[SHORT COMMUNICATION]

Is Abdominal Tergal Chaetotaxy Reliable for Species Diagnosis of Japanese Soil-Dwelling Mundochthonius Pseudoscorpions (Pseudoscorpiones: Chthoniidae)?

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Pseudoscorpions are small arachnid animals living in various habitats, i.e., in leaf litter, under stones or barks, in crevices of rocks along seashore, in caves, and even in desert. Studies on the embryonic and postembryonic developments and reproductive biology, including reproductive behavior, of pseudoscorpions have used specimens collected directly from the field, because it is difficult to establish cultures (e.g., Morikawa, 1960, 1962; Sakayori, 1989, 2002b, 2003, 2014b; Kato and Tsutsumi, 2004). Japanese soil-dwelling pseudoscorpions are mainly classified based on the chaetotaxy of carapace and abdominal tergites, and pedipalpal femur morphology (Morikawa, 1960; Sato and Sakayori, 2002). However, these features are variable within species (Tsutsumi, 2012; Sakayori, 2014a) and chaetotaxy is known to change with growth (Sakayori, 2014b).

In the previous studies dealing with the developmental and reproductive biology on pseudoscorpions, Mundochthonius species have also been used as materials in Japan (Kato and Tsutsumi, 2004). In the identification of Mundochthonius species and subspecies (Chamberlin, 1929; Morikawa, 1954; Sakayori, 2002a, 2009), including M. japonicus japonicus Chamberlin, M. j. scolytis Morikawa, M. kiyoshii Sakayori, and M. itohi Sakayori, abdominal tergal chaetotaxy (ATC) in the first, second, and third abdominal segments are used as the most important characters for classification (Sakayori, 2010), and three types of ATC are currently distinguished: “4–4–4” in M. japonicus, “4–4–6” in M. j. scolytis, and “4–6–6” in M. kiyoshii and M. itohi (Sakayori, 2010). The three numerals that are used to describe ATC represent the number of tergal setae that occur in the first to third abdominal segments and are basically even numbers, because tergal setae are symmetrical and not on the median line. However, ATCs with an odd number are frequently observed and recognized as an irregularity and/or variation within a species. For example, in M. itohi, several irregular types of ATC such as “4–5–6” and “4–6–7” are found in addition to their regular type of ATC, “4–4–4” (Sakayori, 2009; Tsutsumi, 2012). Moreover, Tsutsumi (2012) reported that one of the total 374 samples examined in M. itohi had an irregular “4–4–6” ATC, which is the ATC typical to M. j. scolytis. It may be possible that the ATC of the regular type in one species might be found as an irregular type in other species. Therefore, it should be examined whether the ATC is reliable for the identification of Mundochthonius species. In the present study, we test the reliability of ATC in the identification of Mundochthonius species, using molecular phylogenetic analysis that was used for critical taxonomical

![Fig. 1 Mundochthonius itohi Sakayori, dorsal view. Chaetotaxy is shown only on abdominal tergal plates. Right pedipalp and legs are omitted.](image)
revisions of pseudoscorpions (e.g., Murienne et al. 2008; Harrison et al. 2014).

*Mundochthonius* specimens were collected in Japan from Kanayama (37° 43’ 49.7” N, 140° 3’ 13.6” E) and Sobara (37° 41’ 22.1” N, 140° 4’ 0.5” E) in Kitashiobara, Fukushima Prefecture and from Chinome, which is the type locality of *M. itohi* (Sakayori, 1979), in Hitachiota, Ibaraki Prefecture. Specimens were extracted from leaf litter and directly placed into absolute ethanol using Tullgren funnels. Extracted specimens were transferred to and preserved in absolute ethanol. One pedipalp was removed using a thin tungsten needle under a stereomicroscope and transferred to a PCR tube with absolute ethanol and then processed into a tube for DNA extraction; the body was then stored in a tube for DNA extraction; the body was then stored in a refrigerator in absolute ethanol. Specimens were transferred to and preserved in absolute ethanol. One pedipalp was removed using a thin tungsten needle under a stereomicroscope and transferred to a PCR tube with absolute ethanol and then processed into a tube for DNA extraction; the body was then stored in a refrigerator in absolute ethanol.

Partial sequences of nuclear DNA 18S ribosomal RNA gene (1244 bp) revealed three distinct clades with high bootstrap values (Clades 1–3, Fig. 2). The present analysis revealed that these three clades cannot be clearly distinguished by the ATC types. The ATC types “4–6–6” and “4–4–6” predominated in the clades 2 and 3 respectively, but different ATC types “4–5–6” and “5–4–6” were included as minorities in the clades 2 and 3. The clade 1 included three different types “4–4–6”, “4–6–6”, and “4–5–6”.

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**Table 1** Specimens examined in this study

<table>
<thead>
<tr>
<th>Individual</th>
<th>Locality</th>
<th>Sex</th>
<th>ATC</th>
<th>DDBJ accession no.</th>
</tr>
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<td>M1</td>
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<td>F</td>
<td>4–6–7</td>
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<tr>
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<td>4–4–6</td>
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</tr>
<tr>
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<td>LC082341</td>
</tr>
<tr>
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<tr>
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<td>LC082348</td>
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</table>

F: female; M: male.

Abdominal tergal chaetotaxy (ATC) represents the number of setae in the first, second, and third abdominal tergal plates.

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**Fig. 2** Neighbor-joining dendrogram of Japanese soil-dwelling *Mundochthonius* inferred from the partial sequences (1244 bp) of 18S ribosomal RNA gene. Operational taxonomic units (OTUs) were indicated by the individual number of *Mundochthonius* shown in Table 1 (M1–M18) with the ATC in parenthesis. *Chthonius dacnodes* (GenBank accession number JN018288) and *C. ischnocheles* (JN018289) were used as outgroups. Bootstrap support values are shown above the branches.
and “4–6–7” as well. The present study revealed that the ATC cannot clearly define the monophyletic clades, and this implies that the ATC should not be a reliable taxonomic diagnosis for *Mundochthonius*.

Sakayori (2014a) pointed out that the pedipalpal femur morphology (length:width ratio of the pedipalp femur) is not a useful character in *Allochthonius* species identification. The pedipalpal femur morphology has been employed also in the classification of *Mundochthonius* as another useful diagnosis (Sato and Sakayori, 2015). Its reliability has to be also tested for this genus, and simultaneously more reliable and practical diagnoses in *Mundochthonius* identification should be surveyed.

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**References**


