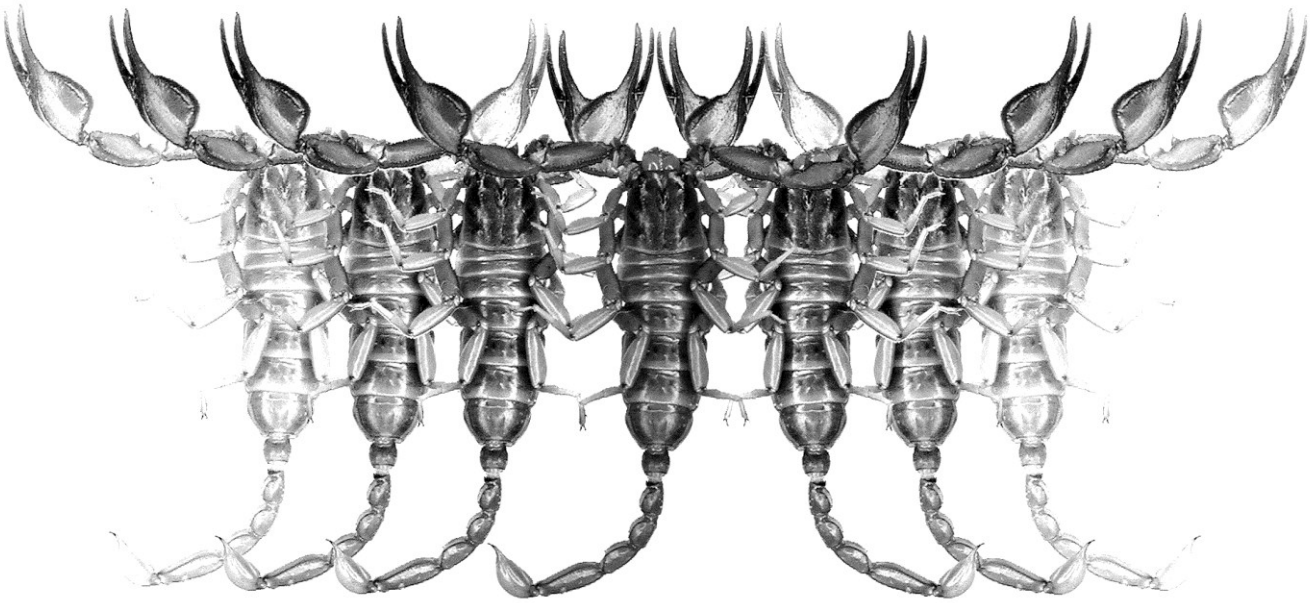
Euscorpius

Occasional Publications in Scorpiology



Three More Species of *Euscorpius* Confirmed for Greece (Scorpiones: Euscorpiidae)

Victor Fet, Michael E. Soleglad, Aristeidis Parmakelis, Panayiota Kotsakiozi & Iasmi Stathi

September 2013 — No. 165

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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).

Euscorpius is located at: **http://www.science.marshall.edu/fet/Euscorpius**
(Marshall University, Huntington, West Virginia 25755-2510, USA)

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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/.

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Euscorpius — Occasional Publications in Scorpiology. 2013, No. 165

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Summary

In Greece, scorpion genus *Euscorpius* has been insufficiently studied. Taxonomy of several species and subspecies has been inconsistent and confusing. We provide new morphological data and redescriptions of type specimens of three "old" taxa, described from Greece and formerly listed under a "catch-all" taxon *Euscorpius carpathicus*. We elevate to, or confirm at species status: *Euscorpius scaber* Birula, 1900 (type locality: Mt. Athos), *E. candiota* Birula, 1903 (type locality: Heraklion, Crete), and *E. ossae* Di Caporiacco, 1950, **stat.n.** (type locality: Mt. Ossa, Thessaly). Species-level separation of these taxa is also confirmed by multiple species delimitation methods implemented on the phylogenetic data generated using four different DNA markers.

Introduction

A number of "old" species described in the genus *Euscorpius* Thorell, 1876 across the Mediterranean, largely has been synonymized by the 1970s; see Fet & Soleglad (2002) for a detailed history of earlier morphological study of *Euscorpius*. From Greece, includeing many islands, many authors in the past have reported *Euscorpius carpathicus* (L., 1767) or its subspecies (Kinzelbach, 1975, 1982; Kritscher, 1993; Stathi & Mylonas, 2001). The review of the Aegean area scorpion fauna by Fet & Braunwalder (2000) indicated that taxonomy of *E. carpathicus* required a complete re-assessment. Initial insights into morphology of forms associated with subgenus *Euscorpius* s.str. from Greece were offered by Fet (1986, 2000). Fet & Soleglad (2002) and Fet et al. (2003a) further explored this taxonomic complex separating species with clearly derived trichobothrial patterns, among them *E. hadzii* Di Caporiacco, 1950, and *E. sicanus* (C.L. Koch, 1837) from Greece. At the same time, they revealed existence of "cryptic" species exhibiting very similar, "standard", and largely invariable trichobothrial patterns earlier lumped under *E. carpathicus*, among them *E. koschewnikowi* Birula, 1900, from Greece (Mt. Athos). Status of many other "standard" Greek populations, however, remained unclear (Kaltsas et al., 2008; Vignoli & Salomone, 2008). Most recently, two more "standard" pattern species were confirmed for Greek islands: *E. corcyraeus* Tropea et Rossi, 2012 (Corfu), and *E. avcii* Tropea et al., 2012 (Samos; Parmakelis et al., 2013).

Our ongoing investigation of many populations from Greece using multiple DNA markers (Parmakelis et al., in press) allowed revealing a diverse set of species, many of them undescribed. Here, we address and redescribe, based on type specimens, three "old" taxa described from Greece and formerly listed under "*Euscorpius carpathicus*". Species-level divergence of these taxa is also supported by multiple DNA markers (Parmakelis et al., in press). We confirm at species status, as originally described, two "old" species: *Euscorpius scaber* Birula, 1900 (type locality: Mt.

Athos) and *E. candiota* Birula, 1903 (type locality: Crete). We also elevate to species status subspecies *E. carpathicus ossae* Di Caporiacco, 1950 (type locality: Mt. Ossa).

With this study, the total number of *Euscorpius* species formally confirmed for Greece, is raised to 10 (*E. avcii*, *E. candiota*, *E. corcyraeus*, *E. hadzii*, *E. italicus*, *E. koschewnikowi*, *E. naupliensis*, *E. ossae*, *E. scaber*, and *E. sicanus*). Our data (in preparation) indicate that a number of other species-level forms, most of them undescribed endemics, are also present in Greece, especially on its Aegean islands.

Methods and Material

Abbreviations

MNHNP, Muséum national d'Histoire Naturelle, Paris, France;
MZUF, Museo di Storia naturale dell'Università di Firenze, Sezione di Zoologia "La Specola", Florence, Italy;
NHMC, Natural History Museum of Crete, University of Crete, Heraklion, Crete, Greece;
NHMW, Naturhistorisches Museum Wien, Vienna, Austria;
NMNHS, National Museum of Natural History, Sofia, Bulgaria;
SMF, Naturmuseum Senckenberg, Frankfurt am Main, Germany;
VFPC, private collection of Victor Fet, Huntington, West Virginia, USA.
ZISP, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia;
ZMH, Zoologisches Museum Hamburg, Hamburg, Germany;
ZMMSU, Zoological Museum of Moscow State University, Moscow, Russia.

Material Studied

We studied 219 specimens of three species redescribed in this paper, including all existing type material (for *E. candiota*, only type series was studied). Detailed list of material with label data is given under each species.

DNA Analysis and Species Validation

Validity of three redescribed species was supported by our molecular phylogenetic study of *Euscorpius* populations across Greece (Parmakelis et al., in press). All DNA work was performed in the University of Athens by P.K. and A.P. For details on molecular and phylogenetic analysis, see Parmakelis et al. (in press). Several methods of species delimitation and a species validation method were employed in Parmakelis et al. (in press) based on the phylogeny inferred using sequence data from one nuclear and three mtDNA loci. In all the species delimitation methods, the *Euscorpius* species described herein, were always strongly supported as corresponding to independent evolutionary units. In the molecular phylogeny study, for *E. scaber*, we analyzed specimens from Thasos Island; and for *E. ossae*, topotypic specimens from Mt. Ossa. *E. candiota* was represented by specimens originating from the satellite islands of Crete. These specimens have high sequence similarity to mainland Cretan specimens (not included in the molecular study). A number of populations related to *E. candiota* were also analyzed, including *E. corcyraeus* from Kerkyra (Corfu) Island recently described by Tropea & Rossi (2012).

In a resulting phylogeny (Parmakelis et al., in press), all three species redescribed in this work are placed within the nominotypic subgenus *Euscorpius* s.str. Two of the redescribed taxa, *E. scaber* from northeastern Greece and *E. ossae* from Thessaly, appear to be sister species, while *E. candiota* is more closely related to *E. corcyraeus* and populations from Kythira and Peloponnese that belong to yet undescribed species.

Systematics

Genus ***Euscorpius*** Thorell, 1876

Subgenus ***Euscorpius*** Thorell, 1876, s.str.

Euscorpius scaber **Birula, 1900**

(Figures 2–20; Tables 1–2)

Euscorpius scaber Birula, 1900: 18–19.

REFERENCES:

Euscorpius scaber: Birula, 1917a: 105, 129, 198, 211; Birula, 1917b: 167; Werner, 1938: 173; Fet, 1986: 5 (under question).

Euscorpius carpathicus s.str.: Kinzelbach, 1975: 30, 32 (in part; Thasos; Mt. Athos).

Euscorpius carpathicus scaber: Soleglad, 1976: 299; Fet & Soleglad, 2007: 419; Tropea & Rossi, 2012: 27, 30; Tropea et al., 2012: 75.

Euscorpius carpathicus: Kinzelbach, 1982: 61 (in part: Thasos); Fet & Sissom, 2000: 358 (in part: Mt. Athos).

Euscorpius carpathicus carpathicus: Kritscher, 1993: 384 (in part: Chalkidiki; Mt. Athos; Thasos).

Euscorpius mesotrichus: Kritscher, 1993: 386 (in part; Chalkidiki).

Euscorpius "carpathicus" scaber: Fet et al., 2004: 52; Kaltsas et al., 2008: 234.

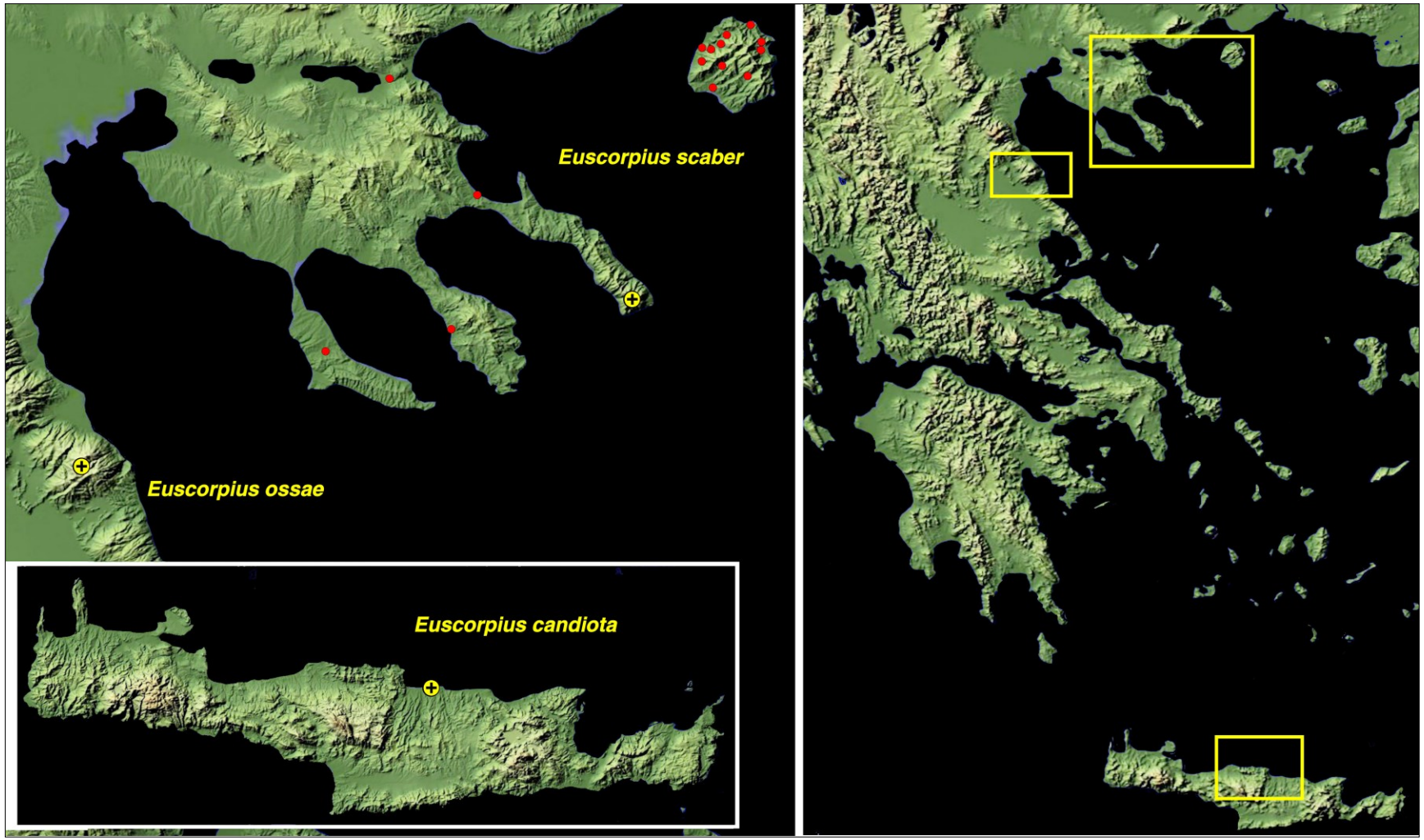


Figure 1: Map showing type localities and known distribution of *Euscorpius scaber* Birula, 1900, *E. candiota* Birula, 1903, and *E. ossae* Di Caporiacco, 1950. Type localities (yellow icon with '+') and other distributions (red icons, *E. scaber* only) are shown. Maps on left show detail of the species' type localities and distribution. Map on right shows Greece proper and the island of Crete with the ranges of the three species indicated by yellow rectangles.

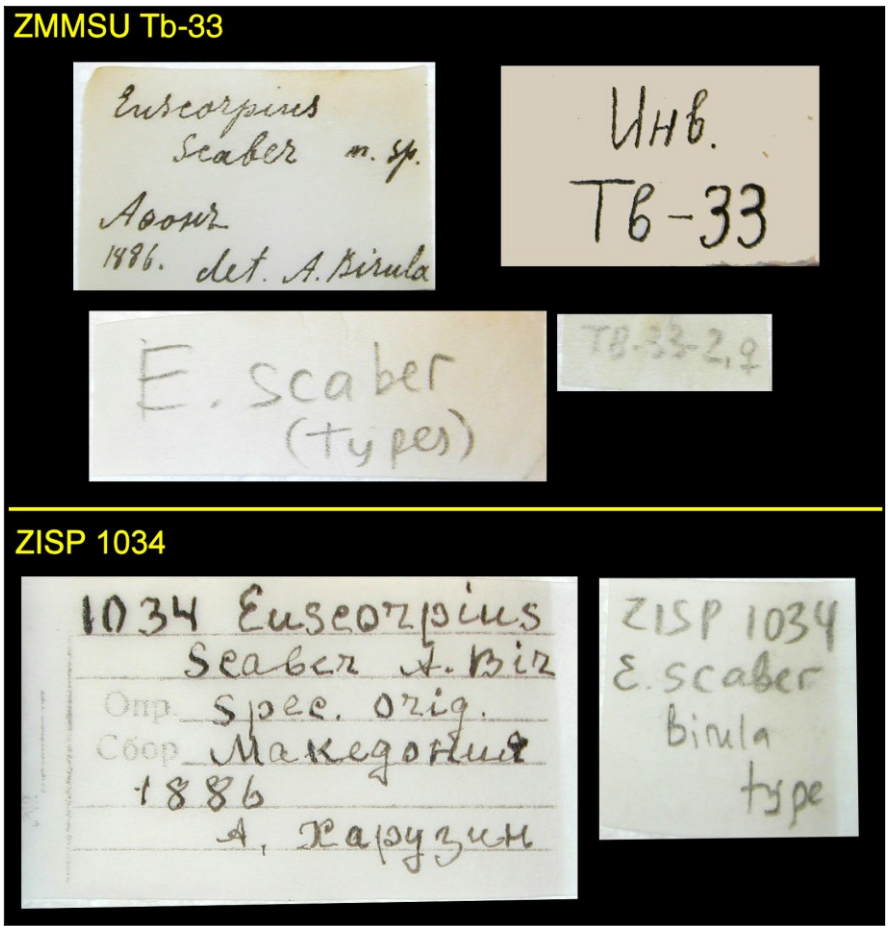


Figure 2: Original type series labels of *Euscorpius scaber* Birula, 1900. The type series material is contained in two vials: ZMMSU Tb-33 (top) with lectotype male and six paralectotypes and four labels, and ZISP 1034 (bottom) with paralectotype female and two labels.

Type material: Lectotype ♂ (designated here): **Greece**: Chalkidiki Peninsula, Mount Athos, 7 (19) May 1886, leg. A. N. Kharuzin (ZMMSU Tb-33) (Fet, 1986). See Fig. 2 for the labels from the type series vial (ZMMSU Tb-33). Birula (1900: 18) mentioned only 5 specimens in ZMMSU collection, among them one ♂ with 11/11 pectinal teeth (our lectotype) and one ♀ with 8/8 teeth.

Geographic range. Greece: *Mount Athos*; *Central Macedonia*: Chalkidiki, Thessaloniki; *East Macedonia and Thrace*: Thasos Island. See map in Fig. 1.

History of Study

Syntypes of *E. scaber* were brought to Russia in 1886 by A.N. Kharuzin from the Greek Orthodox monastic community of Mt. Athos (Agion Oros), Chalkidiki Peninsula. Birula (1900) described a new species along with another, distinctly different species, *E. koschewnikowi* Birula, 1900 (see Fet & Soleglad, 2002, for a detailed redescription of the latter). *Euscorpius scaber* was largely forgotten in reviews until Kinzelbach (1975) listed it, under question, as a synonym of his "*E. mesotrichus*". Fet (1986) published pectinal and trichobothrial statistics of Birula's types from ZISP and ZMMSU but was unsure of their taxonomic status. Birula (1917a: 212) wrote "Unfortunately, we have no information whatever about the scorpion fauna on bigger islands of the northern Aegean Sea, e.g. Thasos, Lemnos…" Only many years later, Kritscher (1993) first collected a very large series on Thasos Island, listed as *E. carpathicus*. Here, we identify this Thasos population as *E. scaber* Birula, 1900.

Fet & Sissom (2000) indicated that Fet (1986) synonymized *E. scaber* with *E. carpathicus*; however, in fact Fet (1986) only noted that its status (species or subspecies) was still uncertain. This species immediately differs from most other forms previously included under "*carpathicus*" in a very high male pectinal teeth number and pronounced metasomal granulation and carination, all observed by Birula (1900) in his detailed original description. Birula (1900: 16; 1917a: 212), who assigned high value to metasomal carination, contrasted *E. scaber* with its heavy carination ("all seven carinae well developed and granulated"), to *E. carpathicus* (*sensu lato*) with less pronounced carinae, and further to *E. koschewnikowi*, with obsolete carinae (as well as forms related to *E. germanus*, now subgenus *Alpiscorpius*).

Later (Birula, 1917b: 167–168), he even introduced formal names for this three groups as "sections" (Sectio) of subgenus *Euscorpius* s.str.: *Scabri*, *Carpathici*, and *Germani*. These "sections", which we today would call "complexes" or "species groups", have not been used since, and are not available nomenclatural units under the current Code.

As already mentioned, our species delimitation approaches using sequence data (Parmakelis et al., in press) validated *E. scaber* as a distinct evolutionary entity, which is here further confirmed by morphological description.

Diagnosis. Small (below 30 mm), brown in color species; legs and chelicerae lighter; slight variegated patterns on carapace. Species heavily granulated (hence the name "*scaber*", scabrous). Pronounced metasomal carinae, most with some granulation, including the single ventromedian carinae on segments II–IV. Strong scalloping on male chela. Pedipalp patellar external trichobothria numbers: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 4, *est* = 4 and *et* = 5–6 (usually 6); ventral aspect of patella 8. Pectinal tooth counts: females 7–8 (usually 8), males 10–11; the latter is an unusually high number for subgenus *Euscorpius* s.str.

MALE. The following description is based on the lectotype male from Mt. Athos, Greece. Measurements of the lectotype, two paralectotypes, and a specimen from Thasos are presented in Table 2. See Figures 3–6 for dorsal and ventral views of the male lectotype and two female paralectotypes.

COLORATION. Carapace, chelae, and patellae dark brown; femur, tergites, metasoma, and telson brown; legs and chelicerae light brown; leg coxae and sternum dark brown; genital operculum, pectines, basal piece, and sternites yellow. Slight variegated patterns on carapace.

CARAPACE (Fig. 7, paralectotype female). Anterior edge slightly convex with a very narrow slight median indentation; slight granulation on lateral edges below lateral eyes, otherwise, smooth and lustrous, lacking any indication of carinae. There are two lateral eyes. Median eyes and tubercle are small to medium in size, positioned slightly anterior of middle with the following length and width ratios: 0.423 (anterior edge to medium tubercle middle / carapace length) and 0.167 (width of median tubercle including eyes / width of carapace at that point).

MESOSOMA. Tergites I–VII essentially smooth; tergite VII lacking lateral and median carinal pairs. Sternites III–VII smooth and lustrous; VII lacking lateral and median carinae. Stigmata are very small, narrow elliptical.

METASOMA (Fig. 12, paralectotype female). Segment I slightly wider than long in ratio 0.967. Segments I–IV: dorsal carinae are granulate; dorsolateral carinae weak to obsolete with slight granulation proximally on I–III, smooth proximally on IV; lateral carinae obsolete; ventrolateral carinae slightly granulated; single ventromedian carina obsolete on I, slightly visible and smooth on II, irregularly granulated on III, and granulated on IV. Segment V: dorsolateral carinae rounded and granulate; lateral carinae obsolete, ventrolateral and ventromedian carinae crenulate to serrulate. Anal arch with 15 small granules. Intercarinal areas generally smooth except for the ventral surface of segment V which is covered with scattered granules.

TELSON (Fig. 15, paralectotype female Fig. 8). Vesicle swollen and elongated, with short highly curved aculeus. Vesicle essentially void of granules, very lustrous. Vesicular tabs smooth.

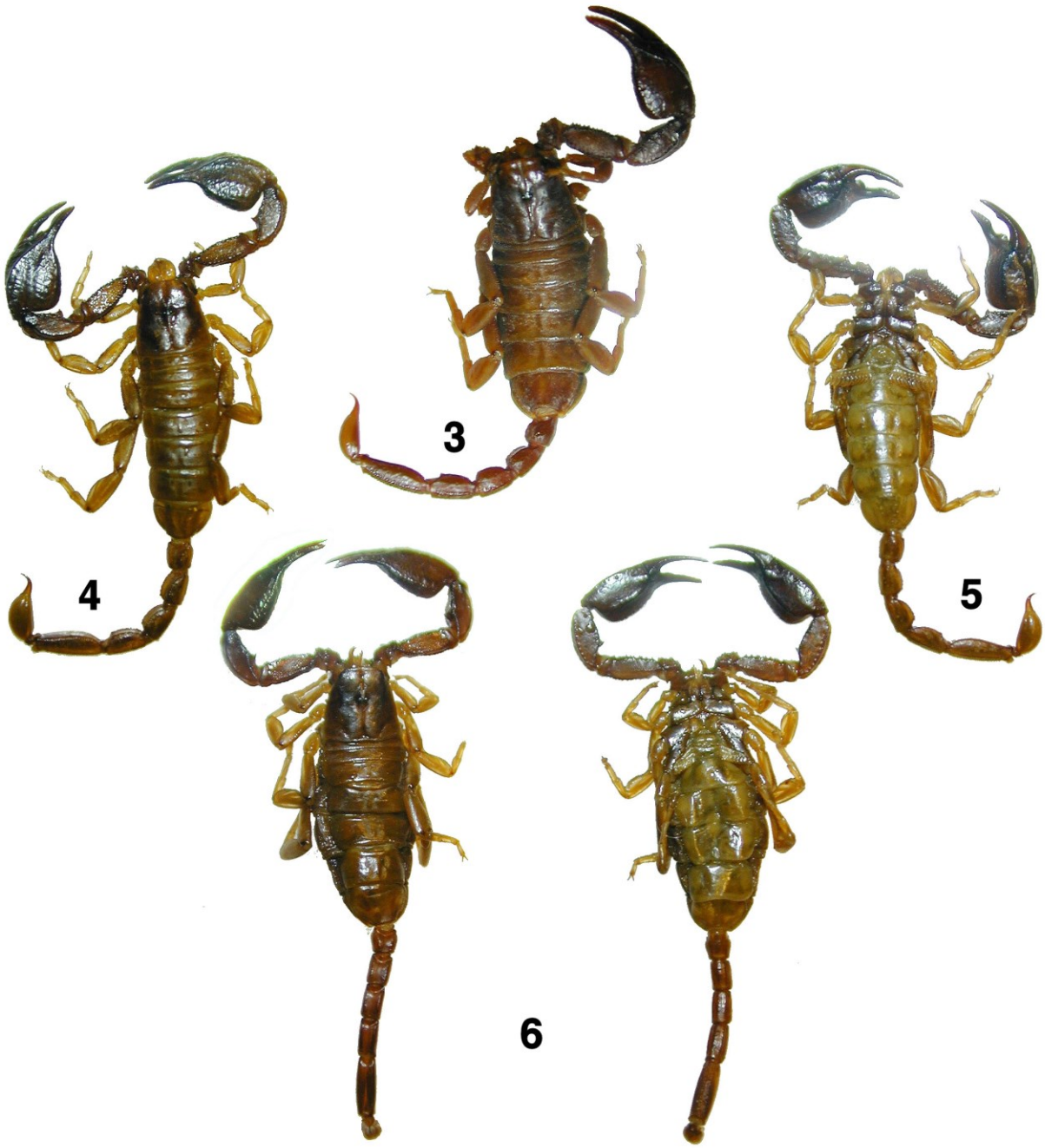
PECTINES (Fig. 17, paralectotype female Fig. 13). Medium-developed segments exhibiting length / width ratio 2.047 (length taken at anterior lamellae / width at widest point including teeth). Sclerite construction complex, three anterior lamellae and 6/7 middle lamellae; fulcra of medium development. Teeth number 11/11. Sensory areas developed along distal aspect on all teeth, including basal tooth. Basal piece large, with subtle shallow indentation along anterior edge, length / width ratio 0.500.

GENITAL OPERCULUM (Fig. 17, paralectotype female Fig. 13). Sclerites triangular, separated for the entire length. Genital papillae present, protruding significantly between the sclerites (see discussion on female below).

STERNUM (Fig. 17, paralectotype female Fig. 13). Type 2, posterior emargination present, modestly-defined convex lateral lobes, apex visible but not conspicuous; slightly longer than wide.

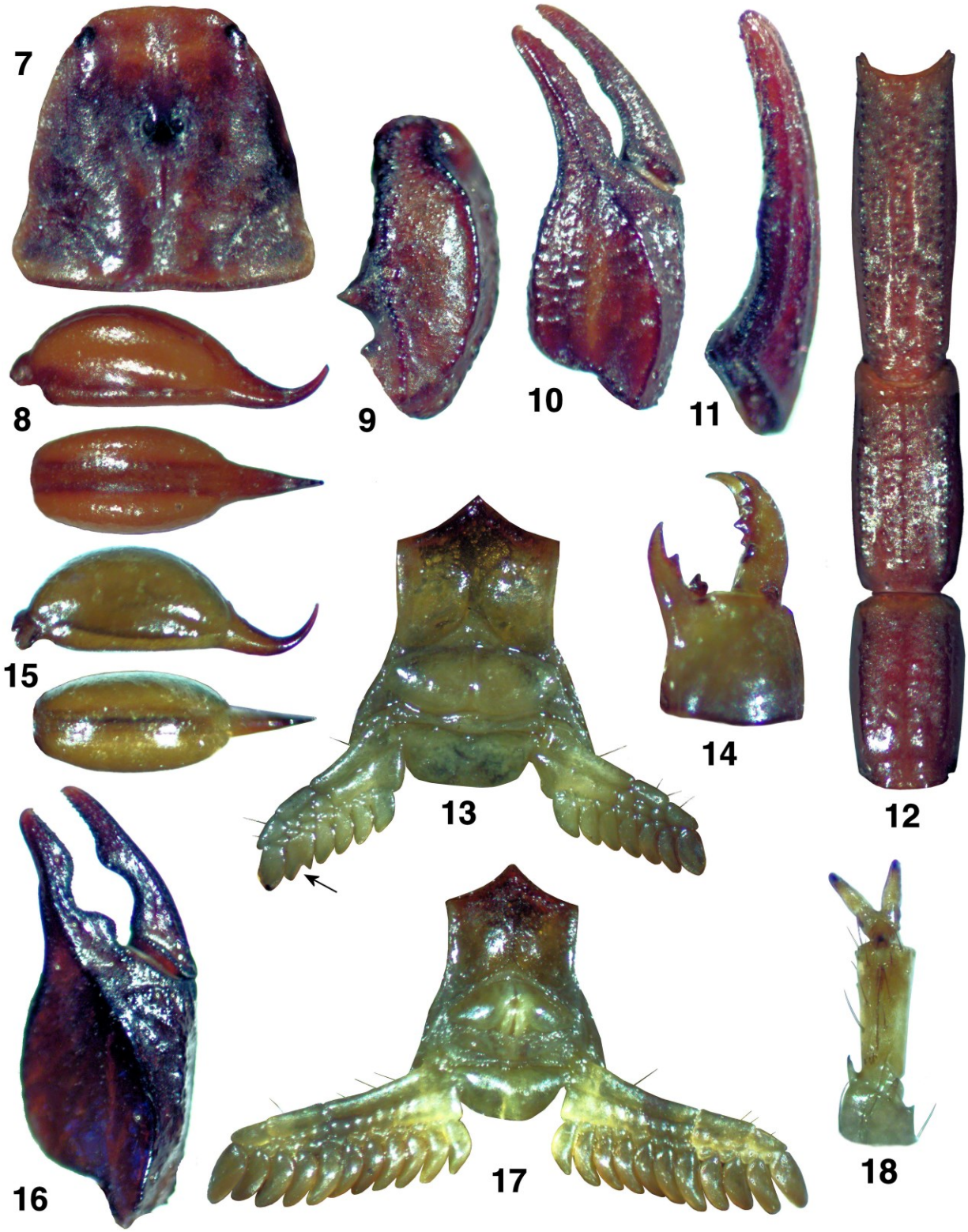
CHELICERAE (Fig. 14 paralectotype female). Following description is based on paralectotype female. Movable finger dorsal edge with two small subdistal (*sd*) denticles; ventral edge smooth; serrula not visible. Ventral distal denticle (*vd*) conspicuously longer than dorsal (*dd*). Fixed finger with four denticles, median (*m*) and basal (*b*) denticles conjoined on common trunk; no ventral accessory denticles present.

PEDIPALPS (Fig. 16, paralectotype female Figs. 9–11). Well-developed chelae, moderately carinated, strong scalloping on chelal fingers. **Femur:** Dorsointernal dorsoexternal, and ventrointernal carinae serrated, ventroexternal rounded, nearly obsolete. Dorsal surface covered with medium-size granules, ventral surface gran-



Figures 3–6: *Euscorpius scaber* Birula, 1900, type specimens. **3.** Female paralectotype, dorsal view. **4–5.** Male lectotype, dorsal and ventral views. **6.** Female paralectotype, dorsal and ventral views.

ulate on proximal 2/3, internal and external surfaces rough with rows of 6 to 7 and 13 serrated granules, respectively. **Patella:** Dorsointernal and ventrointernal carinae serrated, dorsoexternal rounded and granulated, ventroexternal granulated, and externomedian carina obsolete. Dorsal and ventral surfaces covered with medium-sized granules; external surface covered with large granules; internal surface smooth with well-developed DPS and near obsolete VPS. **Chelal carinae:** Complies with the "10-carinae configuration". Digital (*D1*) carina strong, slight traces of low-profile granulation; sub-digital (*D2*) essentially obsolete, represented by 2 small granules; dorsosecondary (*D3*) obsolete, area quite flat; dorsomarginal (*D4*) rounded, with medium-sized granules; dorsointernal (*D5*) highly rounded and covered with granules; ventroexternal (*V1*) strong, slight traces of



Figures 7–18: *Euscorpius scaber* Birula, 1900, Mt. Athos, Greece. **7–14.** Female paralectotype. **15–18.** Male lectotype. **7.** Carapace. **8.** Telson, lateral and ventral views. **9.** Patella, dorsal view. **10.** Chela, external view. **11.** Movable finger dentition (Figs. 9–11 are from a left pedipalp, and are reversed). **12.** Metasomal segments III–V, ventral view. Note the well-defined single ventromedian carina on segments III–IV. **13.** Sternopectinal area (arrow points to two fused teeth). **14.** Left chelicera (reversed). **15.** Telson, lateral and ventral views. **16.** Chela, external view. **17.** Sternopectinal area. **18.** Left leg III tarsus, ventral view.

low-profile granulation, curving to external condyle of movable finger; ventromedian (*V2*) obsolete; ventro-internal (*V3*) strong, but very rounded and smooth; external (*E*) irregularly developed with coarse granulation. **Chelal finger dentition (paralectotype female Fig. 11):** Median denticle (*MD*) row groups in straight line; 6/6 *ID*s fixed finger and 7/7 on movable finger; 6/6 *OD*s on fixed and movable fingers; 4/4 and 4/4 *IAD*s on fixed and movable fingers, respectively. **Trichobothrial patterns (paralectotype female Fig. 19):** Type C, neobothriotaxic: chela ventral = 4/4; patellar *eb* = 4/4, eb_a =4/4, *esb* = 2/2; *em* = 4/4, *est* = 4/4, *et* = 6/6; patellar ventral = 9/9.

LEGS (Fig. 18). Both pedal spurs present on all legs, lacking spinelets; tibial spurs absent. Tarsus with delicate single row of spinules on ventral surface, terminating distally with two closely grouped spinules. Unguicular spine well-developed and pointed.

HEMISPERMATOPHORE (FIG. 20). Hemispermatophore typical of subgenus. Well-developed truncal flexure, lamina with a conspicuous basal constriction, terminus highly tapered, curving towards the external edge. Median projection with both primary and secondary acuminate processes. Primary acuminate process, a complex structure, has three irregular shaped lobes visible from the internoventral perspective and appears flat from a strict dorsal view. The secondary process is simple and reduced to a single pointed spine. The internal lobe exhibits seven irregularly sized tines in its crown.

Sexual dimorphism. The adult female exhibits a subtle proximal gap and movable finger lobe on the chela, whereas they are well developed in the male; the genital operculum sclerites in the female are connected along the middle, not separated as in the male; genital papillae are absent in the female, present in the male. The pectinal tooth counts are smaller in the female, 6–10 (7.85) as compared to 9–13 (10.53) in the male, a 34.1 % difference in the means (see Table 1). The telson vesicle in the female is not as swollen as it is in the male; the telson length compared to its depth is 3.182 in the female and 2.607 in the male, exhibiting a 22 % difference. The chelal palm in the female is not as swollen as it is in the male, the chelal length compared to its width and depth is 2.965 and 2.601 in the female, and 2.636 and 2.390 in the male, a 12.5 % and 12.2 % difference, respectively. Finally, the carapace is relatively longer in the female, dominating in all possible morphometric ratios when compared to 23 other morphometrics, the largest difference, when the carapace is compared to the vesicle depth, exhibited a 41.8 % mean value difference.

Variation. In addition to the type material of *E. scaber*, we examined 14 specimens mostly from Chalkidiki Peninsula, and a very large series from Thasos Island (120 specimens, most collected by E. Kritscher in summer 1975). Pectinal teeth number in males usually varied between 10 (52.8 %) and 11 (37.7 %), with distribution 9 (1), 10 (28), 11 (20), 12 (3), 13 (1) [n=53], mean 10.53, SD = 0.72. Pectinal teeth number in females was usually 8 (71.7.0%), with distribution 6 (4), 7 (40), 8 (152), 9 (14), 10 (2) [n = 212], mean 7.85, SD = 0.61. Number of ventral patellar trichobothria (*Pv*) was usually 8 (87.2 %), with distribution 7 (20), 8 (238), 9 (10), 10 (5) [n = 273], mean 7.96, SD = 0.33. Number of external terminal patellar trichobothria (*et*) was usually 6 (84.0%), with distribution 4 (1), 5 (37), 6 (216), 7 (2), 8 (1) [n = 257], mean 5.86, SD = 0.41.

Material examined. **GREECE.** ***Mount Athos (Agion Oros)*:** 1 ♂ (lectotype, designated here), 7 (19) May 1886, leg. A. N. Kharuzin (ZMMSU Tb-33); paralectotypes, same label as lectotype, 1 ♀ (ZISP 1034), 1 ♂ im., 1 ♀, 4 ♀ im. (ZMMSU Tb-33); 27 June 1936, leg. D. Papazov, 2 ♂ (NMNHS 324), 2 ♀ (NMNHS 325), 1 ♀ im., 4 im. (NMNHS 323); Karyes ("Karye), 24 July 1976, leg. E. Kritscher, 1 ♀ (NHMW 15980); Koutloumousiou Monastery ("M. Koultumuosiv"), 24 July 1976, leg. E. Kritscher, 3 ♀ (NHMW 15981/1-3). ***Central Macedonia***: Chalkidiki Peninsula, Kassandra, 7 August 1988, leg. E. Kritscher, 1 ♀ sbad. (NHMW 15.978); Chalkidiki Peninsula, 5 km W of Marmaras, 14 July 1976, leg. E. Kritscher, 1 ♂ im., 1 ♀ (NHMW 15.979/1-2); Chalkidiki Peninsula, Ierissos, 15 July 1976, leg. E. Kritscher, 2 ♂ (NHMW 16.033/1-2); Thessaloniki, Rentina, 21 August 2009, leg. F. Šťáhlavský, 1 ♀ (VFPC). ***East Macedonia and Thrace:*** **Thasos Island**: Thasos, 19 May 1999, leg. M. E. Braunwalder, 1 ♀ (VFPC), 2 ♀ (NHMC 10.617, 8.1.1.70); Thasos, Agios Panteleimon, 872 m, 7 July 1975, leg. E. Kritscher, 5 ♂, 51 ♀ (NHMW 16.012/1-54, 16.013/1-2); Thasos, Kallirachi, 15 July 1975, leg. E. Kritscher, 2 ♀ im. (NHMW 16.018/1-2); Thasos, Limenaria, 21 July 1975, leg. E. Kritscher, 1 ♂, 1 ♂ sbad. (NHMW 16.023/1-2); Thasos, 3 km S of Makriammos, 20 July 1975, E. Kritscher, 1 ♀ im. (NHMW 16.021); Thasos, Maries, 9 July 1975, leg. E. Kritscher, 2 ♂ sbad., 5 ♀ (NHMW 16.017/1-7); Thasos, Panagia, 24 July 1975, leg. E. Kritscher, 1 ♂, 1 ♀ im. (NHMW 16.025/1-2); Thasos, Potamia, 23 July 1975, leg. E. Kritscher, 1 ♀ (NHMW 16.024); Thasos, Rachoni, 6 July 1975, leg. E. Kritscher, 1 ♀ sbad. (NHMW 16.011); Thasos, Limenas (=Thasos town), 2 May 1942, leg. B. Petrov, 3 ♀ (NMNHS 322); Thasos, Thasos town, 6 July 1975, leg. E. Kritscher, 1 ♂ im. (NHMW 16.010.4); Thasos, Thasos town, 13 July 1975, leg. E. Kritscher, 1 ♂ im. (NHMW 16.017); Thasos, Thasos town, 17 July 1975, leg. E. Kritscher, 4 ♀ (NHMW 16.020/1-4); Thasos,

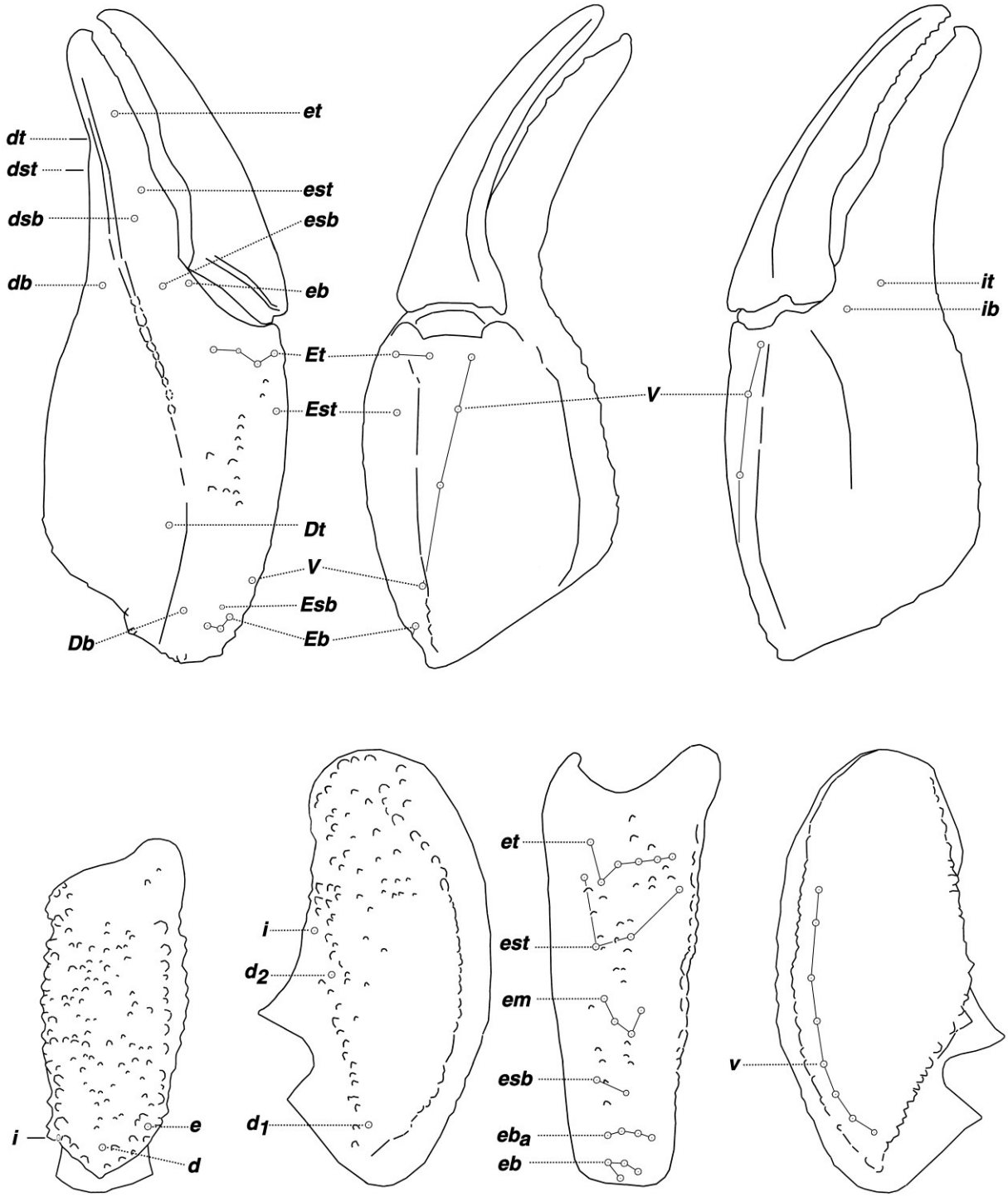


Figure 19: *Euscorpius scaber* Birula, 1900, female paralectotype, Mt. Athos, Greece. Trichobothrial pattern (left pedipalp, reversed).

Theologos, 16 July 1975, leg. E. Kritscher, 4 ♀ (NHMW 16.019/1-2, 16.022/1-2); Thasos, N of Skala Sotiras, pine forest, 40°43′18″N, 24°33′42″E, 12 May 2005, leg. V. Fet & S. Fet, 6 ♂, 23 ♀ (VFPC); Thasos, Sotiras, pasture, 13 May 2005, leg. S. Fet, 3 ♀ (VFPC).

Notes

1. Mount Athos ("Monastic State of Agion Oros") is an autonomous state (polity) under Greek jurisdiction, located on the easternmost "leg" of Chalkidiki Peninsula.

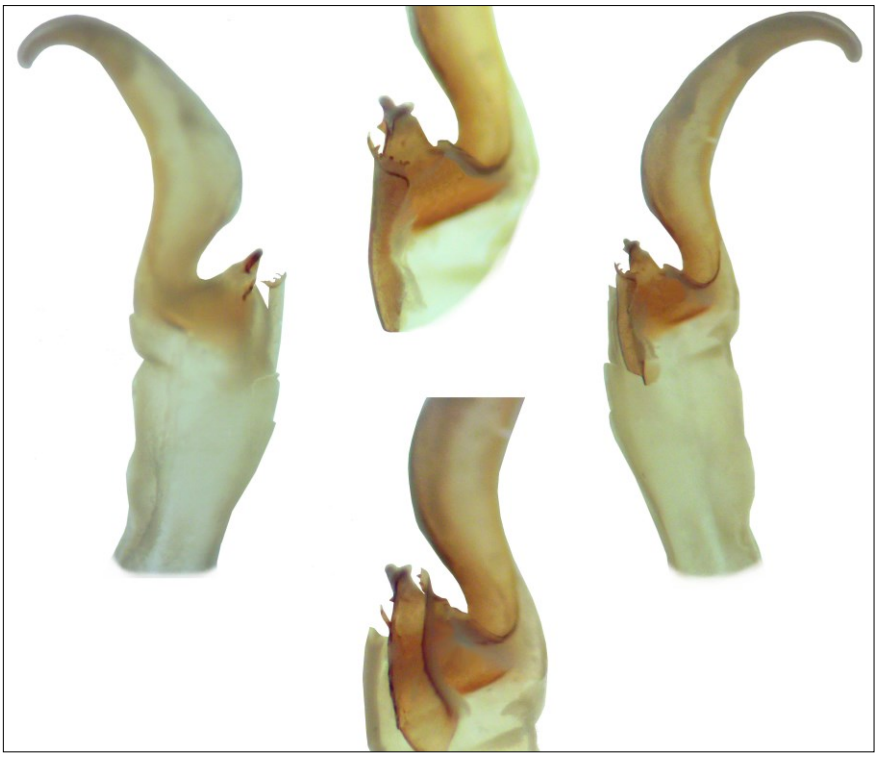


Figure 20: Left hemispermatophore (reversed and submerged in alcohol) of *Euscorpius scaber* Birula, 1900, Mt. Athos, Greece. **Left.** Dorsal view. **Right.** Ventral view. **Top.** Close-up of median area, ventral view. **Bottom.** Close-up of median area, internoventral view.

2. The date of the original label as published by Birula (1900) in a Russian journal, is 7 May 1886. Since Russian (Julian) calendar in 19th century lagged behind the European (Gregorian) by 12 days, this date corresponds to 19 May 1886.

3. The original collector of rare *E. scaber* (as well as *E. koschewnikowi*), Alexei Nikolaevich Kharuzin (1864–1932) visited Mount Athos in 1886 as a young student of Moscow University. His other expeditions of 1880s-1890s included Caucasus, Crimea, Central Asia and the Balkans. Kharuzin became a prominent ethnographer, anthropologist, and a civic servant, a Governor of Bessarabia in 1904–1909, and a Deputy Minister of Interior from 1911. After 1917, he worked in agriculture. In 1927 and 1931, Kharuzin was arrested by Soviet authorities; he died in prison in 1932 (Kerimova & Naumova, 2002). His story is tragically matched by that of Alexei A. Birula (1864–1937), a famous Russian zoologist (and also a prominent polar researcher). Birula was a Director of the Zoological Institute in Leningrad (former Imperial Zoological Museum, now ZISP) when he was demoted in 1929, arrested in 1930 and sent to concentration camps for three years. His scorpion collection remains largely intact in ZISP.

4. We had no topotypic material from Mount Athos to use for DNA marker study. In Parmakelis et al. (in press), we used specimens from Thasos (Skala Sotiras), which also matched by two markers (*16S rDNA* and *COI*) a specimen originating from Rentina near Thessaloniki (data not included in Parmakelis et al., in press). Both on Thasos and the mainland, *E. scaber* is sympatric with another, more widespread undescribed species of *Euscorpius* (Fet et al., in progress). On Mount Athos, *E. scaber* is sympatric with a different species, *E. koschewnikowi* Birula, 1900. Interestingly, Birula (1917a: 211) himself doubted such sympatry indicating that he was not aware of any two sympatric species in the subgenus *Euscorpius* s.str. (which at this time also included subgenus *Alpiscorpius*). The first modern confirmation of such sympatry was only published by Kinzelbach (1975).

5. Our observations with UV light on Thasos Island, north of Skala Sotiras (V. Fet and S. Fet, 12–13 May 2005) showed that *E. scaber* were very common in pine (*Pinus brutia*) forest. This was noted already by Kritscher (1993) who wrote that Thasos specimens were common under pine bark, thus suggesting that they are arboreal. Most surprisingly, we found that *E. scaber* also were abundant on pine forest floor, hiding in large pine cones, between their open scales, which provide good shelter for this small, dark *Euscorpius*.

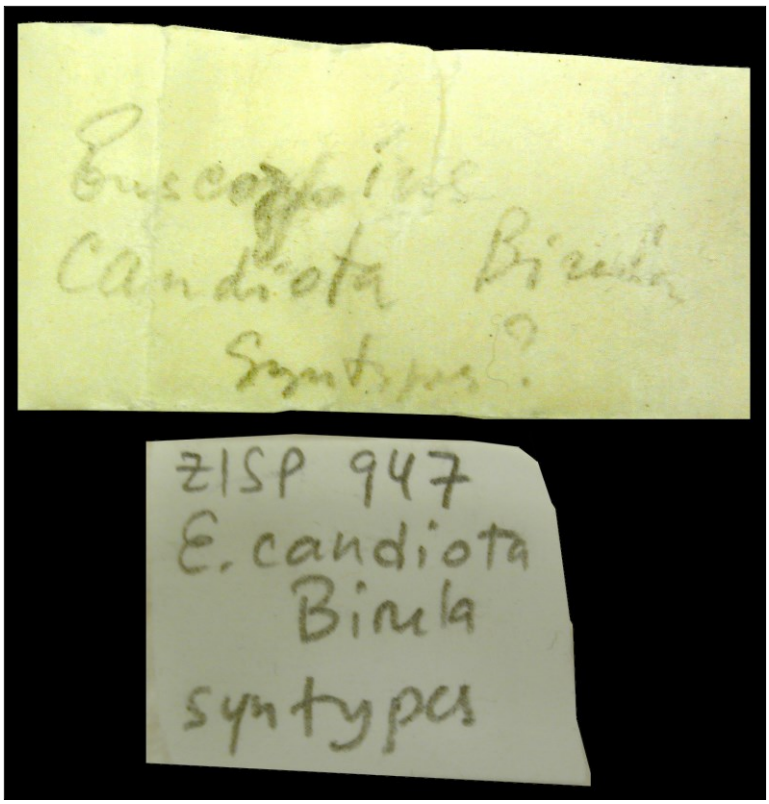


Figure 21: *Euscorpius candiota* Birula, 1903, museum labels (ZISP).

Euscorpius candiota Birula, 1903

(Figures 21–32; Tables 1–2)

Euscorpius candiota Birula, 1903: 298–299.

REFERENCES:

Euscorpius carpathicus: Penther, 1906: 61; Roewer, 1928: 452; Roewer, 1943: 236 (in part; Crete); Vachon, 1948: 63; Stathi & Mylonas, 2001: 289 (in part; Crete); Kovařík, 2002: 13 (in part; Crete).

Euscorpius candiota: Birula, 1917a: 129, 198; Birula, 1917b: 168, 210; Werner, 1938: 173; Di Caporiacco, 1950: 182, 188; Kinzelbach, 1982: 63–64 (in part; Crete); Bonacina, 1983: 9; Fet, 1986: 6 (under question).

Euscorpius carpathicus candiota: Kinzelbach, 1975: 36–37, fig. 12, 16 (in part; Crete); Valle, 1975: 219; Lacroix, 1991: 19; Kritscher, 1993: 384–385 (in part; Crete); Fet & Braunwalder, 2000: 19; Fet & Sissom, 2000: 362; Gantenbein et al., 2001: 302; Fet et al., 2003a: 368; Fet & Soleglad, 2007: 419; Vignoli & Salomone, 2008: 196, fig. 4; Fet, 2010: 7; Tropea & Rossi, 2012: 27, 30; Tropea et al., 2012: 75.

Euscorpius carpathicus "Subgroup A3": Fet, 2000: 53 (in part; Crete).

Euscorpius "carpathicus candiota": Fet & Soleglad, 2002: 3; Fet et al., 2002: 142; Fet, 2003: 272; Fet et al., 2003b: 151; Fet et al., 2003c: S250.

Euscorpius "carpathicus" candiota: Fet et al., 2004: 52; Kaltsas et al., 2008: 234.

Type material: Lectotype (designated here) ♀, **Greece**, Crete, Candia (now Heraklion), 24 October (8 November) 1898, leg. Dr. Bogolyubov (ZISP 947); paralectotypes, 8 ♂ and 14 ♀, same label as lectotype (ZISP 947). Birula (1903) listed 8 ♂ and 18 ♀. Fet (1986) in 1985 examined in ZISP the entire syntype series; of these only 5 ♀ were available on loan for current study. See Fig. 21 for labels accompanying the loaned type specimens (ZISP 947).

Geographic range. Greece: Crete (Heraklion). See map in Fig. 1.

History of Study

Birula (1903, 1917a, 1917b) considered *Euscorpius candiota* an endemic insular species, which he compared to topotypical *E. carpathicus* from Banat in Romania (then "southern Hungary") as well as to *E. tauricus* (C. L. Koch, 1837) from Crimea. Interestingly, Birula (1903) did not even mention two mainland Greek *Euscorpius* he just described previously (Birula, 1900), *E. koschewnikowi* and *E. scaber*, probably since *E. candiota* was very distinct from both in morphology, primarily in granulation and metasomal carination.

Figure 22: *Euscorpius candiota* Birula, 1903, Candia (= Heraklion), Crete, Greece. Female lectotype, dorsal and ventral views. Right pedipalp and chela are detached.

In a lumping trend that prevailed in following decades, Penther (1906: 61) synonymized *E. candiota* with *E. carpathicus*. Vachon (1948: 64–66) studied a series from Crete and noted high variation within the island; he also considered Birula's species a synonym of *E. carpathicus*, specifically of a subspecies he called *E. carpathicus mesotrichus* Hadži, 1929, an unavailable name (a junior homonym of *E. italicus mesotrichus* Hadži; see Fet & Sissom, 2000).

Birula's name *E. candiota* had a special position in Kinzelbach's unsubstantiated hypothesis of hybridogenic speciation within subgenus *Euscorpius*. Kinzel-

bach (1975) maintained that *E. candiota* (or *E. carpathicus candiota*) is an "intermediate", hybrid form between *E. carpathicus* and *"E. mesotrichus*". The hypothesis was erroneously based on a correct discovery by Kinzelbach (1975) that two species of *Euscorpius* s.str. were sympatric in Thessaly (e. g. see below under *E. ossae*, which is sympatric with *E. sicanus* on Mt. Ossa). There is, however, no support for hybridization, and no phylogenetic indication that *E. candiota*, or any other *Euscorpius* species, has a hybridogenic origin. Kinzelbach (1975) recognized *E. carpathicus* (with 8 or less ventral patellar trichobothria) and "*E. mesotrichus* Hadži" (with 10 or more ventral patellar trichobothria). We know today that each of these two taxa *sensu* Kinzelbach (1975) in fact contains many separate species, some still undescribed. To accommodate "intermediate populations" (which ranged from 8 to 11 ventral patellar trichobothria), Kinzelbach (1975) assumed that those are hybrids between his two species, and designated them as "subspecies *E. carpathicus candiota* Birula". Such taxonomic assignment broadened the range of a "mixed form" across Greece from Crete to Kerkyra.

Fet (1986) published pectinal and trichobothrial statistics of Birula's types from ZISP and ZMMSU but was unsure of their taxonomic status. Kritscher (1993) was the first to collect a very large series on Crete (NHMW), which he addressed as *E. carpathicus candiota*. Fet & Sissom (2000) limited *E. c. candiota* to Crete; they listed it as a subspecies of *E. carpathicus* but noted that its status was still uncertain.

Gantenbein et al. (2001), using *16S rDNA* markers, first demonstrated that "western" populations of from France (*E. "carpathicus" niciensis*) and Italy (now *E. concinnus*) were genetically distant from "eastern" *E. carpathicus candiota* Birula (Crete). Same reasoning was used by Fet (2003) to illustrate an isolated position of the Crimean *E. tauricus* (C. L. Koch, 1837). The species delimitation approaches (Parmakelis et al., in press) validated as a distinct evolutionary entity a population from the Dionysades (satellite islands located northeast of Crete) as belonging to "*E. candiota* complex". The exact taxonomy of *Euscorpius* on Crete proper remains unresolved. Additional 16S DNA marker data (unpublished) from within Crete show a potential diversification of this clade, which likely includes the northern population of *E. candiota* redescribed here from type locality (Heraklion).

Diagnosis. Medium sized (about 40 mm), brown in color species; pedipalps dark orange. Metasomal carinae on segments II–IV smooth to obsolete. Pedipalp patellar external trichobothria numbers: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 4, *est* = 4 and *et* = 6 to 7; ventral aspect of patella 9 to 10. Pectinal tooth counts: females usually 7, males 8 to 9.

FEMALE. The following description is based primarily on the lectotype female from Candia (now Heraklion), Crete, Greece, with some structures described from a paralectotype female. Measurements of the lectotype female are presented in Table 2. See Fig. 22 for the dorsal and ventral views of the lectotype female. Lectotype female, an adult, has the right pedipalp detached, chela detached from femur and patella, 2 legs detached, and mesosoma slightly damaged.

COLORATION. Carapace and metasoma dark brown; tergites brown; pedipalp dark orange; telson yellow, aculeus red; legs yellow-orange; genital operculum, pectines, and basal piece yellow; and sternites brown. No patterns present.

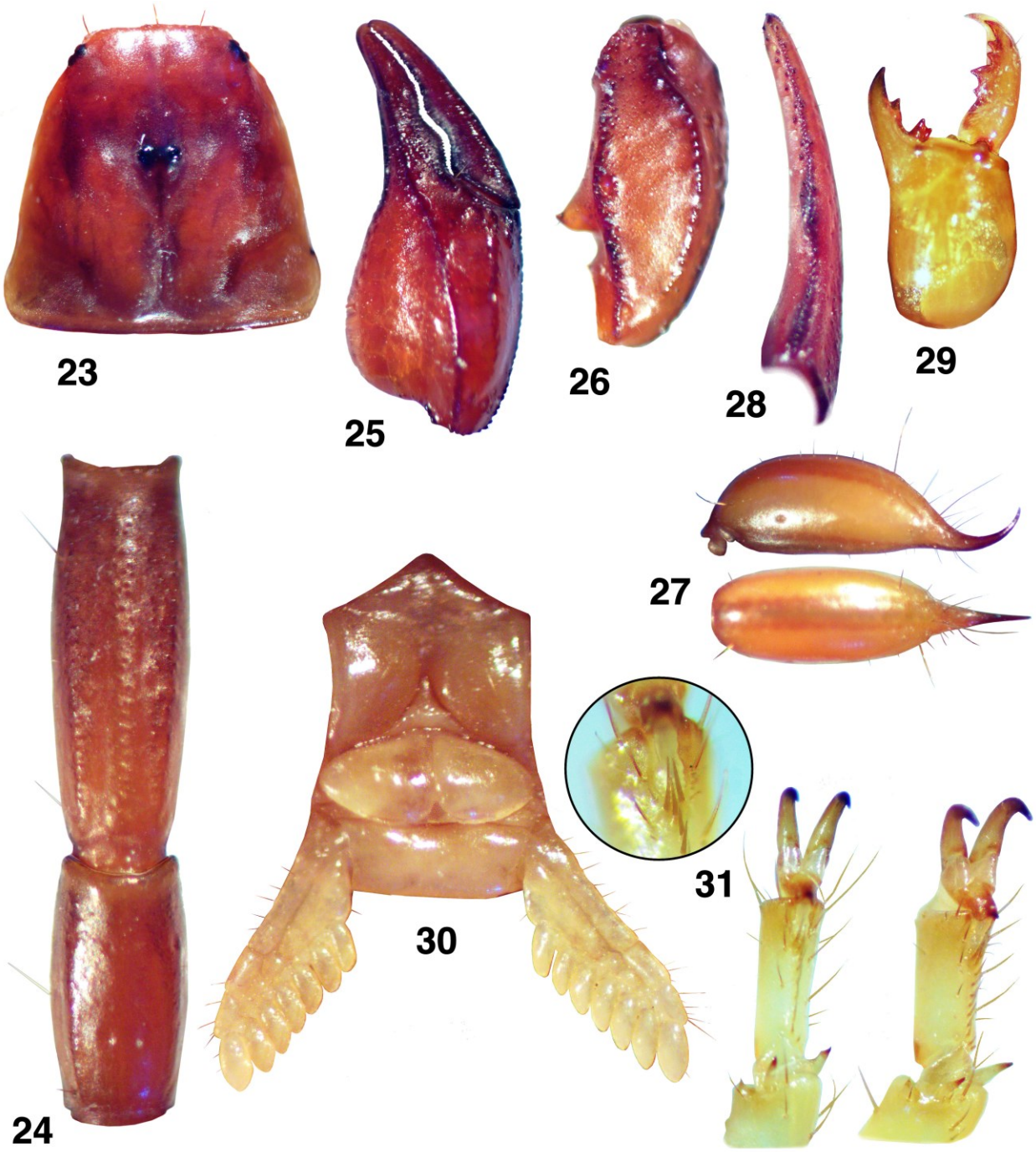
CARAPACE (Fig. 23). Anterior edge slightly convex; slight granulation on lateral edges below lateral eyes, otherwise, smooth and lustrous, lacking any indication of carinae. There are two lateral eyes. Median eyes and tubercle are small to medium in size, positioned slightly anterior of middle with the following length and width ratios: 0.422 (anterior edge to medium tubercle middle / carapace length) and 0.160 (width of median tubercle including eyes / width of carapace at that point).

MESOSOMA. Tergites I–VII smooth and lustrous; tergite VII lacking lateral and median carinal pairs. Sternites III–VII smooth and lustrous; VII lacking lateral and median carinae. Stigmata are very small, narrow elliptical.

METASOMA (Fig. 24). Segment I wider than long in ratio 0.861. Segments I–IV: dorsal carinae are smooth with subtle granulation distally; dorsolateral carinae smooth to obsolete; lateral carinae obsolete; ventrolateral carinae obsolete on I–II, weak and smooth on III–IV; single ventromedian carina obsolete. Segment V: dorsolateral carinae rounded and rough; lateral carinae obsolete; ventrolateral and ventromedian carinae irregularly granulate. Anal arch lined with minute granules. Intercarinal areas generally smooth except for the distal ventral surface of segment V which is covered with scattered granules.

TELSON (Fig. 27). Vesicle slightly swollen and elongated, with moderately curved aculeus. Vesicle essentially void of granules, very lustrous. Vesicular tabs smooth.

PECTINES (Fig. 30, paralectotype female). Medium-developed segments exhibiting length / width ratio 2.222 (length taken at anterior lamellae / width at widest point including teeth). Sclerite construction complex, three anterior lamellae and 5 middle lamellae; fulcra of medium



Figures 23–31: *Euscorpius candiota* Birula, 1903, Candia (= Heraklion), Crete, Greece. **23–27.** Female lectotype. **28–31.** Female paralectotype. **23.** Carapace. **24.** Metasomal segments IV–V, ventral view. Note the obsolescence of the single ventromedian carina on segment IV. **25.** Chela, external view. **26.** Patella, dorsal view. **27.** Telson, lateral and ventral views. **28.** Chelal movable finger showing dentition. **29.** Chelicera showing dentition, dorsal view. **30.** Sternopectinal area. **31.** Right leg III tarsus ventral and lateral views, and close-up of single distal spinule pair.

development. Teeth number 7/7. Sensory areas developed along distal aspect on all teeth, including basal tooth. Basal piece large, length / width ratio 0.541.

GENITAL OPERCULUM (Fig. 30, paralectotype female). Sclerites triangular, wider than long, connected for most of their length. Genital papillae absent.

STERNUM (Fig. 30, paralectotype female). Type 2, posterior emargination present, moderately defined convex lateral lobes, apex visible but not conspicuous; wider than long, width to length ratio 0.80.

CHELICERAE (Fig. 29, paralectotype female). Movable finger dorsal edge with two small subdistal (*sd*) denti-

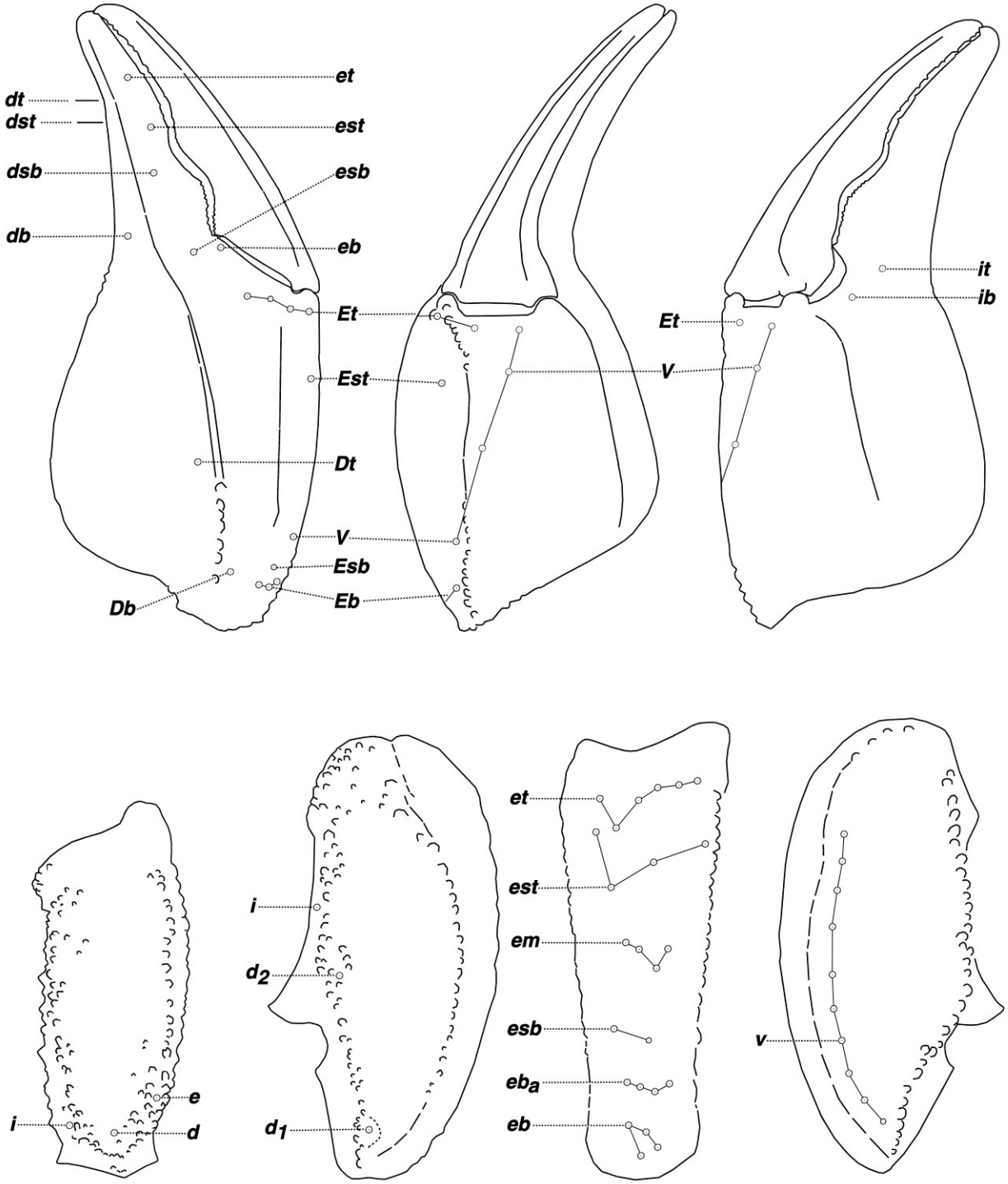


Figure 32: *Euscorpius candiota* Birula, 1903, Candia (= Heraklion), Crete, Greece, female lectotype. Trichobothrial pattern.

cles; ventral edge smooth; serrula not visible. Ventral distal denticle (*vd*) conspicuously longer than dorsal (*dd*). Fixed finger with four denticles, median (*m*) and basal (*b*) denticles conjoined on common trunk; no ventral accessory denticles present.

PEDIPALPS (Figs. 25–26, paralectotype female Fig. 28). Well-developed chelae, moderately carinated, medium scalloping on chelal fingers. **Femur:** Dorso-internal and ventrointernal carinae serrated, dorso-external and ventroexternal crenulated. Dorsal surface

scattered with small granules, ventral surface smooth except for a proximal cluster of small granules, internal surface with a line of 13+ granules, and external surface smooth. **Patella:** Dorsointernal carinae irregularly granulate, ventrointernal crenulate, dorsoexternal with low-profile granules, ventroexternal granulated, and externo-median carina irregularly granulated. Dorsal and ventral surfaces essentially smooth; external surface rough; internal surface smooth with well-developed DPS and near obsolete VPS. **Chelal carinae:** Complies with the "10-carinae configuration". Digital (*D1*) carina strong, smooth, slight traces of low-profile granulation; sub-digital (*D2*) essentially obsolete, represented by 3 small granules; dorsosecondary (*D3*) obsolete, area quite flat; dorsomarginal (*D4*) smooth with large low-profile scattered granules; dorsointernal (*D5*) rounded to obsolete; ventroexternal (*V1*) strong, granulated, curving to external condyle of movable finger; ventromedian (*V2*) obsolete; ventrointernal (*V3*) strong, but very rounded and smooth; external (*E*) strong medially, rough. **Chelal finger dentition (paralectotype female Fig. 28):** Median denticle (*MD*) row groups in straight line; 6 *ID*s fixed finger and 7 on movable finger; 6 *OD*s on fixed finger and 7 on movable finger; 4 and 5 *IAD*s on fixed and movable fingers, respectively. **Trichobothrial patterns (Fig. 32):** Type C, neobothriotaxic: chela ventral = 4/4; patellar *eb* = 4/4, eb_a =4/4, *esb* = 2/2; *em* = 4/4, *est* = 4/4, *et* = 6/6; patellar ventral = 9/10.

LEGS (Fig. 31, paralectotype female). Both pedal spurs present on all legs, lacking spinelets; tibial spurs absent. Tarsus with delicate single row of nine spinules on ventral surface, terminating distally with one pair of spinules. Unguicular spine well-developed and pointed.

HEMISPERMATOPHORE. Hemispermatophore unknown for this species.

Variation. We examined in detail only a lectotype and four paralectotype females of *E. candiota* from Candia (now Heraklion), Crete. In addition, all 23 syntypes (8 ♂ 14 ♀, ZISP 947) were scored for trichobothria and pectinal teeth number by the first author years ago in ZISP (Fet, 1986: 6). This putative species, or forms closely related to it, are widespread and common across Crete; however, the full assessment of variation (and redescription of males) within the island will be a subject of a separate study by our research group using molecular and morphological data (in progress).

Within the syntype series (Fet, 1986), variation was as follows. Pectinal teeth number in males varied unequally between 8 (31.2 %) and 9 (68.8 %), with distribution 8 (5) and 9 (11) [n=16], mean 8.69, SD = 0.48. Pectinal teeth number in females was usually 7 (86.7 %), with distribution 5 (2), 6 (1), 7 (26), and 8 (1) [n=30], mean 6.87, SD = 0.57. Number of ventral patellar trichobothria (*Pv*) varied almost equally between 9 (52.1 %) and 10 (45.8 %), with distribution 8 (1), 9 (25), and 10 (22) [for n=48 as reported by Fet, 1986: 6; should be n=46], mean 9.44, SD = 0.54. Number of external terminal patellar trichobothria (*et*) varied almost equally between 6 (43.5 %) and 7 (54.3 %), with distribution 5 (1), 6 (20), and 7 (25) [n=46], mean 6.52, SD = 0.55. Also, in two cases, number of external subterminal patellar trichobothria (*est*) was aberrant 3, otherwise (in 44 pedipalps, or 95.7 %) it was "standard" 4 [n = 46].

Notes

1. The date of the original label as published by Birula (1903) in a Russian journal, is 27 October 1898. Since Russian (Julian) calendar in 19th century lagged behind the European (Gregorian) by 12 days, this date corresponds to 8 November 1898.

2. Birula (1903) reports that Dr. Bogolyubov (spelled as Bogoljubov) also collected, in the mountains near the seashore of Candia, two other scorpion species: *Buthus gibbosus* [now *Mesobuthus gibbosus* (Brullé, 1832), fam. Buthidae] on 24 October (5 November) 1898, and *Iurus dufoureius* (Brullé, 1832) (now identified for Crete as *Iurus dekanum* (Roewer, 1943), fam. Iuridae] on 21 October (2 November) 1898. These specimens are deposited at ZISP.

3. We identified the original collector, "Dr. Bogoljubov" as a Russian naval surgeon whose zoological excursion falls into a singular dramatic period in Crete's new history. In 1896, the insurrection of Cretan Greeks on the island, an Ottoman possession since 17th century, led to a bloody turmoil. In 1897, six Great Powers (Great Britain, France, Russia, Italy, Germany, and Austria-Hungary) interfered in a rare joint peacekeeping operation. Turkish troops were expelled from Crete in November 1898. On 9 December 1898, the autonomous Cretan State was established under Ottoman suzerainty, garrisoned by an international military force. In 1908, Crete *de facto* became a part of the Kingdom of Greece. Dr. Nikolai Fyodorovich Bogolyubov (1844–1907) of Kronstadt was the senior surgeon on the Russian training armored cruiser *Gertsog Edinburgskiy* [*Duke of Edinburgh*], which joined the navy of Admiral N. I. Skrydlov on Crete in September 1898 (Sokolovskaya, 2009).

Euscorpius ossae Di Caporiacco, 1950, stat. nov.

(Figures 33–48; Tables 1–2)

Euscorpius carpathicus ossae Di Caporiacco, 1950: 202.

REFERENCES:

Euscorpius carpathicus tergestinus: Simon, 1885: 214.

Euscorpius carpathicus s.str.: Kinzelbach, 1975: 30, 36 (in part; Mt. Ossa).

Euscorpius carpathicus ossae: Bonacina, 1983: 5; Bartolozzi et al., 1987: 297; Lacroix, 1991: 19, figs. 66, 76, 86; Fet & Soleglad, 2007: 419; Tropea & Rossi, 2012: 28, 30, 31; Tropea et al., 2012: 75.

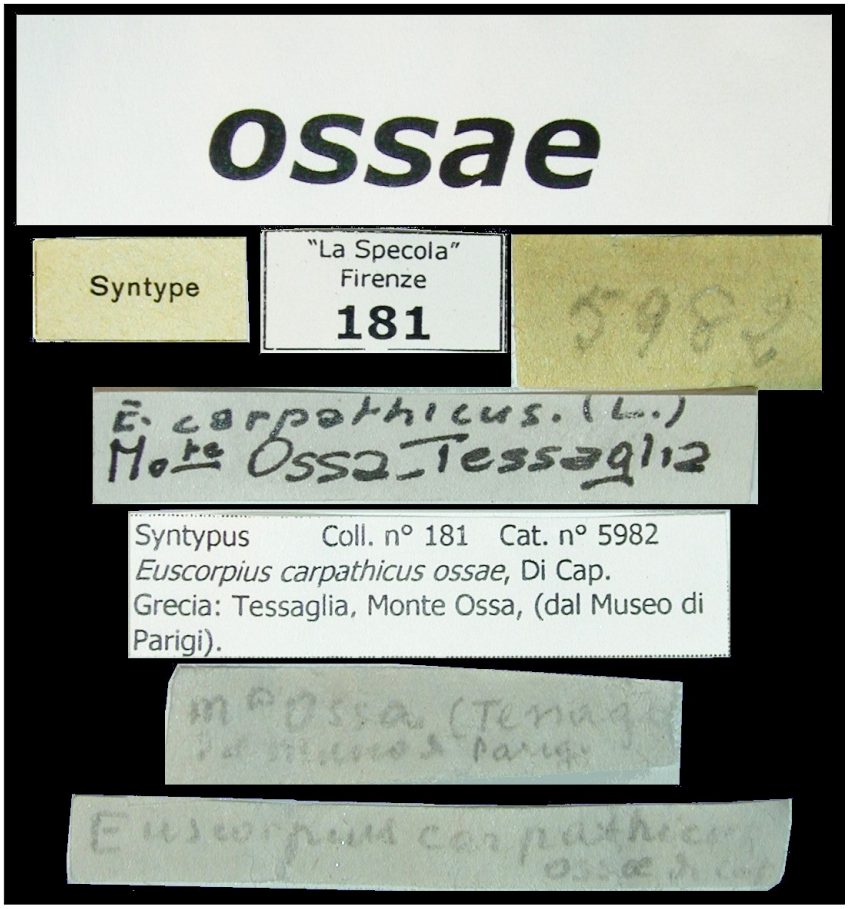


Figure 33: *Euscorpius ossae* Di Caporiacco, 1950, male lectotype, museum labels (MZUF).

Euscorpius carpathicus: Michalis & Dolkeras, 1989: 261 (in part: Larissa); Fet & Sissom, 2000: 357 (in part; Mt. Ossa).

Euscorpius carpathicus complex, Mt. Ossa population (GenBank AY193824): Fet, 2003: 272.

Euscorpius "carpathicus" ossae: Fet et al., 2004: 52; Kaltsas et al., 2008: 234.

Type material: Lectotype ♂ (designated here), partial (MZUF, Coll. No. 181, Cat. No. 5982, "syntypus"), **Greece**, Thessaly, Mt. Ossa ["Tessaglia, Mte. Ossa"], from Paris Museum ["Museo di Parigi"], no date, no collector. See Fig. 33 for the labels accompanying lectotype. Paralectotypes: 3 ♀, not found (see Notes).

Geographic range. Greece: Thessaly, Mt. Ossa (Kissavos) mountain range. See map in Fig. 1.

History of Study

The work of Di Caporiacco (1950) was one of the most comprehensive studies of *Euscorpius* ever published, with validation of many old taxa as subspecies, and description of many new subspecies. However, Di Caporiacco (1950) was mainly concerned with populations from Italy, and had a very limited material available from Greece.

Euscorpius carpathicus ossae has rarely been mentioned in literature. Kinzelbach (1975: 36) listed this *Euscorpius carpathicus ossae* under question as a synonym of his "*E. carpathicus*". In Parmakelis et al. (in press), using different species delimitation methods, *E. ossae* was always supported as a distinct entity, which is here further confirmed by morphological description.

Diagnosis. Medium sized (about 40 mm), brown in color species; pedipalps and metasoma dark mahogany in color. Metasomal carinae in general very underdeveloped. Conspicuous scalloping on male chela. Pedipalp patellar external trichobothria numbers: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 4, *est* = 4 and *et* = 5–6 (usually 5); ventral aspect of patella 7–8 (usually 7). Pectinal tooth counts: females 7–8 (usually 7), males usually 9.

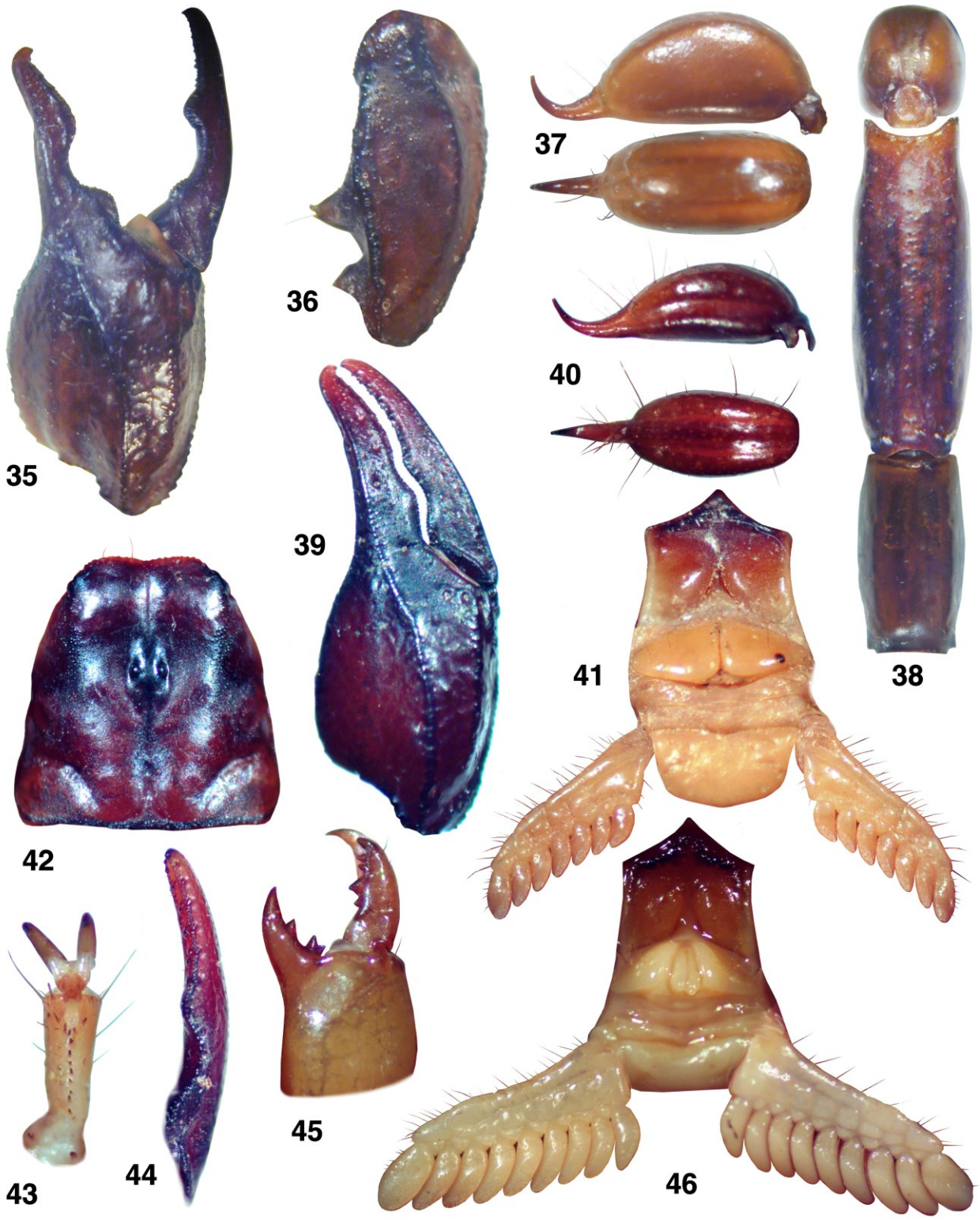
MALE. The following description is based on two males from Mt. Ossa, Thessaly, Greece, including the lectotype. Note, in the lectotype only the metasoma, telson, and pedipalps exist for this specimen, therefore the description of the carapace, mesosoma, chelicerae, legs, and hemispermatophore is based on the second topotypic

Figure 34: *Euscorpius ossae* Di Caporiacco, 1950, Mt. Ossa, Thessaly, Greece. Female, dorsal and ventral views.

male (NHMC 2203). Measurements of the lectotype male (partial) and a female are presented in Table 2. See Fig. 34 for the dorsal and ventral views of the female.

COLORATION. Pedipalps dark mahogany in color, carinae and finger dentition dark brown to black. Metasoma and its carinae dark mahogany. Telson vesicle yellowish brown with two darker irregular wide stripes on ventral surface; aculeus dark brown.

CARAPACE (Fig. 42). Anterior edge slightly convex with a very narrow slight median indentation; slight gran-



Figures 35-46: *Euscorpius ossae* Di Caporiacco, 1950, Mt. Ossa, Thessaly, Greece. **35-38.** Male lectotype. **39-41.** Female. **42-46.** Male. **35.** Chela, external view. **36.** Patella, dorsal view. **37.** Telson, ventral, lateral, and basal views. **38.** Metasomal segments IV-V, ventral view. **39.** Chela, external view. **40.** Telson, ventral and lateral views. **41.** Sternopectinal area. **42.** Carapace. **43.** Right leg III, tarsus. **44.** Dentition of chelal movable finger. **45.** Chelicera, dorsal view. **46.** Sternopectinal area.

ulation on lateral edges below lateral eyes, otherwise, smooth and lustrous, lacking any indication of carinae. There are two lateral eyes. Median eyes and tubercle are small to medium in size, positioned slightly anterior of middle with the following length and width ratios: 0.418 (anterior edge to medium tubercle middle / carapace length) and 0.172 (width of median tubercle including eyes / width of carapace at that point).

MESOSOMA. Tergites I–VII essentially smooth; tergite VII lacking lateral and median carinal pairs. Sternites III–VII smooth and lustrous; VII lacking lateral and median carinae. Stigmata are very small, narrow elliptical.

METASOMA (Fig. 38). Segments very lustrous, segment I wider than long, carinae in general very underdeveloped. Segments I–IV: dorsal carinae weak with scattered low profile granules proximally; dorsolateral carinae essentially obsolete to vestigial and smooth; dorsal (I–IV) carinae terminate with a very small blunted spine; lateral carinae obsolete; ventrolateral carinae obsolete to vestigial on I, and weak, smooth and rounded on II–IV; ventromedian carina obsolete. Dorsolateral carinae of segment IV terminate at articulation condyle. Segment V: dorsolateral carinae obsolete to rounded; lateral carinae obsolete; ventrolateral and single ventromedian carinae irregularly granulate with weak scattered granules. Intercarinal areas of segments I–V smooth.

TELSON (Fig. 37, female Fig. 40). Vesicle elongated and symmetrically swollen, with short curved aculeus. Vesicle essentially void of granules. Small subaculear tubercle with pair of small setae present at vesicle/ aculeus juncture. Vesicular tabs very weak and smooth.

PECTINES (Fig. 46, female Fig. 41). Medium-developed segments exhibiting length / width ratio 2.00 (length taken at anterior lamellae / width at widest point including teeth). Sclerite construction complex, three anterior lamellae and 4/5 middle lamellae; fulcra of medium development. Teeth number 9/9. Sensory areas developed along distal aspect on all teeth, including basal tooth. Basal piece with wide shallow indentation along anterior edge, length / width ratio 0.413.

GENITAL OPERCULUM (Fig. 46, female Fig. 41). Sclerites triangular, separated for entire length. Genital papillae present, protruding significantly between the sclerites (see discussion on female below).

STERNUM (Fig. 46, female Fig. 41). Type 2, posterior emargination present, modestly-defined convex lateral lobes, apex visible but not conspicuous; slightly longer than wide.

CHELICERAE (Fig. 45). Following description is based on non-type topotypic male. Movable finger dorsal edge with two small subdistal (*sd*) denticles; ventral edge smooth; serrula not visible. Ventral distal denticle (*vd*) conspicuously longer than dorsal (*dd*). Fixed finger with four denticles, median (*m*) and basal (*b*) denticles conjoined on common trunk; no ventral accessory denticles present.

PEDIPALPS (Figs. 35–36, female Fig. 39). Well-developed chelae, with medium length fingers, heavily carinated, conspicuous scalloping on chelal fingers: well-developed lobe on movable finger, positioned distal of midpoint in ratio 0.634; strong proximal gap present on fixed finger. **Femur:** Dorsointernal and dorsoexternal carinae serrated, ventrointernal heavily serrate, ventroexternal rounded with scattered granulation. Dorsal and ventral surfaces finely granulate, internal surface with a row of nine serrated granules, and external surface with a row of 18 serrated granules. **Patella:** Dorsointernal carina crenulated to serrated; ventrointernal granulated to crenulated, dorsoexternal granulated, and ventroexternal rounded weakly crenulated, and externomedian carina irregularly granulate. Dorsal and ventral surfaces rough with some marbling; external surface marbled with exteromedian carina; internal surface smooth with well-developed DPS which is distally bifurcated and minimal VPS. **Chelal carinae:** Complies with the "9-carinae configuration". Digital (*D1*) carina strong, lustrous, with elongated flat granules; sub-digital (*D2*) essentially obsolete with two small granules; dorsosecondary (*D3*) essentially obsolete with flat rounded marbled area; dorsomarginal (*D4*) rounded, irregularly granulated; dorsointernal (*D5*) essentially obsolete with flat rounded marbled area; ventroexternal (*V1*) strong lustrous with elongated flat granules, terminating at external condyle of movable finger; ventromedian (*V2*) obsolete; ventrointernal (*V3*) rounded and smooth; external (*E*) irregularly granulated medially, marbled distally. **Chelal finger dentition (Fig. 44):** Median denticle (*MD*) row groups positioned in straight line on fingers, small gap present at each *OD* location; 6/6 *ID*s on fixed finger and 7/7 *ID*s on movable finger; 5/5 *IAD*s on fixed and movable fingers; 6/6 *OD*s on fixed finger and 7/7 *OD*s on movable finger. **Trichobothrial patterns (Fig. 47):** Type C, neobothriotaxic. Chela with 26/26 (left/right) trichobothria; femur with 3/3; and patella with 30/30 (i.e., *eb* series 4/4, eb_a 4/4, esb 2/2, *em* 4/4, *est* 4/4, *et* 5/5, and ventral 7/7).

LEGS (Fig. 43). Both pedal spurs present on all legs, lacking spinelets; tibial spurs absent. Tarsus with single row of stout spinules on ventral surface, terminating distally with a single pair of stout spinules. Unguicular spine well-developed and pointed.

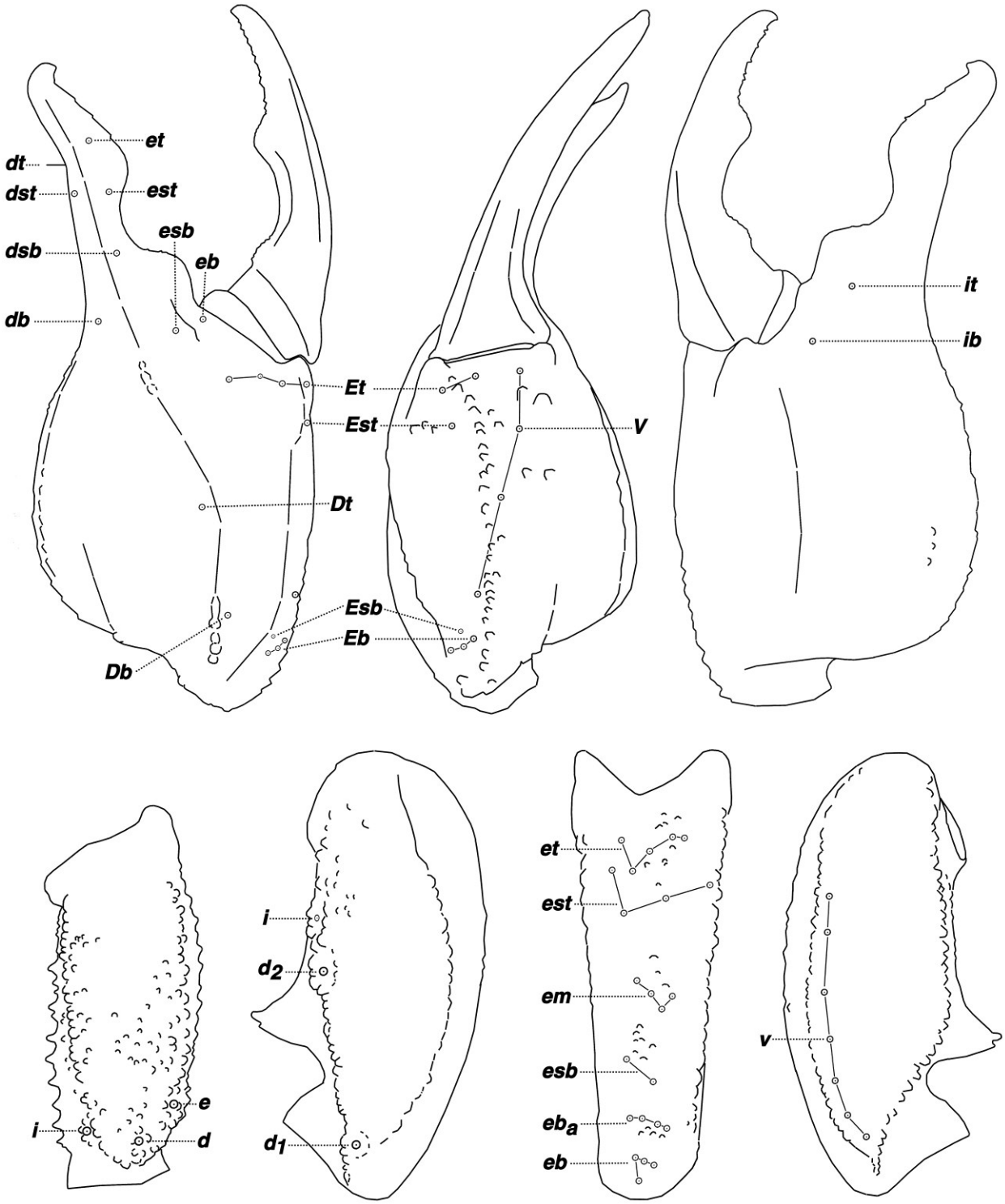


Figure 47: *Euscorpius ossae* Di Caporiacco, 1950, male lectotype. Trichobothrial pattern.

HEMISPERMATOPHORE (FIG. 48). Lamina with a conspicuous basal constriction, terminus strongly tapered and curving towards the external edge. Well-developed truncal flexure present. Median projection with two highly sclerotized acuminate processes, the primary and secondary. The primary acuminate process has a rounded terminus from the dorsal and ventral perspectives but is somewhat flat from the internodorsal view. The smaller secondary acuminate process, which is positioned at the base of the primary acuminate pro-

Figure 48: *Euscorpius ossae*, Mt. Ossa, Thessaly, Greece. Right hemispermatophore and close-ups of median area (submerged in alcohol). **Left.** Hemispermatophore, dorsal view. **Top.** Median area, dorsal and internodorsal views. **Bottom.** Median area, externodorsal view.

cess, is quite narrow and its terminus is pointed. The internal lobe projecting from the internal edge of the trunk exhibits a crown comprised of eleven small irregularly sized tines whose termini are slightly sclerotized, and one elongated tine which is located on the ventral side.

Sexual dimorphism. The adult female exhibits a subtle proximal gap and movable finger lobe on the chela, whereas they are well developed in the male; the genital operculum sclerites in the female are connected along the middle, not separated as in the male; genital papillae are absent in the female, present in the male. The pectinal tooth counts are smaller in the female, 6–8 (7.25) as compared to 8–10 (9.07) in the male, providing a 25.1 % difference in the means (see Table 1). The telson vesicle in the female is not as swollen as it is in the male, the telson length compared to its depth is 3.233 in the female and 2.404 in the male, exhibiting a 34.5 % difference. The chelal palm in the female is not as swollen as it is in the male, the chelal length compared to its width and depth is 2.957 and 2.588 in the female, and 2.580 and 2.375 in the male, a 14.6 % and 9.0 % difference, respectively.

Variation. In addition to the lectotype male of *E. carpathicus ossae*, we examined 50 specimens from Mt. Ossa, mostly collected in July 2001 by Prof. M. Mylonas (NHMC) and his students. Of these, 27 specimens were scored for pectinal teeth and trichobothria numbers. Pectinal teeth number in males usually was 9 (78.6 %), with distribution 8 (1), 9 (11), 10 (2) [n=14], mean 9.07, SD = 0.48. Pectinal teeth number in females usually varied between 7 (62.5 %) and 8 (30.0%), with distribution 6 (3), 7 (25), 8 (12) [n = 40], mean 7.25, SD = 0.54. Number of ventral patellar trichobothria (*Pv*) usually varied between 7 (65.4 %) and 8 (27.3 %), with distribution 6 (2), 7 (36), 8 (15), 9 (2) [n = 55], mean 7.29, SD = 0.60. Number of external terminal patellar trichobothria (*et*) usually varied between 5 (61.8 %) and 6 (36.4 %), with distribution 4 (1), 5 (34), 6 (20) [n = 55], mean 5.36, SD = 0.52.

Material examined. **GREECE.** ***Thessaly*: Larissa,** lectotype ♂, Mt. Ossa, no date, no collector (MZUF, Coll. No. 181, Cat. No. 5982); Mt. Ossa, no date, no collector, 4 ♀ (MNHNP RS 3765, 6792–6795); Mt. Ossa, NE slope, 500 m, 20 April 1968, leg. J. Martens, 2 ♂, 1 ♂ sbad. (SMF); Mt. Ossa, 500–700 m, 20 April 1968, leg. J. Martens, 1 ♀, 1 ♂ (SMF); Mt. Ossa, mountain refuge, 1550 m, N39°48', E22°41', 29 July 2001, leg. S. Simaiakis, 2 ♀, 1 ♂ (NHMC 2204); Mt. Ossa, summit, 1980 m, 29 July 2001, leg. M. Mylonas, 2 ♂ (NHMC 2205); Mt. Ossa, 1100 m, 30 July 2001, leg. S. Simaiakis, 2 ♂ (NHMC 2203); Mt. Ossa, 1030 m, near Karytsa, 30 July 2001, leg. M. Mylonas, 1 ♀ (NHMC 2208); Mt. Ossa, Karytsa – Anatoli, 18 km before Anatoli, N39°47', E22°45', 31 July 2001, leg. S. Simaiakis, 4 ♂, 8 ♀ (NHMC 2212); Mt. Ossa, 700 m, 7 km before Anatoli, 31 July 2001, leg. M. Mylonas, 3 ♀

	Pectinal Teeth Males	Pectinal Teeth Females	Ventral	*et*
E. scaber	9–13 (10.53) [53]	6–10 (7.85) [212]	7–10 (7.96) [273]	4–8 (5.86) [257]
E. candiota	8–9 (8.60) [16]	5–8 (6.87) [28]	8–10 (9.44) [46]	5–7 (6.52) [46]
E. ossae	8–10 (9.07) [14]	6–8 (7.25) [40]	6–9 (7.29) [55]	4–6 (5.36) [55]

Table 1: Statistical data for pectinal tooth counts and patellar trichobothria (ventral and *et* series) in three redescribed species. Minimum–maximum (mean) [Number of samples].

(NHMC 2214); Mt. Ossa, Anatoli – Spilia, 5 km before Spilia, 1150 m, N39°45', E22°40', 31 July 2001, leg. M. Mylonas; 5 ♀ (one with embryos) (NHMC 2215; *E. sicanus* in the same vial); Mt. Ossa, 29–30 July 2002, leg. M. Mylonas, 1 ♀ (NHMC); Melivoia, near Larissa, 13 August 1986, leg. K. Michalis & P. Dolkeras, 1 ♀ (ZMH); Stomion, near Larissa, 12 August 1986, leg. K. Michalis & P. Dolkeras, 1 ♂, 2 ♀ (ZMH).

Notes

1. The original description of Di Caporiacco (1950: 202) was based on four syntypes (1 ♂, represented only by "pedipalps and tail" and 3 ♀) from Ossa that he received from MNHMP. Bartolozzi et al. (1987: 297) also listed "syntypes male and female". However, only one male was found in MZUF under No. 181; three females, which we designate here as paralectotypes, were missing. From description of Di Caporiacco (1950: 202), we see that his three females had 7/7 (2) and 7/8 (1) pectinal teeth, and that number of ventral patellar trichobothria in four specimens was 7/7 (2), 8/8 (1) and 6/? (1) All external patellar trichobothria numbered 23, i.e. external terminal (*et*) series was always 5.

We found and studied four females from Mt. Ossa in MNHNP (RS 3765 6792–6795), also without date and collector. These could be syntypes returned to Paris by Di Caporiacco (who returned other scorpion specimens he loaned from outside Italy). We tried therefore comparing the MNHNP specimens to Di Caporiacco's description,

Judging from pectinal teeth number, at least one of MNHNP females (No. 6795) *does not* match Di Caporiacco's description, since it has 6/7 pectinal teeth. Other three females match the description with 7/8 (6792) and 7/7 (6793, 6794) teeth.

Ventral patellar trichobothria (*Pv*) counts of MNHNP females also *do not* completely match Di Caporiacco's data. MNHNP females have *Pv* = 7/7 (6793), 6/7 (6794), 7/8 (6792) and 7/? (6795; right pedipalp missing). Since lectotype male has *Pv* = 7/7, the 8/8 and 6/? females are not accounted for; instead, we have 7/8 (6792) and 7/? (6795) females not listed by Di Caporiacco (1950). As for the external terminal (*et*) series, in MNHNP females it was always 5 except for female 6794, which had 5/6, again not mentioned by Di Caporiacco (1950).

This excludes 6792, 6794, and 6795 females from syntypes, and leaves only 6793 as a possible match. Therefore, we cannot confirm that MNHNP (RS 3765) females include Di Caporiacco's paralectotypes, since at least three of the four do not match the original description.

Di Caporiacco (1950: 202) explicitly limited the types to Mt. Ossa. He also identified one additional female (MNHNP) as *E. c. ossae*, with *Pv* = 7/7 and 6/6 pectinal teeth. However, it does not belong to type series since its provenance was not known. This female was located along with six other *Euscorpius* specimens in a vial labeled "Mission antipaludique dott. Rivet, Macédoine, Salonique, Ostrovo, Verria, Albanie", i.e. embracing a wide range of localities across the Balkans. We did not find these specimens in MNHNP.

2. Four females deposited in MNHNP, as well as lectotype male in MZUF (and missing paralectotypes), were most likely collected by the postal official and zoologist Joseph Alois Stussiner (1850–1917) from Laibach (now Ljubljana, Slovenia) in 1884 during his excursion to Mt. Ossa and Tempe Valley. Stussiner's scorpion specimens, as well as numerous spiders and some harvestmen he collected, were promptly published (as *E. carpathicus*) by the famous French arachnologist Eugene Simon, in one of the first publications on the arachnids of Thessaly (Simon, 1885).

3. On Mt. Ossa, *E. ossae* is sympatric (but maybe not syntopic) with *E. sicanus* (C. L. Koch, 1837), ecologically the most dominant species throughout Greek mainland. Both species were collected together by Prof. Mylonas's group in 2001.

4. Currently, we limit the distributional range of *E. ossae* only to Mt. Ossa and its immediate environs (Larissa). Our DNA phylogeny (Parmakelis et al., in press) and an ongoing morphological study (Fet et al., in progress) demonstrated that a related but separate, undescribed species is found further north from Mt. Ossa, on Mt. Olympus. A limited material available from other localities in Thessaly needs a closer study and assessment via

	Euscorpius scaber				*Euscorpius candiota*	*Euscorpius ossae*	
	Mt. Athos, Greece			**Panagia, Thasos, Greece**	**Heraklion, Crete, Greece**	**Mt. Ossa, Thessaly, Greece**	
	Male Lectotype	**Female**	**Female**	**Male**	**Female Lectotype**	**Male Lectotype**	**Female**
Total length	27.95	26.20	25.80	29.10	39.15	N/A	42.30
Carapace length	4.00	3.80	4.10	3.85	5.50	N/A	5.95
Mesosoma length	9.50	9.40	8.30	10.25	17.25	N/A	17.05
Metasoma length	11.00	9.85	10.25	11.15	12.10	15.25	14.45
Segment I length/width	1.45/1.50	1.20/1.30	1.35/1.45	1.35/1.50	1.55/1.80	2.00/2.25	1.90/2.00
Segment II length/width	1.80/1.25	1.50/1.15	1.60/1.30	1.75/1.30	1.95/1.50	2.40/1.95	2.25/1.75
Segment III length/width	1.95/1.25	1.75/1.05	1.85/1.20	1.95/1.30	2.15/1.45	2.70/1.90	2.50/1.65
Segment IV length/width	2.30/1.15	2.15/0.95	2.20/1.10	2.35/1,25	2.50/1.35	3.20/1.80	2.95/1.55
Segment V length/width	3.50/1.20	3.25/1.05	3.25/1.15	3.75/1.30	3.95/1.40	4.95/1.90	4.85/1.60
Telson length	3.45	3.15	3.15	3.85	4.30	5.65***	4.85
Vesicle length	2.50	2.00	2.05	2.80	3.15	4.20	3.50
width/depth	1.35/1.40	1.10/0.90	1.20/1.10	1.40/1.40	1.30/1.30	2.10/2.35	1.65/1.50
Aculeus length	0.95	1.15	1.10	1.05	1.15	1.45***	1.35
Pedipalp length	13.80	13.90	13.65	13.90	18.95	20.25	20.45
Femur length/width	3.40/1.35	3.25/1.35	3.20/1.40	3.30/1.40	4.55/1.85	4.65/1.90	4.80/1.90
Patella length/width*	3.45/1.30	3.45/1.30	3.45/1.45	3.45/1.35	4.70/1.90	5.15/1.95	5.30/2.05
DPS height**	0.50	0.45	0.50	0.45	0.55	0.80	0.65
Chela length	6.95	7.20	7.00	7.15	9.70	10.45	10.35
Palm length	3.90	3.90	3.85	4.00	5.05	5.50	5.00
width/depth	2.70/2.90	2.30/2.60	2.50/2.70	2.65/3.00	3.25/4.05	4.05/4.40	3.50/4.00
Fixed finger length	2.90	2.70	2.90	2.90	4.05	4.75	4.45
Movable finger length	3.95	3.65	4.05	3.90	5.65	6.15	5.85
Sternum length/width	1.50/1.45	1.30/1.45	1.40/1.50	1.65/1.45	1.60/2.00	N/A	1.85/2.00
Pectines teeth	11/11	7/7	8/8	11/11	7/7	N/A	7/7
middle lamellae	6/7	4/4	4+/3+	6/6	5/5	N/A	4+/5

Table 2: Morphometrics (mm) of *Euscorpius scaber* Birula, 1900, *E. candiota* Birula, 1903, and *E. ossae* Di Caporiacco, 1950. * Patella width is widest distance between the dorsointernal and externomedial carinae. ** DPS height is from tip of spine to dorsointernal carina centered. *** Telson aculeus tip missing, length is an estimate.

DNA markers, given a high degree of isolation of Greek mountain ranges.

Discussion

Recently, Tropea & Rossi (2012: 30–31) compared and contrasted three taxa treated here (as subspecies) and noted certain variation in coloration, pectinal teeth, and trichobothrial number among them, based on limited literature data. Our further morphological study now allows to further characterize this variation (see above and a summary in Table 1). Among three redescribed species, *E. candiota* belongs to a separate, distantly related clade compared to the clade containing *E. scaber* and *E. ossae*, based on multiple DNA marker information (Parmakelis et al., in press). Number of variable ventral trichobothria is clearly higher (mean 9.44) in *E. candiota* than in (*E. scaber, E. ossae*) clade (1–2 trichobothria mean difference),

At the same time, number of pectinal teeth both in males and females is the lowest in *E. candiota* but increases in (*E. scaber*, *E. ossae*) clade. Especially in *E. scaber* we see a trend toward increase of pectinal teeth number, which reaches 10–11 in males. Such high values within subgenus *Euscorpius* s.str. are rare, known in *E. hadzii* (Fet & Soleglad, 2002) and *E. sicanus* complex (Tropea, pers. comm.; Fet, unpublished data), not closely related to *E. scaber*.

Along with dark coloration as a common trait for *E. scaber* and *E. ossae*, they differ considerably in divergent trends such as granulation, carination, size, and number of trichobothria. Number of trichobothria in variable series, clearly correlated in *Euscorpius*, diverge as follows: ventral, 8 in *E. scaber* (unimodal) versus 7–8 (bimodal, with 7 predominant) in *E. ossae*; external terminal, 6 in *E. scaber* (unimodal) versus 5–6 (bimodal, with 5 predominant) in *E. ossae*. This results in the summary number (*v+et*) (a metric first used for population mapping by Fet & Soleglad, 2007) diverging toward 14 in *E. scaber* (Macedonia) and toward 12 in *E. ossae* (Thessaly).

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