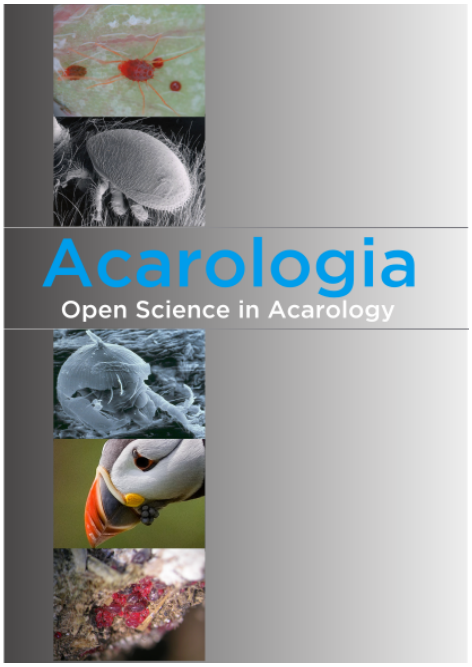

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Description of two new species of *Stigmaeopsis*, Banks 1917 (Acari, Tetranychidae) inhabiting *Miscanthus* grasses (Poaceae)

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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 *et* Sato **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 *et* Lin **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 *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, *i.e.* *Stigmaeopsis malkovskii* (Wainstein 1956) and *Stigmaeopsis meghalayensis* (Gupta and Gupta 1994). Furthermore, Saito *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 *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 *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

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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 J64 (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 (*c*1-3, *d*1-2, *e*1-2, *f*1-2, *h*1-3; *n.b.* setae *h*1 are present, *h*3 placed ventrally); setae *c*1 widely spaced, in sublateral position close to setae *c*2 and *c*3; dorsal body setae slender with fine splits, length variable; opisthonotum with distinctive region of dorsocentral longitudinal striae between setae *c*1-*c*1 and *d*1-*d*1; two pairs of genital setae (*g*1-2); two pairs of pseudanal setae (*ps*1-2); 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 aggresiveness 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 *v*2 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 *sc*1, 10% shorter than distance between their bases (Fig. 1, Table 1), and shorter than distance between bases of *sc*1 and *c*3. Bases of all dorsocentral hysterosomal setae (*c*1, *d*1, *e*1, *f*1) placed approximately in a straight line and the pair of lines forms a V shape. Length of dorsocentral hysterosomal setae *d*1 subequal with distance between their bases, just reaching bases of *f*1. Distance between bases of dorsolateral hysterosomal setae *c*2 longer than distance between bases of dorsolateral hysterosomal setae *d*2. Hysterosomal setae *h*3 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 sensilum), 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 *v*2 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 *sc*1 shorter than distance between *sc*1 and *c*3 bases in *S. sabelisi*, but longer than that in *S. miscanthi;* The length of dorsocentral hysterodosomal setae *d*1 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								
v 2	47.6	2.5	84.7	2.1	37.4	2.2	62.6	3.4
sc 1	106.5	9.0	122.7	4.9	79.1	5.4	87.9	4.3
sc 2	61.6	2.7	211.5	7.4	43.5	4.1	152.1	6.5
c 1	46.8	2.4	146.4	4.8	37.7	2.0	113.2	7.3
c 2	47.9	4.6	199.7	6.8	39.3	2.7	151.7	8.4
c 3	85.1	9.4	239.2	15.2	53.7	5.9	176.6	9.1
d 1	99.7	7.2	98.0	5.2	70.4	5.5	70.9	4.4
d 2	52.3	1.9	174.8	4.0	41.4	2.9	134.6	5.6
e 1	67.5	5.3	65.7	3.6	45.7	2.9	43.0	2.5
e 2	50.9	3.2	144.0	7.6	42.8	3.6	96.7	2.8
f 1	51.3	3.6	38.0	4.4	37.7	2.4	22.3	2.9
f 2	51.4	2.6	84.0	7.3	41.5	4.3	61.4	3.4
h 1	55.3	3.9	24.0	3.2	37.2	3.1	18.6	2.4
h 2	39.8	3.8	34.9	5.7	28.2	3.7	22.7	3.5
h 3	35.3	3.2	-	-	28.5	5.0	-	-
S. continentalis								
v 2	49.3	4.8	85.2	3.6	45.5	4.5	71.6	1.7
sc 1	125.1	4.4	130.9	3.9	92.0	4.7	102.4	1.8
sc 2	61.9	4.1	214.7	11.5	47.7	3.1	171.0	10.0
c 1	52.2	3.1	148.3	6.2	46.0	3.1	130.8	6.3
c 2	54.5	3.3	194.1	7.1	45.6	3.0	171.9	4.0
c 3	77.7	5.4	228.3	12.9	58.4	4.8	211.2	8.5
d 1	119.5	4.7	96.9	4.0	82.5	7.6	81.2	3.8
d 2	59.3	4.2	188.4	5.6	49.9	3.8	168.4	7.4
e 1	70.3	7.0	68.2	2.2	56.8	6.2	49.3	3.1
e 2	58.1	3.9	150.1	7.8	48.0	2.8	114.5	4.9
f 1	49.5	2.4	31.7	4.8	43.5	3.3	24.5	1.6
f 2	57.8	4.3	98.3	6.8	45.3	2.3	67.0	1.4
h 1	59.9	3.5	24.9	2.4	40.5	2.1	25.1	1.9
h 2	40.5	3.2	32.8	2.8	27.2	2.6	27.6	2.0
h 3	34.0	2.4	-	-	23.1	2.7	-	-
*S. miscanthi**								
v 2	58.0	1.6	83.3	3.8	44.2	4.0	61.8	3.8
sc 1	125.6	5.0	133.7	5.8	92.5	3.3	92.5	3.3
sc 2	62.6	2.0	227.0	13.4	48.7	3.3	168.4	9.1
c 1	53.6	6.3	179.2	20.6	42.9	4.1	146.2	13.0
c 2	60.6	3.0	222.2	14.8	45.0	2.4	183.9	11.2
c 3	89.9	7.9	243.2	17.2	58.3	4.8	195.9	9.2
d 1	117.9	3.9	100.7	4.9	81.6	3.7	84.1	4.5
d 2	64.0	3.6	193.3	14.1	46.3	5.2	160.9	8.9
e 1	83.2	9.7	74.8	5.2	47.4	4.8	55.7	4.3
e 2	61.4	3.9	163.0	14.4	44.3	3.5	122.2	6.4
f 1	49.2	4.0	44.2	4.1	36.7	3.4	28.8	3.8
f 2	58.2	2.9	88.7	12.2	33.8	2.7	71.6	4.6
h 1	57.3	3.0	28.9	3.3	31.5	2.3	29.1	2.1
h 2	37.8	3.3	30.4	2.2	25.3	3.5	29.1	2.7
h 3	30.0	3.0	-	-	21.4	2.7	-	-

* referred from Saito (1990); h3, located ventrally; -, difficult to measure.

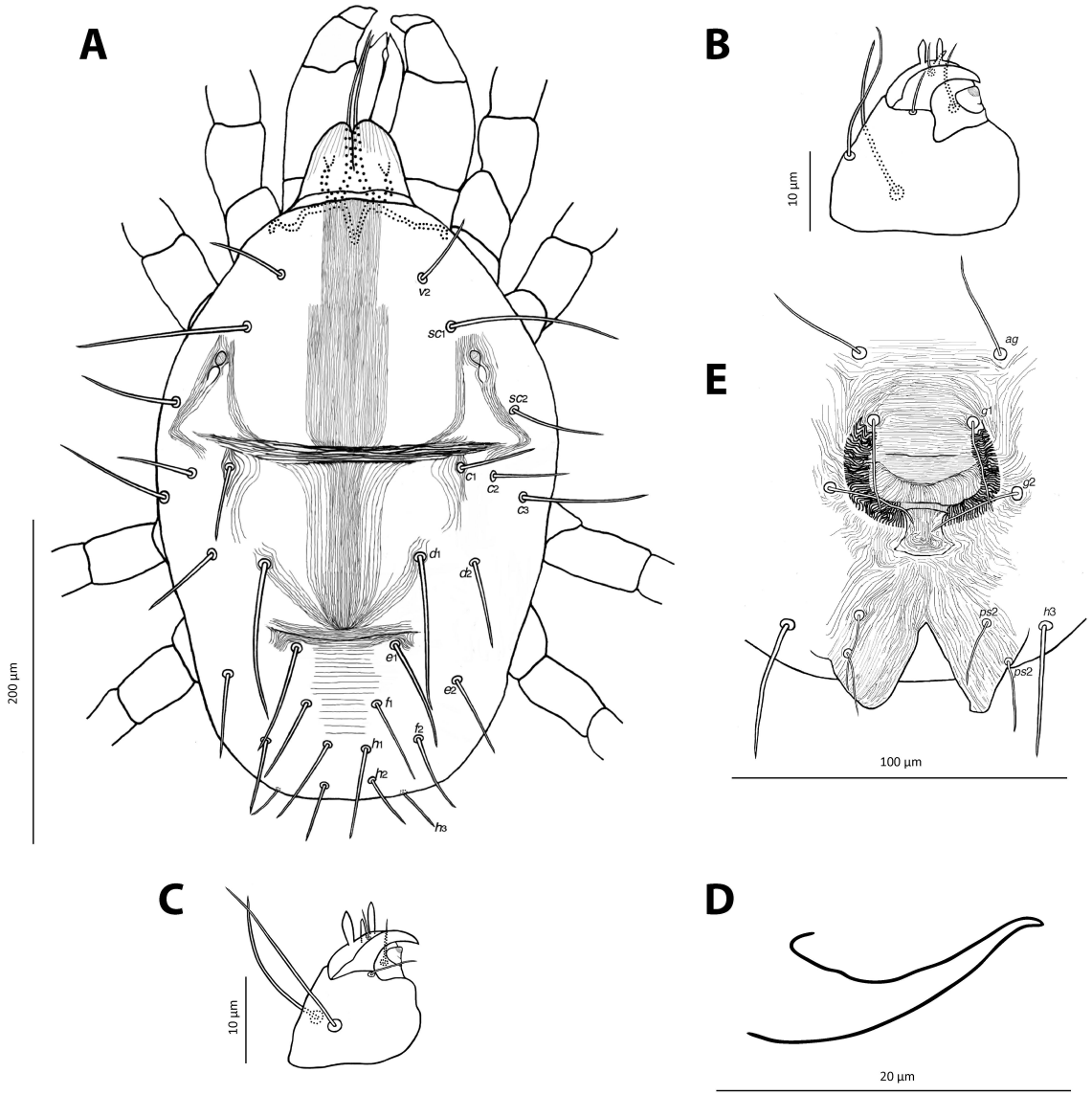

Figure 1 *Stigmaeopsis sabelisi* **n. sp.**: A – Dorsum of female; B – Distal segment of palpus of female; C – Distal segment of palpus of male; D – Aedeagus; E – Female genital flap and anterogenital area.

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

	*c*1 - *d*1	*c*1 - *e*1	*c*1 - *f*1	*c*1 - *h*1	*d*1 - *e*1	*d*1 - *f*1	*d*1 - *h*1	*e*1 - *f*1	*e*1 - *h*1	*f*1 - *h*1
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.

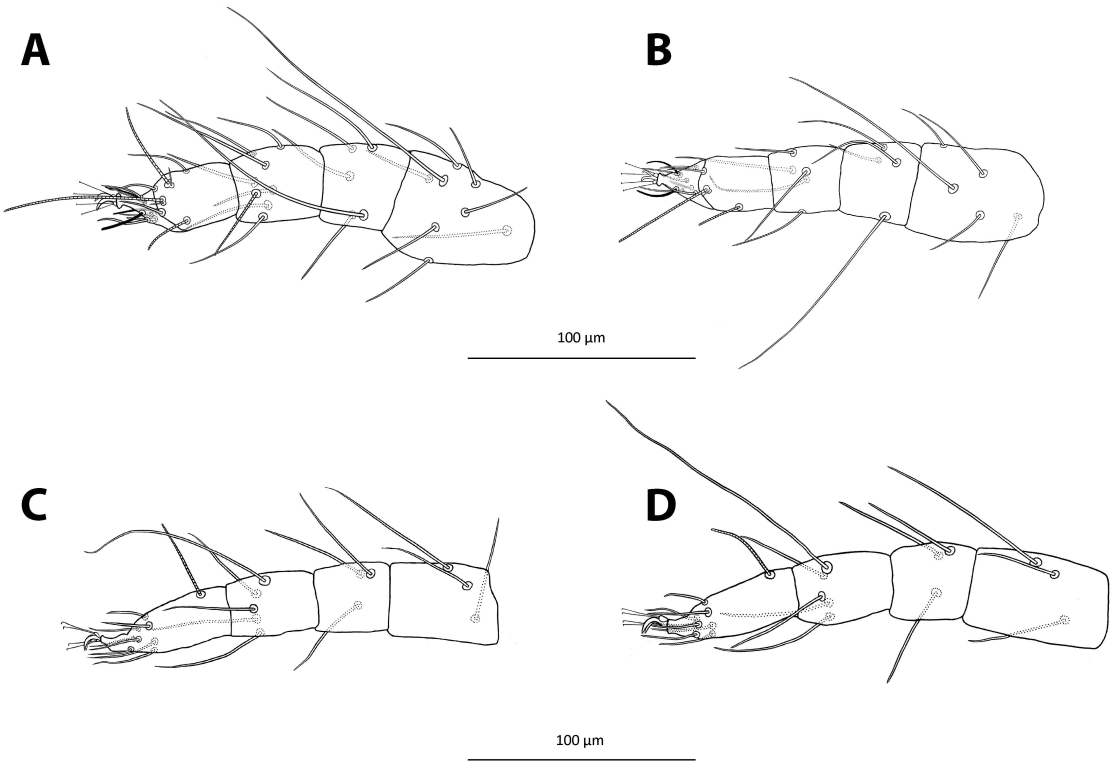

Figure 2 *Stigmaeopsis sabelisi* **n. sp.**: A – Femur, genu, tibia and tarsus I of female; B – Femur, genu, tibia and tarsus II of female; C – Femur, genu, tibia and tarsus III of female; D – Femur, genu, tibia and tarsus IV of female.

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

	Female				Male			
	Leg I	Leg II	Leg III	Leg IV	Leg I	Leg II	Leg III	Leg IV
S. sabelisi								
Femora	8t	5t*	3t	3t	9t<1dr>	5t*	3t*	3t*
Genua	5t	4t	3t	2t	5t*	4t	3t	2t
Tibiae	7t+1s	5t	5t	5t	7t<1dr>+2s	5t*	5t*	5t*
Tarsi	8t*+3e+1s+2d	6t*+3e+1s+1d	8t*+1s	8t*+1s	7t*+3e+1s+2d	7t*+3e+1s+1d	8t*+1s	8t*+1s
S. continentalis								
Femora	8t	5t	3t	3t	9t<1dr>	5t	3t	3t
Genua	5t	4t	3t	2t	5t	4t	3t	2~3t
Tibiae	7t+1s	5t	5t	5t	7t<1dr>+2s	5t	5t	5t
Tarsi	7t*+3e+1s+2d	7t*+3e+1s+1d	8t*+1s	8t*+1s	7t*+3e+1s+2d	7t*+3e+1s+1d	8t*+1s	8t*+1s
*S. miscanthi***								
Femora	8t	5t	3t	3t	9t (9t<1dr>)	5t	3t	3t
Genua	5t	4t	3t	2t	5t	4t	3t	2t
Tibiae	7t+1~2s	5t	5t	5t	7t+2s	5t	5t	5t
Tarsi	10^{***}+1s+2d (7t+3e+1s+2d)	9^{***}+1s+1d (6t+3e+1s+1d)	8t+1s	8t+1s	10***+1s+2d (7t+3e+1s+2d)	9***+1s+1d (6t+3e+1s+1d)	8t+1s	8+1s

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).

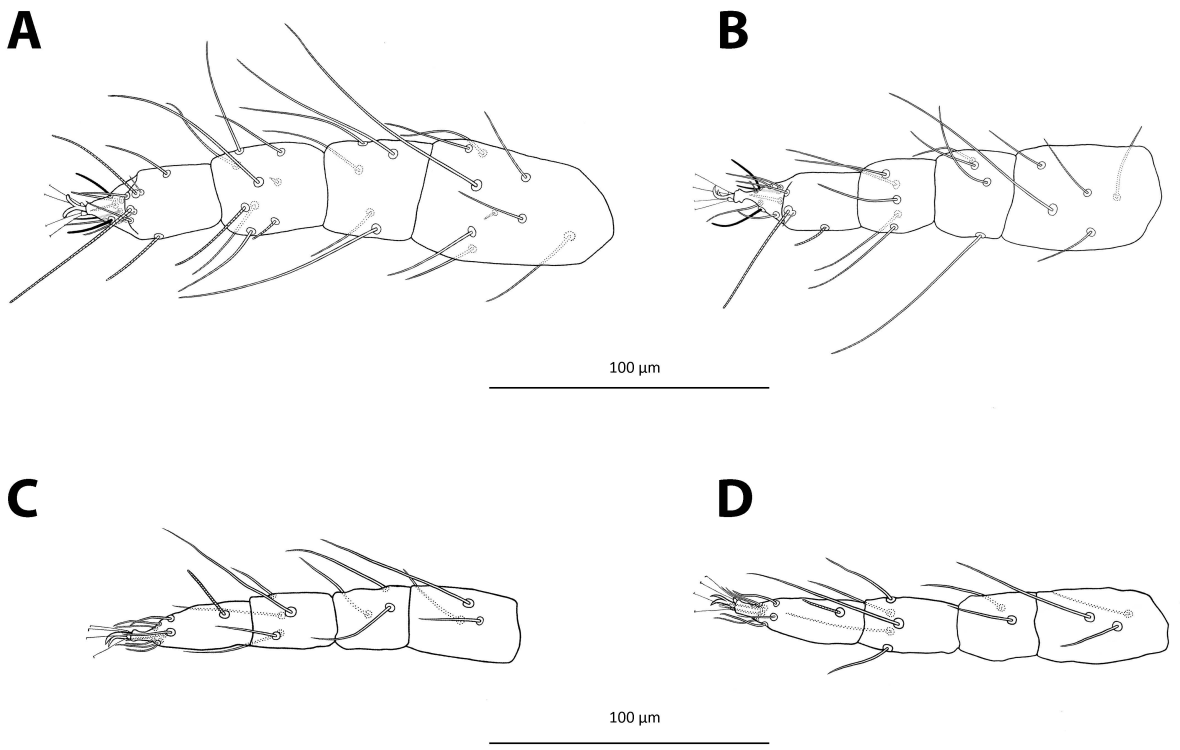

Figure 3 *Stigmaeopsis sabelisi* **n. sp.**: A – Femur, genu, tibia and tarsus I of male; B – Femur, genu, tibia and tarsus II of male; C – Femur, genu, tibia and tarsus III of male; D – Femur, genu, tibia and tarsus IV of male.

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 327.3.1 ± 15.0 µm from middle of horizontal line connecting setae *v*2 bases to end of hysterosoma. Propodosoma well demarcated from hysterosoma. Bases of all dorsocentral hysterosomal setae (*c*1, *d*1, *e*1 and *f*1) placed approximately in a straight line and the pair of lines forms a V shape. Length of dorsocentral hysterosomal setae *d*1 much longer than distance between their bases and exceed bases of *f*1. Distance between bases of dorsolateral hysterosomal setae *c*2 subequal to distance between bases of dorsolateral hysterosomal setae *d*2. Hysterosomal setae *h*3 (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.

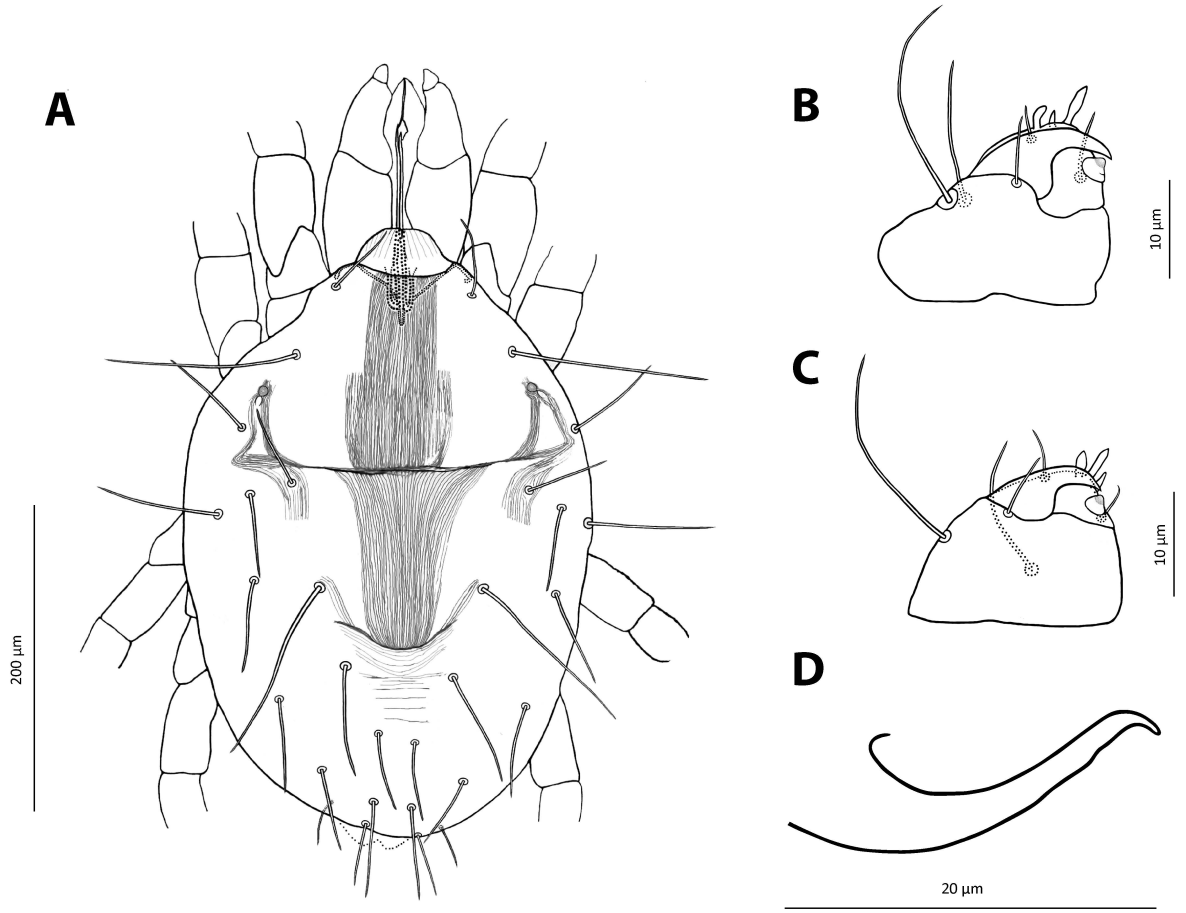

Figure 4 *Stigmaeopsis continentalis* **n. sp.**: A – Dorsum of female; B – Distal segment of palpus of female; C – Distal segment of palpus of male; D – Aedeagus.

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 *v*2 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),

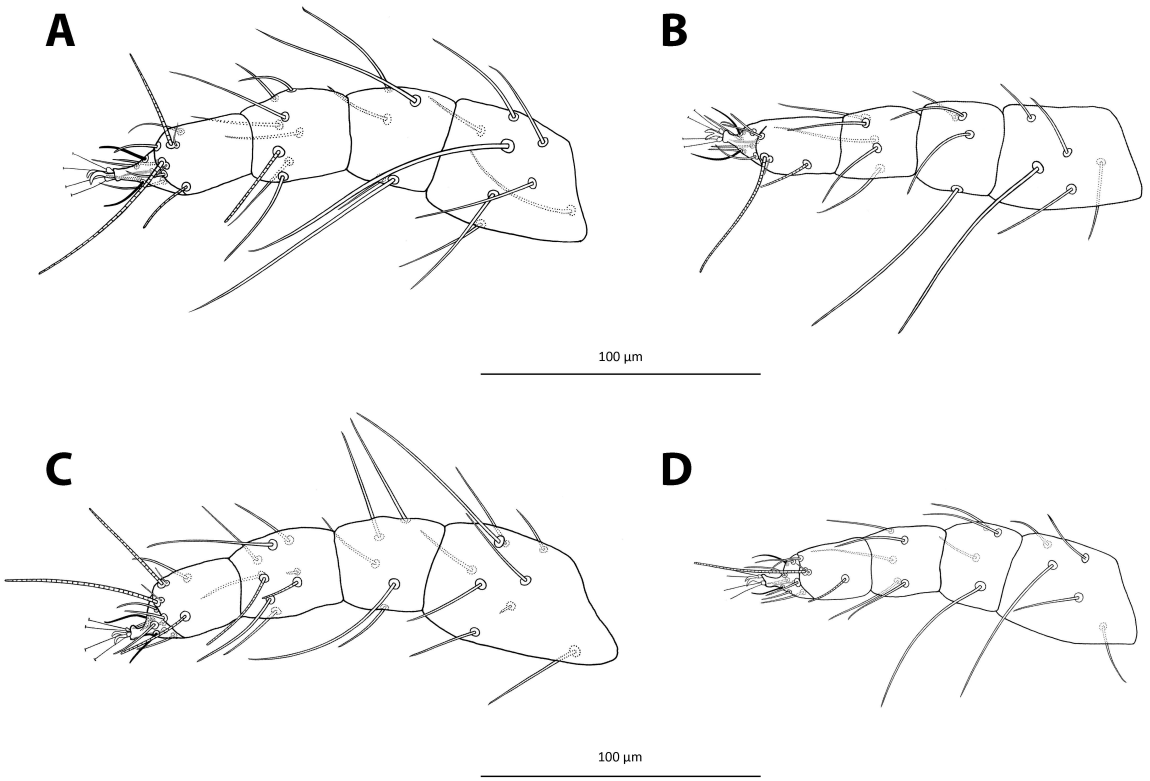

Figure 5 *Stigmaeopsis continentalis* **n. sp.**: A – Femur, genu, tibia and tarsus I of female; B – Femur, genu, tibia and tarsus II of female; C – Femur, genu, tibia and tarsus I of male; D – Femur, genu, tibia and tarsus II of male.

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 *c*2 almost the same as that between the bases of dorsolateral hysterosomal setae *d*2 in *S. continentalis*, but the distance between the bases of *c*2 is longer than that between the bases of *d*2 in both *S. sabelisi* and *S. miscanthi;* in both *S. continentalis* and *S. miscanthi*, length of dorsocentral hysterosomal setae *d*1 are much longer than distance between their bases and extend past the bases of *f*1, but setae *d*1 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 *d*1 shorter than (or similar to) distance between bases of *d*1 setae members 2
— Length of setae *d*1 longer than distance between bases of *d*1setae members 8

2. Length of setae *d*1 shorter than (or similar to) distance between bases of *d*1 and *e*1 setae 3
— Length of setae *d*1 longer than distance between bases of *d*1 and *e*1 setae 5

3. Length of setae *d*2 longer than distance between bases of *d*1 and *d*2 setae . . . . . *Stigmaeopsis tegmentalis* Saito *et* Lin
— Length of seta *d*2 shorter than distance between bases of *d*1 and *d*2 setae 4

4. Length of setae *e*1 similar to distance between bases of *e*1 *and f* 1 setae . . . . . *Stigmaeopsis saharai* Saito *et* Mori
— Length of setae *e*1 much longer than distance between bases of *e*1 *and f* 1 setae . . . . . *Stigmaeopsis temporalis* Saito *et* Ito

5. Length of seta *e*1 similar to distance between bases of *e*1 and *e*2 setae . . . . . *Stigmaeopsis takahashii* Saito *et* Mori
— Length of seta *e*1 longer than distance between bases of *e*1 and *e*2 setae 6

6. Length of setae *d*1 similar to distance between bases of *d*1 and *f* 1 setae . . . . . *S. sabelisi** **n. sp.** Saito *et* Sato
— Length of setae *d*1 shorter than distance between bases of *d*1 and *f* 1 setae 7

7. Length of setae *d*1 shorter than distance between bases of *d*1 and *e*2 setae . . . . . *Stigmaeopsis tenuinidus* (Zhang *et* Zhang)
— Length of setae *d*1 longer than distance between bases of *d*1 and *e*2 setae . . . . . *Stigmaeopsis malkovskii** (Wainstein)

8. Distance between bases of *e*1 setae similar to that between bases of *d*1 setae . . . . . *Stigmaeopsis nanjingensis* (Ma *et* Yuan)
— Distance between bases of *e*1 setae shorter than that between bases of *d*1 setae 9

9. Length of setae *d*1 shorter than (or similar to) distance between bases of *d*1 and *f* 2 setae 10
— Length of setae *d*1 longer than distance between bases of *d*1 and *f* 2 setae 12

10. Distance between bases of *c*2 setae similar to that between bases of *d*2 setae 11
— Distance between bases of *c*2 longer than that between bases of *d*2 setae . . . . . *Stigmaeopsis miscanthi**(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.

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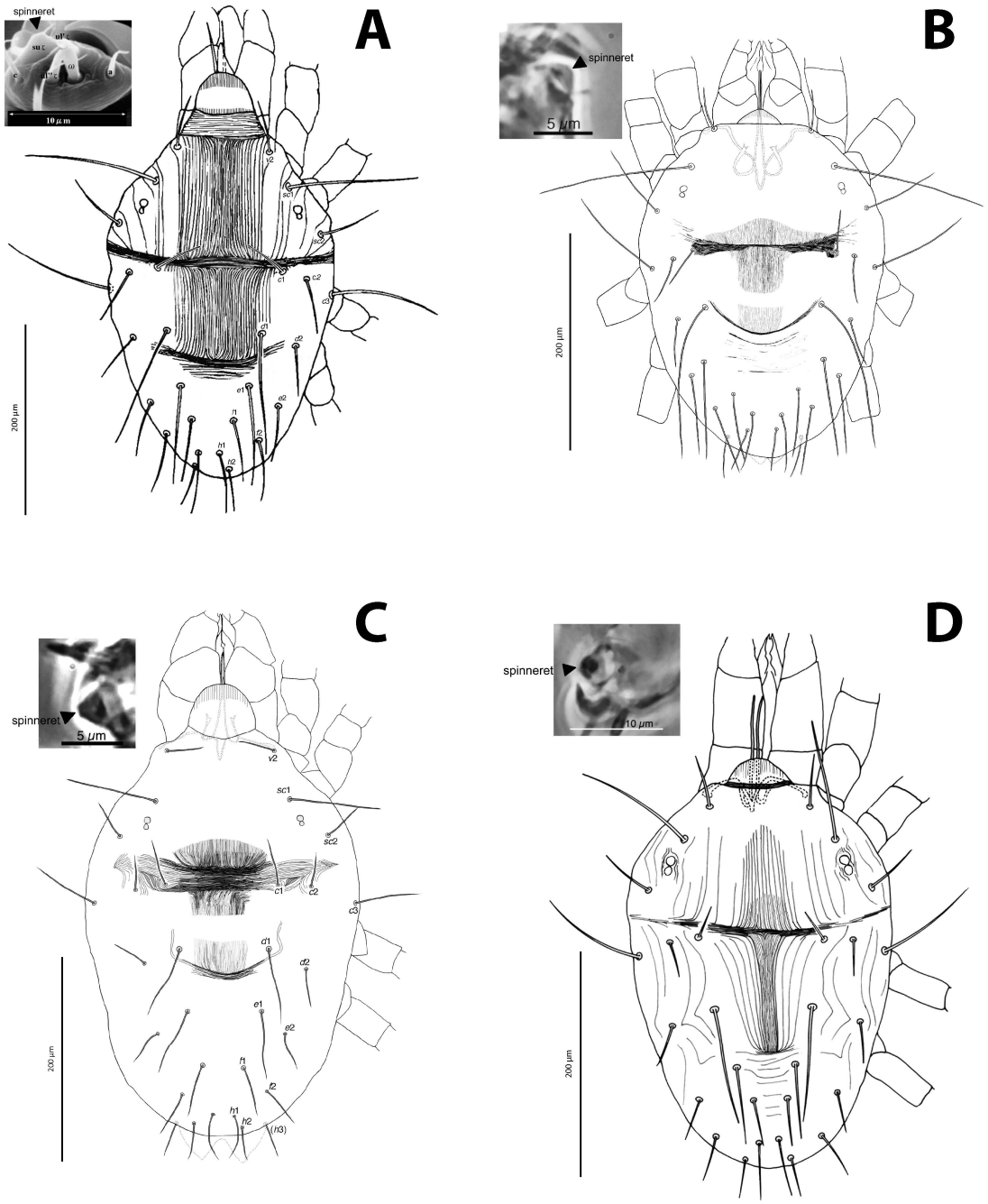

Figure 6 A – *Stigmaeopsis longus* (Saito), from Saito (1990) with some modification. Hysterosomal seta *h*3 was omitted; B – *Stigmaeopsis nanjingensis* (Ma *et* Yuan). New drawing by Y. Saito (specimen collected on June 20, 2014 in Fuzhou, China); C – *Stigmaeopsis tenuinidus* (Zhang *et* Zhang). New 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.

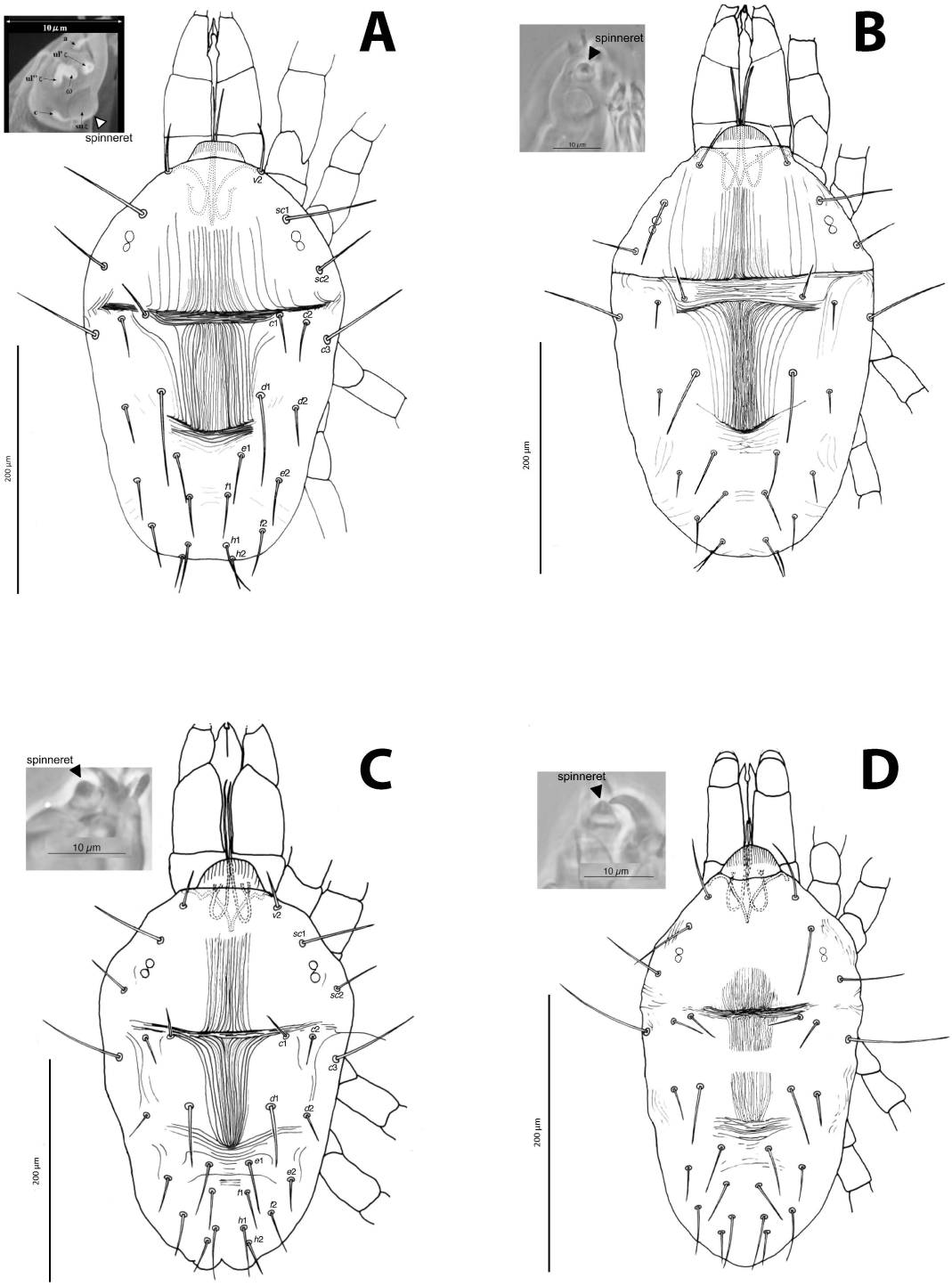

Figure 7 A – *Stigmaeopsis takahashii* Saito *et* Mori, from Saito *et al.* (2004) with some modification. Hysterosomal seta *h*3 was omitted; B – *Stigmaeopsis saharai* Saito *et* Mori, from Saito *et al.* (2004) with some modification. Hysterosomal seta *h*3 was omitted; C – *Stigmaeopsis temporalis* Saito *et* Ito, from Saito *et al.* (2016) with some modification. Hysterosomal seta *h*3 was omitted; D – *Stigmaeopsis tegmentalis* Saito *et* Lin, from Saito *et al.* (2016) with some modification. Hysterosomal seta *h*3 was omitted.

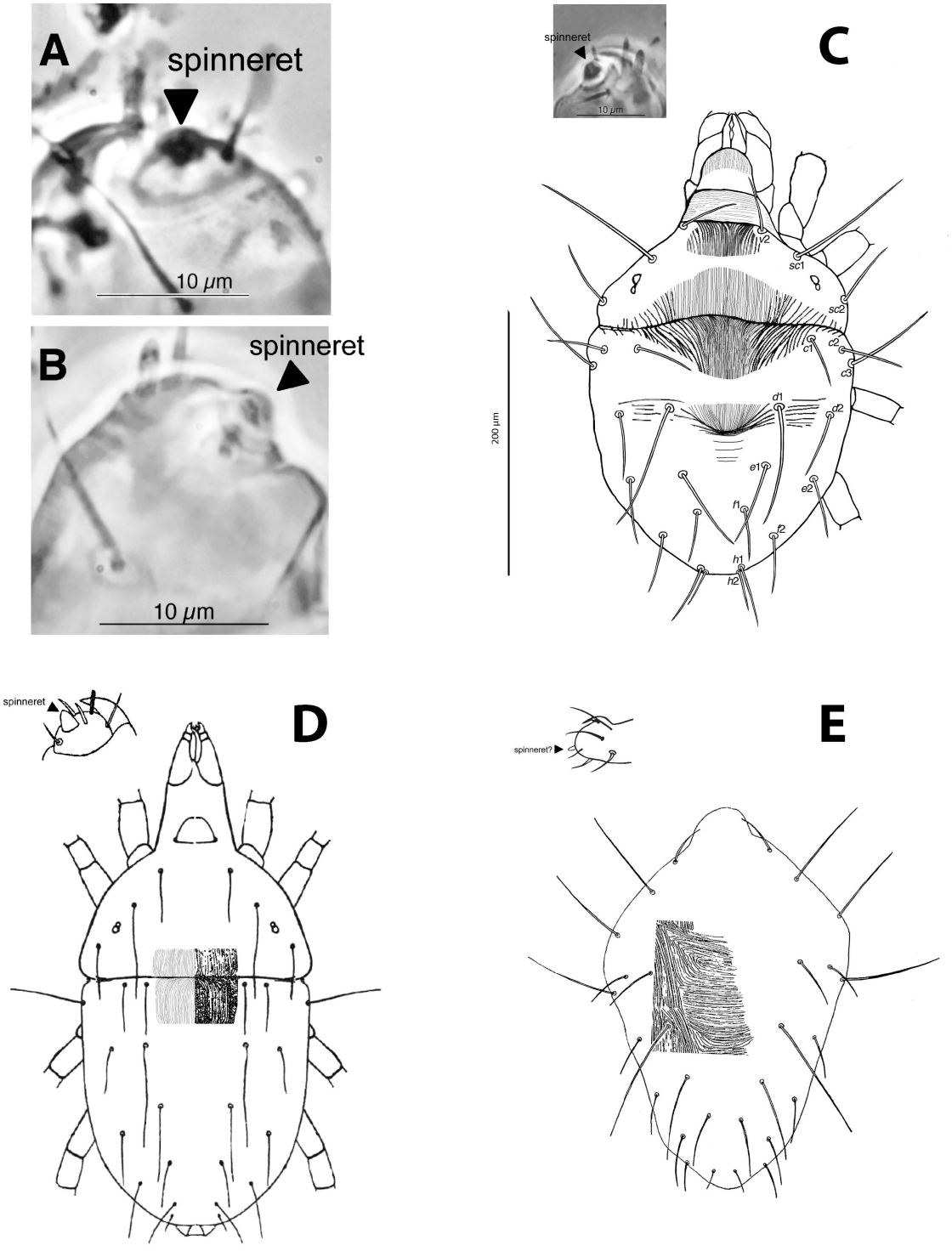

Figure 8 A – Conical spinneret of *Stigmaeopsis continentalis* Saito *et* Lin (dorsal view of this species appears in Figure 4A); B – Conical spinneret of *Stigmaeopsis sabelisi* Saito *et* Sato (Dorsal view of this species appears in Figure 1A); C – *Stigmaeopsis miscanthi* (Saito), from Saito (1990) 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.

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