A new species and new records of Pachytullbergiidae and Tullbergiidae (Collembola: Onychiuroidea) from littoral of China, with notes on the variations of postantennal organ

YUN BU1, MIKHAIL B. POTAPOV2 & YAN GAO1,3
1Institute of Plant Physiology and Ecology, Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences, Shanghai, 200032 China. E-mail: yangao@sibs.ac.cn
2Moscow State Pedagogical University, Kibalchich str., 6, korp. 5, Moscow, 129278 Russia E-mail: mpnk-abroad@yandex.ru
3Corresponding author

Abstract

Sensiphorura oligoseta sp. nov. is described from the sand beach of Pacific coast of China. It is the second member of the genus and differs from S. marshalli Rusek, 1976 by the smaller apical vesicle on antennae, and fewer setae on abdominal tergites. Psammophorura neocaledonica Thibaud & Weiner, 1997 and Mesaphorura yosii (Rusek, 1967) are also found to be widely distributed on the coast. Chinese specimens of P. neocaledonica are described, notes to variations of its postantennal organ are given.

Key words: springtail, taxonomy, sensillum, vesicle, chaetotaxy

Introduction

In the course of our investigation of littoral Collembola of China, some species of Onychiuroidea have been discovered, one of which is described as new in present paper. The new species belongs to the remarkable genus Sensiphorura (Pachytullbergiidae) so far known from Canada (Rusek 1976). Later, this genus was recorded in East and South-East Asia but the species identification was uncertain (Wang et al. 2001; Deharveng et al. 2009; Shveenkova 2011). Another discovery in our material is Psammophorura neocaledonica which was recorded so far in tropical areas of Indian and Pacific oceans (Thibaud & Weiner 1997; Thibaud 2008, 2009a, 2009b). Chinese specimens of the species are described and compared with the original description. The found morphological variations are discussed.

This work is our fifth contribution pertaining to Collembola of sandy beaches of China (Potapov et al. 2011; Bu et al. 2012; Potapov et al. 2013; Sun et al., 2012 submitted).

Materials and methods

Specimens were collected by flotation and preserved in 80% ethanol. The material was mounted in Hoyer’s solution and dried up in an oven at 60 °C for identification.

Abbreviations used in the descriptions: Th.—thoracic segment, Abd.—abdominal segment, Ant.—antennal segment, s—sensory chaeta s, PAO—postantennal organ, a—anterior setae, m—medial setae, p—posterior setae, pl—pleural setae.
Taxonomy

*Sensiphorura oligoseta* sp. nov.
Figs 1–9, Tab. 1–2

Materials examined. Holotype: female, South China, Hainan Province (western coast), Changjiang County, vicinity of Changhua town, Qizi Bay, 19°21’ N 108°40’E, sand beach, flotation of sand samples (No. 54). 7.iv.2011, C. W. Huang, M.B. Potapov, N. A. Kuznetsova, and Y. Bu, leg. Paratype: 1 female (No. 56), same as holotype. 1 female, South China, Hainan Province, Ledong county, Mt. Jianfeng, 18°43’ N 108°54’E, alt. 220 m, soil of semideciduous seasonal rainforest, 14.i.2004, Y. Xiong leg. Holotype and 1 paratype are deposited in Shanghai Institute of Plant Physiology and Ecology, Shanghai Institutes for Biological Sciences, CAS (China), 1 paratype is deposited at Moscow State Pedagogical University.

The material of *S. marshalli*: seven specimens from Canada, Vancouver Island, from thick spongy hemlock litter on top of plateau, 31.v.1983, A. Fjellberg leg.

Description. Holotype length 480 μm, width 120 μm. White in alcohol, without pigmentation, no eyes. Pseudocelli not visible in light microscope. Secondary granulation present, primary granulation fine. Body setae short, few of them on the ventral side longer than others (Figs 2, 3).

Antennae shorter than head (1 : 1.6). Antennal segment III and IV fused. Ant. I and II with 7 and 11 setae respectively. Antennal organ of III well developed (Figs 8, 9), with two separate parts. Dorsal part composed of one large bent sensory club, one small sensory rod covered by club, five or six subequal, slim protecting papillae, and four protecting setae. Some papilla fused together at base (Fig. 8). Ventral part consists of one large bent sensory club, one small sensory rod covered by club, three slim protecting papillae, and three protecting setae. Ventral protecting setae and several others with 1–2 cilia (more setae probably have cilia than shown on Figs 8 and 9). Ant. IV with 11 cylindrical sensilla, two bulb-shaped sensilla, and one small apical vesicle, subapical microsensillum not observed.

Postantennal organ hidden in groove formed by integumentary folds and composed by eight to nine simple vesicles lying side by side in two parallel rows, with 4 setae behind them (Fig. 1).

Head with seta a0 and c1 (Fig. 2). Mouthparts well-developed. Labium generally as in *S. marshalli* (Fig. 41 in Fjellberg, 1999) with 4 papilla, 2 long guards (short guards not seen), 3 proximal setae, 4 basomedian setae, and 5 basolateral setae. Mandibles and maxilla as in *S. marshalli*.

Dorsal chaetotaxy shown in Fig. 2 and Table 1. Th. II–Abd. IV with 2+2 axial setae each. Number of lanceolate sensory chaetae s on dorsal side as 2, 2/2, 4, 4, 4, 5, 1 (Fig. 5), microsensilla present on Th. II–III. Seta a2 absent on tergites of Abd. I–III. Subcoxa with 0, 2+1s, 2+1s setae, coxa with 3, 6, 6 setae, trochanter with 5, 5, 4 setae, femur with 10, 10, 9 setae, and tibiotarsus with 11, 11, 11 setae on leg I, II and III, respectively; without tenent hairs (Fig. 7). Without empodial appendage. Thorax without ventral setae.

### Table 1. Body chaetotaxy of *Sensiphorura oligoseta* sp. nov.

<table>
<thead>
<tr>
<th>Segments</th>
<th>Thorax</th>
<th>Abdomen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>a</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>m</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>pl</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Ventral</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Terms of Use</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnolia Press</td>
<td></td>
</tr>
</tbody>
</table>

1 seta a2 absent; 2 seta m5 present; 3 10 anterior setae, 5 setae on genital plate and 2 posterior sensory chaetae s

Chaetotaxy of ventral side of abdomen shown in Fig. 3 and Table 1. Ventral tube with 5+5 setae (4+4 in distal and 1+1 in basal position, Fig. 6). Abd. IV with 4 longitudinal rows of ventral setae. Without furca and retinaculum. Female genital plate with 5 setae in front of it and one proximal lateral sensory chaeta. Anal spines small, four times shorter than claw III.
FIGURES 1–7. *Sensiphorura oligoseta* sp. nov. (1–3, 5–7) and *S. marshalli* (4): 1, PAO; 2, dorsal chaetotaxy of body; 3, ventral chaetotaxy of abdomen; 4–5, dorsal sensory chaetae patterns, 6, ventral tube; 7, leg III; s—sensory chaeta.

---

**TERMS OF USE**

This pdf is provided by Magnolia Press for private/research use. Commercial sale or deposition in a public library or website is prohibited.
Males unknown.

Remarks. Sensiphorura oligoseta is the second member of the genus. It differs from the type species S. marshalli by characters shown in Table 2. The most important characters are small vesicle on Ant. IV (vs. large), differentiation of sensory chaetae s on body (Figs 4, 5), and absence (vs. presence) of a2 seta on Abd. I–III.

**TABLE 2.** Comparison of characters between Sensiphorura oligoseta sp. nov. and S. marshalli.

<table>
<thead>
<tr>
<th>Species</th>
<th>S. oligoseta sp. nov.</th>
<th>S. marshalli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>South China</td>
<td>West Canada</td>
</tr>
<tr>
<td>papilla of Ant.III ventral organ</td>
<td>all subequally long</td>
<td>two long and one short</td>
</tr>
<tr>
<td>apical vesicle of Ant. IV</td>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>p3 of Th. II–III</td>
<td>slightly thickened</td>
<td>lanceolate</td>
</tr>
<tr>
<td>a2 of Abd. I–III</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>m3 of Abd. IV</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>lanceolate sensory chaeta s of Abd. I</td>
<td>p5</td>
<td>p3</td>
</tr>
<tr>
<td>lanceolate sensory chaeta s of Abd. III</td>
<td>p3, 5</td>
<td>p3</td>
</tr>
</tbody>
</table>

Etymology The new species has fewer setae on abdominal tergites.

Distribution and ecology. The species is known only from two localities of Hainan (SE China), from the dunes of the beach and tropical forest. Type species of the genus, S. marshalli, was found in the litter of old coast western hemlock forest. Habitat of the holotype was shown in Potapov et al. (2011, Fig. 9).

Remarks. The records of Pachytullbergiidae (Pachytullbergiinae in the past) in the world are scanty and its systematic position remains unclear and controversial (Stach 1954; Salmon 1959; Cassagnau & Rapoport 1962; Rusek 1976). Deharveng (2004) transferred Pachytullbergiinae to Hypogastruroidea and ranked it as a family (Pachytullbergiidae). Many taxonomists, however, still incline to place it into superfamily Onychiuroidea like it is accepted in Bellinger et al. 1996–2012. We deem Pachytullbergiidae as a member of superfamily family Onychiuroidea in the present paper, because the similarity of postantennal organ as well as the sensilla on antenna between them. We suppose that at least one of the genera of the family, Sensiphorura, is rather common in Asia but it is likely overlooked in the materials because of small body size.
Psammophorura neocaledonica Thibaud & Weiner, 1997

Material examined. Two females and 7 males (slides Nos. 5, 6, 7), East China, Zhejiang Province, Zhoushan city, Shengsi Island, 30°40’ N 122°15’E, beach with grass dunes, flotation of sand samples, 5.iv.2009, M. B. Potapov, Y. X. Luan, and Y. Bu leg; 1 female and 1 male (No. 47), East China, Zhejiang Province, Zhoushan city, eastern part of Zhujiajian island, 29°50’ N 122°50’E, sandy beach, supralittoral thin sand, with roots and dirt, 12.iv.2011, M. B. Potapov and C. W. Huang leg.

6 female (Nos. 81, 85-1, 88, 91, 98-1, 98-2, ) and 3 males (Nos. 85-2, 86-1, 86-2), East China, Shandong Province, Yantai City, 37°27’ N 121°30’E, middle beach with grass dunes, flotation of sand samples, 22.iv.2011, M. B. Potapov, Y. X. Luan and C. W. Huang leg; 2 females (Nos. 1-1, 1-2), East China, Shandong Province, Yantai City, Golden Beach, flotation of sand samples, supralittoral, thin sand under the roots of ruderal plants, 37°34’ N 121°13’E, 20.iv.2011, M. B. Potapov, Y. X. Luan and C. W. Huang leg; 8 females (Nos. 1-1, 1-2, 2), 1 male (Nos. 4), East China, Zhejiang Province, Zhoushan city, beach with grass dunes, flotation of sand samples, 22.x.2011, Y. Gao and Y. Bu leg.1 female and 1 juvenile (Nos. 1, 2), East China, Fujian Province, Fuzhou city, Changle county, 25°53’ N 119°37’E, sandy beach close to Changle airport, dunes with roots and grass, 5.v.2012, Y. X. Luan, Y. Gao and Y. Bu leg.

Description of the specimens from China. Adult body 500–630 μm long and 100–110 μm wide (n=20). Setae hardly differentiated into micro- and macrosetae (Figs 10, 11). Labium with 5 papilla, 6 apical guard setae, 6 proximal setae, 4 basomedian setae, and 5 basolateral setae. Number (40–65) and arrangement of vesicles in postantennal organ variable (Fig. 12).

Lateral sensory chaetae s on meso- and metanotum 17–18 μm long (Fig. 11). Pseudocelli formula: 11/011/11111, 8–10 μm in diameter, on thorax between setae p2 and p3, and close to p3, on abdomen posterior to seta p3 (Figs 11, 12). Type of pseudocelli variable among different segments, head, thorax and abdominal tergite V with type I, and Abd. I–IV with type I or type III.

Antenna (65–70 μm) shorter than head (75–90 μm). Antennal segment IV (Fig. 13) with four slightly thickened sensilla a–e, without basal heel. Small microsensillum and subapical organite and one apical vesicles present. Antennal organ III (Fig. 13) consists of two thick sensory clubs bent toward each other and two two small sensory rods concealed behind two high papilla, protected by four guard setae.

Legs short, without clavate tibiotarsal hairs. Coxa with 3, 7, 7 setae, trochanter with 6, 6, 5 setae, femur with 9, 9, 9 setae and tibiotarsus with 11, 11, 11 setae on leg I, II and III, respectively. One seta on femur of all legs much smaller than remaining ones. Anal lobes with seta l 2’. Claw 8–10 μm long. Anal spines 5–7 μm long.

Abdominal tergite V with sensory chaeta p3 slightly differentiated or, more rarely, flame-like (Fig. 11). Seta p2 located in posterior position, at level of seta p3 (Fig. 11). Number of ventral setae on Abd. II, III and IV variable, with 19–20, 18–20, and 22–26 setae respectively (Figs 15, 16). Ventral tube with 4 + 4 apical setae and 2 + 2 basal ones (Fig. 15). Male genital plate with 10-13 setae (Fig. 14).

Distribution. New Caledonia, Vanuatu, Vietnam, Madagascar. It is probably distributed widely in China (Shandong, Zhejiang, Fujian).

Remarks. Psammophorura neocaledonica is a new record for Chinese fauna. After Thibaud & Weiner (1997) and Thibaud (2008), it is distinguished from P. gedanica Thibaud & Weiner 1994, by higher number of vesicles in PAO (50 vs. 40), less differentiated sensory chaeta p3 and presence of a2 on Abd. V. Number of vesicles in PAO is considered to be of high taxonomical value in taxonomy of Tullbergiidae, for instance in genera Multivesicula Rusek, 1982, Mesaphorura Börner, 1901, and Metaphorura Bagnall, 1936. After our observations on Chinese specimens of P. neocaledonica, we found high variability of number (40 to 65) and arrangement of vesicles (Fig. 12) in PAO. Specimens with asymmetrical PAO also occurs.

The presence of two types of pseudocelli was described as an important character of genus Psammophorura (Thibaud & Weiner 1994). However, Fjellberg (1998) recorded some specimens of P. gedanica from Norwegia with pseudocelli of type I only. In Chinese specimens, the type of pseudocelli is also variable, most of individuals of P. neocaledonica have pseudocelli of type I only (Figs10–11), pseudocelli of type III was found on abdominal tergites I–IV in few individuals.
FIGURES 10–12. *Psammophorura neocaledonica*: 10, dorsal chaetotaxy of head and thorax; 11, dorsal chaetotaxy of abdomen; 12, variability of PAO; s—sensory chaeta, ms—microsensillum.

We found that the shape of sensory chaetae p3 on Abd. V is also variable (Fig. 11), from slightly differentiated to flame-like (vs. slightly differentiated in type population). As an additional differential character is the posterior position of p2 seta on Abd. V: in P. gedanica p2 is in mid-tergal position like in most other species of the family (vs. posterior-tergal position in P. neocaledonica).

The differences we found between Chinese and New Caledonian specimens are the number of setae on trochanters (6, 6, 5 vs. 5, 5, 4) and tunica of claw (larger in Chinese specimens).

Mesaphorura yosii (Rusek, 1967)

Material examined. One Female, South China, Hainan Province (western coast), Changjiang County, vicinity of Changhua town, Qizi Bay, 19°21' N 108°40'E, sand beach, flotation of sand samples, 7.iv.2011, C. W. Huang, M. B. Potapov, N. A. Kuznetsova, and Y. Bu leg. 2 females, East China, Zhejiang Province, Zhoushan City, Zhujiajian island, 29°56' N 122°25'E, flotation of sand samples (No. 50), 13.iv.2011, M. B. Potapov and C. W. Huang leg. 1 female (No. 8), East China, Zhejiang province, Zhoushan city, Shengsi Island, 30°40' N 122°15'E, beach with grass dunes, flotation of sand samples, 22.x.2011, Y. Gao and Y. Bu leg. 1 female, East China, Shandong Province, Yantai City, Zhifu Island, 37°36' N 121°26'E, flotation of sand samples (No. 24), 21.iv.2011, M. B. Potapov, Y. X. Luan and C. W. Huang leg. 1 female, East China, Shandong Province, Yantai City, 37°27' N 121°30'E, flotation of sand samples from dunes with heavy vegetation (No. 101), 23.iv.2011, M. B. Potapov, Y. X. Luan and C. W. Huang leg.

Distribution. Cosmopolitan. In China the species was often recorded in litter (Shanghai, Guangdong, Hunan, Yunnan, Zhejiang), for the first time in Hainan and Shandong provinces. The species is probably distributed all over the coast of China.
Acknowledgements

We sincerely thank Arne Fjellberg (Norway) and José Palacios-Vargas (Mexico) for loan of the specimens for comparisons, Natalya Kuznetsova, Yunxia Luan, and Cheng-Wang Huang for their generous help during the collection. Some latent problems of the taxonomy of the genus Sensiphorura were discussed with Louis Deharveng (France). Thanks are also given to the two anonymous reviewers for their valuable comments. The study was supported by the National Natural Sciences Foundation of China (31071887, 31201706) and NSFC-RFBR Cooperative Research Project (31111120077 / 11-04-91179-GFENa).

References


http://dx.doi.org/10.1016/j.pedobi.2004.08.001


http://dx.doi.org/10.3897/zookeys.136.1666

http://dx.doi.org/10.3897/zookeys.304.4083.


http://dx.doi.org/10.1139/z76-003

http://dx.doi.org/10.1111/j.1365-2311.1959.tb02279.x


http://dx.doi.org/10.3897/zookeys.31.3a7

