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Article

A contribution to the knowledge of the genus *Charletonia* Oudemans (Acari: Prostigmata: Erythraeidae) from Turkey

Mert Elverici[1], Evren Buğa[2] and Sevgi Sevsay[1*]

1. *Biology Department, Sciences and Arts Faculty, Erzincan Binali Yıldırım University, Turkey; E-mails: mert.elverici@ erzincan.edu.tr, ssevsay@erzincan.edu.tr*
2. *liç Dursun Yıldırım Vocational School, Medical Laboratory Techniques Program, Erzincan Binali Yıldırım University, Turkey; E-mail: evren.buga@ erzincan.edu.tr*

[*] Corresponding author

ABSTRACT
Larvae of *Charletonia krendowskyi* (Feider, 1954) are reported both for the first time as ectoparasitic on adults of bush cricket *Platycleis intermedia* (Orthoptera: Tettigoniidae), and from Turkey. The previously given metric data for this species has been compared. In addition, some structural abnormalities seen in this species are given. This is the third record of *Charletonia* associated with orthopterans of the family Tettigoniidae.

KEY WORDS: Actinotrichida; *Charletonia krendowskyi*; ectoparasite; Orthoptera; new record.

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INTRODUCTION

Erythraeid mites are poorly studied in Turkey. Only 31 species belonging to 11 genera are reported earlier (Sevsay 2017; Noei *et al*. 2017, 2019; Oner *et al*. 2021), indicating the family's under-representation in scientific inventories considering the extraordinary diversity of the family. The subfamily Callidosomatinae Southcott, 1957 consists of 13 genera globally, including *Andrevella* Southcott, *Caeculisoma* Berlese, *Callidosoma* Womersley, *Carastrum* Southcott, *Cecidopus* Karsch, *Charletonia* Oudemans, *Dambullaeus* Haitlinger, *Harpagella* Southcott, *Iguatonia* Haitlinger, *Momorangia* Southcott, *Neoabrolophus* Khot, *Pussardia* Southcott, and *Neomomorangia* Fain and Santiago-Blay (Clark 2014; Noei *et al*. 2015). *Charletonia*, established by Oudemans (1910) is composed of 118 species so far (Noei *et al*. 2015; Šundić *et al*. 2017). Only two species of the genus *Charletonia* have been reported from Turkey; *C. cardinalis* (C.L. Koch, 1837) and *C. cilissa* (Cooreman, 1955) (Haitlinger 2000; Beron 2008; Mąkol and Wohltmann 2012; Sevsay 2017).

In this paper additional information to the description of *Charletonia krendowskyi* is provided, the previously given metric data from the literature have been compared, and a contribution for the distribution of the species is offered. Also, abnormalities observed on the scutum, settlement positions of solenidion on Genu I are given.

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MATERIAL AND METHODS

The larval mites were obtained from 16 adults (9 males, 7 females) of *Platycleis intermedia* (Serville, 1838) (Orthoptera: Tettigoniidae) collected by hand or sweep netting at the barley field margins on wild vegetation (coll. M. Elverici, E. Buğa) (Fig. 1). A total of 40 larvae were examined, with measurements taken for 23 individuals. All are collected from the same locality in Elmaköy Village, Erzincan Province, Turkey, during field samplings on 20 June–6 July 2020, and 26 June–17 July 2021. Habitat type was characterized as a narrow (two to five meters in width) row of dense herbaceous vegetation with trees or shrubs sparsely distributed alongside the field margin. Variable sizes of larvae were collected based on the feeding status (Fig. 2). Larvae were detached from hosts using an insect pin and preserved in 75% ethanol. The fed larvae were cleared in KOH (Mąkol and Sevsay 2011) and mounted in Hoyer's medium (Walter and Krantz 2009). All measurements and photographs were made using an Olympus BX63 DIC microscope. All measurements are given in µm and in the format (minimum-maximum). The terminology, setal notations and abbreviations follow Southcott (1961, 1988), and Haitlinger (1999). The materials are deposited in the Acarology Laboratory of Erzincan Binali Yıldırım University, Erzincan, Turkey (EBYU).

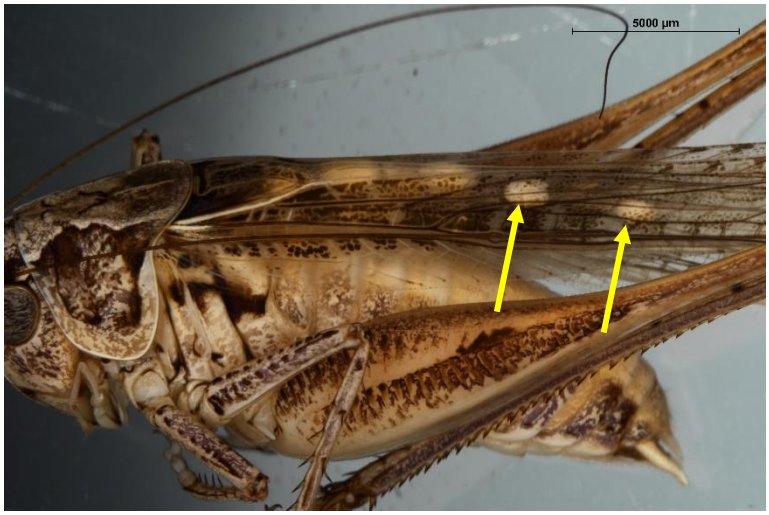


Figure 1. Larvae of *Charletonia krendowskyi* attached to the hindwing of *Platycleis intermedia* (Arrows show mite larvae; the color of the larvae disappeared after storage in 70% ethanol).

Figure 2. Sizes of the larvae on the host according to the feeding period (first row *Charletonia krendowskyi* larvae, second row more fed larvae of *Eutrombidium trigonum*).

RESULTS

Family Erythraeidae Robineau-Desvoidy, 1828
Subfamily Callidosomatinae Southcott, 1957
Genus *Charletonia* Oudemans, 1910

***Charletonia krendowskyi* (Feider, 1954)**

Additions and corrections to the description (n = 40 larvae) – Measurements of 23 specimens are given in Table 1.

Dorsal surface with about 125–135 barbed setae (fD) and ventral surface with 45–50; one eye on each side of idiosoma (Fig. 3). Scutum pentagonal, obvious punctate entirely, chitinized in the middle, and shorter than wide. The upper border of the scutum is convex at the level of the ASE setae, expanded at the PL level. Scutum with two pairs of sensilla (ASE < PSE) both with short barbs in distal part. ASens well anterior to the level of ML scutalae (Fig. 4). Scutalae (AL, ML and PL) slightly barbed, AL as long as ML and both slightly longer than PL. Ventral side of idiosoma with sternalae 1*a*, 2*a*, 3*a*, all with short barbs, subequal in length. Coxae I with one barbed seta (1*b*), coxae II and coxae III each with two barbed setae with four setae between them.

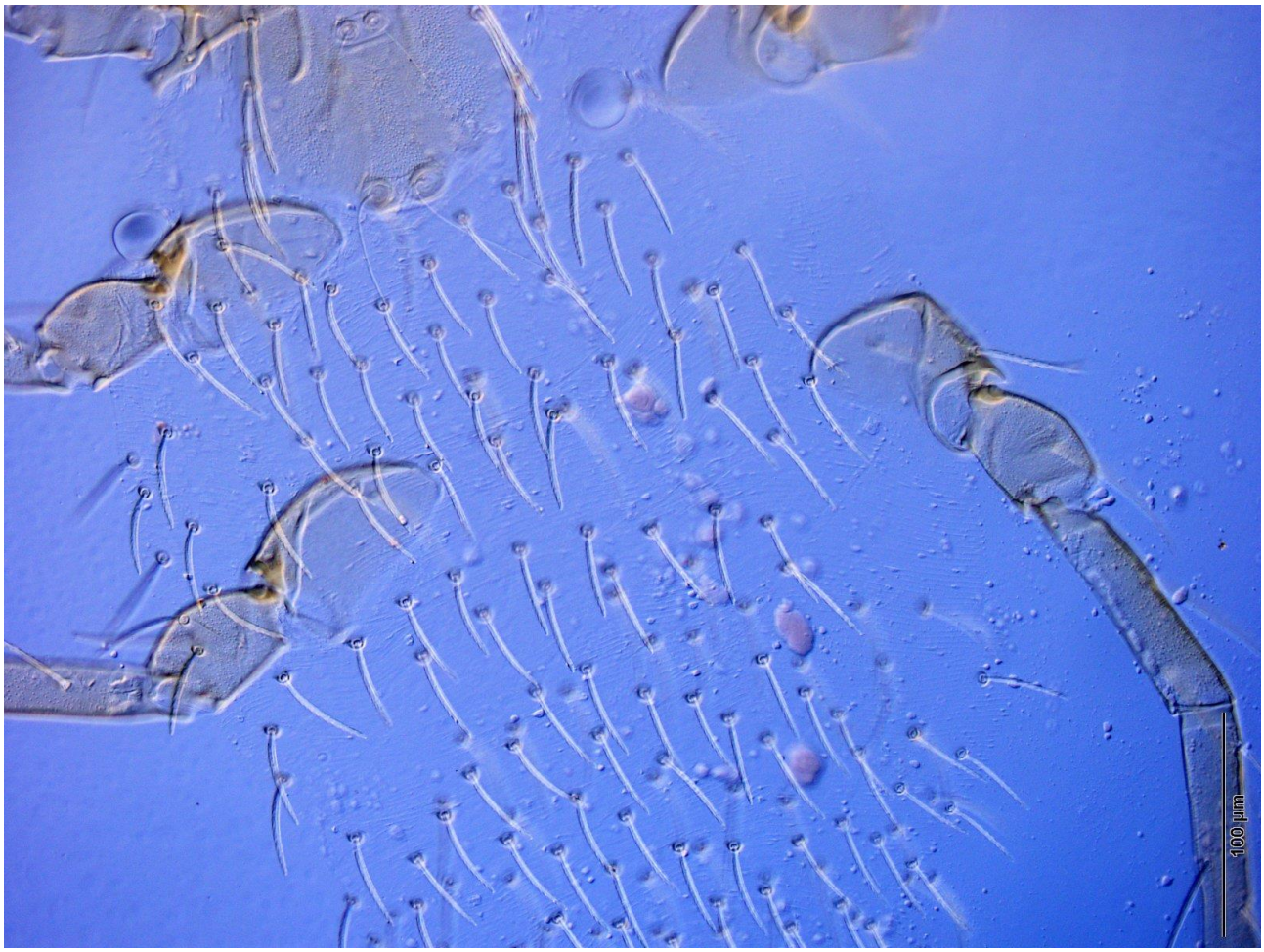


Figure 3. Dorsal view of idiosoma of *Charletonia krendowskyi* (larva).

Leg segmentation formula: **Leg I:** Ta-1ω, 1ε, 3ζ, 1Cp, 22n; Ti-2φ, 1κ, 1Cp, 16-18n; Ge-1σ, 1κ, 12n; TFe- 5n, BFe-4n; Tr-1n. **Leg II:** Ta-1ω, 1ζ, 18-20n; Ti-2φ, 16-17n; Ge-1κ, 12n; TFe-5n, BFe-

4n; Tr-1n. **Leg III:** Ta-2-4ζ, 22-24n; Ti-1φ, 18n; Ge-12n; TFe-5n, BFe-2n; Tr-1n. Solenidion placed in distal half of Ge I and proximal to the most distal normal seta.

Gnathosoma with two pairs of barbed hypostomalae (*as* and *bs*). Palpfemur and palpgenu each with one barbed seta. Palptibia with three barbed (BBB) and pointed setae. Palptarsus with distal one eupathidium, one proximal solenidion, one smooth and four barbed setae. fPp = 0-B-B-BBB_2-BBBBNωζ, solenidion thick and pronounced (Fig. 5).

Figure 4. Scutum of *Charletonia krendowskyi* (larva).

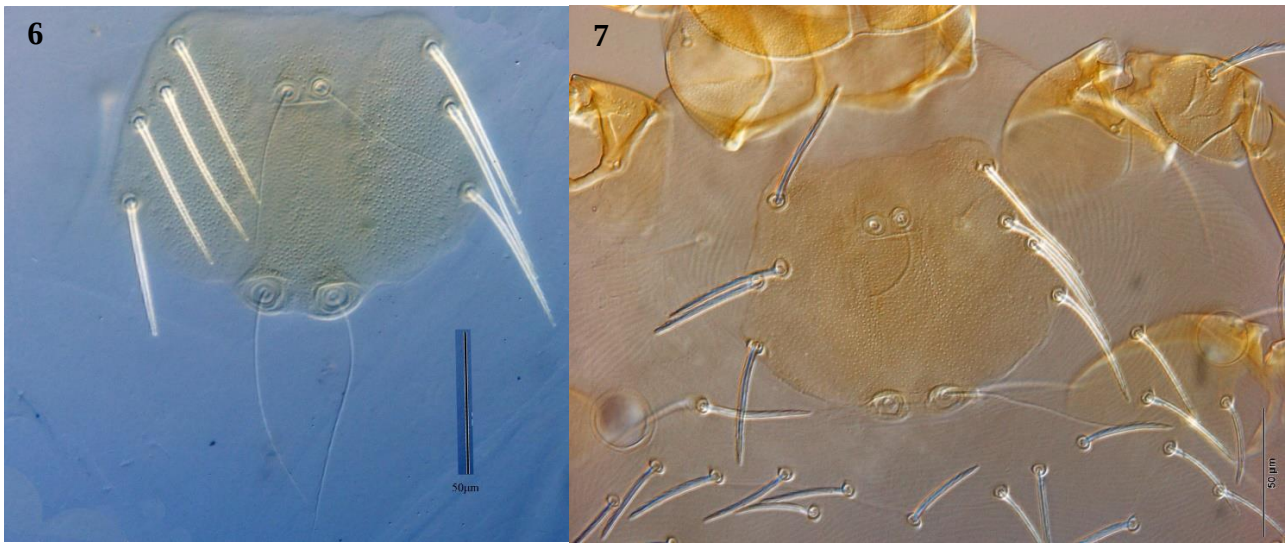
Figure 5. Palptarsus of *Charletonia krendowskyi* (larva).

Table 1. Comparison of *Charletonia krendowskyi* (Feider, 1954) metric data**,** after Haitlinger and Saboori (2007) and present study. R: Romanian specimens, B: Bulgarian specimens; G: Greek specimens; I: Iranian specimens; T: Turkish specimens.

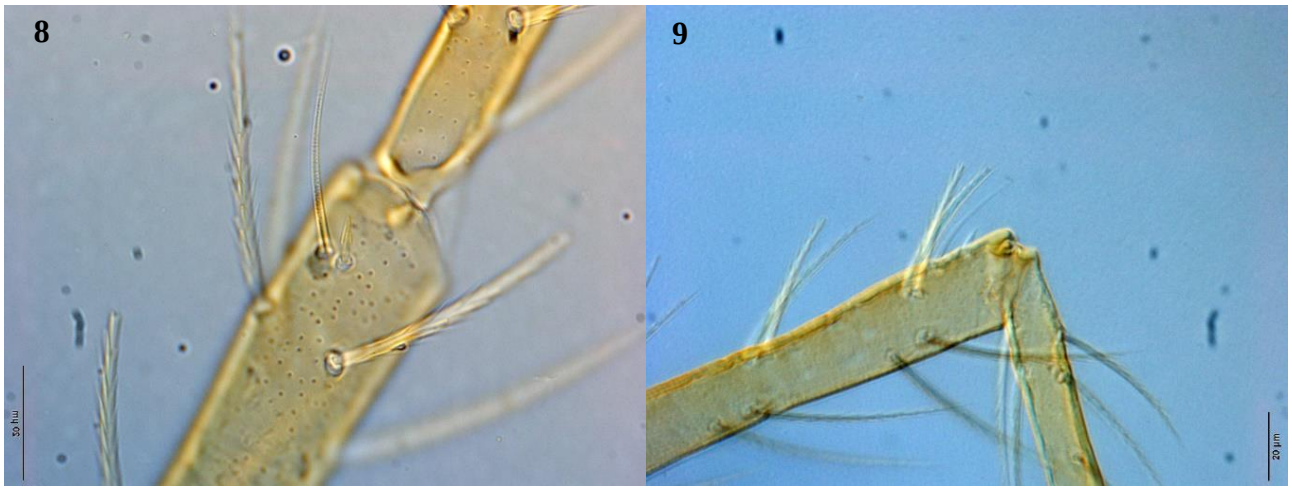
Chracter	R n = 3	B n = 3	G n = 1	I n = 5	T n = 23	Chracter	R n = 3	B n = 3	G n = 1	I n = 5	T n = 23
IL	-	-	686	647–1333	395–682	***cs***	-	-	-	-	30–38
IW	-	-	413	444–1111	268–588	**OC**	21	-	-	22	20–28
L	100–110	108–113	106	88–112	95–115	**ω1**	-	-	-	-	34–46
W	106–129	118–135	132	116–128	100–120	**φ Ia**	-	-	-	-	34–42
AW	80–91	83–90	92	82–94	81–93	**φ Ib**	-	-	-	-	38–46
MW	99–106	95–105	102	94–100	92–109	**σ I**	-	-	-	-	37–44
PW	104–122	115–125	122	108–124	102–124	**ω II**	-	-	-	-	17–20
ISD	67–73	71–73	70	54–74	69–76	**φ IIa**	-	-	-	-	15–36
AP	54–58	58–61	50	44–54	51–60	**φ IIb**	-	-	-	-	15–25
SBa	-	-	-	-	11–13	**Ta I**	178	170–182	182	164–184	167–187
SBp	-	-	-	-	18–21	**Ti I**	199	197–215	218	204–232	202–231
AL	54–69	60–75	68	60–78	63–72	**Ge I**	163	155–170	166	150–174	154–170
ML	53–58	60–70	68	48–62	55–63	**Tf I**	91	-	100	92–108	91–202
PL	47–53	55–63	62	46–60	47–59	**Bf I**	107	-	108	100–122	84–130
LX	-	-	-	-	12–17	**Tr I**	-	-	56	52–64	58–66
ASE	-	-	-	-	52–55	**Cx I**	-	-	64	62–84	62–76
PSE	-	-	-	-	81–92	**Ta II**	166	158–173	174	154–184	161–176
GL	-	-	174	152–172	31–50	**Ti II**	184	185–192	196	174–206	178–205
DS	29–58	-	40–60	36–66	30–65	**Ge II**	145	130–143	142	126–154	136–150
PsFd	-	-	82	66–82	63–84	**Tf II**	87	-	84	78–94	82–90
PsGd	-	-	34	28–40	30–38	**Bf II**	101	-	104	92–110	100–107
PaFe (L)	-	-	-	-	51–70	**TR II**	54	-	62	52–64	51–63
PaFe (W)	-	-	-	-	42–52	**Cx II**	76	-	74	78–86	68–82
PaGe (L)	-	-	-	-	30–58	**Ta III**	181	170–190	184	172–202	177–197
PaGe (W)	-	-	-	-	22–28	**Ti III**	260	263–290	284	260–304	183–286
1*a*	-	-	50	40–50	33–57	**Ge III**	163	155–165	170	142–182	155–173
2*a*	-	-	70	50–70	60–71	**Tf III**	116	-	128	104–130	115–123
3*a*	-	-	-	-	47–57	**Bf III**	108	-	112	114–130	105–126
1*b*	-	-	76	84–100	90–106	**Tr III**	62	-	74	62–68	61–70
2*b'*	-	-	-	64–82	41–80	**Cx III**	76	-	90	82–90	70–90
2*b''*	-	-	60	56–60	51–62	**Leg I**	-	-	894	-	824–969
3*b'*	-	-	-	54–64	51–69	**Leg II**	813	-	836	-	794–864
3*b''*	-	-	62	54–60	52–59	**Leg III**	966	-	1042	-	915–1058
as	-	-	-	-	-	**IP**	-	-	2772	-	2580–2840
bs	-	-	-	-	30–53						

Some abnormalities are observed on examined specimens. In two specimens, there are two ML setae on one side (4+3 scutalae) (Fig. 6). In one of the other specimen, there are two ML setae on both sides (4+4 scutalae) (Fig. 7). Also, placement of solenidion on the Genu I (distal to or in line with the location of the most distal normal seta) is very important character to identify species. Although these setae were distal in our samples, they are located in either near the middle of Genu I

(27 specimens, Fig. 8) or lateral side of Genu I (13 specimens, Fig. 9). It is observed that the location of microsetae depends on the position of solenidion. Additionally, one of the specimens had two microsetae on Genu I (instead of one) (Fig. 10).



Figures 6–7. Scutum of *Charletonia krendowskyi* (larva) – 6. With 4+3 scutalae (more ML setae on left sides); 7. With 4+4 scutalae (more ML setae on both sides).



Figures 8–9. Solenidion and microseta on Genu I of *Charletonia krendowskyi* (larva) – 8. Distally and in the middle; 9. Distally and in the lateral.

Biology

Larvae on the hosts were most abundant at the end of June and the beginning of July. Most parasitic larvae were observed after rainy days. The red-colored larvae of *Charletonia krendowskyi* were attached primarily on the posterior wings of the bush cricket. The number of ectoparasitic larvae of *C. krendowskyi* on *Platycleis intermedia* ranged from 2 to 8, which is interpreted as moderately high. The larvae were usually located under the posterior wing.

Distribution

Bulgaria, Croatia, Greece, Iran, Italy, Macedonia, Moldova, Romania, Ukraine (Mąkol and Wohltmann, 2012), and Turkey (in this study).

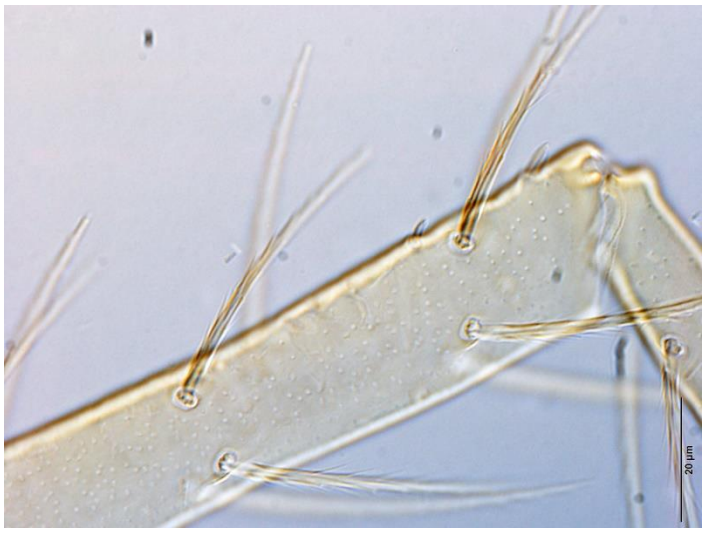


Figure 10. Two microsetae on Genu I of *Charletonia krendowskyi* (larva) abnormally.

DISCUSSION

The type locality of *Charletonia krendowskyi* (Feider, 1954) is Romania. Haitlinger (2003) included Turkey in the distribution range of *C. krendowskyi* in the identification key given for the *Charletonia* species (probably by mistake since there was no valid record), whereas later publications omitted Turkey from the distribution range (Haitlinger and Saboori 2007; Beron 2008; Haitlinger 2010; Mąkol and Wohltmann 2012, Haitlinger and Šundić 2016; Sevsay 2017). For this reason, this species is reported for the first time from Turkey in this study.

Haitlinger and Saboori (2007) summarized morphological measurements of *C. krendowskyi* in a single table by evaluating the previous articles. This table shows that the range of variation in the morphological data of the species is quite broad. Consequently, such variation must be considered when defining a new species. Although our specimens are similar to those from other regions, they differ in some setal structures and measurements. These differences are shown comparatively in Table 1. In our specimens, the structure of the scutum is shown clearly with photographs. While in the previous figures the anterior border was shown as a straight line, in our specimens it has a slight protrusion in medium towards the outside (Fig. 4).

Larvae of the genus *Charletonia* have been reported mostly feeding on orthopteran hosts belonging to Acrididae (*C. buluchestania*, *C. taiwanensis*, *C. braunsi*, *C. justynae*), Pyrgomorphidae (*C. cameroonensis*, *C. keyi*, *C. milanea*, C. *raymondi*) (Haitlinger 2006; Tsai and Chow 2009; Tashakor *et al*. 2015; Haitlinger *et al*. 2020), and Tettigoniidae (*C. brunni*, *C. behshahriensis*) (Haitlinger 2007; Hakimitabar *et al*. 2014). Hitherto, C. *krendowskyi* has been found to parasitize an undetermined Orthoptera and a *Chrysops* sp. (Diptera: Simulidae) (Haitlinger and Saboori 2007). With our finding, the bush cricket *Platycleis intermedia* (Orthoptera: Tettigoniidae) is listed as host for the first time.

Platycleis intermedia is among the harmful bush cricket groups in field crops (TOB 2020). This bush cricket was the dominant species in the studied orthopteran community, accumulating mainly at the barley field margins during the daytime. We recorded moderately high abundances of ectoparasites on the crickets in this study, indicating the potential role of *C. krendowskyi* on biological control as an ecosystem service. Key (1991) gave the geographical distribution and host relationships of 12 species of *Charletonia* whose larvae are known to parasitize ‘short-horned’ grasshoppers (Orthoptera) in Australia (Key 1991). Welbourn (1982) indicated the potential use of 175 nominal

trombidioid and erythraeoid species as biological control agents. *Charletonia* might be a valuable candidate for biological control.

According to Kekeunou *et al*. (2015), *Charletonia* sp. has a higher tendency to attach at the host thorax, compared to head and abdomen. Our results support this idea. The reason behind the high abundance of *Charletonia* sp. on the wings of host might be linked to the soft nature of the membrane, and the shelter effect provided by the wings. In order to have a better understanding of the relationship between orthopterans and *Charletonia* spp., further studies in the field for observing host-parasite interactions, and in the laboratory for experimental rearing and measuring host stress levels are required (Kekeunou *et al*. 2015). Such knowledge might have implications in the biological warfare against harmful orthopterans. Larvae of *Eutrombidium trigonum* (Hermann, 1804) coexisted with *C. krendowskyi* as ectoparasites on *Platycleis intermedia* in the studied bush cricket population, whereas larvae differed both in size and color between species. Considering the alcohol preserved specimens, larvae of *E. trigonum* were red and large, whereas those of *C. krendowskyi* were colorless and tiny (Fig. 2). The exact reason for such difference between these two species is unknown, while competitive effects or temporal niche partitioning might be in play. Further studies are needed on these subjects.

Morphological abnormalities have been reported from Parasitengona mites in many studies (Southcott 1997; Mąkol and Łaydanowicz 2006; Roland and Gabryś 2011). Studies on terrestrial Parasitengona have revealed that morphological abnormalities occur much more frequently in laboratory-rearing larvae. The abnormalities seen in this study were observed in the larvae born in the field. The area where the hosts were gathered was a barley field, and chemical pesticides were sprayed here for weeds. Also, asymmetrical variations can be seen in bilaterally paired structures. In this study, abnormalities were observed in 8 of the 40 slides. The scutum usually bears three pairs (3+3 scutalae) of setae, AL, ML and PL (Fig. 4), whereas variations may occur on their numbers. Southcott (1966, 1997) reported abnormalities seen in prostigmatic mites, as well as for the number of setae on the scutum of *Charlotonia* species. Accordingly, following variations were reported on the scutalae: *Charletonia feideri* for having 4+3, 2+3, 3+4; *Charletonia keyi* for having 3+4; *Charletonia naivashae* for having 2+3; *Charletonia shiroyama* for having 4+3; *Charletonia venus* for having 2+4, 3+3, 3+4, 4+4, 5+4, 5+5; *Charletonia vitzthumi* for having 2+3, 3+4, 3+2.

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اطلاعاتی در مورد جنس *Charletonia* Oudemans (Acari: Prostigmata: Erythraeidae) از ترکیه

مرت الوریسی[۱]، اورن بوغا[۲] و سوگی سوسای[۱*]

۱. گروه زیست شناسی، دانشکده علوم و هنر، دانشگاه ارزینجان بینالی ییلدیریم، ترکیه؛ رایانامه‌ها: mert.elverici@erzincan.edu.tr، ssevsay@erzincan.edu.tr

۲. دانشکدهٔ حرفه‌ای ایلیچ دورسون ییلدیریم، برنامه تکنیک‌های آزمایشگاهی پزشکی، دانشگاه ارزینجان بینالی ییلدیریم، ترکیه؛ رایانامه: evren.buga@erzincan.edu.tr

[*] نویسنده مسئول

چکیده

لارو *Charletonia krendowskyi* (Feider, 1954)، برای نخستین بار هم به عنوان انگل بیرونی حشرات کامل ملخ شاخک بلند *Platycleis intermedia* (Orthoptera: Tettigoniidae) و هم از ترکیه گزارش شده است. داده‌های متریک پیشین برای این گونه مقایسه شده‌اند. افزون بر این، برخی از ناهنجاری های ساختاری که در این گونه دیده می شود، ارایه شده است. این سومین گزارش ارتباط *Charletonia* با راست‌بالان خانوادهٔ Tettigoniidae است.

واژگان کلیدی: Actinotrichida؛ *Charletonia krendowskyi*؛ انگل خارجی؛ راست‌بالان؛ گزارش جدید.

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