibia 31–33, 32 μm , of hind tibia 31–40, 35 μm . Lengths and proportions of legs in Table 2.

Hypopygium (Fig. 8). “Anal point” broadly rounded, with 17–32 setae. Laterosternite IX with 3–5, 4 setae. Phallapodeme 43–62, 50 μm long; transverse sternite

podeme 68–83, 77 μm long. Virga 32–35, 33 μm long, consisting of slender single spine. Gonocoxite 141–148, 144 μm long. Inferior volsella with developed digitiform dorsal lobe. Gonostylus 84–98, 91 μm long, with pointed crista dorsalis. Megaseta hair-like, 17–20, 19 μm long. HR 1.46–1.68, 1.59; HV 2.81–3.15, 2.95.

Remarks. The characters of the new species mainly agree with *L. eltoni* (Edwards, 1922) (Sæther 1990b). However, the new species differs from the latter on the basis of following characters: (1) the obvious costal extension of the new species (22–40 μm), shorter than for *L. eltoni* (77–94 μm); (2) “Anal point” of *L. eltoni* strongly projecting with apical notch, whereas in the new species it is not notched; (3) the new species has hair-like megaseta in the gonostylus, whereas the megaseta of *L. eltoni* is spine-like, subapically.

Distribution. The species were collected in a subtropical mountain area in Sichuan Province in Oriental China.

Key to adult males of *Limnophyes* from China

- 1 Preepisternum with dorsocentral to posterocentral group of setae, no anterior setae..... *L. brachytomus* (Kieffer)
- Preepisternum with anterior row of setae, with or without additional dorso-central to posterocentral setae 2
- 2 Dorsocentral without lanceolate humerals and/or prescutellars 3
- Dorsocentral with lanceolate humerals and/or prescutellars 6
- 3 “Anal point” strongly bifid, inferior volsella triangular
..... *L. verpus* Wang & Sæther
- “Anal point” not bifid, inferior volsella not triangular 4
- 4 First abdominal segment pale..... *L. palleocestus* Wang & Sæther
- First abdominal segment brown..... 5
- 5 Inferior volsella very small or absent..... *L. minerus* Liu & Yan, sp. nov.
- Inferior volsella moderately large, rectangular *L. minimus* (Meigen)
- 6 More than 13 lanceolate humerals and lanceolate prescutellars combined... 7
- Less than 10 lanceolate humerals and lanceolate prescutellars combined... 11
- 7 Virga very slender, anal lobe slightly projecting.....
..... *L. subtilus* Liu & Yan, sp. nov.
- Virga not slender, anal lobe reduced or right angled..... 8
- 8 Lanceolate prescutellars absent..... *L. pumilio* (Holmgren)
- Lanceolate prescutellars present..... 9
- 9 Megaseta long, bristle-like..... *L. optimus* Wang & Sæther
- Megaseta absent or hair-like..... 10
- 10 “Anal point” apically notched, AR 0.49–0.79 *L. pentaplastus* (Kieffer)
- “Anal point” apically not notched, AR 0.18–0.30 *L. gurgicola* (Edwards)
- 11 Gonostylus with strongly triangular protrusive middle part
..... *L. triangulus* Wang
- Gonostylus without such strongly triangular protrusive middle part 12

- 12 Gonostylus with rounded crista dorsalis.....*L. orbicristatus* Wang & Sæther
 – Gonostylus often with pointed crista dorsalis..... 13
 13 “Anal point” pronounced parallel-sided, dorsal lobe of inferior volsella triangular *L. habilis* (Walker)
 – “Anal point” not parallel-sided, dorsal lobe of inferior volsella not triangular...14
 14 Thorax with scalpellate acrostichals, virga with 3 spines
 *L. aquamatus* Andersen
 – Thorax without scalpellate acrostichals, virga with 1 or 2 spines..... 15
 15 Flagellum with 11–12 flagellomeres, a strong tubercle in place of humeral pit..... *L. bullus* Wang & Sæther
 – Flagellum with 13 flagellomeres, humeral pit not as above..... 16
 16 Virga consisting of two fused spines, “Anal point” relatively small, broad-based, bluntly triangular *L. nudus* Song, Zheng, Wang & Qi
 – Virga consisting of one simple spine, “Anal point” strong to moderately projecting with or without apical notch *L. difficilis* Brundin

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