Review of the *Lispe tentaculata*-group (Diptera: Muscidae) in China, with one new synonym

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Published on 30 September 2016

urn:lsid:zoobank.org:pub:274FFB6A-8EED-4409-95E6-B528860CC0BC

Ge Y., Gao Y., Yan L., Liu X. & Zhang D. 2016. — Review of the *Lispe tentaculata*-group (Diptera: Muscidae) in China, with one new synonym. *Zoosystema* 38 (3): 339-352. http://dx.doi.org/10.5252/z2016n3a4

ABSTRACT

The Chinese fauna of *Lispe tentaculata*-group is reviewed. A new synonym for *L. sericipalpis* Stein, 1904 is established: *L. fanjingshanensis* Wei, 2006 n. syn. Taxonomic status of the suspected species *L. alpinicola* Wu & Fan, 1981 is discussed. The keys to males and females of all five species within the group in China are established. Morphological details of both sexes are illustrated using light microscopy photographs, scanning electronic microscopy images and line drawings, of which male and female terminalia are summarized as novel characteristics for diagnosis. The group is divided into two subgroups (*L. tentaculata*-subgroup and *L. orientalis*-subgroup) based on two characteristics (first fore tarsomere and phallus). To fill the gap of molecular research in *Lispe*, we construct a phylogenetic tree within the genus focusing on *L. tentaculata*-group, which verifies the division of two subgroups.

KEY WORDS

Muscidae, *Lispe tentaculata*-group, review, new subgroups, phylogenetic relationships, China, new synonym.

MOTS CLÉS

Muscidae, groupe *Lispe tentaculata*, révision, sous-groupes nouveaux, relations phylogénétiques, Chine, synonymie nouvelle.

RÉSUMÉ

Révision du groupe de *Lispe tentaculata* (Diptera: Muscidae) de Chine, avec établissement d’un nouveau synonyme.

Les espèces chinoises du groupe de *Lispe tentaculata* (Muscidae) sont révisées. Un nouveau synonyme pour *L. sericipalpis* Stein, 1904 est établi: *L. fanjingshanensis* Wei, 2006 n. syn. Le statut taxonomique de l’espèce supposée *L. alpinicola* Wei & Fan, 1981 est discuté. Des clés sont établies pour les mâles et les femelles des cinq espèces du groupe présentes en Chine. Les détails morphologiques des deux sexes sont illustrés avec des photographies en microscopie optique, des images en microscopie électronique à balayage, et des dessins au trait; notamment, les terminalia mâles et femelles sont présentés comme de nouveaux caractères de diagnosis. Le groupe est divisé en deux sous-groupes (les sous groupes *L. tentaculata*- et *L. orientalis*) sur la base de deux caractères (premier tarsomère antérieur et phallus). Pour faire avancer les recherches moléculaires sur *Lispe*, nous avons reconstruit un arbre phylogénétique partiel du genre en nous focalisant sur le groupe *L. tentaculata*: cet arbre confirme la séparation en deux sous-groupes.
INTRODUCTION

Numerous dipteran taxonomists have contributed their efforts to *Lispe* in the past, by which they built up the fundamental taxonomy system of this genus (Kowarz 1892; Stein 1897; Becker 1903, 1904; Aldrich 1913; Malloch 1922; Snyder 1954; Henning 1960; Pont 1977, 1986; Lopes 1992). In China, systematic investigations on this genus were mainly conducted by Wu (1940), Fan (1965, 1992), Xue & Chao (1998) and Xue & Zhang (2005). Most recently, Vikhrev (2014, 2015) has took comprehensive taxonomic notes on the worldwide fauna of nine species-groups and two species-complexes.

Concerning the *Lispe tentaculata*-group, it was initially proposed by Synder (1954), consisting of three species in the Nearctic Region: *L. patellata* Aldrich, 1913; *L. sociabilis* Loew, 1861 and *L. tentaculata* (DeGeer, 1776). In the study of Palearctic diptera, Henning (1960) redefined this species-group and expanded it with four additional species: *L. consanguinea* Loew, 1858; *L. draperi* Séguy, 1933; *L. orientalis* Wiedemann, 1824 and *L. quaerens* Villeneuve, 1936. Pont (1986) considered *L. draperi* as a synonym for *L. tentaculata* and Vikhrev (2011) re-evaluated it as a valid species. Meanwhile, Vikhrev (2011) synonymized *L. quaerens* under *L. sericipalpis* Stein, 1904. Besides, two more species was added to this group after Henning (1960): *L. alpinicola* from Lhasa, Xizang, China by Zhong, Wu & Fan (1981) and *L. endeni* from Jaipur, Rajasthan, India by Vikhrev (2012). The validity of *L. alpinicola* is doubted by Vikhev (2011, 2014) but we hold a different view and consider it an independent species (see the remarks below). In sum, we reviewed the five species of *L. tentaculata*-group in China.

Well-defined as it is, *L. tentaculata*-group remains to be treated more explicitly and carefully since considerable morphological differences still exist between the species within this group.

Though work on *Lispe* morphology is quite abundant, rare molecular research is available for us to explore the true relationship within this genus. As mitochondrial DNA sequences (12S, 16S, COI and Cytb) and nuclear genome sequences (28S, Ef1a and CAD) using primers (Table 2). The reaction system of PCR (polymerase chain reaction) follows Zhang et al. (2010). PCR products are sequenced bidirectionally by BGI in the same way as Zhang et al. (2016). All sequences are edited and assembled with SeqMan (DNASTar, Steve ShearDown, 1998-2001 version, DNASTAR Inc., USA), then aligned using MAFFT (version 7, Katoh et al. 2013). SequenceMatrix (v1.7.9, Meier et al. 2006) is employed to concatenate individual alignments. And PartitionFinder (v1.1.1, Lanfear et al. 2012) is used to evaluate the best partition: schemes = greedy, branch lengths = unlinked, model selection = BIC. The best partitioning scheme for dataset and the respective best models are determined (Table 1). Phylogenetic analysis is performed using maximum likelihood (ML) methods and Bayesian as described in Zhang et al. (2016).

**ABBREVIATIONS**

**Leg chaetotaxy**

\[
\begin{align*}
  a & \text{ anterior seta(e);} \\
  d & \text{ dorsal seta(e);} \\
  p & \text{ posterior seta(e);} \\
  v & \text{ ventral seta(e);} \\
  ad & \text{ anterodorsal seta(e);} \\
  av & \text{ anteroventral seta(e);} \\
  pd & \text{ posterodorsal seta(e);} \\
  pv & \text{ posteroventral seta(e).}
\end{align*}
\]
Lispe tentaculata-group in China

Anatomy
ap appendage;
cer cerci;
ep epiproct;
hp hypoproct;
ster sternite;
ter tergite.

Institutions
SEMCAS Shanghai Entomological Museum, Chinese Academy of Science, Shanghai;
MBFU Museum of Beijing Forestry University, Beijing;
MNHN Muséum national d’Histoire naturelle, Paris.

Molecular phylogeny
12S 12S ribosomal RNA gene;
16S 16S ribosomal RNA gene;
COI cytochrome oxidase subunit I gene;
Cytb cytochrome b gene;
28S 28S ribosomal RNA gene;
Ef1a Elongation factor 1 alpha.

TABLE 1.—Information of species used for phylogenetic analyses and GenBank Accession Numbers. n.a., no data; *, new sequences generated for this study.

| Species                     | Collecting date | Collecting location (province of China) | COI       | 12S       | 16S       | 28S       | Cytb      | Ef1a      | CAD       |
|-----------------------------|-----------------|----------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Coenosia semifumosa Stein, 1914 | n.a.           | n.a.                                   | KJ510613  | KJ476265  | KJ476301  | KJ476336  | KJ510547  | KJ510586  | n.a.      |
| Limnophora simulans Stein, 1913 | n.a.           | n.a.                                   | KJ510626  | KJ476278  | KJ476313  | KJ476348  | KJ510559  | n.a.      | n.a.      |
| Lispe apicalis Mik, 1869     | 2014 Xinjiang  | KX856023* KX856037* KX856045* KX856040* KX856017* KX856031* KX856022* |           |           |           |           |           |           |           |
| Lispe consanguinea Loew, 1858 | 2013 Xinjiang  | KX856024* KX856035* KX856048* n.a.    | KX856016* | n.a.      |           |           |           |           |           |
| Lispe leucospilia Hennig, 1960 | n.a.           | n.a.                                   | KP16194   | n.a.      | n.a.      | n.a.      | n.a.      | KP161827  |           |
| Lispe neimongola Tian & Ma, 2000 | 2009 Xinjiang | KX856028* KX856034* KX856046* KX856041* KX856014* KX856030* KX856020* |           |           |           |           |           |           |           |
| Lispe nivalis Wiedemann, 1830 | n.a.           | n.a.                                   | KJ510628  | n.a.      | KJ476315  | KJ476350  | KJ510561  | n.a.      | n.a.      |
| Lispe orientalis Wiedemann, 1824 | 2013 Hubei    | KX856025* KX856036* KX856043* n.a.    | KX856013* | n.a.      | n.a.      | n.a.      | n.a.      | n.a.      | n.a.      |
| Lispe nivalis Stein, 1904     | 2013 Hubei    | KX856025* KX856033* KX856047* KX856012* KX856029* KX856019* |           |           |           |           |           |           |           |
| Lispe tentaculata (DeGeer, 1776) | 2013 Liaoning | KX856027* KX856038* KX856044* KX856039* KX856015* KX856032* KX856018* |           |           |           |           |           |           |           |

TABLE 2.—Primers sequences used for PCR amplification and sequencing.

| Gene | Primer Sequence | References |
|------|-----------------|------------|
| 12S  | AAA CTA GGA TTA GAT ACC CTA TTA | Kutty et al. 2014 |
|      | CCC TGA TAC ACA AGG TA           |            |
| 16S  | CGC CTG TTT AAC AAA AAC AT       |            |
|      | TGA ACT CAG ATG TAA GAA A        |            |
| 28S  | AGC GGA GGA AAA GAA AC           |            |
|      | GCT ATC CTG AGG GAA ACT TCG G    |            |
| COI  | TAC AAT TTA TCG CCT AAA CTT CAG CC | Folmer et al. 1994 |
|      | CCC GGT AAA ATT AAA ATA TAA ACT TC |            |
|      | CCA CAT TTT GTC TTA TTT TTT GG  |            |
|      | TCC AAT GCA CTA TGC CAT ATTA    |            |
|      | GGT CAA CAA ATC ATA AAG ATA TTA G |            |
|      | TAA ACT TCA GGA TGA CCA AAA AAT CA |            |
| Cytb | TAT GGT TTA CCT TGA GGA CAA ATA TC | Kutty et al. 2014 |
|      | AAA TCC TAT CTT ATG TTT TCA AAA C |            |
| Ef1a | CAG GAA ACA GCT ATG ACC GCT GAG CGY GAR COT GGT ATC AC |            |
|      | ACA GCC ACK GTY TGY CTC ATR TC |            |
| CAD  | GGD GTN ACN GCN TGY TTY GAR CC  | Moulton & Wiegmann 2003 |
|      | TTN GGN AGY TGN CCN CCC AT      |            |

Anatomy
ap appendage;
cer cerci;
ep epiproct;
hp hypoproct;
ster sternite;
ter tergite.

Institutions
SEMCAS Shanghai Entomological Museum, Chinese Academy of Science, Shanghai;
MBFU Museum of Beijing Forestry University, Beijing;
MNHN Muséum national d’Histoire naturelle, Paris.
3. Palpi yellow, apex broad and round; fore tibia without median p, mid tibia with 1 pd, length of finger-like protuberance equal to ½ of second fore tarsomere; only abdominal tergite 3 with dark stripe .............................................. Lispe consanguinea Loew, 1858
— Palpi black, apex slightly narrow; fore tibia with 1 median p, mid tibia with 3 pd, length of finger-like protuberance longer than ½ of second fore tarsomere; abdominal tergites 3-5 with dark stripes ................................................................. Lispe alpinicola Zhong, Wu & Fan, 1981

4. Palpi brownish yellow; hind femur with complete av and pv rows .......... Lispe orientalis Wiedemann, 1824
— Palpi blackish brown; hind femur without complete av and pv rows .......... Lispe sericipalpis Stein, 1904

KEY TO FEMALES OF **Lispe tentaculata**-GROUP IN CHINA
(characters of *L. alpinicola* adapted from Zhong *et al.* 1981)

1. Palpi dark brown; hind femur only with 4 or 5 fine av on apical half .......... Lispe sericipalpis Stein, 1904
— Palpi yellow .................................................................................................................................................. 2

2. Hind femur with complete av and pv row ..................................................... Lispe orientalis Wiedemann, 1824
— Hind femur without pv row, without av or at most on apical ½ with 1 or 2 av ................................................. 3

3. Postesutural part of scutum without velutinous patch; mid and hind tibiae yellowish-brown; hind femur without av on apical ⅔ ........................................................................................................ Lispe consanguinea Loew, 1858
— Postesutural part of scutum with yellowish-brown to blackish brown velutinous patch between the 2 dc rows; mid hind tibia dark grey; hind femur with 1 or 2 long av on apical ⅔ .................................................................................. 4

4. Posterior part of prescutal sulcus with dark or light yellowish-brown velutinous patches ...................................... Lispe tentaculata (DeGeer, 1776)
— Posterior part of prescutal sulcus with brown to black brown velutinous patches .............................................. Lispe alpinicola Zhong, Wu & Fan, 1981

**SYSTEMATIC ACCOUNT**

**Lispe tentaculata**-group

**Lispe tentaculata**-group Synder, 1954: 6. — Hennig 1960: 408. — Xue & Zhang 2005: 122. — Vikhrev 2011: 59; 2014: 153.

**DIAGNOSIS.** — The *Lispe tentaculata*-group is distinguished from other species-group of this genus by the following characters (modified from Snyder 1954, Hennig 1960 and Vikhrev 2011, 2014): aristaplumose, palpi abruptly expanded in apical half; meron setulose

**TABLE 3.** — Best partitioning scheme for the dataset and the respective models.

| Partitions | Best Model |
|------------|------------|
| 12S, 16S   | GTR+G      |
| 28S, CAD, Efia | HKY+G     |
| COI, Cytb   | GTR+H      |

Herein, we update the diagnosis with more detailed genital characters of both sexes (some male genital characters have been mentioned by Snyder 1954) and bring up the distinctive characteristics of two subgroups:

Male: Fifth sternite with a median, anteriorly directed process in addition to the short and apically semi-membranous lateral processes; cercal plate with an inverted U- to V-shaped incision on each side (Fig. 1); gonopod degenerated and fused with hypandrium into a projection (Figs 6; 7); phallus non-membranous.

Female: Abdominal tergites 6 and 7 sometimes divided medially (*L. consanguinea* and *L. tentaculata*), abdominal sternite 6 sometimes degraded into 2 small semi-transparent setulose sclerites (*L. consanguinea* and *L. tentaculata*), abdominal tergite 7 fused with sternite 7, abdominal tergite 8 partly fused with sternite 8, epiproct divided medially into 2 setulose sclerites, cerci with appendage (Figs 3; 4).

— *L. tentaculata*-subgroup: first fore tarsomere modified (except *L. sociabilis*); phallus straight.

— *L. orientalis*-subgroup: first fore tarsomere regular; phallus with a vertically bended distal part.

— Chinese Species:

— *L. tentaculata*-subgroup: *L. alpinicola* Zhong, Wu & Fan, 1981; *L. consanguinea* Loew, 1858 and *L. tentaculata* (DeGeer, 1776).

— *L. orientalis*-subgroup: *L. orientalis* Wiedemann, 1824 and *L. sericipalpis* Stein, 1904.
Lispe alpinicola Zhong, Wu & Fan, 1981
(Fig. 11A)

Lispe alpinicola Zhong, Wu & Fan, 1981: 245. — Fan 1992: 368. — Xue & Chao 1998: 994. — Xue & Zhang 2005: 123. — Vikhrev 2011: 63.

DISTRIBUTION IN CHINA. — Xizang (type locality: Lhasa).

REMARKS
Vikhrev (2011) doubted that this species might be a synonym for *L. tentaculata* and later Vikhrev (2014) proposed this synonym for the reason that the presence of additional *p* on fore and mid tarsi of *L. alpinicola* also presents in several specimens of *L. tentaculata* in the collection of Zoological Museum of the Moscow University. However, no other characters were compared and discussed between these two species in his works. In order to clarify the status of *L. alpinicola*, we tried to find the types in SEMCAS but failed, which is likely to be lost. Without examining the types, we can’t draw a convincing conclusion about its validity. Here we present the original text (Zhong et al. 1981, in Chinese and with an English abstract, not cited in Vikhrev’s works): “This species is closely related to the Holarctic species *Lispe tentaculata*, from which it differs in having the palpi black, the fore tibia with a median seta on posterior surface, the process of the fore metatarsus rather long, the mid tibia with 3 *pd* etc.” Also, in Zhong, Wu & Fan’s remarks, females are distinguished from the color of velutinous patches at postesutural part of scutum. According to the original description, we separate these two species in the keys above.

Another evidence confirms our opinion about the validity of *L. alpinicola* is its difference in male phallus compared with other related species. Their phallus images are placed together for comparison (Fig. 11) especially concentrated on: 1) relative length of aedeagal apodeme and hypandrium; 2) relative length of paramere and phallus; and 3) relative size of submedian membranous part which only exists in *L. alpinicola*.

Lispe consanguinea Loew, 1858
(Figs 1A; 2A; 3A, C, E; 5A, B, C)

Lispe consanguinea Loew, 1858: 8.

MATERIAL EXAMINED. — 3 ♂ and 1 ♀, Liaoning: Dalian, Xiajiahe, 7.VIII.2009, Coll. R. Bi; 1 ♂, Xinjiang: Quiresu, 27.VIII.2009, Coll. D. Zhang; 1 ♂ and 1 ♀, Shandong: Yantai, 1.VII.2009, Coll. Grade 2008 of Biology; 2 ♀, Shandong: Weifang, 16.VII.2012, Coll. X. H. Liu; 3 ♂ and 3 ♀, Shandong: Weifang, 16.VII.2012, Coll. X. H. Liu; 3 ♂ and 6 ♀, Liaoning: Benxi, 26.VIII.2013, Coll. Y. T. Guan. MNHN: 1 ♂, Shandong: Weifang, 16.VII.2009, Coll. D. Zhang; 1 ♂, Xinjiang: Kalamaili, 22.VIII.2013, Coll. D. Zhang.
**DISTRIBUTION IN CHINA.** — Beijing, Gansu, Hebei, Heilongjiang, Jilin, Liaoning, Neimenggu, Shaanxi, Shandong, Shanxi, Xinjiang, Yunnan.

**REMARKS**
The finger-like protuberances on fore tarsi of *L. consanguinea* and *L. tentaculata* look identical by eyes. However, SEM images of the structure reveal interspecific difference concerning the blunt end of the protuberance (Fig. 5): *L. consanguinea* possesses less thorns (Fig. 5C) while *L. tentaculata* has thicker and bended thorns (Fig. 5F). More to mention, all these thorns are bifurcate except the middle one in both species (Fig. 5C, F).
**Lispe orientalis** Wiedemann, 1824  
(Figs 1B; 2B; 3B, D, F; 6A, C, E; 7A, B)  
*Lispe orientalis* Wiedemann, 1824: 51.

**MATERIAL EXAMINED.** — 1 ♂, Beijing: Mt. Song, 31.V.2009, Coll. by D. Zhang; 9 ♂ and 2 ♀, Beijing: Mt. Song, 1.VI.2009, Coll. D. Zhang; 5 ♂ and 3 ♀, Beijing: The Old Summer Palace, 10.V.2009, Coll. D.P. Liu, R. Bi and J.H. Chen; 11 ♂ and 5 ♀, Yunnan: Ba-
Oshan, 14.VII.2013, Coll. J. Na; 10 ♂ and 5 ♀, Hunan: Yichang, 7-22.VII.2013, Coll. M. Zhang.

**Distribution in China.** — Anhui, Beijing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Hubei, Hunan, Jilin, Jiangsu, Liaoning, Shanghai, Shaanxi, Sichuan, Taiwan, Zhejiang, Yunnan.

**Lispe sericipalpis** Stein, 1904

**(Figs 1C; 2C; 4A, C, E; 6B, D, F; 7C, D; 8-10)**

**Lispe quaerens** Villeneuve, 1936: 157.
**Lispe tienmuensis** Fan, 1974: 94. — Pont 1986: 191.
**Lispe fanjingshanensis** Wei, 2006: 511 (n. syn.)

**Lispe sericipalpis** Stein, 1904

(Figs 1C; 2C; 4A, C, E; 6B, D, F; 7C, D; 8-10)

*Fig. 5.* — SEM images of finger-like protuberance on first tarsi of *Lispe consanguinea* Loew, 1858 (A-C) and *L. tentaculata* (De Geer, 1776) (D-F), ventral views: **A, D**, fore tarsi; **B, E**, finger-like protuberances; **C, F**, blunt apex of the protuberance. Scale bars: **A, D**, 400 μm; **B, E**, 200 μm; **C, F**, 20 μm. Arrows: the only un-bifurcate middle thorn on the blunt end of the finger-like protuberance.
Fig. 6. — SEM images of male genitalia of *Lispe orientalis* Wiedemann, 1824 (A, C, E) and *L. sericipalpis* Stein, 1904 (B, D, F): A, B, genitalia, anterior views; C, D, origins of parameres; E, F, distal part of phalli. Scale bars: A, 200 μm; B, 120 μm; C, D, F, 40 μm; E, 80 μm.
Type Material. — Holotype (of *Lispe tienmuensis* Fan), in SEMCAS, ♂, labeled (1) Mt. Tianmu/ Chinese Academy of Science (CAS) [printed, in Chinese]; (2) 1954.IX.11, Coll. Fan & Shen [printed except IX.11 handwritten, in Chinese]; (3) holotype [printed]; (4) type/ *Lispe tienmuensis* Fan 1963, V [first line printed, second handwritten]; (5) *Lispe quaerens* Vill., 1936/ Fan, 1974.IV.22 [handwritten, in Chinese]; allotype (of *Lispe tienmuensis* Fan), in SEMCAS, 1 ♀, labeled (1) Mt. Tianmu/ July.28.1937 [printed, Tienmushan= Mt. Tianmu]; (2) allotype/ *Lispe tienmuensis* Fan, 1963.V. [first line printed, second handwritten]; (3) allotype [printed].

Other Material Examined. — 6 ♂ and 3 ♀, Beijing: Mt. Song, 1-5.VI.2009, Coll. Grade 2007 of Biology; 7 ♂ and 6 ♀, Sichuan: Meigu County, VIII.2010, Coll. L.P. Ma and H.Q. Huang; 3 ♂ and 2 ♀, Shandong: Yantai, 1.VII.2011, Coll. Grade 2008 of Biology; 2 ♂ and 2 ♀, Beijing: Mt. Song, 18.VI.2013, Coll. 7 ♂ and 7 ♀, Yunnan: Baoshan, 14.VII.2013, Coll. J. Na; 82 ♂ and 67 ♀, Hubei: Yichang, Mt. Dalaoing, 22.VII.2013, Coll. D. Zhang and M. Zhang; 5 ♂ and 10 ♀, Jiangxi: Jian, Suichuan County, 12.X.2014, Coll. M. Zhang and C. Wang, MNHN: 2 ♂ and 1 ♀, Sichuan: Dafengding, VIII.2010, Coll. H. Q. Huang, C. W. Gu and L. P. Ma.

Distribution in China. — Hubei, Gansu, Guangdong, Guangxi, Guizhou, Jilin, Liaoning, Shanxi, Shaanxi, Sichuan, Yunnan, Zhejiang.

Remarks

Fan (1974) recorded *Lispe tienmuensis* (Figs 9, 10) (though the specimens were labeled as type material in 1963, it was not until 1974 when the work was published) and noted, "Closely related to *L. orientalis* Wd. but with narrowed parafacialia, poorly haired mid-femur in both sexes, narrowly pointed anal..."
Lispe tentaculata DeGeer, 1776

(Figs 1D; 2D; 4B, D; 5D, E; 11C, D)

**Lispe tentaculata** DeGeer, 1776: 86.

**Material Examined.** — 3♂, Beijing: Mt. Song, 31.V.2009, Coll. D. Zhang; 1♀, Beijing: Mt. Song, 1.VI.2009, Coll. D. Zhang; 47♂ and 35♀, Xinjiang: Kalamaili Nature Reserve, 11-14.VIII.2009, Coll. D. Zhang; 6♂ and 7♀, Xinjiang: Tekesi, 24.VIII.2013, Coll. M. Zhang; 85♂ and 62♀, Xinjiang: Kalamaili Nature Reserve, 18.V-23.VI.2014, Coll. M. Zhang.

**Distribution in China.** — Beijing, Hebei, Heilongjiang, Jilin, Liaoning, Shandong, Shanxi, Xinjiang.

**Remarks**

Hennig’s drawing (1960: 408, fig. 131, with a bended distal part) of the phallus of *L. tentaculata* is not the same as in our dissection (Fig. 11D, specimen from Xinjiang). In our dissection, the phallus of *L. tentaculata* is straight and without a bended distal part, identical to Snyder’s drawing (1954: 15, fig. 53) of the phallus of *L. sociabilis*, about which he stated “might serve equally well for *patellata* and Nearctic specimens of *tentaculata*” (Snyder 1954: 38). Snyder’s statement was confirmed by Vikhrev (2014: 154). These images are placed in one plate for comparison. We speculate that Hennig’s drawing was based on either an aberrant *L. tentaculata* or an underlying species that curiously have both modified first fore tarsomere and bended phallus, an intermediate taxon between *L. tentaculata*-subgroup and *L.orientalis*-subgroup (more information in Discussion below).

**Molecular Phylogeny**

Analysis of maximum likelihood and Bayesian inference recovered largely congruent results and most of the species has a high leaf stability value (Fig. 12). The monophyly of *Lispe* is highly supported (maximum likelihood bootstrap: 98, Bayesian posterior probability: 1), which was already suggested by Kutty et al. (2014). The *L. tentaculata*-group is confirmed to be monophyletic here as well (maximum likelihood bootstrap: 87, Bayesian posterior probability: 1).
Based on two morphological features (first fore tarsomere and phallus), the *L. tentaculata*-group could be separated as two subgroups (*L. tentaculata*-subgroup with modified first fore tarsomere and straight phallus while *L. orientalis*-subgroup is distinguished with regular first fore tarsomere and bended phallus). The tree topologies from the different analyses, ML and Bayesian, are highly corroborated that the group is split into two clades (maximum likelihood bootstrap: 100, Bayesian posterior probability: 1). Therefore, the proposal of two subgroups within *L. tentaculata*-group is verified.

**DISCUSSION**

Our analyses of this group both in morphology and phylogeny reveal the relationships between four species within the *L. tentaculata*-group. Other holarctic species from the group all fall strictly into the definitions of two subgroups except the Nearctic *L. sociabilis*, which has straight phallus but unmodified first fore tarsomere. Another case with characters that contradict with the diagnoses of two subgroups is Hennig’s drawing of *L. tentaculata* (1960: 408, fig. 131). We can not
be certain about whether Hennig’s illustration was derived from an abnormal \textit{L. tentaculata} or an independent species that has both modified first fore tarsomere and bended phallus. However, these two cases are clear evidences of the existence of intermediate taxa between \textit{L. tentaculata}-subgroup and \textit{L. orientalis}-subgroups. More species should be involved in both morphological and phylogenetic research to explore the diversification patterns within this species-group.

Acknowledgements
This study was funded by the National Nature Science Foundation of China (No. 31201741, 31572305) and New Century Excellent Talents in University (No. NCET-12-0783). We thank Dr Weibing Zhu for the help in examining the types of \textit{L. tienmuensis} in SEMCAS. Sincere gratitude to Drs Nikita Vikhrev and Christophe Daugeron for reviewing the manuscript, and to Mr. Emmanuel Delfosse for helping checking the MNHN specimen information.

REFERENCES

ALDRICH J. M. 1913. — The North American species of \textit{Lispa} (Diptera: Anthomyiidae). \textit{Journal of the New York Entomological Society} 21: 126-146.
BECKER T. 1903. — Aegyptische Dipteren. \textit{Mitteilungen aus dem Zoologischen Museum in Berlin} 2: 67-195.
BECKER T. 1904. — Die Palaarktischen Formen der Dipterenarten \textit{Lispa} Latr. \textit{Zeitschrift fuer Entomologie Breslau} 29: 1-70.
FAN Z. D. 1965. — Key to Common Flies of China. First Edition. Science Press, Beijing, 60-64 p. [In Chinese]
FAN Z. D. 1974. — Three New Species and One New Subspecies of Anthomyiidae and Muscidae from China (Diptera). \textit{Acta Entomologica Sinica} 1 (17): 92-96. [In Chinese with English summary]
FAN Z. D. 1992. — Key to the Common Flies of China. Second Revised Edition. Science Press, Beijing, 367-379 p. [In Chinese with English summary]
FOLMER O., BLACK M., HOEH W., LUTZ R. & VRIJENHOEK R. 1994. — DNA primers for amplification of mitochondrial cytochrome oxidase subunit I from diverse metazoan invertebrates. \textit{Molecular Marine Biology and Biotechnology} 3: 294-299.
HENNIG W. 1960. — Muscidae, in LINDNER E. (ed.), \textit{Die Fliegen der Palaearktischen Region}, 63b. Stuttgart, Schweizerbart’sche Verlagshuchhandlung, 399-460 p.
KOWARZ F. 1892. — Die europaischen Arten der Dipterengattung \textit{Lispa} Latr. \textit{Wiener Entomologische Zeitung} 11: 33-54.
KATOH, K., STANDELEY D. M. 2013. — MAFFT Multiple Sequence Alignment Software Version 7: Improvements in performance and usability. \textit{Molecular Biology and Evolution} 30: 772-780.
KUTTY S. N., PAPE T., WIEGMANN B. M. & MEIER R. 2008. — The Musoidea (Diptera: Calyptratae) are paraphyletic: Evidence from four mitochondrial and four nuclear genes. \textit{Molecular Phylogenetics and Evolution} 49 (2008): 639-652. http://dx.doi.org/10.1016/j.ympev.2008.08.012
KUTTY S. N., PAPE T., WIEGMANN B. M. & MEIER R. 2010. — Molecular phylogeny of the Calyptratae (Diptera: Cyclorrhapha) with an emphasis on the superfamily Oestroidea and the position of Mystacinobiidae and McAlpine’s fly. \textit{Systematic Entomology} 35: 614-635. http://dx.doi.org/10.1111/j.1365-3113.2010.00536.x
KUTTY S. N., PONT A. C., MEIER R. & PAPE T. 2014. — Complete tribal sampling reveals basal split in Muscidae (Diptera), confirms saprophyagy as ancestral feeding mode, and reveals an evolutionary-arity correlation between instar numbers and carnivory. \textit{Molecular Phylogenetics and Evolution} 78 (2014): 349-364.
LI Z. Z. & JIN D. C. 2006. — insects from Fanjingshan Landscape. Guizhou Science and Technology Publishing House, Guiyang, Guizhou, 510-512 p. [In Chinese]
LOPES S. M. 1992. — \textit{Lispe} Lareille, 1796, Redescricao E Notas Sinonimica De Cinco Espécies Netropicais (Diptera, Musidae, Coenosinae, Limnophorini). \textit{Boletim do Museu Nacional Nova Serie Rio de Janeiro-Brasil} 352: 1-19.
LANFEAR R., CALCOTT B., HO S. Y. & GUINDON S. 2012. — PartitionFinder: combined selection of partitioning schemes and substitution models for phylogenetic analysis. *Molecular Biology and Evolution* 29: 1695-1701. http://dx.doi.org/10.1093/molbev/msq020

MALLOCH J. R. 1992. — XLIII. – Exotic Muscaridae (Diptera) – VII. *Annals and Magazine of Natural History* Series 9, 10 (58): 379-391.

MCA Alpine J. F. 1981. — Morphology and terminology – adults, in MCA Alpine J. F., PETERTSON B. V., SHEWELL G. E., TESKEY H. J., VOCKEROOTH J. R. & WOOD D. M. (eds), *Manual of Nearctic Diptera*. Volume 1. Research Branch, Agriculture Canada Monograph, Ottawa, 9-63 p.

MEIER R., SHIYANG K., VAIDYA G. & NG P. K. L. 2006. — DNA Barcoding and taxonomy in Diptera: a tale of high intraspecific variability and low identification success. *Systematic Biology* 55: 715-728.

MOULTON J. K. & WIEGMANN B. M. 2003. — Evolution and phylogenetic utility of CAD (rudimentary) among Mesozoic-aged Eremoneuran Diptera (Insecta). *Molecular Phylogenetics and Evolution* 31: 363-378.

PONT A. C. 1977. — Muscidae, in DELFINADO M. D. & HARDY D. E. (eds), *A Catalog of the Diptera of the Oriental Region*. Volume 3. Suborder Cyclorrhapha (excluding Division Aschiza). University of Hawaii, Honolulu, 507-511 p.

PONT A. C. 1986. — Muscidae, in SOÓS A. & PAPP L. (eds), *Catalogue of Palearctic Diptera*. Volume 11. Akadémia Kiadó, Budapest, 184-191 p.

Snyder F. M. 1954. — A review of Nearctic *Lispe* Latreille (Diptera, Muscidae). *American Museum Novitates* 1675: 1-40.

STEIN P. 1897. — Anthomyiden mit Lispa-ähnlich erweiterten Tastern. *Entomologische Nachrichten Berlin* 23: 317-323.

STEIN P. 1904. — Einige neue Javanische Anthomyiden. *Tijdschrift voor Entomologie* 47: 99-113.

Vikhrev N. E. 2011. — Review of the Palearctic members of the *Lispe tentaculata* species-group (Diptera, Muscidae): revised key, synonymy and notes on ecology. *Zoologisk Tidsskrift* 84: 59-70.

Vikhrev N. E. 2012. — Four new species of *Lispe* Latreille, 1796 (Diptera: Muscidae) with taxonomic notes on related species. *Russian Entomological Journal* 21 (4): 423-433.

Vikhrev N. E. 2014. — Taxonomic notes on *Lispe* (Diptera, Muscidae), parts 1-9. *Amurian zoological journal* 6 (2): 147-170.

Vikhrev N. E. 2015. — Taxonomic notes on *Lispe* (Diptera, Muscidae), parts 10-12. *Amurian zoological journal* 7 (3): 228-247.

Vileneuve J. 1936. — Myodaires supérieurs peu connus ou inédits de la Palestine et de l’IdAnatolie. *Konowia (Vienna)* 15: 155-158.

Wu C. F. 1940. — *Catalogus Insectorum Sinensium*. Volume 1. The Fan Memorial Institute of Biology, Beijing, 344-346 p.

Xue W. Q. & Chao C. M. 1998. — *Flies of China*. Volume 1. Liaoning Science and Technology Press, Shenyang, 989-1010 p. [In Chinese with English summary]

Xue W. Q. & Zhang D. 2005. — A review of the genus *Lispe* Latreille (Diptera: Muscidae) from China, with descriptions of new species. *Oriental Insects* 39: 117-139.

Zhong Y. H., Wu F. L. & Fan Z. D. 1981. — Notes on Calyptrate Flies from Xizang District, China. *Contributions-Shanghai Institute of Entomology* 2: 253-258. [In Chinese with English summary]