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Source: Systematic and Applied Acarology, 22(10) : 1639-1650

Published By: Systematic and Applied Acarology Society

URL: https://doi.org/10.11158/saa.22.10.6
Discovery of a new species of genus *Typhlodromus* Scheuten (Acari: Phytoseiidae: Typhlodrominae) on rocky shore habitat from Lanyu Island

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Abstract

Phytoseiid mites have been intensively surveyed in Taiwan during the past decades because of their potential as biological control agent. Despite the fact, many regions of Taiwan remain under-explored especially in mountain areas and neighboring islands. *Typhlodromus* (*Anthoseius*) *crossostephium* sp. nov. was collected from *Crossostephium chinense* (L.) Makino (Asteraceae) on rocky shore habitat during a survey on Lanyu Island. In this paper, presence of a phytoseiid mite on rocky shores is reported for the first time. A detailed morphological description of the new species and a key to the Taiwanese species of subgenus *Anthoseius* are provided.

Key words: Phytoseiidae, Taxonomy, Lanyu Island, rocky shore, new species

Introduction

Phytoseiid mites have received considerable attention because of their potential as biological control agents of phytophagous mites and other small arthropods (McMurtry et al. 2013). Thus far, more than 2,700 species included in 91 genera and three subfamilies, have been recorded worldwide (Chant & McMurtry 2007; Demite et al. 2017). Lanyu Island (also called Botel Tobago Island or Orchid Island) is located southeast of Taiwan and north of Luzon Island, Philippines. Since the 19th century, the great diversity of fauna found in this 48 km² island has attracted several taxonomists. Tseng (1975) reported three phytoseiid species in Lanyu Island, including *Shiehia multispinosa* Tseng (= *Neoseiulella compta* (Corpuz)), *Typhlodromus* (*Anthoseius*) *tridentiger* Tseng, and *T.* (*A.* *) lanyuensis* Tseng. Liao et al. (2017) described *Euseius paraovalis* Liao & Ho. However, knowledge of Lanyu phytoseiid mites is fragmented.

Phytoseiid mites are free-living and terrestrial mites distributed worldwide, with diverse habitats, from the tundra region to tropical rain forests (Chant 2007; McMurtry et al. 2013). These mites extensively exploit the foliage habitat of higher plants, and can be discovered in any place covered with vegetation (Chant & McMurtry, 2007; McMurtry et al. 2013). However, the phytoseiid fauna of coastal regions remains poorly identified, particularly those on the rocky shores. Moraes & Oliveira (1982) and Stathakis et al. (2016) reported phytoseiid mites found in the coastal areas, but only in the vegetative lands, not the rocky shores. A rocky shore is a harsh habitat for mites. Mites found in rocky shores are typically oribatids and rarely mesostigmatids (e.g. families Digamasellidae, Rhodacaridae) (Barendse et al. 2002). This study presents one new species *Typhlodromus* (*Anthoseius*) *crossostephium* sp. nov. found on *C. chinense* on the rocky shores of
Lanyu Island. Descriptions of both sexes are provided, along with a key to Taiwanese Typhlodromus (Anthoseius) species.

Materials and Methods

Specimens examined in this study were collected from Lanyu Islands during 2009–2016, with a particular focus on coastal region. Specimens were mounted in Hoyer's medium. Phytoseiid mites were examined under an optical microscope (Olympus® BX51), and measured using stage-calibrated ocular micrometers and ImageJ 1.47 computer program (Schneider et al. 2012), photos taken by microscopic camera (Motic® Moticam 5+). All measurements were provided in micrometers, holotype measurements are shown in bold type for the new species, followed by their mean and range in parentheses. The general terminology used for morphological descriptions in this study follows that of Chant & McMurtry (2007), while for idiosomal seta terminology followed Rowell et al. (1978) and Chant & Yoshida-Shaul (1991, 1992); for adenotaxy and poroidotaxy terminology we followed 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). Additionally, two paratypes (Aca25-3, 6) and two voucher specimens (Aca4301, 4335) of the closely related species T. philippinensis were received on loan from UPLB-MNH (Museum of Natural History, University of the Philippines Los Banos, Los Banos, Philippines), in order to confirm important morphological characters. 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

Description of new species

Typhlodromus (Anthoseius) crossostephium sp. nov. Liao & Ho

Diagnosis

Female dorsal surface mostly reticulated, bearing 21 pairs of dorsal setae (including r3, R1). All setae smooth, shovel-shaped apically except for Z4 and Z5 which are distinct shovel-shaped apically with expanded blade 1. Five pairs of solenostomes, (gd2, gd4, gd6, gd8, gd9) visible on the dorsal shield. Peritreme extending to level of setae j1. Sternal shield with three pairs of setae; ventrianal shield bearing four pairs of pre-anal setae, with solenostomes (gv7). Fixed digit of chelicera with four teeth; movable digit with three teeth. Spermatheca with calyx bell-shaped. Leg III and leg IV both with

1. Previous studies described the shape called "knobbed, blunt". We observed lateral view of setae with transparent ends (e.g. dorsal setae and JV5), and considered the transparent end shaped like shovel, and Z4, Z5 with expanded blade (Fig. 3–E).
three pair of shovel-shaped macrosetae; genu II with seven setae. Male ventrianal shield bearing six pairs of pre-anal setae; spermatodactyl foot L-shaped.

**FIGURE 1.** The location where the *Typhlodromus (Anthoseius) crossostephium* sp. nov. were found. A. Type locality; B. Neighboring rocky shores.

**Female (n=10)**
A lightly sclerotized mite. Idiosomal setal pattern: 12A:8A/JV:ZV.

**Dorsum** (Fig. 2–A). Dorsal shield nearly oval, constricted at level of *R1*, with lateral reticulation; 317 319 (308–328) long (*j1–J5* level) and 187 193 (187–206) wide at level of *j6*, 183 190 (180–199) wide at level of *S4*; five pairs of solenostomes on dorsal shield, (*gd2, gd4, gd6, gd8, gd9*), 13 pairs of lyrifissures, (*id1, id2, id1a, id4, id6, idm2, idl2, idm3, idl3, idx, idl4, idm5, idm6*); length of setae: *j1* 20 21 (19–23), *j3* 22 22 (19–24), *j4* 14 (11–18), *j5* 13 14 (12–16), *j6* 17 17 (16–19), *J2* 24 23 (21–27), *J5* 9 8 (6–11), *z2* 16 14 (13–16), *z3* 17 19 (16–21), *z4* 21 21 (17–23), *z5* 15 16 (13–20), *Z4* 32 31 (26–37), *Z5* 44 45 (41–51), *s4* 21 21 (19–24), *s6* 24 25 (22–29), *S2* 23 27 (23–31), *S4* 19 23 (19–31), *S5* 16 14 (9–18), *r3* 15 16 (14–19), *R1* 13 13 (11–15). All setae smooth, shovel-shaped apically except for *Z4* and *Z5* which are distinct shovel-shaped apically with expanded blade (Fig. 2–E).

**Peritreme** (Figs. 2–A, B). Peritreme extend to level of *j1*; peritremal shield lightly sclerotized, with one pair of solenostomes (*gd3*), one pair of lyrifissures (*id3*).

**Venter** (Fig. 2–B). Sternal shield smooth, posterior margin irregular, much wider than long, 52 55 (46–63) long, 79 84 (75–89) wide, with three pairs of setae *st1* 25 25 (22–29), *st2* 21 20 (19–21), *st3* 25 20 (15–25), and two pairs of lyrifissures (*pst1, pst2*). Exopodal shield at coxae II–IV. Metasternal platelets tear-shaped, with one pair of metasternal setae, *st4* 17 19 (15–22), with one pair of lyrifissures (*pst3*). Genital shield smooth, with one pair of genital setae *st5* 23 17 (12–23), 69 70 (65–75) wide at level of genital setae. Distances between *st1–st1* 46 46 (43–49), *st2–ST2* 57 60 (56–
Ventrianal shield pentagonal, smooth, 99 103 (98–109) long, 85 90 (84–95) wide at level of \( ZV2 \), 66 67 (63–71) wide at level of anus; with four pairs of pre-anal setae, \( JV1 \) 15 13 (11–16), \( JV2 \) 14 12 (8–16), \( JV3 \) 10 13 (10–15), \( ZV2 \) 16 14 (9–17), solenostomes gv3 crescentic; \( Pa \) 10 10 (8–14), \( Pst \) 9 10 (8–12) on shield. Setae \( JV4 \) 11 11 (9–13), \( JV5 \) 30 31 (26–37), \( ZV1 \) 17 16 (13–19), \( ZV3 \) 8 9 (6–12) on interscutal membrane. All setae smooth, sharp pointed, \( JV5 \) shovel-shaped. Two metapodal plates 20 21 (18–27) long, 3 4 (3–5) wide, 10 8 (5–12) long, 2 2 (1–2) wide.

Spermatheca (Fig. 2–D). Calyx bell-shaped, 17 16 (14–19) long, 7 8 (7–10) wide, atrium connected to the calyx with a neck, minor and major ducts visible.

**FIGURE 2.** *Typhlodromus (Anthoseius) crossostephium* sp. nov. female. A. Dorsal shield; B. Ventral idiosoma; C. Chelicera; D. Spermatheca; E. Setae Z5 dorsal and lateral views and seta S2.
**FIGURE 3.** Typhlodromus (Anthoseius) crossostephium sp. nov. female, legs. A. Leg I anterior view; B. Leg II dorsal-posterior view; C. Leg III posterior view; D. Leg IV posterior view.

**Chelicera** (Fig. 2–C). Movable digit 25 26 (25–28) long, with three teeth; fixed digit 26 25 (23–26) long, anterior half with three teeth, posterior half with one tooth, with pilus dentilis.


Male (n=10)

**Dorsum** (Fig. 4–A). Dorsal shield nearly oval, constricted at level of R1, with lateral reticulation; 252 (240–270) long (j1–J5 level) and 168 (160–178) wide at level of j6, 135 (131–140) wide at level of S4, five pairs of solenostomes on dorsal shield, (gd2, gd4, gd6, gd8, gd9), thirteen
pairs of lyrifissures, \((id1, id2, id1a, id4, id6, idm2, idl2, idm3, idl3, idx, idl4, idm5, idm6)\); length of setae: \(j1 14 (10–19), j3 18 (16–20), j4 13 (11–16), j5 12 (11–14), j6 14 (11–16), J2 18 (16–21), J5 8 (6–10), z2 12 (10–13), z3 15 (13–17), z4 16 (14–18), z5 13 (11–16), Z4 24 (22–26), Z5 31 (29–34), s4 17 (15–21), s6 20 (18–23), S2 21 (20–22), S4 18 (16–19), S5 13 (11–15), r3 13 (11–16), R1 10 (9–12). All setae smooth, shovel-shaped apically except for \(Z5\) which are distinct shovel-shaped apically with expanded blade.

**FIGURE 4.** *Typhlodromus*(Anthoseius)*crossostephiump.* nov. male. A. Dorsal shield; B. Ventral idiosoma; C. Chelicera and spermatodactyl.

*Peritreme* (Figs. 4–A, B). Peritreme extending to level of \(j1\); peritremal shield lightly sclerotized, with one pair of solenostomes \((gd3)\), one pair of lyrifissures \((id3)\).

*Venter* (Figs. 4–B). Sternogenital shield smooth, lateral slightly reticulated, posterior margin with slightly medium projection, longer than wide, 110 (105–123) long, 65 (60–73) wide at level of

Exopodal shield at coxae II–IV. Ventrianal shield subtriangular, with striation, 97 (93–101) long, 136 (129–144) wide at anterior corner, 60 (52–97) at level of anus, fused with peritremal shield cingulum; with four pairs of pre-anal setae, JV1 12 (9–14), JV2 11 (10–12), JV3 10 (7–12), ZV2 11 (9–13), solenostomes gv3 crescentic; Pa 8 (7–12), Pst 9 (7–12) on shield. Setae JV5 16 (13–18) on interscutul membrane. All setae smooth, sharp pointed, JV5 shovel-shaped.

**FIGURE 5.** *Typhlodromus (Anthoseius) crossostephium* sp. nov. male, legs. A. Leg I anterior view; B. Leg II dorsal-posterior view, C. leg III dorsal-posterior view; D. Leg IV dorsal-posterior view.

Chelicera (Fig. 4–C). Movable digit 18 (16–21) long, with one tooth; fixed digit 20 (18–21) long, anterior half with two teeth, with pilus dentilis. Spermatodactyl L-shaped, shaft 18 (18–18) long, heel rounded, foot 11 (9–13) long, with expanded toe and lateral thorn-like projection.

Legs (Figs. 5). Coxal formula 2-2-2-1. Chaetotaxy (femur to basitarsus): leg I, 2-3/1-2/2-2, 2-2/1-2/1-2, 1-1/1-1; leg II, 2-3/1-2/1-1, 2-2/0-2/0-1, 1-1/2-1/1-1, 1-1/1-1; leg III, 1-2/1-1/0-1, 1-2/1-0/1, 1-1/2-1/1-1, 1-1/1-1; leg IV, 1-2/1/0-1, 1-2/0-2/1-1, 1-1/0-2/1-1, 1-1/1-1. Macrosetae: Sge III (ad2) 9 (7–12), Sti III (ad) 8 (7–10), St III (ad) 7 (7–8), Sge IV (ad2) 14 (13–16), Sti IV (ad) 9 (7–12), St IV (ad) 19 (16–21).
**Type specimens**

Holotype female: Lanyu Island, Elephant trunk rock (22°01.077’ N, 121°35.990’ E, 24 m), no. 1901–3 from *Crossostephium chinense* (Compositae), 23.ix.2016, H. Y. Lin (NTU). Paratypes: Lanyu Island, Elephant trunk rock (22°01.077’ N, 121°35.990’ E, 24 m), six females (no. 467–1, 2, 3, 4, 5, 8) from *C. chinense*, 5.iv.2010, J. R. Liao & C. C. Ho (NMNS); Lanyu Island, Elephant trunk rock (22°01.077’ N, 121°35.990’ E, 24 m), 65 females 12 males (HAL099B481, 483, 484, 486, 488, 489, 490, 491, 492, 493, 495, 501, 502, 503, 505, 506, 507, 508, 509, 511, 512, 513, 514, 515, 516, 517, 519, 520, 522, 523, 524, 525, 526, 527, 528, 530, 531, 533, 534, 535, 536, 537, 539, 540, 541, 543, 544, 546, 547, 548, 549, 551, 553, 554, 555, 556, 557, 558, 559, 560, 561, 563, 565, 569, 571, 573, 574, 575, 577, 578, 579, 581) from *C. chinense*, 5.iv.2010, C. C. Ho (5 females in NTU, 4 females 4 males in NSNM, remaining in TARL); Lanyu Island, Elephant trunk rock (22°01.077’ N, 121°35.990’ E, 24 m), one female (no. 1647–2) from *C. chinense*, 4.ix.2016, H. Y. Lin (NPUST); Lanyu Island, Five holes cave (22°4.914’ N 121°30.664’ E, 4 m), two females (no. 1895–1, 2) from *C. chinense*, 4.ix.2016, H. Y. Lin (TARI); Lanyu Island, Lovers cave (22°3.693’ N, 121°34.427’ E, 12 m), one female (no. 1896–1) from *C. chinense*, 4.ix.2016, H. Y. Lin (ESALQ-USP); three females and eight males (no. 1901–2, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14) data as holotype (NTU); Lanyu Island, Red head rock (22°01.077’ N, 121°35.990’ E, 24 m), one female one male (no. 2064–1, 2) from *C. chinense*, 4.ix.2016, C. F. Hsu (NCHU).

**Etymology**

The name *crossostephium* refers to the host plant *Crossostephium chinense* (L.) Makino.

**Remarks**


**TABLE 1.** Differences between *Typhlodromus* (A.) *crossostephium* sp. nov. and related species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Solenostomes</th>
<th>Calyx of spermapheca</th>
<th>Teeth on FD/MD</th>
<th>Z4 shape</th>
<th>Z4 end</th>
<th>Z5 shape</th>
<th>Z5 end</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>acaciae</em></td>
<td>5</td>
<td>bell-shaped</td>
<td>6/3</td>
<td>barbed</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>betulae</em></td>
<td>5</td>
<td>annulated</td>
<td>5/3</td>
<td>smooth</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>brisbanensis</em></td>
<td>5</td>
<td>fundibular</td>
<td>8/3</td>
<td>barbed</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>bullatus</em></td>
<td>5</td>
<td>fundibular</td>
<td>5/3</td>
<td>barbed</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>gressitti</em></td>
<td>5</td>
<td>bell-shaped</td>
<td>4/3</td>
<td>smooth</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>gutierrezi</em></td>
<td>5</td>
<td>bell-shaped</td>
<td>4/3</td>
<td>barbed</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>krimbasi</em></td>
<td>5</td>
<td>annulated</td>
<td>4/3</td>
<td>barbed</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>philippinensis</em></td>
<td>5</td>
<td>bell-shaped</td>
<td>3/3</td>
<td>smooth</td>
<td>sharp pointed</td>
<td>barbed</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>tridentiger</em></td>
<td>5</td>
<td>unknown</td>
<td>V-shaped</td>
<td>3/3</td>
<td>smooth</td>
<td>smooth</td>
<td>shovel-shaped with expanded bladed</td>
</tr>
<tr>
<td><em>crossostephium</em></td>
<td>5</td>
<td>bell-shaped</td>
<td>4/3</td>
<td>smooth</td>
<td>shovel-shaped with expanded bladed</td>
<td></td>
<td></td>
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TABLE 1. (continued).

<table>
<thead>
<tr>
<th>Genus</th>
<th>Setae on tubercles</th>
<th>Remaining setae</th>
<th>dorsal/4 length</th>
<th>Z5 length</th>
<th>Setae shaped end</th>
<th>shovel - Relative length of macrosetae on leg IV</th>
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<tbody>
<tr>
<td>acaciae</td>
<td>lateral setae and</td>
<td>Z4 smooth</td>
<td>45</td>
<td>57</td>
<td>Z5</td>
<td>St IV &gt; Sge IV &gt; Sti IV</td>
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<tr>
<td>betulae</td>
<td>without tubercules</td>
<td>smooth</td>
<td>31</td>
<td>52</td>
<td>Z5</td>
<td>St IV &gt; Sni IV &gt; Sge IV</td>
</tr>
<tr>
<td>brisbanensis</td>
<td>without tubercules</td>
<td>smooth</td>
<td>22–34</td>
<td>41–59</td>
<td>Z5</td>
<td>St IV &gt; Sni IV &gt; Sge IV</td>
</tr>
<tr>
<td>ballatae</td>
<td>without tubercules</td>
<td>smooth</td>
<td>22–34</td>
<td>37–54</td>
<td>Z5</td>
<td>St IV &gt; Sni IV &gt; Sge IV</td>
</tr>
<tr>
<td>gressitti</td>
<td>without tubercules</td>
<td>smooth</td>
<td>25</td>
<td>48</td>
<td>Z5</td>
<td>St IV &gt; Sni IV &gt; Sge IV</td>
</tr>
<tr>
<td>gutierrezi</td>
<td>without tubercules</td>
<td>smooth</td>
<td>30</td>
<td>45</td>
<td>Z5</td>
<td>St IV &gt; Sni IV &gt; Sge IV</td>
</tr>
<tr>
<td>krimbasi</td>
<td>S2, S4, S5, Z4, Z5</td>
<td>without tubercules</td>
<td>32</td>
<td>48</td>
<td>all dorsal setae</td>
<td>Sge IV &gt; St IV &gt; Sti IV</td>
</tr>
<tr>
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<td>32.5</td>
<td>45</td>
<td>none</td>
<td>Sge IV &gt; St IV &gt; Sti IV</td>
</tr>
<tr>
<td>tridentiger</td>
<td>without tubercules</td>
<td>smooth</td>
<td>32</td>
<td>44</td>
<td>all dorsal setae  and JV5</td>
<td>St IV &gt; Sge IV &gt; Sti IV</td>
</tr>
<tr>
<td>crossostephium</td>
<td>without tubercules</td>
<td>smooth</td>
<td>32</td>
<td>44</td>
<td>all dorsal setae  and JV5</td>
<td>St IV &gt; Sge IV &gt; Sti IV</td>
</tr>
</tbody>
</table>

* from Schultz (1973); Ueckermann et al. (2008); Kolodochka (1992); Schicha (1978); Ueckermann et al. (2008); McMurtry & Moraes (1985); Blommers (1973); Papadoulis & Emmanouel (1997); Corpuz (1966), Schicha & Corpuz-Ramos (1992); Tseng (1975), and present study.

FIGURE 6. Dorsal setae Z4, Z5, S5. A. Typhlodromus (Anthoseius) crossostephium sp. nov. (female holotype); B. Typhlodromus (Anthoseius) philippinensis Corpuz, 1966 (female paratype Aca025-6).

T. (A.) philippinensis and T. (A.) tridentiger which seems most close to the new species. The new species differs from T. (A.) philippinensis in the shovel-shaped end of seta Z4 with expanded blade (Z4 shovel-shaped without expanded blade in philippinensis), Z5 smooth (barbed in philippinensis), seta S5 thicker and longer 16 14 (9–18) (8 in philippinensis), relative length of macrosetae St IV > Sge IV > Sti IV (Sge IV > St IV > Sti IV in philippinensis), JV5 with shovel-shaped (JV5 normal in

2. Remaining dorsal setae refers to dorsal setae except Z4 and Z5.

2017 LIAO ET AL.: A NEW SPECIES OF GENUS TYPHLODROMUS FROM LANYU ISLAND 1647
philippinensis), fixed digit with 4 teeth (3 teeth in philippinensis) (Figures 6, 7). These characters are persistent in the two paratypes and four voucher specimens of T. philippinensis we loaned from UPLB-MNH.

FIGURE 7. Macrosetae on leg IV. A. Typhlodromus (Anthoseius) crossostephiun sp. nov. (female holotype); B. Typhlodromus (Anthoseius) philippinensis Corpuz, 1966 (female paratype Aca025-6).

Tseng (1975) described T. (A.) tridentiger from Lanyu Island not detailed enough for the subgenus Anthoseius, and all specimens were lost (Liao et al. 2017b). It is impossible to compare the new species to type specimens of T. (A.) tridentiger. However, this new species is similar to T. (A.) tridentiger based on original description of Tseng (1975). The new species differs from T. (A.) tridentiger in seta Z4 with expanded shovel-shaped end (sharp end in tridentiger), fixed digit with 4 teeth (3 teeth in tridentiger), and leg IV without additional macrosetae (with additional macrosetae on Sge IV, Sti IV in tridentiger). We consider Z4 shape and additional macrosetae present/absent on leg IV could confirm they are separated species.

Key to Typhlodromus (Anthoseius) species known from Taiwan based on adult females

1. Ventrianal shield with three pairs of preanal setae .................................................. transvaalensis
   - Ventrianal shield with four pairs of preanal setae .................................................. 2
2. Preanal pores absent ........................................................................................................ 3
   - Preanal pores present .................................................................................................... 4
3. Sternal shield with two pairs of setae ............................................................................... neocrassus
   - Sternal shield with three pairs of setae ........................................................................ changi
4. Ventrianal shield with small rounded preanal pores ...................................................... ryukyuensis
   - Ventrianal shield with crescentic preanal pores ......................................................... 5
5. Sternal shield with two pairs of setae ............................................................................... obesus
   - Sternal shield with three pairs of setae ........................................................................ 6
6. Movable digit of chelicera with one tooth ....................................................................... 7
   - Movable digit of chelicera with more than one tooth .................................................. 8
7. Fixed digit of chelicera with one tooth ............................................................................. lanyuensis
   - Fixed digit of chelicera with four teeth ....................................................................... gracilentus

3. Due to the inadequate original description, Typhlodromus (Anthoseius) eleglidus Tseng was not treated in the key.
Discussion

In this study, we propose *Typhlodromus* (*Anthoseius*) *crossostephium* sp. nov. as a new taxon for science; this is the first report on phytoseiid species found in rocky shores. Stathakis *et al.* (2016) surveyed a coastal region, where they found phytoseiids, therefore, we suspected the natural coastal regions may have more undiscovered mite species. We observed the plant *C. chinense* on rocky shores on coastal line of the Lanyu Island. *C. chinense* naturally occurs in littoral habitats of Taiwan, Ryukyu Islands, and the Bonin Islands (Hobbs *et al.* 2013). Taiwanese people generally cultivate this plant at their home, because of its well-known efficacy in Chinese medicine. At present, finding this plant in native habitats is difficult owing to environmental destruction. Although we surveyed coastal regions surrounding the main island of Taiwan, no native *C. chinense* plants and phytoseiid mites were found. We also surveyed cultivated *C. chinense* plants, but still no phytoseiid mites were discovered. Thus, we suspected that although phytoseiid mites are strongly associated with their host plant, some other unknown factors also influence their presence; therefore, we could not find these new species on our cultivated *C. chinense* plants. Thus, further survey of the coastal ecosystem for phytoseiid mites is worth.

Acknowledgements

We thank Y.T. Hsu (TTDARES, Taiwan) and H.Y. Lin (Taiwan) for Lanyu Island collection, C. F. Hsu (NTU, Taiwan) for habitat photos, to H. C. Lee (NTU, Taiwan) for illustration, to Dr. M. J. Yang (NCYU, Taiwan), Y. Hsiao, Dr. J. F. Hsieh, Dr. M. C. Chiu (NTU, Taiwan) for suggestions. Thanks also to Dr. İ. Döker (CU, Turkey) for his encouragement and suggestions for the manuscript, Y. Kendrick and R. Mech for English editing of the draft. We also thank L. A. Corpuz–Raros, J. C. T. Gonzalez and J. Naredo (UPLB-MNH, Philippines) for lending type specimens of *T. (A). philippinensis* for comparison. The study is supported by grants (MOST105-2621-B-002-002-MY3) from the Ministry of Science and Technology, Taiwan.

References


1650 SYSTEMATIC & APPLIED ACAROLOGY VOL. 22