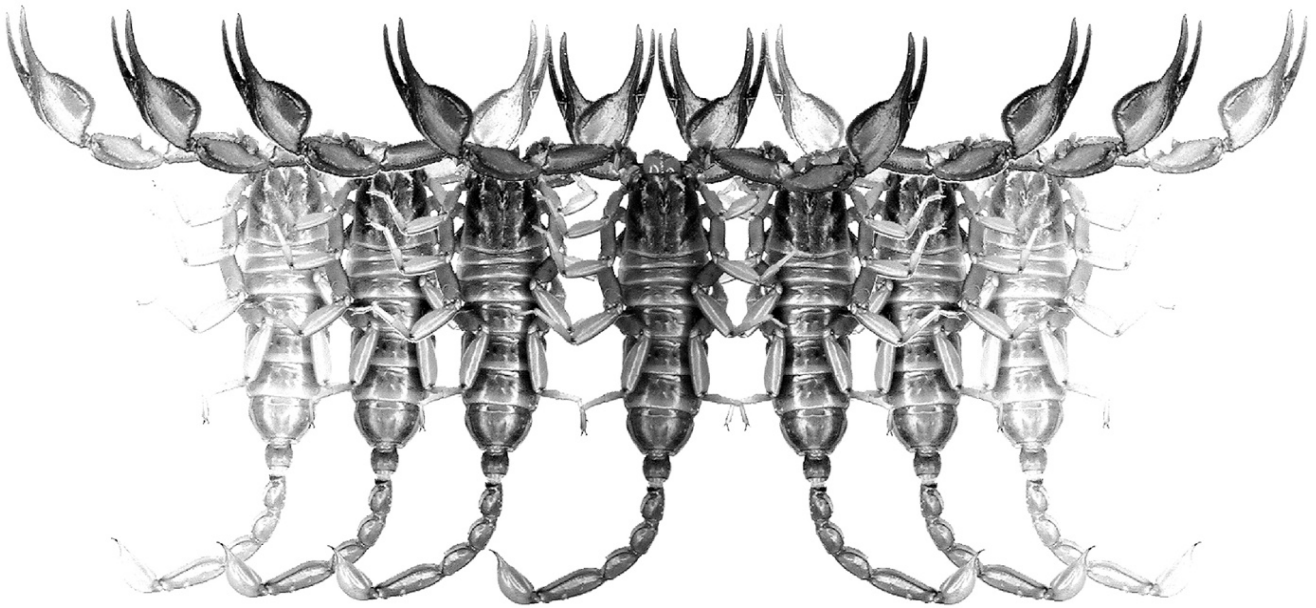


# *Euscorpius*

Occasional Publications in Scorpiology



**Description of the adult male of  
*Euscorpius feti* Tropea, 2013  
(Scorpiones: Euscorpiidae), with notes on  
cave ecology of this species**

**Gioele Tropea & Roman Ozimec**

**October 2019 — No. 291**

# *Euscorpius*

## *Occasional Publications in Scorpiology*

EDITOR: Victor Fet, Marshall University, 'fet@marshall.edu'

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*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).

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Archive of issues 1-270 see also at: <http://www.science.marshall.edu/fet/Euscorpius>

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**Publication date: 21 October 2019**

<http://zoobank.org/urn:lsid:zoobank.org:pub:1D615034-CF01-4CFE-91CF-CA1E84EEABB2>

# Description of the adult male of *Euscorpius feti* Tropea, 2013 (Scorpiones: Euscorpiidae), with notes on cave ecology of this species

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<http://zoobank.org/urn:lsid:zoobank.org:pub:1D615034-CF01-4CFE-91CF-CA1E84EEABB2>

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## Summary

The adult male of *Euscorpius feti* Tropea, 2013 (Euscorpiidae) is described for the first time. A large series (45 specimens including the type material) has been studied, most of the material previously unpublished. *E. feti* has been found in as many as 17 caves in Croatia and Bosnia-Herzegovina, including the Adriatic islands, which makes it the most common *Euscorpius* species so far found in caves. Ecological notes on this species are presented.

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## Introduction

The Croatian scorpion fauna has been little studied. The taxonomic position of various scorpion populations remained doubtful (Di Caporiacco, 1950; Kinzelbach, 1975) until a few years ago, when several articles tried to clarify the position of at least some taxa (Graham et al., 2012; Tropea, 2013a, 2013b, 2015); some populations are still to be clarified (Tropea et al., in progress).

To date, the scorpion fauna of Croatia is represented by two genera and nine species of the family Euscorpiidae, subfamily Euscorpiinae: *Euscorpius* Thorell, 1876, with eight species: *E. aquilejensis* (C. L. Koch, 1837), *E. borovaglavaensis* Tropea, 2015, *E. croaticus* Di Caporiacco, 1950, *E. feti* Tropea, 2013, *E. garganicus* Di Caporiacco, 1950, *E. hadzii* Di Caporiacco, 1950, *E. italicus* (Herbst, 1800), and *E. tergestinus* (C. L. Koch, 1837); and *Alpiscorpius* Gantenbein et al., 1999, with one species, *A. gamma* (Di Caporiacco, 1950) (Scherabon et al., 2000; Fet & Soleglad, 2002; Gantenbein et al., 2002; Graham et al., 2012; Tropea, 2013a, 2013b, 2015, 2017; Kovařík et al., 2019).

Tropea (2013b) has described *E. feti* based on seven specimens, of which the only two known males were not adult. In this work, thanks to the sampling of a larger number of specimens, which also originate from as many as 17 caves in the West Balkans, the adult male of *Euscorpius feti* Tropea, 2013 is described for the first time. In addition, some ecological notes on cave specimens are presented. Discovery of numerous specimens in a high number of caves suggests that *E. feti* can easily adapt to cave habitats (especially the habitat of cave entrance) and thus can be classified as a subtroglophile or an opportunistic eutroglophile.

## Material and Methods

The trichobothrial notation follows Vachon (1974). Morphological measurements are given in millimetres (mm) following Tropea et al. (2014). Morphological nomenclature follows Stahnke (1971), Hjelle (1990) and Sissom (1990); the chela carinae and denticle configuration follows Soleglad & Sissom (2001) but we united *ID+IAD*; and sternum terminology follows Soleglad & Fet (2003). Cave habitats are defined for European Union countries following EUNIS habitat classification (EUNIS, 2012). However, since this classification does not cover all the specifics of individual countries, we added the most detailed classification for cave habitats following the National Classification of Habitats of the Republic of Croatia (IV version) (Nacionalna klasifikacija, 2014). The map was downloaded from <http://d-maps.com> and edited.

**Abbreviations.** *Dp*: pectinal teeth number; *Pe*: trichobothria on pedipalp patella external surface; *Carapace anterior-posterior %*: average ratio of distances from the center of median eyes to anterior and posterior margins of the carapace; *DPS*: dorsal patellar spur; *juv.*: juvenile (non-adult specimen at any stage of development).

**Depositories.** GTC: private collection of Gioele Tropea, Rome, Italy; MSNB: Museo Civico di Scienze Naturali “E. Caffi”, Bergamo, Italy; MZUR: Museo di Zoologia “Charles Darwin” dell’Università di Roma “La Sapienza”, Rome, Italy; MSNG: Museo Civico di Storia Naturale “Giacomo Doria”, Genoa, Italy; MSNT: Museo Civico di Storia Naturale di Trieste, Trieste, Italy; NBC: Naturalis Biodiversity Centre, Leiden, The Netherlands; NHMW: Naturhistorisches Museum Wien, Vienna, Austria; ROC: private collection of Roman Ozimec, Zagreb, Croatia; UL, University of Ljubljana, Ljubljana, Slovenia; VFPC: private collection of Victor Fet, Huntington, West Virginia, USA.



**Figure 1.** Dorsal view of an adult male of *Euscorpius feti*.

Dimensions (MM)		<i>Euscorpis feti</i>	
		♀ holotype	♂
Carapace	L / W	5.64 / 5.27	6.24 / 5.82
Metasoma + telson	L	17.29	22.18
Segment I	L / W	1.61 / 1.53	2.04 / 1.80
Segment II	L / W	1.92 / 1.37	2.40 / 1.61
Segment III	L / W	2.22 / 1.26	2.73 / 1.51
Segment IV	L / W	2.64 / 1.21	3.30 / 1.45
Segment V	L / W	4.38 / 1.20	5.52 / 1.44
Telson	L / W	4.52 / 1.23	6.18 / 2.13
Vesicle	L	2.96	4.80
Pedipalp	L	21.41	24.06
Femur	L / W	5.69 / 1.86	6.30 / 1.92
Patella	L / W	5.22 / 1.92	5.76 / 2.16
Chela	L / W	10.50	12.00
Movable finger	L	6.30	7.62
<b>Total</b>	<b>L</b>	<b>34.89</b>	<b>40.77</b>

**Table 1.** Comparative measurements of adults of *Euscorpis feti*. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width).

### Family Euscorpiidae Laurie, 1896

#### Genus *Euscorpis* Thorell, 1876

#### Subgenus *Incertae Sedis*

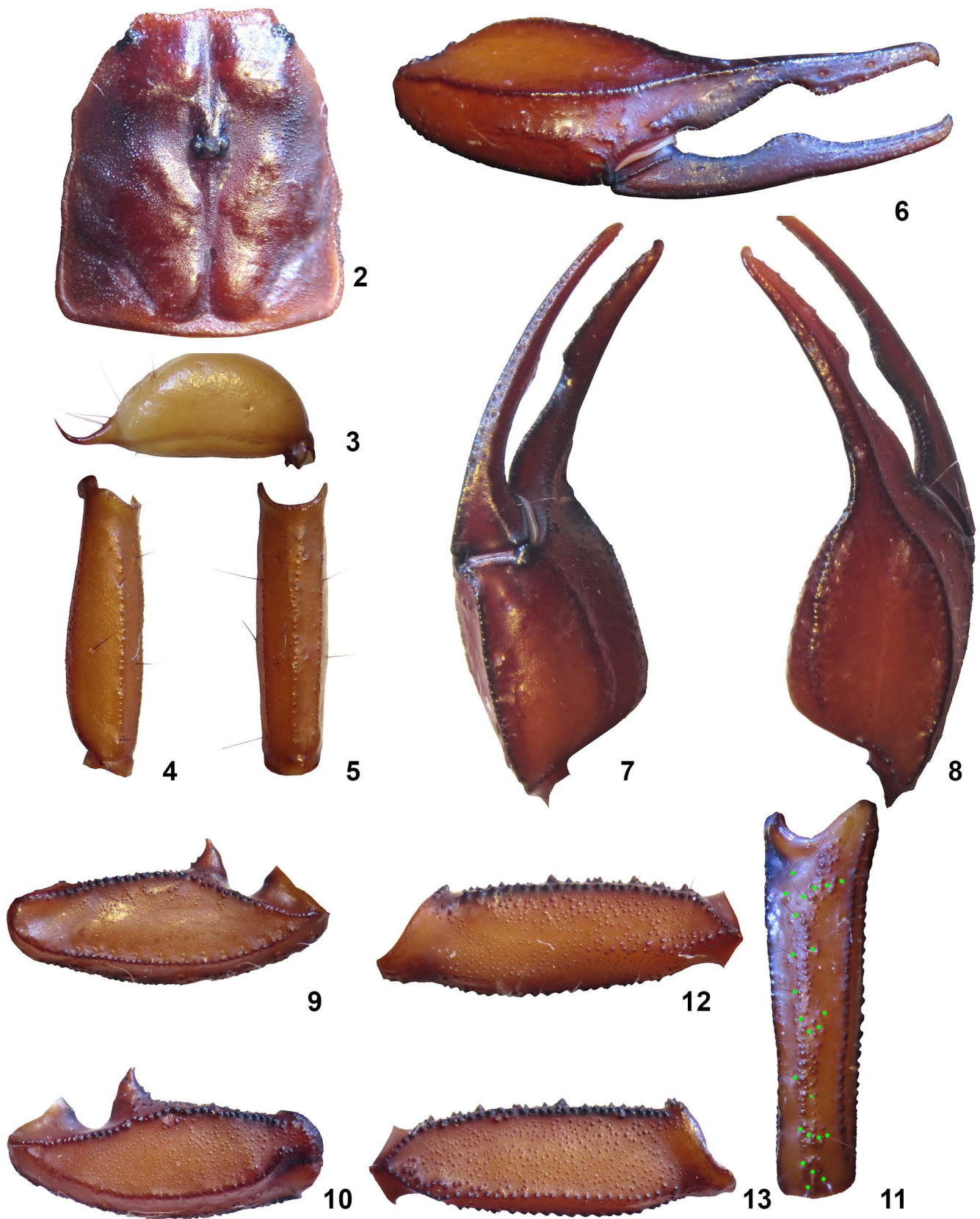
#### *Euscorpis feti* Tropea, 2013

(Figures 1–18, Tables 1–3)

MATERIAL EXAMINED INCLUDING THE TYPE MATERIAL (45 specimens). **Croatia:** Vrbovica, Korčula Island, April 1999, 1♀ holotype (UL); Lapad Peninsula, May 1952, 1♀ (UL); Cavtat (Ragusa Vecchia), 1♂juv. paratype (MZUR 35); Deukalion Jama, Žrnovo, Korčula Island, 21 March 2010, leg. L. Dud, 1♂juv. (ROC); Dubrovnik, May 1962, 1♂ (NBC); Durovića Jama, Aerodrom Čilipi, Dubrovnik, 31 October 2003, leg. R. Ozimec, 1♂ (GTC); Špilja za Gromačkom vlakom (entrance chamber), Gromača, Dubrovnik, 2 November 2003, leg. R. Ozimec, 2♂juvs. (ROC); Gorska Jama, Janjina, Pelješac Peninsula, 3 November 2003, leg. R. Ozimec, 1♂ (GTC); Jama pod Sv. Spasom, Babino Polje, Mljet Island, 20 June 2001, leg. R. Ozimec, 2juvs.♂♀ (ROC); Jama u šumi uvale Bječajka, Soline, Mljet Island, 1 December 2001, leg. R. Ozimec, 1♂ (GTC); Male Ponte Jama, Mljet Island, 13 April 2011, leg. R. Ozimec 2juvs.♂♀ (ROC); Metković, Neretva River, 28 April 2017, leg. R. Kranjčev, 1♀juv. (GTC); Milanovo dvorište (Milan's backyard), Korčula Island, 6 October 2010, leg. M. Vojinović, 1♂1♀ (GTC); Močiljska Špilja, Osojnik, Dubrovnik, 8 October 2004, leg. M. Franičević, 1♂1♀ adult or subadult (ROC); Pišurka, Korčula Island, 19 November 2013, leg. D. Basara, 1♂juv. (ROC); Pišurka, Korčula Island,

15 April 2011, leg. R. Ozimec, 3juvs.♂♀♀ (ROC); Pišurka, Korčula Island, 11 April 1977, 1♂juv. (NBC); Pišurka, Korčula Island, 16/17 June 1975, 1♀ (NBC); Pišurka, Korčula Island, 16 April 2014, leg. D. and R. Ozimec, 2♂ (ROC); Pišurka, Korčula Island, 12 August 2008, leg. R. Ozimec, 3juvs.♂♂♀ (ROC); Pišurka, Korčula Island, 12 August 2011, leg. R. Ozimec, 1♀juv. (ROC); Zaspila, Žrnovo, Korčula Island, 17 March 2010, leg. A. Kirin, 1♀juv. (ROC); Špilja iznad crkvice Gospe od Luga, Gruda, Donje Konavle, 7 April 2010, leg. R. Ozimec, 2♂ (GTC); Špilja kod Nerezinog dola, Mljet Island, 13 April 2011, leg. R. Ozimec, 1♀juv. (ROC); Špilja u Ogradi, Trnovo, 16 October 2011, leg. R. Ozimec, 1♀ (ROC); Tunnel Blato, Korčula Island, 18 November 2013, leg. R. Ozimec, 1♀juv. (ROC); Vilina Špilja, Ombla, Dubrovnik, 7 June 2011, leg. R. Ozimec, 1♀ (ROC). **Bosnia-Herzegovina:** Republika Srpska, Trebinje, 1♀ paratype (UL); Petrina, Trebinje, 6 June 2004, leg. D. Pavić, 1♀juv. paratype (VFPC); Zavala, 1♂juv. paratype (GTC); Gladulja, Popovo Polje, Ravno, Herzegovina, 23 August 2006, leg. M. Pavlek, 1♀juv. (ROC); Vjetrenica (entrance), Ravno, Herzegovina, 16 August 2004, leg. M. Pavlek, 1♂juv. (ROC).

*Unclear locality* (see Reitter, 1881): “Dalmatien: Castel Nuovo, Ragusa, Dricno” [Croatia: Ragusa (now Dubrovnik). – Bosnia & Herzegovina: Drieno (now Drijen, on the road Dubrovnik–Trebinje). – Montenegro: Castelnuovo (now Herceg Novi), April–May] 1880, leg. [E.] Reitter, 1♀ paratype (NHMW 13289).



**Figures 2–13:** Adult male of *Euscorpius feti*. **Figure 2.** Carapace. **Figure 3.** Telson lateral. **Figures 4–5.** Metasoma V, lateroventral (4) and ventral (5) views. **Figures 6–8.** Chela, external (6), ventral (7) and dorsal (8) views. **Figures 9–11.** Pedipalp patella, ventral (9), dorsal (10) and external (11) views. **Figures 12–13.** Pedipalp femur ventral (12) and dorsal views.

<i>Euscorpium feti</i>	♀ holotype	♂
Ratios		
Carapace anterior-posterior %	39.36–60.64	39.42–60.58
Carapace (L/W)	1.07	1.07
Carapace / patella (L)	1.08	1.08
Carapace / telson (L)	2.25	1.01
Pedipalp chela (L/W)	3.43	3.28
Metasomal segment I (L/W)	1.05	1.13
Metasomal segment II (L/W)	1.40	1.49
Metasomal segment III (L/W)	1.75	1.81
Metasomal segment IV (L/W)	2.19	2.28
Metasomal segment V (L/W)	3.65	3.83
Metasoma/ metasoma V (L)	2.92	2.90
Metasoma / carapace (L)	2.26	2.56
Pedipalp femur / patella (L)	1.09	1.09

**Table 2.** Comparison among sexes of *Euscorpium feti*, based upon selected morphometric ratios of adults. Abbreviations: length (L), width (W).

**DIAGNOSIS.** A medium-large *Euscorpium* species of total length 35–41 mm, particularly elongated and long-limbed. Colour of adults light brown to light brown-reddish, with carapace and pedipalps darker reddish. More or less expressed reticulation or marbling on carapace, metasoma and chelicerae may be present. The number of trichobothria on the pedipalp manus ventral surface is 4 (3  $V + Et_1$ ); the number of trichobothria on the pedipalp patella ventral surface usually is 11 or 12 (11 in 44 pedipalps (48.89%) and 12 in 42 pedipalps (46.67%) of pedipalps examined); the number of trichobothria on pedipalp patella external surface usually is:  $eb = 4$ ,  $eb_a = 4$ ,  $esb = 2$ ,  $em = 4$ ,  $est = 4$ ,  $et = 8$  and 7 (series  $et = 8$  in 49 (54.44%) of pedipalps examined and  $et = 7$  in 40 (44.44%) of pedipalps examined). Trichobothria  $et_2$  and  $est_2$  on pedipalp patella external surface are located in a very proximal position; trichobothrium  $et_2$  often is proximal or to the same level of  $est_3$  but sometimes may be distal to it. The pectinal teeth count is 9 in 33 (71.74%) and 8 in 11 (23.91%) in males and usually 7 in females 7 in 32 (72.73%) and 8 in 10 (22.73%) of pectines examined). Metasomal segment I longer than wide in males and usually longer than wide or as long as wide in females; average metasoma I length/width ratio 1.131 in males and 1.031 in females. Pedipalp chela length/width ratio is 3.21. Dorsal patellar spur highly developed. Pedipalp femur longer than patella; femur length/patella length ratio is 1.082. Carapace usually longer than wide; average carapace length/width ratio 1.067; average distance from the center of median eyes to anterior margin of the carapace is 39.73% of the carapace length. Average distance from the center of median eyes to posterior margin of the carapace is 60.27% of the carapace length. Average ratio of metasoma/carapace length 2.517 in males and 2.225 in females.

**DESCRIPTION OF THE ADULT MALE. Coloration.** Whole colour light orange-brown with carapace darker, reddish; tergites outline lighter; sternites greyish/brownish with outline and lateral area very lighter, whitish/ light brownish; pectines

and genital operculum whitish; chelicerae yellowish/light brownish with darker fingers, area distal with dark marbling; telson yellowish/ orange, longitudinal dark line and dark reddish aculeus tip; darker carinae, specially the internal carinae of pedipalps, blackish.

**Carapace.** Length 5.64, posterior width 5.27; fine granulation on whole surface but it becomes gradually larger toward the lateral area, especially in anterior lateral area, from median eyes to half than carapace length; anterior edge from slight granulate to granulate and more or less straight; very deep posterior median and posterior lateral furrows, the latter two combine to form two protuberances at the posterior margin; two pairs of lateral eyes (with a larger anterior eye), and a pair of median eyes, situated anterior of the middle; length from the center of median eyes to anterior margin is 39.37% of carapace length; length from the center of median eyes to posterior margin is 60.63% of the carapace length.

**Mesosoma.** Tergites very finely and homogeneously granulated; sternites finely punctated except the last sternite, which is finely granulated; small spiracles inclined to about 45° downward towards outside; area of overlap between sternites very pale.

**Metasoma.** All the segments longer than wide. Dorsal carinae on segments I–IV granulated, the last distal granules are more pronounced; dorsolateral carinae on segments with some granules proximally or smooth and obsolete; ventrolateral carinae smooth on segments I–IV, granulated and slightly serrated on segment V; ventromedian carina absent on the segments I–IV, granulated on segment V; intercarinal spaces very finely granulated on dorsal surface, mostly smooth on the other surfaces of the segments I–IV, except the V segment which is finely granulated.

**Telson.** Vesicle with a few scattered, very small granules to rough, with ventral setae of different size, especially near the vesicle/aculeus juncture.

**Pectines.** Tooth count 9/9; middle lamellae count 5/5; several microsetae on marginal lamellae, middle lamellae and fulcra.

**Genital operculum.** The genital operculum is formed by two subtriangular sclerites partially divided with genital papillae protruding; a few microsetae are present.

**Sternum.** Pentagonal shape, type 2; more or less as long as wide, with a deep posterior emargination.

**Pedipalps.** Coxa and trochanter with tuberculated carinae. Femur: dorsal internal carinae tuberculated; dorsal external carinae formed by tubercles slightly spaced; external median carinae serrated; ventral internal carinae tuberculated; ventral external carinae formed by spaced tubercles, well-formed only in the proximal half; anterior median formed by spaced, nearly conical tubercles, varying in size, of which three bear a macroseta each; dorsal intercarinal spaces uniformly granulated; ventral intercarinal spaces not uniformly granulated, with larger granules near ventral internal carinae. Patella: dorsal internal carinae tuberculated; dorsal external carinae crenulated; ventral external carinae crenulated; ventral internal carinae tuberculated to lightly serrated; dorsal intercarinal surface finely granulated, with larger granules in distal area; ventral intercarinal surface with few scattered minute granules, especially near ventral

Country	Cave	Coordinates (WGS84)	Altitude (m)	Microregion	Macroregion
Croatia	Deukalion Jama	42°57'21.37"N 17°05'52.72"E	88	Korčula Island	Dubrovnik
Croatia	Durovića Jama	42°33'36.54"N 18°15'48.77"E	149	Konavle	Dubrovnik
Bosnia & Herzegovina	Gladulja Špilja	42°50'55.08"N 17°59'35.80"E	269	Popovo Polje	Herzegovina East
Croatia	Gorska Jama	42°55'37.16"N 17°25'29.46"E	200	Pelješac Peninsula	Dubrovnik
Croatia	Jama pod Sv. Spasom	42°43'54.68"N 17°32'32.77"E	134	Mljet Island	Dubrovnik
Croatia	Jama u šumi uvale Bjeajka	42°45'55.12"N 17°23'11.36"E	12	Mljet Island	Dubrovnik
Croatia	Male Ponte Jama	42°45'41.29"N 17°25'51.12"E	260	Mljet Island	Dubrovnik
Croatia	Močiljska Špilja	42°41'20.90"N 18°04'19.23"E	410	Dubrovnik coast	Dubrovnik
Croatia	Pišurka Špilja	42°57'34.20"N 17°07'45.58"E	47	Korčula Island	Dubrovnik
Croatia	Špilja iznad crkvice Gospe od Luga	42°31'38.36"N 18°20'01.72"E	99	Konavle	Dubrovnik
Croatia	Špilja kod Nerezinog dola	42°45'30.66"N 17°26'09.78"E	199	Mljet Island	Dubrovnik
Croatia	Špilja u Ogradi	42°48'06.99"N 17°51'58.61"E	262	Dubrovnik coast	Dubrovnik
Croatia	Špilja za Gromačkom vlakom	42°44'36.72"N 18°01'38.65"E	605	Dubrovnik coast	Dubrovnik
Croatia	Tunel Blato-Bristva	42°56'48.19"N 16°46'31.09"E	15	Korčula Island	Dubrovnik
Croatia	Vilina Špilja-Ombra source system	42°40'37.97"N 18°08'10.44"E	120	Dubrovnik coast	Dubrovnik
Bosnia & Herzegovina	Vjetrenica Špilja	42°50'45.36"N 17°59'01.71"E	268	Popovo polje	Herzegovina East
Croatia	Zaspila Jama	42°56'36.16"N 17°06'58.49"E	160	Korčula Island	Dubrovnik

**Table 3.** List of cave localities of *Euscorpium feti*

internal carinae. Dorsal patellar spur highly developed. Chela: particularly elongated and long-limbed, with long fingers. Fixed finger with marked notch in correspondence with the lobe on movable finger. Chelal carina *D1* is distinct, strong, dark and from smooth to slightly crenulated; *D4* is rounded and rough; *V1* is distinct, strong, dark and crenulated; *V3* rounded, dark with small and scattered granules; external carina granulated; intercarinal tegument rough to finely granulated with very minute scattered granules. Typical *Euscorpium* chela finger dentition.

**Trichobothria.** Chela: trichobothria on the pedipalp manus ventral surface is 4/4 ( $V_{1-3} + Et$ ). Patella: *Pv*: 12/12; patella external (*Pe*):  $et = 8/8$ ,  $est = 4/4$ ,  $em = 4/4$ ,  $esb = 2/2$ ,  $eb_a = 4/4$ ,  $eb = 4/4$ . Trichobothria  $et_2$  and  $est_2$  on pedipalp patella external surface are located in a very proximal position; trichobothrium  $et_2$  is same level of  $est_3$ . Femur: trichobothrium *d* is slightly proximal to *i*, while the trichobothrium *e* is distal to both *d* and *i*; it is situated on dorsal external carina but is shifted toward its dorsal surface.

**Legs.** Legs with two pedal spurs; no tarsal spur; ventral row of tarsus III with a total of 9 spinules, of increasing size from proximal to distal, ending with a slightly decentralized spinule; 3 flanking pairs of tarsal setae adjacent to the ventral spinule row. Granulation present on dorsal and ventral surface of leg femora, it is mostly marked and dark ventrally; patella with dark marbling.

**Chelicerae.** Smooth, with dark marbling on anterior part, with darker apical portion of denticles. Movable finger: the dorsal distal denticle is very smaller than the ventral distal denticle; ventral edge is smooth with brush-like setae on the inner part; dorsal edge has five denticles: one large distal, one medium and one small subdistal, one large median and a small basal. Fixed finger: it has four denticles: one distal, one subdistal, one median and one basal, the last two in a fork arrangement; the internal surface has brush-like setae.

**Hemispermatothore.** It has a well-developed lamina tapered distally; well-developed basal constriction present; truncal flexure present; median projection with primary and secondary acuminate processes, of which the secondary acuminate process is formed by three weakly marked lobe; internal projection distally with 7 times in its crown, some forked.

**TRICHOBOTHRAL AND PECTINAL TEETH COUNT VARIATION.** The variation observed in 45 examined specimens (23 males, 22 females) is given below (left/ right asymmetry not specified). Pectinal teeth in males ( $n=23$ ): 8/8 (4), 8/9 (3), 9/9 (14), 9/10 (2); in total, 8 in 23.91% and 9 in 71.74%; mean = 8.80.

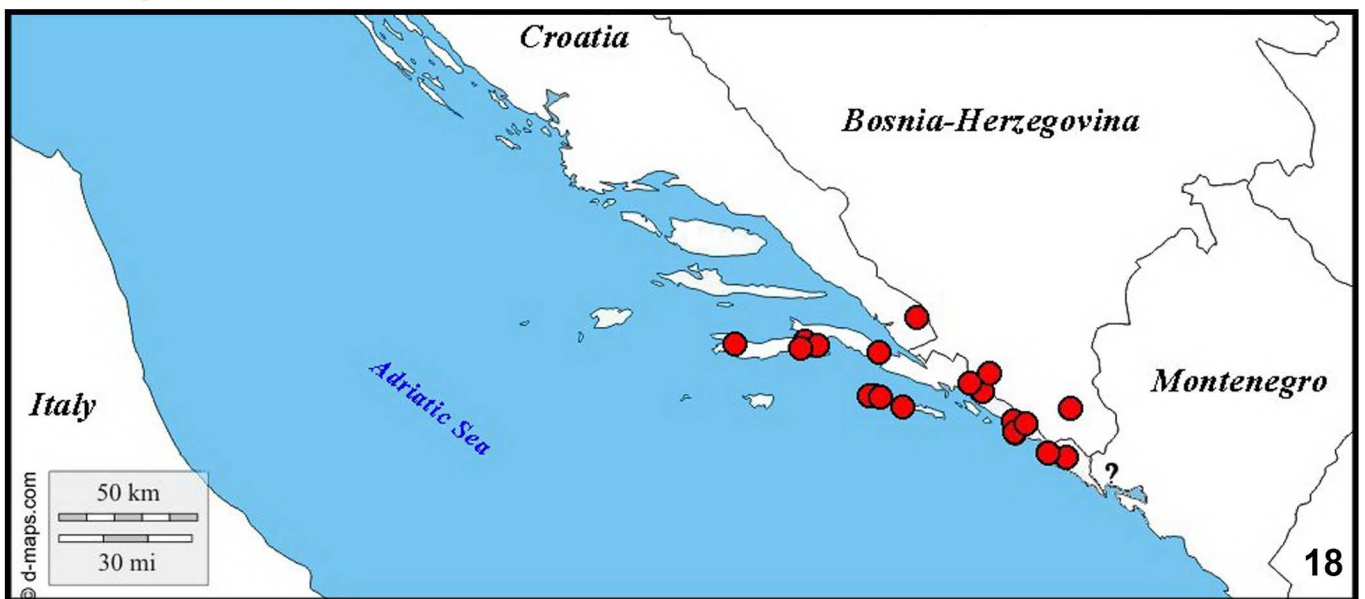
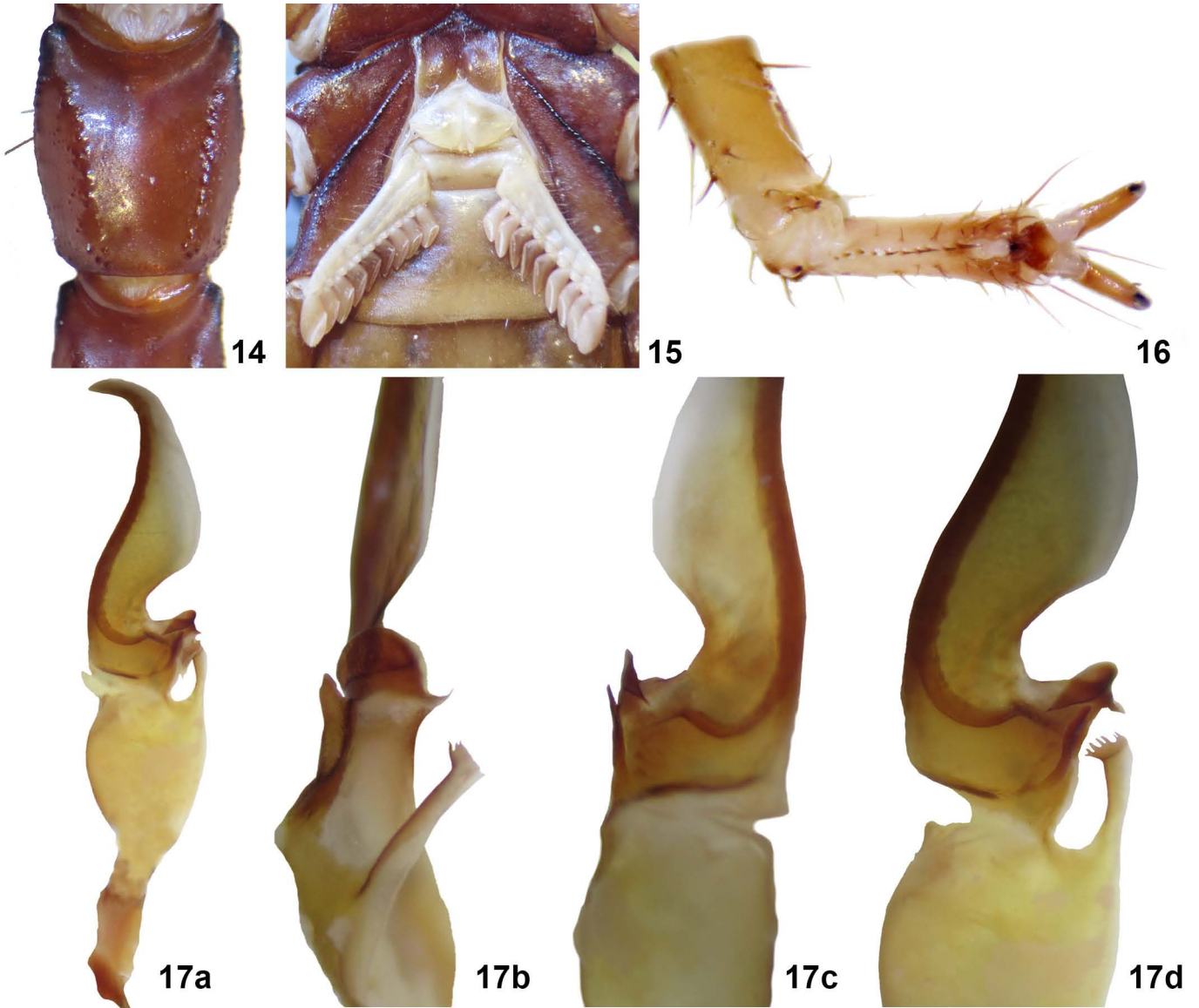
Pectinal teeth in females ( $n=22$ ): 7/7 (14), 7/8 (4), 8/8 (3), 9/9 (1); in total, 7 in 72.73% and 8 in 22.73%; mean = 7.31.

Pedipalp patella trichobothria *Pv* ( $n=45$ ): 10/11 (2), 11/11 (13), 11/12 (16), 12/10 (1), 12/12 (12), 13/12 (1); in total, 11 in 48.89% and 12 in 46.67%; mean = 11.45.

Pedipalp patella trichobothria *Pe* ( $n=45$ ):  $et = 7/6$  (1),  $7/7$  (13),  $7/8$  (13),  $8/8$  (18); in total, 7 in 44.44% and 8 in 54.44%; mean = 7.53;  $est = 3/4$  (1),  $4/4$  (42),  $4/5$  (2);  $em = 2/4$  (1),  $3/4$  (1),  $4/4$  (43);  $esb = 2/2$  (45);  $eb_a = 3/4$  (1),  $4/4$  (44);  $eb = 4/4$  (45).

**SEXUAL DIMORPHISM.** Largely the same as in most *Euscorpium*. The male has a much more swollen telson than the female. The metasoma is longer in males in proportion to the total length (total length/ metasoma length ratio is < 1.55 in males and > 1.60 in females). The males have the fixed finger of chela with marked notch in correspondence of the lobe on movable finger while the females have the notch/lobe poorly marked, almost obsolete. A higher number of pectinal teeth is observed in males (9 in 71.74% and 8 in 23.91% of pectines examined) than in females (7 in 72.73% and 8 in 22.73%). The males have the genital operculum with genital papillae protruding. Males in general are more granulated.





Figures 14–18: Figures 14–17: Adult male of *Euscorpius feti*. Figure 14. Metasoma I. Figure 15. Sternopectinal area. Figure 16. Tarsomere of leg III, ventral view. Figure 17. Hemispermatophore. Figure 18: Localities of the examined specimens of *Euscorpius feti* (red circles).

DISTRIBUTION. Western Balkans: Bosnia & Herzegovina (south), Croatia (south), ?Montenegro (northwest) (see map in Fig. 18).

### Ecological notes on the specimens collected in caves

The biological, and especially biospeleological, studies conducted by the second author in Croatia from 1987 to present, resulted in collecting many scorpion specimens in the surface habitats, but also underground, in caves and similar habitats (mines, underground tunnels). After a detailed taxonomic analysis of the collected material, performed by the first author, a list of cavernicolous sites for *Euscorpius feti* can be presented, including 17 caves (Table 3), which are located in the mainland as well as in the adjacent Adriatic islands. It is obvious that *E. feti* has a significant affinity to cave habitats in its predominantly karstic geographic range, and due to this it is necessary to present here some basic ecological data.

The geographic range of *E. feti* occupies the Mediterranean region of the Dinaric Alps (Dinarides), between the Neretva River in the northwest to the Konavle region in the southeast; it stretches to still warm sub-Mediterranean eastern Herzegovina, together with the Pelješac Peninsula and two south Dalmatian islands, Korčula and Mljet. Most probably this species inhabits also the Elaphite Islands in Croatia (Jakljan, Šipan, Lopud, Koločep, Lokrum) and Boka Kotorska (the Bay of Kotor) area in the western Montenegro.

The Dinaric Alps range belongs to the South Dinaric biogeographical region (Ozimec, 2009), with the highest cave biodiversity in the world, including newly discovered rich cave populations of *Euscorpius feti*. Therefore, *E. feti* can be defined as a South Dinaric endemic and subtroglophilic species.

Specimens of *Euscorpius feti* have been found in cave entrances, usually approximately down to 20 m depth, at the altitudes from 12 m a.s.l. (Jama u šumi uvale Bječajka) on the Mljet Island, to about 605 m a.s.l. (Špilja za Gromačkom vlakom) in the region of Dubrovačko Primorje. Some of the caves are very large, longer than one kilometer: Vjetrenica (7200 m), Vilina Špilja-Ombra source system (3063 m), Špilja za Gromačkom vlakom (2407 m), Močiljska Špilja (1034 m), but specimens are regularly found in the first entrance chambers only, and do not penetrate deeper. Other caves and pits belong to medium or small caves, but the deepest findings of *E. feti* occurred in the Pišurka Cave on the Korčula Island.

**Cave Habitats.** Some of specimens were found in a cave habitat classified as “semi-caves and entrance part of caves” (EUNIS habitat code H.1.1.; NKS H.1.1.1.), but most were collected in “caves and cave systems with troglophilic invertebrates” (EUNIS habitat code H.1.2.; H.1.25; NKS H.1.1.5.). In Vilina Špilja-Ombra source system, *E. feti* occurred in the habitat classified as “Caves and cave systems with subtroglophilic vertebrates” (EUNIS habitat code H.1.22; NKS H.1.1.3.), in a chamber with large bat colonies, feeding on a rich guanophilic fauna (Ozimec, 2014). Most

interesting findings are in the habitat classified as “Caves and cave systems with troglobitic invertebrates” (EUNIS habitat code H.1.23; NKS H.1.1.4.), as well as in the Pišurka Cave on Korčula Island, where specimens can be regularly found in the last, deepest cave chamber, 84 m long and at the depth 31 m from the entrance, together with many troglobitic taxa endemic to deep cave habitats.

**Microclimate.** During biospeleological studies in all caves, the basic microclimate parameters were measured: air temperature, air humidity, substrate temperature, water temperature, relative humidity, wind speed, CO<sub>2</sub> concentration, and illumination. Most of habitats have the standard environment of total darkness, moderate temperature, high humidity, and no wind. Most variable temperature range was measured in cave locations where *E. feti* occurs in the range from 14.2°C (Špilja za Gromačkom vlakom) to 17.4°C (Đurovića Jama) for the air, and from 12.8°C (Špilja za Gromačkom vlakom) to 17.2°C (Đurovića Jama) for the cave substrate. In a regularly populated last chamber in the Pišurka Cave, average measurements are 15.2°C for air and 14.8°C for substrate.

**Bionomics.** Scorpions were usually collected under stones, on the floor, some juvenile specimens also were under stones, but clinging to the stone surface. In the Močiljska Špilja cave, some specimens were found in small stone crevices in cave walls. Sometimes, scorpions occurred directly on the cave walls or roofs, most probably hunting.

**Accompanying cave fauna.** Many troglophilic and troglobitic animals inhabit the same caves and cave habitats together with *Euscorpius feti*. The following terrestrial taxa can be found there: Gastropoda: *Aegopis*, *Hypnophila*, *Meledella*, *Spelaeoconcha*, *Vitrea*; Isopoda: *Aegonethes*, *Alpioniscus*, *Cyphophthalmus*, *Troglocyphoniscus*, *Typhlarmadillidium*; Diplopoda: *Apfelbeckia*, *Brachydesmus*, *Typhloiulus*; Chilopoda: *Lithobius*, *Eupolybothrus*; Araneae: *Barusia*, *Meta*, *Nesticus*, *Folkia*, *Histopona*, *Stalagtia*, *Sulcia*, *Tegenaria*, *Typhloniphia*; Opiliones: *Cyphophthalmus*, *Dycranolasma*, *Nelima*, *Travunia*, *Trogulus*; Pseudoscorpiones: *Acantocreagris*, *Chthonius*, *Neobisium*, *Roncus*; Diplura: *Stygiocampa*; Collembola: *Verhoefiella*; Coleoptera: *Anthroherpon*, *Bryaxis*, *Dalmatiolla*, *Laemostenus*, *Nonveillera*, *Speonesiotes*, *Troglamauropis*; Orthoptera: *Dolichopoda*, *Grylomorpha*, *Troglophilus*; and many others, but with no any other scorpion taxa.

Several *Euscorpius* species have been found in caves, e.g. *E. aquilejensis* (C.L. Koch, 1837), *E. birulai* Fet et al., 2014, *E. giachinoi* Tropea et Fet, 2015, and *E. feti* Tropea, 2013 (Fet et al., 2014; Tropea, 2013a; Tropea & Fet, 2015). All these species also clearly have more elongated features, more long-limbed than most of the other species of *Euscorpius*. In addition, many *Euscorpius* species are often found in the garages, basements, or other human constructions, which could be considered a sort of artificial caves. Thus, it is quite possible that some *Euscorpius* species are more or less troglophilic, opportunistic taxa, and, where an opportunity presents itself, spend part or all of their lives inside a cave or a similar habitat, as does *E. feti*.

## Acknowledgments

We would like to thank especially the specimen collectors (alphabetically): D. Basara, M. Cukrov, L. Đud, A. Kirin, D. Ozimec, M. Pavlek and M. Vojinović. We also would like to thank K. Dorp, V. Fet, C. Hörweg, R. Kranjčev, M. Mei, P. Pantini, M. Uliana, and M. Valle for the specimens they have provided to G.T., and an anonymous reviewer for the valuable comments.

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