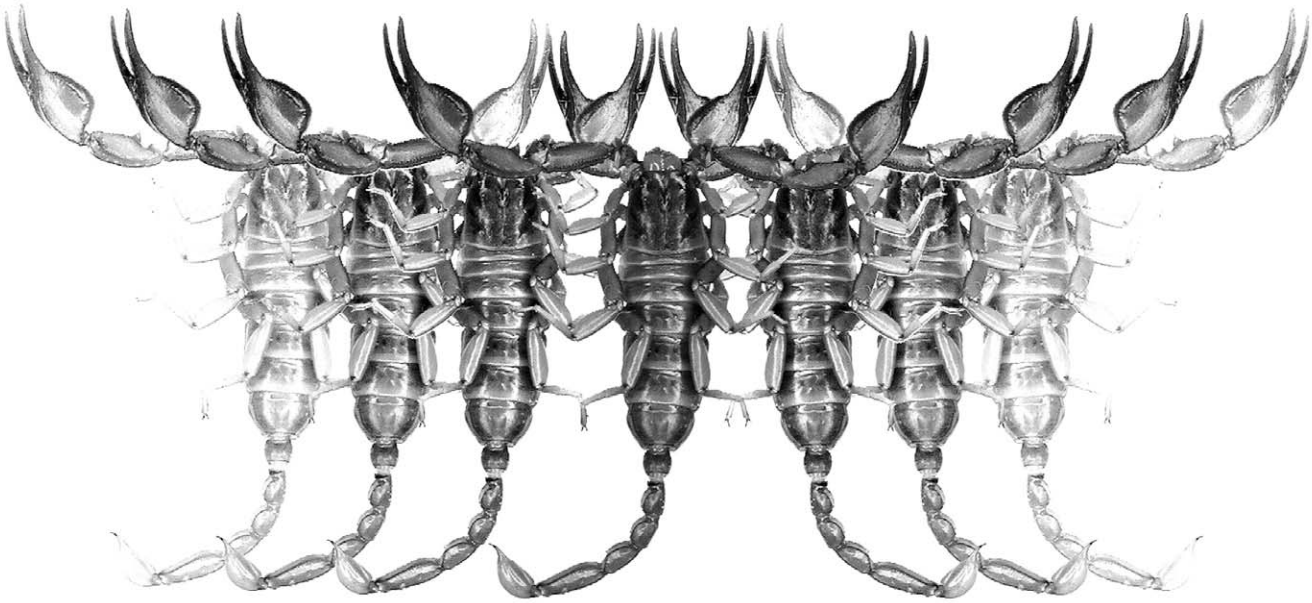
Euscorpius

Occasional Publications in Scorpiology



A New Species of *Euscorpius* Thorell, 1876 from Mount Honaz in Southwestern Turkey (Scorpiones: Euscorpiidae)

Gioele Tropea, Ersen Aydın Yağmur, Lydia Karampatsou, Aristeidis Parmakelis & Fatih Yeşilyurt

April 2016 – No. 222

Euscorpius

Occasional Publications in Scorpiology

EDITOR: **Victor Fet**, Marshall University, **'fet@marshall.edu'**
ASSOCIATE EDITOR: **Michael E. Soleglad, 'soleglad@znet.com'**

Euscorpius is the first research publication completely devoted to scorpions (Arachnida: Scorpiones). ***Euscorpius*** takes advantage of the rapidly evolving medium of quick online publication, at the same time maintaining high research standards for the burgeoning field of scorpion science (scorpiology). ***Euscorpius*** is an expedient and viable medium for the publication of serious papers in scorpiology, including (but not limited to): systematics, evolution, ecology, biogeography, and general biology of scorpions. Review papers, descriptions of new taxa, faunistic surveys, lists of museum collections, and book reviews are welcome.

Derivatio Nominis

The name ***Euscorpius*** Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

Euscorpius is located at: **http://www.science.marshall.edu/fet/Euscorpius**

(Marshall University, Huntington, West Virginia 25755-2510, USA)

ICZN COMPLIANCE OF ELECTRONIC PUBLICATIONS:

Electronic ("e-only") publications are fully compliant with ICZN (*International Code of Zoological Nomenclature*) (i.e. for the purposes of new names and new nomenclatural acts) when properly archived and registered. All ***Euscorpius*** issues starting from No. 156 (2013) are archived in two electronic archives:

- **Biotaxa,** http://biotaxa.org/Euscorpius (ICZN-approved and ZooBank-enabled)
- **Marshall Digital Scholar**, http://mds.marshall.edu/euscorpius/. (This website also archives all *Euscorpius* issues previously published on CD-ROMs.)

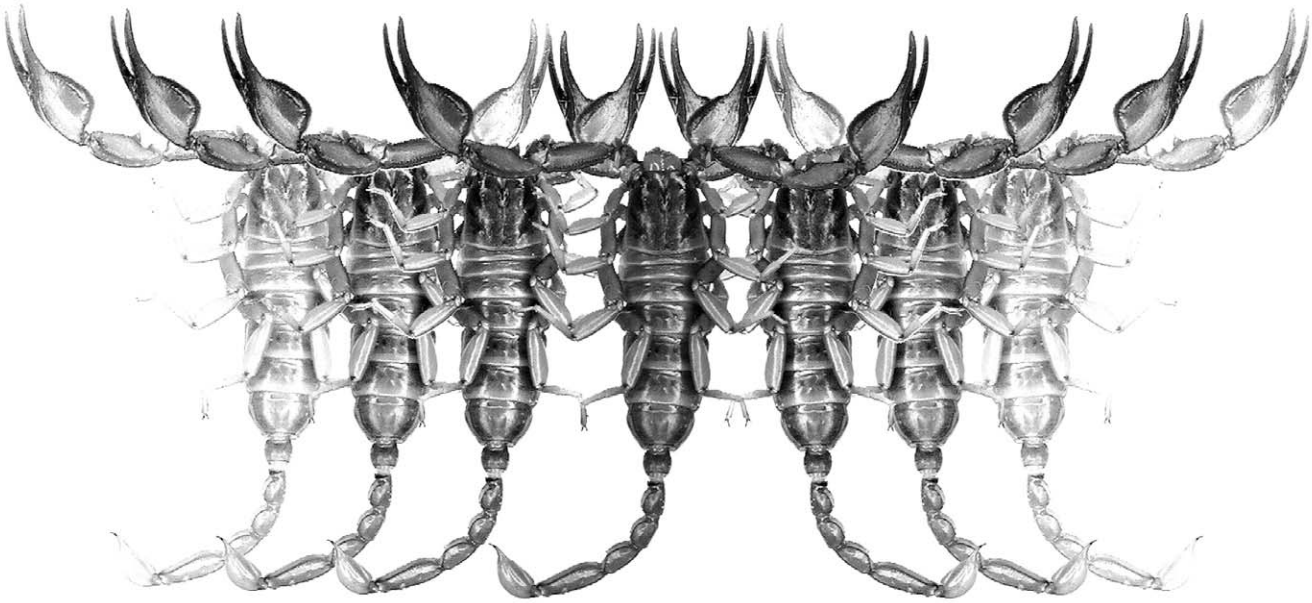
Between 2000 and 2013, ICZN did not accept online texts as "published work" (Article 9.8). At this time, *Euscorpius* was produced in two identical versions: online (*ISSN 1536-9307*) and CD-ROM (*ISSN 1536-9293*) (laser disk) in archive-quality, read-only format. Both versions had the identical date of publication, as well as identical page and figure numbers. Only copies distributed on a CD-ROM from ***Euscorpius*** in 2001-2012 represent published work in compliance with the ICZN, i.e. for the purposes of new names and new nomenclatural acts.

In September 2012, ICZN Article 8. *What constitutes published work*, has been amended and allowed for electronic publications, disallowing publication on optical discs. From January 2013, ***Euscorpius*** discontinued CD-ROM production; only online electronic version (*ISSN 1536-9307*) is published. For further details on the new ICZN amendment, see http://www.pensoft.net/journals/zookeys/article/3944/.

Publication date: 21 April 2016
http://www.zoobank.org/urn:lsid:zoobank.org:pub:8F786A03-7796-4213-BD7F-CD65A511F84B

Euscorpius

Occasional Publications in Scorpiology



A New Species of *Euscorpius* Thorell, 1876 from Mount Honaz in Southwestern Turkey (Scorpiones: Euscorpiidae)

Gioele Tropea, Ersen Aydın Yağmur, Lydia Karampatsou, Aristeidis Parmakelis & Fatih Yeşilyurt

April 2016 – No. 222

Euscorpius

Occasional Publications in Scorpiology

EDITOR: **Victor Fet**, Marshall University, **'fet@marshall.edu'**
ASSOCIATE EDITOR: **Michael E. Soleglad, 'soleglad@znet.com'**

Euscorpius is the first research publication completely devoted to scorpions (Arachnida: Scorpiones). ***Euscorpius*** takes advantage of the rapidly evolving medium of quick online publication, at the same time maintaining high research standards for the burgeoning field of scorpion science (scorpiology). ***Euscorpius*** is an expedient and viable medium for the publication of serious papers in scorpiology, including (but not limited to): systematics, evolution, ecology, biogeography, and general biology of scorpions. Review papers, descriptions of new taxa, faunistic surveys, lists of museum collections, and book reviews are welcome.

Derivatio Nominis

The name ***Euscorpius*** Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

Euscorpius is located at: **http://www.science.marshall.edu/fet/Euscorpius**

(Marshall University, Huntington, West Virginia 25755-2510, USA)

ICZN COMPLIANCE OF ELECTRONIC PUBLICATIONS:

Electronic ("e-only") publications are fully compliant with ICZN (*International Code of Zoological Nomenclature*) (i.e. for the purposes of new names and new nomenclatural acts) when properly archived and registered. All ***Euscorpius*** issues starting from No. 156 (2013) are archived in two electronic archives:

- **Biotaxa,** http://biotaxa.org/Euscorpius (ICZN-approved and ZooBank-enabled)
- **Marshall Digital Scholar**, http://mds.marshall.edu/euscorpius/. (This website also archives all *Euscorpius* issues previously published on CD-ROMs.)

Between 2000 and 2013, ICZN did not accept online texts as "published work" (Article 9.8). At this time, *Euscorpius* was produced in two identical versions: online (*ISSN 1536-9307*) and CD-ROM (*ISSN 1536-9293*) (laser disk) in archive-quality, read-only format. Both versions had the identical date of publication, as well as identical page and figure numbers. Only copies distributed on a CD-ROM from ***Euscorpius*** in 2001-2012 represent published work in compliance with the ICZN, i.e. for the purposes of new names and new nomenclatural acts.

In September 2012, ICZN Article 8. *What constitutes published work*, has been amended and allowed for electronic publications, disallowing publication on optical discs. From January 2013, ***Euscorpius*** discontinued CD-ROM production; only online electronic version (*ISSN 1536-9307*) is published. For further details on the new ICZN amendment, see http://www.pensoft.net/journals/zookeys/article/3944/.

Publication date: 21 April 2016
http://www.zoobank.org/urn:lsid:zoobank.org:pub:8F786A03-7796-4213-BD7F-CD65A511F84B

Euscorpius — Occasional Publications in Scorpiology. 2016, No. 222

A new species of *Euscorpius* Thorell, 1876 from Mount Honaz in southwestern Turkey (Scorpiones: Euscorpiidae)

Gioele Tropea [1], Ersen Aydın Yağmur [2], Lydia Karampatsou [3], Aristeidis Parmakelis [3] & Fatih Yeşilyurt [4]

[1] Via Gavinana 2, 00192 Rome, Italy: e-mail: gioele.tropea@gmail.com
[2] Celal Bayar University, Alaşehir Vocational School, Alaşehir, Manisa, 45600 Turkey; e-mail: ersen.yagmur@gmail.com
[3] Department of Ecology and Taxonomy, Faculty of Biology, National and Kapodistrian University of Athens, Panepistimioupoli Zografou, GR-15784, Athens, Greece; email: aparmakel@biol.uoa.gr
[4] Yüksekova Vocational School, Hakkari University, Hakkari, Turkey

http://www.zoobank.org/urn:lsid:zoobank.org:pub:8F786A03-7796-4213-BD7F-CD65A511F84B

Summary

A new species of scorpion, *Euscorpius honazicus* sp. n., is described from Mount Honaz, in the province of Denizli, in southwestern Turkey, based on morphological and molecular evidence, increasing to 14 the *Euscorpius* species currently recognized in Turkey.

Introduction

The genus *Euscorpius* Thorell, 1876 is one of the most studied groups of scorpions. It is very common in southern Europe and Anatolia, and its species occupy diverse habitats from the sea level up to over 2,600 m a. s. l. (Tropea et al., 2015c). Taxonomy of this genus is complicated and still unresolved throughout its range. In the last years our group is intensively studying the genus *Euscorpius* in Turkey, resulting in a significant increase of the number of species in this country. Since 2012 the number of Turkish species has increased from two to 13 (Tropea & Yağmur, 2015, 2016; Tropea et al., 2012, 2014b, 2015c; Yağmur & Tropea, 2013, 2015; Yağmur et al., 2013). In addition, recently Fet et al. (2016) published a phylogeny on populations related to the subgenus *Alpiscorpius* Gantenbein et al., 1999 in Turkey. In this paper, as a part of an ongoing study on the populations of the genus *Euscorpius* in Turkey, we describe a new *Euscorpius* species, *E. honazicus* sp. n., based on morphological and molecular evidence, increasing to 14 the *Euscorpius* species currently recognized in Turkey, of which eight are related to the subgenus *Alpiscorpius*.

Material and Methods

The trichobothrial notation follows Vachon (1974). Morphological measurements are given in millimetres (mm) following Tropea et al. (2014b). Morphological nomenclature follows Stahnke (1971), Hjelle (1990), and Sissom (1990); the chela carinae and denticle configuration follows Soleglad & Sissom (2001); and sternum terminology follows Soleglad & Fet (2003). The map was generated using Earth Explorer 6.1.

Sequence data generation and phylogenetic analyses

For the present study we extracted total DNA and amplified portions of the 16S rDNA and the COI mtDNA genes from four *Euscorpius* specimens (Table 2). DNA extraction, PCR amplifications and sequencing was performed as described in Parmakelis et al. (2013). Sequence editing and alignment was performed using Codon Code Aligner v.2.06. The genetic distances (Tables 3 and 4) were computed using the Kimura 2-parameter method (Kimura, 1980) as implemented in MEGA5 (Tamura et al., 2011). Genetic distances are expressed as the number of base substitutions per site. Standard error estimate(s) are shown above the diagonal and were obtained by a bootstrap procedure (1000 replicates). All ambiguous positions were removed for each sequence pair. There were a total of 424 positions in the final dataset for 16S *rDNA* fragment and 679 for COI. Out of these, 16 and 60 were parsimony informative in the 16S *rDNA* and the COI fragment, respectively. For the phylogenetic analyses, we retrieved from GenBank the 16S *rDNA* and COI sequences of several *Euscorpius* species (Table 2). These species, based on morphological and distributional data, are the ones that are more

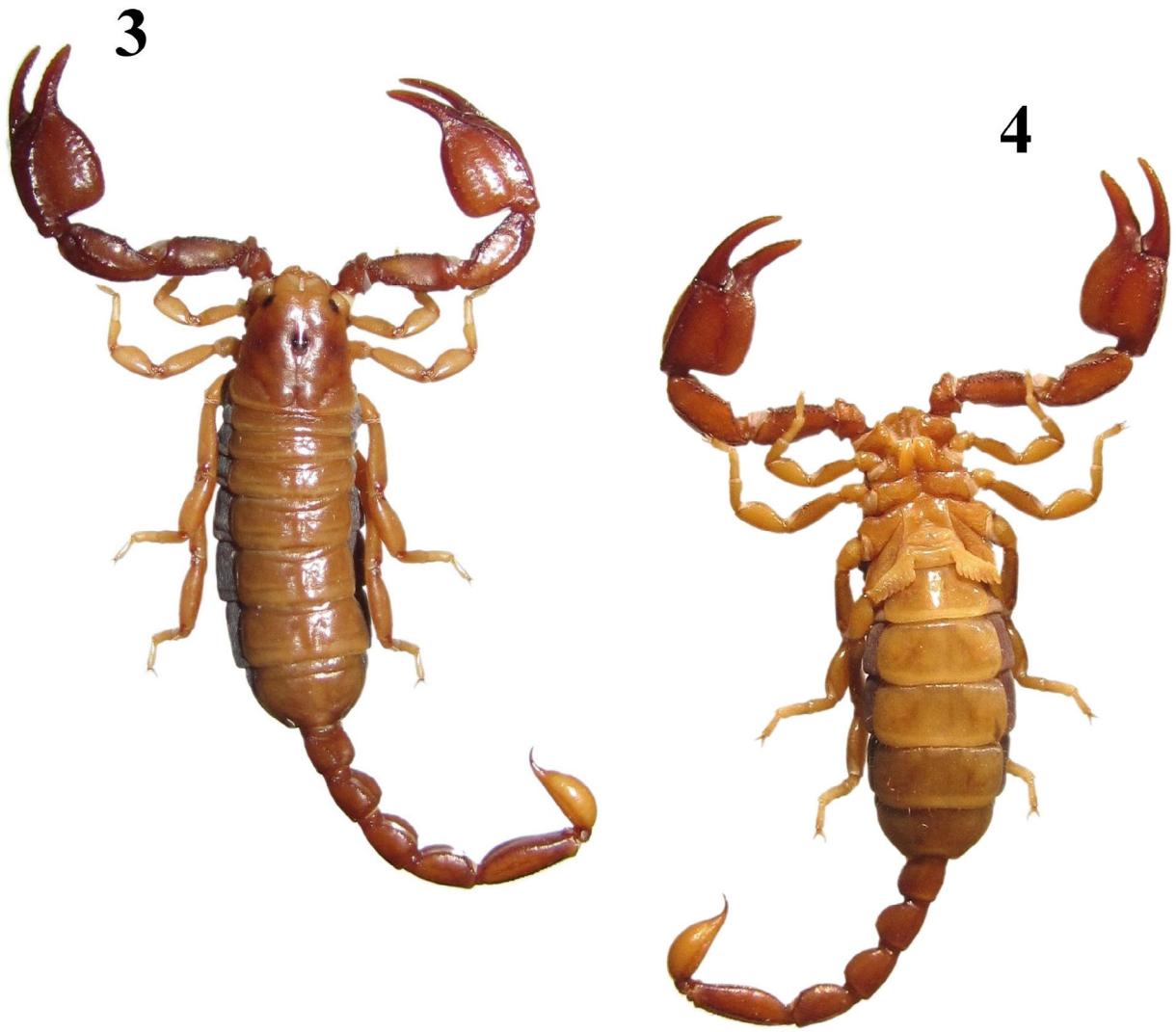
Figures 1–2: *Euscorpius honazicus* sp. n. general habitus. **1**. Male holotype dorsal view. **2**. Male holotype ventral view.

closely related to the species investigated herein. The species *E. stahlavskyi* and *E. gamma* were used as outgroups in the analysis.

The phylogenetic analysis was performed under a Bayesian Inference framework (BI) using MrBayes v.3.2.2 (Ronquist et al., 2012). The Akaike Information Criterion (Akaike, 1974) as implemented in Modeltest 3.7 (Posada & Crandall, 1998) was used to choose the best-fit model of DNA substitution to perform the analyses. The model selected was the HKY+G. In MrBayes, two independent runs with four chains each were run simultaneously. The chain length was set to 5 x 10^6. Convergence was assumed when the average standard deviation of split frequencies was below 0.01. A tree was sampled every 500 generations and, consequently, the summaries of the BI relied on 2 x 10^4 samples (sum of two runs). From each run 7,501 samples were used, while 2,499 were discarded as burn-in phase (25% burn-in). From the remaining 15,002 trees (sum of two runs), a 50% majority rule consensus tree was constructed for each dataset analysis. Support of the nodes was assessed with the posterior probabilities of reconstructed clades.

Abbreviations

V: trichobothrial series on pedipalp chela manus ventral surface (not including Et_1); *Pv*: trichobothria on



Figures 3–4: *Euscorpius honazicus* sp. n. general habitus. **3**. Female paratype dorsal view. **4**. Female paratype ventral view.

the ventral aspect of pedipalp patella; *Pe*: trichobothria on the external surface of pedipalp patella; *et*: external terminal; *est*: external subterminal; *em*: external median; *esb*: external suprabasal; eb_a: external basal-*a*; *eb*: external basal; *db*: dorsal basal trichobothrium on fixed finger; *Dp*: pectinal teeth number; *L*: length; *H*: height; *Lchel*: chela length; *Wchel:* chela width (=*Wchel-A* of Tropea et al. 2014b); *Lcar*: carapace length; *Wcar*: carapace width; *Lfem*: femur length; *Lpat*: patella length; *Lmet*: sum of the length of all metasomal segments; *Wmet:* sum of the width of all metasomal segments; *met.seg*: metasomal segment; *CarA/CarP %*: average ratio of distances from centre of median eyes to anterior and posterior margins of the carapace; *DPS*: dorsal patellar spur; *DD*: distal denticle; *MD*: median denticles; *OD*: outer denticles; *ID*: inner denticles; *IAD*: inner accessory denticles; *imm*.: immature specimen (in any stage of development).

Depositories: AZMM, Alaşehir Zoological Museum, Celal Bayar University, Alaşehir, Manisa, Turkey; GTC, personal collection of Gioele Tropea, Rome, Italy; MSNB, Museo Civico di Scienze Naturali "E. Caffi", Bergamo, Italy; MZUR, Museo di Zoologia dell' Università di Roma "La Sapienza", Rome, Italy.

Material Studied

A detailed list of the material with label data is provided below under each species. Further specimens examined for comparison are listed below:

Euscorpius arikani Yağmur et Tropea, 2015: Turkey, Antalya Province, Finike District, Mt. Alacadag, Eroğlu Hill, 36°26'12"N, 30°02'22"E, 18 September 2014, leg. E. A. Yağmur & A. Avcı, ♂ holotype (AZMM); label as in holotype, 6 ♂, 12 ♀ paratypes (GTC).

E. ciliciensis Birula, 1898: Turkey, Niğde Province, Bolkar Mts., Ulukışla, 37°24'47.2"N, 34°33'57.4"E, 4 July 2013, leg E. A. Yağmur & H. Koç, 7 ♂, 3 ♀ (AZMM); same data, 4 ♂, 3 ♀ (GTC).

E. eskisehirensis Tropea et Yağmur, 2015: Turkey, Eskişehir Province, Alpu District, Çatacık Forest, 1556 m a.s.l,, 39°57'59" N, 31°08'02" E, 1 July 2012, leg. E.A. Yağmur, R. Kaya & H. Koru, 1 ♂ (AZMM holotype); same data, 8 ♂, 20 ♀ (GTC); Turkey, 25 km W from Mihalıççık, 890 m a.s.l,, 39°50'05" N, 31°11'36" E, 27 September 2010, leg. R. Kaya & K.B. Kunt, 2 ♂, 1 ♀ (GTC).

E. mingrelicus (Kessler, 1874): Georgia, Adzharia, Batumi, Botanical Garden, 28 August 1985, leg. V. Fet, ♀ neotype (NHMW 14644); Georgia, Batumi, Botanical Garden, 21 August 1985, leg. V. Fet, 1 ♂ (MSNB 13706); Georgia, Kobuleti, Tskhemvani, Kintrishi Protected Area, 41°47'25,1"N, 41°57'36,8"E, 19 August 2013, leg. P. Crucitti, 4 ♂, 4 ♀ (GTC); Turkey, Artvin Province, Hatila Valley, 25 July 2011, leg. E.A. Yağmur, 1 ♂, 1 ♀ (GTC).

E. phrygius Bonacina, 1980: Turkey, Abant Province, Bolu District, 12 August 1972, leg. A. Valle, 1 ♂ lectotype (MSNB 9125); same label as lectotype, 2 ♂, 2 ♀ paralectotypes (GTC).

E. sultanensis Tropea et Yağmur, 2016*:* Turkey, Sultan Mts. (Sultan Dağları), near the border between Afyonkarahisar and Konya Provinces, 38°26'03.4"N, 31°15'00.4"E, 1914 m a.s.l., 20 June 2013, leg. E.A. Yağmur & S. Örgel, ♂ holotype (AZMM). data as holotype, 1 ♂, 1 ♀ paratypes (AZMM); data as holotype, 3 ♂, 3 ♀ paratypes (GTC); as holotype but 38°26'05.1"N, 31°15'00.0"E, 1906 m a.s.l, 21 June 2013, leg. E.A. Yağmur, 1 ♀ paratypes (AZMM); Turkey, Afyonkarahisar Province, Sultan Mts., 28 May 2004, leg. H. Koç, 2 ♀ paratypes (AZMM).

E. uludagensis Lacroix, 1995: Turkey, Bursa Province, Mt. Uludağ, Alacan Village, leg. E.A. Yağmur, 1 ♂, 1 ♀ (GTC); Turkey, Bursa Province, Keles District, Mt. Uludağ, 1293 m a.s.l,, 39°56'09,3"N, 29°16'54,7"E, 25 September 2010, leg. R.S. Kaya, 4 ♂, 4 ♀ (AZMM); same data, 2 ♂, 2 ♀ (GTC).

Systematics

Family **Euscorpiidae Laurie, 1896**
Genus ***Euscorpius* Thorell, 1876**
Subgenus Incertus

***Euscorpius honazicus* Tropea, Yağmur, Karampatsou, Parmakelis et Yeşilyurt, 2016 sp.n.**
(Figs. 1–18, Table 1)
http://www.zoobank.org/urn:lsid:zoobank.org:act:AEF7EA0F-4204-48E0-B266-3348A52BEB5C

Type material (31 specimens: 14 ♂ and 17 ♀). *Holotype*: ♂, Turkey, Denizli Province, Mount Honaz, 2500 m a.s.l., 37°40'37.6"N, 29°17'10.6"E, 13 June 2013, leg. E.A. Yağmur (AZMM). *Paratypes*: same data as holotype, 6 ♂, 7 ♀ (AZMM); same data as holotype, 6 ♂, 8 ♀ (GTC); Denizli Province, Mt. Honaz, 1160 m a.s.l., 37°43'50"N, 29°14'52"E, 17 October 2009, leg. E.A. Yağmur & F. Yeşilyurt, 1 ♂, 2 ♀ (AZMM).

Other Euscorpius honazicus sp. n. examined but not included in the type series.
Turkey, Denizli Province, Mt. Honaz, 871 m a.s.l., 37°44'16"N, 29°15'47"E, 17 October 2009, leg. E.A. Yağmur & F. Yeşilyurt, 5 ♂, 2 ♀ (AZMM); Turkey, Denizli Province, Mt. Honaz, 1160 m a.s.l., 37°43'50"N, 29°14'52"E, 17 October 2009, leg. E.A. Yağmur & F. Yeşilyurt, 4 ♂, 8♀ (AZMM).

***Geographic range*.** Southwestern Turkey, Denizli Province, Mount Honaz (Fig. 20).

Diagnosis. A small *Euscorpius* species, total length 23–29 mm. Colour of adults is light brown to medium brown-reddish, without dark marbling on chelicerae. The number of trichobothria on the pedipalp manus ventral surface is 4 ($V_{1\text{-}3}$+Et_1). Trichobothrium *et* on fixed finger is located distally to the notch of the fixed finger; *est* is located proximally or above the notch; and *dsb* is located proximally to *est* and the notch. The number of trichobothria on the pedipalp patella ventral surface is usually 6. The number of trichobothria on pedipalp patella external surface usually is: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 3, *est* = 4, *et* = 5. Trichobothrium *i* of the femur is slightly distal or same level of *d*. The pectinal teeth number in males is usually 8 and 9, and in females usually 7. Dorsal patellar spur barely developed. Femur shorter than patella (*Lfem/Lpat* ratio on average is 0.93). Carapace is more or less as long as wide, but it tends to be slightly longer in the males. Average ratio *Lmet/Wmet* is 1.62 (1.49–1.70). Dorsal metasomal carinae granulated. Ventrolateral and ventromedian carina on segment V well formed and serrulated. The ventromedian carinae on segment V can be formed by two rudimentary paired lines of granules.

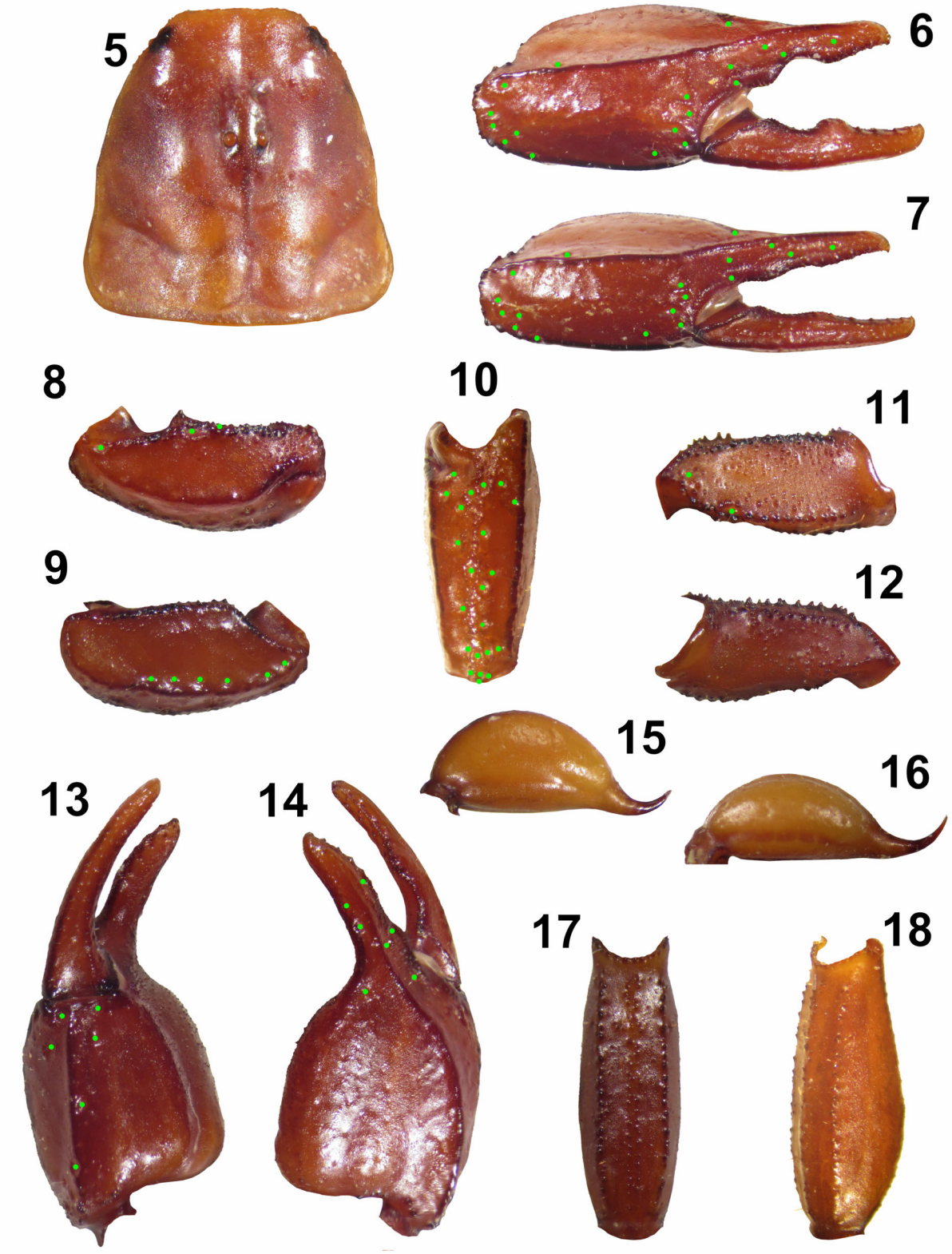
***Trichobothrial and pectinal teeth count variation*.**

The variation observed in 50 examined specimens (23 ♂, 27 ♀) is given below.

Pectinal teeth in males (n=23): 8/8 (9), 8/9 (5), 9/8 (2), 9/9 (5), 9/10 (1), 10/8 (1); in total, 8 in 56.52% (26), 9 in 39.13% (18) and 10 in 4.35% (2); mean = 8.48, SD = 0.58.

Pectinal teeth in females (n=27): 6/6 (1), 7/7 (21), 7/8 (3), 8/8 (2); in total, 6 in 3.70% (2), 7 in 83.33% (45) and 8 in 12.96% (7); mean = 7.09, SD = 0.40.

Pedipalp patella trichobothria Pv (n=50): 5/5 (1), 6/4 (1), 6/6 (45), 6/7 (1), 7/7 (2); in total, 4 in 1% (1), 5



Figures 5–18: *Euscorpius honazicus* sp. n. holotype (except for the Figures 7 and 16) **5.** Carapace. **6.** External view of the chela of adult male. **7.** External view of the chela of adult female. **8.** Dorsal view of pedipalp patella. **9.** Ventral view of pedipalp patella. **10.** External view of pedipalp patella. **11.** Dorsal view of pedipalp femur. **12.** Ventral view of pedipalp femur. **13.** Ventral view of the chela. **14.** Dorsal view of the chela. **15.** Telson of adult male. **16.** Telson of adult female. **17.** Ventral view of the metasomal segment V. **18.** Lateral view of the metasomal segment V.

		Holotype ♂	*Paratype* ♀
Total	Length	24.5	25
Carapace	**Length**	3.72	3.60
	Post. width	3.66	3.72
Metasoma	**Length**	11.64	15.77
Segment I	**Length**	1.50	1.26
	Width	1.56	1.44
Segment II	**Length**	1.86	1.50
	Width	1.50	1.26
Segment III	**Length**	2.04	1.68
	Width	1.39	1.23
Segment IV	**Length**	2.40	1.93
	Width	1.29	1.08
Segment V	**Length**	3.84	3.09
	Width	1.32	1.08
Telson	**Length**	3.66	2.99
Vescicle	**Length**	2.70	1.98
	Width	1.44	1.23
	Height	1.50	1.08
Aculeus	**Length**	0.96	1.01
Femur	**Length**	2.82	2.70
	Width	1.20	1.19
Patella	**Length**	3.00	2.94
	Width	1.23	1.32
Chela	**Length**	5.82	5.76
	Width–A	2.76	2.46
Movable finger	**Length**	3.36	3.24
Ratio	***CarA (%)***	41.93	41.66
	Lcar/Wcar	1.016	0.968
	Lcar/Lfer	1.319	1.333
	Lcar/Ltel	1.016	1.205
	Lchel/Wchel	2.108	2.341
	L/W met.seg I	0.961	0.875
	L/W met.seg II	1.240	1.190
	L/W met.seg III	1.465	1.366
	L/W met.seg IV	1.860	1.789
	L/W met.seg V	2.909	2.861
	Lmet/Wmet	1.648	1.554
	Lmet/Lcar	3.129	2.628
	Lfem/Lpat	0.940	0.918

Table 1: Measurements (mm) and morphometric ratios of holotype ♂ and paratype ♀ of *E. honazicus* **sp. n.**

in 2% (2), 6 in 92% (92) and 7 in 5% (5); mean = 6.01, SD = 0.33.

Pedipalp patella trichobothria Pe (n=50): *et* = 5/4 (2), 5/5 (42), 5/6 (3), 6/5 (3); in total, 4 in 2% (2), 5 in 92% (92) and 6 in 6% (6); mean = 5.04, SD = 0.28; *est* = 4/4 (50); *em* = 2/3 (1), 3/3 (49); *esb* = 2/2 (50); eb_a = 4/3 (1), 4/4 (49); *eb* = 4/4 (50).

Description holotype

Coloration. Whole colour medium brownish reddish; sternites and pectines and genital operculum very light brownish/ivory; chelicerae, telson and legs yellowish without marbling.

Carapace. A more or less homogeneous size granulation is present; anterior edge more or less straight;

posterior lateral, posterior median, and anterior median furrows are present; two pairs of lateral eyes, and a pair of median eyes, situated distally of the middle; distance from centre of median eyes to anterior margin is 41.93 % of carapace length.

Mesosoma. Tergites granulated, especially the seventh; sternites glossy and punctated. Small spiracles inclined about 45° downward towards outside.

Metasoma. Dorsal carinae on segments I–IV granulated; ventrolateral carinae on segment I absent, on segment II obsolete or absent, on segments III some little marked, distanced and little visible granules are present, on segment IV well visible granules are present, on segment V well marked and serrulated; ventromedian carinae absent on segment I–IV, on segment V two rudimentary paired lines of granules are present; ventral intercarinal spaces smooth or almost smooth on surfaces of segments I–III, with a few granules on segment IV, with several small granules a few bigger on segment V, granulated on lateral and dorsal surfaces.

Telson. Vesicle finely granulated, with ventral setae of different size, especially near the vesicle/aculeus juncture.

Pectines. Teeth number 8/8; middle lamellae number 4/4; several microsetae on proximal area of teeth, marginal lamellae, middle lamellae and fulcra.

Genital operculum. The genital operculum is formed by two longitudinally separated subtriangular sclerites; a few microsetae are present.

Sternum. Pentagonal shape, type 2; slightly more wide than long, with a deep posterior emargination.

Pedipalps. Coxa and trochanter with tuberculated carinae. Femur: dorsal internal and ventral internal carinae granulated and tuberculated; dorsal external carinae formed by spaced tubercles serrulated; irregular ventral external carinae formed by tubercles from distal to proximal area just on 1/2 of femur length; external median carinae formed by serrulated tubercles, mostly in proximal 1/2; anterior median carinae adjacent to ventral internal carinae, formed by about ten conical and spaced tubercles of variable size; intercarinal spaces granulated, with bigger granule on dorsal surface near the carinae. Patella: dorsal and ventral internal carinae granulated, the latter slightly serrulated; dorsal external carinae from rough to smooth; ventral external carinae from crenulated with barely visible little pronounced tubercle to rough; intercarinal surfaces finely granulated, especially near the carinae. Dorsal patellar spur barely developed. Chelal carina D_1 is distinct, strong, dark and smooth; D_4 is rounded, rough and little marked; V_1 is distinct, strong, dark and smooth with a few tubercles proximally, following an oblique direction toward the internal of trichobothrium Et_1; V_3 rounded, dark and rough; external carina with little marked granules and rough; intercarinal tegument with fine granules; the fixed finger with notch and movable finger with lobe well formed.

Finger dentition. in the most distal part is present a *DD* on the tip; *MD* is formed by very small denticles closely spaced forming a more or less straight line, discontinued at each 5–8 denticles at level of the *OD*, in proximal position some *MD* denticles are overlap forming two lines; fixed finger has 6/6 *OD*, 5/5 *ID*, and 4/6 *IAD*; movable finger has 7/7 *OD*, 7/7 *ID*, and 7/7 *IAD*.

Trichobothria. Chela: trichobothria on the pedipalp manus ventral surface V = 3/3 ($V_{1\text{-}3}$) + Et_1 = 1/1; trichobothrium V_4 situated on the carina V_1; trichobothrium on fixed finger *est* situated in proximal half of the notch of the fixed finger. Patella: Pv = 6/6; et = 5/5, est = 4/4, em = 3/3, esb = 2/2, eb_a = 4/4, eb = 4/4. Femur: trichobothrium d is barely proximal to i, while trichobothrium e is well distal to both d and i, and situated on dorsal surface barely on dorsal external carina.

Legs. Two pedal spurs present; no tarsal spur; ventral row of the tarsus of the legs pair I with a total of 13/13 spinules, 12/13 on tarsus of the legs pair II, 14/14 on tarsus of the legs pair III, and the tarsi of IV legs are missing. The spinule are of increasing size from proximal to distal, ending with two spinules that form a "Y" shape; 3 main flanking tarsal setae present. Tubercles present on ventral and dorsal surface of all leg femora, they are more marked and dark ventrally.

Chelicerae. Typical of the genus *Euscorpius*.

Phylogenetic analysis

The 50% majority-rule consensus BI tree is shown in Figure 19. The tree is very well resolved and it is evident that the three specimens of the newly described species form a monophyletic group with high posterior support. *E. arikani* is the species more closely related to this group, whereas *E. phrygius* is the most distant.

Ecological notes

Mount Honaz (Turk. Honaz Dağı) is an isolated mountain located in southwestern Turkey. At 2528 m a.s.l. (Kırmacı, 2008), it is the highest mountain in Turkey's Aegean Region. It is covered with forests, particularly in its northern areas and below 1800 m a.s.l., dominated by red pine, black pine and juniper. The specimens of *Euscorpius honazicus* sp. n. were collected between 871 and 2500 m a.s.l.; only *E. ciliciensis* was collected at greater heights (Tropea et al., 2015c). The type locality of *E. honazicus* sp. n. is on the top of Mount Honaz to 2500 m a.s.l., where low temperatures prevail. This habitat is characterized by rocky places and stones with scattered vegetation and *Juniperus* sp. formations. Some specimens were collected very close to patches of snow. The sampling locality in the northernslope of Mt. Honaz is covered by black pine

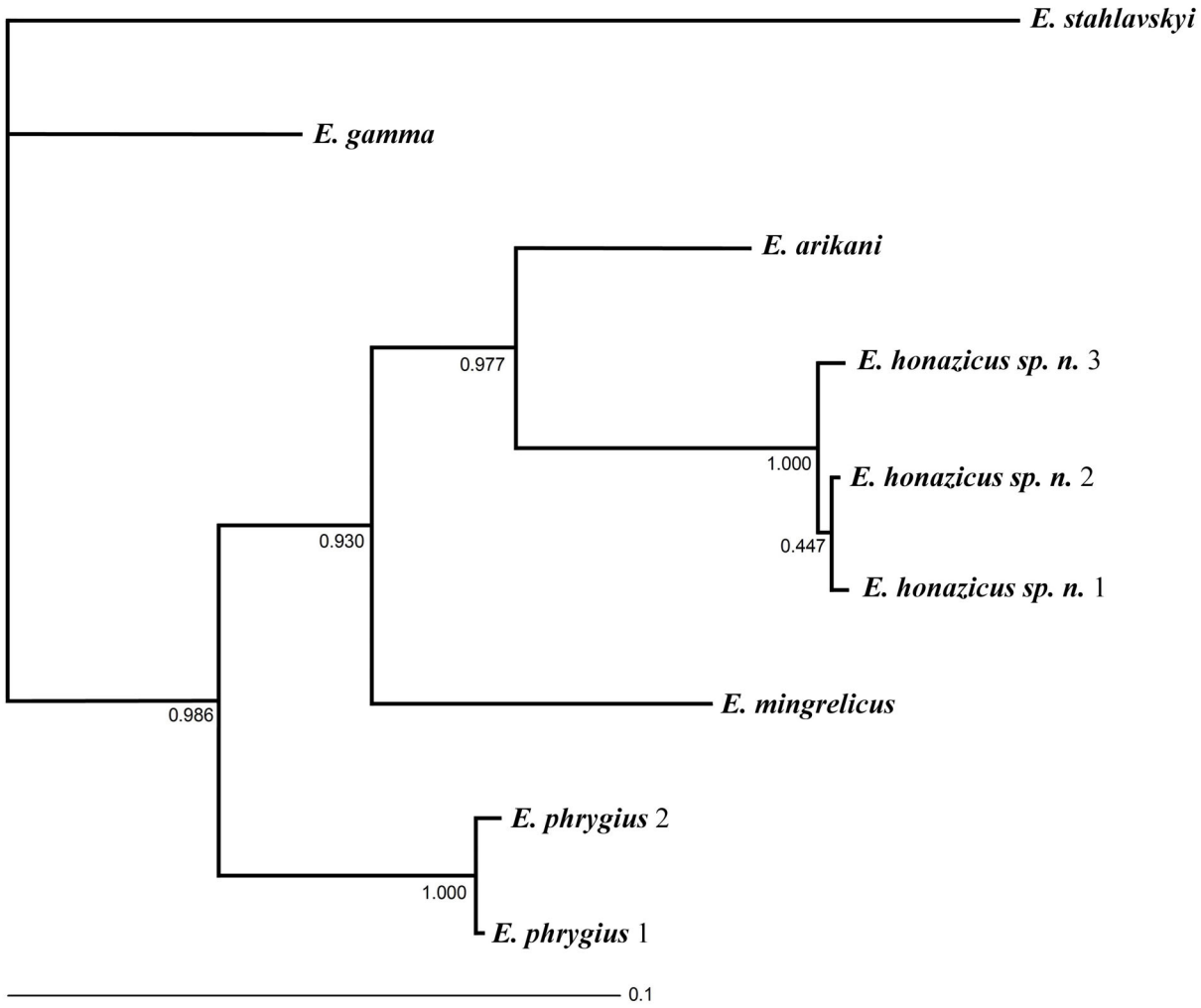


Figure 19: 50% majority-rule consensus tree of the Bayesian Inference analysis performed on the concatenated *16S rDNA* and *COI mtDNA* gene fragments. Posterior probabilities are indicated on the nodes. The species *E. stahlavskyi* and *E. gamma* were used as out groups. The scale bar indicates substitutions per site.

forest (*Pinus nigra* J.F. Arnold). All the specimens of *Euscorpius honazicus* sp. n. were collected under stones.

Mount Honaz is a lone mountain that does not belong to any mountain range. It is isolated by Büyük Menderes River in the north, Akçay River in the west, and Dalaman River in the south. Probably due to the isolation, numerous endemic species have been reported from this mountain massif. According to Duran et al. (2009), 99 endemic plant species occur in the Mount Honaz National Park. Among recently described animal endemics of Mt. Honaz are two mite species (Urhan, 2009, 2010), two staphylinid beetles (Anlaş & Örgel, 2014; Anlaş, 2015), and one ant species (Karaman & Aktaç, 2013).

Differences between *E. honazicus* sp. n. and other similar species

In Turkey there are seven species with the trichobothrial series *Pe-em* = 3 (not including the new species), all morphologically and/or geographically well distinguishable from *E. honazicus* sp. n.

E. honazicus sp. n. can mainly be differentiated from *E. mingrelicus* as follows: (1) *E. honazicus* sp. n. is from light to medium brown-reddish, without marbling on chelicerae, while *E. mingrelicus* is dark brown with dark marbling on chelicerae; and (2) *E. honazicus* sp. n. has the metasomal segment V with carinae well marked and granulated, versus a almost smooth segment V, with or without very small and spaced granules in *E. mingrelicus*. *E. honazicus* sp. n. is found in south-western Turkey, while *E. mingrelicus* is found along the Black Sea coast of Turkey and Georgia, slightly expanding beyond the northwestern border of Georgia into Russia.

E. honazicus sp. n. can mainly be differentiated from *E. phrygius* and *E. uludagensis* as follows: (1) *E. honazicus* sp. n. has the trichobothrial series on pedipalp patella external surface *et* = 5, versus *et* = 4 in *E. phrygius* and *E. uludagensis*; (2) *E. honazicus* sp. n. is

Species	Locality	Accession number and references	
		16S rDNA	COI
Euscorpius honazicus **sp. n.** 1	Turkey, Denizli Province, Mt. Honaz, 2500 m a.s.l., 37°40'37.6"N, 29°17'10.6"E	n/a	KU987039
Euscorpius honazicus **sp. n.** 2	Turkey, Denizli Province, Mt. Honaz, 1160 m a.s.l., 37°43'50"N, 29°14'52"E	n/a	KU987040
Euscorpius honazicus **sp. n.** 3	Turkey, Denizli Province, Mt. Honaz, 1500 m a.s.l., 37.7184°N, 29.2511°E	KT764035 (Fet et al., 2016)	HM418280 (Fet et al., 2016)
Euscorpius arikani	Turkey, Antalya Province, Finike, Mt. Alacadag, 36°26'12"N, 30°02'22"E	KU987043	KU987041
Euscorpius phrygius 1	Turkey, Bolu Province, Mt. Abant	KU987044	KU987042
Euscorpius phrygius 2	Turkey, Ankara Province, Kizilcahamam, Soğuksu National Park, 40.6611°N, 32.7078°E	KT764032 (Fet et al., 2016)	KT764039 (Fet et al., 2016)
Euscorpius mingrelicus	Turkey, Rize Province, Çamlıhemşin, near Şenköy village, 720 m a.s.l., 40.8644°N, 40.9647°E	KT764037 (Fet et al., 2016)	KT764044 (Fet et al., 2016)
Euscorpius gamma	Austria, Carinthia, Trögerner-Klamm, 46.4577°N, 14.5005°E	AJ249555 (Scherabon et al., 2000)	HM418273 (Graham et al., 2012)
E. stahlavskyi	Greece, Epiros, Smolikas Mts.	KC215653 (Parmakelis et al., 2013)	KC215739 (Parmakelis et al., 2013)

Table 2: DNA sequences used in the phylogenetic analysis.

light to medium brown-reddish, without marbling on chelicerae, while *E. phrygius* and *E. uludagensis* are dark brown with dark marbling; and (3) *E. honazicus* sp. n. has the trichobothrial series *Pv* = 6, versus *Pv* = 5 in *E. uludagensis*. *E. honazicus* sp. n. is found in southwestern Turkey, while *E. phrygius* and *E. uludagensis* in northwestern Turkey.

E. honazicus sp. n. can mainly be differentiated from *E. ciliciensis* as follows: (1) *E. honazicus* sp. n. has *Pv* = 6, versus *Pv* = 7 in *E. ciliciensis*; and (2) *E. honazicus* sp. n. has the dorsal patellar spur barely developed, while *E. ciliciensis* has it well-developed. *E. honazicus* sp. n. is found in southwestern Turkey, while *E. ciliciensis* is found in southern Turkey in the Central Taurus Mountains.

E. honazicus sp. n. can mainly be and easily differentiated from *E. eskisehirensis* and *E. sultanensis* because *E. honazicus* sp. n. has the trichobothrial series on pedipalp patella external surface *et* = 5, versus *et* = 4 in *E. eskisehirensis* and *E. sultanensis.*

E. honazicus sp. n. has more or less the same trichobothrial and pectinal number of *E. arikani* but it can easily be differentiated because *E. honazicus* has well marked and granulated carinae on metasomal segment V.

	16S rDNA	1	2	3	4	5	6	7
1	*E. stahlavskyi*	-	0.015	0.019	0.017	0.024	0.025	0.017
2	*E. gamma*	0.082	-	0.012	0.010	0.013	0.014	0.012
3	*E. mingrelicus*	0.104	0.053	-	0.011	0.011	0.014	0.013
4	*E. phrygius 2*	0.094	0.036	0.045	-	0.005	0.012	0.011
5	*E. phrygius 1*	0.104	0.038	0.029	0.005	-	0.012	0.017
6	*E. arikani*	0.125	0.050	0.049	0.038	0.038	-	0.013
7	*E. honazicus* sp. n. 3	0.102	0.053	0.065	0.045	0.068	0.042	-

Table 3: Genetic distances between *16S rDNA* sequences. Standard error estimates are above the diagonal. See Material and Methods for explanations.

	COI mtDNA	1	2	3	4	5	6	7	8	9
1	*E. stahlavskyi*	-	0.016	0.015	0.015	0.015	0.015	0.015	0.014	0.014
2	*E. gamma*	0.124	-	0.013	0.012	0.013	0.013	0.011	0.012	0.012
3	*E. mingrelicus*	0.112	0.106	-	0.011	0.011	0.012	0.013	0.014	0.013
4	*E. phrygius 2*	0.115	0.089	0.075	-	0.002	0.012	0.012	0.012	0.012
5	*E. phrygius 1*	0.111	0.084	0.068	0.002	-	0.012	0.012	0.012	0.012
6	*E. arikani*	0.113	0.088	0.074	0.084	0.080	-	0.011	0.011	0.011
7	*E. honazicus* sp. n. 3	0.114	0.080	0.093	0.084	0.078	0.066	-	0.002	0.003
8	*E. honazicus* sp. n. 2	0.105	0.076	0.089	0.078	0.075	0.060	0.004	-	0.002
9	*E. honazicus* sp. n. 1	0.103	0.078	0.087	0.080	0.076	0.061	0.005	0.002	-

Table 4: Genetic distances between *COI mtDNA* sequences. Standard error estimates are above the diagonal. See Material and Methods for explanations.

Finally, the phylogenetic tree presented in Fig. 19 strongly supports the clear distinction of *E. honazicus* sp. n. from *E. arikani*, *E. mingrelicus* and *E. phrygius*.

Comments

In the last years our research group is intensively studying the genus *Euscorpius* in Turkey, resulting in a significant increase of the species of this genus in the country. Since 2012, the number of species in Turkey has increased from two to 13, not including the new species herein described (Tropea & Yağmur, 2015, 2016; Tropea et al., 2012, 2014b, 2015c; Yağmur & Tropea, 2013, 2015; Yağmur et al., 2013).

These species have been found mostly in relatively restricted mountainous areas with the exception of *E. mingrelicus*, which, at present, has a very extensive distribution when compared to other Turkish species of *Euscorpius*. This high extent of speciation in the mountainous areas, often with restricted ranges, is in agreement with other new species of *Euscorpius* described in other countries in recent years (e.g. see Tropea et al., 2013, 2014a, 2015a; 2015b).

Our unpublished morphological and molecular data indicate the presence of probable good species from different mountainous areas and that some populations might need to be more thoroughly investigated (Tropea & Yağmur, 2016).

Recently, Fet et al. (2016) presented a phylogeny based on specimens related to subgenus *Alpiscorpius* collected in Turkey. Independently, our group also has been studying different populations on genetic basis, in addition to the morphological, and the high diversification shown from their data is in accordance with our published, and unpublished, morphological and genetic data. We compared some of our sequences with those published by Fet et al. (2016), and as it was expected, the new species described herein clusters with their population “number 7” from Mt. Honaz. In addition, recently Tropea & Yağmur (2016) described *E. sultanensis*, which is found in Sultan Mts., relatively close to the population "number 10" of Fet et al. (2016), so they could be the same species, but at the moment we have no data to confirm this.

Note that Fet et al. (2016) show a population labelled *Euscorpius* sp. from Ankara Province well separated, with a divergence of 5.8% in 16S *rDNA* and 4.5% in COI, from a population labelled as *E. phrygius* originating from the type locality of the species. We compared our genetic sequence of *E. phrygius* from the type locality, and as shown in our phylogenetic tree (Fig. 19) and in Tables 2 and 3, they are the same species with a divergence of 0.5% and 0.2%, for 16S *rDNA* and COI, respectively. As regards the sequence of the population considered by them as *E. phrygius*, a visual investigation showed several dubious unique bases. There may be

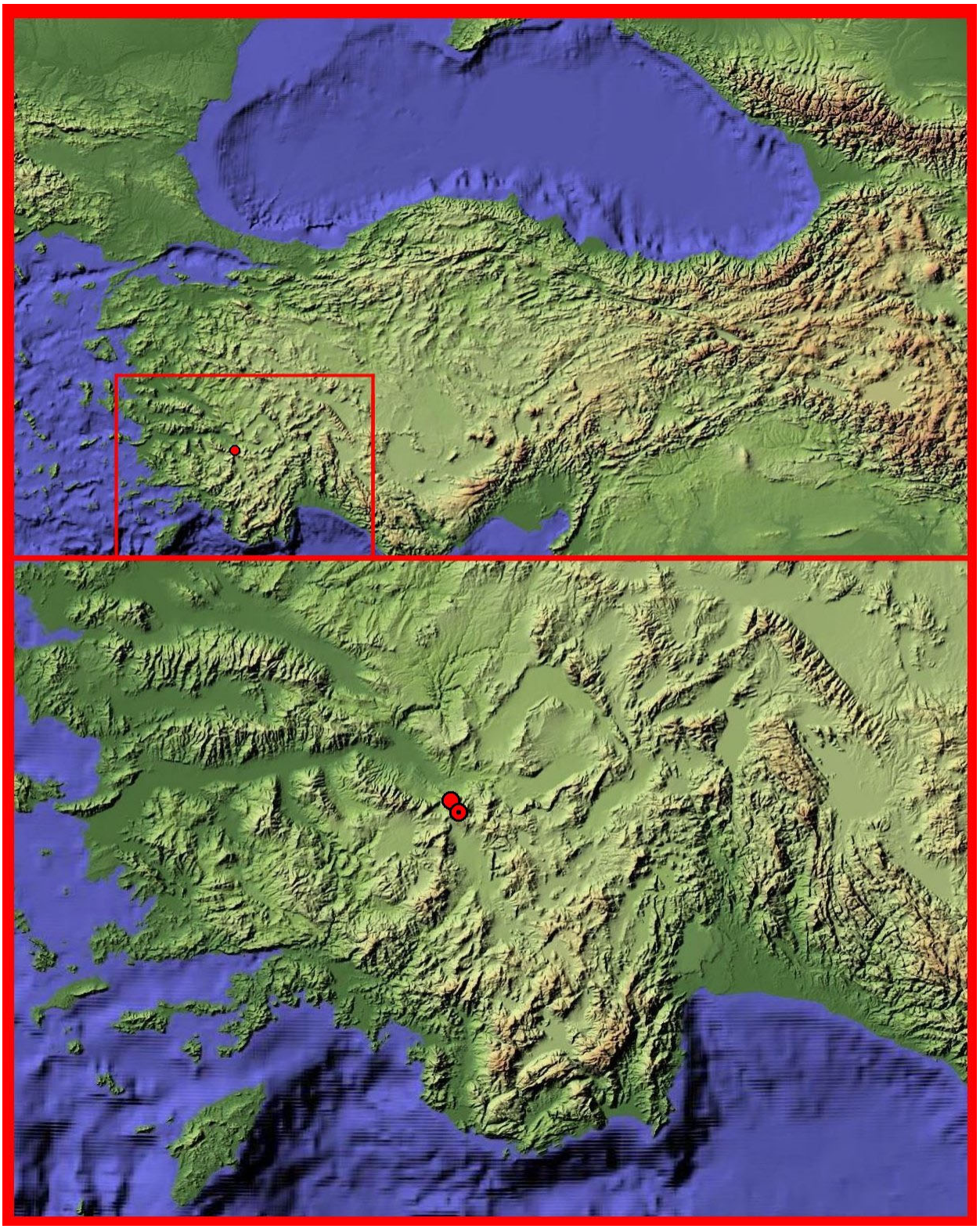


Figure 20: Map showing the type locality of *Euscorpius honazicus* sp. n. (red circle with black dot).

several explanations for this, anyway, this sequence is not reliable, and therefore it should not be considered as *E. phrygius*. Note also that in Table 4, *E. eskisehirensis* has a genetic divergence with *E. ciliciensis* of only 0.8% in COI. This data is curious and unexpected, since usually COI sequences have a higher divergence, or sometimes of similar value, to those of the 16S *rDNA* marker (Tropea et al., 2015b), which according to their

Figures 21–22: Natural habitat of *Euscorpius honazicus* sp. n.

Table 3, is 4.3%, namely far higher than divergence between many well defined and valid species, as evidenced by Tropea & Yağmur (2015). At least one of the reasons for this low divergence is probably the length of their COI sequence of *E. ciliciensis*, which consists of 145 bases, but it is likely that it is not the only reason. Additional sequences of both species would help to understand their relationship.

In this paper we describe *E. honazicus* sp. n., based on morphological and molecular evidence. It is easily distinguished from the other species, as has been shown above. In addition, we show here for the first time the 16S *rDNA* and COI *mtDNA* genetic sequences of *E. arikani*, the relatively closer species, both morphologically, geographically and phylogenetically, to *E. honazicus* sp. n. However, *E. arikani* is well separated from *E. honazicus* sp. n. with a genetic divergence of 4.5% for 16S *rDNA* and from 6.0% to 6.6% for COI, as well as the phylogenetic tree presented in Fig. 19 strongly supports the clear distinction of these two species. *E. arikani* was described in a high place from Mt. Alacadag, in the western Taurus and it maybe be restricted to those area, although further specimens from more sites are needed to understand the real areal of both *E. arikani* and *E. honazicus* sp. n.

Additional specimens and both morphological and genetic studies are needed to better understand the true biodiversity and relationships of the species of the genus *Euscorpius* in Turkey. Within the frame of a well informed morphological and molecular phylogeny approach, it is very likely that the number of species will increase considerably.

Acknowledgments

We wish to thank Domniki Dimitriadou (University of Athens) for helping in the generation of 16S *rDNA* and COI sequences used in this study. In addition, we wish to thank two anonymous reviewers for reviewing the English text and for their suggestions.

References

AKAIKE, H. 1974. A new look at statistical-model identification. *IEEE Transactions on Automatic Control*, 19: 716–723.

ANLAŞ, S. 2015. Four new species of *Astenus* (*Eurysunius*) Dejean, 1833 from Western Anatolia, Turkey (Coleoptera: Staphylinidae, Paederinae). *Zootaxa*, 3986 (4): 472–482.

ANLAŞ, S. & S. ÖRGEL. 2014. A new species of *Sunius* Curtis, 1829 from Turkey. *Türkiye Entomoloji Dergisi*, 38(4): 427–430

DURAN, A., Ö. ÇETİN & M. ÖZTÜRK. 2009. *Globularia anatolica* sp. nov. (Globulariaceae) from the Honaz Mountain. *Nordic Journal of Botany*, 27(3): 232–237.

FET, V., M. R. GRAHAM, G. BLAGOEV, A. KARATAŞ & A. KARATAŞ. 2016. DNA barcoding indicates hidden diversity of *Euscorpius* (Scorpiones: Euscorpiidae) in Turkey. *Euscorpius*, 216: 1–12.

HJELLE, J.T. 1990. Anatomy and morphology. Pp. 9–63 In: Polis G.A. (ed.). *The Biology of Scorpions*. Stanford, CA: Stanford University Press, 587 pp.

KARAMAN, C. & N. AKTAÇ. 2013. Descriptions of four new species of *Camponotus* Mayr (Hymenoptera: Formicidae), with a key for the worker caste of the *Camponotus* of Turkey. *Journal of the Kansas Entomological Society*, 86(1): 36–56.

KIMURA, M. 1980. A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution*, 16: 111–120.

KIRMACI, M. 2008. Tufa formation originating from Bryophytes in Babadağ and Honaz Mountain (Denizli/Turkey). *Biological Diversity & Conservation*, 1(1): 116–126.

PARMAKELIS, A., I. STATHI, P. KOTSAKIOZI, S. POULIKARAKOU & V. FET. 2013. Hidden diversity of *Euscorpius* (Scorpiones: Euscorpiidae) in Greece revealed by multilocus species-delimitation approaches. *Biological Journal of the Linnean Society*, 110: 728–748.

POSADA, D. & K.A. CRANDALL. 1998. MODELTEST: testing the model of DNA substitution. *Bioinformatics*, 14: 817–818.

RONQUIST, F., M. TESLENKI, P. VAN DERMARK, D.L. AYRES, A. DARLING, S. HÖHNA, B. LARGET, L. LIU, M.A. SUCHARD & J.P. HUELSENBECK. 2012. MrBayes 3.2: Efficient Bayesian Phylogenetic Inference and Model Choice Across a Large Model Space. *Systematic Biology*, 61: 539–542.

SCHERABON, B., B. GANTENBEIN, V. FET, M. BARKER, M. KUNTNER, C. KROPF & D. HUBER. 2000. A new species of scorpion from Austria, Italy, Slovenia and Croatia: *Euscorpius gamma* Caporiacco, 1950, stat. nov. (Scorpiones: Euscorpiidae). In: Gajdoš, P. & S. Pekár (eds):

Proceedings of the 18th European Colloquium of Arachnology, Stará Lesná, 1999. *Ekológia* (Bratislava), 19, Suppl. 3: 253–262.

SISSOM, W.D. 1990. Systematics, biogeography and paleontology. Pp. 64–160 In: Polis G. A. (ed.). *The Biology of Scorpions*. Stanford University Press: Stanford, CA, 587 pp.

SOLEGLAD, M.E. & V. FET. 2003. The scorpion sternum: structure and phylogeny (Scorpiones: Orthosterni). *Euscorpius*, 5: 1–33.

SOLEGLAD, M.E. & W.D. SISSOM. 2001. Phylogeny of the family Euscorpiidae Laurie, 1896: a major revision. (pp. 25-112). In: Fet V. & Selden P. A. (eds). *Scorpions 2001. In memoriam Gary A. Polis*. Burnham Beeches, Bucks, UK: British Arachnological Society.

STAHNKE, H.L. 1971. Scorpion nomenclature and mensuration. *Entomological News*, 81: 297–316.

TAMURA, K., D. PETERSON, N. PETERSON, G. STECHER, M. NEI & S. KUMAR. 2011. MEGA5: Molecular Evolutionary Genetics Analysis using Maximum Likelihood, Evolutionary Distance, and Maximum Parsimony Methods. *Molecular Biology and Evolution*, 28: 2731–2739.

TROPEA G., V. FET, A. PARMAKELIS, P. KOTSAKIOZI & I. STATHI. 2013. A new species of *Euscorpius* Thorell, 1876 from Peloponnese, Greece (Scorpiones: Euscorpiidae). *Euscorpius*, 169: 1–11.

TROPEA, G., V. FET, A. PARMAKELIS, P. KOTSAKIOZI & I. STATHI. 2014a. Three new species of *Euscorpius* (Scorpiones: Euscorpiidae) from Greece. *Euscorpius*, 190: 1–22.

TROPEA, G., V. FET, A. PARMAKELIS, P. KOTSAKIOZI & I. STATHI. 2015a. A new species of *Euscorpius* (Scorpiones: Euscorpiidae) from southern Bulgaria. *Arachnologische Mitteilungen*, 49: 10–20.

TROPEA, G., V. FET, A. PARMAKELIS, P. KOTSAKIOZI & I. STATHI. 2015b. A new species of *Euscorpius* from Bulgaria and Greece (Scorpiones: Euscorpiidae). *Euscorpius*, 207: 1–15.

TROPEA, G. & E.A. YAĞMUR. 2015. Two new species of *Euscorpius* Thorell, 1876 from Turkey (Scorpiones: Euscorpiidae). *Arachnida*, 4: 13–32.

TROPEA, G. & E.A. YAĞMUR. 2016. A new species of *Euscorpius* Thorell, 1876 from the Sultan Mountains in western Turkey (Scorpiones: Euscorpiidae). *Arachnida*, 6: 32–43.

TROPEA, G., E.A. YAĞMUR & V. FET. 2015c. A revision of the Anatolian-Caucasian "*Euscorpius mingrelicus* complex" (Scorpiones: Euscorpiidae). *Euscorpius*, 203: 1–32.

TROPEA, G., E.A. YAĞMUR, H. KOÇ, F. YEŞILYURT & A. ROSSI. 2012. A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from Turkey. *ZooKeys*, 219: 63–80.

TROPEA, G., E.A. YAĞMUR & F. YEŞILYURT. 2014b. A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from the Antalya Province, Southern Turkey. *Euscorpius*, 184: 1–13.

URHAN, R. 2009. *Zercon honazicus* sp. n., a new species of mite from Turkey (Acari: Zerconidae). *Zoology in the Middle East*, 48: 97–100.

URHAN, R. 2010. *Prozercon celali* sp. nov. of soil mites (Acari: Zerconidae) from Turkey. *Annales Zoologici*, 60: 133–137.

VACHON, M. 1974. Etude des caractères utilisés pour classer les familles et les genres de scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les scorpions. *Bulletin du Muséum National d'Histoire naturelle, Paris*, 140: 859–958.

YAĞMUR, E.A. & G. TROPEA. 2013. A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from Marmara Region of Turkey. *ZooKeys*, 281: 91–105

YAĞMUR, E.A. & G. TROPEA. 2015. A new species of *Euscorpius* Thorell, 1876 from southwestern Turkey (Scorpiones: Euscorpius). *Arachnida*, 3: 14–26.

YAĞMUR, E.A., G. TROPEA & F. YEŞILYURT. 2013. A new species of *Euscorpius* Thorell, 1876 (Scorpiones, Euscorpiidae) from south western Turkey. *ZooKeys*, 348: 29–45.