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Survey of phytoseiid mites (Acari: Mesostigmata, Phytoseiidae) in citrus orchards and a key for Amblyseiinae in Vietnam

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Original research

ABSTRACT

Citrus is the second largest fruit crop in Vietnam. Phytoseiid mites are important natural enemies of mite pests and small insects in citrus orchards. By examining the specimens collected from three citrus orchards in the Mekong Delta in the south of Vietnam, a new record of phytoseiid mite *Amblyseius obtuserellus* Wainstein and Begljarov, 1971 was found and two other species *Amblyseius largoensis* (Muma, 1955) and *Euseius ovalis* (Evans, 1953) were also obtained. Herein, they are re-described and illustrated based on the current specimens. A key for Amblyseiinae in Vietnam is also provided

Keywords *Amblyseius*; *Euseius*; taxonomy; description

Introduction

Vietnam is long and narrow, located in the east of Indochina Peninsula. Vietnam shares its land borders with China to the north, Laos and Cambodia to the west, and surrounded by the south China sea to the east and south. Its climate is characterized by the interplay of the East Asian and South Asian Monsoons, cold surges in the winter months and a long rainy season which extend beyond summer (Nguyen *et al.* 2014). Latitude of the south (8°10′ N–10°48′ N) is more southern than Hainan Island (18°10′ N–20°10′ N) in China, and its temperatures vary less in the southern plains around the Mekong Delta. Vietnam is one of the 25 countries considered to possess a high level of biodiversity (Vietnam Environment Protection Agency, 2005, *electronic source*) (Sohn and Park, 2009). Until now, only 15 species of phytoseiid mites (Acari: Phytoseiidae) have been recorded in Vietnam (Nguyen *et al.* 2016; Nguyen and De Clercq, 2018; Thuan *et al.* 2019; Nguyen, 2019a, 2019b; Nguyen and Dao 2019; Nguyen *et al.* 2019a, 2019b).

Citrus is the second largest fruit crop in Vietnam, with Mekong Delta the main citrus production area. The sampling sites in this survey are all located in Mekong Delta. Phytoseiid mites are important natural enemies of pest mites and small insects in citrus orchards (Wu *et al.* 2009; Huang 2011). Phytoseiid mites have been mass-reared and widely used for biological control of pest mites and insects in citrus orchards in China (Zhang *et al.* 2002; Ouyang *et al.* 2007; Fang *et al.* 2013, 2018). It is important to survey the native species of phytoseiid mites in citrus orchard, which is supposed to be the most adapted bio-control agents can be used in local citrus orchards. This study proposes a new record *A. obtuserellus* Wainstein and Begljarov, 1971 and two other species, *Amblyseius largoensis* (Muma, 1955) and *Euseius ovalis* (Evans, 1953), from citrus orchards in Mekong Delta.

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Material and methods

Mite specimens examined in this study were collected from three citrus orchards in Mekong Delta in April 2018. One citrus orchard in Chau Thanh district, Ben Tre Province is about 5 ha, 10-year-old *Citrus reticulata* × *sinensis* and *Psidium guajava* Linn. interplanted, surrounded by eucalyptus on edge; SK mineral oil was mainly used in this orchard. The citrus orchard in Phong Dien district, Can Tho Province is also about 5 ha, 3-year-old *Citrus reticulata* × *sinensis* and *Psidium guajava* Linn. interplanted, surrounded by a wild bush on one side; mineral oil and chemical pesticides are used in this orchard. The citrus orchard in Cao Lanh district, Dong Thap is about 7 ha, only 10-year-old *Citrus reticulata* × *sinensis* trees planted, surrounded by other citrus orchards; chemical pesticide abamectin was mainly used in this orchard.

Mites were mounted in Hoyer's medium and examined, measured and illustrated under a phase and DIC (differential interference contrast) microscope (Zeiss® Axio Imager A2) and picture pick-up system [ZEN 2.3 (Blue edition) © Carl Zeiss Microscopy GmbH, 2011]. Measurements are presented in μm, by their mean and range in parentheses. Morphological features of adult mites were measured as follows: dorsal shield length and width were taken from the anterior to posterior margins of the shield along the midline and from the lateral margins at *s4* level; for all ventral shields, lengths were measured along their midline from the anterior to posterior margins; widths were taken from the lateral margins at *st2, st5* and *ZV2* level respectively; cheliceral fixed digit length was measured from dorsal poroid to anterior tip and movable digit length measured from the basal articulation to the tip. The general terminology used for morphological descriptions in this study follows that of Chant and McMurtry (2007), idiosomal setal terminology follows those by Rowell *et al*. (1978) and Chant and Yoshida-Shaul (1991, 1992), adenotaxy and poroidotaxy terminology followed that of Beard (2001), and chaetotaxy of legs follows that of Evans (1963).

All mites collected were measured. They were deposited in GIABR (Guangdong Institute of Applied Biological Resources, Guangzhou, China). The previous records of these species mainly referenced to the Phytoseiidae Database (Demite *et al.* 2019).

Results and discussion

Family Phytoseiidae Berlese

Subfamily Amblyseiinae Muma

Tribe Amblyseiini Muma

Subtribe Amblyseiina Muma

Genus *Amblyseius* Berlese

Amblyseius obtuserellus Wainstein & Begljarov

(Figs. 1 a – e)

Amblyseius obtuserellus Wainstein & Begljarov, 1971: 1806; Ehara & Yokogawa 1977: 54; Wainstein 1979: 14; Wu 1980: 44; Moraes *et al.* 1986: 24; Ryu & Lee 1992: 28; Wu *et al.* 1997: 50; Wu *et al.* 2009: 194.

Amblyseius (Multiseius) obtuserellus, Denmark & Muma 1989: 124.

Description — Female (n = 8)

Dorsum — Idiosomal setal pattern: 10A: 9B/JV-3: ZV. Dorsal shield smooth (Fig. 1a), 317 (300–330) long and 200 (185–218) wide, distances between setae *j1*- *J5* 303 (289–316) and *s4*-*s4* 176 (164–186), shield nearly oval, constricted at level of *R1*. Setae *r3* and *R1* on soft membranous cuticle laterad dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. All setae smooth, except Z4, Z5 with minute thorns. With seven pairs of solenostomes (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*) on dorsal shield. Length of setae: *j1* 24 (23–26), *j3* 43 (40–46), *j4* 5 (4–6), *j5* 5 (4–6), *j6* 6 (4–8), *J2* 7 (5–9), *J5* 6 (4–7), *z2* 9 (7–11), *z4* 9 (7–11), *z5* 5 (4–6), *Z1* 7

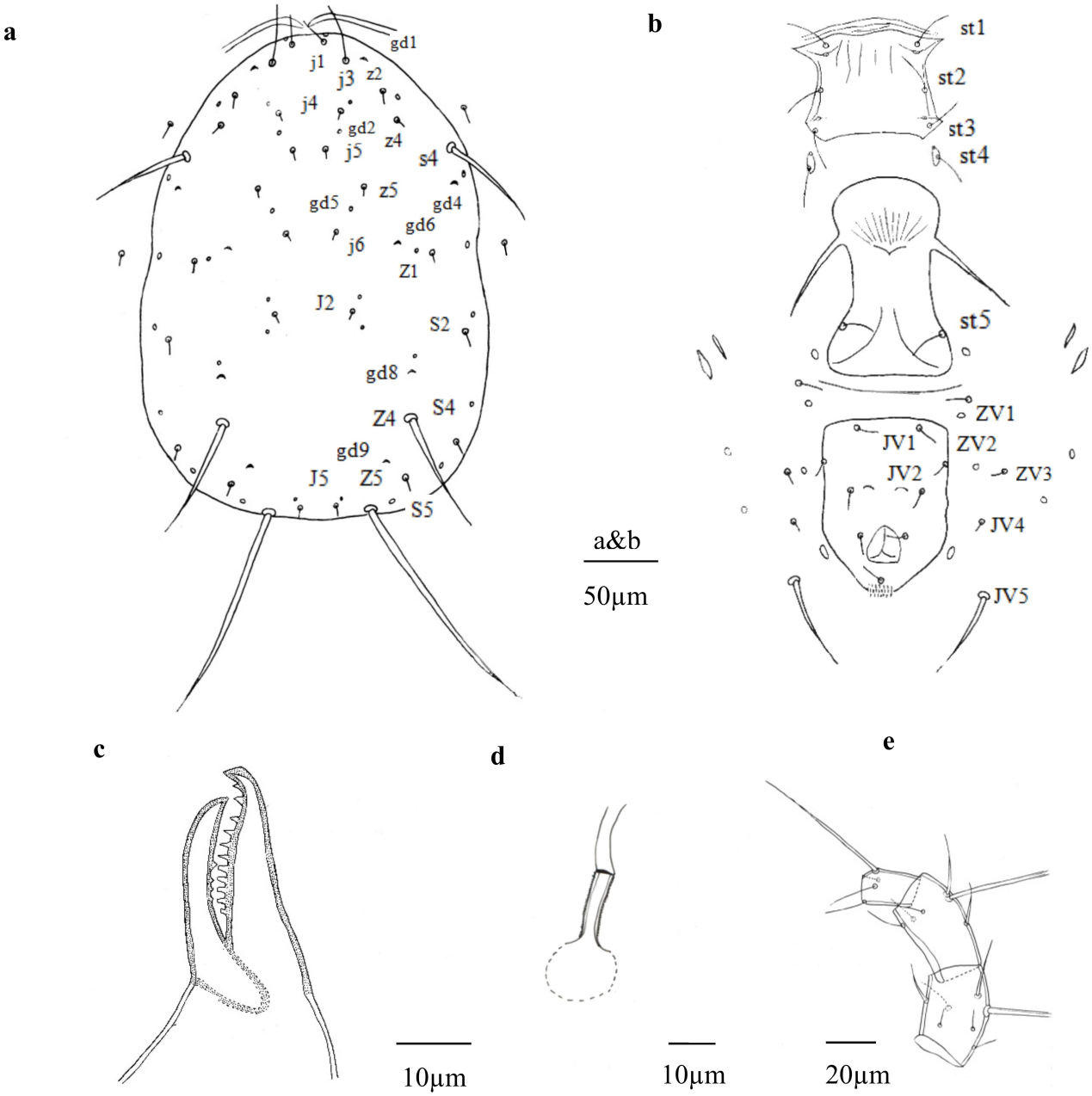


Figure 1 Female of *Amblyseius obtuserellus*. a – Dorsal shield; b – Ventral idiosoma; c – Chelicera; d – Spermatheca; e – Leg IV, genu-basitarsus.

(6–9), *Z4* 82 (75–88), *Z5* 161 (155–167), *s4* 68 (63–72), *S2* 8 (7–9), *S4* 7 (6–9), *S5* 7 (5–8), *r3* 12 (11–14), *R1* 8 (7–9).

Venter — (Fig. 1b). All ventral setae smooth. Sternal shield with sparse striation, anterior margin convex, posterior margin slightly concaved, 69 (68–71) long, 74 (73–75) wide, wider than long, with three pairs of setae *st1* 31 (29–33), *st2* 28 (25–32), *st3* 26 (24–30), and two pairs of lyrifissures (*pst1-pst2*), distance between *st1-st3* 55 (53–58) and *st2-st2* 68 (67–69). Metasternal platelets drop-shaped, each with one metasternal seta, *st4* 25 (24–26) and one lyrifissure (*pst3*). Genital shield smooth, with one pair of thin genital setae *st5* 27 (25–28), distance between *st5-st5* 59 (64–71); one pair of associated poroids on soft cuticle near posterior

corners of shield. Ventrianal shield nearly pentagonal, 112 (105–116) long, 82 (76–88) wide at level of *ZV2*, 78 (73–84) wide at level of anus, with three pairs of thin pre-anal setae *JV1* 16 (14–19), *JV2* 14 (11–17), *ZV2* 12 (10–13); *Pa* 14 (12–17), *Pst* 16 (14–19) long. Pre-anal pores crescentic, posteromedian to *JV2*, distance between pores 21 (19–23). Opisthogastric soft cuticle with four pairs of setae, *ZV1* 14 (13–16), *ZV3* 9 (7–10), *JV4* 8 (6–9), *JV5* 59 (54–64) long. All ventral setae thin, except *JV5*, thicker. Two pairs of metapodal platelets, primary platelets 19 (17–21) long, 5 (3–5) wide, secondary ones 11 (10–12) long, 2 (1–2) wide.

Peritremes — Peritremes extending anteriorly between *j1*.

Chelicerae — (Fig. 1c). Fixed digit 32 (30–36) long, with 11 teeth, movable digit 28 (27–30) long, with four teeth.

Spermatheca — (Fig. 1d). Calyx of spermatheca tubular, 25 (22–28) long, the proximal part mostly distal part thicker, granular surface, 9 (8–10) long, 2 (2–2) wide at the junction with the vesicle, atrium and major duct indiscernible.

Legs — Genua formula for leg I 2 – 1/2, 2/1– 1, leg II 0 – 2/1, 0/2 – 2, leg III 1 – 1/2, 1/2 – 0, leg IV 2 – 2/1, 0/1 – 1. Genua I-III each with one macroseta, *Sge* I 32 (29–34), *Sge* II 31 (28–32), *Sge* III 42 (39–45). Leg III with one macroseta on tibia, *Sti* III 30 (27–32). Leg IV (Fig. 1e) with three macrosetae on genu, tibia and basitarsus, *Sge* IV 82 (76–86), *Sti* IV 46 (40–51) and *St* IV 59 (56–62).

Specimens examined — 8 ♀♀, Chau Thanh district, Ben Tre Province (accession no. BT-0190, BT-0200, BT-0211, BT-0212, BT-0220, BT-0231, BT-0232, BT-0240), on *Citrus reticulata* × *sinensis*, 10 IV 2018, Fang X.D. coll.

Previous records — China, Japan, Russia, South Korea.

Remarks — *Amblyseius obtuserellus* holotype specimen was from the Primorsky Territory, U.S.S.R. (Wainstein and Begljarov, 1971; Denmark and Muma, 1989). This species was also recorded in Japan (Ehara and Yokogawa, 1977) and South Korea (Ryu and Lee, 1992). *A. obtuserellus* have been found in many Provinces in China, including Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hunan and Guangdong. Wu (1982) reported that the size of its genital shield, ventrianal shield and distance between pre-anal pores are variable, but the calyx shape of spermatheca does not present differences. The calyx of the spermatheca in this species is cylindrical and long and the distal part of calyx thickened and more sclerotized.

Ehara and Yokogawa (1977), Denmark and Muma, 1989, Ryu and Lee (1992) and Wu *et al.* (2009) re-described this species. Geographical populations in different countries all have distinctive, granular spermathecal cervix, but they have differences in the individual size, length of some setae on dorsal shield and the macrosetae on Leg IV, and the length of cervix of spermatheca. Their measurements differences are listed in Table 1.

Amblyseius obtuserellus has 11 well-developed teeth on fixed digit and four teeth on movable digit of the chelicerae and this species may play an important role in bio-control. Its biology and bio-control application need to be further studied.

Amblyseius largoensis (Muma)

(Figs. 2 a – e, 3 a – c)

Amblyseiopsis largoensis Muma 1955: 266; Garman 1958: 76.

Typhlodromus (Amblyseius) largoensis, Chant 1959: 96.

Amblyseius largoensis, Ehara 1959: 293; De Leon 1966: 90, 1967: 23; Muma & Denmark 1970: 69; Wu 1980: 41; Schicha 1981: 105; McMurtry & Moraes 1984: 29; Chen *et al.* 1984: 332; Moraes *et al.* 1986: 17, 2000: 239, 2004a: 143, 2004b: 33; Denmark & Muma 1989: 55; Wu & Lan 1989: 449; Wu *et al.* 1997: 39; Gondim Jr & Moraes 2001: 72; Chant & McMurtry 2004: 208, 2007: 78; Zannou *et al.* 2007: 16; Ferragut *et al.* 2011: 40; Oliveira *et al.* 2012: 4; Nguyen & Dao 2019.

Amblyseius (Amblyseialus) largoensis, Muma 1961: 287.

Amblyseius magnoliae, Denmark & Evans 2011: 69.

Typhlodromus largoensis, Hirschmann 1962.

Amblyseius (Amblyseius) largoensis, Ehara 1966; Ehara & Bhandhufalck 1977: 67; Denmark & Evans 2011: 69.
Amblyseius amtalaensis, Gupta 1977: 53; 1986: 51.
Amblyseius neolargoensis, Van der Merwe 1965:59; Chant *et al.* 1978: 1347.
Amblyseius sakalava, Blommers 1976: 96; Ueckermann & Loot 1988: 70.

Description — Female (n = 25)

Dorsum — Idiosomal setal pattern: 10A: 9B/JV-3: ZV. Dorsal shield (Fig. 2a) mostly smooth except anteriorly striated. Dorsal shield 355 (341–376) long and 224 (212–253) wide, distances between setae *j1*- *J5* 338 (326–364) and *s4*-*s4* 194 (181–213), shield nearly oval, slightly constricted at level of *R1*. Setae *r3* and *R1* on soft membranous cuticle laterad dorsal shield, *r3* at level of between *z4* and *s4*, *R1* at level of shield incisions. All setae smooth. With six pairs of solenostomes (*gd1*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*) on dorsal shield. Length of setae: *j1* 36 (30–40), *j3* 51 (41–59), *j4* 6 (4–8), *j5* 5 (3–6), *j6* 7 (4–10), *J2* 9 (6–12), *J5* 9 (6–12), *z2* 11 (8–14), *z4* 9 (7–13), *z5* 6 (4–8), *Z1* 10 (6–14), *Z4* 98 (89–105), *Z5* 277 (243–296), *s4* 95 (86–103), *S2* 13 (9–16), *S4* 12 (9–16), *S5* 11 (8–15), *r3* 12 (10–16), *R1* 10 (7–14).

Venter — (Fig. 2b). Ventral setae smooth. Sternal shield with sparse striation, anterior margin convex, posterior margin straight, 80 (72–90) long, 77 (68–82) wide, with three pairs of setae *st1* 34 (29–39), *st2* 31 (27–34), *st3* 30 (26–33), and two pairs of lyrifissures (*pst1*-*pst2*), distance between *st1*-*st3* 63 (57–67) and *st2*-*st2* 68 (60–73). Metasternal platelets drop-shaped, each with one metasternal seta, *st4* 29 (26–34) and one lyrifissure (*pst3*). Genital shield smooth, with one pair of thin genital setae *st5* 27 (23–33), distance between *st5*-*st5* 74 (68–81); one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield vase-shaped, 109 (99–117) long, 48 (45–53) wide at level of *ZV2*, 72 (64–84) wide at level of anus, with three pairs of thin pre-anal setae *JV1* 20 (15–23), *JV2* 17 (15–20), *ZV2* 15 (12–18); *Pa* 18 (15–21), *Pst* 18 (14–21) long. Pre-anal pores crescentic, posteromediad to *JV2*, distance between pores 26 (23–28). Opisthogastric soft cuticle with four pairs of setae, *ZV1* 17 (14–21), *ZV3* 10 (8–13), *JV4* 10 (6–13), *JV5* 64 (53–74) long. All ventral setae thin, except *JV5*, thicker. Two pairs of metapodal platelets, primary platelets 23(18–27) long, 4 (3–6) wide, secondary ones 13 (9–16) long, 2 (1–4) wide.

Peritremes — Peritremes extending anteriorly between *j1*.

Chelicerae — (Fig. 2c). Fixed digit 32 (29–35) long, with nine teeth and *pilus dentilis*, movable digit 29 (26–31) long, with three teeth.

Spermatheca — (Fig. 2d). Calyx of spermatheca tubular, 21 (18–24) long, 4 (2–5) wide at

Table 1 Comparison of measurements of different geographical origins of *Amblyseius obtuserellus*.

Geographical origin	Vietnam[a]	U.S.S.R.[b]	China[c]	Japan[d]	South Korea[e]
Size length	317	380	361-365	380	352
Size width	200	204	258-261	270	227
Seta *j1*	24	30	31	31	32.4
Seta *j3*	43	41	45	48	49.6
Seta *s4*	68	80	72-76	84	81
Seta *Z4*	82	110	96-100	111	111
Seta *Z5*	161	194	216-231	214	218.4
Macroseta Sge IV	82	98-101	96	101	100.4
Macroseta Sti IV	46	61-69	69	69	68.8
Macroseta St IV	59	70-77	65	77	79
Cervix length	25	24	15	Unknown	Unknown

[a] from eight specimens, [b] from Wainstein & Begljarov, 1971 and Denmark & Muma, 1989, [c] from Wu *et al.*, 2009; [d] from Ehara & Yokogawa, 1977; [e] from Ryu & Lee, 1992.

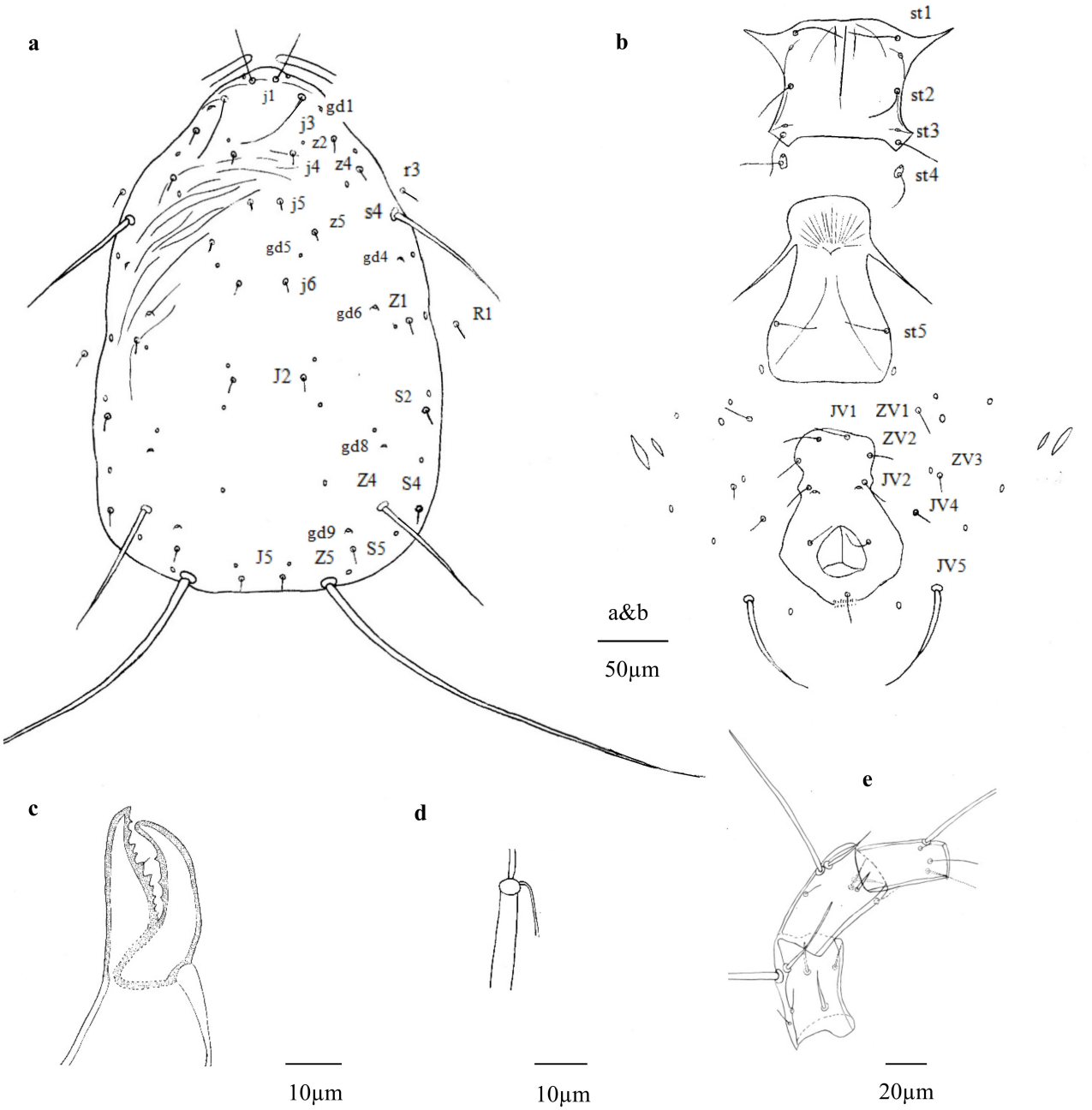


Figure 2 Female of *Amblyseius largoensis*. a – Dorsal shield; b – Ventral idiosoma; c – Chelicera; d – Spermatheca; e – Leg IV, genu-basitarsus.

the opening; atrium 4 (2–5) long, 4 (3–5) wide, massive atrium as wide as cervix, connected with calyx; major duct broad, short, directly attached to atrium, and minor duct visible.

Legs — Genua formula for leg I 0 – 1/2, 2/2– 2, leg II 0 – 1/2, 1/1 – 2, leg III 2 – 2/1, 1/1 – 0, leg IV 2 – 2/1, 0/1 – 1. Genua I-III each with one macroseta, *Sge* I 41 (37–45), *Sge* II 38 (32–41), *Sge* III 50 (42–55). Leg III with one macroseta on tibia, *Sti* III 41 (35–45). Leg IV (Fig. 2e) with three long-whipped macrosetae on genu, tibia and basitarsus, *Sge* IV 128 (111–138), *Sti* IV 101 (91–113) and *St* IV 65 (56–73).

Male — (n=7)

Dorsum — (Fig. 3a). Idiosomal setal pattern: 10A: 9B/JV-3: ZV. Dorsal shield mostly

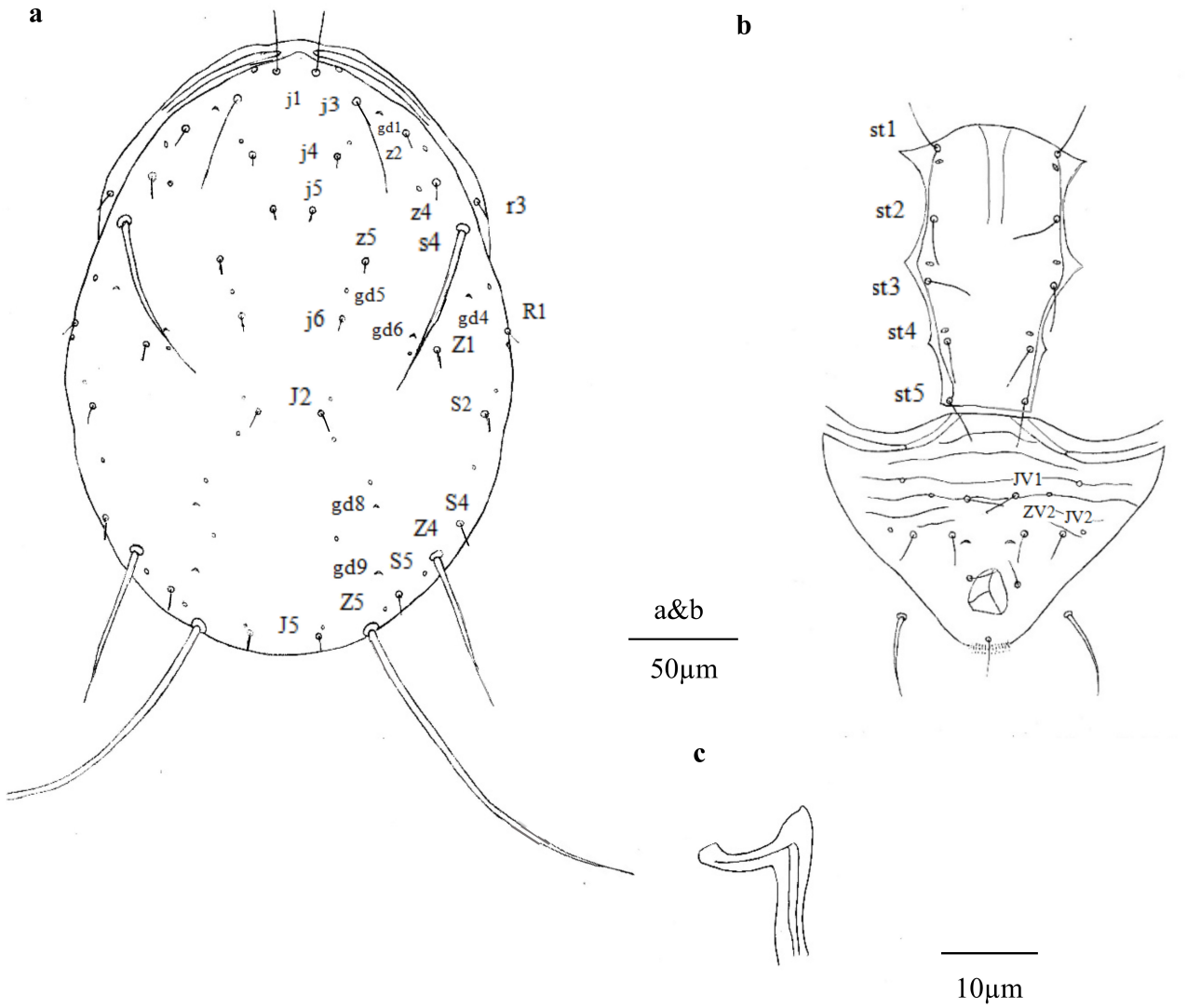


Figure 3 Male of *Amblyseius largoensis*. a – Dorsal idiosoma; b – Ventral idiosoma; c – Spermatodactyl.

smooth except anteriorly striated, same as on female, 271 (264–291) long and 184 (173–201) wide at level of setae *s4*, shield nearly oval, nineteen pairs of dorsal setae, all smooth. Same adenotaxy and poroidotaxy as in females. Length of setae: *j1* 29 (24–31), *j3* 47 (42–50), *j4* 6 (4–7), *j5* 5 (4–6), *j6* 6 (5–8), *J2* 8 (7–9), *J5* 7 (5–8), *z2* 9 (7–11), *z4* 9 (7–10), *z5* 5 (4–7), *Z1* 9 (6–10), *Z4* 73 (65–81), *Z5* 215 (194–236), *s4* 79 (75–82), *S2* 11 (8–13), *S4* 10 (9–11), *S5* 10 (9–11), *r3* 11 (9–13), *R1* 8 (7–10).

Venter — (Fig. 3b). Ventral setae smooth. Sternogenital shield smooth, 131 (125–143) long, wider 81 (77–87) between coxae II–III than at posterior corners 41 (38–44). Five pairs of sterogenital setae (*st1–st5*), *st1* 27 (24–30), *st2* 23 (21–24), *st3* 22 (20–26), *st4* 21 (19–24), *st5* 22 (19–24), and three pairs of lyrifissures (*pst1-pst3*). Chaetotaxy of genua similar to female. Ventrianal shield subtriangular, 111 (106–116) long, 155 (147–161) wide at level anterior corners; transversally striated; striation on anterior part of the shield more obvious, with three pairs of thin pre-anal setae *JV1* 17 (14–20), *JV2* 15 (13–17), *ZV2* 13 (11–17); *Pa* 14 (11–17), *Pst* 17 (15–18) long. Preanal pores crescentic, posteromedian to *JV2*, distance between pores 19 (18–21). Opisthogastric soft cuticle with one pairs of setae, *JV5* 37 (33–40) long.

Peritremes — Peritremes extending to between *j1*. Peritrematal shield fused with dorsal shield.

Chelicerae and spermatodactyl — (Fig. 3c). Cheliceral dentition not discernible in the examined specimens. Fixed digit 22 (20–23) long, movable digit 20 (18–22) long. Spermatodactyl L-shaped; shaft 16 (15–18), foot 8 (7–10) long.

Legs — Chaetotaxy of genua similar to female. Macrosetae on genu I 31 (29–35), genu II 31 (30–33), genu III 37 (35–40), tibia III 35 (32–38), genu IV 81 (78–85), tibia IV 69 (65–72), tarsus IV 56 (52–59).

Specimens examined – 9 ♀♀, Chau Thanh district, Ben Tre Province (accession no. BT-0121, BT-0130, BT-0140, BT-0180, BT-0250, BT-0260, BT-0270, BT-0281, BT-0282), on *Citrus reticulata* × *sinensis*, 10 IV 2018, Fang X.D. coll.; 2 ♂♂ (accession no. BT-0122, BT-0160) same locality, host, date and collector; 16 ♀♀, Phong Dien district, Can Tho Province (accession no. CT-0301, CT-0302, CT-0321, CT-0322, CT-0341, CT-0342, CT-0350, CT-0360, CT-0371, CT-0372, CT-0401, CT-0402, CT-0430, CT-0441, CT-0450, CT-0481), and 2 ♂♂ (accession no. CT-0442, CT-0482), 12 IV 2018, same host and collector; 4 ♀♀, Cao Lanh district, Dong Thap Province (accession no. DT-0490, DT-0500, DT-0521, DT-0540) and 3 ♂♂ (accession no. DT-0522, DT-0532, DT-0550), 13 IV 2018, same host and collector.

Previous Records — Nearctic, Neotropical, Oriental, Australasian, Ethiopian, West Palaearctic and East Palaearctic, almost including all biogeographic realms except Antarctica (Hernandes *et al.* 2011).

Remarks — This species is very similar to *A. herbicolus* (Chant, 1959) and *A. eharai* Amitai and Swirski, 1981, but having differences in sternal shield with weak sclerotization and posterior margin straight, and calyx of spermatheca tubular. This species prefers high humidity environment, and it is the dominant species of brushes in Hainan islands in China. This species is important natural enemies of agriculture and forestry pest mites (Wu *et al.* 2009). In this survey, *A. largoensis* was found the dominant native species in surveyed citrus orchards in Vietnam.

Tribe Euseiini Chant and McMurtry

Subtribe Euseiina Chant and McMurtry

Genus *Euseius* Wainstein

Euseius ovalis (Evans)

(Figs. 4 a – e)

Typhlodromus ovalis Evans 1953: 458.

Typhlodromus (*Amblyseius*) *ovalis*, Chant 1959: 68; Narayanan, Kaur and Ghai 1960: 388.

Amblyseius (*Typhlodromalus*) *ovalis*, Muma 1961.

Amblyseius ovalis, Collyer 1964: 634; Gupta 1970: 98; Prasad 1974: 168; Wu 1980: 46; Ray and Gupta 1981: 279; Chen *et al.* 1984: 327.

Amblyseius (*Amblyseius*) *ovalis*, Ehara 1966: 24.

Euseius ovalis, Gupta 1978: 335; Moraes *et al.* 1986: 49; Wu *et al.* 1997: 117; Wu *et al.* 2009: 235; Liao *et al.* 2017: 220.

Amblyseius (*Euseius*) *ovalis*, Gupta 1985; Ehara and Amano 1998: 43.

Description — Female (n = 2)

Dorsum — Idiosomal setal pattern: 10A: 9B/JV-3: ZV. Dorsal shield (Fig. 4a) smooth, with anterolateral striated. Dorsal shield 359 (348–365) long and 238 (230–248) wide, distances between setae *j1*- *J5* 344 (331–353) and *s4*-*s4* 206 (198–213), shield nearly oval, constricted at level of *R1*. Setae *r3* and *R1* on soft membranous cuticle laterad dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. All setae smooth, except *Z5* slightly serrate. With six pairs of solenostomes on dorsal shield (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*). Length of setae: *j1* 33 (30–35), *j3* 14 (13–15), *j4* 8 (7–9), *j5* 7 (5–8), *j6* 8 (7–8), *J2* 12 (10–13), *J5* 7 (5–8), *z2* 10 (9–11), *z4* 10

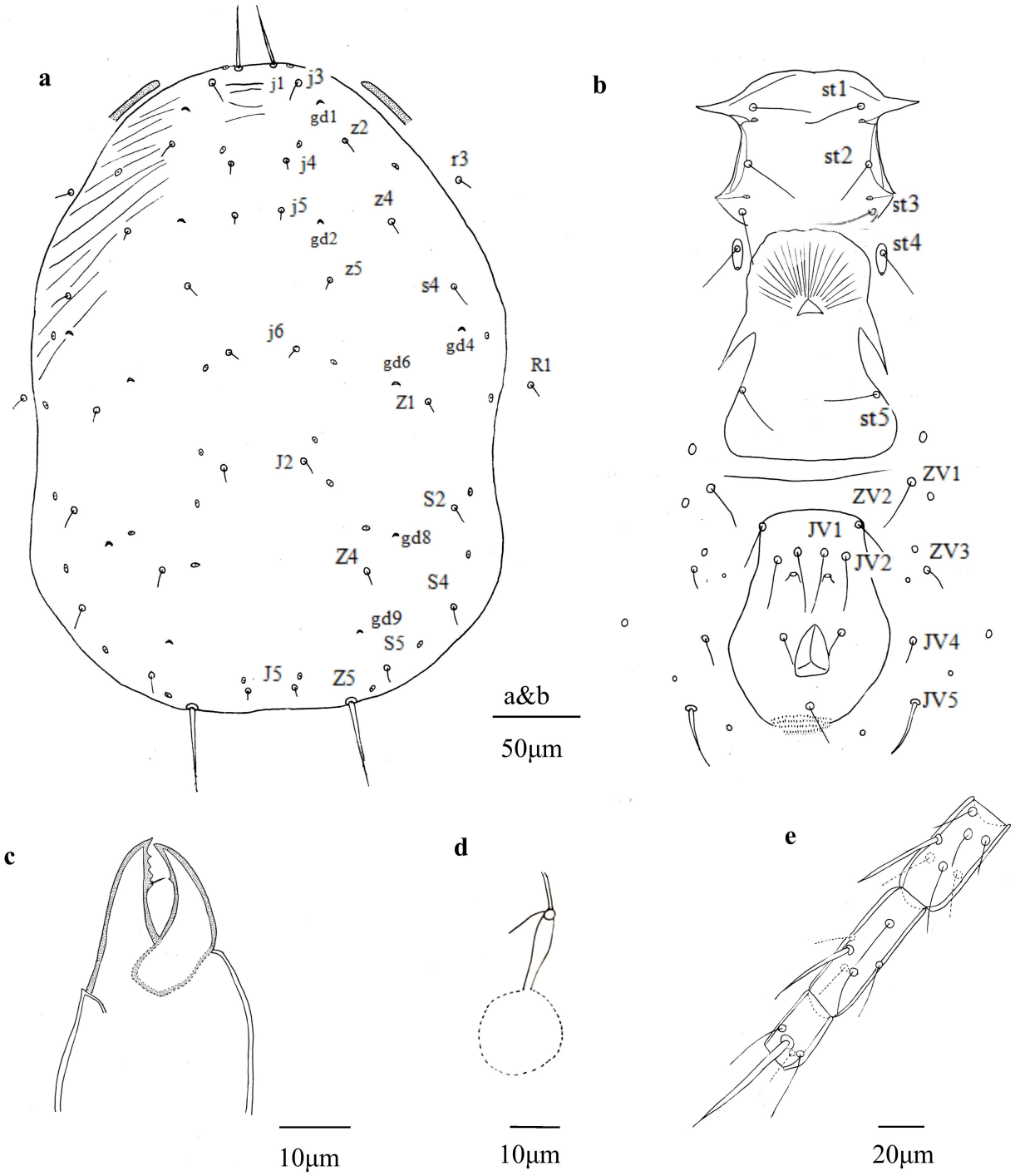


Figure 4 Female of *Euseius ovalis*. a – Dorsal shield; b – Ventral idiosoma; c – Chelicera; d – Spermatheca; e – Leg IV, genu-basitarsus.

(8–12), *z5* 8 (7–9), *Z1* 11 (9–12), *Z4* 13 (11–14), *Z5* 56 (53–58), *s4* 14 (13–16), *S2* 14 (12–15), *S4* 14 (13–16), *S5* 12 (11–14), *r3* 13 (12–15), *R1* 10 (9–11).

Venter —(Fig. 4b). All ventral setae smooth. Sternal shield smooth, posterior margin not discernible in the examined specimens, 79 (78–81) wide, with three pairs of setae *st1* 33 (32–35), *st2* 29 (27–32), *st3* 30 (28–32), and two pairs of lyrifissures (*pst1-pst2*), distance between *st1-st3* 59 (57–60) and *st2-st2* 66 (65–68). Metasternal platelets drop-shaped, each

with one metasternal seta, *st4* 27 (25–29) and one lyrifissure (*pst3*). Genital shield smooth, with one pair of thin genital setae *st5* 30 (29–31), distance between *st5-st5* 78 (76–80); one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield smooth, nearly oval, 105 (102–109) long, 49 (47–52) wide at level of *ZV2*, 81 (79–83) wide at level of anus, three pairs of thin pre-anal setae, *JV1* migrate next to *JV2*, *JV1* 29 (27–32), *JV2* 24 (23–26), *ZV2* 16 (14–19); *Pa* 15 (14–16), *Pst* 16 (15–17) long. Pre-anal pores crescentic, posteromedian to *JV2*, distance between pores 33 (31–34). Opisthogastric soft cuticle with four pairs of setae, *ZV1* 22 (20–23), *ZV3* 10 (8–11), *JV4* 13 (13–14), *JV5* 28 (27–30) long. All ventral setae thin, except *JV5*, thicker. Two pairs of metapodal platelets, primary platelets 22 (21–23) long, 5 (4–6) wide, secondary ones 13 (12–14) long, 2 (1–2) wide.

Peritremes — Peritremes extending anteriorly between *j3* and *z2*.

Chelicerae — (Fig. 4c). Fixed digit 25 (24–27) long, with three teeth and *pilus dentilis*, movable digit 23 (21–24) long, unidentate.

Spermatheca — (Fig. 4d). Calyx of spermatheca 12 (10–13) long, base swollen, tubular, 3 (3–4) wide at inflated part, 1 (1–1) at distal part, atrium 1 1 (1–2) wide, small-knobbed, incorporated with calyx; major duct narrow, directly attached to calyx, without neck, and minor duct visible.

Legs — Genua formula for leg I 2 – 2/1, 2/1 – 2, leg II 2 – 2/0, 2/0 – 1, leg III 1 – 2/1, 2/0 – 1, leg IV 1 – 2/1, 2/1 – 0. Genua and tibia III each with one macroseta, *Sge* III 27 (25–28), tibia III 23 (21–24). Leg IV with three macrosetae on genu, tibia and basitarsus (Fig. 4e), *Sge* IV 36 (35–38), *Sti* IV 35 (33–36) and *St* IV 55 (52–57).

Material examined — 2 ♀♀, Cao Lanh district, Dong Thap Provine (accession no. DT-0532, DT-0560), on *Citrus reticulata* × *sinensis*, 13 IV 2018, Fang X.D. coll.

Previous records — Australia, China, Cook Islands, Fiji, Hawaii, India, Indonesia, Japan, Malaysia, Mauritius, Mexico, New Zealand, Papua New Guinea, Philippines, Sri Lanka.

Remarks — The calyx of the examined specimens is tubular, similar to illustration in Wu *et al.* (2009), but not distal flaring as illustration in Gupta (1986). Fixed digit of the examined specimens with three teeth is similar to illustration in Liao *et al.* (2017), but not only with one tooth as the original description (Evans, 1953).

Euseius ovalis can be mass-reared on pollen and it is the dominant natural enemy in controlling *Aceria litchi* (Keifer) (Wu *et al.* 1991). This species also had potentiality in controlling *Tetranychus kanzawai* Kishida (Shih *et al.* 1993) and *Oligonychus mangiferus* (Rahman and Sapra) (Nguyen and Shih, 2010). Liao *et al.* (2017) reported *E. ovalis* rarely located on the leaves with *Tetranychus* colonies and only located close to *Oligonychus* and *Panonychus* colonies.

The above three species are all found in citrus orchards in Vietnam, and they are associated with spider mites and small pests. Now, there are fifteen species reported in Vietnam in total. Nguyen *et al.* (2016) first reported eight phytoseiid mites were found in Ho Chi Minh city, including *A. matinikus* Schicha and Corpuz-Raros, 1992, *Graminaseius polisensis* (Schicha and Corpuz-Raros, 1992), *Neoseiulus longispinosus* (Evans, 1952), *Paraphytoseius orientalis* (Narayanan, Kaur and Ghai, 1960) (synonym of *Paraphytoseius multidentatus* Swirski and Shechter according to Chant and McMurtry 2003, Kreiter *et al.* 2018), *Scapulaseius asiaticus* (Evans, 1953), *Amblyseius tamatavensis* Blommers, 1974, *Proprioseiulus dahonagnas* (Schicha and Corpuz-Raros, 1992) and an undetermined *Typhlodromus* sp. Furthermore, *Paraphytoseius cracentis* (Corpuz and Rimando, 1966), *Neoseiulus californicus* (McGregor, 1954), *Proprioseiopsis lenis* (Corpuz and Rimando, 1966), *E. aizawai* (Ehara and Bhandhufalck, 1977), *E. ovalis* (Evans, 1953) and *A. largoensis* were reported to be found in the Red River Delta respectively (Nguyen and De Clercq, 2018; Thuan *et al.* 2019; Nguyen, 2019a, 2019b; Nguyen and Dao 2019; Nguyen *et al.* 2019a, 2019b). In this paper, *A. obtuserelus* was first recorded in Vietnamese fauna. Fourteen identified species all belong to the subfamily Amblyseiinae. A key to the Vietnamese Amblyseiinae species is given as below.

Key to the Vietnamese Amblyseiinae species

1. Ventrianal shield oval, *JV1* migrate next to *JV2* 2
— Ventrianal shield non-oval, *JV1* not migrate next to *JV2* 3

2. Spermatheca with calyx slender, tubular . . . . . *Euseius ovalis*
— Spermatheca with calyx short, saccular . . . . . *Euseius aizawai*

3. Setae *S4* absent 4
—Setae *S4* present 5

4. Setae *S5* absent, with seven macrosetae on Leg IV . . . . . *Paraphytoseius orientalis*
— Setae *S5* present, with five macrosetae on Leg IV . . . . . *Paraphytoseius cracentis*

5. *J2* absent 6
— *J2* present 7

6. *S2* absent, Leg I with one or more macrosetae on tibia . . . . . *Proprioseiulus dahonagnas*
— *S2* present, Leg I without elongate macrosetae on tibia . . . . . *Proprioseiopsis lenis*

7. Ratio seta *s4*: *Z1* < 3.0: 1: 0 8
— Ratio seta *s4*: *Z1* > 3.0: 1: 0 10

8. GeII without a macroseta 9
— GeII with a macroseta . . . . . *Scapulaseius asiaticus*

9. Most dorsal setae very long . . . . . *Neoseiulus longispinosus*
— Dorsal setae general long . . . . . *Neoseiulus californicus*

10. Ventrianal shield vase-shaped . . . . . *Amblyseius largoensis*
— Ventrianal shield pentagonal, sub-pentagonal 11

11. Cervix bladder-like, with spines . . . . . *Amblyseius matinikus*
— Cervix tubular or funnel-like 12

12. Leg IV with two macrosetae on genu and basitarsus . . . . . *Graminaseius polisensis*
— Leg with three macrosetae on genu, tibia and basitarsus 13

13. The calyx of spermatheca with an granular surface on the distal part . . . . . *Amblyseius obtuserellus*
— The calyx of spermatheca without an granular surface . . . . . *Amblyseius tamatavensis*

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