



Species of the genus *Euseius* Wainstein (Acari: Phytoseiidae: Amblyseiniinae) from Taiwan

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Abstract

The six mite species of the genus *Euseius* Wainstein from Taiwan are reviewed, including *E. ovalis* (Evans), *E. daluensis* sp. nov., *E. macaranga* sp. nov., *E. paraovalis* sp. nov., and two species recorded for the first time in Taiwan, *E. aizawai* (Ehara & Bhandhufalck) and *E. circellatus* (Wu & Li). Measurements of these species and an identification key for adult females of the six *Euseius* species from Taiwan are provided.

Key words: Phytoseiidae, taxonomy, Taiwan, new species, new record

Introduction

Euseius Wainstein is a genus of phytoseiid mites mainly distributed in tropical and subtropical areas (Chant & McMurtry, 2005, 2007). Among the 193 known species (Demite *et al.*, 2016), only *E. ovalis* has been recorded in Taiwan (Tseng, 1983; Liao *et al.*, 2013).

As generalist predators, *Euseius* mites are considered potential biocontrol agents (McMurtry *et al.*, 2013), although some species have been observed to feed on plant leaves without causing substantial damage (Adar *et al.*, 2012). In Taiwan, *E. ovalis* has been studied for future use as a biological control agent, especially regarding its response to different food resources and its predator-prey interactions (Shih *et al.*, 1993; Shih & Wang, 1997). Recently, Nguyen & Shih (2010, 2011, 2012) compared the development and predation rates of *Neoseiulus womersleyi* (Schicha) and *E. ovalis*. *Euseius ovalis* demonstrated better biocontrol potential as a predator of *Oligonychus mangiferus*. In China, *E. aizawai* was reported as a natural enemy that can control the citrus red mite in central Guizhou (Li *et al.*, 2006).

Previous studies have revealed 53 species from the islands of Taiwan (Ehara, 1970; Lo, 1970; Tseng, 1972, 1973, 1975, 1976; Chang & Tseng, 1978; Tseng, 1983; Ho & Lo, 1989; Ho *et al.*, 2003). These studies mainly focused on agricultural areas in the main island of Taiwan, and include little information from mountain areas. To gain a more comprehensive understanding of the Phytoseiidae of Taiwan, we paid special attention to mountain areas of higher altitude, and collected mainly from wild plants. We here describe the species of *Euseius* found during this survey, and provide a key for identification of their females.

Materials and methods

Specimens were collected from various plants from Taiwan and surrounding islands during 1985–2016, with a particular focus on mountainous areas. Specimens were mounted in Hoyer's medium. Poor quality specimens were soaked with water, bleached in a high concentration (50%) H₂O₂ until the cuticle colour returned to normal, rinsed in ethanol (75%) (Yeh *et al.*, 2008), and remounted in Hoyer's medium. Specimens were examined under an optical microscope (Olympus BX51), and measured using stage-calibrated ocular micrometers and ImageJ 1.47 software

(Schneider *et al.*, 2012). All measurements are provided in micrometres. Holotype measurements are shown in bold type for the new species, followed by their mean and range in parentheses. Measurements of the paratypes of *E. aizawai* (Ehara & Bhandhufalck) are provided in square brackets. The general terminology used for morphological descriptions in this study follows Chant & McMurtry (2007), while idiosomal seta terminology follows Rowell *et al.* (1978) and Chant & Yoshida-Shaul (1991, 1992). Adenotaxy and poroidotaxy follow Beard (2001).

Type specimens and voucher specimens were deposited in the following institutions: ESALQ-USP (Escola Superior de Agricultura Luiz de Queiroz, Piracicaba, State of São Paulo, Brazil), NCHU (Department of Entomology, National Chung Hsing University, Taichung, Taiwan), NMNS (National Museum of Natural Science, Taichung, Taiwan), NTU (Department of Entomology, National Taiwan University, Taipei, Taiwan), NPUST (National Pingtung University of Science and Technology, Pingtung County, Taiwan), TARI (Taiwan Agricultural Research Institute, Taichung City, Taiwan), TARL (Taiwan Acari Research Laboratory, Taichung City, Taiwan). Other specimens were received on loan from acarological collections of HUM (Hokkaido University Museum, Sapporo, Japan) and NSMT (National Museum of Nature and Science, Tsukuba, Japan). If necessary, the locality names were translated using the Geographic Name Information System, Department of Land Administration, Ministry of the Interior (Taiwan) (<http://gn.moi.gov.tw/geonames/Translation/Translation.aspx>).

Results

Overall, specimens from six species belonging to the *Euseius* were collected and identified. Specific information on the species is provided as follows. Three species, *E. daluensis* **sp. nov.**, *E. macaranga* **sp. nov.** and *E. paraovalis* **sp. nov.** are new to science. Two species, *E. aizawai* (Ehara & Bhandhufalck) and *E. circellatus* (Wu & Li), were recorded from Taiwan for the first time. Specimens from the remaining species, *E. ovalis*, were measured for comparison. In addition, an identification key for all species of the *Euseius* from Taiwan is provided.

Family Phytoseiidae Berlese

Euseius aizawai (Ehara & Bhandhufalck)

Amblyseius (*Amblyseius*) *aizawai* Ehara & Bhandhufalck, 1977: 59.

Amblyseius aizawai.—Liang & Ke, 1983: 163.

Amblyseius (*Euseius*) *aizawai*.—Ehara, 2002b: 36.

Euseius aizawai.—Moraes *et al.* 1986: 36.

Female (n=10). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

Dorsum. Dorsal shield smooth, with lateral reticulation, 334 (288–359) [325] long (*j1*–*J5* level) and 236 (206–265) [206] wide at level of *j6*, 214 (168–238) [211] wide at level of *S4*; with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*), ten pairs of lyrifissures (*idl1*, *idl1a*, *id4*, *idl1*, *idl3*, *idm3*, *idl4*, *idm4*, *idm5*, *idm6*); length of dorsal setae: setae *j1* 30 (27–34) [27], *j3* 29 (24–40) [23], *j4* 9 (6–10) [6], *j5* 8 (4–11) [4], *j6* 10 (7–12) [4], *J2* 11 (9–14) [6], *J5* 6 (5–7) [2], *z2* 18 (12–22) [12], *z4* 17 (12–22) [12], *z5* 9 (8–11) [6], *Z1* 12 (9–14) [8], *Z4* 12 (10–14) [8], *Z5* 52 (54–59) [53], *s4* 26 (22–31) [23], *S2* 17 (15–20) [13], *S4* 21 (18–20) [16], *S5* 21 (17–28) [14], *r3* 14 (10–17) [9], *R1* 13 (11–14) [10]. All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme extending to *z2*, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternal shield smooth, with projection on posterior margin, wider than long, 66 (57–77) [63] long, 87 (81–92) [82] wide at level of *st3*, with three pairs of setae *st1* 28 (20–32) [32], *st2* 24 (16–30) [23], *st3* 23 (18–27) [18], and two pairs of lyrifissures (*pst1*, *pst2*). Metasternal platelets drop-shaped, with one pair of metasternal setae, *st4* 20 (16–22) [18], and one pair of lyrifissures (*pst3*). Genital shield smooth, 82 (75–89) [77] wide at level of genital setae, with one pair of genital setae *st5* 24 (20–29) [20]. Distances between *st1*–*st1* 52 (47–60) [51], *st2*–*st2* 61 (57–68) [58], *st3*–*st3* 66 (59–72) [67], *st1*–*st3* 54 (49–59) [49], *st5*–*st5* 68 (60–76) [64]. Ventrianal shield smooth, vase-shaped, 95 (88–102) [93] long, 51 (45–59) [53] wide at level of *ZV2*, 72 (64–79) [74] wide at level of anus;

with three pairs of pre-anal setae, *JV1* near *JV2*, *JV1* 26 (21–30) [22], *JV2* 22 (18–28) [19], *ZV2* 17 (14–20) [12], solenostomes *gv3* crescentic; *Pa* 12 (10–15) [10], *Pst* 12 (8–15) [7] on shield. Setae *JV4* 9 (6–11) [4], *JV5* 32 (24–39) [30], *ZV1* 18 (12–20) [17], *ZV3* 9 (7–10) [5] on interscutal membrane. All ventral setae smooth. Two pairs of metapodal platelets 18 (15–21) [16] long, 6 (5–7) [4] wide, 11 (8–15) [9] long, 2 (2–3) [1] wide.

Chelicera. Movable digit 21 (19–23) [20] long, with one tooth; fixed digit 23 (21–24) [21] long, anterior half with three teeth, without pilus dentilis.

Spermatheca. Calyx funnel-shaped, 13 (10–16) [14] long, 8 (6–10) [8] wide, atrium with neck, indistinguishable embolus, with a thin major duct.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 1 3/1 2/3 1, 2 2/2 2/1 1, 2 2/2 2/1 1, 1 1/1 1 1; leg II, 1 3/1 2/1 1, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 2/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *Sge* II (pd1) 21 (19–21) [25]; *Sge* III (ad1) 30 (27–36) [22], *Sti* III (ad1) 25 (23–28) [25], *St* III (ad1) 30 (27–37) [21]; *Sge* IV 37 (32–40) [32], *Sti* IV 35 (31–38) [32], *St* IV 58 (48–66) [65].

Male (n=5). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3, 4:ZV-1, 3.

Dorsum. Dorsal shield smooth, with lateral reticulation, 238 (230–248) long (*j1*–*J5* level) and 192 (181–197) wide at level of *j6*, 162 (157–167) wide at level of *S4*; with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*), ten pairs of lyrifissures (*idl1*, *idl1a*, *id2*, *id4*, *is1*, *idl1*, *idl3*, *idl4*, *idm5*, *idm6*); length of dorsal setae: setae *j1* 23 (21–24), *j3* 22 (20–23), *j4* 5 (4–6), *j5* 5 (4–6), *j6* 7 (5–10), *J2* 8 (6–11), *J5* 3 (3–4), *z2* 10 (7–15), *z4* 11 (9–14), *z5* 6 (5–6), *Z1* 7 (6–7), *Z4* 8 (6–10), *Z5* 43 (40–44), *s4* 20 (19–23), *S2* 13 (12–15), *S4* 17 (15–21), *S5* 19 (17–21), *r3* 10 (9–10), *R1* 10 (8–12). All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme extending beyond *z2*, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternogenital shield smooth, posterior margin almost straight, longer than wide, 115 (104–122) long, 67 (60–74) wide at level of *st5*, with five pairs of setae *st1* 21 (19–23), *st2* 17 (14–20), *st3* 18 (15–21), *st4* 14 (12–17), *st5* 15 (13–18) and three pairs of lyrifissures (*pst1*, *pst2*, *pst3*). Distances between *st1*–*st1* 47 (44–53), *st2*–*st2* 53 (48–56), *st3*–*st3* 49 (46–51), *st4*–*st4* 44 (39–47), *st5*–*st5* 34 (30–39), *st1*–*st5* 99 (95–101). Ventrianal shield subtriangular, slightly reticulated, 95 (91–100) long and 143 (140–147) wide at level of anterior corner, 48 (44–53) wide at level of anus, fused with peritrematic shield cingulum; with three pairs of pre-anal setae, arranged in tangential row, *JV1* 15 (14–18), *JV2* 15 (12–17), *ZV2* 10 (6–13), solenostomes *gv3* crescentic; *Pa* 7 (7–7), *Pst* 12 (9–15) on shield. Setae *JV5* 19 (16–23) on interscutal membrane. All ventral setae smooth.

Chelicera. Movable digit 18 (17–20) long, with one tooth; fixed digit 22 (20–24) long, anterior half with three teeth, without pilus dentilis. Spermatodactyl U-shaped, shaft 22 (21–23) long, heel rounded, foot 10 (8–13) long, with expanded toe and lateral thorn-like projection.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 1 3/1 2/3 1, 2 2/2 2/1 1, 2 2/2 2/1 1, 1 1/1 1; leg II, 1 3/1 2/1 1, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 2/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *Sge* II 16 (16–19), *Sge* III 19 (15–23), *Sti* III 18 (15–19), *St* III 20 (17–23), *Sge* IV 29 (27–31), *Sti* IV 28 (25–31), *St* IV 44 (43–44).

Specimens examined. TAIWAN: Wuling Farm, Heping District, Taichung City (24°22.667' N, 121°18.494' E, 1774m), eight females from *Prunus campanulata* (Rosaceae), 19.x.2009, J.R. Liao & C.C. Ho (NTU); Zhiliang, Heping District, Taichung City (24°20.144' N, 121°18.756' E, 1924m), two females two males from *Prunus campanulata* (Rosaceae), 19.x.2009, J.R. Liao & C.C. Ho (NTU); Zhiliang, Heping District, Taichung City (24°20.539' N, 121°18.486' E, 2334m), one female one male from *Prunus campanulata* (Rosaceae), 19.x.2009, J.R. Liao & C.C. Ho (NTU); Lishan, Heping District, Taichung City (24°15.263' N, 121°15.057' E, 1989m), two females one male from *Morus alba* (Moraceae), 20.x.2009, J.R. Liao & C.C. Ho (NTU); Huanshan, Heping District, Taichung City (24°18.493' N, 121°17.422' E, 1704m), one female from *Solanum nigrum* (Solanaceae), 20.x.2009, J.R. Liao & C.C. Ho (NTU); Huanshan, Heping District, Taichung City (24°19.119' N, 121°17.151' E, 1583m), four females one male from *Tetradium glabrifolium* (Rutaceae), 20.x.2009, J.R. Liao & C.C. Ho (NTU); Huanshan, Heping District, Taichung City (24°19.119' N, 121°17.151' E, 1583m), one female from *Tabebuia chrysantha* (Bignoniaceae), 21.x.2009, J.R. Liao & C.C. Ho (NTU); Dalu Forest Road, Wufeng Township, Hsinchu County (24°32.470' N, 121°06.733' E, 1279m), five females two male from *Morus alba* (Moraceae), 20.i.2010, Y.H. Chiang & J.R. Liao (NTU); Dalu Forest Road, Wufeng Township, Hsinchu County (24°32.061' N, 121°07.110' E, 1570m), three females from *Debregeasia orientalis* (Urticaceae), 20.i.2010, Y.H. Chiang & J.R.

Liao (NTU); Daoxiang Rd., Beitou District, Taipei City (25°08.818' N, 121°28.960' E, 213m), two females one male from *Michelia compressa* (Magnoliaceae), 9.ii.2010, J.R. Liao & S.W. Kong (NPUST); Taizhi Temple Park, Xinying District, Tainan City (23°17.652' N, 120°16.432' E, 9m), one female from *Bischofia javanica* (Euphorbiaceae), 20.ii.2010, J.R. Liao (NTU); Chaishan, Gushan District, Kaohsiung City (22°39.034' N, 120°16.481' E, 101m), one female from unknown plant, 11.iii.2010, J.R. Liao & S.W. Kong (NTU); Chaishan, Gushan District, Kaohsiung City (22°39.034' N, 120°16.481' E, 101m), one female from *Macaranga tanarius* (Euphorbiaceae), 11.iii.2010, J.R. Liao & S.W. Kong (NTU); Shitou Mountain, Xindian District, New Taipei City (24°57.671' N, 121°32.481' E, 123m), one female from unknown plant, 17.iv.2010, J.R. Liao (NCHU); Shitou Mountain, Xindian District, New Taipei City (24°57.568' N, 121°32.564' E, 155m), nine females one male from *Prunus campanulata* (Rosaceae), 17.iv.2010, J.R. Liao (NMNS); Nanzhuang Township, Miaoli County (24°38.365' N, 120°57.342' E, 94m), one male from *Dimocarpus longan* (Sapindaceae), 19.iv.2010, J.R. Liao (NCHU); Nanzhuang Township, Miaoli County (24°32.212' N, 120°57.190' E, 772m), one female from *Debregeasia edulis* (Urticaceae), 19.iv.2010, J.R. Liao (NTU); Qingshi Road, Wufeng Township, Hsinchu County (24°33.789' N, 121°06.772' E, 924m), one female from *Morus alba* (Moraceae), 3.v.2010, J.R. Liao & Y.H. Chiang (NTU); Qingshi Road, Wufeng Township, Hsinchu County (24°33.789' N, 121°06.774' E, 926m), one female from *Turpinia formosana* (Staphyleaceae), 3.v.2010, J.R. Liao & Y.H. Chiang (NTU); Jinping Road, Jianshi Township, Hsinchu County (24°41.164' N, 121°13.581' E, 447m), three females from *Cinnamomum osmophloeum* (Lauraceae), 17.v.2010, J.R. Liao & Y.H. Chiang (NTU); Maokong, Wenshan District, Taipei City (24°20.539' N, 121°18.486' E, 2334m), one female three males from *Ficus* sp. (Moraceae), 9.vi.2010, J.R. Liao & A.K. Dubey (NTU); Maokong, Wenshan District, Taipei City (24°58.062' N, 121°35.332' E, 313m), one female from *Cinnamomum osmophloeum* (Lauraceae), 9.vi.2010, J.R. Liao & A.K. Dubey (NTU); Maokong, Wenshan District, Taipei City (24°58.062' N, 121°35.332' E, 313m), seven females from unknown plant, 9.vi.2010, J.R. Liao & A.K. Dubey (NTU); Maokong, Wenshan District, Taipei City (24°58.062' N, 121°35.332' E, 313m), two females from *Cocos nucifera* (Arecaceae), 9.vi.2010, J.R. Liao & A.K. Dubey (NTU); Dalu Forest Road, Wufeng Township, Hsinchu County (24°32.165' N, 121°06.852' E, 1334m), four females one male from *Morus alba* (Moraceae), 13.viii.2010, C.T. Chen & J.R. Liao (TARL); Dalu Forest Road, Wufeng Township, Hsinchu County (24°32.165' N, 121°06.852' E, 1334m), one female from *Debregeasia orientalis* (Urticaceae), 13.viii.2010, C.T. Chen & J.R. Liao (NTU); Jiabao Mountain, Fuxing District, Taoyuan City (24°49.138' N, 121°21.195' E, 441m), one female from *Quercus glauca* (Fagaceae), 24.viii.2010, Y.J. Tsao & J.R. Liao (NTU); Baling, Fuxing District, Taoyuan City (24°40.515' N, 121°24.001' E, 881m), one female from *Morus alba* (Moraceae), 28.viii.2010, J.R. Liao & C.T. Chen (NTU); Baling, Fuxing District, Taoyuan City (24°40.515' N, 121°24.001' E, 881m), one female from *Quercus glauca* (Fagaceae), 28.viii.2010, J.R. Liao & C.T. Chen (NTU); LaLa mountain, Fuxing District, Taoyuan City (24°41.463' N, 121°34.717' E, 1207m), one female from *Debregeasia orientalis* (Urticaceae), 28.viii.2010, J.R. Liao & C.T. Chen (NTU); Jiali Mountain, Nanzhuang Township, Miaoli County (24°31.651' N, 121°01.599' E, 1326m), two females from *Diospyros* sp. (Ebenaceae), 13.x.2010, J.R. Liao (NTU); Jiali Mountain, Nanzhuang Township, Miaoli County (24°31.651' N, 121°01.599' E, 1326m), three females three males (MZLQ 7598 to MZLQ 7603) from *Litsea* sp. (Lauraceae), 13.x.2010, J.R. Liao (ESALQ-USP); Lunbei Township, Yunlin County (23°46.480' N, 120°21.713' E, 15m), one female from *Morus alba* (Moraceae), 24.x.2010, J.F. Hsieh & C.T. Chen (NTU); Simaxian, Tai'an Township, Miaoli County (24°24.679' N, 120°56.725' E, 852m), one female from *Phoebe formosana* (Lauraceae), 31.x.2010, J.R. Liao & W. C. Yang (NTU); Sandimen Township, Pingtung County (22°43.866' N, 120°40.059' E, 487m), one female from unknown plant, 20.xi.2010, J.R. Liao (NTU); Laonong, Liugui District, Kaohsiung City (22°55.785' N, 120°39.148' E, 224m), one female from *Bauhinia variegata* (Fabaceae), 20.xi.2010, J.R. Liao (NTU); Guanziling, Baihe District, Tainan City (23°19.301' N, 120°29.014' E, 451m), three females from *Bauhinia blakeana* (Fabaceae), 11.i.2011, J.R. Liao (NTU); Guanziling, Baihe District, Tainan City (23°19.301' N, 120°29.014' E, 451m), one female from *Colocasia esculenta* (Araceae), 11.i.2011, J.R. Liao (NTU); Guanziling, Baihe District, Tainan City (23°19.301' N, 120°29.014' E, 451m), three females from *Mangifera indica* (Anacardiaceae), 11.i.2011, J.R. Liao (NTU); Jinfeng Township, Taitung County (22°35.779' N, 120°57.244' E, 132m), one male from *Macaranga tanarius* (Euphorbiaceae), 23.i.2011, J.R. Liao & J.F. Hsieh (NTU); Paomagudao, Jiaoxi Township, Yilan County (24°50.276' N, 121°46.346' E, 147m), one female from *Carica papaya* (Caricaceae), 9.ii.2011, J.R. Liao (NTU); Caopingtou, Xinyi Township, Nantou County (23°33.447' N, 120°52.575' E, 1119m), two females from *Prunus campanulata* (Rosaceae), 24.iv.2011, J.R. Liao (NTU); Caopingtou, Xinyi Township, Nantou County (23°33.447' N, 120°52.575' E, 1119m), one female from *Machilus*

zuihensis (Lauraceae), 24.iv.2011, J.R. Liao (NTU); Nanqing Highway, Zhudong Township, Hsinchu County (24°40.634' N, 121°05.987' E, 203m), two females one male from *Dendrocalamus latiforus* (Poaceae), 30.vi.2014, J.R. Liao (NTU); Jinshuiying Historic Trail, Chunri Township, Pingtung County (22°24.766' N, 120°43.628' E, 1078m), one female from *Turpinia formosana* (Staphyleaceae), 24.vi.2014, J.R. Liao (NTU); Shenshan, Wutai Township, Pingtung County (22°44.986' N, 120°43.640' E, 740m), one female from *Pachira aquatica* (Malvaceae), 25.vi.2014, J.R. Liao (NTU); Shimen Reservoir, Longtan District, Taoyuan City (24°49.221' N, 121°12.473' E, 286m), two females from *Morus alba* (Moraceae), 30.v.2010, J.R. Liao (NTU); Shimen Reservoir, Longtan District, Taoyuan City (24°49.221' N, 121°12.473' E, 286m), one female from *Schefflera octophylla* (Araliaceae), 30.v.2010, J.R. Liao (NTU). THAILAND: Chiang Dao, one paratype female (ZIHU-3608) from *Carica papaya* (Caricaceae), 4.xi.1970, S. Ehara (HUM).

Distribution. Asia: China: Guangdong (Liang & Ke, 1983), Guangxi (Moraes *et al.*, 1989), Hainan (Chen *et al.*, 1980), Yunnan (Liang & Ke, 1983), Malaysia (Ehara, 2002b), Taiwan (present study), Thailand (Ehara & Bhandhufalck, 1977).

Remarks. The females of this species resemble those of *E. ovalis* (Evans, 1953), but differ in the reticulation of the anterolateral margin of the dorsal shield; seta *j1* is slightly longer than *j3* (*j1* is apparently longer than *j3* in *E. ovalis*), and the calyx of the spermatheca is funnel-shaped (tubular in *E. ovalis*). The females of this species are also similar to those of *E. nicholsi* (Ehara & Lee, 1971) but differ in the dorsal shield being lightly sclerotised (strongly sclerotised in *E. nicholsi*). We also observed some Taiwanese female specimens that differed from other Taiwanese specimens (dorsal shield with lateral reticulation) only in dorsal shield with strong reticulation except for the central part of the podosoma, with no other observable differences between them. We suggest that this is an intraspecific variation, but this requires more evidences for validation. We also observed one undetermined male specimen on the paratype slide (ZIHU-3608), that belongs to the genus *Amblyseius*.

Li *et al.* (2006) reported that *E. aizawai* is a natural enemy that can control citrus red mite (*Panonychus citri*) on citrus leaves in central Guizhou. They fed *E. aizawai* with 19 different types of pollen to rear it in the laboratory. They considered the pollens could be an alternative food for mass-rearing in the laboratory, and can also help the *E. aizawai* survive in the field when spider mite numbers are too low.

In Taiwan, *E. aizawai* and *E. ovalis* are distributed across all the islands and are easy to collect. However, by comparing the collection records of these two species, we observed *E. aizawai* was located from flat ground to high mountain areas (approximately 2400 m) (e.g., Wuling Farm, an organic farm located in a high altitude mountain area), but *E. ovalis* was primarily located in developed flat ground areas. Additionally, in some cases (e.g., Maokong, Taipei City), these two species were located at the same collection site, but on different host plants. In one case in Guanaziling, Tainan City, these two species were simultaneously collected from the same plant, *Mangifera indica*. Accordingly, we suggest that *E. aizawai* and *E. ovalis* share similar ecological niches, (i.e. type IV pollen feeding generalist predators). *E. aizawai* was observed to occur with other phytoseiid mites such as *Amblyseius eharai*, *A. herbicolus*, and *E. ovalis*. We suspect that they are competitors in the field. Additionally, we observed that this species feeds on spider mites such as *Panonychus citri* and *Tetranychus kanzawai*. Therefore, this species may have biocontrol potential in the field, but this needs further study.

***Euseius circellatus* (Wu & Li)**

Amblyseius (*Amblyseius*) *circellatus* Wu & Li, 1983: 173.

Typhlodromalus circellatus.—Moraes *et al.*, 1986: 128.

Amblyseius circellatus.—Wu *et al.*, 1997: 77.

Amblyseius (*Neoseiulus*) *circellatus*.—Ehara, 2002a: 125.

Amblyseius (*Neoseiulus*) *circillatus* [sic].—Wu *et al.*, 2009: 80.

Euseius circellatus.—Chant & McMurtry, 2005: 215.

Female (n=6). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

hield with lateral reticulation, 268 (251–278) long (*j1*–*J5* level) and 160 (150–170) wide at level of *j6*, 148 (143–155) wide at level of *S4*; with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*), seven pairs of lyrifissures (*idl1*, *idl1a*, *id2*, *id4*, *is1*, *idl2*, *idm5*); length of setae: *j1* 21 (19–24), *j3* 21 (19–24), *j4* 16 (15–17), *j5* 17 (15–20), *j6* 15 (14–18), *J2* 15 (13–17), *J5* 5 (4–6), *z2* 22 (190–26), *z4* 23 (21–25), *z5* 17 (14–18), *Z1* 16 (14–17), *Z4*

16 (14–18), *Z5* 39 (37–43), *s4* 32 (25–35), *S2* 19 (16–21), *S4* 16 (11–18), *S5* 17 (14–19), *r3* 21 (17–24), *R1* 13 (8–15); All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme reaching beyond *z4* level, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternal shield smooth, with projection on posterior margin, wider than long, 58 (51–64) long, 81 (76–86) wide at *st3* level, with three pairs of setae *st1* 24 (22–26), *st2* 22 (16–27), *st3* 20 (15–22), and two pairs of lyrifissures (*pst1*, *pst2*). Metasternal platelets drop-shaped, with one pair of metasternal setae, *st4* 18 (12–22), and one pair of lyrifissures (*pst3*). Genital shield smooth, 69 (63–75) wide at level of genital setae, with one pair of genital setae *st5* 20 (17–22). Distances between *st1–st1* 49 (47–51), *st2–st2* 53 (51–56), *st3–st3* 62 (60–64), *st1–st3* 50 (48–51), *st5–st5* 56 (53–59). Ventrianal shield smooth, vase-shaped, 84 (81–87) long, 41 (39–43) wide at level of *ZV2*, 53 (47–56) wide at level of anus; with three pairs of pre-anal setae, arranged in a triangular pattern, *JV1* 18 (14–23), *JV2* 17 (11–19), *ZV2* 18 (13–24), solenostomes *gv3* crescentic; *Pa* 12 (11–17), *Pst* 12 (10–14) on shield. Setae *JV4* 10 (7–12), *JV5* 23 (17–25), *ZV1* 19 (14–21), *ZV3* 11 (5–13) on interscutal membrane. All ventral setae smooth. Two pairs of metapodal platelets 20 (17–25) long, 2 (1–2) wide, 13 (10–15) long, 3 (2–3) wide.

Chelicera. Movable digit 19 (17–23) long, with one tooth; fixed digit 21 (20–24) long, anterior half with five teeth, without pilus dentilis.

Spermatheca. Calyx funnel-shaped, 14 (13–15) long, 1 (1–2) wide, atrium sac-shaped with thick walls.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 2, 2 2/1 2/1 2, 2 2/1 2/2 2, 1 1/1 1; leg II, 1 3/2 2/1 0, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/2 1/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 2 2/0 2/1 0, 2 1/0 2/1 1, 1 1/1 1. Macrosetae: *St* IV48 (42–50).

Male (n=6). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3, 4:ZV-1, 3.

Dorsal shield with lateral reticulation, 207 (196–213) long (*j1–J5* level) and 141 (130–147) wide at level of *j6*, 99 (94–107) wide at level of *S4*; with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*), seven pairs of lyrifissures (*idl1*, *idl1a*, *id2*, *id4*, *is1*, *idl2*, *idm5*); length of setae: *j1* 17 (16–19), *j3* 21 (17–27), *j4* 17 (15–18), *j5* 17 (15–20), *j6* 16 (12–20), *J2* 14 (12–16), *J5* 4 (3–6), *z2* 22 (21–22), *z4* 22 (21–25), *z5* 16 (14–17), *Z1* 15 (12–19), *Z4* 16 (14–18), *Z5* 32 (30–34), *s4* 28 (25–29), *S2* 17 (12–19), *S4* 14 (11–17), *S5* 17 (14–21), *r3* 18 (15–20), *R1* 12 (10–15); All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme reaching beyond *z4* level, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternogenital shield smooth, slightly lateral reticulated, posterior margin almost straight, longer than wide, 109 (105–114) long, 59 (53–64) wide at level of *st5*, with five pairs of setae *st1* 19 (17–23), *st2* 19 (17–228), *st3* 17 (14–20), *st4* 15 (11–18), *st5* 15 (13–17), and three pairs of lyrifissures (*pst1*, *pst2*, *pst3*). Distances between *st1–st1* 37 (32–41), *st2–st2* 44 (37–48), *st3–st3* 43 (37–46), *st4–st4* 37 (33–39), *st5–st5* 24 (19–26), *st1–st5* 87 (78–96). Ventrianal shield subtriangular, slightly reticulated, 81 (75–93) long and 118 (109–133) wide at level of anterior corner, 41 (38–50) wide at level of anus, fused with peritrematic shield cingulum, with three pairs of pre-anal setae, arranged in a triangular pattern, solenostome *gv3* crescentic, *JV1* 12 (9–15), *JV2* 12 (9–16), *ZV2* 14 (12–17), *Pa* 8 (5–10), *Pst* 9 (7–12) on shield. Setae *JV5* 20 (18–21) on interscutal membrane. All ventral setae smooth.

Chelicera. Movable digit 17 (15–23) long, with one tooth; fixed digit 19 (16–20) long, anterior half with five teeth, without pilus dentilis. Spermatodactyl U-shaped, shaft 17 (15–22) long, heel rounded, foot 19 (16–20) long, with narrow toe and lateral thorn-like projection.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 2, 2 2/1 2/1 2, 2 2/1 2/2 2, 1 1/1 1; leg II, 1 3/2 2/1 0, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/2 1/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 2 2/0 2/1 0, 2 1/0 2/1 1, 1 1/1 1. Macrosetae: *St* IV 41 (37–45).

Specimens examined. TAIWAN: Dongpu, Xinyi Township, Nantou County, two females from Leguminosae plant, 18.x.1985, C.C. Ho (TARL), Taoshan Village, Wufeng township, Hsinchu County (24°32.165' N, 121°06.852' E, 1337m), one female and male from *Conyza sumatrensis* (Asteraceae), 13.viii.2010, J.R. Liao & C.T. Chen (NTU); Jinping Road, Jianshi Township, Hsinchu County (24°40.185' N, 121°16.296' E, 1057m), one female from *Mallotus japonicus* (Chamaesyce), 17.iv.2014, J.R. Liao (NTU); Simaxian, Tai'an Township, Miaoli County (24°24.466' N, 120°56.309' E, 818m), five male from *Pueraria lobata* (Fabaceae), 2.v.2016, J.R. Liao (NTU); Simaxian, Tai'an Township, Miaoli County (24°24.466' N, 120°56.309' E, 818m), one female from *Broussonetia papyrifera* (Moraceae), 2.v.2016, J.R. Liao (NTU); Simaxian, Tai'an Township, Miaoli County (24°24.333' N, 120°58.561' E, 1267m), one female from *Pueraria lobata* (Fabaceae), 2.v.2016, J.R. Liao (NMNS).

Distribution. Asia: China, Fujian (Wu & Li, 1983), Guangdong (Wu *et al.*, 2009), Hainan (Wu *et al.*, 2009), Yunnan (Wu *et al.*, 2009), Indonesia (Sumatra) (Ehara, 2002a), Taiwan (present study).

Remarks. The Taiwanese female specimens mostly agreed with the descriptions of Chinese and Sumatran specimens by Wu & Li (1983) and Ehara (2002a). However, we observed slight differences among them: (1) Chinese specimens have anterolateral reticulation on the dorsal shield but Taiwanese and Sumatran specimens have lateral reticulation. (2) Taiwanese specimens have *St* IV length of 48 (43–50) μm but Chinese specimens have 30 μm , and Sumatran specimens have $29.0 \pm 0.6 \mu\text{m}$. (3) Ehara (2002a) mentioned that in Sumatran specimens' *st4* is located on metasternal platelets, which is in agreement with Taiwanese specimens but not with Chinese specimens, where it is on the interscutal membrane. Wu & Li (1983) reported that in the Chinese specimens *st4* is located on metasternal platelets, but without an illustration. Wu *et al.* (1997) reported that in Chinese specimens *st4* is located on metasternal platelets in the text, but on interscutal membrane in the illustration. Wu *et al.* (2009) showed Chinese specimens as having *st4* located on the interscutal membrane in both the text and illustration. In addition, the Taiwanese female specimens resembles *E. dowdi* (Schicha, 1993) in the special spermatheca calyx and the length of *St* IV being 47–50 μm , but differs in lateral reticulation on the dorsal shield (smooth in *E. dowdi*).

Ehara (2002a) mentioned that *Euseius circellatus* might be a junior synonym of the Indian species *E. kalimpongensis* Gupta (1969); however, we observed differences between them: *E. kalimpongensis* has a smooth dorsal shield and a concave posterior margin of the sternal shield.

***Euseius daluensis* Liao & Ho sp. nov.**

(Figs 1–15)

Female (n=6). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

Dorsum (Fig. 1). Dorsal shield with anterolateral reticulation; **293** 312 (285–335) long (*j1*–*J5* level) and **208** 217 (204–234) wide at level of *j6*, **199** 207 (183–220) wide at level of *S4*; five pairs of solenostomes on dorsal shield, (*gd2*, *gd4*, *gd6*, *gd8*, *gd9*), seven pairs of lyrifissures (*idl*, *idl1a*, *id2*, *id4*, *idl3*, *idl4*, *idm5*); length of setae: *j1* **23** 27 (23–32), *j3* **19** 21 (15–27), *j4* **6** 6 (4–5), *j5* **3** 5 (3–6), *j6* **6** 6 (5–9), *J2* **8** 8 (6–10), *J5* **3** 3 (2–5), *z2* **9** 10 (7–13), *z4* **8** 9 (6–12), *z5* **6** 6 (4–7), *Z1* **6** 8 (6–11), *Z4* **9** 9 (8–11), *Z5* **46** 51 (46–56), *s4* **14** 16 (7–24), *S2* **10** 11 (8–14), *S4* **9** 11 (9–14), *S5* **12** 12 (9–14), *r3* **8** 9 (8–1), *R1* **7** 8 (6–10). All setae smooth, except *Z5* slightly serrate.

Peritreme (Figs 1–2). Peritreme extending to level of *z2*, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

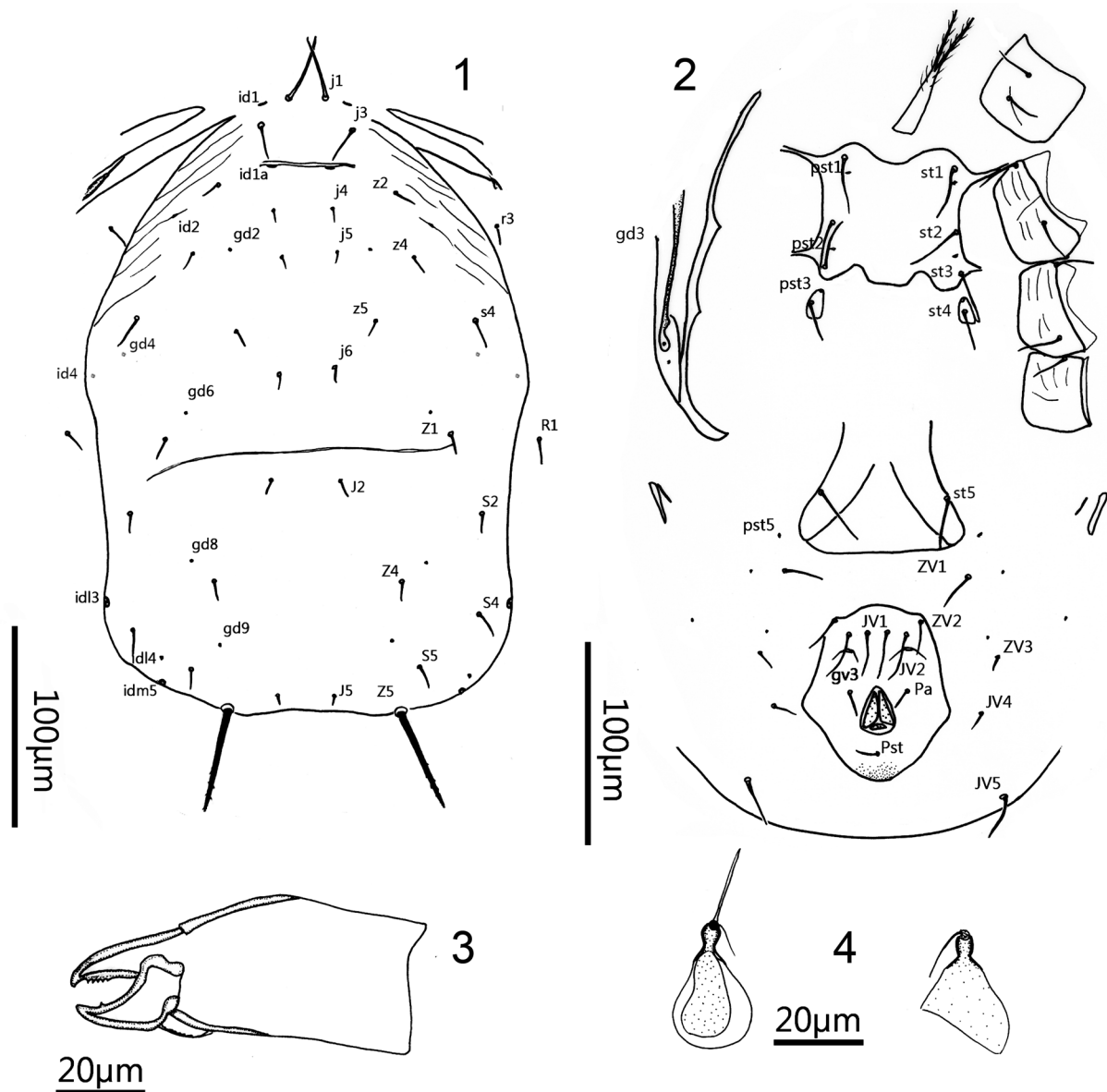
Venter (Fig. 2). Sternal shield smooth, posterior margin with median projection, much wider than long, **60** 63 (51–71) long, **82** 85 (75–95) wide, with three pairs of setae *st1* **25** 26 (23–28), *st2* **26** 26 (23–28), *st3* **23** 23 (22–24), and two pairs of lyrifissures (*pst1*, *pst2*). Exopodal shield II–IV almost reaching coxa I. Metasternal platelets drop-shaped, with one pair metasternal setae, *st4* **19** 21 (19–23) and one pair of lyrifissures (*pst3*). Genital shield smooth, with one pair of genital setae *st5* **23** 25 (21–30), **76** 81 (74–86) wide at level of genital setae. Distances between *st1*–*st1* **53** 53 (49–55), *st2*–*st2* **62** 63 (58–67), *st3*–*st3* **62** 63 (58–67), *st1*–*st3* **51** 54 (51–56), *st5*–*st5* **62** 66 (57–78). Ventrianal shield vase-shaped **91** 92 (83–99) long, **49** 52 (48 60) wide at level of *ZV2*, **69** 71 (69–76) wide at level of anus; with three pairs of pre-anal setae, *JV1* migrate next to *JV2*, *JV1* **24** 25 (20–27), *JV2* **22** 22 (18–26), *ZV2* **16** 17 (13–21), solenostomes *gv3* crescentic; *Pa* **7** 10 (7–12), *Pst* **10** 12 (9–16) on shield. Setae *JV4* **7** 9 (5–12), *JV5* **22** 24 (17–29), *ZV1* **19** 19 (16–21), *ZV3* **7** 8 (5–11) on interscutal membrane. All ventral setae smooth. Two metapodal plates **21** 22 (21–23) long, **4** 4 (1–10) wide, **11** 13 (10–17) long, **1** 3 (2–4) wide.

Spermatheca (Fig. 4). Calyx funnel-shaped, **8** 7 (5–9) long, **6** 6 (4–8) wide, atrium with contracted neck, indistinguishable embolus, with a thin major duct.

Chelicera (Fig. 3). Movable digit **20** 21 (20–24) long, with one tooth; fixed digit **25** 24 (22–27) long, anterior half with five teeth, without pilus dentilis.

Legs (Figs 5–8). Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 2, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1 1; leg II, 2 3/1 2/1 1, 2 2/0 2/0 1, 1 2/1 1/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *Sge* III (ad2) **28** 30 (26–37), *Sge* IV (ad2) **35** 38 (33–46), *Sti* IV (ad1) **35** 34 (30–36), *St* IV (pd1) **55** 59 (50–67).

Male. (n=1). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3, 4:ZV-1, 3.



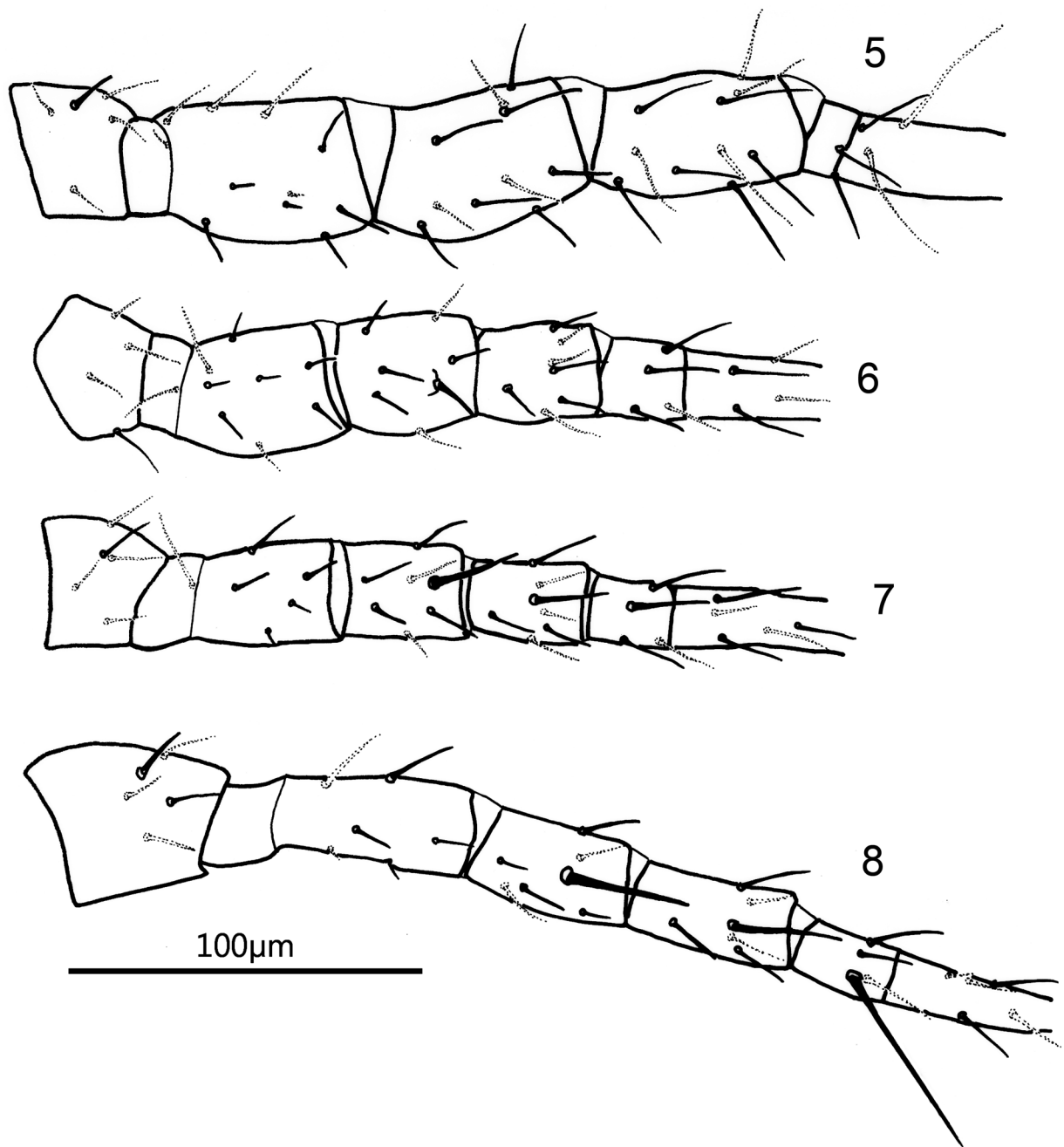
FIGURES 1–4. *Euseius daluensis* sp. n. Female, 1. dorsal shield, 2. ventral idiosoma, 3. chelicera, 4. spermatheca.

Dorsum (Fig. 9). Dorsal shield with lateral reticulation; 230 long (*j1*–*J5* level) and 156 wide at level of *j6*, 137 wide at level of *S4*, five pairs of solenostomes on dorsal shield, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*, seven pairs of lyrifissures, *id1*, *id1a*, *id2*, *id4*, *idl3*, *idl4*, *idm5*; length of setae: *j1* 23, *j3* 19, *j4* 4.59, *j5* 5, *j6* 5, *J2* 6, *J5* 2, *z2* 8, *z4* 9, *z5* 5, *Z1* 6, *Z4* 7, *Z5* 38, *s4* 27, *S2* 10, *S4* 9, *S5* 9, *r3* 9, *R1* 8. All setae smooth, except *Z5* slightly serrate.

Peritreme (Fig. 10). Peritreme extending to level of *z2*, not visible dorsally, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter (Fig. 10). Sternogenital shield smooth, laterally slightly reticulated, posterior margin straight, longer than wide, 104 long, 63 wide at level of *st5*, with five pairs of setae *st1* 22, *st2* 16, *st3* 19, *st4* 15, *st5* 15, and three pairs of lyrifissures (*pst1*, *pst2*, *pst3*). Distances between *st1*–*st1* 44, *st2*–*st2* 52, *st3*–*st3* 49, *st4*–*st4* 41, *st5*–*st5* 33, *st1*–*st5* 94. Exopodal shield present near coxae I–IV. Ventrianal shield subtriangular, strongly reticulated, 79 long, 123 wide at level of anterior corner, 47 wide at level of anus, anterolaterally fused with peritrematic shield; with three pairs of pre-anal setae, arranged in tangential row, *JV1* 18, *JV2* 17, *ZV2* 14, solenostomes *gv3* crescentic; *Pa* 8, *Pst* 8 on shield. Setae *JV5* 21, on interscutal membrane. All ventral setae smooth.

Chelicera (Fig. 11). Movable digit 17 long, with one tooth; fixed digit 20 long, anterior half with five teeth. Spermatodactyl T-shaped, shaft 21 long, heel elongate, foot 7 long, with elongate toe and lateral thorn-like projection.



FIGURES 5–8. *Euseius daluensis* sp. n. Female, legs 5. leg I anterior view, 6. leg II dorsal view, 7. leg III dorsal view, 8. leg IV anterodorsal view.

Legs (Figs 12–15). Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 2, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1 1; leg II, 2 3/1 2/1 1, 2 2/0 2/0 1, 1 2/1 1/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *Sge* III (ad2) 22, *Sge* IV (ad1) 28, *Sti* IV (ad1) 25, *St* IV (pd1) 40.

Type specimens. Holotype: TAIWAN: Dalu Forest Road, Wufeng Township, Hsinchu County (24°33.924' N, 121°05.433' E, 771m), one female (no. 770–1) from *Bambusa oldhamii* (Poaceae), 13.viii.2010, C.T. Chen & J.R. Liao (NTU). Paratypes: Dongpu, Xinyi Township, Nantou County, two females (TAL074C10-1, 2) from *Dendrocalamus latiforus* (Poaceae), 18.xi.1985, C.C. Ho (TARL); three females one male (no. 770–2, 4, 5) data same with holotype (NTU); one female (no. 770–3) data same with holotype (TARL); Nanqing Highway, Zhudong Township, Hsinchu County (24°40.634' N, 121°05.987' E, 203m), one female (no. 1326–1) from *Dendrocalamus latiforus* (Poaceae), 30.vi.2014, J.R. Liao (NMNS); Nanqing Highway, Zhudong Township, Hsinchu County

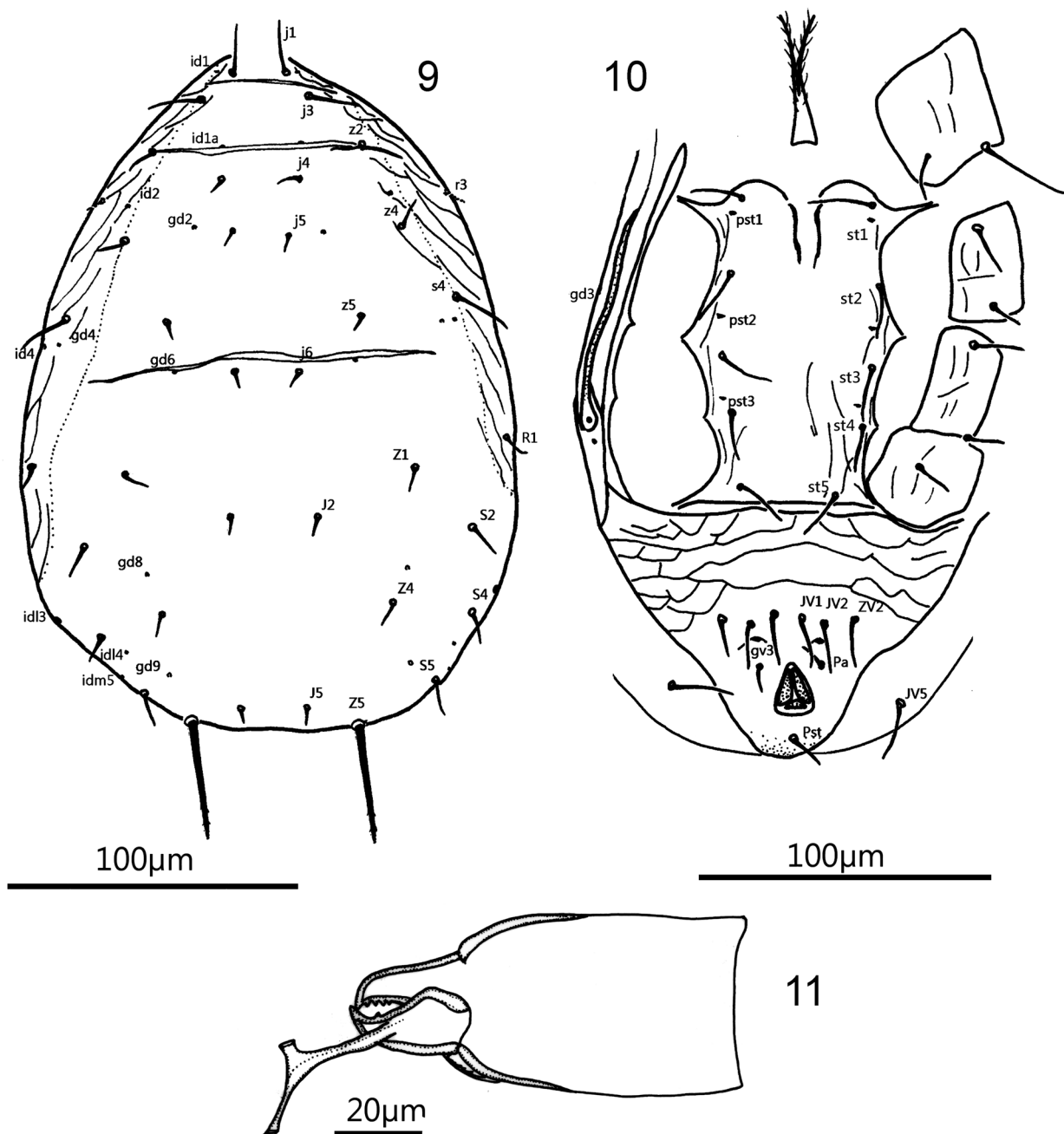
(24°40.634' N, 121°05.987' E, 203m), one female one male (no. 1326–2, 3) (T-MZLQ 3277 and T-MZLQ 3278) from *Dendrocalamus latiforus* (Poaceae), 30.vi.2014, J.R. Liao (ESALQ-USP); Liouyi Mountain, Jiashian District, Kaohsiung City (23°04.703' N, 120°34.727' E, 314m), one female (no. 1616–3) from *Bambusa oldhamii* (Poaceae), 12.iii.2016, J.R. Liao (NTU).

Etymology. The name *daluensis* refers to type locality, Dalu Forest Road.

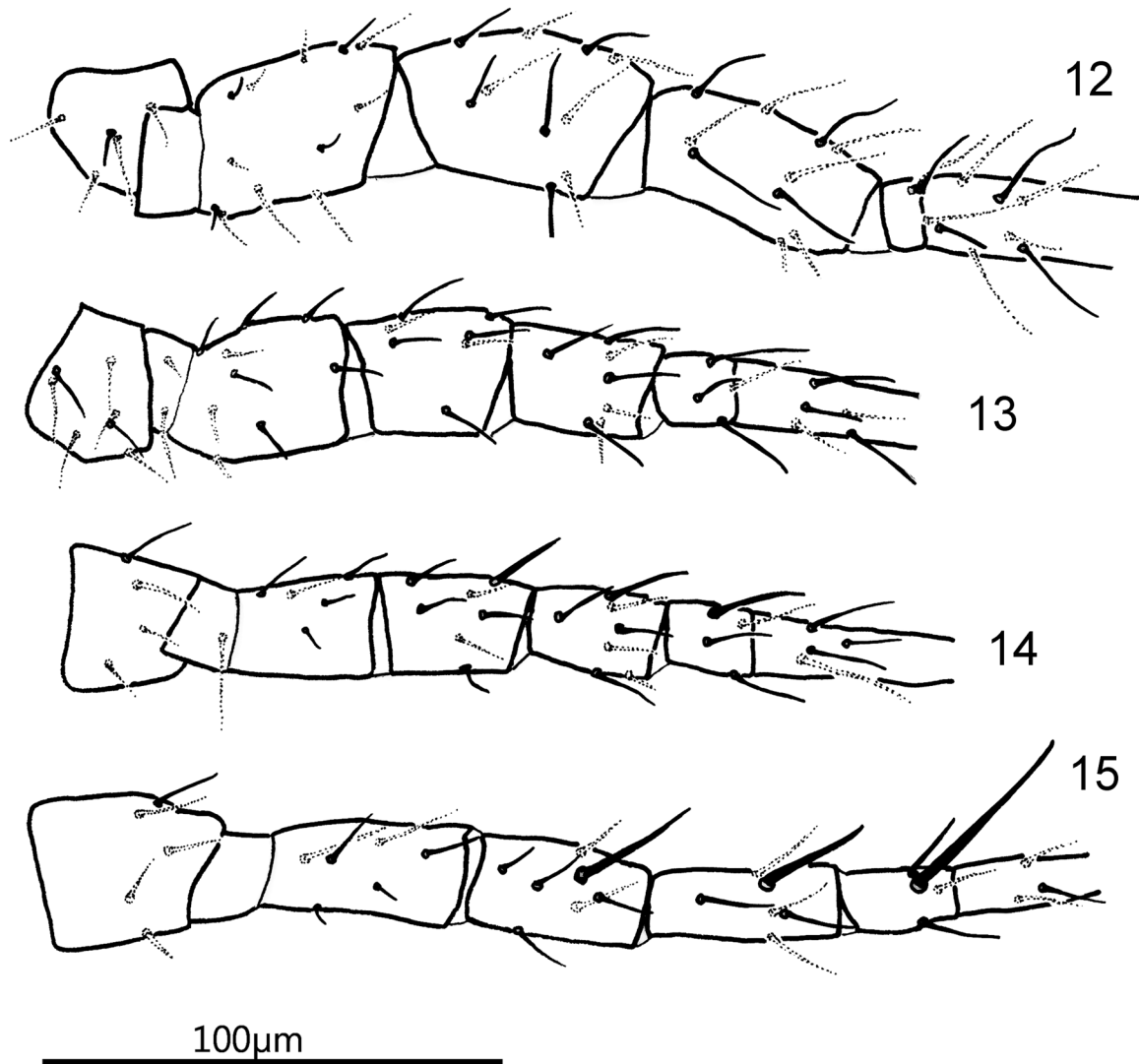
Distribution. Asia: Taiwan (present study).

Remarks. The females of this species resemble *E. finlandicus* (Oudemans, 1915) and *E. ovalis* (Evans, 1953), but differ from *E. finlandicus* in *z*2, *z*4 being minute, and *St* IV > *Sge* IV > *Sti* IV (*St* IV > *Sge* IV = *Sti* IV in *E. finlandicus*); from *E. ovalis* in the calyx of the spermatheca funnel-shaped (tubular in *E. ovalis*), *j*1 slightly longer than *j*3 (*j*1 apparently longer than *j*3 in *E. ovalis*), and the chelicera lacking pilus dentilis.

We often collected *Euseius daluensis* together with *E. aizawai* in the same place but from different adjacent plants. We suspect these two species may have similar ecological niches and food habit. Additionally, the specimens 770–2 and 770–5 were broken when remounting the slides.



FIGURES 9–11. *Euseius daluensis* sp. n. Male, 9. dorsal shield, 10. ventral idiosoma, 11. chelicera and spermatodactyl.



FIGURES 12–15. *Euseius daluensis* sp. n. Male, legs 12. leg I posterior view, 13. leg II, 14. leg III dorsal-posterior view, 15. leg IV dorsal view.

***Euseius macaranga* Liao & Ho sp. n.**

(Figs 16–34)

Female (n=10). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

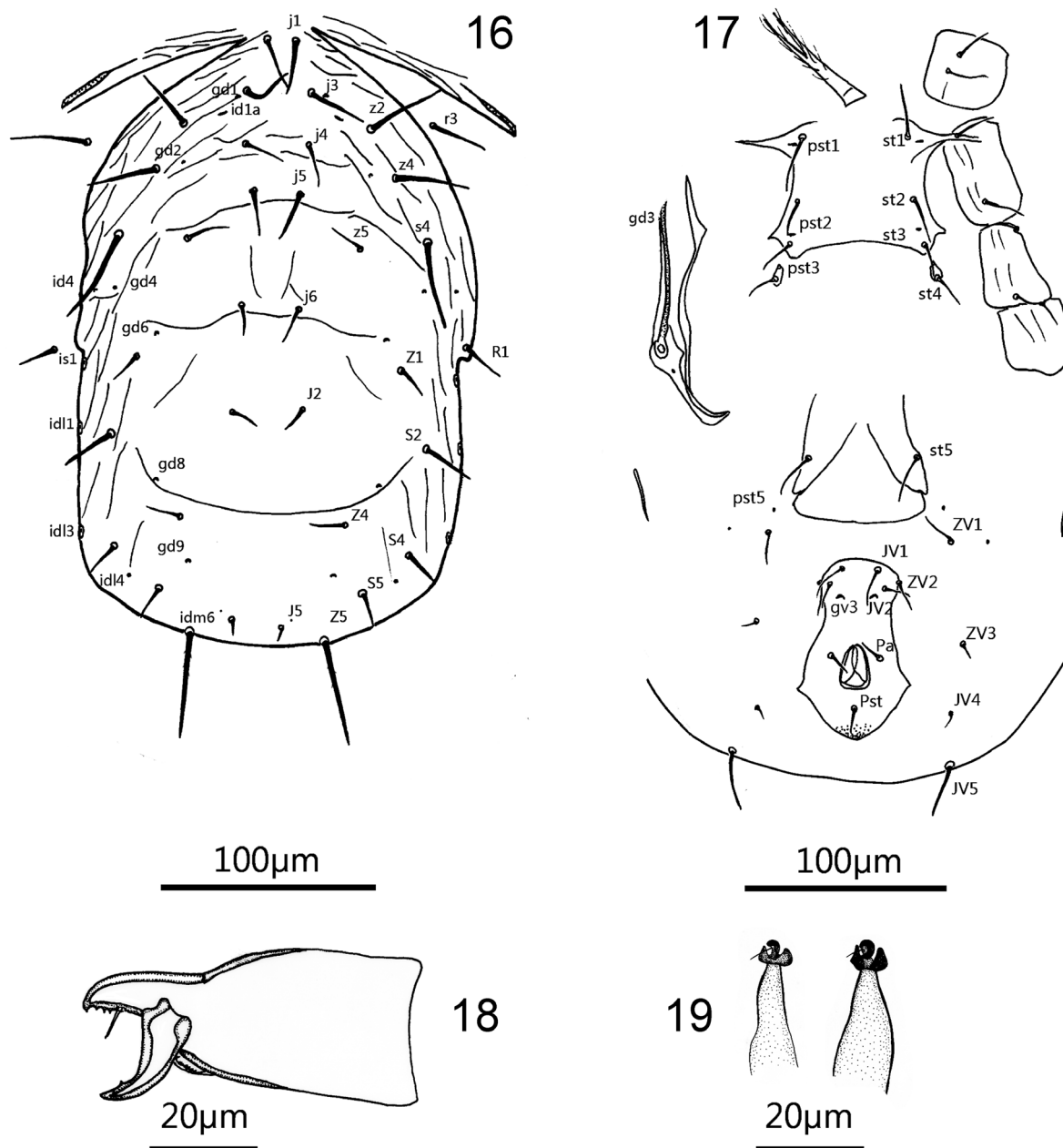
Dorsum (Fig. 16). Dorsal shield much smaller than idiosoma, lateral margin indented at level of *R1*; dorsal shield with reticulation except central part; **240** 259 (240–279) long (*j1*–*J5* level) and **147** 151 (137–160) wide at level of *j6*, **145** 141 (130–150) wide at level of *S4*; six pairs of solenostomes on dorsal shield, (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*), seven pairs of lyrifissures, (*idl1a*, *id4*, *is1*, *idl1*, *idl3*, *idl4*, *idm6*); length of setae: *j1* **20** 20 (18–23), *j3* **27** 21 (18–27), *j4* **17** 16 (13–17), *j5* **19** 17 (13–20), *j6* **14** 13 (8–15), *J2* **13** 12 (9–15), *J5* **5** 4 (3–6), *z2* **24** 22 (18–28), *z4* **28** 25 (18–30), *z5* **15** 15 (11–21), *Z1* **14** 13 (10–19), *Z4* **13** 12 (7–15), *Z5* **38** 42 (38–46), *s4* **33** 32 (27–36), *S2* **21** 18 (14–23), *S4* **14** 13 (10–16), *S5* **12** 12 (9–16), *r3* **29** 26 (22–29), *R1* **15** 14 (10–18). All setae smooth, except *Z5* slightly serrate.

Peritreme (Figs 16–17). Peritreme extending beyond level of *z2*; peritrematic shield lightly sclerotised, with reticulation, with one pair of solenostomes (*gd3*).

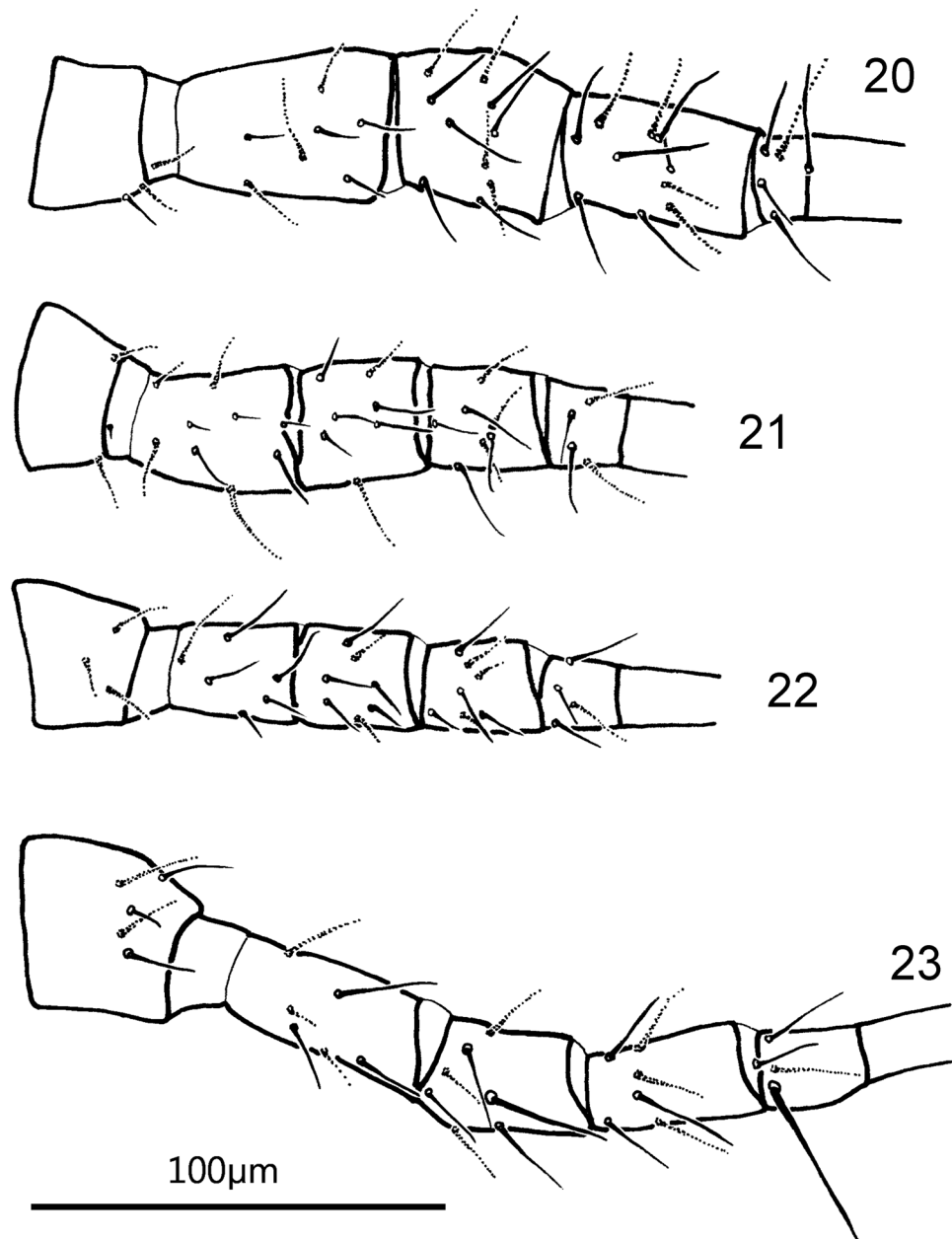
Venter (Fig. 17). Sternal shield smooth, posterior margin concave, much wider than long, **59** 63 (59–67) long, **74** 77 (72–83) wide, with three pairs of setae, *st1* **24** 24 (17–29), *st2* **22** 21 (18–24), *st3* **22** 20 (15–24), and two

pairs of lyrifissures (*pst1*, *pst2*). Exopodal shield opposite coxae II-IV. Metasternal platelets drop-shaped, with one pair metasternal setae, *st4* 18 17 (12–19), with one pair of lyrifissures (*pst3*). Genital shield smooth, with one pair of genital setae *st5* 21 22 (18–25), 55 57 (52–65) wide at level of genital setae. Distances between *st1-st1* 45 44 (42–47), *st2-st2* 50 52 (48–54), *st3-st3* 58 58 (54–63), *st1-st3* 46 49 (46–51), *st5-st5* 49 44 (39–51). Ventrianal shield vase-shaped, smooth, 78 81 (74–90) long, 35 36 (28–39) wide at level of *ZV2*, 46 49 (44–59) wide at level of anus; with three pairs of pre-anal setae, arranged in triangular pattern, *JV1* 18 15 (10–18), *JV2* 13 1 (9–17), *ZV2* 14 12 (9–16), solenostomes *gv3* crescentic; *Pa* 9 10 (5–13), *Pst* 10 11 (9–14) on shield. Setae *JV4* 8 7 (6–9), *JV5* 24 23 (18–25), *ZV1* 16 15 (11–18), *ZV3* 8 7 (3–9) on interscutal membrane. All ventral setae smooth. Metapodal plate 21 18 (15–22) long, 3 2 (1–3) wide. *Chelicera* (Fig. 18). Movable digit 23 20 (18–23) long, with one tooth; fixed digit 22 21 (19–22) long, anterior half with three teeth, with pilus dentilis.

Spermatheca (Fig. 19). Calyx horn-shaped, 21 20 (14 22) long, 9 7 (5 9) wide, atrium c-shaped with one pair of petal-shaped structures as illustrated.



FIGURES 16–19. *Euseius macaranga* sp. n. Female, 16. dorsal shield, 17. ventral idiosoma, 18. chelicera, 19. spermatheca.



FIGURES 20–23. *Euseius macaranga* sp. n. Female, legs. 20. leg I anterior-dorsal view, 21. leg II dorsal view, 22. leg III dorsal view, 23. leg IV anterior view.

Legs (Figs 20–23). Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/1 2, 2 2/2 2/1 1, 2 2/1 2/1 2, 1 1/1 1; leg II, 2 3/1 2/1 1, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *St* IV (pd1) 41 36 (31–41).

Male (n=5). A lightly sclerotised mite. Idiosomal setal pattern: 10A: 9B/JV-3, 4: ZV-1, 3.

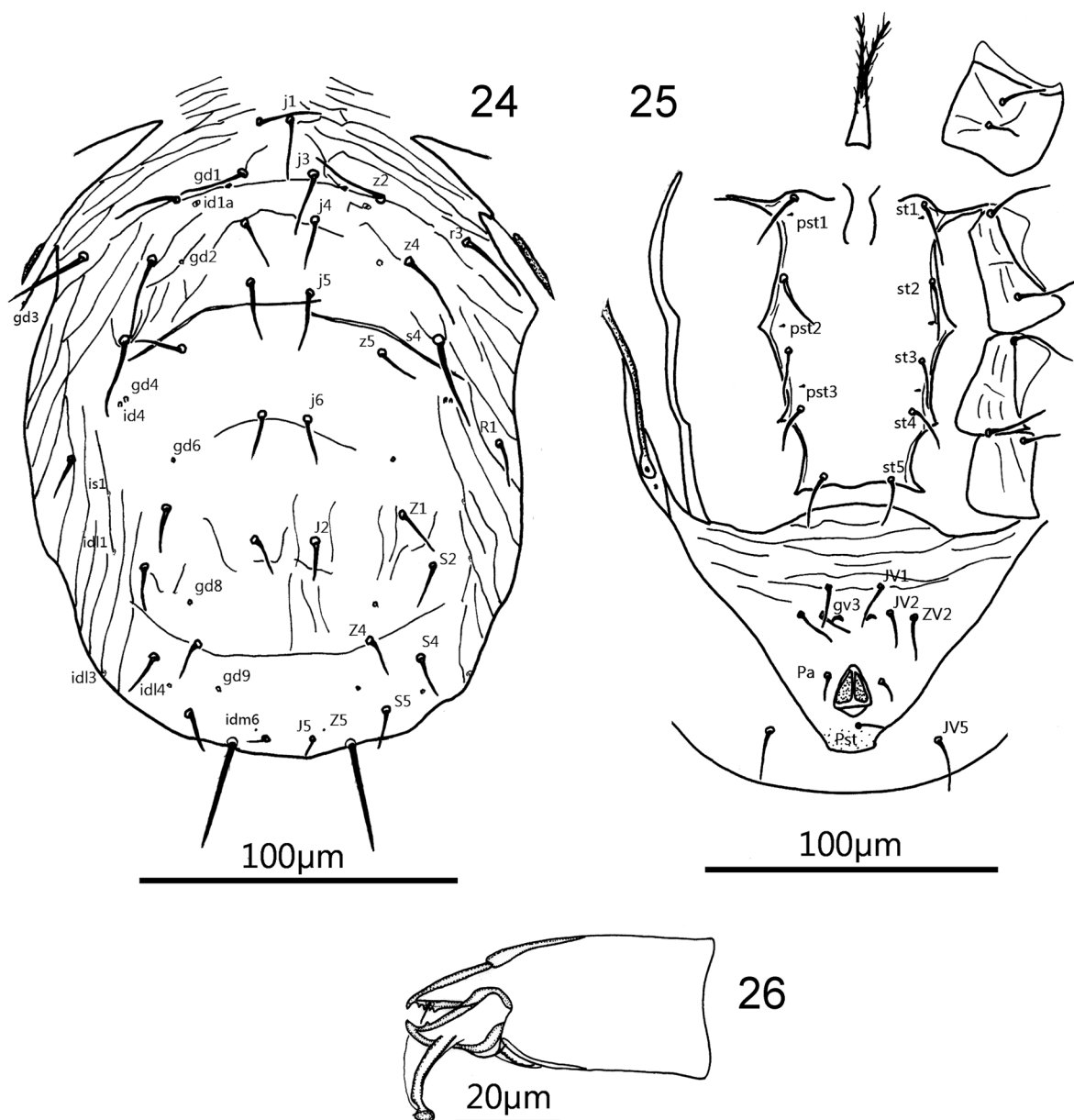
Dorsum (Fig. 24). Dorsal shield with reticulation except in central part; 192 (186–196) long (*j1*–*J5* level) and 140 (133–146) wide at level of *j6*, 118 (115–121) wide at level of *S4*, six pairs of solenostomes on dorsal shield, (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*), seven pairs of lyrifissures, (*idl1a*, *id4*, *is1*, *idl1*, *idl3*, *idl4*, *idm6*); length of setae: *j1* 17 (16–18), *j3* 18 (16–21), *j4* 16 (14–17), *j5* 16 (14–18), *j6* 12 (10–14), *J2* 13 (12–14), *J5* 4 (2–55), *z2* 19 (16–21), *z4* 21 (16–24), *z5* 12 (12–13), *Z1* 12 (10–13), *Z4* 13 (9–15), *Z5* 33 (30–36), *s4* 26 (24–27), *S2* 15 (13–17), *S4* 14 (12–17), *S5* 13 (12–14), *r3* 24 (21–27), *R1* 11 (10–12). All setae smooth, except *Z5* slightly serrate.

Peritreme (Figs 24–25). Peritreme extending to level of *z2*; peritrematic shield lightly sclerotised, with reticulation, anteriorly narrow, with one pair of solenostomes (*gd3*).

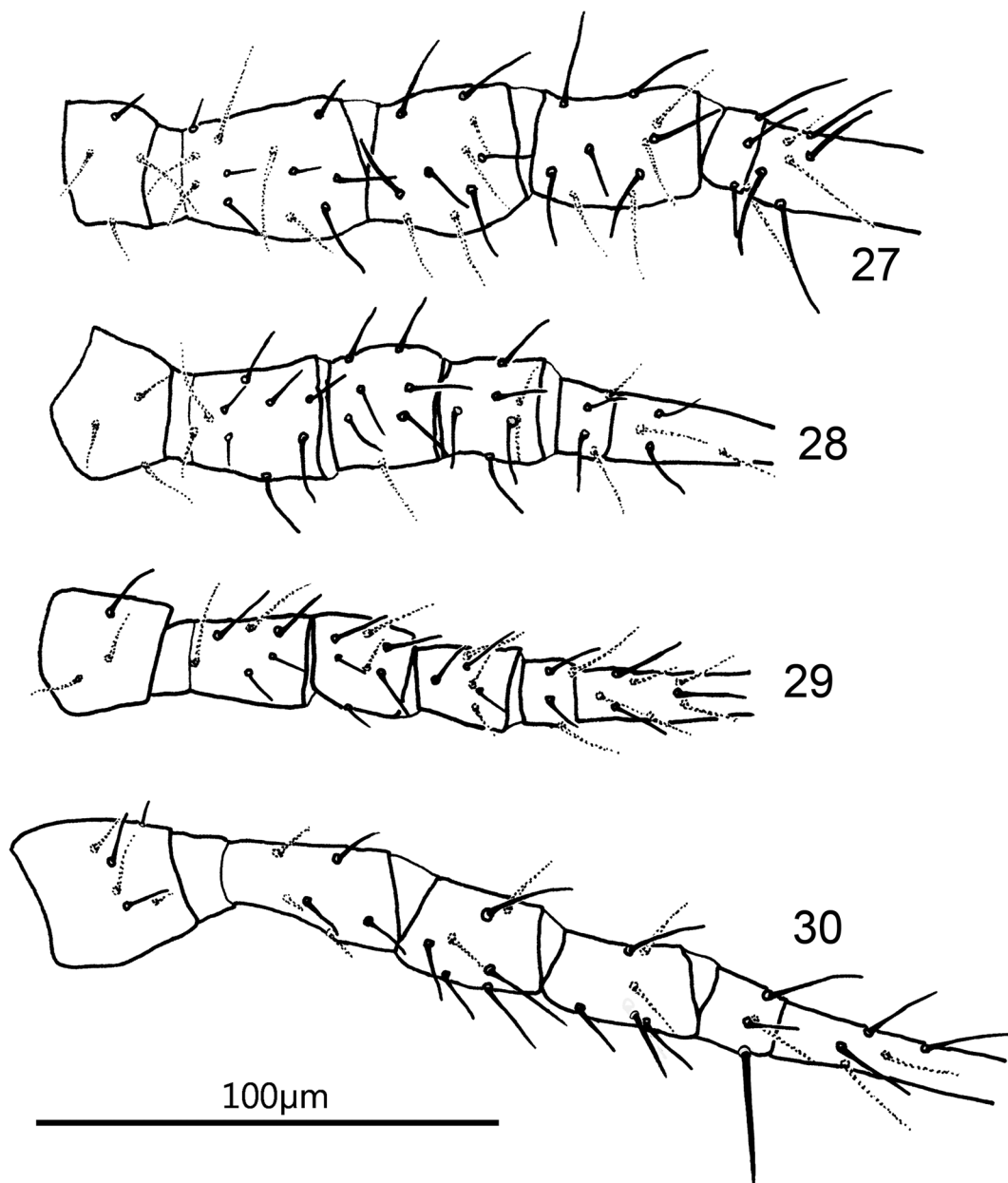
Venter (Fig. 25). Sternogenital shield smooth, laterally slightly reticulated, posterior margin with small medial projection, longer than wide, 99 (92–109) long, 56 (50–62) wide at level of *st5*, with five pairs of setae *st1* 19 (18–19), *st2* 16 (15–17), *st3* 16 (15–17), *st4* 16 (13–19), *st5* 12 (11–14), three pairs of lyrifissures (*pst1*, *pst2*, *pst3*). Distances between *st1*–*st1* 36 (33–38), *st2*–*st2* 41 (40–44), *st3*–*st3* 39 (38–41), *st4*–*st4* 33 (32–34), *st5*–*st5* 20 (19–21), *st1*–*st5* 84 (80–87). Exopodal shield opposite coxae II–IV. Ventrianal shield subtriangular, strongly reticulated, 77 (69–83) long, 105 (92–112) wide at anterior corner, 42 (39–45) at level of anus, fused with peritrematic shield cingulum; with three pairs of pre-anal setae, arranged in triangular pattern, *JV1* 11 (10–12), *JV2* 10 (10–11), *ZV2* 11 (9–12), solenostomes *gv3* crescentic; *Pa* 6 (4–8), *Pst* 8 (7–10) on shield. Setae *JV5* 15 (13–18) on interscutal membrane. All ventral setae smooth.

Chelicera (Fig. 26). Movable digit 15 (15–16) long, with one tooth; fixed digit 17 (16–19) long, anterior half with three teeth, with pilus dentilis. Spermatodactyl L-shaped, shaft 16 (13–18) long, heel reduced, foot 5 (4–7) long, with expanded toe and lateral thorn-like projection.

Legs (Figs 27–30). Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 2, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1 1; leg II, 1 3/1 2/1 1, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *St* IV (pd1) 29 (26–32).



FIGURES 24–26. *Euseius macaranga* sp. n. Male, 24. dorsal shield, 25. ventral idiosoma, 26. chelicera and spermatodactyl.



FIGURES 27–30. *Euseius macaranga* sp. n. Male, legs 27. leg I anterior-dorsal view, 28. leg II dorsal view, 29. leg III dorsal view, 30. leg IV anterior view.

Type specimens. Holotype: TAIWAN: Xiziwan, Gushan District, Kaohsiung City (22°38.539' N, 120°15.275' E, 58m), one female (no. 390–2) from *Macaranga tanarius* (Euphorbiaceae), 11.iii.2010, J.R. Liao & S.W. Kong (NTU). Paratype: Kaohsiung City, two females (no. 85–1159) from unknown plant, 4.xii.1985, C.C. Ho (TARI); Beiyi Road, Xindian District, New Taipei City (24°57.173' N, 121°32.514' E, 43m), one female one male (no. 310–8, 9) from *Macaranga tanarius* (Euphorbiaceae), 28.i.2010, J.R. Liao (NTU); nine female one male, (no. 390–1, 3, 4, 5, 6, 7, 8, 9, 10,) data same as holotype (NTU); Xiziwan, Gushan District, Kaohsiung City (22°38.539' N, 120°15.275' E, 58m), 13 females 3 males (no. 389–3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20,) from *Millettia pinnata* (Papilionaceae), 11.iii.2010, J.R. Liao & S.W. Kong (TARL); Nanren Mountain, Manzhou Township, Pingtung County (22°05.087' N, 120°49.810' E, 140m), two females two males (no. 609–1, 2, 3, 4) from *Callicarpa formosana* (Lamiaceae), 14.vi.2010, J.R. Liao (NMNS); Hutoushan, Ruisui Township, Hualien County (23°30.377' N, 121°20.793' E, 631m), one female two males (no. 737–2, 3, 4) from *Macaranga tanarius* (Euphorbiaceae), 2.viii.2010, J.R. Liao & S.F. Lin (NCHU); Sandimen Township, Pingtung County (22°43.866' N, 120°40.059' E, 487m), one male (no. 939–6) (T-MZLQ 3279) from unknown plant, 20.xi.2010, J.R. Liao (ESALQ-

USP); Laonong River, Liugui District, Kaohsiung City (22°55.785' N, 120°39.148' E, 224m), one female (no. 940–3) (T-MZLQ 3281) from *Morus* sp. (Moraceae), 20.xi.2010, J.R. Liao (ESALQ-USP); National Pingtung University of Science and Technology, Pingtung County, one female from *Macaranga tanarius* (Euphorbiaceae), 22.i.2015, P.C. Ma (NPUST); Wutai Township, Pingtung County (24°44.795' N, 120°42.595' E, 370m), three females (no. 1479–1, 2, 3) from *Macaranga tanarius* (Euphorbiaceae), 25.iv.2015, J.R. Liao (NPUST); Nan'ao Township, Yilan County (24°25.208' N, 121°44.200' E, 205m), six female one male (no. 1820–1, 2, 3, 4, 5, 7, 8) from *Macaranga tanarius* (Euphorbiaceae), 2.viii.2016, J.R. Liao (NMNS); Baihe District, Tainan City (23°20.035' N, 120°28.930' E, 319m), five females one male (no.1826–2, 3, 4, 6, 7, 9, 10) from *Macaranga tanarius* (Euphorbiaceae), 10.viii.2016, J.R. Liao (NPUST).

Additional material examined. Zhiben, Taitung County, 18 females from *Macaranga tanarius* (Euphorbiaceae), 15.v.1991, C.C. Ho (TARL); Beikeng, Wufeng District, Taichung City, two females and one male from *Vernicia fordii* (Euphorbiaceae), 16.iii.2007, C.C. Ho (TARL); Zhanggong Lane, Wufeng District, Taichung City, three females from *Vernicia fordii* (Euphorbiaceae), 20.iii.2007, C.C. Ho (TARL); Wufeng District, Taichung City, one female and one male from *Boehmeria nivea* (Urticaceae), 10.xii.2008, C.C. Ho (TARL); Paomagudao, Jiaoxi Township, Yilan County (24°49.656' N, 121°45.928' E, 36m), two females from *Bidens pilosa* (Asteraceae), 16.vii.2010, M.C. Chiu & J.R. Liao (NTU); Laonong River, Liugui District, Kaohsiung City (22°55.785' N, 120°39.148' E, 224m), five females from *Macaranga tanarius* (Euphorbiaceae), 20.xi.2010, J.R. Liao (NTU); Fudekeng Recovery Park, Wenshan District, Taipei City (25°00.505' N, 121°35.388' E, 112m), four females from *Macaranga tanarius* (Euphorbiaceae), 1.xii.2010, J.R. Liao (NTU); Jinfeng Township, Taitung County (22°35.779' N, 120°57.244' E, 132m), three females from *Macaranga tanarius* (Euphorbiaceae), 23.i.2011, J.R. Liao (NTU); Jinfeng Township, Taitung County (22°35.779' N, 120°57.244' E, 132m), one female from *Ageratum conyzoides* (Asteraceae), 23.i.2011, J.R. Liao (NTU); Paomagudao, Jiaoxi Township, Yilan County (24°50.276' N, 121°46.346' E, 147m), two females from *Mallotus japonicus* (Chamaesyce), 9.ii.2011, J.R. Liao (NTU); Ung ku, Nan'ao Township, Yilan County (24°30.302' N, 121°45.762' E, 109m), two females from *Trema orientalis* (Ulmaceae), 9.ii.2011, J.R. Liao (NTU); Lupishanuncai Road, Nan'ao Township, Yilan County (24°27.950' N, 121°45.317' E, 209m), five females from *Trema orientalis* (Ulmaceae), 9.ii.2011, J.R. Liao (NTU); Agricultural Insect Building, Da'an District, Taipei City (25°00.747' N, 121°32.831' E, 13m), two females from *Macaranga tanarius* (Euphorbiaceae), 17.iii.2011, J.R. Liao (NTU).

Etymology. The name *macaranga* refers to habitat plant *Macaranga tanarius*, where this species was most commonly observed.

Distribution. Asia: Taiwan (present study).

Remarks. This species has similarities to seven *Euseius* species, namely *E. circellatus*, *E. dowdi* (Schicha, 1993), *E. kalimpongensis* (Gupta, 1969), *E. macaranga* n. sp., *E. ploreriformis* (Schicha & Corpuz-Raros, 1992), *E. ruiliensis* (Wu & Li, 1985), *E. vaseformis* (Wu & Ou, 2009), according to the following these characteristics: (1) a relatively small dorsal shield (approximately 250 µm); (2) anterior reticulation on the dorsal shield; (3) ventrianal shield vase-shaped, with *JV1* and *JV2* at a normal position; (4) peritremes extending to the *r3* to *z4* level, but never to *j1* level; and (5) leg IV with one macroseta on the basitarsus.

Many specimens in this study were collected from leaves of *Macaranga tanarius*, which are mildly hairy and pubescent. We suggest that the species may have a strong relationship with *M. tanarius* and possibly has a subtype III lifestyle as a generalist predator living on pubescent leaves. However, the species with short and smooth dorsal setae differ from other species in this subtype (e.g., *Paraphytoseius* spp. and *Phytoseius* spp.). These species are considered to have strong dorsal setae for passing through leaf hairs. Walter (1999) reported that *E. dowdi* shows preferences for leaves with tomentum. By comparing the specimen records, we observed that *E. circellatus* was located on *Conyza sumatrensis* (present study), *E. vaseformis* on *Boehmeria longispica* (Wu *et al.*, 2009), *E. dowdi* on *Cissus antartica* (Schicha & O'Dowd, 1993) and *Lantana camara* (Walter, 1999), and *E. ploreriformis* on *M. tanarius* (Schicha & Corpuz-Raros, 1992). We suggest that because these species typically have a smaller body, they can move between the leaf hairs without impediment.

***Euseius ovalis* (Evans, 1953)**

Typhlodromus ovalis Evans, 1953: 485.

Typhlodromus (Amblyseius) ovalis.—Chant, 1959: 68.
Amblyseius (Typhlodromalus) ovalis.—Muma, 1961: 288.
Amblyseius (Amblyseius) ovalis.—Ehara, 1966: 24.
Amblyseius (Euseius) ovalis.—Ehara & Amano, 1998: 43.
Euseius ovalis.—Gupta, 1978: 335.

Female (n=10). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

Dorsum. Dorsal shield smooth, with anterolateral reticulation, 376 (358–401) long (*j1*–*J5* level) and 265 (242–283) wide at level of *j6*, 251 (231–281) wide at level of *S4*; six pairs of solenostomes on dorsal shield, (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*), 12 pairs of lyrifissures, (*id1*, *id1a*, *id2*, *id4*, *is1*, *idl1*, *idm2*, *idl3*, *idl4*, *idm4*, *idm5*, *idm6*); length of setae: setae *j1* 34 (31–37), *j3* 10 (8–12), *j4* 4 (2–6), *j5* 5 (4–7), *j6* 6 (3–8), *J2* 8 (6–9), *J5* 4 (3–6), *z2* 7 (4–11), *z4* 7 (6–8), *z5* 6 (4–8), *Z1* 7 (5–10), *Z4* 8 (6–8), *Z5* 53 (49–58), *s4* 13 (10–15), *S2* 3 (9–16), *S4* 14 (10–17), *S5* 11 (8–15), *r3* 12 (11–14), *R1* 8 (6–11). All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme extending to level of *z2*, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternal shield smooth, with projection on posterior margin, wider than long, 75 (63–85) long, 95 (87–102) wide at level of *st5*, with three pairs of setae *st1* 27 (24–31), *st2* 24 (20–29), *st3* 20 (14–29), and two pairs of lyrifissures (*pst1*, *pst2*). Metasternal platelets drop-shaped, with one pair metasternal setae *st4* 17 (11–20), and one pair of lyrifissures (*pst3*). Genital shield smooth, 96 (84–119) wide at level of genital setae, with one pair of genital setae *st5* 21 (17–26). Distances between *st1*–*st1* 56 (50–60), *st2*–*st2* 62 (59–6), *st3*–*st3* 74 (67–79), *st1*–*st3* 59 (56–62), *st5*–*st5* 78 (72–87). Ventrianal shield 114 (106–121) long, 53 (48–58) wide at level of *ZV2*, 83 (73–90) wide at level of anus; with three pairs of pre-anal setae, *JV1* next to *JV2*, solenostome *gv3* crescentic, *JV1* 24 (20–27), *JV2* 16 (14–18), *ZV2* 16 (13–21); *Pa* 11 (9–14), *Pst* 14 (10–18) on shield. Setae *JV4* 7 (4–10), *JV5* 27 (21–30), *ZV1* 16 (10–21), *ZV3* 7 (5–9) on interscutal membrane. Two metapodal platelets 24 (20–27) long, 6 (4–8) wide, 10 (6–15) long, 2 (1–3) wide.

Spermatheca. Calyx tubular, elongated, 18 (15–21) long, 2 (2–4) wide, with atrium at the basis, minor duct and major duct visible.

Chelicera. Movable digit 23 (20–25) long, with one tooth; fixed digit 26 (22–31) long, anterior half with three teeth, without pilus dentilis.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/2 2/2 1, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1 1; leg II, 1 3/0 2/2 1, 2 2/0 2/0 1, 1 2/1 1/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/1 0, 1 2/1 1/1 0, 1 1/1 1. Macrosetae: *Sge* II 20 (17–23), *Sti* II 19 (16–21), *St* II 25 (24–26), *Sge* III 27 (24–28), *Sti* III 23 (20–30), *St* III 26 (23–28), *Sge* IV 36 (31–41), *Sti* IV 33 (24–41), *St* IV 57 (50–64).

Male (n=5). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3, 4:ZV-1, 3.

Dorsum. Dorsal shield smooth, with anterolateral reticulation, 268 (249–284) long (*j1*–*J5* level) and 207 (189–229) wide at level of *j6*, 144 (123–157) wide at level of *S4*; six pairs of solenostomes on dorsal shield, (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*), 12 pairs of lyrifissures, (*id1*, *id1a*, *id2*, *id4*, *is1*, *idl1*, *idm2*, *idl3*, *idl4*, *idm4*, *idm5*, *idm6*); length of setae: *j1* 28 (20–31), *j3* 11 (8–15), *j4* 5 (4–5), *j5* 4 (3–5), *j6* 7 (5–8), *J2* 7 (5–8), *J5* 4 (3–5), *z2* 6 (3–9), *z4* 9 (6–9), *z5* 5 (4–6), *Z1* 7 (4–9), *Z4* 8 (7–9), *Z5* 47 (44–50), *s4* 13 (11–16), *S2* 13 (11–15), *S4* 14 (13–15), *S5* 12 (10–16), *r3* 12 (10–14), *R1* 9 (8–10). All setae smooth, except *Z5* slightly serrate.

Peritreme. Peritreme extending to level of *z2*, peritrematic shield smooth, lightly sclerotised, with one pair of solenostomes (*gd3*).

Venter. Sternogenital shield 126 (107–137) long, 76 (66–82) wide at level of *st5*; *st1* 22 (19–27), *st2* 22 (18–24), *st3* 21 (17–23), *st4* 17 (14–21), *st5* 18 (15–20). Distances between *st1*–*st1* 45 (37–50), *st2*–*st2* 54 (46–59), *st3*–*st3* 54 (51–58), *st4*–*st4* 50 (46–54), *st5*–*st5* 36 (30–42), *st1*–*st5* 107 (95–115). Ventrianal shield 110 (98–121) long and 161 (132–179) wide at anterior corner, 63 (57–69) wide at level of anus, fused with peritrematic shield cingulum; with three pairs of pre-anal setae, arranged in tangential row, *JV1* 21 (20–22), *JV2* 19 (17–22), *ZV2* 13 (11–16), solenostomes *gv3* crescentic; *Pa* 9 (7–10), *Pst* 12 (9–13) on shield. Setae *JV5* 23 (20–25) on interscutal membrane.

Chelicera. Movable digit 18 (14–22) long with one tooth; fixed digit 20 (15–22) long, anterior half with three teeth, without pilus dentilis. Spermatodactyl L-shaped, shaft 23 (19–27) long, heel reduced, foot 7 (6–9) long, with elongate toe and lateral thorn-like projection.

Legs. Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/2 2/2 1, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1

1 1; leg II, 1 3/0 2/2 1, 2 2/0 2/0 1, 1 2/1 1/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/1 0, 1 2/1 1/1 0, 1 1/1 1. Macrosetae: *Sge* II 17 (15–19), *Sge* III 24 (21–25), *Sti* III 21 (20–23), *St* III 21 (21–21), *Sge* IV 34 (29–36), *Sti* IV 29 (24–34), *St* IV 50 (41–57).

Specimens examined. TAIWAN: Taipei City, one female (0025) from *Vitis vinifera* (Vitaceae), 9.xi.1966, P.K.C. Lo (TARI); Taipei City, one female (0131) from *Brassica rapa pekinensis* (Brassicaceae), 24.i.1967, P.K.C. Lo (TARI); Taichung City, one male (0910) from *Pyrus* sp. (Rosaceae), 5.x.1967, P.K.C. Lo (TARI); Taipei City, three males (0918) from *Salix chaenomeloides* (Salicaceae), 1.xi.1967, P.K.C. Lo (TARI); Taipei City, one female (1021) from *Pyrus* sp. (Rosaceae), 28.i.1968, P.K.C. Lo (TARI); Taipei City, one male (1067) from *Bryophyllum pinnatum* (Crassulaceae), 31.x.1968, P.K.C. Lo (TARI); Taipei City, five females three males (1080) from *Lycium chinense* (Solanaceae), 9.i.1969, P.K.C. Lo (TARI); TARI, Wufeng District, Taichung City, three females from *Morus alba* (Moraceae), 23.x.1980, P.K.C. Lo (TARI); Wufeng District, Taichung City, one female from *Cinnamomum camphora* (Lauraceae), 25.x.1980, P.K.C. Lo (TARI); Wufeng District, Taichung City, three females from *Passiflora edulis* (Passifloraceae), 28.x.1980, P.K.C. Lo (TARI); TARI, Wufeng District, Taichung City, one female from *Bauhinia variegata* (Fabaceae), 28.x.1980, P.K.C. Lo (TARI); Ruisui Township, Hualien County, one female from *Morus alba* (Moraceae), 22.ii.1988, Y.J. Wang (TARI); TARI, Wufeng District, Taichung City, three females from *Lagerstroemia speciosa* (Lythraceae), 17.x.1988, S.M. Yu (TARI); TARI (31), Wufeng District, Taichung City, two females from unknown plant, 18.x.1988, S.M. Yu (TARI); Wuhe Village, Ruisui Township, Hualien County, one female from *Citrus sinensis* (Rutaceae), 20.ii.1989, Y.J. Wang (TARI); Baxiandong, Changbin Township, Taitung County, six females two males from unknown plant, 4.iv.1989, C.C. Ho (TARI); Baxiandong, Changbin Township, Taitung County, one female from *Lygodium japonicum* (Lygodiaceae), 4.iv.1989, C.C. Ho (TARI); Zhongpu Township, Chiayi County, one female from *Phaseolus lunatus* (Leguminosae), 4.xi.1992, C.C. Ho (TARI); Jiaoxi Township, Yilan County, one female from vine, 27.i.2011, Y.T. Shih (NTU); Dongshanhe, Dongshan Township, Yilan County, two females from *Turpinia formosana* (Staphyleaceae), 27.i.2011, Y.T. Shih (NTU); Guangxing, Xindian District, New Taipei City (24°54.804' N, 121°32.747' E, 79m), one male from *Ageratum houstonianum* (Asteraceae), 27.ii.2011, J.R. Liao (NTU); Guangxing, Xindian District, New Taipei City (24°54.804' N, 121°32.747' E, 79m), one male from *Persicaria chinensis* (Polygonaceae), 27.ii.2011, J.R. Liao (NTU); Guangxing, Xindian District, New Taipei City (24°54.804' N, 121°32.747' E, 79m), one female from *Debregeasia orientalis* (Urticaceae), 27.ii.2011, J.R. Liao (NTU); Agricultural Insect Building, Da'an District, Taipei City (25°00.747' N, 121°32.831' E, 13m), four females one male from *Bischofia javanica* (Euphorbiaceae), 17.iii.2011, J.R. Liao (NMNS); Agricultural Insect Building, Da'an District, Taipei City (25°00.747' N, 121°32.831' E, 13m), two females one male (MZLQ 7604 to MZLQ 7606) from *Koelreuteria henryi* (Sapindaceae), 17.iii.2011, J.R. Liao (ESALQ-USP); Agricultural Insect Building, Da'an District, Taipei City (25°00.747' N, 121°32.831' E, 13m), two females from *Macaranga tanarius* (Euphorbiaceae), 17.iii.2011, J.R. Liao (NTU); Agricultural Insect Building, Da'an District, Taipei City (25°00.747' N, 121°32.831' E, 13m), one female from *Morus* sp. (Moraceae), 17.iii.2011, J.R. Liao (NTU); Huwei Township, Yunlin County, three females two males from *Morus* sp. (Moraceae), 6.iv.2011, B.C. Liao (NCHU); Zhuolan Township, Miaoli County, one female from *Vitis vinifera* (Vitaceae), 18.xii.2013, Jean Hsu (NTU); Zhuolan Township, Miaoli County, two females from *Vitis vinifera* (Vitaceae), 18.xii.2013, Jean Hsu (NTU); Zhuolan Township, Miaoli County, one female from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Zhuolan Township, Miaoli County, two females one male from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (TARL); Zhuolan Township, Miaoli County, one female from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Zhuolan Township, Miaoli County, two females one male from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Zhuolan Township, Miaoli County, one female from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Zhuolan Township, Miaoli County, two females from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Zhuolan Township, Miaoli County, one female from *Vitis vinifera* (Vitaceae), 24.i.2014, Jean Hsu (NTU); Heshe, Xinyi Township, Nantou County (23°34.932' N, 120°52.922' E, 866m), one female one male (MZLQ 7607 to MZLQ 7608) from *Cordia dichotoma* (Boraginaceae), 24.iv.2014, J.R. Liao (ESALQ-USP); Danayigu Park, Chiayi County (23°23.411' N, 120°39.917' E, 736m), one female from *Broussonetia papyrifera* (Moraceae), 25.v.2014, J.R. Liao (NTU); Duona Forest Road, Maolin District, Kaohsiung City (22°54.585' N, 120°42.891' E, 450m), three females one male from *Morus* sp. (Moraceae), 25.iv.2014, J.R. Liao (NPUST).

Distribution. Africa: Mauritius (Moutia, 1958). Asia: China (Fujian (Wu, 1981), Guangdong (Wu, 1982), Guangxi (Wu, 1982), Hainan (Wu & Ou, 2002), Jiangsu (Liang & Ke, 1983), Jiangxi (Zhu & Chen, 1983), Sichuan

(Liang & Ke, 1983), Wuling Mountain Region (Wu & Lan, 1992), Yunnan (Liang & Ke, 1983)), Hong Kong (Swirski & Shechter, 1961), India (Gupta, 1978), Indonesia (Ehara, 2002b), Japan, Malaysia (Evans, 1953), Philippines (Corpuz & Rimando, 1966), Sri Lanka (Moraes *et al.*, 2004), Taiwan (Ehara, 1970). North America: Mexico (Chant, 1959). Oceania: Australia (Schicha, 1987), Cook Islands (Collyer, 1980), Fiji (Collyer, 1980), Hawaii (Chant, 1959), New Zealand (Collyer, 1964), Papua New Guinea (Collyer, 1980).

Remarks. Schicha (1977) reported that *E. victoriensis* (Womersley, 1954), *E. ovalis*, and *E. elinae* (Schicha, 1977) are similar. We observed that the females of *E. victoriensis* can be identified by dorsal setae $j1 < j3$, $j1, j3, z2, z4, Z5, s4$ longer; the females of *E. ovalis* can be identified by $j1, Z5$ longer; *E. elinae* can be identified by $j1, j3, Z5$ longer. Additionally, the females of this species resemble *E. mundillovalis* (Schicha, 1987), *E. ovaloides* (Blommers, 1974), *E. similiovalis* (Liang & Ke, 1983), but differ from *E. mundillovalis* in a longer $j1$, and shorter dorsal shield length (approximately 300 μm and 400 μm in *E. mundillovalis*); the females differ from *E. ovaloides* and *E. similiovalis* in anterolateral reticulation on the dorsal shield.

In our investigation, *E. ovalis* was observed to occur widely, not only in agricultural areas but also in a variety of plant habitats. Typically, *E. ovalis* lives on smooth leaves but not hairy ones. According to a comparison of the distributions, we observe *E. ovalis* dominates at lower altitudes and developed areas, whereas *E. aizawai* dominates at higher altitudes and less-developed areas.

Nguyen & Shih (2010, 2011, 2012) compared the rates of development and predation in *N. womersleyi* and *E. ovalis*. They found the former had already been considered as crucial biocontrol agent, but the latter also showed biocontrol potential for *O. mangiferus*. In our experience, this species is prevalent in Taiwan in various plant habitats, but is typically located on leaves without spider mites, and rarely located on the leaves with *Tetranychus* colonies. Occasionally, this species is located close to *Oligonychus* and *Panonychus* colonies, and often on leaves with other insects in addition to spider mites. We suggest that this species maintains its population by feeding on various food sources. Therefore, this species can play a critical role in the field, but probably not as an effective biocontrol agent.

***Euseius paraovalis* Liao & Ho sp. nov.**

(Figs 31–38)

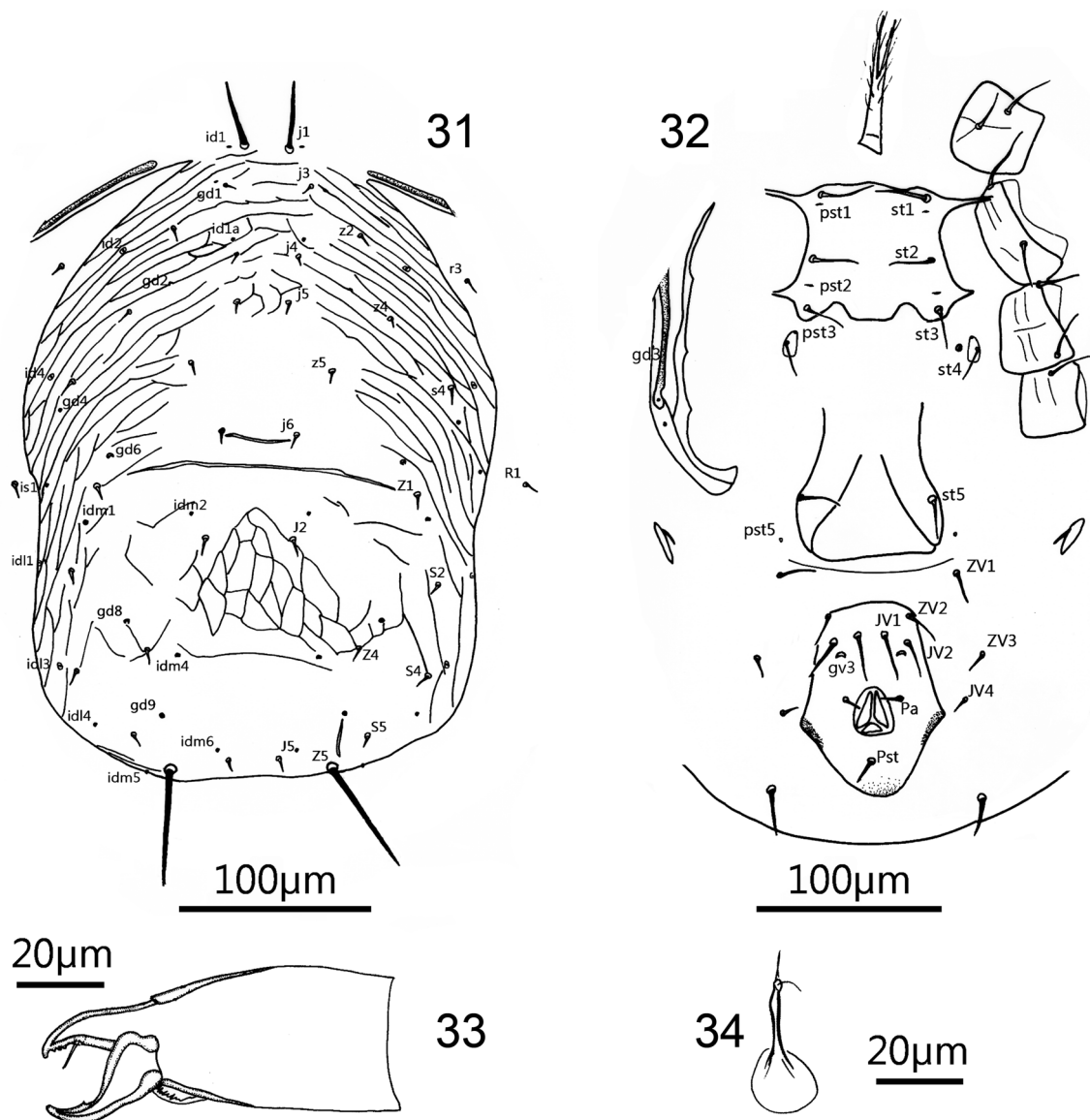
Female (n=6). A lightly sclerotised mite. Idiosomal setal pattern: 10A:9B/JV-3:ZV.

Dorsum (Fig. 31). Dorsal shield with strong reticulation except for central part of podosoma; **347** 338 (321–347) long ($j1$ – $J5$ level) and **246** 241 (217–252) wide at level of $j6$, **225** 218 (200–226) wide at level of $S4$; six pairs of solenostomes on dorsal shield, ($gd1, gd2, gd4, gd6, gd8, gd9$), eleven pairs of lyrifissures, ($id2, id1a, id2, id4, is1, idm1, idl1, idl3, idl4, idm5, idm6$); length of setae: $j1$ **33** 333 (29–35), $j3$ **6** 5 (4–6), $j4$ **4** 5 (4–5), $j5$ **4** 4 (4–5), $j6$ **5** 6 (5–7), $J2$ **7** 7 (5–8), $J5$ **5** 4 (4–5), $z2$ **4** 5 (4–6), $z4$ **5** 5 (5–6), $z5$ **5** 5 (4–6), $Z1$ **5** 6 (5–8), $Z4$ **7** 7 (5–7), $Z5$ **57** 52 (47–57), $s4$ **8** 10 (8–11), $S2$ **4** 6 (4–7), $S4$ **7** 7 (6–8), $S5$ **6** 6 (5–7), $r3$ **5** 7 (5–10), $R1$ **5** 6 (4–8). All setae smooth, except $Z5$ slightly serrate.

Peritreme (Figs 31–32). Peritreme beyond level of $z2$; peritrematic shield lightly sclerotised, smooth with one pair of solenostomes ($gd3$).

Venter (Fig. 32). Sternal shield smooth, posterior margin with medial projection, much wider than long, **62** 67 (62–72) long, **81** 92 (81–100) wide, with three pairs of setae $st1$ **29** 27 (24–30), $st2$ **27** 24 (20–27), $st3$ **25** 22 (19–25), and two pairs of lyrifissures ($pst1, pst2$). Exopodal shield at coxae II–IV. Metasternal platelets drop-shaped, with one pair of metasternal setae, $st4$ **20** 18 (15–20), with one pair of lyrifissures ($pst3$). Genital shield smooth, with one pair of genital setae $st5$ **23** 22 (19–24), **80** 82 (78–87) wide at level of genital setae. Distances between $st1$ – $st1$ **59** 51 (47–59), $st2$ – $st2$ **68** 61 (58–68), $st3$ – $st3$ **77** 68 (65–77), $st1$ – $st3$ **65** 56 (52–65), $st5$ – $st5$ **76** 69 (66–76). Ventrianal shield vase-shaped, smooth, **101** 101 (96–106) long, **76** 76 (72–79) wide at level of $ZV2$, **60** 51 (46–60) wide at level of anus; with three pairs of pre-anal setae, $JV1$ migrate next to $JV2$, $JV1$ **23** 23 (21–25), $JV2$ **19** 19 (15–22), $ZV2$ **14** 14 (11–16), solenostomes $gv3$ crescentic; Pa **12** 11 (10–12), Pst **13** 12 (11–13) on shield. Setae $JV4$ **7** 7 (5–10), $JV5$ **23** 22 (20–23), $ZV1$ **14** 16 (14–18), $ZV3$ **8** 6 (5–8) on interscutal membrane. All ventral setae smooth. Two metapodal plates 24 22 (20–24) long, **5** 5 (3–5) wide, 11 9 (7–11) long, **2** 2 (1–2) wide.

Spermatheca (Fig. 34). Calyx tubular, elongated, **13** 12 (11–13) long, **2** 2 (2–2) wide, with atrium at the basis, minor duct and major duct visible.



FIGURES 31–34. *Euseius paraovalis* sp. n. Female, 31. dorsal shield, 32. ventral idiosoma, 33. chelicera, 34. spermatheca.

Chelicera (Fig. 33). Movable digit **23** 22 (20–24) long, with one tooth; fixed digit **28** 24 (21–28) long, anterior half with three teeth, with pilus dentilis.

Legs (Figs 35–38). Coxal formula 2–2–2–1. Chaetotaxy (femur to basitarsus): leg I, 2 3/1 2/2 1, 2 2/1 2/1 2, 2 2/1 2/1 2, 1 1/1 1; leg II, 2 3/1 2/1 1, 2 2/0 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg III, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/1 1, 1 1/1 1; leg IV, 1 2/1 1/0 1, 1 2/1 2/0 1, 1 1/1 2/0 1, 1 1/1 1. Macrosetae: *Sge* III (ad1) **28** 25 (22–28), *Sti* III (ad1) **23** 22 (20–27), *St* III (ad1) **25** 25 (23–27), *Sge* IV (ad1) **38** 37 (32–40), *Sti* IV (ad1) **33** 32 (28–34), *St* IV (pd1) **58** 55 (51–58).

Male. Unknown.

Type specimens. Holotype: TAIWAN: Dongqing Sewage Treatment Plant, Lanyu Island, Taitung County (22°03.549' N, 121°33.569' E, 56m), one female (no. 445–2) from *Macaranga tanarius* (Euphorbiaceae), 3.iv.2010, J.R. Liao & C.C. Ho (NTU). Paratype: Dongqing, Lanyu Island, Taitung County (22°03.791' N, 121°34.034' E, 46m), two females from *Macaranga tanarius* (Euphorbiaceae), 2.iv.2010, J.R. Liao & C.C. Ho (NMNS); one female (no. 445–1) data same as holotype (NTU); two females (no. 445–3, 4) data same as holotype (TARL); Lanyu Island, Taitung County (22°00.791' N, 121°34.034' E, 32m), one female (no. 463–14) from *Trema orientalis* (Ulmaceae), 4.iv.2010, J.R. Liao (NCHU); Hongtong Village, Lanyu Island, Taitung County, one female from *Morus alba* (Moraceae), 6.iv.2011, Y.J. Lu (NPUST); Lanyu Island, Taitung County (22°02.040' N,

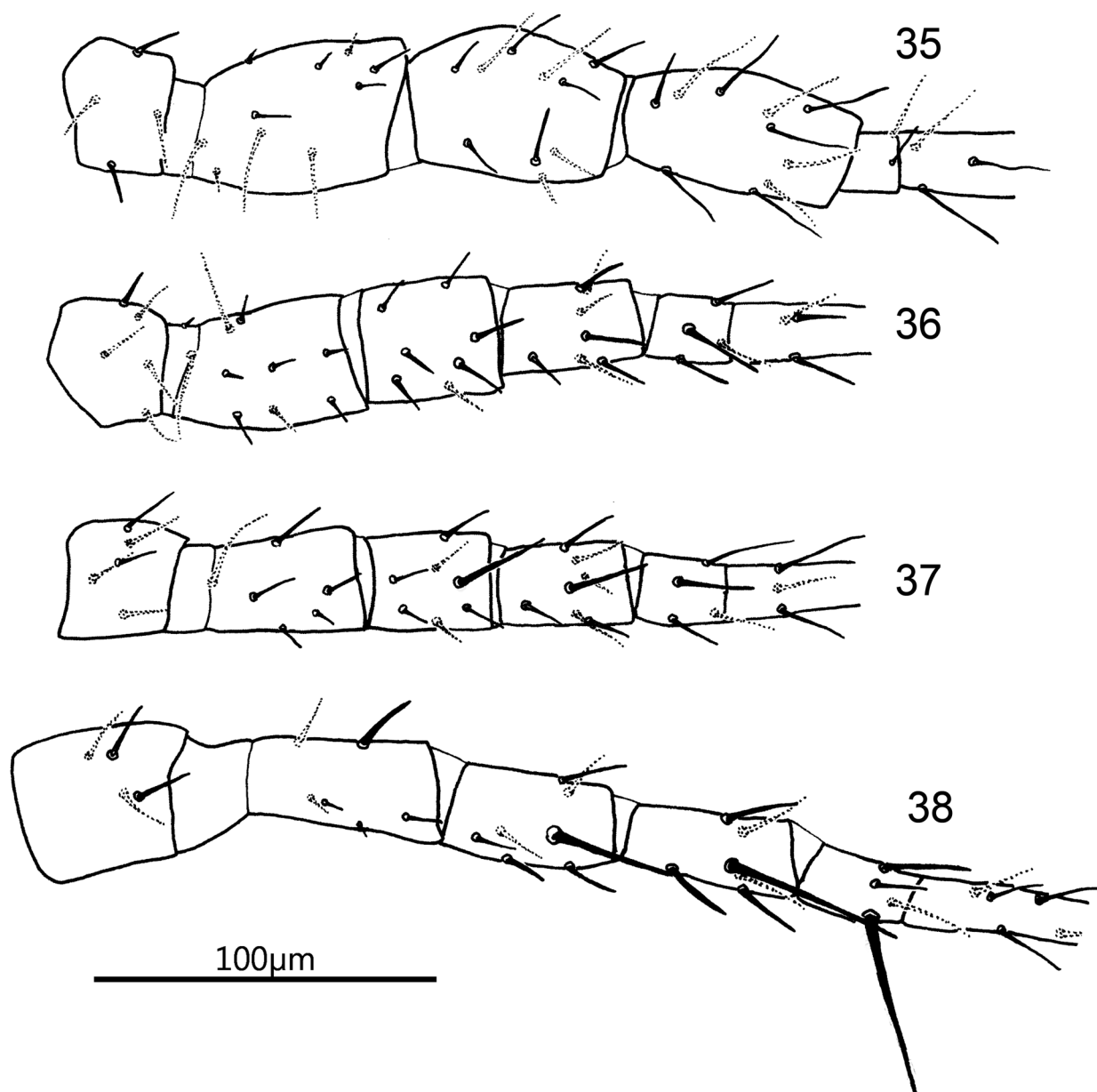
121°33.445' E, 187m), three females (no. 1324–1, 3, 5) (T-MZLQ 3282 to T-MZLQ 3284) from *Morus alba* (Moraceae), 2.vi.2014, J.F. Hsieh (ESALQ-USP).

Etymology. The name *paraovalis* refers to the similarity of the new species with *Euseius ovalis*.

Distribution. Asia: Taiwan (Lanyu Island (present study)).

Remarks. The females of this species resemble *E. ovalis* (Evans, 1953) and *E. elinae* (Schicha, 1977), but differ from *E. ovalis* in strong reticulation on the dorsal shield, anterior reticulation on the peritrematic shield, and the length of the spermatheca; from *E. elinae* in $j\beta$ minute (23–26 in *E. elinae*) and strong reticulation on the dorsal shield.

Euseius ovalis is prevalent in Taiwan and dominates flat ground areas. However, we observed that *E. paraovalis* occurred in similar habitat plants to those of *E. ovalis* on Lanyu Island, from the coastal region to the deep forest. We suggest that the lifestyle of *E. paraovalis* is similar to that of *E. ovalis*, but it is limited in Lanyu Island. According to the lifestyles described in McMurtry *et al.* (2013), we considered *E. paraovalis* may as a generalist predator that also feeds on pollen. They can prey on a broad range of small arthropods and various plant pollens.



FIGURES 35–38. *Euseius paraovalis* sp. n., Female, legs 35. leg I posterior view, 36. leg II anterior-dorsal view, 37. leg III anterior-dorsal view, 38. leg IV anterior view.

Key to females of *Euseius* species from Taiwan

1. Dorsal shield relative smaller, c.a. 250 μm (Fig. 16); ventrianal shield vase-shaped with setae *JV1* and *JV2* in normal position, in triangular pattern with *ZV2* (Fig. 17); only leg IV with macrosetae (Fig. 23) 2
- Dorsal shield relative larger, c.a. 350 μm (Fig. 1); ventrianal shield vase-shaped with pre-anal setae (*JV1* and *JV2*) arranged in tangential row (Fig. 2); leg III and leg IV with macrosetae (Figs 7, 8) 3
3. Calyx of spermathecal funnel-shaped, very narrow, atrium sac-shaped with thick walls. *circellatus*
- Calyx of spermathecal horn-shaped, atrium c-shaped with a pair of petal-shaped structure (Fig. 19) *macaranga*
4. Dorsal setae *j1*, *Z5* longer, others minute (Fig. 31); calyx of spermatheca tubular (Fig. 34) 4
- Dorsal setae *j1*, *Z5* longer, also with other setae longer (Fig. 1); calyx of spermatheca funnel-shaped 5
5. Dorsal shield with weak anterolateral reticulation *ovalis*
- Dorsal shield with strong reticulation except for central part of podosoma (Fig. 31) *paraovalis*
6. Dorsal shield with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*), ten pairs of lyrifissures *idl1*, *idl1a*, *idl4*, *idl2*, *idl3*, *idm3*, *idl4*, *idm4*, *idm5*, *idm6*. *aizawai*
- Dorsal shield with five pairs of solenostomes on dorsal shield *gd2*, *gd4*, *gd6*, *gd8*, *gd9*, seven pairs of lyrifissures *idl1*, *idl1a*, *idl2*, *idl4*, *idl3*, *idl4*, *idm5* (Fig. 1) *daluensis*

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