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Scientific Note

First report of *Amblyseius tamatavensis* Blommers, 1974 (Acari: Phytoseiidae) in Peru, with predation observation and a key for the *Amblyseius* species reported so far from that country

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Abstract. Phytoseiidae (Acari: Mesostigmata) is an important family of predatory mites, with some species being commercialized as biological control agents for the control of phytophagous mites and small insects. In Peru, 65 species of this family have been recorded so far, with *Amblyseius* being the most diverse genus, with 11 species. The aim of this study is to report for the first time the presence of *Amblyseius tamatavensis* Blommers, 1974 in Peru. In South America, this species has so far been reported only in Brazil and Venezuela. In Peru, *A. tamatavensis* was found on orange plants [*Citrus sinensis* (L.) Osbeck] in the district of Pangoa, department of Júnin. In the laboratory, collected specimens were observed to feed on *Phyllocoptruta oleivora* (Ashmed, 1879) (Acari: Eriophyidae) and *Frankliniella occidentalis* (Pergande, 1895) (Thysanoptera: Thripidae). Studies to verify the potential of this species as a biological control agent for pests occurring in Peru should be conducted. A key to the *Amblyseius* species recorded in Peru is presented.

Keywords: Biological control, diversity, citrus.

Phytoseiidae (Mesostigmata) is an important family of predatory mites, with some species being commercialized as biological control agents for the control of phytophagous mites and small insects (McMurtry et al. 2013). This family has more than 2800 described species, 65 of which are known from Peru. *Amblyseius* is the most diverse phytoseiid genus in this country, with 11 reported species (Denmark & Muma 1989; McMurtry & Moraes 1989; Moraes *et al.* 1991; Guanilo & Martínez 2007; Guanilo *et al.* 2008; Aguirre-Gil *et al.* 2013; Muñoz & Berrio 2014), namely *Amblyseius aerialis* (Muma, 1955), *A. chiapensis* De Leon, 1961, *A. chungas* Denmark & Muma, 1989, *A. franzellus* Athias-Henriot, 1967, *A. herbicolus* (Chant, 1959), *A. invictus* Schuster, 1966, *A. largoensis* (Muma, 1955), *A. leonardi* McMurtry & Moraes, 1989, *A. lynnae* McMurtry & Moraes, 1989, *A. perditus* Chant & Baker, 1965 and *A. vasiformis* Moraes & Mesa, 1991.

In August 2015, samples of branches, leaves and fruits of orange plants [*Citrus sinensis* (L.) Osbeck (Rutaceae)] were collected from a grove adjacent to an area of native vegetation of the type known as "Bosque Pluvial Montano Tropical" (natural regions of Peru: Rupa-Rupa or High Jungle) (Pulgar-Vidal 1996), located in Satipo Province, Pangoa district, Junín department (11°23'03" S; 74°29'10" W; 650m asl.), Peru. These were stored in plastic bags, in turn placed in paper bags and transported to a laboratory for examination under a dissecting microscope. A few insects were collected, mounted and dried for later identification, done by the first author based on Martin et al. (2000); these were found at low population levels, and identified as the woolly whitefly *Aleurothrixus floccosus* (Maskell, 1895) (Hemiptera: Aleyrodidae) and the West Indian red scale, *Selenaspidus articulatus* (Morgan, 1889), and the purple scale, *Lepidosaphes beckii* (Newman, 1869) (Hemiptera: Diaspididae). Phytophagous mites of the family Eriophyidae were also found and mounted on microscope slides, in Berlese medium. After dried, they were identified as the citrus rust mite, *Phyllocoptruta oleivora* (Ashmead), based on unpublished taxonomic keys used in the summer course at Ohio State University, Columbus, USA.

Phytoseiid mites were collected live, and transferred to a rearing unit consisting of a leaf of acalifa/Joseph's coat plant [*Acalypha wilkesiana* (Müll. Arg); Euphorbiaceae] placed upside down onto a piece of foam mat inside a tray (23.5 cm x 15.5 cm x 6.5 cm), the mat maintained humid by periodic addition of distilled water to the tray. The leaf margin was covered with cotton wool, to maintain leaf turgidity and to prevent the mites from escaping. A small amount of vermiculite was maintained onto the leaf as a resting microhabitat for the predatory mites. The predators were fed with pollen of castor bean (*Ricinus communis* L.; Euphorbiaceae), a mixture of all developmental stages of *Tyrophagus* sp. (Acari: Acaridae), *P. oleivora* and the western flower thrips, *Frankliniella occidentalis* (Pergande, 1895) (Thysanoptera: Thripidae). The tray was held at 25°C and 60% relative humidity. Three phytoseiid specimens were mounted on microscope slides in Hoyer's medium. After dried, they were examined under a phase contrast microscope (Leica, DMLB); measuring taxonomically relevant structures with the use of a graded eye-piece. The identification was carried out by comparing the information available in the world literature. Voucher specimens of the predatory mite were deposited at Departamento de Entomologia e Acarologia, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, São Paulo, Brazil and MHN (Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos) Jesús Maria, Lima, Peru.

The phytoseiids were identified as *Amblyseius tamatavensis* Blommers, 1974, described from Madagascar and widely distributed, mainly in tropical areas (Demite et al. 2021); it occurs on every continent except Antarctica and Europe. In South America, it was reported in Venezuela and Brazil. However, this is the first record of this species for Peru. The measurements of the Peruvian specimens were very close to those of the holotype (Blommers 1974) and other specimens reported in the literature (Zannou et al. 2007; Oliveira et al. 2012; Souza et al. 2015; Döker et al. 2018; Kreiter et al. 2020), except for the slightly shorter macrosetae of the genua of legs III and IV, about 20% longer in the holotype (Tab. 1).

In the laboratory, *A. tamatavensis* was observed to feed on castor bean pollen, astigmatine mites, *P. oleivora*, and *F. occidentalis* (Fig. 1); this is the first record of this phytoseiid preying upon the latter two species. According to Cavalcante et al. (2017), *A. tamatavensis* is a promising biological control agent of the whitefly *Bemisia tabaci* biotype B (Gennadius) (Hemiptera: Aleyrodidae), reducing populations of this insect by 60-80% on pepper plants. This predator is presently registered in Brazil for the control of that pest. Massaro et al. (2016, 2021) referred to the possible use of *Thyreophagus cracentiseta* Barbosa, O'Connor & Moraes, 2016 (Acari: Acaridae) as a factitious food for the commercial production of this predator. Dörkel et al. (2018) observed, under laboratory conditions, the consumption of the whitefly *Singhiella simplex* (Singh, 1931) (Hemiptera: Aleyrodidae) by *A. tamatavensis*. Given the demonstrated potential of *A. tamatavensis* for the control of some different pests, studies should be carried out in Peru envisioning its practical use.

Plants of spontaneous growth might favor the occurrence of *A. tamatavensis* in orange orchards. Because of the diversity of plants in natural vegetation prevailing at the department of Júnin (Pulgar-Vidal 1996), the diversity of phytoseiids is expected to be great, warranting the conduction of further studies in this area to determine the occurrence of other predatory mites that could be promising as biological control agents.

Key to *Amblyseius* species (females) recorded from Peru (adapted from Guanilo et al. 2008)

1. Female ventrianal shield vase-shaped or divided into separate ventral and anal shields, wider at level of anus than at level of *ZV2* .. 2

- Female ventrianal shield neither vase-shaped nor divided into separate ventral and anal shields, not wider at level of anus than at level of *ZV2* 5

2. Calyx of spermatheca bell-shaped .... *Amblyseius vasiformis* Moraes & Mesa

- Calyx of spermatheca elongate, tubular 3

3. Ventrianal shield divided into separate ventral and anal shields .... *Amblyseius perditus* Chant & Baker

- Ventrianal shield entire 4

4. Calyx of spermatheca trumpet shaped .... *Amblyseius herbicolus* (Chant)

- Calyx of spermatheca tubular, parallel sided .... *Amblyseius largoensis* (Muma)

5. Calyx of spermatheca cup- or V-shaped; ratio length/width at mid-point of calyx < 3.0: 1.0 6

- Calyx of spermatheca saccular or tubular, ratio length/width at mid-point of calyx > 3.4: 1.0 9

6. Ratio between setae *s4: Z1* ca. 3.0; *Sge IV* and *Sti IV* knobbed, calyx of spermatheca V-shaped ... *Amblyseius leonardi* McMurtry & Moraes

- Ratio between setae *s4*: *Z1* > 9.0; *Sge IV* and *Sti IV* sharp; calyx of spermatheca V-shaped or cup-shaped 7

7. Seta *Z5* ca. as long as *Z4* ..... *Amblyseius lynnae* McMurtry & Moraes

- Seta *Z5* ca. twice as long as *Z4* 8

8. Calyx of spermatheca cup-shaped; *Sti IV* > *St IV* .... *Amblyseius chiapensis* De Leon

- Calyx of spermatheca V-shaped; *Sti IV* < *St IV* .... *Amblyseius invictus* Schuster

9. Calyx of spermatheca saccular .... *Amblyseius franzellus* Athias-Henriot

- Calyx of spermatheca tubular or funnel-shaped 10

10. Calyx of spermatheca funnel-shaped .... *Amblyseius chungas* Denmark & Muma

- Calyx of spermatheca tubular 11

11. Atrium nodular; major duct not distinctly sclerotized and considerably narrower than calyx .... *Amblyseius aerialis* (Muma)

- Atrium undifferentiated; major duct distinctly sclerotized and about as wide as the calyx .... *Amblyseius tamatavensis* Blommers

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Authors' Contributions

SJJ conducted the field work. SJJ and GJM identified the mites. SJJ and PRD prepared the manuscript. SJJ, PRD and GJM revised different versions of the manuscript.

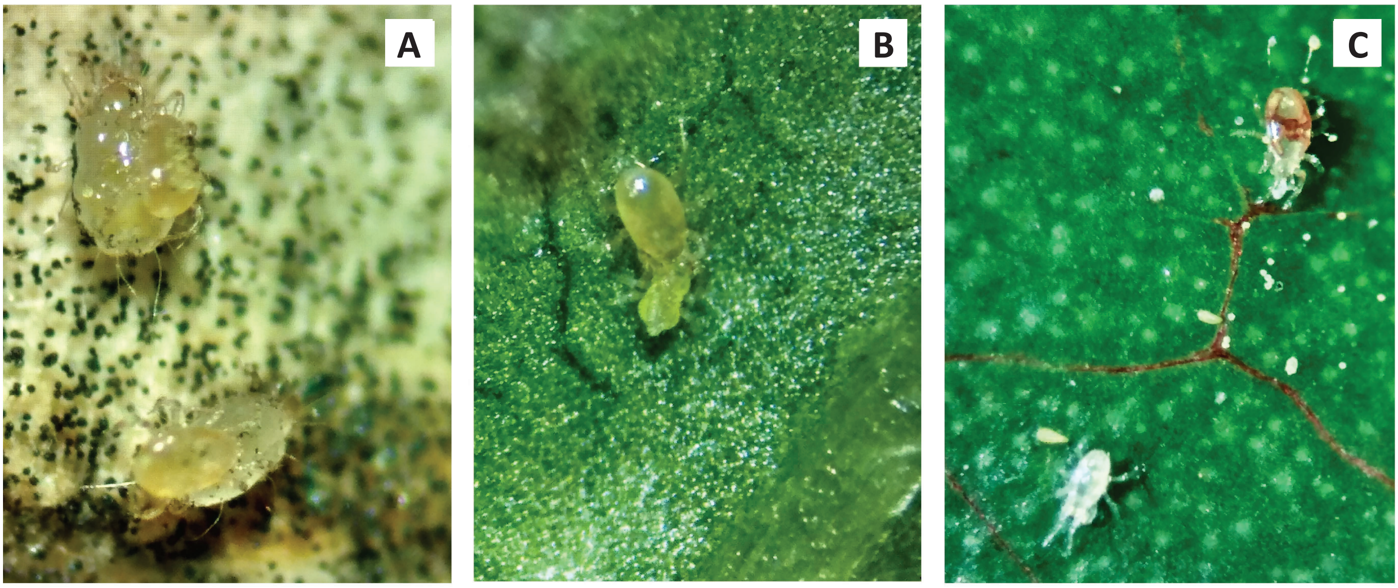

Figure 1. Specimens of *Amblyseius tamtavensis* Blommers, 1974 feeding on *Tyrophagus* sp. (A), *Frankliniella occidentalis* (Pergande, 1895) (B), and *Phyllocoptruta oleivora* (Ashmead, 1875) (C) under laboratory conditions.

Table 1. Character measurements (mean and range) of adult females of *Amblyseius tamatavensis* Blommers, 1974 collected in this study and in previous studies.

Character	Peru (n=3)	Madagascar Holotype	Africa (n=10)	Brazil (n=7)	La Reunion (n=11)	Thailand (n=9)	USA (n=4)
DSL	348 (343-353)	340	354 (328-390)	352 (323-379)	320 (295-338)	337 (310-360)	295 (292-298)
DSW	218 (210-224)	250	237 (218-256)	216 (182-238)	240 (223-288)	213 (190-230)	183 (180-184)
j1	31 (30-32)	32	31 (36-40)	33 (31-36)	30 (25-35)	32 (28-37)	32 (30-34)
j3	52 (50-52)	54	50 (38-59)	53 (50-57)	52 (48-55)	52 (49-55)	53 (52-54)
j4	4 (4-5)	4	5 (5-8)	5 (4-5)	4 (3-5)	5 (4-5)	5 (4-6)
j5	3	3	4 (3-5)	4 (3-4)	3 (3-5)	4 (3-4)	5 (4-6)
j6	5 (4-6)	3	6 (5-8)	5 (5-6)	3 (3-5)	5 (4-6)	5 (4-6)
J2	5 (5-6)	5	7 (5-8)	6 (5-6),	4 (3-5)	5 (5-7)	5 (4-6)
J5	6 (5-7)	6	8 (5-10)	7 (6-7)	6 (4-8)	6 (4-7)	7 (6-8)
z2	5 (5-6)	6	9 (8-11)	7 (6-8)	5 (5-6)	7 (6-9)	5 (4-6)
z4	5 (5-6)	6	8 (6-10)	8 (7-8)	6 (5-8)	7(5-9)	5 (4-6)
z5	3 (3-4)	3	5 (3-6)	4 (3-4)	4 (3-4)	4 (3-5)	5 (4-6)
Z1	6	5	7 (5-8)	6 (6-7)	5 (4-6)	6 (5-7)	5 (4-6)
Z4	107 (105-112)	115	108 (94-125)	108 (100-115)	106 (100-113)	107 (86-116)	117 (114-120)
Z5	223 (221-227)	250	250 (221-272)	235 (227-246)	221 (203-233)	231 (212-240)	237 (232-242)
s4	83 (81-85)	88	87 (77-96)	91 (90-92)	85(80-90)	86 (80-92)	87 (86-88)
S2	6 (6-7)	5	8 (6-10)	7 (6-7)	5 (4-8)	7 (6-9)	5 (4-6)
S4	5 (5-6)	6	8 (6-10)	6 (6-7)	5 (4-6)	6 (5-9)	5 (4-6)
S5	6 (5-7)	6	8 (6-10)	6 (5-6)	5 (5-6)	6 (5-9)	5 (4-6)
r3	12 (12-13)	15	15 (14-18)	14 (13-16)	13 (10-15)	14 (9-17)	14 (12-16)
R1	6 (5-7)	5	8 (6-10)	8 (7-8)		7 (6-8)	5 (4-6)
st1-st3	61 (59-63)		63 (59-66)	60 (58-63)	60 (58-63)	60 (58-65)	63 (60-64)
st2-st2	68 (66-70)		72 (67-77)	69 (67-72)	68 (65-70)	70 (67-75)	67 (66-72)
st5-st5	72		73 (69-77)	73 (70-77)	73 70- 78)	74 (69-80)	68 (66-72)
VSL	109 (102-110)	120	122 (110-136)	113 (108-118)	111 (100-115)	117 (110-125)	105 (104-108)
VSWant	93 (88-87)	100	90 (75-101)	95 (89-99)	92 (85-100)	89 (79-100)	91 (88-94)
VSWpost	82 (78-84)		84 (69-102)	85 (80-87)	82 (75-88)		
JV5	71 (65-75)	84			83 (70-93)		79 (78-80)
calyxL	19 (19-20)	16	23 (18-32)	17 (16-18)	17 (13-20)	12 (9-15)	17 (16-18)
MDL	35 (35-36)	35	39 (39-40)	37 (36-38)	37 (28-38)	38(35-41)	32 (31-33)
MD teeth	4	3	3		3		4
FDL	30	35	34 (34-35)	30 (27-32)	34(30-38)	31 (29-35)	33 (30-33)
FD teeth	10-11	14	13		11		11
SgeI	38 (36-40)	41	39 (35-45)	40 (37-42)	41 (39-43)	39 (37-44)	41 (40-42)
SgeII	36 (36-37)	39	38 (35-42)	39 (35-41)	39 (38-40)	36 (34-38)	40 (38-42)
SgeIII	52 (50-53)	61	58 (48-70)	57 (55-61)	55 (53-58)	55 (50-60)	53 (52-54)
StiIII	42 (41-43)	41	46 (34-53)	47 (46-47)	45 (43-48)	46 (42-48)	43 (42-44)
SgeIV	99 (98-100)	120	106 (85-126)	103 (100-105)	102 (100-103)	106 (100-120)	103 (102-104)
StiIV	69 (66-72)	75	69 (54-86)	77 (68-80)	73 (69-78)	72 (65-77)	73 (72-74)
StIV	64 (61-67)	73	71 (58-86)	71 (70-72)	69 (68-70)	66 (62-70)	71 (70-72)

Sources of measurement - Peru (this study); Madagascar (Blommers 1974), Brazil (Souza et al. 2015), La Reunion (Kreiter et al. 2020), Thailand (Oliveira et al. 2012), USA (Döker et al. 2018). **Character -** DSL: Dorsal Shield Length; DSW: Dorsal Shield Width; VSL: Ventrianal Shield Long; VSWant: Ventrianal Shield Wide at level of *ZV2*; VSWpost: Ventrianal Shield widht at anus level; calyxL: calyx of spermatheca length; MDL: Movable Digit Length; FDL: Fixed Digit Length.

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