[SHORT COMMUNICATION]

Occurrence of *Amblyseius andersoni* (Chant) (Acari: Phytoseiidae) in deciduous fruit tree orchards in Japan

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INTRODUCTION

Basic surveys of phytoseiid mites have been conducted in orchards and surrounding natural vegetation for more than 30 years in Japan. Species composition and seasonal dynamics of native phytoseiid mites in orchards have been increasingly clarified, but their species diversity is not fully understood. Recently, *Amblyseius andersoni* (Chant) was collected, as the first record in Japan, during a survey in apple (*Malus domestica* Borkh.) and apricot (*Prunus armeniaca* L.) orchards in Nagano Prefecture. Thus, the evidence of identification was provided, and the discrimination of *A. andersoni* from species of the genus *Amblyseius* in Japan was described.

MATERIALS AND METHODS

A periodic survey for phytoseiid mites was conducted in 12 apple and 3 apricot commercial orchards in Nagano Prefecture, central Japan; 1874 and 1338 adult female phytoseiid mites were collected in 2014 and 2015, respectively. The specimens were mounted in Hoyer's medium (Krantz, 1978) and identified using a phase-contrast and differential interference-contrast BX53 microscope system (Olympus Corp.). Micrographs and measurements were obtained using a DP27 digital camera with microscope (Olympus Corp.) and cellSens™ imaging software (Olympus Corp.). The setal nomenclature used in the present study was according to Rowell et al. (1978) for the dorsal surface and Chant and Yoshida-Shaul (1991) for the ventral surface of

日本の落葉果樹園に発生したアンダソニカブリダニ

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the idiosoma.

RESULTS AND DISCUSSION

Amblyseius andersoni (Chant), 1957

Typhlodromus (Amblyseius) andersoni Chant, 1957: p. 296, Figs. 17 and 18.

Amblyseius andersoni: Athias-Henriot, 1958, p. 33, Fig. 15B; Chant and Hansell, 1971, p. 715, Figs. 76–80, 229; Chant and Yoshida-Shaul, 1990, pp. 7–10, Figs. 3–9.

Material Examined

A specimen of an unidentifiable adult female was initially collected in an apple orchard on 4 August 2014. Subsequently, 26 females were collected in five apple orchards and one apricot orchard between 7 August and 10 September 2014, and 37 females were collected between 28 July and 29 September 2015. Among the unidentifiable females, 11 specimens were selected for further examination. No male specimen was found, but spermathecae inflated by spermatophores were observed in six female specimens. All materials were collected by MK, one of the authors. Voucher specimens used in the present study were deposited in the National Agriculture and Food Research Organization (Hokkaido Agricultural Research Center, Toyohira, Sapporo, Hokkaido).

Morphological Features

The specimens showed characteristic features of the genus *Amblyseius* as described in Chant and McMurtry (2004), including long setae s4, Z4 and Z5 and short setae z2, z4, Z1, S2, S4, S5, and dorsocentral setae on the dorsal shield; smooth surface of dorsal and ventrianal shields; and 3 macrosetae on leg IV (Fig. 1). Specimens were identified as the *obtusum* species group in the genus by the shape of the ventrianal shield (pentagonal), and as the *andersoni* species subgroup by the shape of the spermatheca (cup- or bell-shaped calyx) (Chant and McMurtry, 2004) (Table 1).

Among 113 species in the *andersoni* species subgroup (Chant and McMurtry, 2004), specimens were identified as *A. andersoni* by the length of s4, Z4 and Z5 setae on the dorsal shield, and the shape of the spermatheca. Measurements of the shields and setae of the present specimens, *A. andersoni* (original description and redescription) and junior synonyms of *A. andersoni* (*A. britannicus*, *A. reflexus*, *A. potentillae*, and *A. meghriensis*; their synonymy was reviewed in Chant and Yoshida-Shaul [1990]), are shown in Table 2. The table also shows measurements of *A. andersoni* specimens in the private collection of HA (one of the authors), collected in Toronto, Canada, in 1974. Although measurements taken in the present study were smaller than those reported in the original description and obtained from privately held specimens, the ratio of each setal length to dorsal shield length was similar. The dorsal and ventral surfaces, chelicera, macrosetae on leg IV, and spermatheca of the specimens in the present study are shown in Fig. 1.

Fig. 1. Morphological features of Japanese specimens of *Amblyseius andersoni* (Chant): (A) dorsal surface (micrograph and drawing), (B) ventral surface (micrograph and drawing), (C) macrosetae on leg IV, (D) chelicera, and (E) spermatheca.

Table 1. Discrimination of *andersoni* species subgroup from species in the genus *Amblyseius* in Japan, based on the review of the subfamily Amblyseinae by Chant and McMurtry (2004)

Step	Morphological key and comparison	Species and steps
1.	Female ventrinal shield vase-shaped or divided into separate ventral and anal shields, wider at level of anus than at level of setae ZV2.	<i>eharai</i> , <i>ezoensis</i> , <i>kokufuensis</i>
--.	Female ventrinal shield not vase-shaped or divided into separate ventral and anal shields, not wider at the level of anus than at level of setae ZV2.	2
2.	Spermatheca with calyx having annulated stalk, flaring distally.	<i>obtuserellus</i>
--.	Spermatheca without calyx annulated.	3
3.	Spermatheca with calyx swollen basally, bladder-like, then narrowing and finally flaring distally.	<i>firmus</i> , <i>orientalis</i>
--.	Spermatheca with calyx not swollen basally.	4
4.	Spermatheca with length/width of calyx at mid-point $> 3.4 : 1.0$.	<i>indocalami</i> , <i>neofirmus</i> , <i>tamatavensis</i>
--.	Spermatheca with calyx dish-, cup-, bell- or V-shaped, ratio length/width at mid-point of calyx $< 3.0 : 1.0$.	<i>andersoni</i> species subgroup

Diagnosis

Among five known Japanese domestic species belonging to the *andersoni* species subgroup, *A. ishizuchiensis*, *A. kaguya*, and *A. shiganus* had longer Z4 and Z5 setae than did *A. andersoni* (Table 2). Z4 was shorter than s4 in our specimens and in the original description of *A. andersoni* (Chant, 1959). Z4 was longer than s4 in *A. ishizuchiensis*, *A. kaguya*, *A. shiganus*, and *A. rademacheri*. Z4 and Z5 of *A. tsugawai* were shorter than those of *A. andersoni*. Spermathecae of *A. rademacheri* and *A. tsugawai* had V-shaped cervixes and differed from the cup-shaped spermathecae of *A. andersoni* (Table 3).

Remarks

In North American, European, and Arabian countries, *A. andersoni* is the dominant phytoseiid species in apple and citrus orchards (Barbar, 2014; Tixier et al., 2014), and an effective biocontrol agent in orchards (Lorenzon et al., 2012; Szabó and Péntzes, 2013). In Japan, however, *Typhlodromus vulgaris*, *Amblyseius orientalis*, *Neoseiulus californicus*, and *N. womersleyi* were reported to be the dominant species in apple, pear, and citrus orchards (Kishimoto, 2002; Toyoshima 2003; Katayama et al., 2006). Results of the present study support the conducting of a future survey of *A. andersoni* in apple, pear, and citrus orchards.

In the present study, the lengths of dorsal and ventral shields, and those of setae on the dorsal shield and leg IV, were compared with those of 93 species in the *andersoni* species subgroup listed in Chant and McMurtry (2004). Unfortunately, information for 20 species (*altiplanumi*, *apocynae*, *araraticus*, *blosis*, *brevicervix*, *bryophilus*, *carnis*, *crassicaudalis*, *daliensis*, *filicinae*, *humilis*, *igarassuensis*, *longimediis*, *neopascalis*, *patrius*, *pseudoequipilus*, *similicaudatus*, *subhainanensis*, *wangi*, and *wui*) of the subgroup was not available for the present study.

Table 2. Shield and setal measurements of *Amblyseius andersoni*, its junior synonyms and morphological related species.

	<i>A. andersoni</i>		<i>A. britannicus</i>		<i>A. reflexus</i>		<i>A. potentillae</i>		<i>A. meghrensis</i>		<i>A. ishizuchiensis</i>		<i>A. kagiva</i>		<i>A. shiganus</i>		<i>A. rademacheri</i>		<i>A. tsugovai</i>		
	Present study (mean, min - max) (µm)	Chant, 1957 (µm)	Chant & Yoshida-Shauli, 1990 (µm)	private collection of IIA (mean, min - max) (µm)	(µm)	Chant, 1959 (µm)	Krisley & Denmark, 1978 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)	Denmark & Muma, 1989 (µm)
	n=11	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	n=10	
	type ²																				
Dorsal shield	Length	342, 318-363	356-376	375, 365-382	343	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361
	W at waist	209, 196-219	210-222	218, 207-226	186	188	188	196	196	264	264	300	300	224	224	224	224	224	224	224	224
	W at S2	227, 218-239	234-253	236, 226-246																	
Sternal shield	Length	65, 62-72	65-68	73, 67-79																	
	width	79, 76-84	79-81	78, 73-82																	
Genital shield	Length	77, 70-85	80-92	77, 72-80																	
Ventralsal shield	Length	125, 116-132	122-140	132, 120-139	115																
Primary metapodal plate	W at ZV2	89, 80-96	92-102	95, 88-99	86																
	W at waist	80, 77-87	80-90	87, 83-92																	
	W at anus	90, 85-95	86-98	94, 88-98																	
Spermatheca	Length	21, 18-24	18-25	21, 20-24																	
	width	8, 6-9	5-5	8, 6-9																	
	length ¹⁾	16, 11-19		16, 11-22																	
Setae	j1 (D1)	27, 25-29	28-29	30, 28-34																	
	j3 (L1)	50, 33-56	48-56	54, 46-56	45	55	55	52	52	50	50	35	35	44	44	44	44	44	44	44	44
	j4 (D2)	7, 6-9	8-8	7, 6-9				9	9	10	10	6	6	5	5	5	5	5	5	5	5
	j5 (D3)	6, 4-9	6-7	7, 5-8				8	8	7.5	7.5	6	6	5	5	5	5	5	5	5	5
	j6 (D4)	8, 7-10	8-10	7, 4-8				11	11	12.5	12.5	9	9	5	5	5	5	5	5	5	5
	z2 (L2)	12, 9-16	15-15	12, 9-15				13	13	15	15	9	9	5	5	5	5	5	5	5	5
	z4 (L3)	17, 13-19	20-21	17, 14-20				21	21	15	15	6	6	5	5	5	5	5	5	5	5
	z5 (M1)	6, 4-7	6-6	6, 5-7				6	6	7.5	7.5	6	6	5	5	5	5	5	5	5	5
	s4 (L4)	78, 73-83	72-78	81, 75-83	70	79	79	75	75	75	75	149	149	78	78	78	78	78	78	78	78
	r3 (S1)	24, 22-26	21-27	25, 22-28				25	25	25	25	8	8	11	11	11	11	11	11	11	11
	j2 (D5)	8, 5-9	9-10	7, 6-8				8	8	10	10	9	9	10	10	10	10	10	10	10	10
	j5 (D6)	8, 7-10	10-10	9, 8-10				11	11	12.5	12.5	11	11	5	5	5	5	5	5	5	5
	z1 (L5)	9, 7-10	9-10	9, 7-9	7	19	19	11	11	12.5	12.5	178	178	104	104	104	104	104	104	104	104
	z4 (M2)	72, 62-76	70-79	77, 73-80	68	72	72	68	68	77.5	77.5	235	235	188	188	188	188	188	188	188	188
	z5 (L9)	144, 128-165	145-158	160, 145-169	145	133	133	134	134	150	150	9	9	5	5	5	5	5	5	5	5
	S2 (L6)	15, 12-17	20-23	20, 18-22	14	11	11	18	18	15	15	11	11	5	5	5	5	5	5	5	5
	S4 (L7)	9, 8-10	11-11	9, 7-12				11	11	10	10	11	11	5	5	5	5	5	5	5	5
	S5 (L8)	8, 7-9	9-10	9, 7-12				9	9	7.5	7.5	11	11	5	5	5	5	5	5	5	5
	R1 (S2)	13, 11-15	15-15	14, 12-16				16	16												
JV5 (VL1)	70, 64-79	70-75	77, 69-83	59																	
Macrosetae	Genu IV	63, 52-71	65-72	75, 69-80	71	71	71	70	70	65	65	139	139	99	99	99	99	99	99	99	99
	Tibia IV	51, 39-55	56-58	59, 53-62	55	55	55	55	55	55	55	87	87	63	63	63	63	63	63	63	63
	Basitarsus IV	67, 61-76	73-78	74, 68-80	66	66	66	75	75	75	75	57	57	50	50	50	50	50	50	50	50

1 : The length between the top (at the opening) and bottom (at the atrium) of calyx was measured.

2 : Measurements were based on the type specimen.

Table 3. Discrimination of *Amblyseius andersoni* from specie of the genus *Amblyseius* in Japan, based on the identification guide for Japanese domestic species (Ehara, 2009)

Step	Morphological key and comparison	Species and steps
1.	Ventrianal shield vase-shaped, with distinct waist.	<i>eharai</i> , <i>ezoensis</i> , <i>kokufuensis</i>
--.	Ventrianal shield triangular or pentagonal, with at most a slight waist.	2
2.	Ventrianal shield wider than long.	<i>ishizuchiensis</i> *
--.	Ventrianal shield longer than, or about as long as wide.	3
3.	Macroseta on tibia longer than, or about as long as that on basitarsus IV.	<i>firmus</i> , <i>kaguya</i> *, <i>neofirmus</i> , <i>orientalis</i> , <i>shiganus</i> *, <i>tamatavensis</i>
--.	Macroseta on tibia IV shorter than that on basitarsus IV.	4
4.	Ventrianal pores just behind posterior pair of preanal setae (JV2).	<i>indocalami</i>
--.	Ventrianal pores between and slightly caudal to posterior pair of preanal setae (JV2).	5
5.	Z5 slightly longer than Z4.	<i>rademacheri</i> *
--.	Z5 at least twice as long as Z4.	6
6.	Macroseta on tibia IV distinctly shorter than that on genu IV.	<i>obtuserellus</i>
--.	Macroseta on tibia IV slightly shorter than that on genu IV.	7
7.	Z5 about as long as half of width of dorsal shield.	<i>tsugawai</i> *
--.	Z5 longer than half of width of dorsal shield.	<i>andersoni</i> *

Species with * belong to the *andersoni* species subgroup.

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