

# Summary statistics for fossil spider species taxonomy

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Academic editor: D. Dimitrov | Received 18 March 2012 | Accepted 27 April 2012 | Published 8 May 2012

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**Citation:** Penney D, Dunlop JA, Marusik YM (2012) Summary statistics for fossil spider species taxonomy. ZooKeys 192: 1–13. doi: 10.3897/zookeys.192.3093

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## Abstract

Spiders (Araneae) are one of the most species-rich orders on Earth today, and also have one of the longest geological records of any terrestrial animal groups, as demonstrated by their extensive fossil record. There are currently around 1150 described fossil spider species, representing 2.6% of all described spiders (i.e. extinct and extant). Data for numbers of fossil and living spider taxa described annually (and various other metrics for the fossil taxa) were compiled from current taxonomic catalogues. Data for extant taxa showed a steady linear increase of approximately 500 new species per year over the last decade, reflecting a rather constant research activity in this area by a large number of scientists, which can be expected to continue. The results for fossil species were very different, with peaks of new species descriptions followed by long troughs, indicating minimal new published research activity for most years. This pattern is indicative of short bursts of research by a limited number of authors. Given the frequent discovery of new fossil deposits containing spiders, a wealth of new material coming to light from previously worked deposits, and the application of new imaging techniques in palaeoarachnology that allow us to extract additional data from historical specimens, e.g. X-ray computed tomography, it is important not only to ensure a sustained research activity on fossil spiders (and other arachnids) through training and enthusing the next generation of palaeoarachnologists, but preferably to promote increased research and expertise in this field.

## Keywords

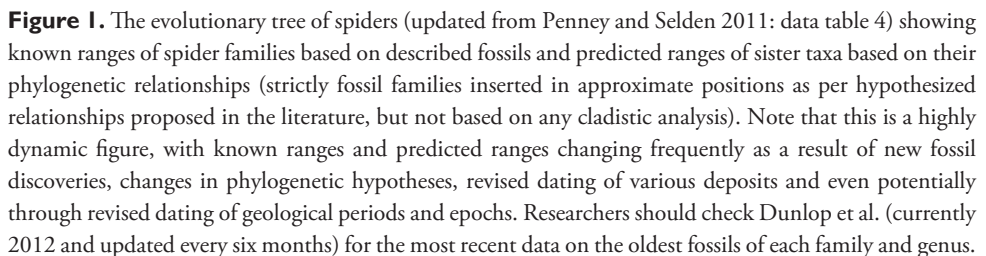
Arachnida, Araneae, palaeontology

## Introduction

With 42,751 currently recognized extant species (Dunlop and Penney 2011; Platnick 2012), spiders (Araneae) are one of the most species-rich orders on Earth today and also have one of the longest geological records of any terrestrial animal groups as demonstrated by their extensive fossil record (Selden and Penney 2010; Penney and Selden 2011). They have the best documented fossil record of all arachnids (Dunlop and Penney 2012; Dunlop et al. 2012) with approximately 1150 described fossil spider species, representing around 2.6% of all described spiders (fossil and extant). Fossil spiders are most commonly found as inclusions in amber, where they usually represent 1.0–5.9% ( $3.2 \pm 1.25$ ) (Penney and Selden 2011: Table 6) of all inclusions, and in this mode of preservation they are usually autochthonous. Penney (2002) demonstrated that Dominican amber is biased towards preserving active spiders that lived on or around the amber producing tree, and Penney and Langan (2006) concluded that different ambers derived from resins that acted as a trap for spiders in the same way. However, fossil spiders also occur in sediments that would have accumulated in an aquatic setting, and in this case the vast majority are allochthonous, and accordingly they are much rarer than fossil spiders in amber. Spiders preserved in sediments are likely to have lived in close proximity to, or in webs suspended over the water body. Spiders appear to have been as diverse in the Eocene (e.g. Wunderlich 2004) as they are today and data are amassing to suggest a high diversity in the Cretaceous too. Evidence supporting this supposition derives not only from the fossils themselves, but also from the predicted range extensions of their related taxa based on their phylogenetic relationships (Figure 1).

One of the most valuable contributions that fossils can make towards modern studies of spider evolution is dating when groups or families first appeared. Fossils provide a minimum age for any given family (Figure 1) or genus and they have been used to calibrate molecular phylogenies (e.g. Dimitrov et al. 2011). However, molecular clock dates often predict splits between groups much further back than the evidence shown in the fossil record (e.g. Ayoub and Hayashi 2009). Of course older specimens may be discovered, but one of the most exciting recent developments has been the use of fossil data by molecular biologists to calibrate their molecular trees in attempts to determine when the major groups appeared and how the fossils fit into wider patterns of relationships.

New, significant amber deposits containing fossil spiders are being discovered frequently (e.g. Hand et al. 2010 – the first for Australia [an earlier record by Hickman 1957 actually refers to sub-fossilized copal]; Rust et al. 2010 – the first for India; Schmidt et al. 2010 – the first for Africa), and a wealth of significant new material from previously studied localities continues to be described (e.g. Penney 2009; Selden 2010; Selden and Huang 2010; Selden et al. 2011; Pérez-de la Fuente et al. in press; Dalla Vecchia and Selden in press). The application of synchrotron scanning (Saupe et al. 2012) and X-ray computed tomography (Penney et al. 2007, 2011; Bosselaers et al. 2010; McNeil et al. 2010) to fossil spiders has recently



been used to extract new and additional morphological data from historical specimens too (Dunlop et al. 2011). This means that we can now revisit palaeospecies described more than 150 years ago in order to clarify their taxonomy within the present framework of spider systematics, using much closer taxonomic practices to those applied for extant taxa. These minimal preparation and non-destructive techniques also mean we can now visualize specimens in totally opaque amber (Perrichot et al. 2010) and because we can rotate and digitally dissect the 3D reconstructions (Penney et al. 2007, 2011; Dunlop et al. 2011; Saupe et al. 2012), specimens preserved in such a manner that the diagnostic features are obscured no longer hinder their taxonomic study. Previously, such specimens would have been set aside as impossible to work with. Here, we investigate some summary statistics relating to the history of fossil spider taxonomy and consider the implications of these for future research in this field.

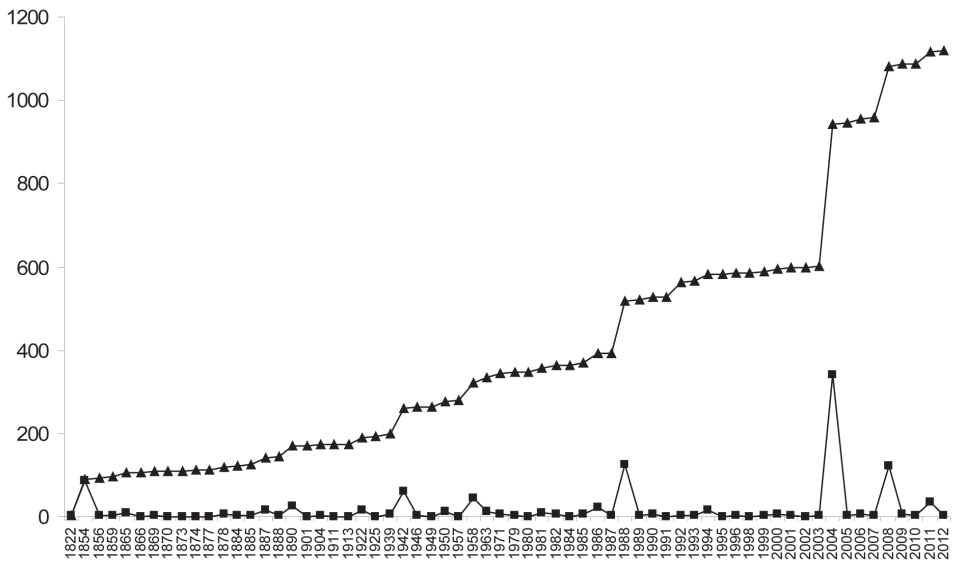
## Methods

Data for numbers of fossil spider species (excluding subfossils in copal, peat cores and extant species collected from archaeological sites) were taken from Dunlop et al. (2012). Data for numbers of described extant spider species described for each year from 2001–2012 were taken from the ‘counts’ pages of Platnick’s online *World Spider Catalogs*. Only data for species currently considered to be valid were used. Data were plotted and examined qualitatively, although a best fit line was generated for the extant taxa. Various other metrics we considered may be informative with regard to the history of the description of new fossil spider species were also investigated. For comparable approaches using discovery accumulation curves for fossil arthropods – in this case trilobite genera – see e.g. Tarver et al. (2007). A similar curve for fossil scorpion species was also recently published by Legg et al. (2012: fig. 1).

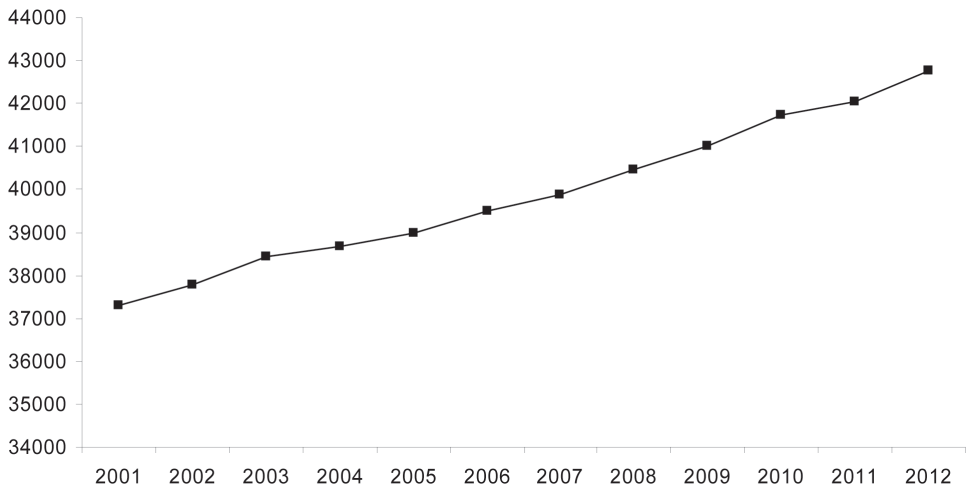
## Results

Data for numbers of fossil spider species (excluding subfossils) are plotted in Figure 2 and data for extant species are plotted in Figure 3. The line of best fit (not illustrated) for the extant species data has a formula of  $y = 482.81x + 36738$  ( $R^2 = 0.992$ ), suggesting an annual increment in the number of described extant species of approximately 480; based on a calculated mean of the actual data the value is  $496 \pm 162$ . The plot of the palaeontological data does not show a linear increase, but rather sporadic peaks interspersed with periods of little activity. The classification of fossil species within families is shown in Figure 4 and the numbers of fossil spider species per geological time period are shown in Figure 5.





**Figure 2.** The numbers of described fossil spider species by year. Note that data for the 126 years where no fossil spider species were described are not included. Hence, the actual lull periods between peaks of activity are artificially shortened in this graph. For example, the period between the first described fossil spider in 1822 and the next data plot is actually 32 years. Squares = newly described fossil spider species, triangles = cumulative number of described fossil spider species. Data derived from Dunlop et al. (2012).



**Figure 3.** The cumulative number of newly described extant spider species this century. Data from Platnick (2001–2012). Total number of described extant species = 42,751 (Platnick 2012).

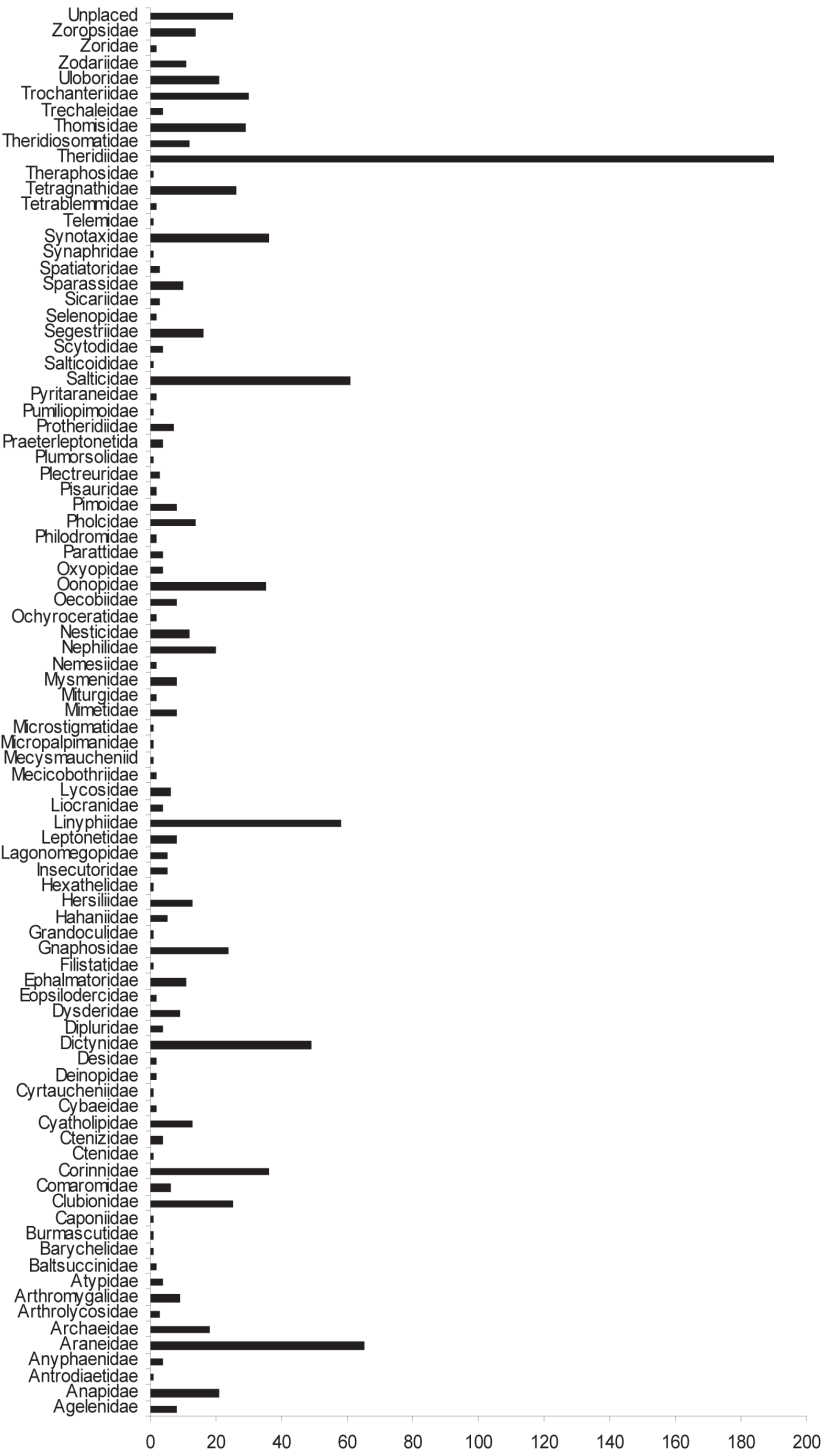
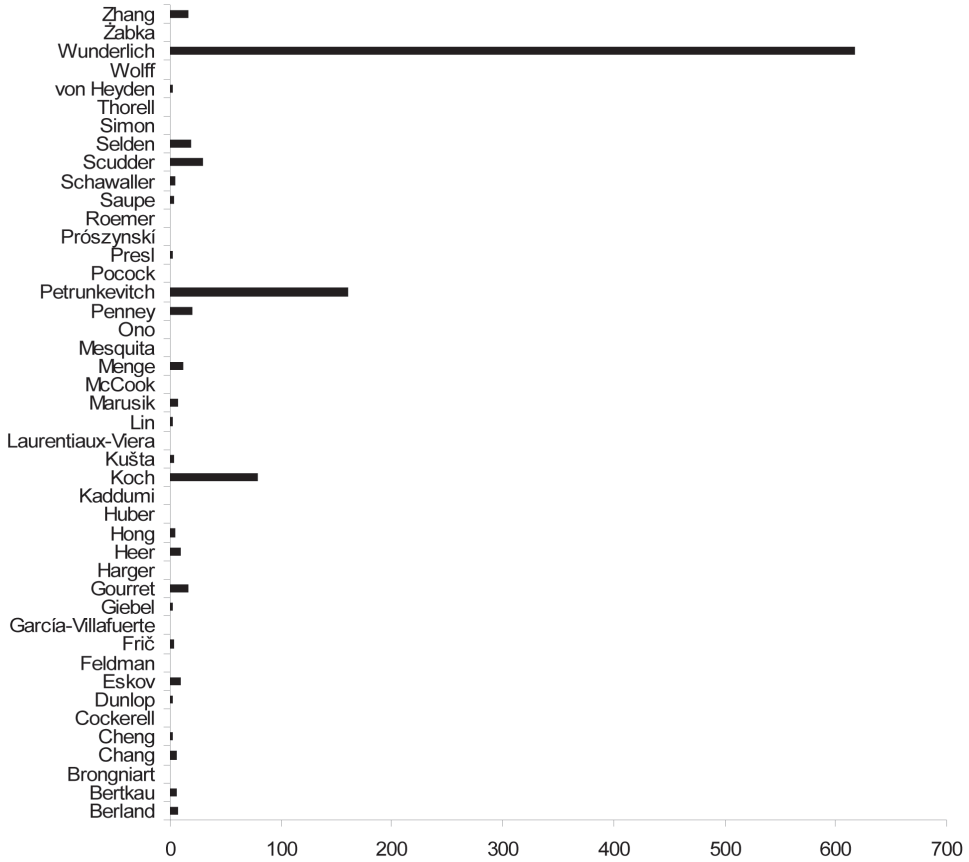


Figure 4. Number of fossil spider species per family (as currently assigned).



**Figure 5.** Number of fossil spider species described by different arachnologists. Only first authorship data are considered, so in reality some authors will have described more species than the value indicated.

## Discussion

Our research has focused on species as this tends to be the most informative unit of bio/palaeodiversity data; families are too few to allow any informative analysis on a broad scale, and genera are too idiosyncratically defined. Nonetheless, it is interesting to note that 70 (= 63%) extant spider families (including Comaromidae *sensu* Wunderlich 2011) have now been documented in the fossil record and there are an additional 18 strictly fossil families, the most recent described by Penney (2011). However, many of these extinct families are based on very few poorly preserved and/or juvenile specimens and require taxonomic scrutiny in order to confirm their validity (Penney and Selden 2006, 2011). Our data for the numbers of species described per year are actually under-representations because they do not include junior synonyms, *nomina nuda*, etc., a constraint applicable to both the fossil and extant data; nor do they include sub-fossils. However, such taxa are relatively few in

the fossil record (Dunlop et al. 2012) so their exclusion will not have created any unrealistic trends.

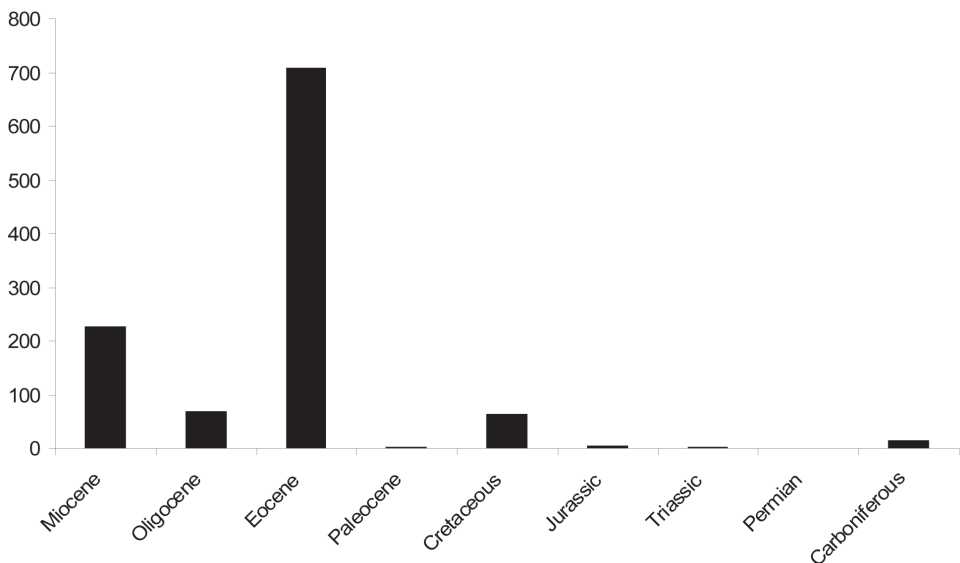
It is evident from Figure 4 that some families are much more common as fossils than others, for example Theridiidae, Salticidae, Linyphiidae and Araneidae, and it is noteworthy that these represent four of the five most diverse spider families on the planet today. The fifth family is Lycosidae, which are ground dwellers and so are unlikely to be preserved in amber and most probably only evolved in the Miocene (Jocqué and Alderweireldt 2005). The reason for the high palaeodiversity in the aforementioned families is because they occur in various different deposits, whereas those with few described fossil species are often restricted to a single deposit. Penney and Langan (2006) compared the spider faunas of Baltic and Dominican ambers (which account for approximately 71% of described fossil spider species to date). There were more families (29) shared between the deposits than those that occurred in just one of the deposits (24 families restricted to Baltic, 15 families restricted to Dominican). Of further interest is that the shared families tended to be more diverse in each of the two deposits than the non-shared families. For example the average number of species per family for Baltic only families was 5.88, but for those families that also occurred in Dominican amber the average number of species was 12.44 for the Baltic fauna. Similarly, the average number of species for families specific to Dominican amber was 1.27 species per family whereas for those shared with Baltic amber the number of species was 5.17 for Dominican amber. In summary, 76% of all species belonged to families that were shared between both deposits and this value is most likely to rise, rather than fall, as a result of new fossil spider descriptions (e.g. Penney 2009; Penney et al. 2011, in press; Saupe et al. 2010; Wunderlich 2008, 2011). These data are based on relatively young Tertiary fossils, so their similarity to the extant fauna should not be a great surprise. If we had a similar number of fossil spider species described from the Mesozoic then we could expect a rather different pattern, particularly as two of the families that are most diverse in the Tertiary (Salticidae and Theridiidae) are currently unknown from the Mesozoic and probably evolved (or at least underwent their major diversification) following the end-Cretaceous extinction event. It must also be remembered that the spider fossil record is heavily biased towards amber, so the observed palaeodiversity is an artefact of sampling and so is not truly representative of what existed in the past.

New extant spider species are described every year, but this is not so for fossils. In our palaeodata there are 126 years in which no fossil spider species were described. These are omitted from the graphs, so the actual lull periods between peaks of activity are artificially shortened in Figure 3. For example, the period between the first described fossil spider by Presl (1822) and the next data point (Koch and Berendt 1854) is 32 years. Since 1822 we have 64 data points for years with described fossil species, equating to approximately 33% of years with newly described fossils. There is no linear pattern to the increment of new fossil spider species. The peaks in Figure 3 represent the publication of monographs that focus on particular deposits (e.g. Koch and Berendt 1854; Petrunkevitch 1942, 1958; Wunderlich 1988, 2004, 2008, 2011) and most of these, and consequently the authorship of described fossil spider species, can be assigned to a limited number of authors (Figure 5). In total, 44 researchers have described valid fos-

sil spider species, with 54% of the names assigned to a single author (J. Wunderlich), who is still publishing on the topic. These data refer only to the first authorship of a published taxon, so in reality there are actually more species attributed to individual authors than Figure 5 suggests (as a result of co-authored taxa). It also means there is a descriptive bias to particularly productive deposits and hence geological periods (Figure 6) (see also Saupe and Selden 2011). Indeed, 652 fossil spider species have been described to date from the Baltic amber deposits, representing approximately 57% of all named fossil spider species. This is followed by Dominican amber with 164 named species, representing approximately 14%. Other than the Eocene Florissant Formation and Miocene Bitterfeld amber, both of which have 46 described fossil spider species, all other fossil deposits currently have 25 or fewer described fossil spider species, and in most the number of described taxa rarely exceeds five (Dunlop et al. 2012). However, work on Baltic amber spiders has spanned almost two centuries, whereas the first spider from Dominican amber was not described until 1981 (Penney 2008).

It should be noted that the holotypes of many of the older species names – e.g. the Florissant specimens described by Scudder (1890) and Petrunkevitch (1922) – require taxonomic revision in order to confirm their status. Many of the early Baltic amber taxa (e.g. those of Koch and Berendt 1854) were treated in the recent monographs by Wunderlich (2004, 2008).

Data for extant taxa showed a steady linear increase of approximately 500 new taxa per year over the last decade, reflecting a rather constant research activity in extant



**Figure 6.** Number of fossil spider species described from each geological period. The Paleogene Period has been broken down into its various Epochs (Paleocene, Eocene and Oligocene) in order to show the spread of data; the Neogene Period is represented only by the Miocene Epoch because Pleistocene sub-fossils have not been included.

spider taxonomy by a large number of scientists, which can be expected to continue. The results for the description of fossil species were very different, with peaks of new species descriptions followed by long troughs indicating short bursts of research by only a few authors, often with a long hiatus in between. Were these data to represent patterns within natural populations, one would consider the latter to be at considerable risk of extinction. Given the frequent discovery of new fossil deposits containing spiders, a wealth of new material coming to light from previously worked deposits, and the application of new imaging techniques in palaeoarachnology that allow us to extract additional data from historical specimens, e.g. X-ray computed tomography, it is important not only to ensure a sustained research activity on fossil spiders (and other arachnids) through training and enthusing the next generation of palaeoarachnologists, but preferably to promote increased research and expertise in this field.

## Acknowledgements

DP acknowledges financial support from Siri Scientific Press, YMMs contribution to this work was supported in part by the Russian Foundation for Basic Research (grant № 11–0401716).

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# Review of Chinese Oligaphorurini (Collembola, Onychiuridae) with descriptions of two new Palearctic species

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Academic editor: L. Deharveng | Received 16 February 2012 | Accepted 17 April 2012 | Published 8 May 2012

[urn:lsid:zoobank.org:pub:30D72D39-3423-472A-8C69-B38E21008F74](https://zoobank.org/urn:lsid:zoobank.org:pub:30D72D39-3423-472A-8C69-B38E21008F74)

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**Citation:** Sun X, Wu D (2012) Review of Chinese Oligaphorurini (Collembola, Onychiuridae) with descriptions of two new Palearctic species. ZooKeys 192: 15–26. doi: 10.3897/zookeys.192.2959

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## Abstract

A checklist of Chinese Oligaphorurini is given. Two new Chinese species, *Micraphorura changbaiensis* sp. n. and *Oligaphorura pseudomontana* sp. n., are described from Changbai Mountain Range. *M. changbaiensis* sp. n. has the same dorsal pseudocelli formula and number of papillae in Ant. III sensory organ as *M. uralica*, but they can be easily distinguished by number of chaetae in Ant. III sensory organ, ventral pseudocelli formula, ventral parapseudocelli formula, number of pseudocelli on subcoxa 1 of legs I–III, dorsal axial chaeta on Abd. V and number of chaetae on tibiotarsi. *O. pseudomontana* sp. n. is very similar to the species *O. montana* having an increased number of pseudocelli on body dorsally, well marked base of antenna with 1 pseudocellus and 3 pseudocelli outside, subcoxa 1 of legs I–III with 1 pseudocellus each, dorsally S-chaetae formula as 11/011/22211 from head to Abd. V, S-microchaeta present on Th. II–III, claw without inner teeth and with 1+1 lateral teeth, and unguiculus with basal lamella; but they can be separated easily by the number of pseudocelli on Abd. V and VI terga, parapseudocelli on the body, number of chaetae on Th. I tergum, and number of chaetae on tibiotarsi. A key to Chinese species of Oligaphorurini is provided in the present paper.

## Keywords

Collembola, identification key, *Micraphorura changbaiensis* sp. n., *Oligaphorura pseudomontana* sp. n., taxonomy

## Introduction

The tribe Oligaphorurini, erected by Bagnall (1949) as a subfamily, is characterized by having a small postantennal organ with a 3–5 lobed vesicle. So far, 38 species belonging to five genera were reported in the world (Bellinger et al. 2012). Nevertheless, the Chinese fauna of Oligaphorurini is poorly known, only two species, *Dimorphaphorura sanjiangensis* Sun & Wu, 2012 and *Oligaphorura ursi* (Fjellberg, 1984), were reported from northeast China (Sun and Wu 2012).

In the present paper, two new Chinese Oligaphorurini species are described from Changbai Mountain Range in Jilin Province, and two newly recorded species, *Oligaphorura judithae* (Weiner, 1994) and *Oligaphorura koreana* (Weiner, 1994), are mentioned. A checklist of Chinese Oligaphorurini and an identification key to all Chinese species of this tribe are given below.

## Material and methods

Specimens were mounted in Marc André II solution, after clearing in lactic acid, and were studied using a Nikon Eclipse 80i microscope. Material is deposited in the Key laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun.

## Abbreviations used in descriptions

Labial papillae types are named after Fjellberg (1999). Labium areas and chaetal nomenclature follow Massoud (1967) and D’Haese (2003). Chaetae on anal valves are named after Yoshii (1996).

Ant.—antennal segments, PAO—postantennal organ, Th.—thoracic segments, Abd.—abdominal segments, p-chaeta—chaeta of row p, Sp—posterior S-chaeta (e.g. on Abd. V or on head), ms—S-microchaeta, pso—pseudocellus, a-pso—postero-internal pso on head, psx—parapseudocellus, psp—pseudopore, x—axial pseudopore of Abd. IV.

Pseudocelli, parapseudocelli and pseudopore formula are the number of pseudocelli, parapseudocelli or pseudopores by half tergum (dorsally) or half-sternum (ventrally) as follows: head anterior, head posterior/Th. I, Th. II, Th. III/Abd. I, Abd. II, Abd. III, Abd. IV, Abd. V (for instance: 43/144/54464).

S-chaetae formula is the number of S-chaetae by half tergum from head to Abd. VI (for instance: 11/011/222111).

Tibiotarsus chaetotaxy formula: total number of chaetae (number of basal chaetae, number of chaetae in row B, number of chaetae in distal row A+T, for instance: 19 (1, 7, 11)).

**Checklist of Chinese species of *Oligaphorurini* Bagnall, 1949*****Dimorphaphorura sanjiangensis* Sun & Wu, 2012**

**Distribution.** Heilongjiang Province (according to the original paper), Jilin Province (Changbai Mountain Range, alt. 689m, 43.037640°N, 128.199653°E).

***Micraphorura changbaiensis* sp. n.**

**Distribution.** Jilin Province.

***Oligaphorura judithae* (Weiner, 1994) newly recorded in China**

**Distribution.** Jilin Province (Changbai Mountain Range, alt. 689m, 43.037640°N, 128.199653°E); North Korea (according to the original paper).

***Oligaphorura koreana* (Weiner, 1994) newly recorded in China**

**Distribution.** Jilin Province (Changbai Mountain Range, alt. 689m, 43.037640°N, 128.199653°E and alt. 1763m, 41.755265°N, 127.941123°E); North Korea (according to the original paper).

***Oligaphorura ursi* (Fjellberg, 1984)**

**Distribution.** Jilin Province (Changbai Mountain Range, alt. 689m, 43.037640°N, 128.199653°E), Heilongjiang Province (according to Sun and Wu 2012); Northern Holarctic (according to the original paper).

***Oligaphorura pseudomontana* sp. n.**

**Distribution.** Jilin Province.

**Key to Chinese species of *Oligaphorurini* Bagnall, 1949**

- 1 Furca reduced to a finely granulated area, with 1+1 dental chaetae posteriorly (*Dimorphaphorura* Bagnall, 1949)..... ***Dimorphaphorura sanjiangensis* Sun & Wu, 2012**
- Furca reduced to a small cuticular fold, with 1+1 or 2+2 dental chaetae posteriorly..... **2**
- 2 1+1 dental chaetae posteriorly (*Micraphorura* Bagnall, 1949)..... ***Micraphorura changbaiensis* sp. n.**
- 2+2 dental chaetae in two rows posteriorly (*Oligaphorura* Bagnall, 1949) ... **3**
- 3 First thoracic tergum with 0+0 pso ..... ***Oligaphorura koreana* (Weiner, 1994)**
- First thoracic tergum with 1+1 pso ..... **4**
- 4 The base of antenna with 4+4 pso ..... ***Oligaphorura pseudomontana* sp. n.**
- The base of antenna with 3+3 pso ..... **5**

- 5 Lateral ms absent on Th. III, 5+5 pso on Abd. IV and 4+4 pso on Abd. V ...  
 ..... *Oligaphorura judithae* (Weiner, 1994)  
 – Lateral ms present on Th. III, 4+4 pso on Abd. IV and 3+3 pso on Abd. V ..  
 ..... *Oligaphorura ursi* (Fjellberg, 1984)

## Systematics

### *Micraphorura changbaiensis* sp. n.

urn:lsid:zoobank.org:act:E9432AE4-B11B-4F86-B581-BC15BC6A85E8

[http://species-id.net/wiki/Micraphorura\\_changbaiensis](http://species-id.net/wiki/Micraphorura_changbaiensis)

Figs 1–2

**Type material.** Holotype female, 4 female and 1 male paratypes. China: Jilin Province: Changbai Mountain Range (alt. 1763m, 41.755265°N, 127.941123°E): 15.VIII.2009, litter and soil, Berlese extraction, Wu Dong-hui leg.

Holotype and 5 paratypes on slides are deposited in the Key laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun.

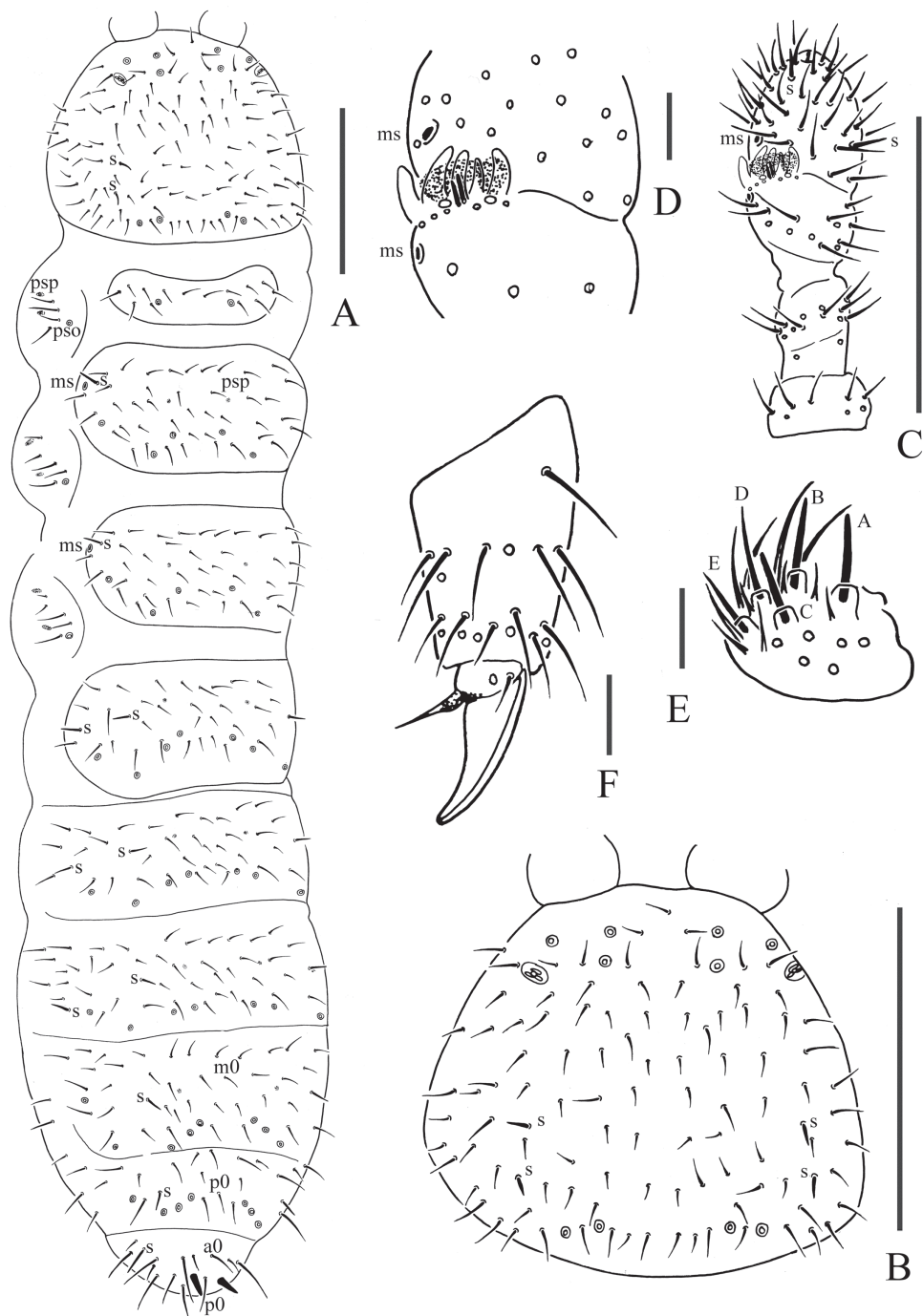
**Diagnosis.** Pso formula as 32/133/44454 dorsally and 11/000/00000 ventrally; subcoxa 1 of legs I–III with 1 pso each; psx formula as 00/000/222200 ventrally, absent dorsally; S-chaetae formula as 11/011/222111 dorsally and 11/000/000100 ventrally; Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small sensory rods, 2 granulated sensory clubs; Abd. V tergum with one dorsal axial chaeta (p0), Abd. VI with two axial chaetae (a0 and p0); tibiotarsi of legs I, II and III with 20, 20 and 19 chaetae; anal spines present on indistinct papillae, as long as inner edge of unguis.

**Description.** Body color white in alcohol. Size 0.70–0.82 mm, holotype: 0.78 mm. Body slender and elongated.

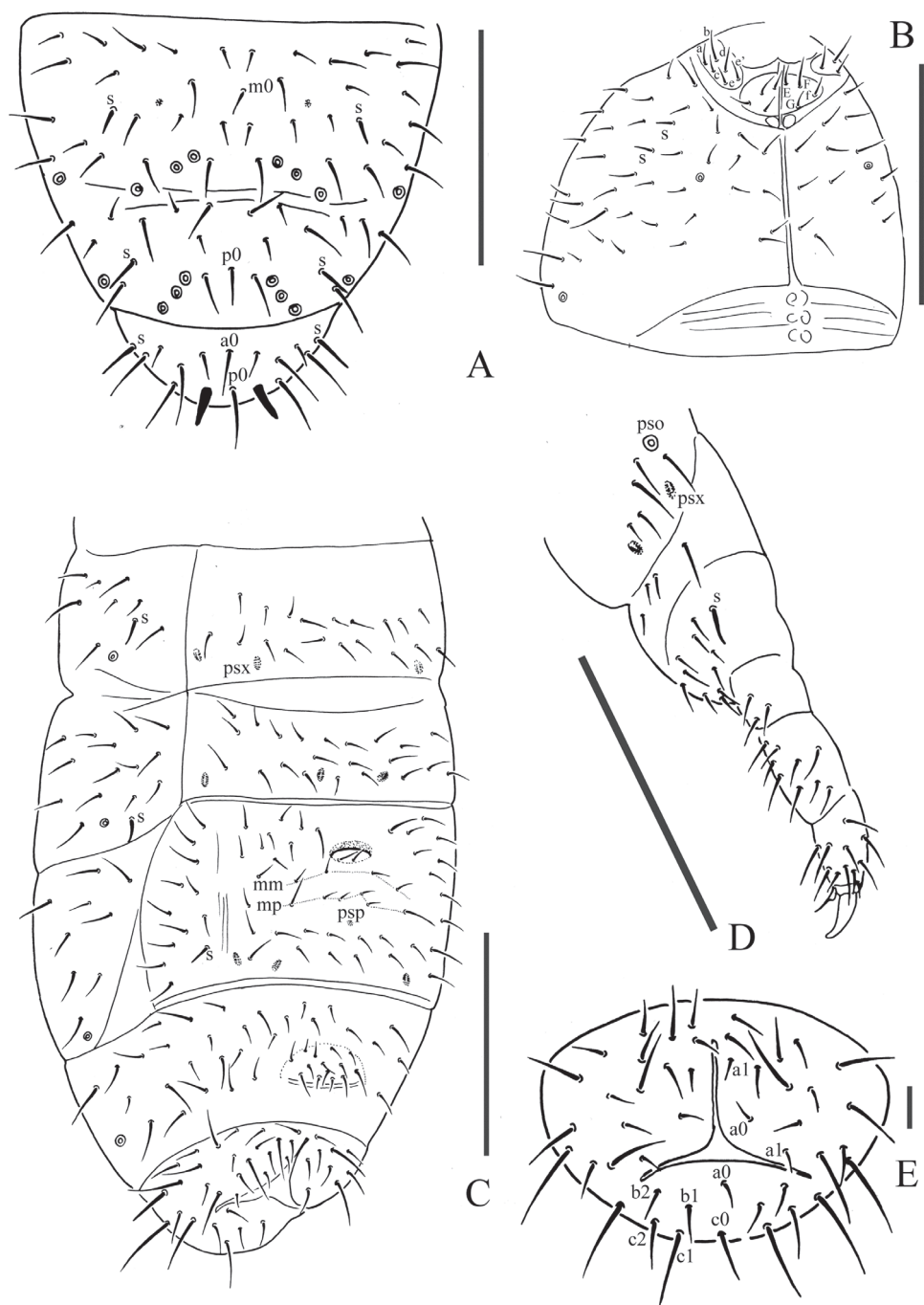
Pseudocelli (pso) formula as 32/133/44454 dorsally and 11/000/00000 ventrally (Figs 1A, 2C); subcoxa 1 of legs I–III with 1 pso each. Parapseudocelli (psx) formula as 00/000/222200 ventrally and absent dorsally (Figs 1A, 2C); subcoxa 1 of legs I–III with 2 psx each. Pseudopore (psp) formula as 00/011/111100 dorsally and 00/111/000x00 ventrally (Figs 1A, 2C).

S-chaetae cylindrical, well differentiated, formula as 11/011/222111 dorsally and 11/000/000100 ventrally (Figs 1A, 2C); subcoxae 2 of legs I, II and III with 0, 0 and 1 S-chaeta respectively (Fig. 2D). Two posterior S-chaetae (Sp) present on head. S-microchaetae tiny and blunt, present on Th. II–III (Fig. 1A).

Head. Antennae short and distinctly segmented, 0.8 times as long as head. Length ratio of antennal segments I: II: III: IV = 1: 1.8: 1.8: 2. Ant. IV with two distinct thickened S-chaetae, subapical organite with apex globular and basolateral ms just above posterior chaetae (Fig. 1C). Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small sensory rods, 2 granulated sensory clubs, the outer about twice as large as the inner, and a lateral ms (Fig. 1D). Ant. II with 14 chaetae. Ant. I with 8 chaetae. Antennal base without



**Figure 1.** *Micraphorura changbaiensis* sp. n. **A** dorsal side of body **B** dorsal side of head **C** antenna **D** organ of Ant. III **E** labium **F** distal part of leg III. Scales: 0.1 mm (A–C), 0.01 (D–F)



**Figure 2.** *Micraphorura changbaiensis* sp. n. **A** dorsal side of Abd. IV–VI **B** ventral side of head **C** ventral side of Abd. II–VI **D** leg III **E** anal valves. Scales: 0.1 mm (A–D), 0.01 (E)



distinct granulation. PAO located on cuticular furrow built with a 3–4 lobed vesicle (Fig. 1B). Dorsal cephalic chaeta d0 absent, 3+3 p-chaetae between posterior a-pso on head (Fig. 1B). Mandible with strong molar plate and 4 apical teeth. Maxilla bearing 3 teeth and 6 lamellae. Maxillary palp simple with 1 basal chaeta and 2 sublobal hairs. Labral chaetae formula 4/342. Labium with 6 proximal, 4 basomedian (E, F, G, f) and 6 basolateral (a, b, c, d, e, e') chaetae (Fig. 2B); labial type ABC, papillae A–E respectively with 1, 4, 0, 3, 3 guard chaetae (Fig. 1E). Postlabial chaetae 4+4 along ventral groove (Fig. 2B).

Body chaetotaxy. Ordinary chaetae differentiated in meso- and macrochaetae. Th. I tergum with 7+7 chaetae dorsally (Fig. 1A). Th. II–III and Abd. I–III terga with three chaetae on both side of axial line and no dorsal axial chaetae. Abd. IV tergum with one dorsal axial chaeta (m0), Abd. V with one dorsal axial chaeta (p0), Abd. VI with two axial chaetae (a0 and p0) (Fig. 2A). Th. I, II and III sterna with 0+0/1+1/1+1 (2+2) chaetae.

Appendages. Subcoxa 1 of legs I–III with 4, 5 and 5 chaetae, subcoxa 2 with 1, 4 and 4 chaetae respectively. Tibiotarsi of legs I, II and III with 20 (1, 8, 11), 20 (1, 8, 11) and 19 (1, 7, 11) chaetae (Fig. 1F). Unguis without teeth. Unguiculus slender and pointed, 0.6 times as long as inner edge of unguis, with inner basal lamella (Figs 1F, 2D). Ventral tube with 6+6 distal chaetae and 2+2 basal chaetae, without anterior chaetae. Furca reduced to a small cuticular fold with 1+1 dental chaetae posteriorly; two manubrial rows of chaetae present (Fig. 2C).

Female genital plate with 14 chaetae; in our specimens, the only male is juvenile. Anal valves with numerous acuminate chaetae; each lateral valve with a0 and 2a1; upper valves with chaetae a0, 2b1, 2b2, c0, 2c1, 2c2 (Fig. 2E). Anal spines present on indistinct papillae, as long as inner edge of unguis (Fig. 1A).

**Etymology.** Named after the mountain range where we found the new species.

**Ecology.** Found in coniferous forest.

**Remarks.** The new species has the same dorsal pseudocelli formula (32/133/44454) and number of papillae in Ant. III sensory organ (5) as *M. uralica* (Khanislamova, 1986), but they can be easily distinguished by number of guard chaetae on Ant. III sensory organ (5 in *changbaiensis* sp. n., 4 in *uralica*), ventral pseudocelli formulae (11/000/00000 in *changbaiensis* sp. n., 11/000/11120 in *uralica*), ventral parapseudocelli formulae (00/000/222200 in *changbaiensis* sp. n., indistinct in *uralica*), pseudocelli on subcoxa 1 of legs I–III (1, 1, 1 in *changbaiensis* sp. n., 2, 3, 3 in *uralica*), dorsal axial chaeta on Abd. V (m0 in *changbaiensis* sp. n., absent in *uralica*), and number of chaetae on tibiotarsi (20, 20, 19 in *changbaiensis* sp. n., 19, 19, 18 in *uralica*).

***Oligaphorura pseudomontana* sp. n.**

urn:lsid:zoobank.org:act:6691C23D-A275-4C91-B001-C4C5AFCC8D04

[http://species-id.net/wiki/Oligaphorura\\_pseudomontana](http://species-id.net/wiki/Oligaphorura_pseudomontana)

Figs 3–4

**Type material.** Holotype male, 2 female and 5 male paratypes. China: Jilin Province: Changbai Mountain Range (alt. 689m, 43.037640°N, 128.199653°E): 3.X.2011, litter and soil, Berlese extraction, Tang Xu-guang leg.

Holotype and 7 paratypes on slides are deposited in the Key laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun.

**Diagnosis.** Pso formula as 43/144/54464 dorsally and 11/000/00000 ventrally; subcoxa 1 of legs I–III with 1 pso each; psx formula as 00/000/222401 ventrally and absent dorsally; S-chaetae formula as 11/011/222111 dorsally and 11/000/000100 ventrally; Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small sensory rods, 2 granulated sensory clubs; Abd. V without dorsal axial chaetae, Abd. VI with two axial chaetae (a0 and p0); tibiotarsi of legs I, II and III with 20, 20 and 19 chaetae; anal spines present on indistinct papillae, 0.75 times as long as inner edge of unguis.

**Description.** Body color white in alcohol. Size 0.80–1.04 mm; holotype: 0.90 mm. Body slender and elongated.

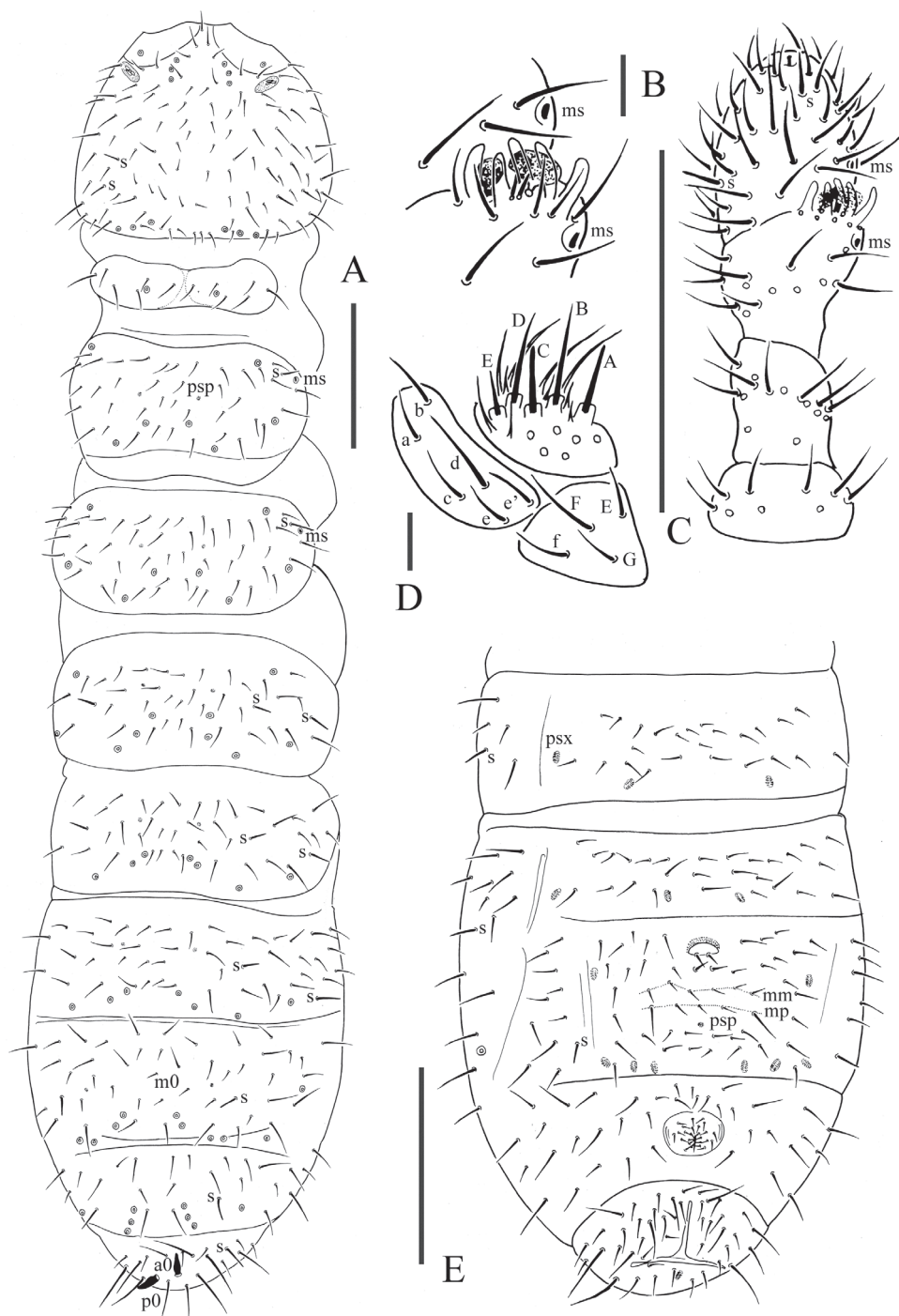
Pseudocelli (pso) formula as 43/144/54464 dorsally and 11/000/00000 ventrally (Figs 3A, E); subcoxa 1 of legs I–III with 1 pso each (Fig. 4C). Parapseudocelli (psx) formula as 00/000/222401 ventrally and absent dorsally (Figs 3A, E); subcoxa 1 of legs I–III with 1 psx each (Fig. 4C). Pseudopore (psp) formula as 00/011/111100 dorsally and 00/111/000x00 ventrally (Figs 3A, E).

S-chaetae cylindrical, well differentiated, formula as 11/011/222111 dorsally and 11/000/000100 ventrally (Figs 3A, E); subcoxae 2 of legs I, II and III with 0, 0 and 1 S-chaeta respectively (Fig. 4C). Two posterior S-chaetae (Sp) present on head. S-microchaetae tiny and blunt, present on Th. II–III (Fig. 3A).

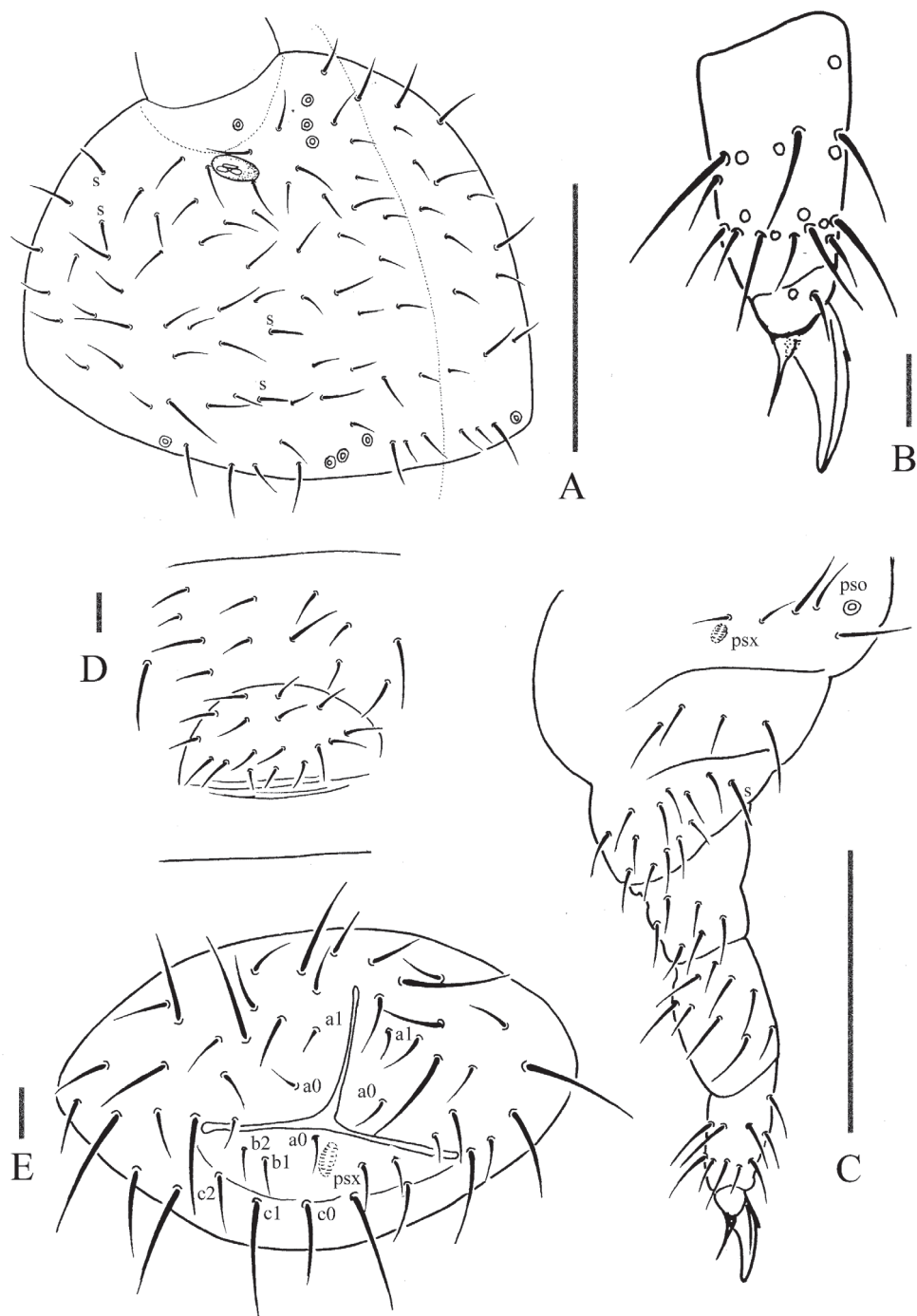
Head. Antennae short and distinctly segmented, as long as head. Length ratio of antennal segments I: II: III: IV = 1: 2: 2: 2. Ant. IV with two distinct thickened S-chaetae, subapical organite with apex globular and basolateral ms just above posterior chaetae (Fig. 3C). Ant. III sensory organ composed of 5 papillae, 5 guard chaetae, 2 small sensory rods, 2 granulated sensory clubs, the outer about twice as large as the inner, and a lateral ms (Fig. 3B). Ant. II with 15 chaetae. Ant. I with 9 chaetae. Antennal base with distinct granulation. PAO located on cuticular furrow built with a 3 lobed vesicle (Fig. 4A). Dorsal cephalic chaeta d0 absent, 3+3 p-chaetae between posterior a-pso on head (Fig. 4A). Mandible with strong molar plate and 4 apical teeth. Maxilla bearing 3 teeth and 6 lamellae. Maxillary palp simple with 1 basal chaeta and 2 sublobal hairs. Labral chaetae formula 4/342. Labium with 6 proximal, 4 basomedian (E, F, G, f) and 6 basolateral (a, b, c, d, e, e') chaetae; labial type AC, papillae A–E respectively with 1, 4, 0, 3, and 2 guard chaetae (Fig. 3D). Postlabial chaetae 4+4 along ventral groove.

Body chaetotaxy. Ordinary chaetae differentiated in meso- and macrochaetae. Th. I tergum with 6+6 chaetae dorsally (Fig. 3A). Th. II–III and Abd. I–III terga with three chaetae on both side of axial line and no dorsal axial chaetae. Abd. IV tergum with one dorsal axial chaeta (m0), Abd. V without dorsal axial chaetae, Abd. VI with two axial chaetae (a0 and p0) (Fig. 3A). Th. I, II and III sterna without chaetae.

Appendages. Subcoxa 1 of legs I–III with 4, 5 and 5 chaetae, subcoxa 2 with 1, 4 and 4 chaetae respectively. Tibiotarsi of legs I, II and III with 20 (1, 8, 11), 20 (1, 8, 11) and 19 (1, 7, 11) chaetae (Fig. 4B). Unguis without inner teeth, with lateral teeth.



**Figure 3.** *Oligaphorura pseudomontana* sp. n. **A** dorsal side of body **B** organ of Ant. III **C** antenna **D** labium **E** ventral side of Abd. II–VI. Scales: 0.1 mm (A, C & E), 0.01 (B & D)



**Figure 4.** *Oligaphorura pseudomontana* sp. n. **A** dorsal side of head **B** distal part of leg III **C** leg III **D** female genital plate **E** anal valves. Scales: 0.1 mm (A & C), 0.01 mm (B, D & E)

Unguiculus slender and pointed, 0.6 times as long as inner edge of unguis, with inner basal lamella (Fig. 4B). Ventral tube with 6–7+6–7 distal chaetae and 2+2 basal chaetae, without anterior chaetae. Furca reduced to a small cuticular fold with 2+2 dental chaetae in two rows posteriorly; two manubrial rows of chaetae present (Fig. 3E).

Female genital plate with 17 chaetae (Fig. 4D), male genital plate with 19–24 chaetae. Anal valves with numerous acuminate chaetae; each lateral valve with a0 and 2a1; upper valves with chaetae a0, 2b1, 2b2, c0, 2c1, 2c2 (Fig. 4E). Anal spines present on indistinct papillae, 0.75 times as long as inner edge of unguis (Fig. 3A).

**Etymology.** Named for the similarity with the Korean species *O. montana* Weiner, 1994.

**Ecology.** Found in coniferous forest.

**Remarks.** The new species is very similar to the species *montana* collected in the mountain of North Korea, sharing the following characters: an increased number of pseudocelli dorsally; well marked base of antenna with 1 pseudocellus and 3 dorsal pseudocelli outside; subcoxa 1 of legs I–III with 1 pseudocellus each; dorsally S-chaetae formula as 11/011/22211 from head to Abd. V; S-microchaetae present on Th. II–III; head with chaeta p1 level with p2; Th. I, II and III sterna without chaetae; anal spines 0.75 times as long as inner edge of unguis; claw without inner teeth but with one lateral tooth; unguiculus with basal lamella. But they can be separated easily by the number of pseudocelli on Abd. V and VI terga (5 and 3 in *montana* versus 6 and 4 in *pseudomontana* sp. n.), parapseudocelli on the body (indistinct in *montana*, versus 00/000/222401 by half-sternite in *pseudomontana* sp. n.), the number of chaetae on Th. I tergum (7+7 in *montana* versus 6+6 in *pseudomontana* sp. n.), and the number of chaetae on tibiotarsi (19, 19, 18 in *montana* versus 20, 20, 19 in *pseudomontana* sp. n.).

## Acknowledgements

Thanks should be given to Dr. Tang Xuguang (Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences) who collected the specimens for our work. The present study was supported by the National Natural Sciences Foundation of China (NO. 31070467, 40901036, 41171047), Knowledge Innovation Programs of Chinese Academy of Sciences (KZCX2-YW-BR-16), and the Fundamental Research Funds for the Central Universities (NO. 2008-10008 and 2009-05022).

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# Two new species of *Amblypsilopus* Bigot with a key to species from Taiwan (Diptera, Dolichopodidae)

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‡ [urn:lsid:zoobank.org:author:4B89A27C-E0EE-488F-8602-8D30693CBC5D](https://doi.org/urn:lsid:zoobank.org:author:4B89A27C-E0EE-488F-8602-8D30693CBC5D)

§ [urn:lsid:zoobank.org:author:FD9077E0-D8D5-4A3A-80FD-2862726AA066](https://doi.org/urn:lsid:zoobank.org:author:FD9077E0-D8D5-4A3A-80FD-2862726AA066)

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Academic editor: Martin Hauser | Received 21 April 2012 | Accepted 27 April 2012 | Published 8 May 2012

[urn:lsid:zoobank.org:pub:81F681D3-B6BB-429C-A898-BDD578A86EB1](https://doi.org/urn:lsid:zoobank.org:pub:81F681D3-B6BB-429C-A898-BDD578A86EB1)

**Citation:** Wang J, Zhu Y, Yang D (2012) Two new species of *Amblypsilopus* Bigot with a key to species from Taiwan (Diptera, Dolichopodidae). ZooKeys 192: 27–33. doi: 10.3897/zookeys.192.3265

## Abstract

The following two new species of the genus *Amblypsilopus* Bigot from Taiwan are described: *Amblypsilopus flavellus* **sp. n.** and *Amblypsilopus ventralis* **sp. n.** One species, *Amblypsilopus crassatus* Yang, 1997, is newly reported from Taiwan. A key to the species of the genus from Taiwan is given.

## Keywords

Diptera, Dolichopodidae, *Amblypsilopus*, new species

## Introduction

The genus *Amblypsilopus* Bigot is a large genus in the subfamily Sciapodinae with 275 known species from the world (Bickel 1994; Yang et al. 2006). There are 45 known species from China, of which 8 species occur in Taiwan (Yang et al. 2011). This genus is characterized by the following features: body usually appearing delicate with long thin legs; arista usually dorsal, shorter than head width; crossvein m-cu straight; male vertical seta reduced (Bickel 1994; Yang et al. 2011). The major references dealing with



the Oriental species of *Amblypsilopus* are Becker (1922), Bickel (1994), and Yang et al. (2011). The Chinese species were reviewed by Yang et al. (2011). Here three species including two new species are added to the fauna of Taiwan. A key to the species of the genus from Taiwan is given.

## Material and methods

Types are deposited in the Entomological Museum of China Agricultural University, Beijing (CAU). The following abbreviations are used: a = anterior seta(e), acr = acrostichal seta(e), ad = anterodorsal seta(e), av = anteroventral seta(e), d = dorsal seta(e), dc = dorsocentral seta(e), ih = inner humeral seta(e), LI = fore leg, LII = mid leg, LIII = hind leg, npl = notopleural seta(e), oc = ocellar seta(e), p = posterior seta(e), pd = postero-dorsal seta(e), ph = posthumeral seta(e), psa = postalar seta(e), pvt = postvertical seta(e), sa = supraalar seta(e), su = sutural seta(e), sc = scutellar seta(e), v = ventral seta(e), vt = vertical seta(e). CuAx ratio = length of m-cu / length of distal portion of CuA.

## Key to species of *Amblypsilopus* Bigot from Taiwan

- |   |  |                                    |
|---|--|------------------------------------|
| 1 | Thorax mostly metallic green .....   | 2                                  |
| – | Thorax mostly yellow .....   | <i>A. aurichalceus</i> (Becker)    |
| 2 | Only posterior 2 dc strong, anterior dc hair-like .....  | 3                                  |
| – | 4–5 strong dc .....  | 10                                 |
| 3 | Fore tibia without distinct curved posterior bristle .....   | 4                                  |
| – | Fore tibia with 1 or 5–6 distinct curved posterior bristles .....  | 6                                  |
| 4 | Male cercus shorter than epandrium .....   | 5                                  |
| – | Male cercus very long, about two times as long as epandrium. ....  |                                    |
|   | .....  | <i>A. ignobilis</i> (Becker)       |
| 5 | Male cercus curved, hook-like .....  | <i>A. falcatus</i> (Becker)        |
| – | Male cercus straight, finger-like .....  | <i>A. humilis</i> (Becker)         |
| 6 | Fore tibia with 1 pale curved posterior bristle at apical quarter; vt weak; legs elongate .....  | 7                                  |
| – | Fore tibia with 5–6 distinct pale curved posterior bristles; both sexes with strong vt; legs relatively short; hind tarsomeres 3-5 flattened ..... |                                    |
|   | .....  | <i>A. subtilis</i> (Becker)        |
| 7 | Arista dorsal .....  | 8                                  |
| – | Arista apical .....  | 9                                  |
| 8 | Cercus broad, nearly elliptic .....  | <i>A. mutatus</i> (Becker)         |
| – | Cercus narrow, not elliptic .....  | <i>A. crassatus</i> Yang           |
| 9 | Wing with brown apico-anterior spot; thoracic pleuron yellow; male cercus thin, filiform, longer than epandrium .....                              | <i>A. pallidicornis</i> (Grimshaw) |



- Wing entirely hyaline; thoracic pleuron black except metapleuron yellow; male cercus thick, finger-like, shorter than epandrium (Fig. 1)..... *A. flavellus* sp. n.
- 10 4 strong dc; hind tarsomeres 4-5 strongly flattened ..... *A. imitans* (Becker)
- 5 strong dc; hind tarsomeres 4-5 normal..... *A. ventralis* sp. n.

## Taxonomy

### *Amblypsilopus crassatus* Yang, 1997

[http://species-id.net/wiki/Amblypsilopus\\_crassatus](http://species-id.net/wiki/Amblypsilopus_crassatus)

*Amblypsilopus crassatus* Yang, 1997: 133. Type locality: China: Zhejiang, Hangzhou.

**Diagnosis.** Antenna yellow except first flagellomere dark brown and subrectangular. Fore tarsomere 5 distinctly flattened with lateral flags. Male cercus rather thick with ventral surface slightly concave; hypandrium rather wide.

**Specimen examined.** 1 male, Taiwan: Nantou, Lienhuachi, 675 m, 2010. XI. 11, Ding Yang.

**Distribution.** China (Henan, Hubei, Yunnan, Guizhou, Guangxi, Guangdong, Zhejiang, Fujian, Taiwan); Singapore.

**Remarks.** This species belongs to the *Amblypsilopus triscuticatus* group (Yang et al. 2011). It is newly recorded from Taiwan.

### *Amblypsilopus flavellus* sp. n.

[urn:lsid:zoobank.org:act:63EB632F-0262-47ED-BAF0-14AAFC47E176](http://species-id.net/wiki/Amblypsilopus_flavellus)

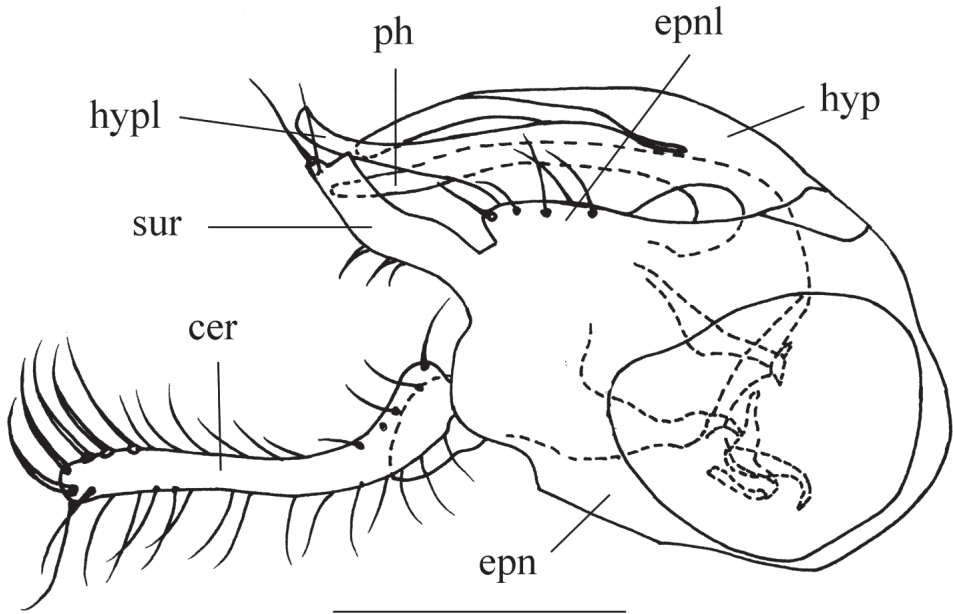
[http://species-id.net/wiki/Amblypsilopus\\_flavellus](http://species-id.net/wiki/Amblypsilopus_flavellus)

Fig. 1

**Diagnosis.** 2 long and strong paired acr. Antenna yellow. Mesonotum with small anterolateral area including humerus and large posterolateral area including postalar callus dark yellow; metapleuron yellow. Abdomen partly yellow at base. Fore tarsomere 1 white, slightly longer than mid and hind tarsomere 1.

**Description.** Male. Body length 4.5 mm, wing length 4.0 mm.

Head brightly metallic green with pale grey pollen. Hairs and bristles on head pale yellow; frons with 1 pale curved and slightly thick hair on posterolateral slope; 1 pvt at end of postocular line. Ocellar tubercle with 2 long strong oc and 2 posterior hairs. Antenna yellow; pedicel with cirlet of short blackish apical bristles except 1 dorsal bristle and 1 ventral bristle relatively long; first flagellomere short triangular, nearly as long as wide; arista [broken apically] apical, blackish. Proboscis yellow with pale yellow hairs; palpus yellow with pale hairs and 2 brownish yellow bristles.



**Figure 1.** *Amblypsilopus flavellus* sp. n. Male genitalia, lateral view. Scale bar 0.25 mm. Abbreviations: **cer** cercus **epn** epandrium **epnl** epandrial lobe **hyp** hypandrium **hypl** hypandrial lateral arm **ph** phallus **sur** surstylius.

Thorax brightly metallic green with pale grey pollen, except mesonotum with small anterolateral area including humerus and large posterolateral area including postalar callus dark yellow; metapleuron yellow. Hairs and bristles on thorax black; 2 long strong black posterior dc and 3 pale yellow anterior hairs; 2 long and strong paired acr, 3–4 very short paired hairs anteriad; 1 short ih, 1 short ph, 1 short su, 2 sa, 1 psa, 2 npl; scutellum with 2 sc, basal pair absent. Legs yellow except fore tarsomere 1 white, mid and hind tarsomere 1 dark brown. Hairs and bristles on legs black except coxae with pale yellow hairs and brownish yellow bristles. Fore coxa with 3 bristles, hind coxa with 1 exterior bristle. Fore and mid femora thickened with narrowed apex. Fore tibia without distinct d, but with 1 long brownish posterior bristle at apical 1/5; apically with 1 av. Mid tibia with 1 a at middle, 1 ad at base and 4 pd; apically with 1 ad and 1 av. Hind tibia with row of pd and pv; apically with 1 ad and 1 av. Hind tarsomere 1 with 1 v at extreme base. Relative length ratio of tibiae and tarsomeres: LI 3.9 : 2.5 : 0.95 : 0.85 : 0.4 : 0.3; LII 4.1 : 3.2 : 0.85 : 0.6 : 0.3 : 0.2; LIII 5.7 : 2.6 : 1.0 : 0.7 : 0.4 : 0.2. Wing hyaline, veins dark brown. Vein  $M_1$  basally curved nearly at a right angle. Crossvein m-cu straight, CuAx ratio 1.3. Squama yellow with dark brown margin and with pale hairs. Halter dark yellow.

Abdomen pale metallic green with thin pollen except segments 1–4 dark yellow or yellow with posterior margins of tergites 1–4 brown or dark brown. Hairs and bristles

on abdomen black. Male genitalia (Fig. 1): Epandrium longer than wide in lateral view; epandrial lobe short, obtuse. Surstylus finger-like, slightly bent. Cercus dark yellow, shorter than epandrium, finger-like, basally slightly curved. Hypandrium apically nearly straight, with lateral arm rather thick near base.

Female. Unknown.

**Type material.** Holotype male, Taiwan: Kaohsiung, Nancai Mountain, 50 m, 2009. VI.

**Distribution.** China (Taiwan).

**Remarks.** This species belongs to *Amblypsilopus pallidicornis* group. It is similar to *C. flavicercus* Zhu & Yang from Hainan of China, but can be separated from it by the antenna entirely yellow, male cercus shorter than the epandrium and distinctly curved basally, and surstylus long and distinctly bent. In *C. flavicercus*, the antennal scape and flagellum are brownish at tip, male cercus is as long as the epandrium and nearly straight, and the surstylus is short and nearly straight (Yang et al. 2011).

**Etymology.** The specific name refers to the yellow antenna.

***Amblypsilpus ventralis* sp. n.**

urn:lsid:zoobank.org:act:D54756C1-64E7-4123-9F61-60706038CCE4

[http://species-id.net/wiki/Amblypsilpus\\_ventralis](http://species-id.net/wiki/Amblypsilpus_ventralis)

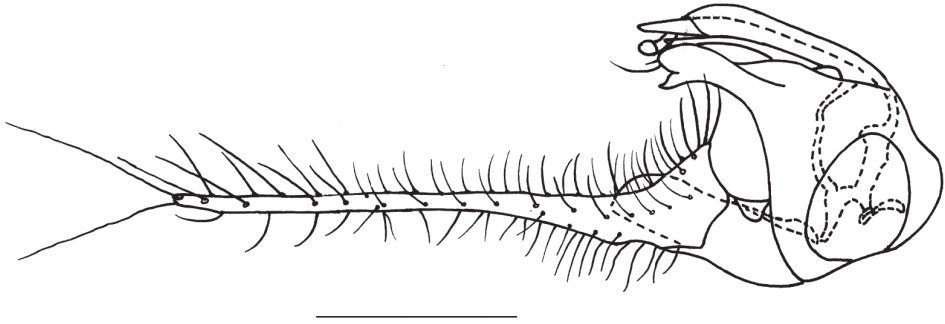
Fig. 2

**Diagnosis.** 1 strong vt. 5 strong dc. 3-4 very short paired acr present only before 1 anteriormost dc. Fore femur with two rows of short v. Mid tarsomeres 4-5 slightly thickened.

**Description.** Male. Body length 3.8-3.9 mm, wing length 3.0-3.2 mm.

Head brightly metallic green with pale grey pollen. Hairs and bristles on head black except middle and lower postocular bristles including posteroventral hairs pale yellow; frons with 1 strong vt, anteriorly without hair on posterolateral slope; 1 pvt near end of postocular line. Ocellar tubercle with 2 long strong oc and 2 posterior hairs. Antenna black; pedicel with cirlet of short black apical bristles except 1 dorsal bristle and 2 ventral bristles relatively long; first flagellomere nearly trapezoid, nearly as long as wide; arista dorsal, blackish. Proboscis mostly reddish yellow with blackish hairs; palpus brownish yellow with blackish hairs and 2 black bristles.

Thorax brightly metallic green with pale grey pollen. Hairs and bristles on thorax black; 5 long strong dc; 3-4 very short, paired acr present before anteriormost dc; h indistinct, 1 ih, 1 ph, su absent, 2 sa, 1 psa, 2 npl; scutellum with two pairs of sc, basal pair very short and hair-like (about 1/5 of apical pair). Legs yellow except mid and hind coxae brown with yellow apex and tarsi dark brown from tip of fore tarsomere 1 onward. Hairs and bristles on legs black except coxae with pale yellow hairs and bristles. Fore coxa with 3 bristles, hind coxa with 1 brownish yellow exterior bristle. Fore femur thickened with two rows of v on basal 2/3 and narrowed on apical 1/3. Fore tibia ventrally slightly swollen at base, with 4 pv and one row of short dense av hairs, without distinct d; apically with 1 pd and 1 p. Mid tibia with 3 strong ad and 3 weak



**Figure 2.** *Amblypsilopus ventralis* sp. n. Male genitalia, lateral view. Scale bar 0.25 mm.

pd; apically with 1 ad and 1 av. Hind tibia with 4 pd and 2–3 weak pv at middle; apically with 1 ad and 1 av. Hind tarsomere 1 with 1 v at extreme base. Relative length ratio of tibiae and tarsomeres: LI 1.9 : 1.7 : 0.7 : 0.5 : 0.3 : 0.2; LII 3.2 : 2.4 : 0.9 : 0.6 : 0.2 : 0.25; LIII 4.0 : 1.5 : 1.1 : 0.6 : 0.4 : 0.2. Wing nearly hyaline, veins dark brown. Vein  $M_1$  basally curved nearly at a right angle. Crossvein m-cu straight, CuAx ratio 1.3. Squama yellow with dark brown margin and with pale hairs. Halter dark yellow.

Abdomen metallic green with thin pollen except venter and hypopygium pale metallic green. Hairs and bristles on abdomen black except those on lateral portion of tergite 1 pale yellow. Male genitalia (Fig. 2): Epandrium wider than long in lateral view; epandrial lobe indistinct. Surstylus slightly thick, apically shallowly furcated. Cercus about two times as long as epandrium, long finger-like, basally thick with subtriangular ventral process. Hypandrium distinctly bent apically, with thin lateral arm.

Female. Unknown.

**Type material.** Holotype male, Taiwan: Wulai, Fushan, Shuiguan Road, 2007. V. 18, Nanyi Cai. Paratype 1 male, same data as holotype.

**Distribution.** China (Taiwan).

**Remarks.** This species is somewhat similar to *A. basalis* Yang from Southern China, but can be separated from it by the antenna black, and male cercus as long as the epandrium, with the large ventral process at base. In *A. basalis*, the antenna is yellow, and male cercus is about two times as long as the epandrium and has the small ventral process at base (Yang 1997; Yang et al. 2011).

**Etymology.** The specific name refers to the fore femur with two rows of short v.

## Acknowledgements

Our sincere thanks are due to Prof. Shen-Horn Yen (National Sun Yat-Sen University, Kaohsiung) for his help during the survey in Taiwan in 2011 and 2012 and providing us with specimens. Dr. Patrick Grootaert (Royal Belgian Institute of Natural Sciences, Brussels) and Dr. Justin B. Runyon (Montana State University, Bozeman) are

thanked for providing useful comments on an earlier draft of this paper. The research was funded by the National Natural Science Foundation of China (Nos. 30970395, 31061160186), Beijing Natural Science Foundation (No. 5092014), the Doctoral Program of Higher Education of China (20090008110016) and Chinese Universities Scientific Fund (No. 2009-2-08).

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# Description of two new species of Cossidae (Lepidoptera) from China

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| [urn:lsid:zoobank.org:author:3331547B-6B8F-48DE-B6B4-1619D2416228](https://zoobank.org/urn:lsid:zoobank.org:author:3331547B-6B8F-48DE-B6B4-1619D2416228)

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Academic editor: Carlos Peña | Received 13 December 2011 | Accepted 17 April 2012 | Published 8 May 2012

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**Citation:** Ivinskis P, Rimsaite J, Saldaitis A, Yakovlev R (2012) Description of two new species of Cossidae (Lepidoptera) from China. ZooKeys 192: 35–49. doi: 10.3897/zookeys.192.2611

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## Abstract

Two new Cossidae species from China's Zhejiang and Sichuan provinces are described. The new species *Phragmataecia monika* **sp. n.** and *Patoptoformis rimsaite* **sp. n.** superficially resemble related congeners but can be distinguished by differences in wing pattern, genitalia and distribution. Checklists of the genera *Phragmataecia* and *Patoptoformis* are presented.

## Keywords

Cossidae, *Phragmataecia*, *Patoptoformis*, new species, China

## Introduction

During a study of the Cossidae collection at the Zoologische Staatssammlung der Bayerischen Staaten (Munich, Germany)/Museum of Thomas Witt (Munich, Germany) the authors found two unknown specimens from China belonging to the genera *Phragmataecia* and *Patoptoformis*. After examining their morphology relative to related species the authors are describing the new species herein.

## Materials and methods

The material was collected in 2010, during May and July, using artificial light. Taxonomic nomenclature and checklists used in this study were compiled pursuant to consulting expert taxonomists and relevant literature (Schoorl 1990, Yakovlev 2011).

Abbreviations of depositories:

**ZSSM/MWM** collection of Zoologische Staatssammlung der Bayerischen Staaten (Munich, Germany)/Museum of Thomas Witt (Munich, Germany).

## Systematic accounts

### Genus *Phragmataecia* Newman, 1850

<http://species-id.net/wiki/Phragmataecia>

*Phragmataecia* Newman, 1850, Zoologist 8: 2931

### Type species. *Noctua arundinis* Hübner, [1808]

Members of this genus are generally medium sized with very long abdomens, especially in females, and long bipectinate antennae. In males the length of pecten abruptly shortens to the distal part of tip, while in females pecten length is short to the tip of antenna as near invisible papilla. Coloration is white to black with unexpressed wing patterns except small black dots between the vein of the forewing in females.

**Male genitalia.** Uncus base short and wide, tip acute; tegumen medium size; gnathos reduced; valvae lancete-shaped with even edges, gradually narrowing to rounded tip; juxta wide with two lateral outgrowth patches; saccus elongated, semioval form; aedeagus long, weakly hooked and slightly longer than valva; vesica without cornutus, with pale indistinct opening.

**Female genitalia.** Long oviductus; papillae anales elongated, ellipse form; apophyses posteriores about 1.5 times longer than apophysis anterioris; ostium opening immersed, cup-like; postvaginal plate indistinct; ductus thin, long; bursa sack rounded, small without signum and with insignificant bulla on lateral side.

**Distribution.** 39 species distributed in Old world excluding Papuan and Australian ranges.

### *Phragmataecia monika* Yakovlev & Saldaitis, sp. n.

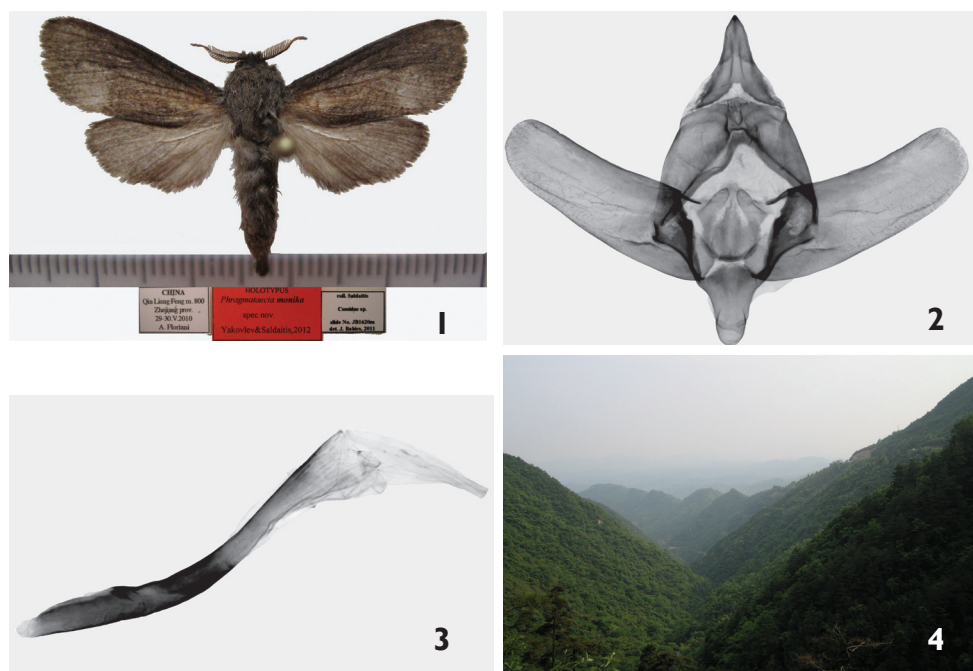
urn:lsid:zoobank.org:act:A8A6C34C-3A71-43D5-8F96-754BCA5B921A

[http://species-id.net/wiki/Phragmataecia\\_monika](http://species-id.net/wiki/Phragmataecia_monika)

Figs 1–4

**Holotype.** male (Fig. 1), China, Qin Liang Feng m.800 Zhejiang prov. [province] 29-30.V.2010 A. Floriani (slide No.JB1620), (deposited in ZSSM/MWM).

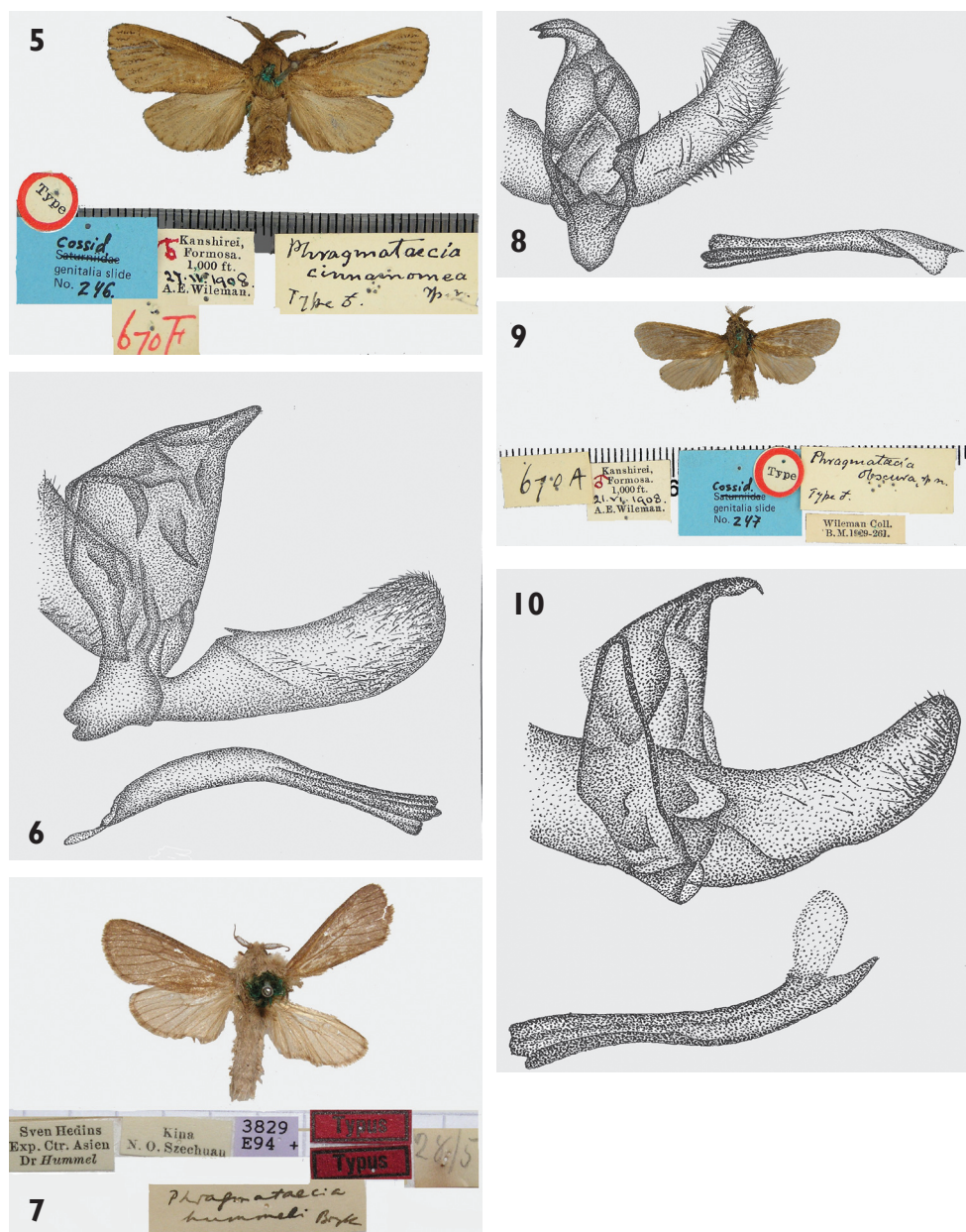




**Figures 1–4.** *Phragmataecia monika* Saldaitis & Yakovlev sp. n. **1** *Ph. monika*, male, holotype, China, Zhejiang prov. **2** *Ph. monika*, holotype, male genitalia capsule prep. Nr. UFO 1 **3** *Ph. monika*, holotype, male genitalia aedeagus prep. Nr. UFO 1 **4** Type locality of *Ph. monika*, China, Zhejiang prov.

**Diagnosis.** Externally the new species is most similar to sibling species *Phragmataecia cinnamomea* Wileman, 1911, *Phragmataecia hummeli* Bryk, 1942 and to *Phragmataecia fusca* Wileman, 1911. *Ph. cinnamomea* differs by having a yellow-brown body and wings, veins covered with dark brown scales in the postmedian forewing and dark brown dots in the terminal area (Fig. 5) and male genitalia valvae which widen to the apical part (Fig. 6). *Ph. hummeli* has a grey-brown body and unicolor wing pattern with forewings lighter brown and hindwings grey brown (Fig. 7). Its male genitalia differ by the pointed shape of the valvae, the rounded and very wide saccus and straight aedeagus (Fig. 8). *Ph. fusca* has a dark yellow-brown body (Fig. 9), forewings dark brown in postmedian part, and reddish-brown hindwings. Its male genitalia valvae are rounded at the apical part (Fig. 10).

**Description. Male** (Fig. 1): Forewing length of holotype 14 mm, wingspan 31 mm. Antennae one-third the length of forewing; last third strongly bipectinate with very short triangular pecten. Ground color of forewings blackish brown; median part of wing from base to inner edge yellow brown extending to j-shaped wing edge; cilia yellow mixed with brown scales; hindwing unicolor yellow, cilia greyish brown; dorsal forewing dark brown, anal edge grey; dorsal hindwing dark brown, costal area black brown. Head, thorax blackish brown.



**Figures 5–10.** *Phragmataecia* spp., adults and genitalia. **5** *Ph. cinnamomea* Wileman, adult, holotypus. **6** *Ph. cinnamomea* Wileman, holotypus, male genitalia **7** *Ph. hummeli* Bryk, adult, holotypus **8** *Ph. hummeli* Bryk, holotypus, male genitalia **9** *Ph. fusca* Wileman (= *Phragmataecia obscura* Wileman, 1911 adult. **10** *Ph. fusca* male genitalia.

**Male genitalia** (Figs 2, 3): Uncus wide, strong narrowing to acute tip; valvae almost the same width as length, flat tips with long blunt outgrowths at base; tegumen wide in medial part with plunging wide neckline; saccus long, narrow, rounded; juxta wide with a pair of lateral processes; aedeagus longer than valva, thin, curved and at the tip twice wider than base.

**Female genitalia.** Unknown.

**Bionomics and distribution.** Known only from the Qin Liang Feng Shan mountains in Zhejiang province of eastern China (Fig. 4), *Phragmataecia monika* is likely endemic to East China. The single male specimen was attracted to light in late May at an altitude of 800m in mountainous virgin mixed forest habitat dominated by various broad-leaved trees such as oak *Quercus dentata*, *Quercus glauca*, poplar *Populus cathayana*, *P. simonii*, elm *Ulmus parvifolia*, rhododendron *Rhododendron brachycarpum*, *Rh. dauricum*, and bamboo *Phyllostachys* spp., *Borinda* spp., *Fargesia* spp. Suspected host plants are *Phragmites* spp.

**Etymology.** The new species is named after Monika Rimsaite, daughter of the second author.

#### Key to species *Phragmataecia* related to *Ph. monika* based on external characters

- 1 Forewings dark colored.....2
- Forewings light colored.....3
- 2 Forewings blackish brown.....*Ph. monika* sp. n., China: Zhejiang
- Forewings dark brown ..... *Ph. fusca* Wileman, Taiwan
- 3 Forewings light brown ..... *Ph. hummeli* Bryk, China
- Forewings yellow brown with dark brown scales group and dots in terminal part..... *Ph. cinnamomea* Wileman, China, Taiwan

#### Key to species *Phragmataecia* related to *Ph. monika* based on male genitalia

- 1 Saccus long rounded .....2
- Saccus short or slightly bilobed .....3
- 2 Valva almost the same width as length .... *Ph. monika* sp. n., China: Zhejiang
- Valva in the apical part pointed ..... *Ph. hummeli* Bryk, China
- 3 Valva rounded, wider in the apical part.....
- ..... *Ph. cinnamomea* Wileman, China, Taiwan
- Valva in the apical part slightly narrowed, rounded .....
- ..... *Ph. fusca* Wileman, Taiwan

**Genus *Patoptoformis* Yakovlev, 2006**

<http://species-id.net/wiki/Patoptoformis>

*Patoptoformis* Yakovlev, 2006, Tinea, 19 (3): 203.

**Type species.** *Patoptoformis hanuman* Yakovlev, 2006.

Small dark colored moths with dark hair densely covering the body. Antennae bipectinate. Forewing with a scarcely seen streaky pattern; hindwing dark without pattern; fringe evenly dark on both wings. Sexual dimorphism weakly expressed but female somewhat larger than male with wider wings and non-pectinate antennae.

**Male genitalia.** Uncus long, narrowly triangular with pointed apex; gnathos arms long and densely covered with spinules; valva with costal crest, blunt apex and scarcely noticeable transition between sclerotized and membranous parts, sclerotization gradually weakening towards apex; arms of transtilla small, pointed; juxta small; saccus very poorly expressed; aedeagus short, vesica opening occupies a dorso-apical position and comprises half of aedeagus length; vesica without cornuti.

**Female genitalia.** Papillae anales elongated with rounded apices; apophyses posteriores thin, twice as long as anteriores; ostium opening immersed, fissure-like, surrounded by cordate rim; ductus bursae membranous, long and narrow; bursa elongate, gradually inflating to apex; ductus seminalis thin, enters bursa near its junction with ductus bursae.

**Distribution.** Three species distributed in NE India (Assam), Nepal, SE China (Sichuan).

***Patoptoformis rimsaitae* Saldaitis & Yakovlev, sp. n.**

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[http://species-id.net/wiki/Patoptoformis\\_rimsaitae](http://species-id.net/wiki/Patoptoformis_rimsaitae)

Figs 11–14

**Type material. Holotype:** male China, Sichuan prov. [province], Env. [environs] Mianning Ling Shan Mts. [mountains], h[high], -3760 m 01-03. 07. 2010, local collector leg. (slide No.JB1620), (deposited in ZSSM/MWM).

**Diagnosis.** Externally the new species is most similar to sibling species *Patoptoformis ganesha* (Yakovlev, 2004) and *Patoptoformis hanuman* Yakovlev, 2006. Unlike the new species, *P. ganesha* has dark forewings generally with a row of narrow transverse bands in medial and submarginal zones and black hindwings with a black fringe (Fig. 15). Male genitalia in *P. ganesha* differ as its uncus is triangular, broad gnathos is densely set with spinules, valvae are cut near apex, arms of transtilla are hook-like and saccus is rounded (Fig. 16). In *P. hanuman* the forewings are brown with a faint black streaky pattern with a clear submarginal streak and spot in the distal area and hindwings are dark brown, almost black (Fig. 17, 19). Male genitalia differ in shape of



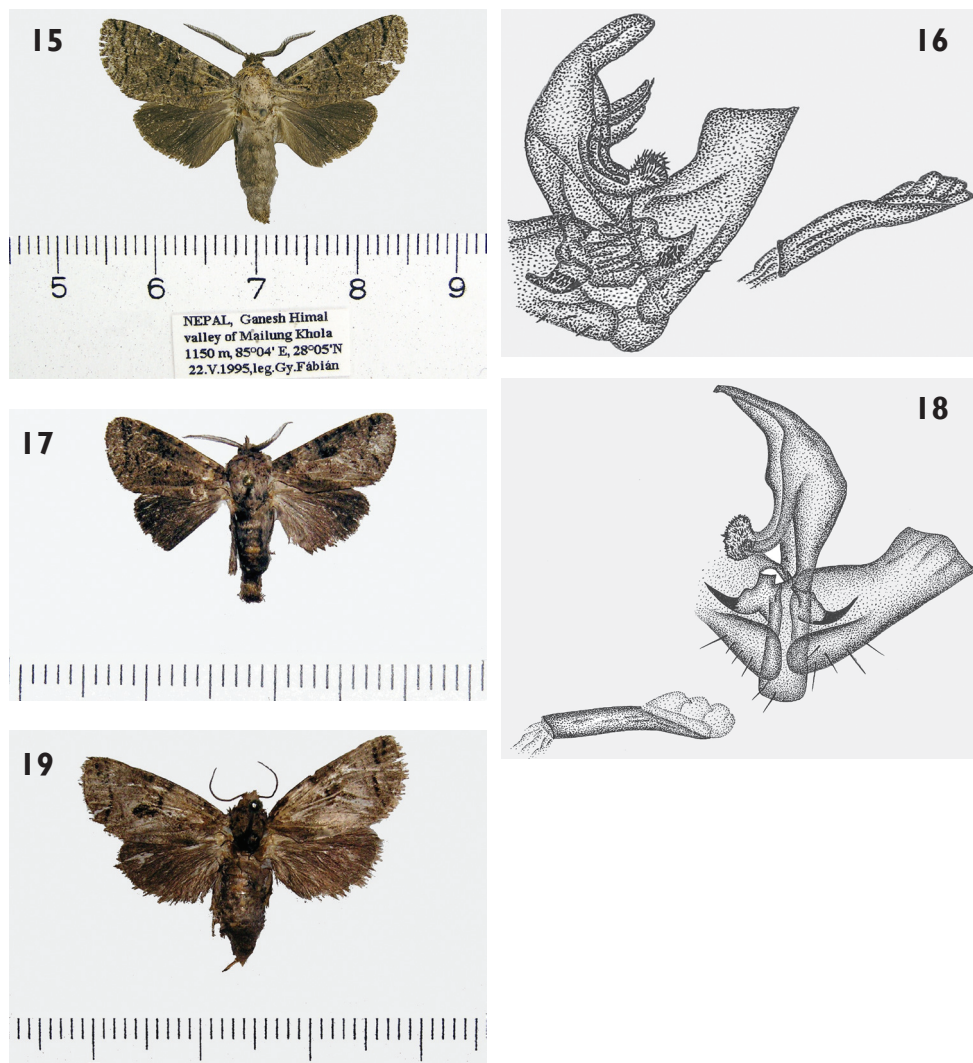


**Figures 11–14.** *Patoptoformis rimsaitae* Saldaitis & Yakovlev sp. n. **11** *P. rimsaitae* Saldaitis & Yakovlev, holotype, Sichuan province **12** *P. rimsaitae*, holotype, male genitalia, capsule, prep. Nr. UFO 2 **13** *P. rimsaitae*, holotype, male genitalia, aedeagus, prep. Nr. UFO 2 **14** Type locality *P. rimsaitae*, China, Sichuan.

the valvae which are narrower, the gnathos arms which are thicker and aedeagus which is somewhat curved in the middle (Fig. 18).

**Description. Male** (Fig. 11): Forewing length of holotype 11 mm; wingspan 24 mm. Antennae almost half as long as forewing, strongly bipectinate and last third with very short triangular pecten; ground color of forewings grey blackish with large yellow patch in middle of basal area, middle part of wing from base to inner edge yellow brown, cilia yellow mixed with brown scales; hindwing unicolor yellow, cilia greyish brown; upper side of forewing dark brown, anal edge grey; upper side of hindwing dark brown, costal area black brown; head, thorax blackish brown.

**Male genitalia** (Figs 12, 13): Uncus wide with blunt tip; gnathos wide but arms narrow; valvae short, very wide at base narrowing to middle then widening abruptly at tip; arms of transstilla hook-like, thin, acute in tip; saccus wide, rounded; aedeagus almost the same length as valva, weakly curved with sharp curved tip; vesica like equilateral sack with opening size more than half of aedeagus length.



**Figures 15–19.** *Patoptoformis* spp. adults and genitalia. **15** *P. ganeshia* (Yakovlev, 2004, holotypus **16** *P. ganeshia*, holotypus male genitalia **17** *P. hanuman* Yakovlev, 2006 holotypus, male **18** *P. hanuman*, holotypus, male genitalia **19** *P. hanuman*, paratypus, female.

**Female genitalia.** Unknown.

**Bionomics and distribution.** Known only from the China's Sichuan province on the eastern edge of the Tibetan plateau. *Patoptoformis rimsaitae* is likely endemic to West Sichuan. A single male was attracted to light at an altitude of 3700 m. The new species was collected in the shrubby transition between the mountain primary mixed forest and the alpine grassland zones (Fig. 14). Nothing is known about the early stages.

**Etymology.** The species is named in honor of Dr Jolanta Rimsaite, a prominent expert of general entomology.

**Key to species *Patoptoformis* based on external characters**

- 1 Forewings dark brown with reticulated patterns formed by black lines.....2
- Forewings dark brown without reticulated patterns but with big black patch  
.....*P. hanuman* Yakovlev, India: Assam
- 2 Forewings grey black with yellow patch *P. rimsaitae* sp. n., China: Sichuan
- Forewings with row of narrow transversal bands in medial and submarginal  
zones.....*P. ganesha* (Yakovlev), Nepal

**Key to species *Patoptoformis* based on male genitalia**

- 1 Arms of transtilla hook –like, thin .....2
- Arms of transtilla hook –like, massive... *P. hanuman* Yakovlev, India: Assam
- 2 Tip of valva flat, edges rounded ..... *P. rimsaitae* sp. n., China: Sichuan
- Tip of valva with pointed edge.....*P. ganesha* (Yakovlev), Nepal

**Checklist of the genus *Phragmataecia******Phragmataecia albida* Erschoff, 1874**

= *Phragmataecia erschoffi* Reisser, 1962

Distribution. Iran, Turkmenistan, Uzbekistan, Kazakhstan, NW China (Kuldja), Afghanistan, SW Russia (S. Volga reg.) (Christoph 1884, Daniel 1963, 1965, Falkovich 1986, Gross 1925, Uvarov 1910, Yakovlev 2005a, 2009).

***Phragmataecia andarana* Clench, 1959**

Distribution: Namibia, South Africa (Vári et al. 2002).

***Phragmataecia anikini* Yakovlev, 2011**

Distribution: SW Mongolia (Hovd aimak, Dzhungarian Gobi desert) (Yakovlev 2011).

***Phragmataecia annapurna* Yakovlev, 2009**

Distribution: Nepal (Annapurna Himal) (Yakovlev 2009a).

***Phragmataecia brunni* Pagenstecher, 1892**

Distribution: E. Africa (Tanzania) (Pagenstecher 1892).

***Phragmataecia castaneae* (Hübner, 1790)**

= *Phalena (Bombyx) arundinis* Hübner [1802-1808]

= *Phalena castanea*, Esper (1807)

- = *Phragmatoecia castanea* Teich, 1884
- = *Phragmataecia castanea sicca* Dannehl, 1829
- = *Phragmataecia castaneae f. fusca* Lempke, 1961
- = *Phragmataecia castaneae leonadae* Gomez Bustillo, 1977
- = *Phragmataecia meloina* Gomez Bustillo & Fernandes-Rubio, 1976
- = *Phragmataecia sica* Gomez bustillo & Fernandes-Rubio, 1976

Distribution: Central and Southern Europe, S. England, M. East, Caucasus, Transcaucasia, Turkmenistan, Kazakhstan, NW Iran, Iraq, Syria, Lebanon, Turkey, W. China, SW Siberia, Egypt, Tunisia, Morocco (Yakovlev 2011).

***Phragmataecia cinnamomea* Wileman, 1911**

= *Xyleutes Hansi* Strand, 1915.

Distribution: Taiwan, S. China (Jianxi-Fujian border) (Gaede 1933, Ueda in Heppner et Inoue 1992, Wang & Lee 1998, Yakovlev 2009b).

***Phragmataecia dushman* Yakovlev, 2009**

Distribution: Afghanistan (Yakovlev 2009a).

***Phragmataecia furia* Grum-Grshimailo, 1890**

Distribution: Uzbekistan, Tadzhikistan ?, Afghanistan (Daniel 1964).

***Phragmataecia geisha* Yakovlev, 2011**

Distribution: Japan (Yakovlev 2011).

***Phragmataecia gummata* Swinhoe, 1892**

= *Phragmatoecia* (sic!) *lata* Snellen, 1895

= *Phragmatoecia* (sic!) *sordida* Snellen, 1901

Distribution: China (Fukien, Lingping), Vietnam, Thailand, Indonesia (Java, Sumatra) (Daniel 1940, Gaede 1933, 1949, Roepke 1957, Yakovlev 2009b, Yakovlev, Witt 2009).

***Phragmataecia gurkoi* Yakovlev, 2007**

Distribution: NW Pakistan (Yakovlev 2007a).

***Phragmataecia fusca* Wileman, 1911**

= *Phragmataecia obscura* Wileman, 1911

Distribution: Taiwan (Ueda 1992), Thailand, Hong Kong (Ades and Kendrick 2004).

***Phragmataecia fuscifusa* Hampson, 1910**

Distribution: Sierra Leone, Nigeria (Yakovlev 2011).



***Phragmataecia hummeli* Bryk, 1942**

Distribution: China (NE Sichuan) (Yakovlev 2009b).

***Phragmataecia impura* Hampson, 1891**

Distribution: India, Nepal, S. China (Hainan Isl., Zhejiang and Guangxi prov.), Vietnam, Laos, Thailand, Java (Snellen 1901, de Joannis 1929, Arora 1976, Yakovlev 2004, 2009b, Yakovlev & Witt 2009).

***Phragmataecia innominata* Dalla Torre, 1923**

=*Phragmatoecia reticulata* Hampson, 1910

Distribution: South Africa, Mozambique, Malawi (Schoorl 1990, Vári et al. 2002).

***Phragmataecia innotata* (Walker, 1865)**

Distribution: China, Vietnam, Laos, Thailand (Yakovlev, Witt 2009, Yakovlev 2011).

***Phragmataecia irrorata* Hampson, 1910**

Distribution: Zimbabwe, South Africa, Namibia, Botswana, Mozambique, Zambia, Malawi (Pinhey 1979, Vári et al. 2002, Yakovlev 2011).

***Phragmataecia itremo* Viette, 1974**

Distribution: Madagascar (Viette 1974).

***Phragmataecia laszloi* Yakovlev, 2009**

Distribution: Nepal (Annapurna Himal) (Yakovlev 2009a).

***Phragmataecia longivitta* Ćandèze, 1926**

Distribution: Laos (Ćandèze 1926).

***Phragmataecia minima* Hampson, 1891**

Distribution: S. India (Hampson 1891).

***Phragmataecia minor* Moore, 1879**

Distribution: Bangladesh, Myanmar ?, China (Lingping) (Cotes, Swinhoe 1887, Swinhoe 1890, Daniel 1949, Yakovlev 2011).

***Phragmataecia monika* Saldaitis & Yakovlev, sp. n.**

Distribution: China Zhejiang province.

***Phragmataecia okovangae* Clench, 1959**

Distribution: Namibia, South Africa (Vári et al. 2002).

***Phragmataecia pacifica* Yakovlev, 2007**

Distribution: Russia, Caucasus, Daghestan (Yakovlev 2007b).

***Phragmataecia parvipuncta* (Hampson, 1892)**

Distribution: India, Sri Lanka, Vietnam (Arora 1976, Gaede 1933, de Joannis 1929, Yakovlev and Witt 2009).

***Phragmataecia pelostema* (Hering, 1923)**

Distribution: Togo, Cameroon, Nigeria (Yakovlev 2011).

***Phragmataecia pectinicornis* (Strand, 1914)**

Distribution: Central Sudan (Strand 1914).

***Phragmataecia psyche* (Le Cerf, 1919)**

Distribution: Benin? and different parts of Western Africa (Yakovlev 2011).

***Phragmataecia purpureus* Fletcher, 1927**

Distribution: India (Bihar) (Arora 1976; Fletcher 1927).

***Phragmataecia pygmaea* Graeser, 1888**

Distribution: SE Russia, Korea, NE China (Charbin) (Staudinger 1892, Staudinger & Rebel 1901, Witt 1985, Yakovlev 2005b, 2009b).

***Phragmataecia roborowskii* Alpheraky, 1897**

=*Phragmataecia longialatus* Hua, Chou, Fang & Chen, 1990

Distribution: NW China, S. Mongolia (Yakovlev 2007c).

***Phragmataecia saccharum* Moore, 1879 (Walker, 1865)**

Distribution: India (Cotes and Swinhoe 1887).

***Phragmataecia sericeata* Hampson, 1910**

Distribution: Ghana, Nigeria (Yakovlev 2011).

***Phragmataecia sumatrensis* Snellen, 1892**

Distribution: Indonesia (Sumatra) (Snellen 1892, Gaede 1933).

***Phragmataecia terebrifer* Fletcher, 1927**

Distribution: India (Fletcher 1927).

***Phragmataecia turkmenbashi* Yakovlev, 2008**

Distribution: Turkmenistan (Kopetdagh Mts., Valley of Ipay-Kala ) (Yakovlev 2008).

### Checklist of the genus *Patoptoformis*

#### *Patoptoformis ganesha* (Yakovlev, 2004)

Distribution: Nepal, Ganesh Himal.

#### *Patoptoformis hanuman* Yakovlev, 2006

Distribution: NE India, Assam.

#### *Patoptoformis rimsaitae* Saldaitis & Yakovlev, sp. n.

Distribution: province China, Sichuan.

### Acknowledgements

The authors are especially grateful to Mr Robert Borth (Milwaukee, United States) for English grammar suggestions, Ms Lina Jasiukonyte for ink drawings, Mr Janos Babics (Budapest, Hungary) for genitalia preparations, pictures and very useful suggestions on genitalia comparisons, Mr Alessandro Floriani (Milan, Italy) for providing habitat information and photos of Qin Liang Feng Shan mountains and to anonymous reviewers.

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# Description and DNA barcoding of *Tipula (Pterelachisus) recondita* sp. n. from the Palaearctic region (Diptera, Tipulidae)

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Academic editor: V. Blagoderov | Received 15 November 2011 | Accepted 4 May 2012 | Published 8 May 2012

[urn:lsid:zoobank.org:pub:651AB2AE-DC5E-4CE5-B748-60410402E5B2](https://zoobank.org/urn:lsid:zoobank.org:pub:651AB2AE-DC5E-4CE5-B748-60410402E5B2)

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**Citation:** Pilipenko VE, Salmela J, Vesterinen EJ (2012) Description and DNA barcoding of *Tipula (Pterelachisus) recondita* sp. n. from the Palaearctic region (Diptera, Tipulidae). ZooKeys 192: 51–65. doi: 10.3897/zookeys.192.2364

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## Abstract

*Tipula (Pterelachisus) recondita* Pilipenko & Salmela, **sp. n.** is described. The new species is collected from two localities: Finland, Kittilä (North boreal ecoregion) and Russia, Primorski kray (Zone of temperate broadleaf and mixed forests). Although variation in the structure of male hypopygium between the Finnish and Russian populations is observed, DNA barcode sequences differ only by three nucleotides (0.2 % K2P distance), supporting presence of one widespread species. K2P minimum distances between the new species and 17 other species of the subgenus range from 5.3 to 15.8 % (mean 8.8 %). The new species is forest-dwelling, known from an old-growth herb-rich forest (Finland) and *Quercus mongolica* forest (Russia). The new species is perhaps closest to *T. (P.) imitator* Alexander and in lesser extent to *T. (P.) pauli* Mannheims; the inner gonostylus of both species are illustrated.

## Keywords

Crane flies, Tipulinae, taxonomy, Finland, Russia, COI

## Introduction

Tipulidae (Diptera, Nematocera), or long-palped crane flies, are medium to large sized true flies. Globally, 4269 tipulid species and subspecies are known, of these 1322 occupying the Palaearctic region (Oosterbroek 2011). In general, northwest European tipulid fauna is rather well known (e.g. Salmela 2010, 2011). The majority of the species have large European or Palaearctic ranges, only a few species are known from Fennoscandia or Russian Karelia alone. On the other hand, certain species have disjunct occurrences in northern Fennoscandia and the East Palaearctic region (viz. *Tipula kaisilai* Mannheims, *T. subexcisa* Lundström, *T. tchukchi* Alexander).

*Tipula* (*Pterelachisus*) Rondani is a northern hemisphere subgenus, totaling over 200 species and subspecies (Oosterbroek 2011). Despite taxonomic monographs covering Russia (former USSR, Savchenko 1964) and Europe (Theowald 1980), the Palaearctic fauna of the subgenus includes several elusive species, known from the type locality or female specimens only. Finnish *Tipula* (*Pterelachisus*) species were reviewed by Salmela (2009) and those of the Central European territory of Russia were listed by Pilipenko (2009). The subgenus *Pterelachisus* is closely allied to *Lunatipula* Edwards and *Savtshenkia* Alexander, but is diagnosable due to the bare squama, grayish coloration, patterned wings and structure of male hypopygium (Theowald 1980). Savchenko (1964), dealing with the fauna of former USSR, recognized 11 species groups and two mixed groups within *Tipula* (*Geotipula*) and *T.* (*Oreomyza*). These subgenera were synonymized to *Pterelachisus* by Alexander (1965) and later Theowald (1980) named 18 species groups from the West Palaearctic region. These species groups are mainly based on differences in the structure of male hypopygium (Theowald 1980), but no cladistic analysis or phylogeny of the species groups was provided by Theowald or authors after him.

DNA barcoding is a molecular-based method used in the identification and delimitation of species, having usually considerable congruence with morphology-based identifications (Ward et al. 2006, Hausmann et al. 2011, Park et al. 2011). Furthermore, barcoding has revealed cryptic diversity within a morphospecies (Smith et al. 2006, Huemer and Hebert 2011) or indicated a presence of one species despite morphological variation within studied specimens (Memon et al. 2006). DNA barcoding has its disadvantages (Meier 2008, Skevington et al. 2007, Taylor and Harris 2012), but it may be used as an additional, and apparently very powerful, method in taxonomy (Schlick-Steiner et al. 2010). Despite the wide use of DNA barcodes in the current taxonomy and biodiversity studies, the method has been only rarely used in taxonomic studies of crane flies (Ujvárosi et al. 2009, Ujvárosi and Bálint 2012).

In the present article we provide a description of *Tipula* (*P.*) *recondita* Pilipenko & Salmela sp. n. collected from Europe (Finland) and Asia (Russian Far East). Both sexes of the new species are richly illustrated. In addition, mtDNA sequences (COI) were used to assess (i) the conspecific status of disjunct Finnish and Russian populations and (ii) genetic divergence between the new species and 17 consubgeneric species.



## Material and methods

Total DNA of *Tipula* (*P.*) *recondita* Pilipenko & Salmela sp. n. specimens was extracted using a modified non-destructive salt extraction method (Aljanabi & Martinez 1997, Gilbert et al. 2007). Whole holotype (JES-20110034) and one paratype (JES-20110035) adult specimens and one leg from a paratype (JES-20110036) were placed on 250 µl 96-plate wells. Ethanol-stored samples were briefly dried at 60 °C. First 118 µl of sterile salt homogenizing buffer (0.4 M NaCl, 10 mM Tris-HCl pH 8.0, 2 mM EDTA pH 8.0 and 2% SDS) containing 8 µl of 20 mg/ml proteinase K (400 µg/ml final concentration) was added into each well. The samples were incubated overnight in the buffer at 55–65 °C. After the incubation, the intact samples were removed from the buffer and placed into 99.5% ethanol to stop further digestion. Type specimens JES-20110034 and JES-20110035 were finally preserved in 70 % ethanol. Then 80 µl of 6 M NaCl (NaCl saturated H<sub>2</sub>O, pH 8) was added to each well. Samples were vortexed for 1 min at maximum speed, and centrifuged for 20 minutes at 4000 rpm. Thereafter 100 µl of supernatant was transferred to wells on a new plate. An equal volume (100 µl) of isopropanol was added to each sample and the plate was briefly vortexed. Then the plate was placed into freezer (–20 °C) for 1 hour. After freezing, the samples were centrifuged for 20 minutes at 4000 rpm. The supernatant was discarded and the pellet was washed by adding 150 µl of ice-cold 70% ethanol and centrifuging for 20 min at 4000 rpm. The ethanol was then carefully pipetted out and the pellet was dried for overnight at room temperature. The next day, DNA pellet was dissolved in 50 µl of previously warmed ultrapure water.

The DNA barcode region (*cytochrome oxidase subunit I*) was amplified and sequenced from all specimens using universal primers LCO1490: 5'-GGGTCAACAAATCAT-AAAGATATTGG-3' and HCO2198: 5'-TAAACTTCAGGGTGACCAAAAAAT-CA-3' (Folmer et al. 1994). All PCR reactions were performed in a 20 µl volume containing 1 µl of DNA extract, 12.5 µl ddH<sub>2</sub>O, 2.0 µl 10x buffer, 2.0 µl MgCl<sub>2</sub>, 1.0 µl primer1 (LCO), 1.0 µl Primer 2 (HCO), 0.4 µl dNTPs, and 0.1 µl AmpliTaq Gold polymerase. The cycling profile was 95°C for 5 min, 40 cycles of 94 °C for 30 sec, 50 °C for 30 sec, 72°C for 1 min 30 sec and a final extension period of 72 °C for 10 min. Sterile water samples were used as controls in each PCR batch. All of the controls were negative. Successful PCR products were purified and sequenced by Macrogen Incorporated (South Korea).

For other species (totaling 17 species and 26 specimens, Table 1) DNA barcodes were obtained at the Canadian Centre for DNA Barcoding. Legs or 2–3 abdominal segments of the specimens were placed in 96% ethanol in a 96-well lysis microplate and dispatched to the Biodiversity Institute of Ontario where DNA was extracted and sequenced using standard protocols and primers (deWaard et al. 2008). Resultant sequence data were placed into a project (HOLPT) on BOLD (<http://www.boldsystems.org>, Ratnasingham and Hebert 2007). These sequence records are now publically available on both BOLD and on GenBank.

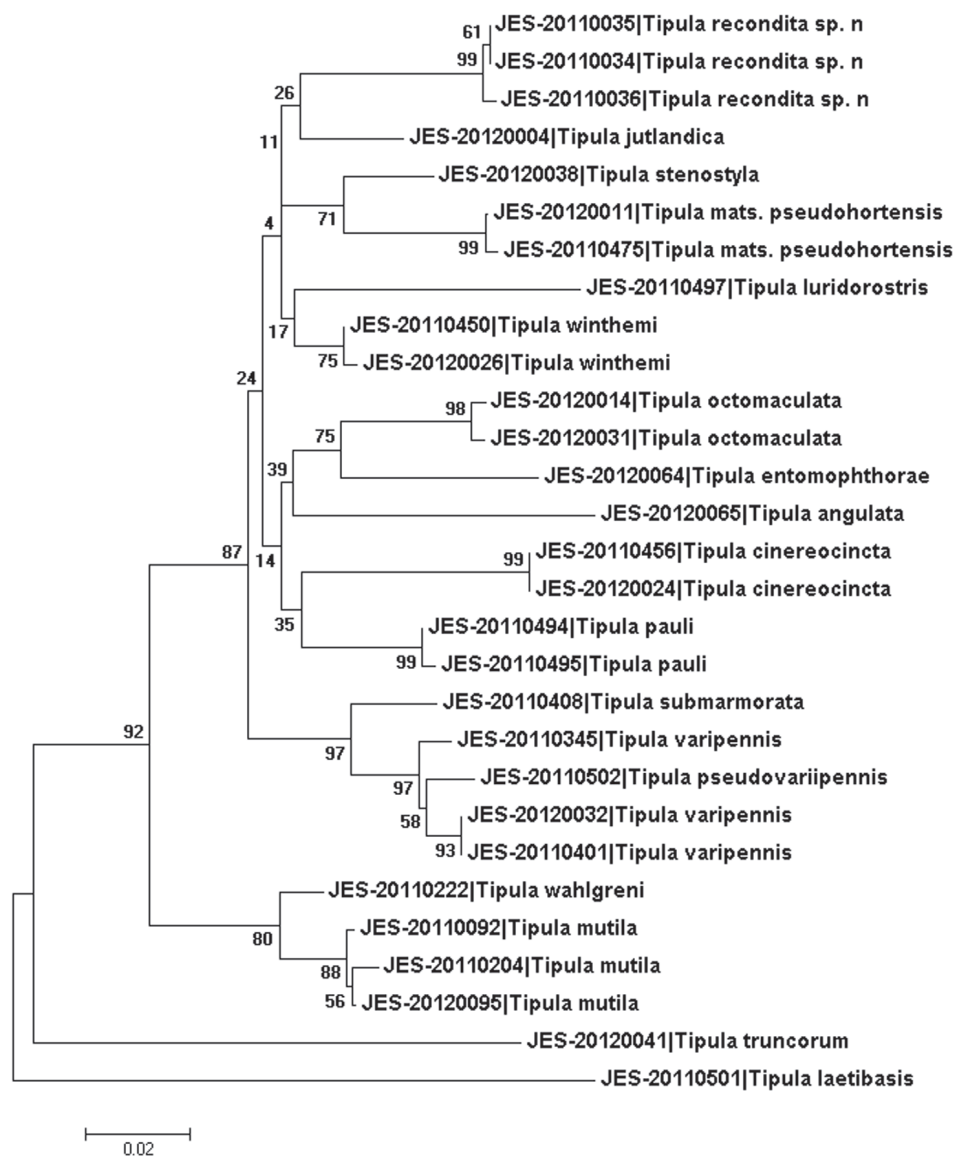
In order to assess the COI divergence between the new species and 17 Holarctic *Tipula* (*Pterelachisus*) species, we calculated Kimura two-parameter (K2P) (Kimura

**Table 1.** *Tipula* (*Pterelachisus*) specimens used in DNA barcoding (COI). Species and associated BOLD Sample ID are according to HOLPT project, available in <http://www.boldsystems.org/>. Co-ordinates are given in WGS84 decimal format.

Sample ID, species	Year	Country	Locality	N	E
JES-20110456  <i>Tipula_cinereocincta</i>	2005	Finland	Heinävesi	62.419	28.596
JES-20120024  <i>Tipula_cinereocincta</i>	2007	Finland	Savonranta	62.251	28.877
JES-20120065  <i>Tipula_angulata</i>	2006	Canada	Ontario	45.483	-76.081
JES-20120064  <i>Tipula_entomophthorae</i>	2003	Canada	Manitoba	54.9	-101.43
JES-20120004  <i>Tipula_jutlandica</i>	2008	Finland	Parikkala	61.565	29.559
JES-20110501  <i>Tipula_laetibasis</i>	2002	Finland	Tuupovaara	62.442	30.606
JES-20110497  <i>Tipula_luridorostris</i>	2006	Finland	Taivalkoski	65.785	28.321
JES-20120011  <i>Tipula_mats._pseudohortensis</i>	2007	Finland	Inkoo	60.018	23.822
JES-20110475  <i>Tipula_mats._pseudohortensis</i>	2007	Finland	Siuntio	60.213	24.135
JES-20110092  <i>Tipula_mutila</i>	2009	Finland	Enontekiö	68.639	22.552
JES-20110204  <i>Tipula_mutila</i>	2008	Finland	Kiuruvesi	63.52	26.69
JES-20120095  <i>Tipula_mutila</i>	2007	Finland	Kittilä	68.33	24.64
JES-20120014  <i>Tipula_octomaculata</i>	2008	Finland	Liekka	63.217	30.218
JES-20120031  <i>Tipula_octomaculata</i>	2006	Finland	Taivalkoski	65.693	28.32
JES-20110494  <i>Tipula_pauli</i>	2007	Russia	Primorski kray	47.94	137.72
JES-20110495  <i>Tipula_pauli</i>	1995	Russia	Moscow region	56.02	37.11
JES-20110502  <i>Tipula_pseudovariipennis</i>	2006	Latvia	Tukums	56.998	23.003
JES-20110035  <i>Tipula_recondita_sp._n</i>	2009	Finland	Kittilä	67.634	25.416
JES-20110034  <i>Tipula_recondita_sp._n</i>	2009	Finland	Kittilä	67.634	25.416
JES-20110036  <i>Tipula_recondita_sp._n</i>	2006	Russia	Primorski kray	43.125	131.4
JES-20120038  <i>Tipula_stenostyla</i>	2009	Finland	Kittilä	67.634	25.416
JES-20110408  <i>Tipula_submarmorata</i>	2009	Finland	Jyväskylä	62.236	25.679
JES-20120041  <i>Tipula_truncorum</i>	2010	Finland	Enontekiö	69.183	21.521
JES-20110345  <i>Tipula_varipennis</i>	2007	Finland	Ranua	66.017	26.852
JES-20120032  <i>Tipula_varipennis</i>	2005	Finland	Jyväskylä	62.213	25.793
JES-20110401  <i>Tipula_varipennis</i>	2009	Finland	Jyväskylä	62.236	25.679
JES-20110222  <i>Tipula_wahlgreni</i>	2008	Finland	Kiuruvesi	63.52	26.69
JES-20110450  <i>Tipula_winthemi</i>	2009	Finland	Lammi	61.091	25.002
JES-20120026  <i>Tipula_winthemi</i>	2008	Finland	Virolahti	60.465	27.426

1980) distances between all sequenced specimens. Based on K2P distances we also produced Neighbor-Joining (NJ) tree to visualize similarity of the *Pterelachisus* species. We also inferred relatedness of the species with character based Maximum Likelihood (ML) method (GTR + gamma as evolutionary model, 1000 Bootstrapping replicates). However, because the NJ and ML trees were practically identical, only ML tree is presented (Fig. 1). K2P distances, NJ and ML were produced by using MEGA5 program (Tamura et al. 2011). Because one gene is far too little for reasonable phylogenetic analysis (Gatesy et al. 2007), the ML tree presented here do not reliably illustrate evolutionary relationships among the sequenced taxa.

The morphological terminology used here mainly follows Alexander and Byers (1981). Terminology of some special parts of male genitalia was taken from Frommer (1963). If not otherwise stated, measurements are given in  $\mu\text{m}$ . The following acro-



**Figure 1.** Maximum Likelihood tree based on COI sequences (mtDNA) of 17 *Tipula* (*Pterelachisus*) species. Numerical values denote to Bootstrap values after 1000 replications. In the tree Bootstrap value 26 refers to the clade including *T. recondita* sp. n. and *T. jutlandica* and value 11 refers to the clade including *T. recondita* sp. n., *T. jutlandica*, *T. stenostyla* and *T. matsumuriana pseudohortensis*. Scale bar: nucleotide substitutions per site.

nyms for museums and collections are used in the text: ZMKU – Zoological Museum of National Museum of Natural History, National Academy of Science of Ukraine, Kiev, Ukraine; NCBN – Netherlands Centre for Biodiversity Naturalis, Leiden, the

Netherlands; ZMUM – Zoological Museum, Moscow State University, Moscow, Russia; ZMUT – Zoological Museum, University of Turku, Turku, Finland; ZISP – Zoological Institute Russian Academy of Sciences, St. Petersburg, Russia; VPM – Private collection of Valentin Pilipenko, Moscow, Russia.

Specimens were studied with a Zoom Stereo Microscope. Photographs were taken with a Canon PowerShot A640 camera and processed using Combine ZP software. All drawings were prepared from photographs.

[Comparative morphological material examined. *Tipula* (*P.*) *imitator* Alexander: Russia, Shikotan Island, Kray Sveta cape, 25.VII.1965, V. Ermolenko, 1 male (ZMKU); Russia, Iturup Island (Kuril Is), Kurilsk env., 5.VII.1963; Krilov & Krivolutskaya, 1 male (ZISP). *Tipula* (*P.*) *pauli* Mannheims: Russia, Moscow region, Chashnikovo, 29.V.1995, V. Pilipenko, 1 male (VPM).]

## Taxonomy

### *Tipula* (*Pterelachisus*) *recondita* Pilipenko & Salmela, sp. n.

urn:lsid:zoobank.org:act:CFBAD0A0-AC21-4067-88E4-C15BCA35CC56

[http://species-id.net/wiki/Tipula\\_recondita](http://species-id.net/wiki/Tipula_recondita)

**Material examined.** Holotype: Male, in alcohol (NCBN). “Finland, Lkoc: Kittilä, Iso Mustavaara, old-growth herb-rich forest, 67.6340°N, 25.4160°E, 30.V.–1.VII. 2009, J. Salmela leg.” (white label, printed) “*Tipula* (*Pterelachisus*) *recondita* sp. n./ Pilipenko & Salmela 2011/ HOLOTYPE” (white label, printed) “BOLD sample ID JES-20110034” (white label, printed). Both wings are detached. Only one leg is present, other legs are missing. Tip of abdomen is detached and, including separate sperm pump, preserved in a microvial. This microvial is in the same tube as are wings and rest of the specimen. DNA barcode (524 bp) of holotype (coded JES-20110034|FINTI034-11|*Tipula recondita*):

ATGCTTTTATTATAAATTTTTTTTATAGTTATACCTATTATAATTG-  
GAGGATTTGGAAATTGATTAGTACCTTTAATATTAGGTGCCCCCTGA-  
TATAGCCTTTCCTCGAATAAATAATATAAGTTTTTGAATATTACCTC-  
CTTCACTTACTCTTTTATTAGCTAGTAGTATAGTCGAAAACGGT-  
GCGGGGACTGGATGAACCGTTTATCCCCCACTCTCATCTAGAATT-  
GCCCATACAGGAGCTTCAGTTGATTTAGCCATTTTTTCTCTTCATT-  
TAGCTGGAATTTCTTCAATTTTAGGAGCAGTAAATTTTATTACTACA-  
GTAATTAATATACGATCAAGAGGAATTACTTTAGACCGAATACCTT-  
TATTTGTTTGATCGGTAGTAATTACTGCAGTATTATTACTACTCTCTT-  
TACCTGTATTAGCGGGAGCTATTACTATACTTTTAACTGATCGAAATT-  
TAAATACATCATTTTTTTGATCCTGCAGGAGGTGGAGATCCAATTCTT-  
TACCAACATTTATTT

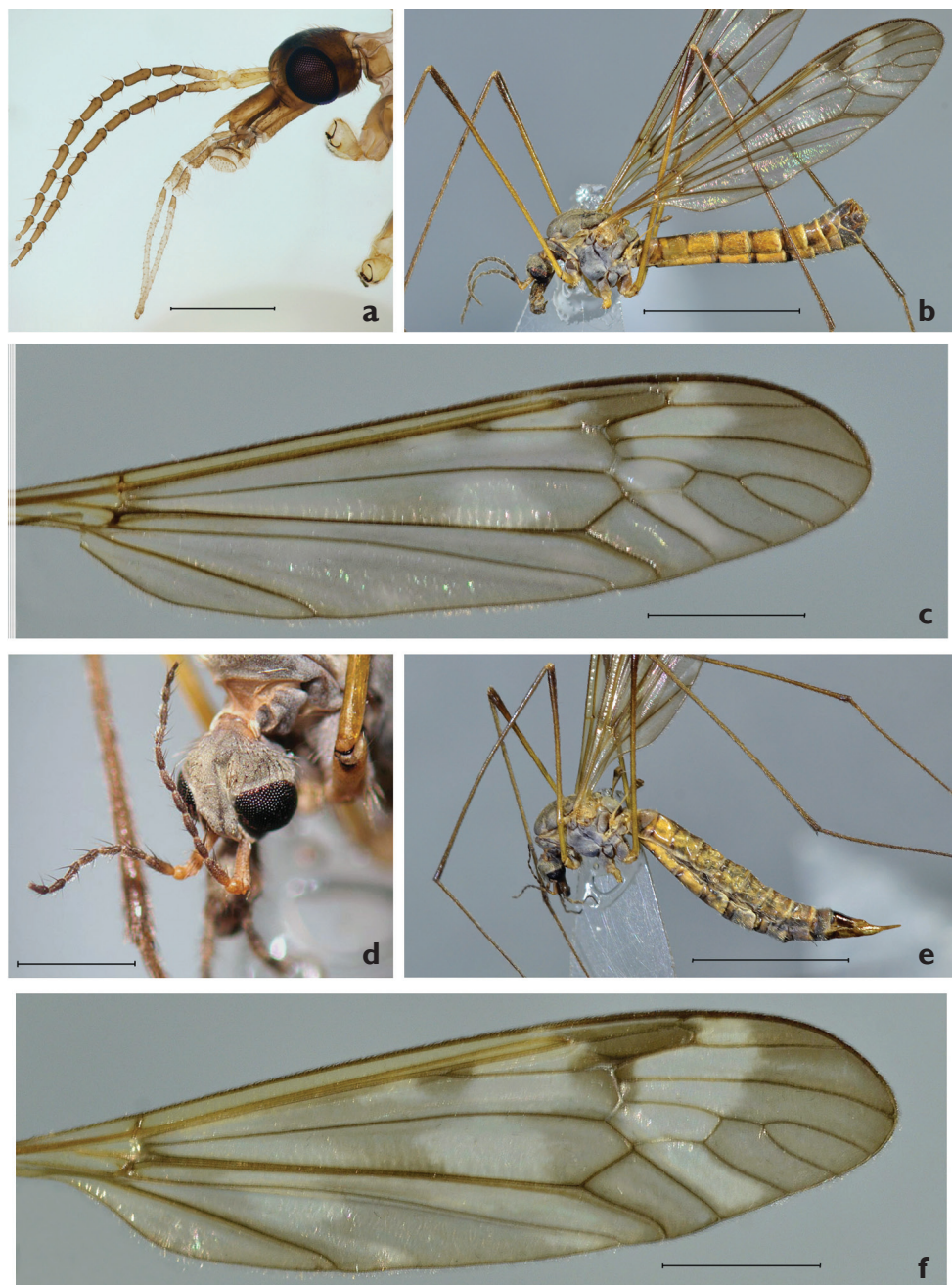
**Paratypes.** Finland, Lkoc: Kittilä, Iso Mustavaara Nature reserve, herb-rich old-growth forest, 67.6340°N, 25.4160°E, 30.V.–1.VII. 2009, Malaise trap, J. Salmela leg.,

2 males (ZMUT, in alcohol [BOLD sample ID JES-20110035] and a pinned specimen). DNA barcode (524 bp) of paratype (JES-20110035|FINTI035-11) is identical to the holotype sequence. Russia, Far East, Primorski kray, Kedrovaya Pad', oak forest (*Quercus mongolica*), 43.1301°N, 131.5041°E, 7.VII. 2006 V. Pilipenko leg., 3 males and 3 females, deposited in ZSIP (BOLD sample ID JES-20110036), ZMUM, VPM. DNA barcode (524 bp) of paratype male (JES-20110036|FINTI036-11) differs from holotype at three positions (212=C, 473=T, and 515=G). In other words, intraspecific K2P distance between Finnish and Russian specimens was 0.2 %.

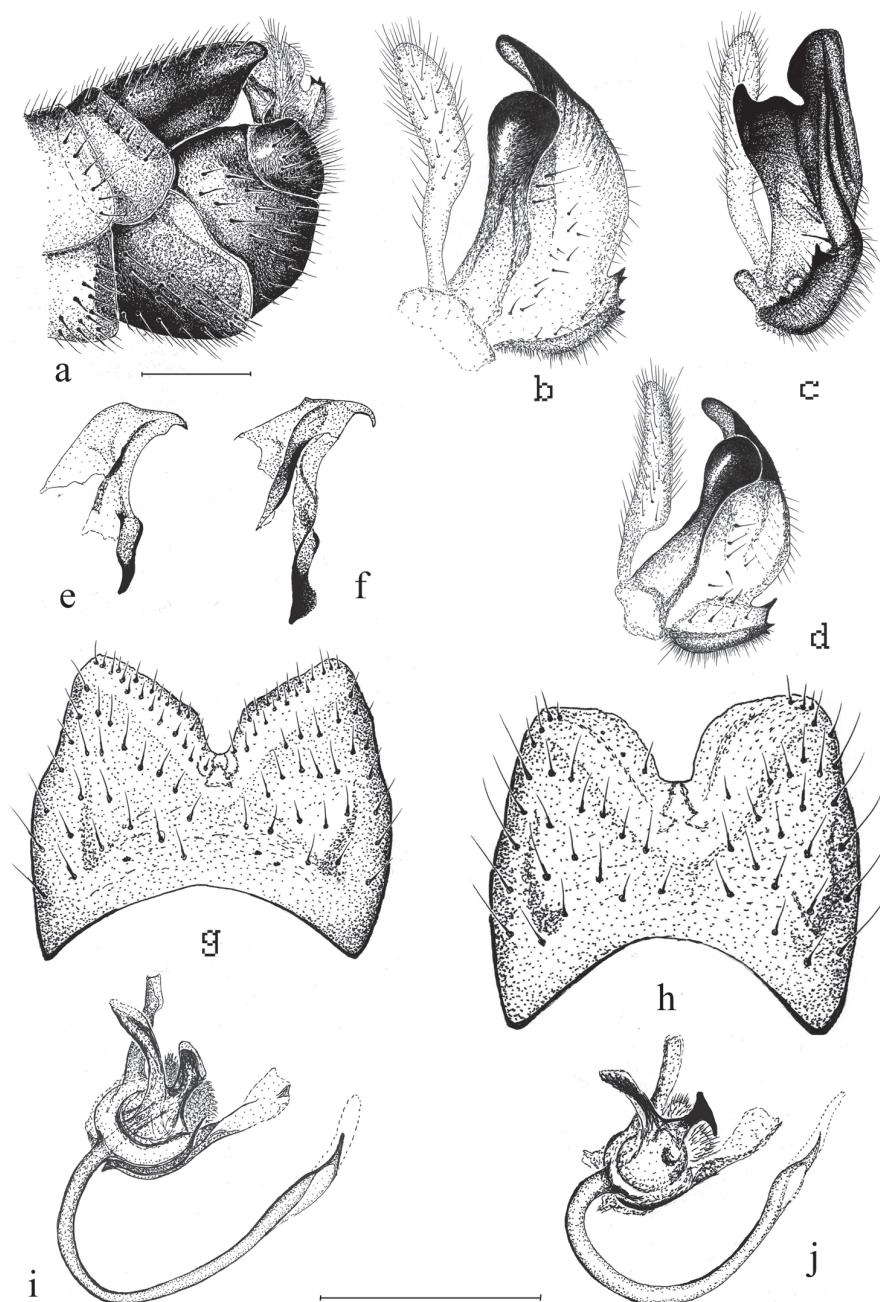
**Diagnosis.** Rather small yellowish brown *Tipula* species (body length: 11 mm male, 12.3 mm female; wing length 11–12.6 mm male, 12.5–13.5 mm female). Scape, pedicel and base of 1<sup>st</sup> flagellomere yellowish, other flagellomeres brown. Caudal margin of male 9<sup>th</sup> tergite with a median notch, bearing no tooth or other elevated structures. Outer gonostylus narrow, about as long as inner gonostylus, slightly bent sub-basally. Lower beak of inner gonostylus apically rounded, black. Outer basal lobe of inner gonostylus with 3–4 stout black spines.

**Description.** Male. Head gray pruinose, sparsely covered with dark hairs. Base of rostrum gray pruinose, otherwise dark brown, shining. Nasus distinct, tip with light bristles (Fig. 2a). Palpi brownish. Lengths of palpal segments (n=2): p1 128–147, p2 307–309, p3 317–365, p4 309–333 and p5 1207–1359. Scape, pedicel and base of 1<sup>st</sup> flagellomere yellowish, other flagellomeres brown. Scape cylindrical (length 442–466, width 119–120, n=2). Pedicel globular (length 132–134, width 134–135, n=2). Flagellar segments cylindrical, covered with silvery, erect and thick pubescence. Verticils black, shorter than respective segments (Fig. 2a). Lengths of flagellomeres (n=2): f1 371–398, f2 312–314, f3 298–316, f4 289–326, f5 297–324, f6 296–325, f7 291, f8 270–289, f9 257–261, f10 227–230 and f11 100. Thorax. General coloration dark brown, with gray pruinosity (Fig. 2b). Pronotum with light hairs. Prescutum with four longitudinal brown bands; lateral bands short, median bands distinctly separated. Anepisternum, katepisternum and anepimeron with dense, gray pruinosity. Scutum, scutellum, laterotergite and mediotergite unicolorous, dark brown. Coxae brown, with light hairs. Trochanters yellowish, with light hairs. Proximal part (ca. two thirds) of femora yellowish, turning dark brown toward tips. Tibiae and tarsi dark brown, spur formula 1:2:2. Tarsal claws smooth. Legs covered with dark brown – black bristles. Stem of halter yellowish, knobs infuscated. Wings with marmorate pattern, length (n= 5) 11.9 mm (11–12.6 mm), venation as in Fig. 2c.  $R_{1+2}$  is variable, reach or not reach Costa. Wing cells c and sc yellowish, other cells brown tinged (see Figs. 2b, 2c). Pterostigma distinct. Abdomen yellowish brown, with a narrow dorsal stripe (Fig. 2b). Hypopygium (Fig. 3a) dark brown. Caudal margin of 9<sup>th</sup> tergite with a median notch, bearing no tooth or other elevated structures (Figs. 3g–h). Caudal margin of 9<sup>th</sup> tergite oblique (Finnish specimens) or almost horizontal, truncated (Russian specimens) (Figs. 3g–h). Outer gonostylus narrow, about as long as inner gonostylus, slightly bent sub-basally (Figs. 3b, d). Lower beak of inner gonostylus apically rounded, black. Beak of inner gonostylus rather narrow and elongated in lateral view (Figs. 3b, d), tip roundish and proximal margin oblique, notched in posterior view (Fig. 3c). Outer basal lobe of inner





**Figure 2.** *Tipula (Pterelachisus) recondita* Pilipenko & Salmela, sp. n. **a** Holotype male, head, lateral view (Finland) **b** paratype male, habitus, lateral view (Russia) **c** paratype male, wing (Russia) **d** paratype female, head, dorso-lateral view (Russia) **e** paratype female, habitus, lateral view (Russia) **f** paratype female, wing (Russia). Scale bars: **a, d** 1 mm; **c, f** 2.5 mm; **b, e** 5 mm.



**Figure 3.** *Tipula* (*Pterelachisus*) *recondita* Pilipenko & Salmela, sp. n., paratype males **a** hypopygium, lateral view (Russia) **b** outer and inner gonostylus, lateral view (Finland) **c** outer and inner gonostylus, posterior view (Finland) **d** outer and inner gonostylus, lateral view (Russia) **e** aedeagal guide, lateral view (Finland) **f** aedeagal guide, lateral view (Russia) **g** 9<sup>th</sup> tergite, dorsal view (Finland) **h** 9<sup>th</sup> tergite, dorsal view (Russia) **i** sperm pump and aedeagus, ventro-lateral view (Finland) **j** sperm pump and aedeagus, ventro-lateral view (Russia). Scale bars: 0.5 mm.

gonostylus with 3–4 stout black spines. Aedeagal guide as in Figs. 3e–f. Sperm pump hairy between posterior immovable apodemes, apex of aedeagus pointed (Figs. 3i–j).

Female. Wing length (n=3) 12.8 mm (12.5–13.5 mm), body length (n=3) 12.3 mm (12–13 mm). Generally similar to male (Fig. 2e). Antenna short (2.4 mm), not extending to wing base (Fig. 2d). The wing's marmorate pattern more intensive than in male (Fig. 2f). Ovipositor (Figs. 4a, b) elongate, similar to that of most other tipulines; 8<sup>th</sup> tergite dark brown, 9<sup>th</sup> tergite narrow dull dark brown, 10<sup>th</sup> tergite shining chestnut brown. 8<sup>th</sup> sternite dull dark brown anteriorly, grading to shining yellow posteriorly. Cerci narrow, yellow, slightly longer than 10<sup>th</sup> tergite. Hypogynial valves yellow, reaching mid-length of cerci, relatively wide, gradually narrowing (Fig. 4c).

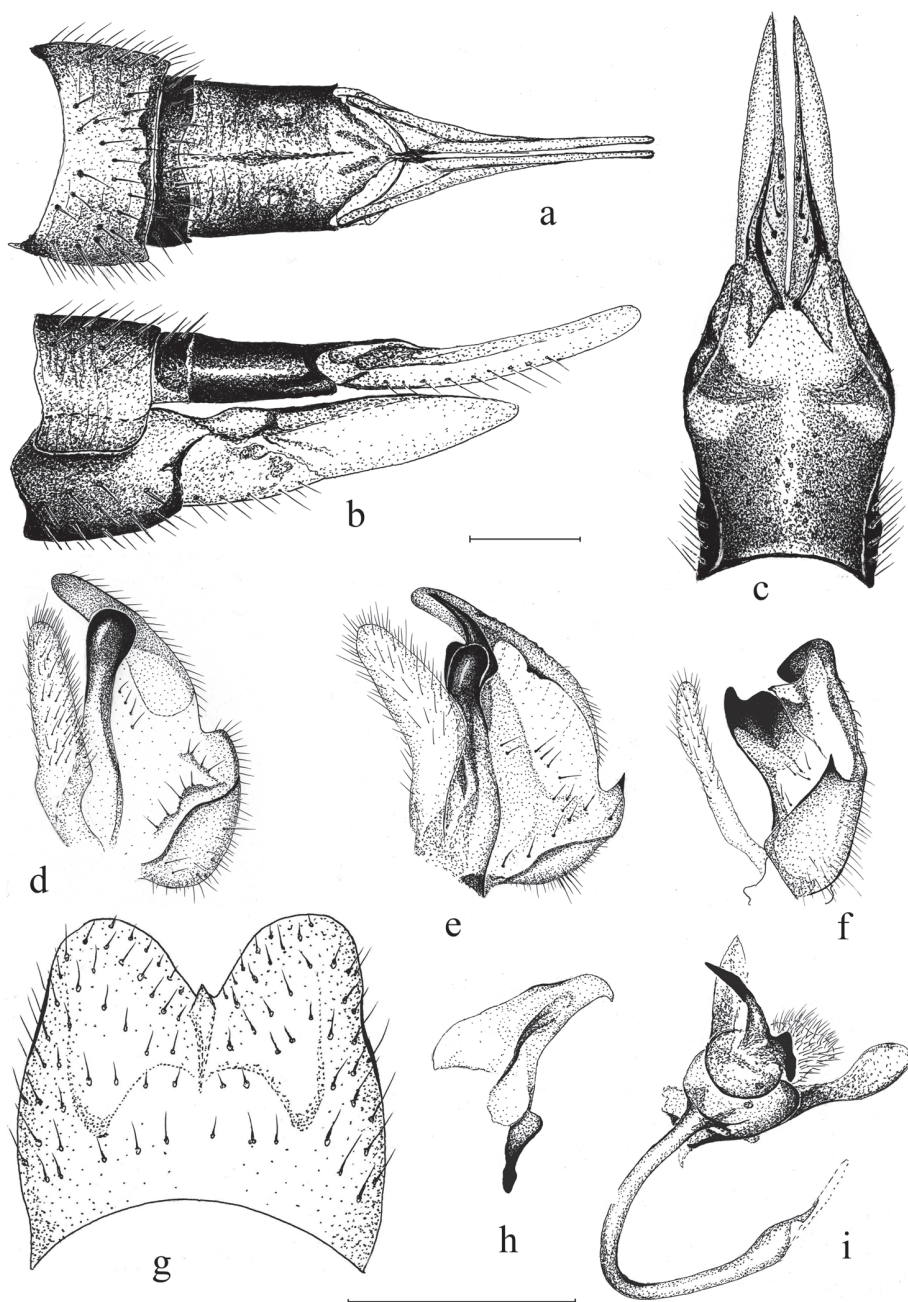
**Etymology.** The species epithet is from *reconditus* (Latin, adjective) meaning hidden, concealed. This word refers to the rarity and apparent low detectability of the new species, so far known only from two sites in the Palaearctic region.

**Distribution and ecology.** *Tipula* (P.) *recondita* Pilipenko & Salmela, sp. n. is known from North Europe (Finland) and Asia, Russian Far East. The Finnish collecting site in Kitilä, Iso Mustavaara, is a state-owned Nature Reserve (Lehtojensuo-jelualue), included in the Natura2000 network of conservation areas. It is part of the biogeographical province of Lkoc (*Lapponia kemensis pars occidentalis*) and lies in the North boreal vegetation zone. The collecting site is an old-growth mixed forest, dominated by birch (*Betula pubescens*), goat willow (*Salix caprea*) and Norway spruce (*Picea abies*), with scattered aspen (*Populus tremula*) trees. Lower vegetation is characterized by herbs and shrubs such as *Calypso bulbosa*, *Daphne mezereum*, *Actaea erythrocarpa*, *Ribes spicatum*, *Filipendula ulmaria* and *Geranium sylvaticum*. Decaying trees, especially goat willow and birch, are abundant in the site. The Russian collecting site is located in the Kedrovaya Pad' Nature Reserve, within the temperate broadleaf and mixed forest zone, in an oak forest (*Quercus mongolica*) growing on limestone outcrops on the southern slope of a mountain range. Lower vegetation is characterized by *Lespedeza bicolor*, *Spodiopogon sibiricus*, *Astragalus ageratoides*, *Carex siderosticta*, *Artemisia keiskeana*, *Lathyrus davidii* and *Calamagrostis brachytricha*.

**Discussion.** *Tipula* (P.) *recondita* Pilipenko & Salmela, sp. n. is rather easily distinguished from other Holarctic *Tipula* (*Pterelachisus*) species. The new species is distinctive in characters of the male hypopygium, especially that of the 9<sup>th</sup> tergite. There are several *Tipula* (*Pterelachisus*) species with a U-shaped median notch or an emargination in the caudal margin of the tergite, but usually having a tooth or other elevated structures at the mid-point (e.g. *T. (P.) angulata* Loew [Alexander 1919, p. 984, Salmela & Autio 2007, p. 55], *T. (P.) varipennis* Meigen [Savchenko 1964, p. 56], *T. (P.) imitator* Alexander [Alexander 1953, Plate 1], *T. (P.) resupina* Alexander [Alexander 1935, Plate 2]); the new species is peculiar having no such structures in the 9<sup>th</sup> tergite.

Morphologically the new species is perhaps the closest to two Palaearctic species, namely *T. (P.) imitator* and *T. (P.) pauli*. The former species has a median notch in 9<sup>th</sup> tergite, but also a distinct tooth at the midpoint (Fig. 4g); the outer basal lobe of inner gonostylus bears one conspicuous black spine, not 3–4 smaller ones (Fig. 4e). For other differences, see Figures 4f, h, i. *Tipula pauli* also has a median notch in 9<sup>th</sup> tergite





**Figure 4.** *Tipula* (*Pterelachisus*) *recondita* Pilipenko & Salmela sp. n., paratype female (Russia) **a–c** *T. (P.) pauli* Mannheims **d** and *T. (P.) imitator* Alexander (**e, f, g, h, i**). **a** female terminal abdominal segments and cerci, dorsal view **b** female terminal abdominal segments, cerci and hypovalva, lateral view **c** female hypovalva and 8<sup>th</sup> sternite, dorsal view **d–e** male inner gonostylus, lateral view **f** outer and inner gonostylus, posterior view **g** 9<sup>th</sup> tergite, dorsal view **h** aedeagal guide, lateral view **i** sperm pump and aedeagus, ventro-lateral view. Scale bars: 0.5 mm.

and a small but discernible tooth in the midpoint; the lower beak of inner gonostylus is roundish and black, but the outer basal lobe bears no stout, black spines (Fig. 4d). *Tipula* (P.) *imitator* is known from Japan and Kuril Islands and *T.* (P.) *pauli* from Europe, Altay and Russian Far East (Oosterbroek 2012, V. Pilipenko pers. obs.).

Based on COI divergence, the new species is apparently rather isolated from the members of the subgenus *Pterelachisus* (Fig. 1). Among the other species vs. the new species, interspecific distances varied from 5.3 % (*Tipula winthemi* Lackschewitz) to 16.1 % (*Tipula laetibasis* Alexander). Mean of the minimum interspecific distances was 8.8 %. According to K2P divergence, the new species is closest to *T. winthemi* (5.3 %), *T. jutlandica* Nielsen (5.5 %), *T. stenostyla* Savchenko (6.6 %) and *T. pauli* (6.8 %); distances between the other species range from 7.4 to 16.1 %. In other words, no very close relatives were present in the pair-wise comparisons of COI sequences. For example, much shorter interspecific K2P distances were found between *T. varipennis*/*T. pseudovaripennis* (1.5 %), *T. mutila*/*T. wahlgreni* (2.2 %), *T. stenostyla*/*T. winthemi* (3.7 %). However, it must be emphasized that *T. imitator* was not included in COI analysis, due to the lack of fresh material. Given to the morphological similarity of the new species and *T. imitator*, it is likely that their barcoding distances would be similar to those three comparisons given above.

There are some morphological differences (9<sup>th</sup> tergite, inner gonostylus) between Finnish and Russian specimens, perhaps due to the long distance and lack of gene flow between the populations. These differences, however, are here considered to be intraspecific variation. Very small K2P divergence of COI gene (0.2 %) between Finnish and Russian specimens also substantiates the presence of one widespread, but disjunct, species. In rare cases (see Burns et al. 2007) differences of only one to three nucleotides may be observed between otherwise (for example morphologically and ecologically) distinct species. However, in this case we were able to produce 524 bp of high quality sequence, instead of <400 as in the problematic cases of Burns et al. (2007). Moreover, the known biologies of the Finnish and Russian individuals seem alike. To say more of the COI variation, it would be essential to collect more individuals which is rather difficult, given the rarity of the species.

The new species is most probably a very rare tipulid. Despite the rather long tradition of crane fly taxonomy and faunistics in North Europe, this species has hitherto remained unnoticed. One of the authors (JS) has within 12 years identified some 70 000 crane flies from a Finnish Malaise trapping material consisting of 476 sampling sites and ca. 1670 Malaise trapping months. Thus, despite this relatively large sampling effort, only three specimens from a single locality have been caught. The true range of the species is Palaearctic, whether disjunct or not remains to be seen. In Northwestern Europe the species is likely to occur in the north boreal zone (for further information on boreal ecoregions or vegetation zones, see e.g. Ahti et al. 1968). *Tipula* (P.) *recondita* Pilipenko & Salmela, sp. n. may be confined to old-growth forests, and its rarity is perhaps due to the narrow habitat niche. On the other hand, the new species may be hard to collect using traditional methods. Larval associations of this species are unknown, but some *T.* (*Pterelachisus*) species are saproxylic, i.e. dependent on decaying trees. Such species are e.g. *T.* (P.) *pseudoirrorata* Goetghebuer and *T.* (P.) *stenostyla* Savchenko (Salmela 2009), both of them also encountered in the type locality.

To our regret we were not able to examine the holotype male of *T. imitator* (D. Furth, pers. comm.). Description of that species was based on a single male specimen (Alexander 1953). We have however examined other material (two male specimens, see above) that very likely represents *T. imitator*. Despite morphological similarity of *T. (P.) recondita* Pilipenko & Salmela, sp. n. and *T. imitator*, we are confident that these are separate taxa, due to the differences in the structure of male hypopygium.

## Acknowledgements

Special thanks to Pjotr Oosterbroek (Amsterdam) for his help with the vast *Tipula* (*Pterelachisus*) literature. It would have been much more laborious for us to resolve the status of the new species without Pjotr's help. Metsähallitus, Lapin luontopalvelut (Finnish Natural Heritage Services) provided a permission to collect insects in Iso Mustavaara Nature Reserve. Comments by John Kramer (Leicester), Fenja Brodo (Ottawa), anonymous referee and Vladimir Blagoderov (London) improved manuscript. Aleksanteri Hihnavaara (Ponku) is thanked for such a cheerful field company. Barcode sequences were obtained at the Canadian Centre for DNA Barcoding based in the Biodiversity Institute of Ontario at the University of Guelph. Their work was supported by funding from the Government of Canada through Genome Canada and the Ontario Genomics Institute in support of the International Barcode of Life Project. Finnish Barcode of Life (FinBOL) is also thanked for a help in the barcoding process. JS was financially supported by Finnish Cultural Foundation, Oskar Öflunds Stiftelse and Societas pro Fauna et Flora Fennica and EJV by Betty Väänänen Rahasto.

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## Biological nomenclature terms for facilitating communication in the naming of organisms

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Academic editor: Lyubomir Penev | Received 4 May 2011 | Accepted 7 May 2012 | Published 8 May 2012

**Citation:** David J, Garrity GM, Greuter W, Hawksworth DL, Jahn R, Kirk PM, McNeill J, Michel E, Knapp S, Patterson DJ, Tindall BJ, Todd JA, van Tol J, Turland NJ (2012) Biological nomenclature terms for facilitating communication in the naming of organisms. *ZooKeys* 192: 67–72. doi: 10.3897/zookeys.192.3347

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**Abstract**

A set of terms recommended for use in facilitating communication in biological nomenclature is presented as a table showing broadly equivalent terms used in the traditional *Codes* of nomenclature. These terms are intended to help those engaged in naming across organism groups, and are the result of the work of the International Committee on Bionomenclature, whose aim is to promote harmonisation and communication amongst those naming life on Earth.

**Keywords**

Nomenclature, Code, terminology

The International Committee on Bionomenclature (ICB, <http://www.bionomenclature.net/>) met in Berlin from 26–28 April 2012. As a part of this meeting it reviewed the status of communication between and change in the various international sets of rules that biologists follow when naming organisms – the *Codes* of nomenclature. The group exchanged updates on the status of the *Codes* (see Table 1 for abbreviations used for the various *Codes* of nomenclature) and discussed how to enhance inter-community communication with the aim of bringing together those concerned with naming life on Earth.

Recent progress on developing a Global Names Architecture (<http://www.global-names.org>) has meant that the communities working on the various indices for a variety of organism groups are not only working in their own domains, but are increasingly developing technological solutions to enable more efficient retrieval of names of all organisms, along with information pertaining to their first publication. As groups focused on the nomenclature of various organisms work more closely together, efficient communication becomes ever more important. Recent changes in the rules governing the naming of prokaryotes (Labeda 2000; and for example Labeda and Oren 2011) and of algae, fungi and plants (see Hawksworth 2011; Knapp et al. 2011; McNeill and Turland 2011), in addition to those proposed for zoology (e.g., International Commission on Zoological Nomenclature 2008), are bringing the terminology used in and practices of the *Codes* closer together, and the Committee felt that agreement on a basic set of terms to be used when engaging in inter-community communication would greatly assist this on-going process. Naming of organisms is so critical that it is important that we work together on a greater consistency in nomenclatural practices to enable a swifter, more efficient documentation of biodiversity and help meet the global challenges of understanding Earth's genetic diversity and resources.

This table of terms is not comprehensive, but includes those terms that differ (or have differed in the past) significantly and have the potential to cause confusion. It is based on the table of equivalence of technical terms arising from discussions on harmonisation of nomenclature (Hawksworth 1995) and that accompanying the first *Draft BioCode* (Greuter et al. 1996). These early attempts have here been updated to reflect current usage of terms in the various *Codes*. As with the early tables, the



**Table 1.** Recommended terms for use in biological nomenclature with a comparison of equivalents across six current *Codes of nomenclature*

<b>Bionomenclature</b>	<b>ICN<sup>1</sup></b>	<b>ICNCP<sup>2</sup></b>	<b>ICNP<sup>3</sup></b>	<b>ICVCN<sup>4</sup></b>	<b>ICZN<sup>5</sup></b>	<b>PhyloCode<sup>6</sup></b>
<i>Publication and precedence of names</i>						
published	effectively published	published	effectively published	[none]	published	published
precedence/priority	priority	priority	priority	[none]	precedence/priority	precedence
earlier	earlier	earlier	earlier	[none]	senior	earlier
later	later	later	later	[none]	junior	later
<i>Nomenclatural status</i>						
established	validly published	established	validly published	established	available	established
compliant	legitimate	acceptable	legitimate	valid	potentially valid	acceptable
non-compliant	illegitimate	[none]	illegitimate	[none]	permanently invalid	[none]
registered	[deposited]	registered	validly published	[none]	registered	registered
<i>Taxonomic status</i>						
accepted	correct	accepted	correct	accepted	valid	accepted
<i>Synonymy and homonymy</i>						
homotypic	homotypic	[none]	homotypic	[none]	objective	homodefinitinal
heterotypic	heterotypic	[none]	heterotypic	[none]	subjective	heterodefinitinal
replacement name	replacement name	replacement name	replacement name	[none]	new replacement	replacement name
<i>Conservation and suppression</i>						
conserved	conserved	conserved	conserved	[none]	conserved	conserved
protected	listed	[none]	listed <sup>7</sup>	accepted	protected	[none]
sanctioned (fungi only)	sanctioned (fungi only)	[none]	[none]	[none]	[none]	[none]
suppressed/rejected	rejected	rejected	rejected	[none]	suppressed	suppressed
<i>Types of names</i>						
name-bearing type	nomenclatural type	nomenclatural	nomenclatural type	[none]	name-bearing type	[none]
nominal taxon	name and type	standard	name and type	[none]	nominal taxon	[none]

<sup>1</sup> *International Code of Nomenclature for algae, fungi, and plants* (ICN) or *Melbourne Code* (McNeill et al. 2012). It is expected to be available online in 2013 at <http://www.iapt-taxon.org> <sup>2</sup> *International Code of Nomenclature for Cultivated Plants* (ICNCP) or *Cultivated Plant Code*, 8th edition (Brickell et al. 2009); [http://www.acta-hort.org/chronica/pdf/sh\\_10.pdf](http://www.acta-hort.org/chronica/pdf/sh_10.pdf) <sup>3</sup> *International Code of Nomenclature of Prokaryotes* (the name adopted for the *International Code of Nomenclature of Bacteria* (ICNB) or *Bacteriological Code* (Lapage et al. 1992), see Labeleda 2000); <http://www.ncbi.nlm.nih.gov/books/NBK88171/> <sup>4</sup> *The International Code of Virus Classification and Nomenclature* (ICVCN), in *Virus Taxonomy* (ed. King et al. 2011) <sup>5</sup> *International Code of Zoological Nomenclature* (ICZN), 4th edition (International Commission on Zoological Nomenclature 1999); <http://www.nhm.ac.uk/hosted-sites/iczn/code/> <sup>6</sup> *International Code of Phylogenetic Nomenclature* or *PhyloCode*, version 4c (Cantino and Queiroz 2010); <http://www.ohio.edu/phylocode/> <sup>7</sup> Listed in the sense of appearing on *The Approved Lists of Bacterial Names*

terms in each row are not perfectly congruent. We recommend the use of these terms to facilitate communication between those working with the nomenclature of different groups of organisms without necessarily displacing those used by tradition within the various communities. These terms can be employed where considered of value in presentations, publications, and teaching, as well as in discussions between the communities who use the different *Codes*. We invite and welcome comment on the commended terms, and suggestions for other terms that have caused confusion that might be added – our aim is not to impose practice, but to facilitate communication among all involved in the naming of organisms of all kinds.

## Acknowledgements

We thank the International Union of Biological Sciences (IUBS) for financial support for our through the 2009–2012 IUBS “BioCode Programme”.

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## **Current membership of the International Committee on Bionomenclature**

(ICB – contact details for all members are available at <http://www.bionomenclature.net/>)

Michael J. Adams, Rothamsted, UK

Philip D. Cantino, Athens Ohio, USA

John David, Wisley, Surrey, UK

George Garrity, East Lansing, Michigan, USA

Daphne Fautin, Lawrence, Kansas, USA

Werner Greuter, Berlin, Germany and Palermo, Italy

David L. Hawksworth, London, UK and Madrid, Spain  
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Sandra Knapp, London, UK (Chair)  
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