Acarologia is proudly non-profit, with no page charges and free open access

Please help us maintain this system by encouraging your institutes to subscribe to the print version of the journal and by sending us your high quality research on the Acari.

Subscriptions: Year 2023 (Volume 63): 450 €
http://www1.montpellier.inra.fr/CBGP/acarologia/subscribe.php
Previous volumes (2010-2021): 250 € / year (4 issues)
Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France
ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d’avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

Acarologia is under free license and distributed under the terms of the Creative Commons-BY
Description of two new species of *Stigmaeopsis*, Banks 1917 (Acari, Tetranychidae) inhabiting *Miscanthus* grasses (Poaceae)

Y. Saito\textsuperscript{a,b}, Y. Sato\textsuperscript{c}, A.R. Chittenden\textsuperscript{d}, J.-Z. Lin\textsuperscript{b}, Y.-X. Zhang\textsuperscript{b}

\textsuperscript{a} Research Faculty of Agriculture, Hokkaido University, Sapporo 060-8589, Japan.  
\textsuperscript{b} Research Center of Engineer and Technology of Natural Enemy Resource of Crop Pest in Fujian, Institute of Plant Protection, Fujian Academy of Agricultural Sciences, Fuzhou 350013, China.  
\textsuperscript{c} Sugadaira Research Station, Mountain Science Center, University of Tsukuba, Ueda, Nagano 386-2204, Japan.  
\textsuperscript{d} Research Faculty of Fisheries Sciences, Hokkaido University, Hakodate, 041-8611, Japan.

**ABSTRACT**

We provided a new diagnosis of the genus *Stigmaeopsis*. Then we described two new species that are very closely related to *Stigmaeopsis miscanthi* (Saito) from *Miscanthus* spp. in Japan and China. The Japanese species, named *Stigmaeopsis sabelisi* Saito \textit{et} Sato \textit{n. sp.}, was previously referred to as *Stigmaeopsis miscanthi* low aggressiveness form, and is characterized by its low male-to-male aggression behavior. The other species, *Stigmaeopsis continentalis* Saito \textit{et} Lin \textit{n. sp.}, was found in China (Fujian district). Thus four species could be discriminated from the species inhabiting *Miscanthus* and reed grasses. However, the two new species and *S. miscanthi* resemble each other very closely, thus they are considered to be sibling species. To identify them several naive characters, geographic distribution and genetic data are needed. An updated key to all known species of *Stigmaeopsis* is also proposed.

**Keywords**  
spider mite, criptic species, male-to-male aggression, sociality

**Zoobank**  
http://zoobank.org/B2740172-4F3F-4FB0-8682-FB3E2E92A9B3

**Introduction**

*Stigmaeopsis celarius* was first described by Banks (1917) from an introduced bamboo plant (*Pleioblastus simonii*) and established as the type species of the new genus *Stigmaeopsis*. Thirty-three years after the first description, this species was redescribed and *Stigmaeopsis* was synonymized with *Schizotetranychus* (Trägårdh 1915) by McGregor (1950). Much later, Saito \textit{et al.} (2004) reinstated the genus *Stigmaeopsis* Banks (1917), described two new species and moved five others to the genus, formerly of the *celarius* species group of *Schizotetranychus*. Flechtmann (2012) added two new combinations, \textit{i.e.} *Stigmaeopsis malkovskii* (Wainstein 1956) and *Stigmaeopsis meghalayensis* (Gupta and Gupta 1994). Furthermore, Saito \textit{et al.} (2016) described two more *Stigmaeopsis* species from bamboo plants. Thus we now recognize 11 species as belonging to this genus.

Almost all members of the *Stigmaeopsis* genus have characteristic nest-weaving habits (Saito 2010; Saito \textit{et al.} 2016). Considerable nest size variation exists between species on bamboo plants, which is correlated with species-specific variation in dorsal setal lengths (Mori and Saito 2013; Saito \textit{et al.} 2016).

On the other hand, two *Stigmaeopsis* species are known to inhabit the perennial grasses, *Miscanthus* spp. and a reedgrass (Poaceae). In *Stigmaeopsis miscanthi* (Saito 1990), three
forms, each of which possess different levels of male-to-male aggression (Saito 1995), were recently recognized (Sato et al. 2013a). The HG (males having high aggressiveness) and LW (males having low aggressiveness) forms of S. miscanthi have both been observed in Japan. The former is distributed over high temperature areas, and the latter over most low temperature areas with the exception of Hokkaido prefecture (Saito and Sahara 1999). However, there are very few morphological characters that can be used to identify these two forms other than the proportion of male leg development (armoured leg I in Saito and Sahara 1999; Sato et al. 2013a). Recently Sakamoto et al. (2017) found large differences between the LW, HG and a chinese (Cn) forms, suggesting that they are actually different species.

In the present study, we investigated the characteristics three forms in detail then discriminate two new species from S. miscanthi. Furthermore a new diagnosis of Stigmaeopsis was presented and a key to the world known species of Stigmaeopsis is also provided.

Materials and methods

The two mite species described in the present study were collected from their respective fields (see results) and preserved in glass tubes containing MA solution (Saito and Osakabe 1993). Several of these preserved specimens were then prepared into permanent specimens using the Canada balsam method described in Saito et al. (1993). The specimens used for dorsal setae measurements were taken from colonies reared in the laboratory after collection and mounted on slides using Hoyer’s solution. A 10g weight was gently placed on each cover glass to flatten the mite bodies. The specimens were kept on a hot plate at 55 °C for more than 7 days. The measurements were made from digital photographs taken with a digital camera (Sony Nex-7, Sony Corp., Tokyo, Japan) set up on a phase contrast microscope (Olympus BX63, Olympus Corp., Tokyo, Japan with 20x and 40x objective lens). Image J (provided by NIH, USA) for Macintosh (Apple Inc., USA) was used to measure seta and body lengths.

Results

Genus Stigmaeopsis Banks

Diagnosis — Palp tarsus with six phaneres (projections): conical spinneret, two eupathidia, one solenidion and two tactile setae (n.b. seta b absent). Propodosoma well demarcated from hysterosoma; opisthonotum with 12 pairs of setae (c1-3, d1-2, e1-2, f1-2, h1-3; n.b. setae h1 are present, h3 placed ventrally); setae c1 widely spaced, in sublateral position close to setae c2 and c3; dorsal body setae slender with fine splits, length variable; opisthonotum with distinctive region of dorsocentral longitudinal striae between setae c1-c1 and d1-d1; two pairs of genital setae (g1-2); two pairs of pseudanal setae (ps1-2); tarsus I with two pairs of distal, adjacent duplex setae; tarsus II with one pair of duplex setae; empodium split into two claws, male tarsus I with empodium same as female empodium; male aedeagus weakly sigmoid, bending dorsally, without head. Leg setation typically reduced (e.g., genua 5-4-3-2).

Remarks — Stigmaeopsis is similar to some species of Schizotetranychus but is distinguished by its distinctive region of mid-dorsal longitudinal striae (though S. meghalayensis shows transverse striae), the loss of the palpal tactile seta b, and conical shape of spinneret.
Stigmaeopsis sabelisi Saito et Sato n. sp. (Figures 1 – 3, Tables 1 – 3)

(Japanese name: Tomo-sugomori-hadani)

Zoobank: AB01B8D1-9CE9-473B-97A3-F06E920F936B

Stigmaeopsis miscanthi low aggressiveness form in Saito (1995); Saito (2000); Saito (2010); Saito & Sahara (1999); Saito et al. (1999); Saito et al. (2000); Saito et al. (2002); Saito et al. (2005); Saito et al. (2013b); Sakagami et al. (2009); Sakamoto et al. (2017); Sato et al. (2000a, b); Sato et al. (2008); Sato et al. (2013a, b); Yano et al. (2011)

Description

Female — Body flattened and wide, straw to greenish yellow with small blackish green spots. Body size 485.4 ± 15.9 μm from tip of rostrum to end of hysterosoma and 347.1 ± 15.7 μm from middle of horizontal line connecting setae v2 bases to end of hysterosoma. Peritreme bent and slightly dilated at distal end (but varies with specimen conditions). Propodosoma well demarcated from hysterosoma. Dorsal propodosomal setae sc1, 10% shorter than distance between their bases (Fig. 1, Table 1), and shorter than distance between bases of sc1 and c3. Bases of all dorsocentral hysterosomal setae (c1, d1, e1, f1) placed approximately in a straight line and the pair of lines forms a V shape. Length of dorsocentral hysterosomal setae d1 subequal with distance between their bases, just reaching bases of f1. Distance between bases of dorsolateral hysterosomal setae c2 longer than distance between bases of dorsolateral hysterosomal setae d2. Hysterosomal setae h3 exist ventrally. Lengths of dorsal setae and distances between their bases listed in Tables 1 and 2. Genital flap and area anterior to flap transversely striate (Fig. 1E). Distal segment of palpus has two simple setae and one spinneret (terminal sensillum), two eupathidia and one solenidion. Spinneret is conical in shape (Fig. 1B). Numbers of setae on leg segments presented in Figure 2 and Table 3.

Male — Body size 379.6 ± 39.6 μm from tip of rostrum to end of hysterosoma and 264.0 ± 26.7 μm from middle of horizontal line connecting setae v2 bases to end of hysterosoma. Lengths of dorsal setae and distances between their bases as in Tables 1 and 2. Femur-I with 9 tactile setae, one of which is tiny (dwarfed) and additional to those present in the female. Distal segment of palpus similar to female, spinneret slightly smaller (Fig. 1C). Aedeagus curved dorsally, weakly sigmoid (Fig. 1D). Numbers of setae on leg segments presented in Figure 3 and Table 3.

Type Material — HOLOTYPE: 1 male mounted with Canada balsam, Itoshima, Fukuoka, Japan, Miscanthus sinensis (Poaceae) on 12 May 2007, Saito Y. PARATYPE: 2 females and 2 males, same data; 2 females mounted with Canada balsam, Hiranai, Aomori, Japan, M. sinensis on 24 Aug. 2016 and 4 females and 1 male mounted with Hoyer’s medium, Itoshima, Fukuoka, Japan, M. sinensis on 12 May 2007. These are deposited in the Hokkaido University Museum, Sapporo, 060-0810, Japan

Host and Distribution — On Miscanthus sinensis and Miscanthus spp. in Japan other than Hokkaido and Okinawa Prefectures.

Remarks — This species resembles Stigmaeopsis miscanthi but is distinguished from it by two morphological characters, as follows: the length of dorsal propodosomal setae sc1 shorter than distance between sc1 and c3 bases in S. sabelisi, but longer than that in S. miscanthi. The length of dorsocentral hysterosomal setae d1 almost the same as distance between their bases in S. sabelisi, but much longer than that in S. miscanthi.

Life Type — This species lives within a dense web nest (WN-c life type in Saito 1983) built over depressions on the leaf adaxial surface (along midvein).
Table 1 Measurements of dorsal seta lengths and distances between their bases in *Stigmaeopsis sabelisii* and *Stigmaeopsis continentalis* with reference to *Stigmaeopsis miscanthi* (µm)

| Setae       | Female | | | | | | Male | | | |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|             | Length | SD     | Distance| SD     | Length | SD     | Distance| SD     |
| *S. sabelisii* |        |        |         |        |        |        |         |        |
| v2          | 47.6   | 2.5    | 84.7    | 2.1    | 37.4   | 2.2    | 62.6    | 3.4    |
| sc1         | 106.5  | 9.0    | 122.7   | 4.9    | 79.1   | 5.4    | 87.9    | 4.3    |
| sc2         | 61.6   | 2.7    | 211.5   | 7.4    | 43.5   | 4.1    | 152.1   | 6.5    |
| c1          | 46.8   | 2.4    | 146.4   | 4.8    | 37.7   | 2.0    | 113.2   | 7.3    |
| c2          | 47.9   | 4.6    | 199.7   | 6.8    | 39.3   | 2.7    | 151.7   | 8.4    |
| c3          | 85.1   | 9.4    | 239.2   | 15.2   | 53.7   | 5.9    | 176.6   | 9.1    |
| d1          | 99.7   | 7.2    | 98.0    | 5.2    | 70.4   | 5.5    | 70.9    | 4.4    |
| d2          | 52.3   | 1.9    | 174.8   | 4.0    | 41.4   | 2.9    | 134.6   | 5.6    |
| e1          | 67.5   | 5.3    | 65.7    | 3.6    | 45.7   | 2.9    | 43.0    | 2.5    |
| e2          | 50.9   | 3.2    | 144.0   | 7.6    | 42.8   | 3.6    | 96.7    | 2.8    |
| f1          | 51.3   | 3.6    | 38.0    | 4.4    | 37.7   | 2.4    | 22.3    | 2.9    |
| f2          | 51.4   | 2.6    | 84.0    | 7.3    | 41.5   | 4.3    | 61.4    | 3.4    |
| h1          | 55.3   | 3.9    | 24.0    | 3.2    | 37.2   | 3.1    | 18.6    | 2.4    |
| h2          | 39.8   | 3.8    | 34.9    | 5.7    | 28.2   | 3.7    | 22.7    | 3.5    |
| h3          | 35.3   | 3.2    | -       | -      | 28.5   | 5.0    | -       | -      |
| *S. continentalis* |        |        |         |        |        |        |         |        |
| v2          | 49.3   | 4.8    | 85.2    | 3.6    | 45.5   | 4.5    | 71.6    | 1.7    |
| sc1         | 125.1  | 4.4    | 130.9   | 3.9    | 92.0   | 4.7    | 102.4   | 1.8    |
| sc2         | 61.9   | 4.1    | 214.7   | 11.5   | 47.7   | 3.1    | 171.0   | 10.0   |
| c1          | 52.2   | 3.1    | 148.3   | 6.2    | 46.0   | 3.1    | 130.8   | 6.3    |
| c2          | 54.5   | 3.3    | 194.1   | 7.1    | 45.6   | 3.0    | 171.9   | 4.0    |
| c3          | 77.7   | 5.4    | 228.3   | 12.9   | 58.4   | 4.8    | 211.2   | 8.5    |
| d1          | 119.5  | 4.7    | 96.9    | 4.0    | 82.5   | 7.6    | 81.2    | 3.8    |
| d2          | 59.3   | 4.2    | 188.4   | 5.6    | 49.9   | 3.8    | 168.4   | 7.4    |
| e1          | 70.3   | 7.0    | 68.2    | 2.2    | 56.8   | 6.2    | 49.3    | 3.1    |
| e2          | 58.1   | 3.9    | 150.1   | 7.8    | 48.0   | 2.8    | 114.5   | 4.9    |
| f1          | 49.5   | 2.4    | 31.7    | 4.8    | 43.5   | 3.3    | 24.5    | 1.6    |
| f2          | 57.8   | 4.3    | 98.3    | 6.8    | 45.3   | 2.3    | 67.0    | 1.4    |
| h1          | 59.9   | 3.5    | 24.9    | 2.4    | 40.5   | 2.1    | 25.1    | 1.9    |
| h2          | 40.5   | 3.2    | 32.8    | 2.8    | 27.2   | 2.6    | 27.6    | 2.0    |
| h3          | 34.0   | 2.4    | -       | -      | 23.1   | 2.7    | -       | -      |
| *S. miscanthi* |        |        |         |        |        |        |         |        |
| v2          | 58.0   | 1.6    | 83.3    | 3.8    | 44.2   | 4.0    | 61.8    | 3.8    |
| sc1         | 125.6  | 5.0    | 133.7   | 5.8    | 92.5   | 3.3    | 92.5    | 3.3    |
| sc2         | 62.6   | 2.0    | 227.0   | 13.4   | 48.7   | 3.3    | 168.4   | 9.1    |
| c1          | 53.6   | 6.3    | 179.2   | 20.6   | 42.9   | 4.1    | 146.2   | 13.0   |
| c2          | 60.6   | 3.0    | 222.2   | 14.8   | 45.0   | 2.4    | 183.9   | 11.2   |
| c3          | 89.9   | 7.9    | 243.2   | 17.2   | 58.3   | 4.8    | 195.9   | 9.2    |
| d1          | 117.9  | 3.9    | 100.7   | 4.9    | 81.6   | 3.7    | 84.1    | 4.5    |
| d2          | 64.0   | 3.6    | 193.3   | 14.1   | 46.3   | 5.2    | 160.9   | 8.9    |
| e1          | 83.2   | 9.7    | 74.8    | 5.2    | 47.4   | 4.8    | 55.7    | 4.3    |
| e2          | 61.4   | 3.9    | 163.0   | 14.4   | 44.3   | 3.5    | 122.2   | 6.4    |
| f1          | 49.2   | 4.0    | 44.2    | 4.1    | 36.7   | 3.4    | 28.8    | 3.8    |
| f2          | 58.2   | 2.9    | 88.7    | 12.2   | 33.8   | 2.7    | 71.6    | 4.6    |
| h1          | 57.3   | 3.0    | 28.9    | 3.3    | 31.5   | 2.3    | 29.1    | 2.1    |
| h2          | 37.8   | 3.3    | 30.4    | 2.2    | 25.3   | 3.5    | 29.1    | 2.7    |
| h3          | 30.0   | 3.0    | -       | -      | 21.4   | 2.7    | -       | -      |

* referred from Saito (1990); h3, located ventrally; -, difficult to measure.
Figure 1 *Stigmaeopsis sabelisi* n. sp.: A – Dorsum of female; B – Distal segment of palpus of female; C – Distal segment of palpus of male; D – Aedeagus; E – Female genital flap and anterogenital area.

Table 2 Longitudinal distances between bases of hystersomal setae in females of three *Stigmaeopsis* species (n ≥ 5, average ± SD µm).

| Species          | c1 - d1 | c1 - e1 | c1 - f1 | c1 - h1 | d1 - e1 | d1 - f1 | d1 - h1 | e1 - f1 | e1 - h1 | f1 - h1 |
|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| *S. sabelisi*    | 66.0±3.6| 129.1±8.7| 169.8±10.9| 213.2±16.6| 64.9±5.9| 104.9±8.3| 148.4±15.0| 40.6±3.7| 84.3±9.1| 44.4±6.0|
| *S. continentalis* | 67.2±4.2| 116.6±7.2| 151.9±10.7| 187.7±14.5| 51.1±7.0| 86.9±12.1| 122.4±14.5| 37.1±5.4| 72.5±11.9| 38.2±7.5|
| *S. miscanthi*   | 68.3±6.7| 126.7±7.0| 166.8±10.6| 205.1±21.5| 58.9±4.3| 98.9±8.5| 137.6±18.0| 40.2±4.3| 78.9±15.4| 39.0±11.3|

* data newly obtained for the specimens collected on Feb. 23, 2017, Motobu, Okinawa, Japan.
**Figure 2** *Stigmaeopsis sabelisi* n. sp.: A – Femur, genu, tibia and tarsus I of female; B – Femur, genu, tibia and tarsus II of female; C – Femur, genu, tibia and tarsus III of female; D – Femur, genu, tibia and tarsus IV of female.

**Table 3** Numbers of setae on leg segments of *Stigmaeopsis sabelisi* and *Stigmaeopsis continentalis* with reference to *Stigmaeopsis miscanthi* (from Saito, 1990).

|        | Leg I            | Leg II           | Leg III           | Leg IV          |
|--------|------------------|------------------|-------------------|-----------------|
| Female |                  |                  |                   |                 |
| S. sabelisi |                   |                   |                   |                 |
| Femora | 8t               | 5t*              | 3t                | 3t              |
| Genua  | 5t               | 4t               | 3t                | 2t              |
| Tibiae | 7t+1s            | 5t               | 5t                | 5t              |
| Tarsi  | 8t+3e+1s+2d      | 6t+3e+1s+1d      | 8t+1s             | 8t+1s           |
| S. continentalis |                 |                   |                   |                 |
| Femora | 8t               | 5t               | 3t                | 3t              |
| Genua  | 5t               | 4t               | 3t                | 2t              |
| Tibiae | 7t+1s            | 5t               | 5t                | 5t              |
| Tarsi  | 7t+3e+1s+2d      | 7t+3e+1s+1d      | 8t+1s             | 8t+1s           |
| S. miscanthi** |                 |                   |                   |                 |
| Femora | 8t               | 5t               | 3t                | 3t              |
| Genua  | 5t               | 4t               | 3t                | 2t              |
| Tibiae | 7t+1-2s          | 5t               | 5t                | 5t              |
| Tarsi  | 10***+1s+2d      | 9***+1s+1d       | 8t+1s             | 8t+1s           |

Female: t, tactile setae; <1dr>, one of tactile setae was dwarfed; e, euphathidium; s, solenidia; d, duplex setae (1d = set of 1 solenidion + 1 tactile seta). At least six specimens were checked.

Male: t, tactile setae; <1dr>, one of tactile setae was dwarfed; e, euphathidium; s, solenidia; d, duplex setae (1d = set of 1 solenidion + 1 tactile seta). At least six specimens were checked.

* varying at least ± 1; ** referred from Saito (1990), and additional data newly obtained for the specimens collected on Feb. 23, 2017, Motobu, Okinawa, Japan were added in parentheses; *** no discrimination of euphathidium was made in Saito (1990).
Figure 3 Stigmaeopsis sabelisi n. sp.: A – Femur, genu, tibia and tarsus I of male; B – Femur, genu, tibia and tarsus II of male; C – Femur, genu, tibia and tarsus III of male; D – Femur, genu, tibia and tarsus IV of male.

Etymology — Stigmaeopsis sabelisi is named in honor of the late Dr. Maurice W. Sabelis, a former Amsterdam University professor, who kindly advised on many of our long-term research projects.

Stigmaeopsis continentalis Saito et Lin n. sp. (Figures 4 – 5, Tables 1, 2 and 3)

(Japanese name: Bin-sugomori-hadani)

Zoobank: DCFE3743-86CD-45CC-BC50-9FB5F6DD8C32

Stigmaeopsis miscanthi in Tsuji et al. (2011); Stigmaeopsis miscanthi Cn form in Sakamoto et al. (2017)

Female — Body flattened and wide, straw to greenish yellow with small blackish green spots. Body size 476.3 ± 25.2 μm from tip of rostrum to end of hysterosoma and 327.3 ± 15.0 μm from middle of horizontal line connecting setae v2 bases to end of hysterosoma. Propodosoma well demarcated from hysterosoma. Bases of all dorsocentral hysterosomal setae (c1, d1, e1 and f1) placed approximately in a straight line and the pair of lines forms a V shape. Length of dorsocentral hysterosomal setae d1 much longer than distance between their bases and exceed bases of f1. Distance between bases of dorsolateral hysterosomal setae c2 subequal to distance between bases of dorsolateral hysterosomal setae d2. Hysterosomal setae h3 (2nd para-anal setae) present. Lengths of dorsal setae and distances between their bases listed in Tables 1 and 2. Genital flap and area anterior to flap transversely striate (almost same as Fig.
1E). Palp tarsus with two simple setae and one conical spinneret, two eupathidia and one solenidion. Spinneret conical in shape (Fig. 4A). Numbers of setae on leg segments presented in Figures 5A-B and Table 3.

Male — Body size 415.9 ± 15.6 μm from tip of rostrum to end of hysterosoma and 302.4 ± 9.5 μm from middle of horizontal line connecting setae v2 bases to end of hysterosoma. Lengths of dorsal setae and distances between their bases as in Table 1. Femur-I with 9 normal setae, one of which is tiny (dwarfed) and additional to female setation. Numbers of setae and solenidia on distal segment of palpus presented in Fig. 4C and those on leg segments presented in Figures 5C-D, and Table 3. Aedeagus broadly curved dorsally, weakly sigmoid (Fig. 4D).

Type Material — HOLOTYPE: 1 male, made with Canada balsam, Fuqing, China, Miscanthus sp. 26 Feb. 2014, Saito Y. PARATYPES: 1 female, same data. 2 males (1 collected on 20 Feb. 2015 made with balsam and the other on 14 Apr. 2017 with Hoyer’s medium).
Figure 5 *Stigmaeopsis continentalis* n. sp.: A – Femur, genu, tibia and tarsus I of female; B – Femur, genu, tibia and tarsus II of female; C – Femur, genu, tibia and tarsus I of male; D – Femur, genu, tibia and tarsus II of male.

Fuzhou, China, *Miscanthus* sp. and 3 females (on 28 Aug. 2015, one with balsam and the other with Hoyer’s medium), Fuzhou, China, *Miscanthus* sp. These are deposited in the Zoological Museum at Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China.

Host and Distribution — Fuqing, Fuzhou and Wuiy, Fujian Prov., China parasitic to *Miscanthus sinensis* and *Miscanthus* spp.

Remarks — This species resembles both *S. miscanthi* and *S. sabelisi* but is distinguished from them by several characters as follows: the distance between the bases of dorsolateral hysterosomal setae c2 almost the same as that between the bases of dorsolateral hysterosomal setae d2 in *S. continentalis*, but the distance between the bases of c2 is longer than that between the bases of d2 in both *S. sabelisi* and *S. miscanthi*; in both *S. continentalis* and *S. miscanthi*, length of dorsocentral hysterosomal setae d1 are much longer than distance between their bases and extend past the bases of f1, but setae d1 are almost the same length as distance between their bases in *S. sabelisi*.

Life type — This species lives within dense web nests (WN-c life type in Saito 1983) built over depressions on leaf adaxial surface (along midvein).


**Discussion**

**Key to the species of Stigmaeopsis (for adult female)**

Due to the addition of two new species, the key to the *Stigmaeopsis* species in Saito *et al.* (2016) should be changed as follows (following mite identification we recommend to refer to Figures 6 to 8 placed at the end of the article to get additional useful data on each species):

1. Length of setae *d1* shorter than (or similar to) distance between bases of *d1* setae members ........................................... 2
   — Length of setae *d1* longer than distance between bases of *d1* setae members .................. 8

2. Length of setae *d1* shorter than (or similar to) distance between bases of *d1* and *e1* setae ........................................... 3
   — Length of setae *d1* longer than distance between bases of *d1* and *e1* setae .............. 5

3. Length of setae *d2* longer than distance between bases of *d1* and *d2* setae ................. 4
   — Length of setae *d2* shorter than distance between bases of *d1* and *d2* setae ........... 10
   — *Stigmaeopsis tegmentalis* Saito et Lin
   — Length of seta *d2* shorter than distance between bases of *d1* and *d2* setae ........... 4

4. Length of setae *e1* similar to distance between bases of *e1* and *f1* setae .................. 11
   — *Stigmaeopsis saharai* Saito et Mori
   — Length of setae *e1* much longer than distance between bases of *e1* and *f1* setae ........ 5
   — *Stigmaeopsis temporalis* Saito et Ito

5. Length of seta *e1* similar to distance between bases of *e1* and *e2* setae .................. 8
   — *Stigmaeopsis takahashii* Saito et Mori
   — Length of seta *e1* longer than distance between bases of *e1* and *e2* setae ............ 6

6. Length of setae *d1* similar to distance between bases of *d1* and *f1* setae .................. 9
   — *S. sabelisi* **n. sp.** Saito et Sato
   — Length of setae *d1* shorter than distance between bases of *d1* and *f1* setae ........... 7

7. Length of setae *d1* shorter than distance between bases of *d1* and *e2* setae ............ 10
   — *Stigmaeopsis tenuinidus* (Zhang et Zhang)
   — Length of setae *d1* longer than distance between bases of *d1* and *e2* setae ............ 12
   — *Stigmaeopsis malkovskii* **n. sp.** (Wainstein)

8. Distance between bases of *e1* setae similar to that between bases of *d1* setae ............ 13
   — *Stigmaeopsis nanjingensis* (Ma et Yuan)
   — Distance between bases of *e1* setae shorter than that between bases of *d1* setae ....... 9

9. Length of setae *d1* shorter than (or similar to) distance between bases of *d1* and *f2* setae ........................................... 10
   — Length of setae *d1* longer than distance between bases of *d1* and *f2* setae ............ 12

10. Distance between bases of *e2* setae similar to that between bases of *d2* setae .......... 11
    — Distance between bases of *e2* longer than that between bases of *d2* setae ............... 14
    — *Stigmaeopsis miscanthi* **n. sp.** (Saito)
11. Length of setae $d_2$ shorter than (or similar to) distance between bases of $d_1$ and $d_2$ setae. 

---

Stigmaeopsis celarius Banks

— Length of setae $d_2$ longer than distance between bases of $d_1$ and $d_2$ setae.

---

S. continentalis* n. sp. Saito et Lin

12. Mediodorsal striae (central part of quadrilateral forming $c_1$ and $d_1$ setae bases) longitudinal

---

Stigmaeopsis longus (Saito)

— Mediodorsal striae (central part of quadrilateral forming $c_1$ and $d_1$ setae bases) transverse.

---

Stigmaeopsis meghalayensis (Gupta et Gupta)

* mite species inhabiting Miscanthus sp. and reedgrasses.

Although S. meghalayensis does not satisfy several characters that represent Stigmaeopsis, we hold the decision until we can confirm the type specimen. The species marked with asterisk inhabit Miscanthus grasses and reedgrass (Poaceae), whereas all others inhabit Bambusoideae (Poaceae) plants. As shown in the above key, the lengths of dorsal setae are important characters for species identification in Stigmaeopsis. However, these setae are often broken and shortened in field collected mites, such that we must get our great attention to this possibility (Sakamoto et al. 2017). Specimens of newly emerged females from teleiocrysalis may help to avoid such troubles.

There are very few morphological differences between S. continentalis and S. miscanthi, thus they are considered to be cryptic species, such that geographic distribution (China in the case of the former and Japan in the case of the latter) and genetic information must be considered to distinguish S. continentalis from S. miscanthi. Furthermore, variation in the armored male morphology: S. miscanthi male leg I / leg III = 1.41; S. continentalis male = 1.32; S. sabelisi male = 1.29 (Saito and Sahara 1999; Sato et al. 2013a; in this study) may help with species identification, though males are rare in natural populations, due to their mortal combat tendencies.

From the above, we recognize 13 species of Stigmaeopsis. Although it is difficult to say that all species have been described, we reviewed several characteristics of Stigmaeopsis species in the genus diagnosis. From a morphological standpoint, no visible variations could be determined from the peritreme, aedeagus, striae of genital flap or those anterior to the flap (genital flap and area anterior to flap transversely striate) between congeneric species, which are useful characteristics for classifying other tetranychid species (Ehara 1999).

Almost all known species build nests over leaf depressions using silk threads (Saito et al. 2017; in this study) and live within them gregariously. Host plants are restricted to Poaceae distributed across Asian countries (India, Thailand, China (including Taiwan), Kazakhstan, Korea and Japan) other than artificial introduction.

Acknowledgements

We sincerely thank the late Maurice M. Sabelis who supported our work for long periods. We also thank Flechtmann C.H.W. who kindly provided us with several pieces of important literature. We also thank Gotoh T., Sahara K., Ito K., Uchida Y., Obokata S., Ji J., Chen X. and Sun L. for their help. This study was supported by the Fujian Council of Natural Science Foundation (2014J01108), China Recruitment Program of Global Experts (Foreign Experts) (2012-323), State Administration of Foreign Experts Affairs Key Project for Introduction of Foreign Expert (SZ2013003), the Agricultural Department of China (2017YFD0201000) and Special Research Fund of Fujian Academy of Agricultural Sciences (STT2017-2-2). This study was also supported in part by JSPS KAKENHI Grant Numbers JP26891003 (YS), JP17K07556 (YS).
Figure 6  A – Stigmaeopsis longus (Saito), from Saito (1990) with some modification. Hysterosomal seta $h_3$ was omitted; B – Stigmaeopsis nanjingensis (Ma et Yuan). New drawing by Y. Saito (specimen collected on June 20, 2014 in Fuzhou, China); C – Stigmaeopsis tenuinidus (Zhang et Zhang). New drawing by Y. Saito (specimen collected on May 20, 2015 in Fuzhou, China); D – Stigmaeopsis celarius Banks, from Saito et al. (2004) with some modification. Hysterosomal seta $h_3$ was omitted.
Figure 7  A – Stigmaeopsis takahashii Saito et Mori, from Saito et al. (2004) with some modification. Hysterosomal seta h3 was omitted; B – Stigmaeopsis saharai Saito et Mori, from Saito et al. (2004) with some modification. Hysterosomal seta h3 was omitted; C – Stigmaeopsis temporalis Saito et Ito, from Saito et al. (2016) with some modification. Hysterosomal seta h3 was omitted; D – Stigmaeopsis tegmentalis Saito et Lin, from Saito et al. (2016) with some modification. Hysterosomal seta h3 was omitted.
Figure 8  A – Conical spinneret of *Stigmaeopsis continentalis* Saito et Lin (dorsal view of this species appears in Figure 4A); B – Conical spinneret of *Stigmaeopsis sabelisi* Saito et Sato (Dorsal view of this species appears in Figure 1A); C – *Stigmaeopsis miscanthi* (Saito), from Saito (1990) with some modification. Hysterosomal seta $h_3$ was omitted; D – *Stigmaeopsis malkovskii* (Wainstein), from Wainstein (1956) with modifications. Hysterosomal seta $h_3$ was omitted; E – *Stigmaeopsis meghalayensis* (Gupta et Gupta), from Gupta and Gupta (1994) with modifications. Hysterosomal seta $h_3$ was omitted.
References

Banks N. 1917. New mites, mostly economic (Arach., Acar.). Entomol. News, 28: 193-199.

Elhara S. 1999. Revision of the spider mite family Tetranychidae of Japan (Acari, Prostigmata). Species Diversity, 4: 63-141.

Flechtmann C.H.W. 2012. Schizotetranychus-like spider mites (Acari, Prostigmata, Tetranychidae). revisited, new combinations and a key to groups of Schizotetranychus based on females. Acarologia, 52: 87-95. doi:10.1016/j.acarologia.2012.03.003

Gupta S.K., Gupta Y.N. 1994. A taxonomic review of Indian Tetranychidae (Acari: Prostigmata) with descriptions of new species, re-descriptions of known species and keys to genera and species. Genus Tetranychus. Schizotetranychus Trägårdh. Mem. Zool. Survey of India, 18: 86-99.

Ma E.-P., Yuan Y.-L. 1980. New species and new records of tetranychid mites from China I. (Acari: Tetranychidae). Acta Entomol. Sinica, 5: 42-45.

McGregor E.A. 1950. Mites of the family Tetranychidae. Am. Midl. Nat., 44: 257-420. doi:10.2307/2421856

Mori K., Saito Y. 2013. Genetic basis of woven nest size in subsocial spider mites. Exp. Appl. Acarol., 60: 463-469. doi:10.1007/s10493-013-9661-2

Saito Y. 1983. The concept of “life types” in Tetranychidae. An attempt to classify the spinning behaviour of Tetranychinae. Acarologia, 24: 377-391.

Saito Y. 1990. Two new spider mite species of the Schizotetranychus celarius complex (Acari: Tetranychidae). Appl. Entomol. Zool., 25: 389-396. doi:10.1007/s00114-016-9878-3

Saito Y. 1992. Climal variation in male-to-male antagonism and weaponry in a subsocial mite. Evolution, 49: 413-417. doi:10.1111/j.1558-5646.1995.tb02273.x

Saito Y. 2010. Plant Mites and Sociality. Diversity and evolution. Tokyo, Springer, pp. 187. doi:10.1007/978-4-431-99456-5

Saito Y., Ito K., Sakagami T. 2005. Imaginal induction of diapause in several adult-female diapausing spider mites. Physiol. Entomol., 30: 96-101. doi:10.1111/j.0033-2863.2004.00441.x

Saito Y., Kanazawa M., Sato Y. 2013. Life history differences between two forms of the social spider mite, Stigmaeopsis miscanthi. Exp. Appl. Acarol., 60: 313-320. doi:10.1007/s10493-019-9646-6

Saito Y., Lin J.-Z., Zhang Y.-X., Ito K., Liu Q., Chittenden A.R. 2016. Two new species and four new life types in Tetranychidae. Ann. Entomol. Soc. Amer., 109: 463-472. doi:10.1093/ae/aqs158

Saito Y., Mori K., Chittenden A.R. 1999. Body characters reflecting the body size of spider mites in flattened specimens (Acari, Tetranychidae). Appl. Ent. Zool., 34: 383-386. doi:10.1303/aez.34.383

Saito Y., Mori K., Chittenden A.R., Sato Y. 2000. Correspondence of male-to-male aggression to spatial distribution of individuals in field populations of a subsocial spider mite. J. Ethol., 18: 79-83. doi:10.1016/s1016400700004

Saito Y., Mori K., Sakagami T., Lin J.-Z. 2004. Reinstatement of the genus Stigmaeopsis Banks, with descriptions of two new species (Acari, Tetranychidae). Ann. Entomol. Soc. Amer., 97: 635-646. doi:10.1093/ae/sao116

Saito Y., Sahara K. 1999. Two clinal trends in male-to-male aggressiveness in a subsocial spider mite. Behav. Ecol. Sociobiol., 46: 25-29. doi:10.1007/s002650050588

Saito Y., Sakagami T., Sahara K. 2002. Differences in diapause attributes between two clinal forms distinguished by male-to-male aggression in a subsocial spider mite, Schizotetranychus miscanthi. Ecol. Res., 17: 645-653. doi:10.1046/j.1440-1703.2002.00522.x

Saito Y., Osakabe Mh., Sakagami Y., Yasui Y. 1993. A method for preparing permanent specimens of mites with Canada balsam. Appl. Entomol. Zool., 28: 593-597. doi:10.1303/aez.28.593

Saito Y., Zhang Y.-X., Mori K., Ito K., Saito Y., Chittenden A.R., Lin J.-Z., Chae Y., Sakagami T., Sahara K. 2016. Variation in nesting behavior of eight species of spider mites, Stigmaeopsis having sociality. Syst. Entomol., 103: 87. doi:10.1111/sent.12408

Sakagami T., Saito Y., Kongchhuen M., Sahara K. 2009. Molecular phylogeny of Stigmaeopsis, with special reference to speciation through host plant shift. Ann. Entomol. Soc. Amer., 102: 360-366. doi:10.1603/0016-476X-102.0303

Sakamoto H., Matsuda T., Suzuki R., Saito Y., Lin J.-Z., Zhang Y.-X., Saito Y., Gotot H. 2017. Molecular identification of seven species of the genus Stigmaeopsis (Acari: Tetranychidae) and preliminary attempts to establish their phylogenetic relationships. Syst. Appl. Acarol., 22: 91-101. doi:10.11158/saas.22.1.10

Saito Y., Breeuwer J.A.J., Egas M., Sabelis M.W. 2015. Incomplete premating and postmating reproductive barriers between two parapatric populations of a social spider mite. Exp. Appl. Acarol., 65: 277-291. doi:10.1007/s10493-015-9878-3

Saito Y., Egas M., Sabelis M.W., Mochizuki A. 2013a. Male-male aggression peaks at intermediate relatedness in a social spider mite. Ecology and Evolution, 3: 2661-2669. doi:10.1002/ece3.661

Saito Y., Sabelis M.W., Mochizuki A. 2013b. Asymmetry in male lethal fight between parapatric forms of a social spider mite. Exp. Appl. Acarol., 60: 451-461. doi:10.1007/s10493-013-9668-8

Saito Y., Saito Y., Chittenden A.R. 2008. The parapatric distribution and contact zone of two forms showing different male-to-male aggressiveness in a social spider mite, Stigmaeopsis miscanthi (Acari: Tetranychidae). Exp. Appl. Acarol., 44: 265-276. doi:10.1007/s10493-008-9147-9

Saito Y., Saito Y., Mori K. 2000a. Patterns of reproductive isolation between populations showing different aggression in a subsocial spider mite, Schizotetranychus miscanthi Saito (Tetranychidae: Acarina). Exp. Appl. Zool., 35: 605-610. doi:10.1303/aez.2000.605

Saito Y., Saito Y., Mori K. 2000b. Patterns of reproductive isolation between two groups of Schizotetranychus miscanthi Saito (Tetranychidae: Acarina) showing different male aggression traits. Appl. Ent. Zool., 35: 611-618. doi:10.1303/aez.2000.611
Tsuji N., Chittenden A.R., Ogawa T., Takada T., Zhang Y.-X., Saito Y. 2011. The possibility of sustainable pest management by introducing bio-diversity: simulations of pest mite outbreak and regulation. Sustain Sci., 6: 97-107. doi:10.1007/s11625-010-0113-1

Trägårdh I. 1915. Bidrag till Kännedomen om Spinnkvalstren (Tetranychus Duf.). Meddelande Nr. 109 från Centralanstalten för försöksväsendet på Jordbruksomradet, 109 (Entomol. Avd. 20): 1-60.

Wainstein B.A. 1956. Material on the fauna of tetranychid mites of Kazakhstan. Tr. Resp. St. Zashch. Rast. KaziiBial Vaskhvil, 3: 70-83.

Yano J., Saito Y., Chittenden A.R., Sato Y. 2011. Variation in counterattack success against a phytoseiid predator between two forms of the social spider mite Stigmaeopsis miscanthi. J. Ethol., 29:337-342 doi:10.1007/s10164-010-0265-6

Zhang Z.-Q., Zhang Y.-X., Lin J.-Z. 2000. Mites of Schizotetranychus (Acari: Tetranychidae) from moso bamboo in Fujian, China. Syst. Appl. Acarol. Spec. Pub., 4: 19-35. doi:10.11158/sasp4.1.5