

## Zerconid mites (Acari, Zerconidae) in İstanbul, with four new records for the Turkish fauna

Elif Hilal DURAN\*, Raşit URHAN

Department of Biology, Faculty of Arts and Sciences, Pamukkale University, Denizli, Turkey

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**Abstract:** The zerconid mites collected from İstanbul Province between January 2012 and September 2013 are evaluated and the following species are recorded: *Prozercon balikesirensis*, *P. buraki*, *P. carpathofimbriatus*, *P. demirsoyi*, *P. fimbriatus*, *P. satapliae*, *P. sultani*, *P. traegardhi*, *P. yavuzi*, *Zercon colligans*, *Z. cretensis*, *Z. inonuensis*, *Z. istanbulensis*, *Z. laczii*, *Z. lepurus*, *Z. marinae*, and *Z. nemoralis*. Of these, *P. carpathofimbriatus*, *Z. cretensis*, *Z. laczii*, and *Z. marinae* are recorded for the first time from Turkey. On the basis of collected specimens, short descriptions of newly recorded species are noted, the measurements of 17 species are given, and their geographic distributions are discussed. Additionally, altitude and habitat preferences of zerconid species are presented.

**Key words:** Acari, Zerconidae, new records, İstanbul, Turkey

According to recent molecular systematic studies, the family Zerconidae belongs to suborder Monogynaspida, cohort Gamasina, and superfamily Zerconoidea (Sikora, 2014). Zerconid mites are important members of the soil fauna, colonizing various soil substrates (Karaca and Urhan, 2015a). They are free-living and mostly associated with humus, soil, decomposed litter, leaf mold, plant parts, and mosses (Urhan, 2010a). Their body lengths vary between 200 and 700 µm. These small, predatory mites feed on the eggs, larvae, and nymphs of other mites and springtails (Shereef et al., 1984; Martikainen and Huhta, 1990). Their dorsal shields are divided into two separate parts: the podonotum and opisthonotum. These mites are weakly sclerotized and their life cycle includes 4 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 have been some locality reports from the alpine zone of Central Mexico and Taiwan (Ma et al., 2011; Ujvári, 2011a, 2011b, 2012). At present, approximately 40 genera, which comprise more than 400 species, are known worldwide. Only two genera, *Prozercon* and *Zercon*, and 88 species were known from Turkey until now (Karaca and Urhan, 2014, 2015b). In Turkey, the first study on zerconid mites was published by Polish acarologist Błaszak (1979)

based on samples collected from the Amanos Mountains, Bolu Province, and the surrounding area, collected by Dominiak and Pawlowski. From 1992 to date, further studies about zerconids in Turkey have been made by Urhan and Ayyıldız (1992, 1994a, 1994b, 1996a–h), Urhan (1997a, 1997b, 1998a–c, 1999, 2001a–d, 2002, 2007a–c, 2008a–e, 2009a, 2009b, 2010a–d, 2011, 2012, 2013), Urhan and Ekiz (2002), Urhan et al. (2003, 2004, 2007, 2010, 2012, 2013, 2014, 2015a, 2015b), Öztaş (2011), Urhan and Öztaş (2013), Urhan and Karaca (2013), Duran (2013), Karaca et al. (2013, 2014a, 2014b, 2015a, 2015b), Duran et al. (2014a, 2015b, 2015), Karaca and Urhan (2014, 2015a, 2015b), Duran and Urhan (2015a, 2015b), and Karaca (2015).

The main important characters for distinguishing zerconid mites are the number of setae situated on the peritremal shield, the shape and length of the peritremal setae, the shape of posterior part of the peritremal shield and its connection with the ventrianal shield, the shape of the slit between the lateral margin of the peritremal shield and the podonotal shield, the condition of the adgenital shields and gland openings gv2, the number of setae of the ventrianal shield, the condition of the dorsal cavities, the number of setae in the marginal setal series of the opisthonotum, the setal pattern of opisthonotal setae, and the shape of the epistome (Sikora, 2014).

İstanbul, located in both Europe and Asia, is an entry gate to Anatolia for species of European origin (Demirsoy, 2008). It is surrounded by the Black Sea coasts in the north

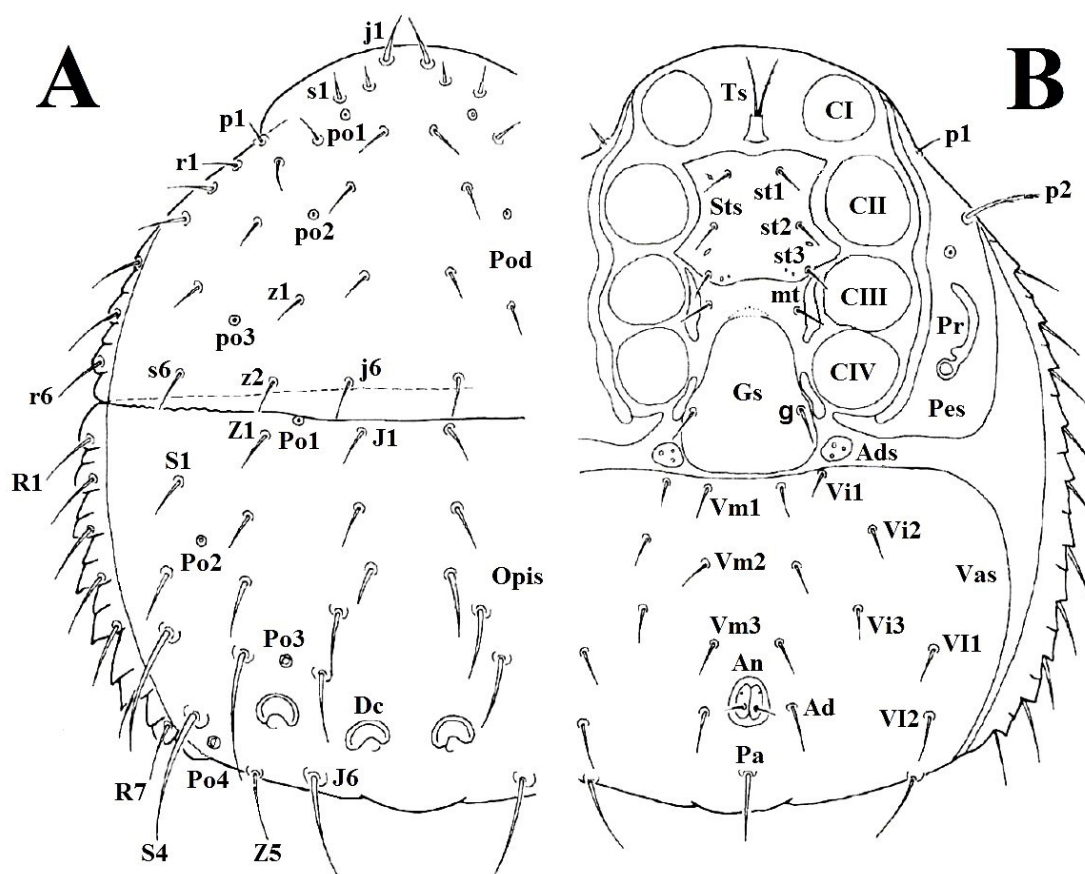
\* Correspondence: elifhilalduran@hotmail.com

and Sea of Marmara coasts in the south. Although İstanbul has been a metropolis for centuries owing to its history, half of the land of İstanbul is forest. There are humid forests in the north and dry forests in the middle and south. The Bosphorus separates the two sides of İstanbul (Gürel and Gündüz, 2011). Moreover, İstanbul has special significance due to its containing two phytogeographic regions (Euro-Siberian and Mediterranean).

As a contribution to the knowledge of the Zerconidae and the understanding of the mite faunal richness of Turkey, we report herein the diversity of zerconid mites of İstanbul Province with some new records for the Turkish fauna. This paper presents their localities in the research area and geographic distributions in the world.

*Prozercon carpathofimbriatus*, *Zercon laczii*, and *Z. cretensis* were the subject of a conference paper (poster) submitted to both international and national congresses. These species were recorded for the first time from Turkey (Duran et al., 2014a, 2014b, 2015).

Soil and litter samples were taken from 250 different localities in forests of İstanbul Province. The samples were placed in plastic bags, labeled, 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 stereomicroscope. They were cleared in 60% lactic acid and mounted on permanent microscope slides using a glycerin medium. The examination and drawing of mites were carried out using an Olympus BX50 microscope with a DP25 camera. The examined materials were stored in 70% ethanol and deposited in the Acarology Laboratory of Pamukkale University, Denizli (Turkey). Morphological terminology, idiosomal chaetotaxy, and poidotaxy (Figure 1) used in the descriptions follow that of Mašán and Fend'a (2004).



**Figure 1.** 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) ventrianal shield, (Vm1–Vm3) ventromedial setae, (Vi1–Vi3) ventrointernal setae, (V11–V12) ventrolateral setae, (An) anal orifice, (Ad) adanal setae, (Pa) postanal seta (modified after Mašán and Fend'a, 2004).

Seventeen zerconid species belonging to two genera (*Prozercon* and *Zercon*) were found in İstanbul Province. Data on distribution in İstanbul and the world, altitude, and habitats of preference are given. Moreover, the new records are marked with an asterisk.

Family *Zerconidae* Canestrini, 1891

Genus *Prozercon* Sellnick, 1943

Type species: *Zercon fimbriatus* C. L. Koch, 1839

Species: *Prozercon balikesirensis* Urhan, 2008

Number of examined specimens: 15 ♀♀ and 2 ♂♂.

Average length and width of idiosoma: 348/241 µm (in females); 280/208 µm (in males).

Distribution in İstanbul: Beykoz, Çatalca, Eyüp, and Sarıyer.

Distribution in the world: Turkey (Urhan, 2008).

Species: *Prozercon buraki* Urhan, 2008

Number of examined specimens: 120 ♀♀ and 39 ♂♂.

Average length and width of idiosoma: 292/225 µm (in females); 254/200 µm (in males).

Distribution in İstanbul: Beykoz, Eyüp, Sarıyer, and Şile.

Distribution in the world: Turkey (Urhan, 2008c).

Species: *Prozercon carpathofimbriatus*\* Maşán & Fend'a, 2004

Number of examined specimens: 32 ♀♀ and 13 ♂♂.

Average length and width of idiosoma: 350/255 µm (in females); 279/211 µm (in males).

Description of female (Figure 2A): on podonotum, 20 pairs setae present (j row with 6, z row with 2, s row with 5 and, r row with 7 pairs). Setae j1, r1, and r3–7 densely pilose and brush-like, setae z2 and s5 plumose, remaining setae smooth. On opisthonotum, 23 pairs of setae present (J row with 6, Z row with 5, S row with 4, and R row with 8 pairs). Setae J1–6, Z1–5, S2–4 elongated and densely pilose. Seta S1 smooth. Marginal R setae short, smooth, and thorn-like. Pore Po2 located below base of seta S1 and pore Po3 located outside line connecting setae Z2–4. Dorsal cavities distinct, small, and equal in size. Adgenital shields absent. Anterior margin of ventrianal shield with 2 setae.

Chaetotaxy and poroidotaxy of males similar to that of females.

Distribution in İstanbul: Arnavutköy, Çatalca, Eyüp, and Şile.

Distribution in the world: Slovakia (Maşán and Fend'a, 2004) and Croatia (Ujvári, 2011d).

Species: *Prozercon demirsoyi* Urhan & Ayyıldız, 1996

Number of examined specimens: 119 ♀♀, 129 ♂♂, 32 deutonymphs, and 7 protonymphs.

Average length and width of idiosoma: 346/252 µm (in females); 284/210 µm (in males).

Distribution in İstanbul: Arnavutköy, Beykoz, Eyüp, Sarıyer, and Şile.

Distribution in the world: Turkey (Urhan and Ayyıldız, 1996f).

Species: *Prozercon fimbriatus* (C. L. Koch, 1893)

Number of examined specimens: 41 ♀♀, 14 ♂♂, and 2 deutonymphs.

Average length and width of idiosoma: 369/273 µm (in females); 299/225 µm (in males).

Distribution in İstanbul: Arnavutköy, Eyüp, Çatalca, and Silivri.

Distribution in the world: Turkey (Urhan, 2013).

Species: *Prozercon satapliae* Petrova, 1977

Number of examined specimens: 121 ♀♀ and 2 ♂♂.

Average length and width of idiosoma: 360/261 µm (in females); 286/212 µm (in males).

Distribution in İstanbul: Beykoz, Çekmeköy, Eyüp, Kartal, Sarıyer, and Şile.

Distribution in the world: Russia (Petrova, 1977) and Turkey (Urhan and Ayyıldız, 1996h).

Species: *Prozercon sultani* Duran & Urhan, 2015

Number of examined specimens: 27 ♀♀ and 2 ♂♂.

Average length and width of idiosoma: 389/287 µm (in females); 301/208 µm (in males).

Distribution in İstanbul: Beykoz, Kartal, Sarıyer, and Şile.

Distribution in the world: Turkey (Duran and Urhan, 2015).

Species: *Prozercon traegardhi* (Halbert, 1923)

Number of examined specimens: 59 ♀♀ and 27 ♂♂.

Average length and width of idiosoma: 310/226 µm (in females); 240/176 µm (in males).

Distribution in İstanbul: Çatalca, Eyüp, Pendik, Silivri, and Şile.

Distribution in the world: Known from Holarctic region (Urhan and Ayyıldız, 1992; Karaca, 2015).

Species: *Prozercon yavuzi* Urhan, 1998

Number of examined specimens: 4 ♀♀.

Average length and width of idiosoma: 335/226 µm (in females).

Distribution in İstanbul: Çatalca.

Distribution in the world: Turkey (Urhan, 1998) and Greece (Ujvári, 2011c).

Genus *Zercon* C. L. Koch, 1836

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

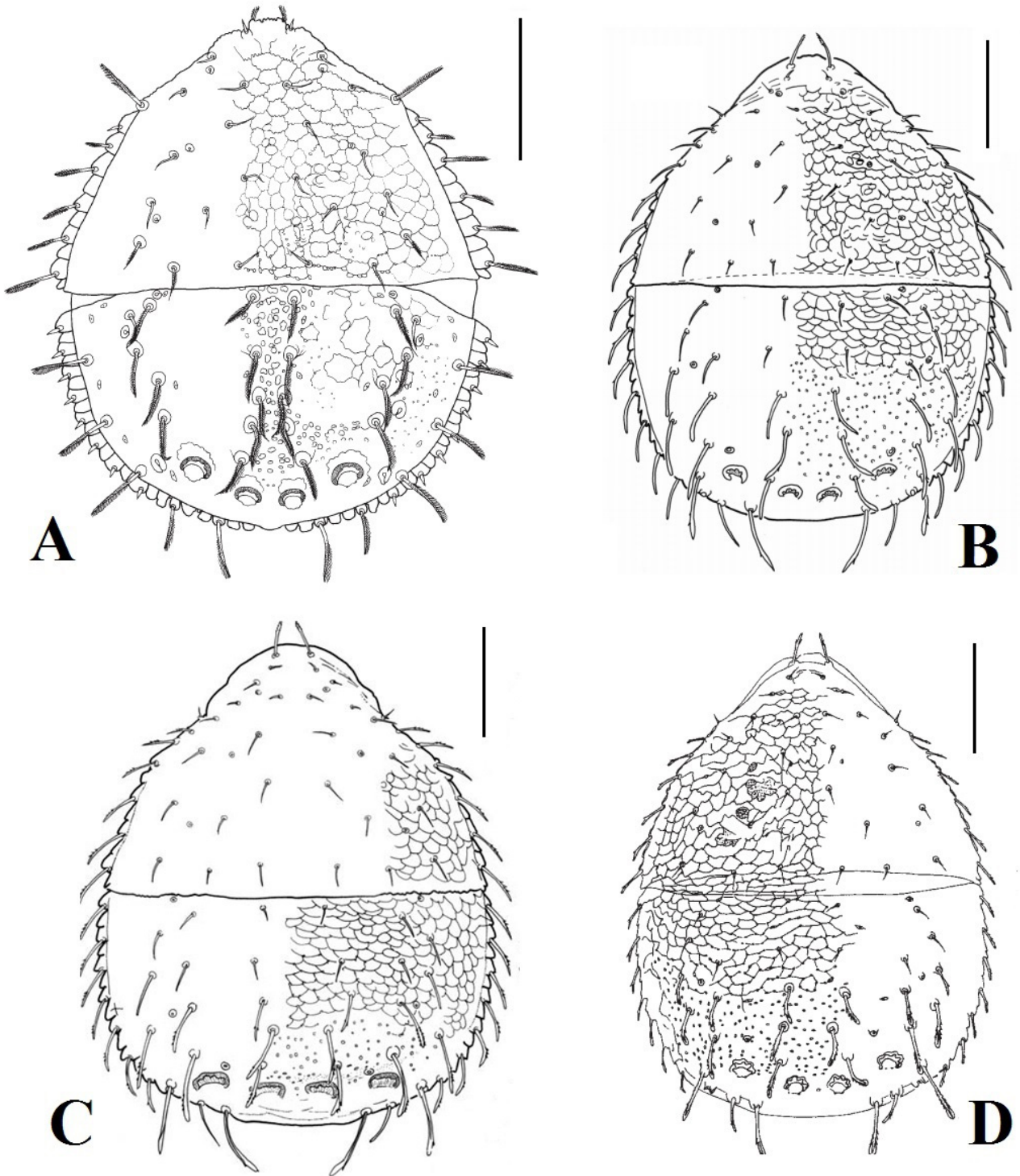
Species: *Zercon colligans* Berlese, 1920

Number of examined specimens: 72 ♀♀, 44 ♂♂, 11 deutonymphs, and 8 protonymphs.

Average length and width of idiosoma: 428/320 µm (in females); 337/232 µm (in males).

Distribution in İstanbul: Arnavutköy, Beykoz, Çatalca, Çekmeköy, Eyüp, Pendik, Sarıyer, Silivri, and Şile.

Distribution in the world: Known from Holarctic region (Sellnick, 1958; Urhan and Ayyıldız, 1994b; Karaca, 2015).



**Figure 2.** New recorded species of zirconid mites for the Turkish acarofauna (females): A) *Prozercon carpathofimbriatus* (Ujvári, 2011d), B) *Zercon cretensis* (Ujvári, 2008), C) *Zercon laczii* (Ujvári, 2010), D) *Zercon marinae* (Ujvári and Călugăr, 2010) (scale bars = 100  $\mu$ m).

Species: *Zercon cretensis*\* Ujvári, 2008

Number of examined specimens: 38 ♀♀, 6 ♂♂, and 4 deutonymphs.

Average length and width of idiosoma: 413/338 µm (in females); 341/225 µm (in males).

Description of female (Figure 2B): on podonotum, 20 pairs setae present (j row with 6, z row with 2, s row with 6, and r row with 6 pairs). Setae j1 apically plumose, r4–6 elongated, finely barbed with hyaline ending. Remaining setae short and smooth. On opisthonotum, 22 pairs setae present (J row with 6, Z row with 5, S row with 4, and R row with 7 pairs). Setae J1–2, Z1–2, and S1 smooth. Setae J3–6, Z3–5, S2–4, and R1–7 elongated, finely barbed with hyaline ending. Pore Po2 located between setae Z2–S2 and pore Po3 located between setae J5–Z4. Dorsal cavities distinct, semimoon-shaped and equal in size. Adgenital shields present. Anterior margin of ventrianal shield with 2 setae.

Chaetotaxy and poroidotaxy of males similar to that of females.

Distribution in İstanbul: Arnavutköy, Beykoz, Çatalca, Sarıyer, and Şişli.

Distribution in the world: Greece (Ujvári, 2008).

Species: *Zercon inonuensis* Urhan, 2007

Number of examined specimens: 11 ♀♀ and 5 ♂♂.

Average length and width of idiosoma: 447/365 µm (in females); 375/280 µm (in males).

Distribution in İstanbul: Beykoz, Çatalca, Silivri, and Şile.

Distribution in the world: Turkey (Urhan, 2007).

Species: *Zercon istanbulensis* Duran & Urhan, 2015

Number of examined specimens: 90 ♀♀ and 23 ♂♂.

Average length and width of idiosoma: 396/311 µm (in females); 310/235 µm (in males).

Distribution in İstanbul: Arnavutköy, Beykoz, Çatalca, Kartal, Pendik, Sarıyer, and Şile.

Distribution in the world: Turkey (Duran and Urhan, 2015).

Species: *Zercon laczii*\* Ujvári, 2010

Number of examined specimens: 407 ♀♀, 136 ♂♂, and 24 deutonymphs.

Average length and width of idiosoma: 440/322 µm (in females); 344/239 µm (in males).

Description of female (Figure 2C): on podonotum, 20 pairs setae present (j row with 6, z row with 2, s row with 6, and r row with 6 pairs). Setae j1 apically plumose, r1–6 elongated, finely barbed without hyaline ending. Remaining setae short and smooth. On opisthonotum, 22 pairs setae present (J row with 6, Z row with 5, S row with 4, and R row with 7 pairs). Setae J1–2, Z1–2, and S1 smooth. Setae J3–6, Z3–4, S3–4, and R1–7 elongated, finely barbed with hyaline ending. Setae S2 and Z5 smooth with hyaline ending. Pore Po2 located outside base of seta Z3, and pore

Po3 located between setae J5–Z4. Dorsal cavities distinct, large, and equal size. Adgenital shields present. Anterior margin of ventrianal shield with 2 setae.

Chaetotaxy and poroidotaxy of males similar to that of females.

Distribution in İstanbul: Beykoz, Eyüp, Sarıyer, Silivri, and Şile.

Distribution in the world: Croatia (Ujvári, 2010).

Species: *Zercon lepurus* Blaszak, 1979

Number of examined specimens: 13 ♀♀, 6 ♂♂, and 4 deutonymphs.

Average length and width of idiosoma: 454/369 µm (in females); 338/255 µm (in males).

Distribution in İstanbul: Çatalca and Sarıyer.

Distribution in the world: Turkey (Blaszak, 1979).

Species: *Zercon marinae*\* Ivan & Călugăr, 2004

Number of examined specimens: 147 ♀♀, 63 ♂♂, and 26 deutonymphs.

Average length and width of idiosoma: 380/282 µm (in females); 330/235 µm (in males).

Description of female (Figure 2D): on podonotum, 20 pairs setae present (j row with 6, z row with 2, s row with 6, and r row with 6 pairs). Setae j1 apically plumose, r1–6 finely barbed with hyaline ending. Remaining setae short and smooth. On opisthonotum, 22 pairs setae present (J row with 6, Z row with 5, S row with 4, and R row with 7 pairs). Setae J1–2, Z1–2, and S1 smooth. Setae J3–6, Z3–5, S2–4, and R1–7 finely barbed with hyaline ending. Pore Po2 located between setae Z3–S2, and pore Po3 located

between setae J4–Z4. Dorsal cavities distinct, semimoon-shaped, and equal in size. Adgenital shields present. Anterior margin of ventrianal shield with 2 setae.

Chaetotaxy and poroidotaxy of males similar to that of females.

Distribution in İstanbul: Arnavutköy, Beykoz, Çatalca, Eyüp, Pendik, Sarıyer, Silivri, and Şile.

Distribution in the world: Romania (Ivan and Călugăr, 2004).

Species: *Zercon nemoralis* Urhan, 2001

Number of examined specimens: 5 ♀♀ and 18 ♂♂.

Average length and width of idiosoma: 471/374 µm (in females); 369/275 µm (in males).

Distribution in İstanbul: Çatalca, Sarıyer, and Şile.

Distribution in the world: Turkey (Urhan, 2001).

Altitude and habitat preferences of zerconids: For the sampling localities in the research area, the soil layer was divided into 100-m ranges. Samplings were made from 0 to 300 m. Distribution altitudes of detected zerconid specimens are noted in Table 1. Habitat preferences of zerconid mites in the study area are given in Table 2.

According to Table 1, all of the determined species generally occur at 0–300 m. *P. yavuzi* only occurs at over 200 m. The remaining specimens show a wider preference

**Table 1.** Altitudinal ranges of zerconid mite species.

Altitude (m)	<i>P. satapliae</i>	<i>P. demirsoyi</i>	<i>P. buraki</i>	<i>P. fimbriatus</i>	<i>P. traegardhi</i>	<i>P. yavuzi</i>	<i>P. balkesirensis</i>	<i>P. carpathofimbriatus</i>	<i>P. sultani</i>	<i>Z. colligans</i>	<i>Z. nemoralis</i>	<i>Z. inonuensis</i>	<i>Z. lepurus</i>	<i>Z. laczii</i>	<i>Z. cretensis</i>	<i>Z. marinae</i>	<i>Z. istanbulensis</i>
0–100	+	+	+	+	+		+	+		+	+	+	+	+	+	+	
100–200	+	+	+	+	+		+	+	+	+	+		+	+	+	+	+
200–300	+				+	+	+	+	+	+	+	+	+	+		+	+

**Table 2.** Habitat preferences of zerconid mite species.

	<i>Arbutus unedo</i>	<i>Castane sativa</i>	<i>Cistus laurifolius</i>	<i>Cupressus</i> sp.	<i>Erica manipuliflora</i>	<i>Fagus orientalis</i>	<i>Hedera</i> sp.	<i>Juniperus communis</i>	<i>Morus</i> sp.	Moss	<i>Pinus brutia</i>	<i>Pinus halepensis</i>	<i>Pinus pinea</i>	<i>Pinus</i> sp.	<i>Platanus orientalis</i>	<i>Pteridium</i> sp.	<i>Rosa canina</i>	<i>Rosaceae</i> spp.	<i>Rubus</i> sp.	<i>Quercus cerris</i>	<i>Quercus coccifera</i>	<i>Quercus frainetto</i>	<i>Quercus hartwissiana</i>	<i>Quercus infectoria</i>	<i>Quercus petraea</i>	<i>Quercus pubescens</i>	<i>Quercus robur</i>	<i>Quercus</i> sp.	
<i>P. satapliae</i>							+			+	+	+	+				+										+	+	
<i>P. demirsoyi</i>						+	+			+				+								+						+	+
<i>P. buraki</i>		+				+	+			+		+	+	+										+					+
<i>P. fimbriatus</i>						+			+	+				+							+		+						+
<i>P. traegardhi</i>							+			+				+	+							+					+	+	
<i>P. yavuzi</i>										+																			
<i>P. balkesirensis</i>						+		+		+								+				+							+
<i>P. carpathofimbriatus</i>							+			+					+		+												+
<i>P. sultani</i>										+	+	+										+							+
<i>Z. colligans</i>				+						+	+	+	+	+				+		+		+	+		+				+
<i>Z. nemoralis</i>										+								+				+			+				
<i>Z. inonuensis</i>										+												+							+
<i>Z. lepurus</i>										+								+											+
<i>Z. laczii</i>			+			+	+	+		+	+	+	+	+				+				+				+			+
<i>Z. cretensis</i>						+				+		+	+									+				+			+
<i>Z. marinae</i>	+	+		+	+	+		+		+		+	+		+							+			+		+	+	+
<i>Z. istanbulensis</i>								+	+	+	+			+				+				+					+	+	+

in terms of altitudinal ranges. According to Table 2, the determined species were commonly recorded in habitats of moss, *Pinus* spp., and *Quercus* spp. However, there were no species in habitats of *Rosa canina* and *Rubus* sp. In terms of species richness, 12 species belonging to Zerconidae were recorded under pines and 17 species in moss pads. As a result of the study, both *Prozercon* and *Zercon* species, which preferred the same habitats, were observed.

The terra typica of *P. carpathofimbriatus* is in Slovakia, but this species has also been found in Croatia (Ujvári, 2011d) and Turkey (present paper). *Z. cretensis* was found first on the island of Crete in Greece (Ujvári, 2008) and is recorded from Turkey in this study. Terra typicas of *Z. laczii* and *Z. marinae* are in Croatia (Ujvári, 2010) and Romania (Ujvári and Călugăr, 2010) respectively; in this study, these species were recorded outside of their type



localities for the first time. In light of this information, it is concluded these four zirconid species have their origins in South Europe and extend their distribution areas up to Turkey. It is thought that the Thrace region of Turkey is a bridge between Turkey and Europe allowing the spread of various zirconid species belonging to the genera *Prozercon* and *Zercon*, which have European origins, to the northwestern parts of Turkey. As a result, it is expected

that new species and new records of zirconid mites will be found by subsequent investigations in Turkey (especially in the Thrace region).

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