

NEW LOCALITIES OF ZERCONID MITES FROM TURKEY (ACARI: ZERCONIDAE)

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ABSTRACT: In this study, we reported the presence of 20 zerconid mite species belonging to 2 genera (*Prozercon* and *Zercon*) from Amasya, Balıkesir, Bolu, Bursa, Eskişehir and Isparta provinces of Turkey. Specimens were collected between 2011 and 2015. Distributions of species within Turkey are presented as a catalogue of provincial records. Unknown immature stages (deutonymphs and protonymphs) of some known zerconid mites and males of *Zercon ignobilis* are here recorded for the first time. Several species known previously from only a few localities in Turkey have been shown to have much wider distributions in the country. In addition, the habitats of these species found in the provinces were given.

KEY WORDS: Acari, Mesostigmata, Zerconidae, zerconid mites, new localities, Turkey

According to recent molecular systematic studies the family Zerconidae belongs to suborder Monogynaspida, cohort Gamasina and the superfamily Zerconoidea (Sikora, 2014). Zerconid mites are important members of the soil fauna and these free-living mites colonise in various soil substrates (Karaca & Urhan, 2015a). Their body lengths vary between 200-700 micrometers. They mostly associated with humus and soil, decomposed litter, leaf mould, plant parts, and mosses (Urhan, 2010b), however, there are rare records from wood substrates, ant-hills, nests of birds and small terrestrial mammals (Mašan & Fend'a, 2004). These small, predatory mites feed on the eggs, larvae and nymphs of other mites and springtails (Shereef et al., 1984; Martikainen & Huhta, 1990). Their dorsal shields divided into two separate parts: podonotum and opisthonotum. These mites are weakly sclerotized and their life cycle include four active stages; larva, protonymph, deutonymph and adult. The presence of zerconids in various soil substrates shows that they can be used as bioindicators for environmental changes (Sikora, 2014).

The members of Zerconidae are well known from the Holarctic region (Krantz, 1978), however, in recent years there are locality reports from alpine zone of Central Mexico and Taiwan (Ma et al., 2011; Ujvári, 2011a-b, 2012). In present, approximately 40 genera which are comprised of more than 400 species are known worldwide. Only two genera, *Prozercon* and *Zercon*, and 88 species were recorded known from Turkey until now (Karaca & Urhan, 2014, 2015b). In Turkey, the first study of zerconids was published by Polish acarolog C. Błaszak (1979) based on samples collected from Amanos Mountains and surrounding of Bolu province, collected by B. Dominiak and J. Pawlowski. From 1992 to date, further studies about zerconids have been made by R. Urhan and his team-mates in Turkey.

The aim of this study was to make a contribution to Turkish zerconid mites fauna.

MATERIAL AND METHODS

Soil, litter and moss samples were taken from 27 different localities in forestlands of Amasya, Balıkesir, Bolu, Bursa, Eskişehir and Isparta provinces (Fig. 1). The samples were placed in plastic bags, labelled and transferred to the laboratory and placed in combined Berlese funnels. Mites were extracted for 5-7 days according to the humidity of the samples. At the end of this process, the contents of the bottles were transferred to Petri dishes and mites were separated under a stereo-microscope. They were placed in 60% lactic acid for clearing and mounted on permanent microscope slides using a glycerine medium. The examination and drawing of mites were carried out using an Olympus BX50 microscope with DP25 camera. The examined materials are stored in 70% ethanol and deposited in the Acarology Laboratory of Pamukkale University, Denizli (Turkey). Morphological terminology, idiosomal chaetotaxy and poidotaxy (Fig. 2) used in the description follows that of Mašán & Fend'a (2004).

A list of localities is given in Table 1. The 'List of species' gives the sampling locations for each species. The dates of sampling and total number of individuals are also noted.

RESULTS

Family Zerconidae Canestrini, 1891

Genus *Prozercon* Sellnick, 1943

Type species: *Zercon fimbriatus* C. L. Koch, 1836

***Prozercon balikesirensis* Urhan, 2008**

Materials: BU₁: 2 females, 23.09.2011; IS₂: 7 females, 23.06.2015. **Distribution in Turkey:** Balıkesir, İstanbul (Urhan, 2008a; Duran, 2013; Karaca, 2015). **Distribution in the world:** Turkey (Urhan, 2008a).

***Prozercon buraki* Urhan, 2008**

Materials: BO₃: 98 females, 19 males, 8 deutonymphs, 6 protonymphs, 12.10.2012; BO₄: 24 females, 5 males, 2 deutonymphs, 13.10.2012; BO₅: 19 females, 2 males, 2 deutonymphs, 13.10.2012; BO₁₀: 3 females, 15.10.2012; BO₁₁: 8 females, 2 males, 1 deutonymph, 15.10.2012; BO₁₂: 16 females, 7 males, 2 deutonymphs, 15.10.2012; **Distribution in Turkey:** İstanbul, Kocaeli (Urhan, 2008a; Duran, 2013; Karaca, 2015). **Distribution in the world:** Turkey (Urhan, 2008a). **Remark:** Deutonymph and protonymph individuals of this species are recorded for the first time.

***Prozercon carpathofimbriatus* Mašán & Fend'a, 2004**

Materials: BU₁: 6 females, 23.09.2011. **Distribution in Turkey:** Edirne, İstanbul, Kırklareli, Tekirdağ (Duran, 2013; Karaca, 2015). **Distribution in the world:** Croatia, Czech Republic, Poland, Slovakia, Turkey (Mašán & Fend'a, 2004; Ujvári 2011c; Duran, 2013).

***Prozercon demirsoyi* Urhan & Ayyıldız, 1996**

Materials: BO₁: 12 females, 8 males, 3 deutonymphs, 11.10.2012; BO₂: 7 females, 11.10.2012; BO₃: 3 females, 4 males, 3 deutonymphs, 12.10.2012; BO₄: 6 females, 13.10.2012; BO₆: 1 female, 14.10.2012; BO₈: 18 females, 1 male, 14.10.2012; BO₉: 40 females, 14 males, 5 deutonymphs, 14.10.2012; BO₁₀: 38 females, 16 males, 3 deutonymphs, 15.10.2012; BO₁₁: 77 females, 28 males, 6 deutonymphs, 2 protonymphs, 15.10.2012; BO₁₂: 38 females, 13 males, 4 deutonymphs, 15.10.2012; BO₁₇: 3 females, 2 males, 18.10.2012; **Distribution in Turkey:** Artvin, Giresun, İstanbul (Urhan & Ayyıldız, 1996b; Öztaş, 2011; Duran, 2013; Karaca, 2015). **Distribution in the world:** Turkey (Urhan & Ayyıldız, 1996b).

***Prozercon graecus* Ujvári, 2011**

Materials: BO₄: 9 females, 5 males, 13.10.2012; BO₁₃: 18 females, 19 males, 6 deutonymphs, 1 protonymph, 16.10.2012; BO₁₄: 5 females, 3 males, 2 deutonymphs, 17.10.2012; BO₁₉: 3 females, 2 males, 1 deutonymph, 18.10.2012. **Distribution in Turkey:**

Kırklareli, Tekirdağ (Karaca, 2015; Karaca & Urhan, 2015b). **Distribution in the world:** Greece, Turkey (Ujvári 2011c; Karaca, 2015). **Remark:** Deutonymph individuals of this species are recorded for the first time.

***Prozercon sultani* Duran & Urhan, 2015**

Materials: BO₇: 2 females, 1 deutonymph, 14.10.2012; BO₁₄: 3 females, 1 male, 17.10.2012. **Distribution in Turkey:** İstanbul (Duran, 2013; Duran & Urhan, 2015; Karaca, 2015). **Distribution in the world:** Turkey (Duran, 2013). **Remark:** Deutonymph individuals of this species are recorded for the first time.

***Prozercon tragardi* (Halbert, 1923)**

Materials: BO₁: 10 females, 6 males, 2 deutonymphs, 11.10.2012. **Distribution in Turkey:** Erzurum, Giresun, İstanbul, Kırklareli, Tekirdağ (Urhan, 1995; Öztaş, 2011; Duran, 2013; Karaca, 2015). **Distribution in the world:** Austria, Czech Republic, England, Germany, Hungary, Iceland, Ireland, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia, Sweden, Swiss, Turkey, Ukraine (Urhan & Ayyıldız, 1992; Mašán & Fend'a, 2004; Ujvári, 2009).

Genus *Zercon* C. L. Koch, 1836

Type species: *Zercon triangularis* C. L. Koch, 1836

Zercon agnostus* Błaszak, 1979

Materials: AM₁: 57 females, 32 males, 18 deutonymphs, 6 protonymphs, 13.03.2011. **Distribution in Turkey:** Adana, Yozgat (Błaszak, 1979; Urhan et al., 2007). **Distribution in the world:** Turkey (Błaszak, 1979; Urhan et al., 2007). **Remark:** Deutonymph and protonymph individuals of this species are recorded for the first time.

***Zercon burdurensis* Urhan, 2001**

Materials: IS₁: 2 females, 22.06.2015. **Distribution in Turkey:** Burdur (Urhan, 2001). **Distribution in the world:** Turkey (Urhan, 2001).

***Zercon cabylus* Athias-Henriot, 1961**

Materials: BO₁: 18 females, 1 male, 11.10.2012; BO₅: 1 female, 13.10.2012; BO₁₀: 1 female, 15.10.2012; BO₁₁: 5 females, 15.10.2012. **Distribution in Turkey:** Artvin, Tekirdağ (Urhan & Ayyıldız, 1996a; Karaca, 2015). **Distribution in the world:** Algeria, Turkey (Athias-Henriot, 1961; Urhan & Ayyıldız, 1996a).

***Zercon cokelezicus* Urhan, 2009**

Materials: ES₂: 15 females, 8 males, 10.04.2013. **Distribution in Turkey:** Denizli (Urhan, 2009). **Distribution in the world:** Turkey (Urhan, 2009).

***Zercon colligans* Berlese, 1920**

Materials: AM₁: 31 females, 17 males, 11 deutonymphs, 8 protonymphs, 13.03.2011; ES₁: 23 females, 12 males, 7 deutonymphs, 4 protonymphs, 10.04.2013; IS₁: 1 female, 22.06.2015. **Distribution in Turkey:** Artvin, Aydın, Çanakkale, Denizli, Edirne, Erzurum, Giresun, İstanbul, Kırklareli, Tekirdağ (Urhan, 1991, 1995; Güler, 1999; Orman, 2001; Öztaş, 2011; Duran, 2013; Karaca, 2015). **Distribution in the world:** France, Italy, Sweden, Swiss, Turkey (Sellnick, 1958; Urhan & Ayyıldız, 1994).

***Zercon denizliensis* Urhan, 2011**

Materials: ES₂: 9 females, 5 males, 10.04.2013. **Distribution in Turkey:** Denizli, Giresun (Urhan, 2011; Öztaş, 2011). **Distribution in the world:** Turkey (Urhan, 2011).

***Zercon foveolatus* Halašková, 1969**

Materials: BO₅: 1 female, 1 male, 13.10.2012; BO₆: 1 male, 14.10.2012; BO₇: 1 female, 1 male, 14.10.2012. **Distribution in Turkey:** Kırklareli, Kocaeli, Tekirdağ (Urhan, 2008b; Karaca, 2015). **Distribution in the world:** Czechoslovakia, Romania, Slovakia, Turkey, Ukraine (Halašková, 1969; Petrova, 1977; Karg, 1993; Mašán & Fend'a, 2004; Urhan, 2008b).

***Zercon ignobilis* Błaszak, 1979**

Materials: BO₁: 1 female, 11.10.2012; BO₃: 3 females, 1 male, 2 deutonymphs, 1 protonymph, 12.10.2012; BO₄: 4 females, 13.10.2012; BO₅: 36 females, 2 males, 13.10.2012; BO₆: 113 females, 5 males, 3 deutonymphs, 14.10.2012; BO₇: 12 females, 14.10.2012; BO₈: 10 females, 14.10.2012; BO₉: 23 females, 1 male, 14.10.2012; BO₁₀: 22 females, 15.10.2012; BO₁₁: 13 females, 2 males, 15.10.2012; BO₁₂: 81 females, 4 males, 15.10.2012; BO₁₆: 1 female, 17.10.2012; BO₂₀: 2 females, 20.10.2012. **Distribution in Turkey:** Bolu (Błaszak, 1979). **Distribution in the world:** Turkey (Błaszak, 1979). **Remark:** Male, deutonymph and protonymph individuals of this species are recorded for the first time.

Zercon laczii Ujvári, 2010

Materials: BO₁₆: 22 females, 1 male, 17.10.2012. **Distribution in Turkey:** İstanbul (Duran, 2013; Karaca, 2015). **Distribution in the world:** Croatia, Turkey (Ujvári, 2010; Duran, 2013).

Zercon leporus Blaszk, 1979

Materials: BO₃: 10 females, 12.10.2012; BO₄: 5 females, 1 male, 13.10.2012. **Distribution in Turkey:** Bolu, İstanbul (Blaszak, 1979; Duran, 2013; Karaca, 2015). **Distribution in the world:** Turkey (Blaszak, 1979).

Zercon longisetosus Urhan, 2008

Materials: BO₁₃: 76 females, 23 males, 8 deutonymphs, 1 protonymph, 16.10.2012; BO₁₄: 112 females, 13 males, 2 deutonymphs, 17.10.2012; BO₁₅: 123 females, 14 males, 6 deutonymphs, 17.10.2012; BO₁₇: 81 females, 32 males, 4 deutonymphs, 2 protonymphs, 18.10.2012; BO₁₈: 126 females, 29 males, 18 deutonymphs, 6 protonymphs, 18.10.2012; BO₁₉: 152 females, 59 males, 24 deutonymphs, 8 protonymphs, 18.10.2012. **Distribution in Turkey:** Kocaeli (Urhan, 2008c). **Distribution in the world:** Turkey (Urhan, 2008c). **Remark:** Protonymph individuals of this species are recorded for the first time.

Zercon marinae Ivan & Călugăr, 2004

Materials: BA₁: 9 females, 4 males, 03.11.2013. **Distribution in Turkey:** Çanakkale, Edirne, İstanbul, Kırklareli, Tekirdağ (Duran, 2013; Karaca, 2015). **Distribution in the world:** Romania, Turkey (Ivan & Călugăr, 2004; Ujvári & Călugăr, 2010; Duran, 2013).

Zercon yusuñi Urhan, 2010

Materials: BO₂: 1 female, 11.10.2012; BO₆: 10 females, 14.10.2012; BO₇: 10 females, 1 male, 14.10.2012; BO₂₀: 1 female, 20.10.2012. **Distribution in Turkey:** Kütahya (Urhan, 2010a). **Distribution in the world:** Turkey (Urhan, 2010a).

DISCUSSION

In this paper, several unknown stages (deutonymphs and protonymphs) of *Prozercon buraki*, *P. graecus*, *P. sultani*, *Zercon agnostus*, *Z. ignobilis*, *Z. longisetosus* and male individuals of *Zercon ignobilis* are reported for the first time.

The unique zoogeographical position of Turkey between Asia, Europe and North Africa, in the western Palearctic region, provides a rich biological diversity in terms of both floral and faunal elements. As zerconids are closely related with litter types plant communities which are specific to a particular area, may allow spreading endemic zerconid species associated with these special floral elements. Terra typica of 58 zerconid species is Turkey. Most probably, it is expected to found new species and new records of zerconids in Turkey with local faunistic investigations (especially in Black Sea and Mediterranean regions).

* First records of nymphs of *Zercon agnostus* was presented as a poster and published as an abstract at 12nd National Ecology and Environment Congress, which was held at Muğla Sıtkı Koçman University between 14–17 September 2015, in Muğla, Turkey.

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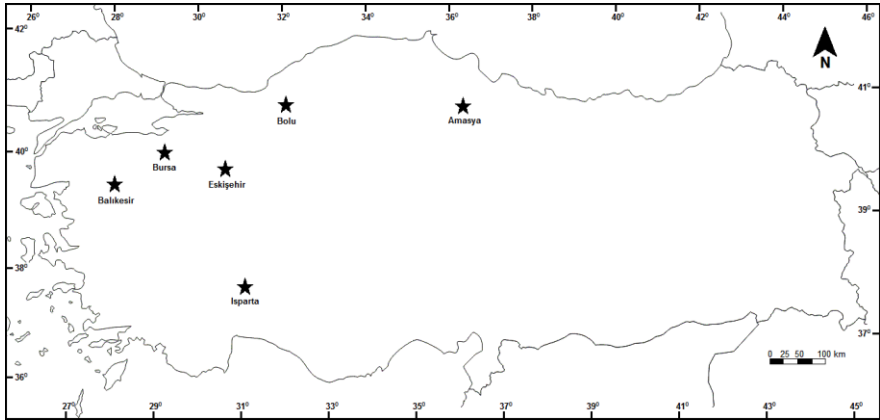


Figure 1. Research areas and collecting localities (*).

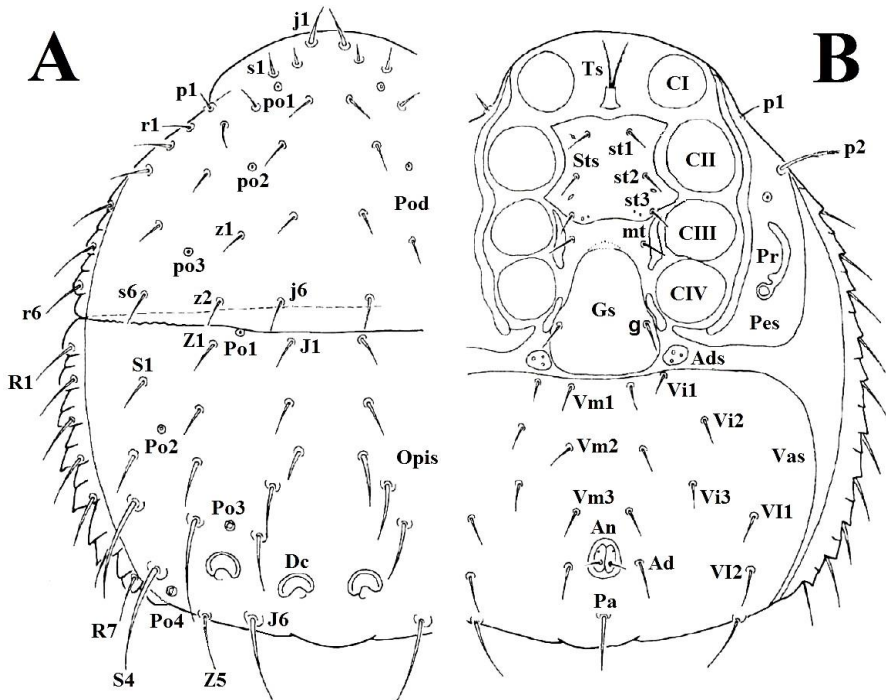


Figure 2. General view of a zerconid mite (female): A) dorsal view, B) ventral view. Abbreviations: (Pod) podonotum, (j1-6, z1-2, s1-6, p1-2 and r1-7) podonotal setae, (po1-3) podonotal glands, (Opis) opisthonotum, (J1-6, Z1-5, S1-4 and R1-7) opisthonotal setae, (Po1-4) opisthonotal glands, (Dc) dorsal cavities, (Ts) tritosternum, (Sts) sternal shield, (st1-st3) sternal setae, (mt) metasternal seta, (Gs) genital shield, (g) genital seta, (CI-CIV) endopodal shields, (Ads) adgenital shield, (Pr) peritreme, (Pes) peritremal shield, (Vas) ventroanal shield, (Vm1-Vm3) ventromediales setae, (Vi1-Vi3) ventrointernales setae, (VI1-VI2) ventrolaterales setae, (An) anal orifice, (Ad) adanal setae, (Pa) postanal seta (modified after Masan & Fend'a, 2004).

Table 1. List of sampling sites in research areas. Abbreviations: (AM) Amasya, (BA) Bahkesir, (BO) Bolu, (BU) Bursa, (ES) Eskişehir, (IS) Isparta.

No.	Sampling site	Coordinates	Altitude (m)	Habitat(s)	Code
1.	Urban Forest (Centre, Amasya)	40°.38'N-35°.47'E	600	<i>Juniperus</i> sp. + <i>Pinus brutia</i>	AM ₁
2.	Hamamlı village (Erdek, Bahkesir)	40°.24'N-27°.53'E	95	<i>Quercus</i> sp.	BA ₁
3.	Yedigöller National Park (Centre, Bolu)	40°.56'N-31°.45'E	830	<i>Pinus nigra</i>	BO ₁
4.	Yedigöller National Park (Centre, Bolu)	40°.56'N-31°.45'E	830	Moss + <i>Ulmus</i> sp.	BO ₂
5.	Yedigöller National Park (vicinity of Sazıgöl)	40°.56'N-31°.44'E	850	<i>Ulmus</i> sp.	BO ₃
6.	Yedigöller National Park (vicinity of Şelale)	40°.56'N-31°.44'E	785	Moss	BO ₄
7.	Gölcük village (Centre, Bolu)	40°.48'N-31°.42'E	1040	<i>Alnus</i> sp. + <i>Quercus</i> sp.	BO ₅
8.	Gölcük village (Centre, Bolu)	40°.48'N-31°.42'E	1075	<i>Quercus</i> sp.	BO ₆
9.	Gölcük village (Centre, Bolu)	40°.48'N-31°.42'E	1075	Moss	BO ₇
10.	Gölcük village (Centre, Bolu)	40°.48'N-31°.42'E	1050	<i>Pinus nigra</i>	BO ₈
11.	Gölcük village (Centre, Bolu)	40°.48'N-31°.42'E	1050	<i>Ulmus</i> sp.	BO ₉
12.	Gölcük village (Centre, Bolu)	40°.49'N-31°.41'E	1130	<i>Pinus nigra</i>	BO ₁₀
13.	Gölcük village (Centre, Bolu)	40°.49'N-31°.41'E	1130	<i>Ulmus</i> sp.	BO ₁₁
14.	Gölcük village (Centre, Bolu)	40°.49'N-31°.41'E	1130	<i>Quercus</i> sp.	BO ₁₂
15.	Gerede village (Gerede, Bolu)	40°.48'N-32°.11'E	1630	<i>Picea</i> sp. + <i>Pinus sylvestris</i>	BO ₁₃
16.	Plateau road (Gerede, Bolu)	40°.49'N-32°.11'E	1705	<i>Pinus sylvestris</i>	BO ₁₄
17.	Plateau road (Gerede, Bolu)	40°.49'N-32°.11'E	1705	<i>Picea</i> sp.	BO ₁₅
18.	Plateau road (Gerede, Bolu)	40°.49'N-32°.11'E	1705	Moss	BO ₁₆
19.	Gerede plateau (Gerede, Bolu)	40°.49'N-32°.13'E	1750	<i>Pinus sylvestris</i>	BO ₁₇
20.	Gerede plateau (Gerede, Bolu)	40°.49'N-32°.13'E	1750	Moss	BO ₁₈
21.	Gerede plateau (Gerede, Bolu)	40°.49'N-32°.13'E	1750	<i>Picea</i> sp.	BO ₁₉
22.	Abant road (Mudurnu, Bolu)	40°.37'N-31°.17'E	1335	<i>Crataegus</i> sp.	BO ₂₀
23.	Güngörmez village (Karacabey, Bursa)	40°.19'N-28°.20'E	475	<i>Pinus</i> sp. + <i>Quercus</i> sp.	BU ₁
24.	İdrisyaıla village (Seyitgazi, Eskişehir)	39°.22'N-30°.26'E	1370	<i>Juniperus</i> sp. + <i>Quercus</i> sp.	ES ₁
25.	Çürüttüm village (Seyitgazi, Eskişehir)	39°.21'N-30°.25'E	1400	<i>Cistus</i> sp. + <i>Pinus nigra</i>	ES ₂
26.	Kırntı village (Eğirdir, Isparta)	39°.39'N-30°.50'E	1225	<i>Juniperus oxycedrus</i> + Moss	IS ₁
27.	Yukarıgökdere village (Eğirdir, Isparta)	37°.44'N-30°.49'E	1540	<i>Quercus vulcanica</i> + Moss	IS ₂