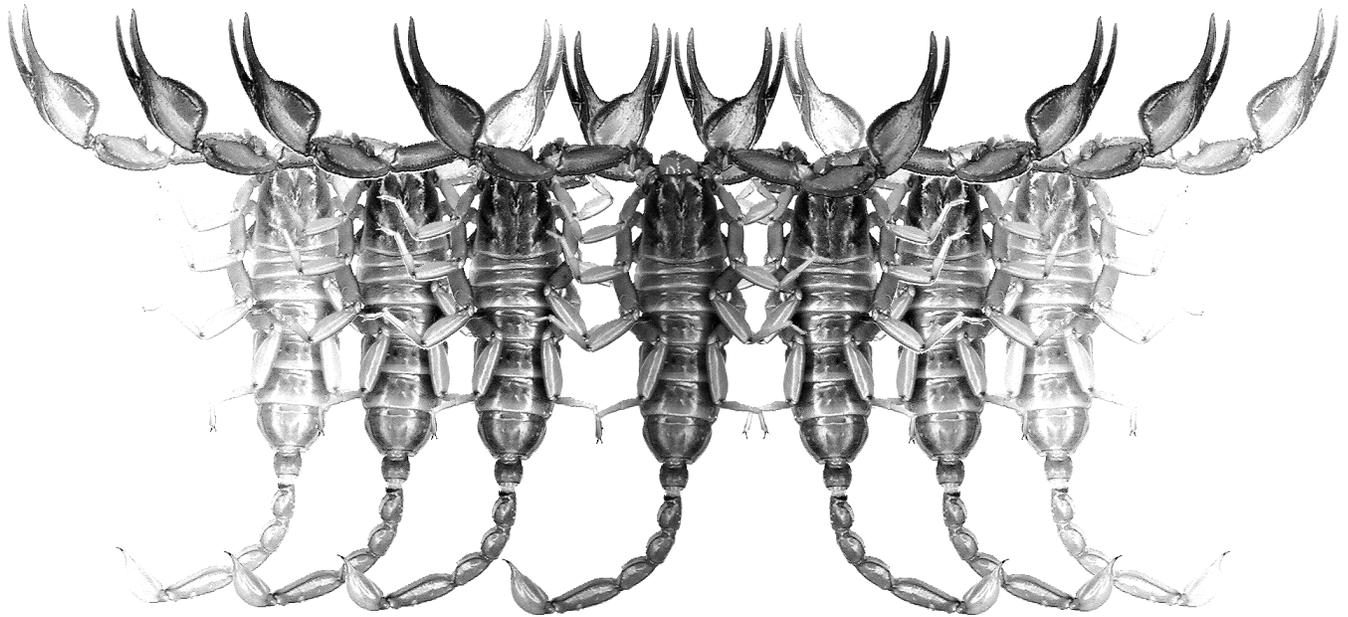


# *Euscorprius*

Occasional Publications in Scorpiology



**Morphology Analysis Supports  
Presence of More Than One Species in the  
“*Euscorprius carpathicus*” Complex  
(Scorpiones: Euscorpriidae)**

**V. Fet and M.E. Soleglad**

**September 2002 – No. 3**

# *Euscorpilus*

## Occasional Publications in Scorpiology

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

*ASSOCIATE EDITOR*: Michael E. Soleglad, 'soleglad@la.znet.com'

*Euscorpilus* is the first research publication completely devoted to scorpions (Arachnida: Scorpiones). *Euscorpilus* 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). *Euscorpilus* 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 *Euscorpilus* Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpilidae).

*Euscorpilus* is located on Website '<http://cos-server.marshall.edu/euscorpilus>' at Marshall University, Huntington, WV 25755-2510, USA.

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The International Code of Zoological Nomenclature (ICZN, 4th Edition, 1999) does not accept online texts as published work (Article 9.8); however, it accepts CD-ROM publications (Article 8). *Euscorpilus* is produced in two *identical* versions: online (ISSN 1536-9307) and CD-ROM (ISSN 1536-9293). Only copies distributed on a CD-ROM from *Euscorpilus* are considered published work in compliance with the ICZN, i.e. for the purposes of new names and new nomenclatural acts. All *Euscorpilus* publications are distributed on a CD-ROM medium to the following museums/libraries:

- **USNM**, United States National Museum of Natural History (Smithsonian Institution), Washington, DC, USA
- **AMNH**, American Museum of Natural History, New York, USA
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- **MNHN**, Museum National d'Histoire Naturelle, Paris, France
- **NMW**, Naturhistorisches Museum Wien, Vienna, Austria
- **BMNH**, British Museum of Natural History, London, England, UK
- **MZUC**, Museo Zoologico "La Specola" dell'Universita de Firenze, Florence, Italy
- **ZISP**, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia
- **WAM**, Western Australian Museum, Perth, Australia

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## Morphology analysis supports presence of more than one species in the “*Euscorpius carpathicus*” complex (Scorpiones: Euscorpiidae)

Victor Fet<sup>1</sup> and Michael E. Soleglad<sup>2</sup>

<sup>1</sup>Department of Biological Sciences, Marshall University, Huntington, West Virginia 25755-2510, USA

<sup>2</sup> P.O. Box 250, Borrego Springs, California 92004, USA

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### Summary

We investigate a number of scorpion populations from southern and central Europe, commonly classified under a “catch-all” name of *Euscorpius carpathicus* (L., 1767). This species includes a high number of described subspecies but its composition is not resolved. The detailed morphology analysis in the present paper includes a number of new characters, in particular individually mapped external patellar accessory trichobothria. It suggests that several clearly separated lineages are present. *E. carpathicus* (L.) is restricted here to geographically marginal populations from Romania (terra typica), which exhibit loss of one trichobothrium in the patellar series *em* (= 3). Another lineage (Austria, Croatia, Italy, France, Slovenia) is characterized here as *E. tergestinus* (C.L. Koch, 1837); it has a “standard” trichobothrial number in the patellar series *eb* (= 4), *eb<sub>a</sub>* (= 4) and *em* (= 4) and exhibits only variation in the ventral and *et* series. This species includes as new synonyms the following seven subspecies described by Caporiacco (1950): *E. c. apuanus*, *E. c. concinnus*, *E. c. niciensis*, *E. c. aquilejensis*, *E. c. picenus*, *E. c. oglasae*, and *E. c. corsicanus*. A very distinct Balkan lineage is delineated based on unique trichobothrial numbers in patellar series *eb* (= 5) and *eb<sub>a</sub>* (= 7); it is elevated here to the species status as *E. hadzii* Caporiacco, 1950 (Albania, Bosnia, Bulgaria, Croatia, Greece, Macedonia, Yugoslavia). This species includes as a new synonym *E. c. lagostae* Caporiacco, 1950. The fourth species-rank taxon confirmed here is *E. koschewnikowi* Birula, 1900 (Greece), with “standard” trichobothrial number in the patellar *eb* (= 4), *eb<sub>a</sub>* (= 4) and *em* (= 4) series but with other unique morphological features. We fix neotypes of *E. tergestinus* and *E. hadzii*, and a lectotype of *E. koschewnikowi*. These four species and *E. balearicus* Caporiacco, another member of this complex, are contrasted in detail using trichobothrial patterns, morphometric ratios and carinal development trends as diagnostic characters.

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### Introduction

Scorpions of the genus *Euscorpius* Thorell, 1876 (Scorpiones: Euscorpiidae) are very common in southern Europe (Fet & Sissom, 2000). Ecologically diverse, they occupy a variety of habitats from xeric to mesic, from the Mediterranean shoreline to the high altitudes of the Alps and Balkans. Linnaeus (1767: 1038) described *Scorpio carpathicus* from Transylvanian Alps (Romania) (now *Euscorpius carpathicus*, the type species of the genus). Thorell (1876) introduced a new generic name *Euscorpius* which has been the only valid name for this genus; see Fet & Sissom (2000) for the detailed discussion and list of synonyms. Numerous species have been described in *Euscorpius*. The traditional taxonomy of this genus, based mainly on morphosculpture and coloration characters, was complicated and confusing. Already C.L. Koch (1850: 86-87) gave a survey on all the *Euscorpius* species he had described in his series “Die Arachniden”, and clearly divided these species into

three groups according to the number of trichobothria (“Grübchen”) on the ventral aspect of pedipalp patella. By the end of the 19<sup>th</sup> century, Kraepelin (1899) considered only four “good” species, with a long list of synonyms. At this time, Birula (1900: 14) ironically noticed that “the genus *Euscorpius* belongs to such a category of systematic groups, in which the number of species accepted by a specialist depends on how well developed this specialist’s passion was to compile long columns of synonymous species names”. He quite correctly wrote further that “...only studying the morphology of all forms as related to their geographic distribution will we possibly make some positive conclusions about the classification of this genus”. Unfortunately, Birula did not live to see the advent of chaetotaxy – a detailed trichobothrial pattern analysis which brought a new age to the taxonomy of *Euscorpius* (as well as to other scorpions).

Large and conspicuous trichobothria of *Euscorpius* were already used as taxonomic characters by Hadži (1929, 1930) and Caporiacco (1950) who used overall

trichobothrial counts on different aspects of pedipalp chela and patella for delineation of species and subspecies. During the 50 years since Caporiacco's revision, many authors attended to the intricate and intriguing taxonomy of this commonest European scorpion genus (Vachon, 1963, 1975, 1978, 1981; Ćurčić, 1968, 1971, 1972; Kinzelbach, 1975; Valle, 1975; Bonacina, 1980, 1983; Fet, 1986, 1993, 1997a, 1997b; Scherabon, 1987; Lacroix, 1991a, 1991b, 1995). Traditionally, only four species were listed: *E. carpathicus*, *E. germanus*, *E. flavicaudis* and *E. italicus* (Kraepelin, 1899; Birula, 1900, 1917; Caporiacco, 1950; Vachon, 1963, 1981; Ćurčić, 1972; Vachon & Jaques, 1977). Later, Bonacina (1980) reestablished *E. mingrelicus*. Currently, there are 10 recognized species: *E. alpha*, *E. balearicus*, *E. beroni*, *E. carpathicus*, *E. gamma*, *E. germanus*, *E. flavicaudis*, *E. italicus*, *E. mingrelicus*, and *E. tergestinus* (Fet, 2000; Fet & Sissom, 2000; Gantenbein et al., 2000, 2001; Scherabon et al., 2000), and the "splitting" of some overly inflated taxa is likely to continue.

The most recent development in *Euscorpium* taxonomy was the introduction of molecular techniques by our research team which started with the pioneering paper of Gantenbein et al. (1999) on application of 16S ribosomal RNA gene sequence analyses to assess the phylogeny of the genus *Euscorpium*. This study provided the first ever published DNA-based phylogeny among the order Scorpiones. These data revealed a phylogenetic relationship between four species (*E. flavicaudis*, *E. carpathicus*, *E. italicus*, *E. germanus*) which was different from the former views on evolution of this genus, based only on morphology (Hadži, 1931; Kinzelbach, 1975). Further work of this team and its collaborators included more detailed genetic and morphological analysis of *E. germanus*, *E. alpha*, and *E. gamma* (Gantenbein et al., 2000; Scherabon et al., 2000) as well as *E. carpathicus* (Gantenbein et al., 2001; Huber et al., 2001).

## Discussion of Taxonomy

There is no comprehensive modern revision of *Euscorpium*, although this genus received a lot of attention from the Old World taxonomists starting with Linnaeus (1767) himself. Numerous species and subspecies have been described but their validity remains inconclusive, and changes constantly.

Main reason for this situation is that most authors in the past used unreliable morphological character sets to establish species (or subspecies). The traditional characters such as pectinal tooth number, coloration and metasomal carination (e.g. Birula, 1900, 1917) are often inconclusive, and so are total numbers of trichobothria which are variable on pedipalp manus and patella. Also, *Euscorpium* is so geographically diverse that the complete picture is often non-observable without analysis of many variable populations from many various countries

– a no small task – especially in the Balkans, the center of *Euscorpium* diversity. We gave serious consideration to the traditional morphological character sets – first of all, trichobothria (mechanosensory bristles on pedipalps).

Starting with Carl L. Koch (1837), large, variable in number and pattern, and easily observable trichobothria of *Euscorpium* pedipalp became a routine taxonomic character set reported by researchers (Birula, 1898, 1900, 1903, 1917; Calinescu & Calinescu 1930; Zottu, 1927). We emphasize, however, that understanding of *Euscorpium* morphological variation is impossible without separate treatment of patellar trichobothrial series (*sensu* Vachon, 1974), which unequally contribute to the variation among species. We know now that considering the total number variation of patellar trichobothria in *Euscorpium* (external or ventral) often obscures true valuable characters. Many attempts to separate taxa solely on the basis of trichobothrial number variation were not very successful and led to confusion (Hadži, 1929, 1930; Caporiacco, 1950; Ćurčić, 1972, Kinzelbach, 1975). The genus *Euscorpium* stands apart among all Euscorpiidae by its record number of described subspecies (Fet & Sissom, 2000; Fet, 2000; Gantenbein et al., 2000; Scherabon et al., 2000). This record number was achieved in 1890s-1970s by: (1) incorporating (without sufficient reasons) various described species-rank taxa under the "umbrella" of four main species: *E. carpathicus* (L. 1767), *E. flavicaudis* (DeGeer, 1778), *E. italicus* (Herbst, 1800), and *E. germanus* (C. L. Koch, 1837) (e.g. Kraepelin, 1899; Birula, 1900, 1917), and (2) further describing numerous subspecific forms in *E. carpathicus* (L. 1767), especially from Italy and the Balkans (Hadži, 1929; Caporiacco, 1950).

No formal subspecies at all were created within the genus *Euscorpium* before Hadži (1929) (except for "*E. tergestinus* "forma" *austriacus* Ferrari, 1872). Hadži (1929) for the first time attempted to treat enormous trichobothrial variation in *Euscorpium* (albeit only total number, not patterns). The set of "*oligotrichus*", "*mesotrichus*" and "*polytrichus*" names was published by Hadži in 1929 simultaneously (in the same work) for each of three species: *E. italicus*, *E. carpathicus* and *E. germanus*. The geographic treatment of Hadži was not exhaustive but concentrated on Balkan populations; Hadži (1930) continued discussion of these taxa. Later (Hadži, 1956), he explained that in erecting his 1929 subspecies he did not really adhere to the taxonomic standards (not too fixed at that time) and treated his "*oligotrichus*", "*mesotrichus*" and "*polytrichus*" forms (in each of the three species he studied) as meristic classes characterizing variation, rather than Latin names. Nevertheless, these names were, and should be, treated as available Latin names according to all further editions of the Code, up to the current 4<sup>th</sup> edition (ICZN, 1999). Caporiacco (1950) as "the first reviser" according to the

Code (ICZN, 1999, Article 24.2), declared that Hadži’s set of “*oligotrichus*”, “*mesotrichus*” and “*polytrichus*” names are available subspecific names only for *E. italicus* and therefore are homonyms for *E. carpathicum* and *E. germanus*.

Modern scorpion taxonomy based on trichobothria (Soleglad & Fet, 2001) historically started with *Euscorpium* species (Vachon, 1963); already 40 years ago Vachon appreciated the diversity of their trichobothrial counts and patterns. It is interesting that both Hadži (1929, 1930) and Caporiacco (1950) appreciated variation in trichobothrial counts of *Euscorpium*, but used total numbers for ventral and external patellar aspects. Such an approach obscured variation within individual series, which became obvious only when Vachon (1963, 1974, 1975) and Valle (1975) started distinguishing trichobothrial “series” on the external patellar aspect.

Since Caporiacco (1950) described numerous subspecies of *E. carpathicum* (mostly from Italy), only Valle (1975) attempted to discuss some of those using criteria of trichobothriotaxy. Probably because Valle used the old system of Vachon (1963) for designations of patellar external trichobothria, his data were not noticed by further researchers. However, comparing Fig. 1 in Valle (1975; scored for both sides) and Fig. 3 in Vachon (1963), we can adjust this system to the convention used today (Vachon, 1975 and later; scored for one side only) with the following formulas: D1 (variable) = (*et*-right - 1) + (*et*-left - 1); D2 (constant, always 8, i.e. 4 on each side) = 2 x (2 from *et* and 2 from *est*); D3 (constant, always 6, i.e. 3 on each side) = 2 x [(*est* - 2) + 1] (*est* is always 4); D4 (variable) = *em*-right + *em*-left; B4 (constant, always 4, i.e. 2 on each side) = *esb*-right + *esb*-left (*esb* is always 2); B3 (variable) = *eb<sub>a</sub>*-right + *eb<sub>a</sub>*-left; B2+B1 (B2 variable; B1 constant, always 2, i.e. 1 on each side) = *eb*-right + *eb*-left. This rather elaborate adjustment allows one to use Valle’s statistical data, which are based on the analysis of large series from various localities, in much more detail than in Caporiacco (1950) who used only total counts for patellar external trichobothria. Valle (1975) was therefore the first to identify the most important trend in the neobothriotaxy of *E. carpathicum* complex: variation of B2 + B1 series (i.e., variation of *eb*).

Valle’s system, borrowed from an old scheme created by Vachon (1963), was not used by any subsequent authors (e.g. Bonacina, 1980, 1983; Fet, 1986, 1993, 1997a, 2000; Scherabon, 1987; Michalis & Dolkeras, 1989; Soleglad & Sissom, 2001) who followed the nomenclature of Vachon (1974, 1975, 1978). Those authors who did not consider the trichobothrial character set important (or limited its use only to ventral patellar series) often obtained inconclusive or superficial results (Kinzelbach, 1975, 1982, 1985; Kritscher, 1993).

Soleglad & Sissom (2001: 70-73) demonstrated in detail the inherent problems of using total trichobothrial

numbers found on pedipalp surfaces in their comparisons of various cladistic based models of neobothriotaxy. In their approach, trichobothria numbers were confined to those found in individual patellar series thus establishing, in a sense, homology at the series level. Soleglad & Fet (2001), in their analysis of the evolution of scorpion orthobothriotaxy, improved on this modeling by establishing *individual* homologies for all trichobothria, thus each trichobothrium was considered separately in a cladistic sense. This same technique was employed in this study except the application of homology argumentation was applied to *accessory* trichobothria of the pedipalp patella, therefore modeling the neobothriotaxic condition found in *Euscorpium*.

In the late 1990s, our research group and its associates were the first to apply modern molecular techniques to *Euscorpium* systematics (Fet et al., 1999; Gantenbein et al., 1999, 2000, 2001; Scherabon et al., 2000; Huber et al., 2001). The first phylogenies provided by mitochondrial DNA sequence analysis changed the systematics of *Euscorpium* dramatically, revealing lineages not suspected before from morphological approach only. In its turn, DNA data helped to reorient morphological analysis towards important character sets.

A recent study (Gantenbein et al., 2001) elevated an isolated *E. carpathicum* population (subspecies) from Balearic Islands to the species status as *E. balearicum*. The data reported in this present paper suggest that *E. carpathicum* (L., 1767) should be restricted to geographically marginal, “oligotrichous” populations from Romania (terra typica), which commonly exhibit loss of one trichobothrium in the patellar series *em*. Another, “mesotrichous” “western” lineage (Italy, France, Slovenia, Croatia, Austria) is treated here as a valid species *E. tergestinus* (C.L. Koch, 1837); it has a “standard” patellar trichobothrial number in series *eb*, *eb<sub>a</sub>* and *em* (four in each series) and exhibits only variation in series *et*. In contrast, a separate “polytrichous” Balkan lineage is observed with larger numbers of patellar trichobothria in series *eb* and *eb<sub>a</sub>*; it is elevated here to the species status as *E. hadzii* Caporiacco, 1950. The fourth species-rank taxon confirmed here is *E. koschewnikowi* Birula, 1900 (northeastern Greece) which possesses a “standard” trichobothrial number but exhibits other unique morphometric features.

It is important to note that the five species discussed in the present paper do not embrace all diversity of populations traditionally placed under *E. carpathicum*. Gantenbein et al. (2001) demonstrated that “western” populations from France and Italy (established in this paper as *E. tergestinus*) are genetically distant from “eastern” “*E. c. candiota* Birula” (type locality Crete), although all of them have the “standard” trichobothrial pattern (“Group A” of Fet, 2000). Status of “*E. c. candiota*” and other Aegean and Balkan populations, as well as populations from Turkey and Crimea, remains to be

addressed (see Fet, 1997a, 2000; Fet & Braunwalder, 2000). Kinzelbach (1975) maintained that all forms of *E. carpathicus* complex which had intermediate number of ventral patellar trichobothria are in fact hybrids between *E. carpathicus* and “*E. mesotrichus*” (see below). One of the conclusions in this theory was that *E. carpathicus candiota* Birula from Crete is a hybrid. However, our preliminary DNA and allozyme data on this crucial population (Gantenbein et al., 2001) in comparison with other forms from the Balkans (Fet et al., in progress) do not indicate any hybrid characterization of “*E. c. candiota*”.

There are also some deviations from the “standard” trichobothrial pattern in *E. carpathicus* complex which require a further study. An enigmatic Balkan form, *E. g. croaticus* Caporiacco, 1950 (Velebit Mts., Croatia), which has *em* (=3), was moved by Gantenbein et al. (2000) to the *E. carpathicus* complex. Still another, unnamed form with *em* (=3) is found in the Rodope mountains of Bulgaria (“Group C” of Fet, 2000: 55, 58). At this moment such forms cannot be synonymized with *E. carpathicus* (L.), *s.str.*

Fet & Braunwalder (2000) outlined the controversy surrounding some Greek populations of *E. carpathicus* complex, named “*E. mesotrichus*” by Kinzelbach (1975). Kinzelbach (1975) divided *E. carpathicus* into two species, designating the second one as *E. mesotrichus* Hadži, 1929. The latter name, however, is not available since it is a junior homonym of *E. italicus mesotrichus* Hadži, 1929 (Fet 1997b). According to the International Code of Zoological Nomenclature (ICZN, 1999), the correct name for such species should be *E. tergestinus* (C. L. Koch, 1837) (this name was listed by Kinzelbach (1975) as a synonym of his “*E. mesotrichus*”). Kinzelbach (1975) further classified all described subspecific forms of *E. carpathicus* in two species (without providing sufficient justification), and observed sympatry of two different forms of *E. carpathicus* complex in Greece (Thessaly). The name “*E. mesotrichus* Hadži” was used afterwards by some authors (Vachon & Kinzelbach, 1987, Kritscher, 1993), while others (Bonacina, 1983; Fet, 1986, 1997a) did not accept Kinzelbach’s division. Fet & Sissom (2000) tentatively accepted Koch’s name *E. tergestinus* for those populations, using this name as an available senior synonym of homonymous *E. c. mesotrichus* Hadži. However, our current studies (Fet et al., 2002b; in progress) indicate that the Thessalian populations belong not to *E. tergestinus* (as defined in this present paper) but to at least one more separate lineage of *E. carpathicus* complex. This refers also to a number of Italian subspecies established by Caporiacco (1950) which do not fall under “standard” diagnosis of *E. tergestinus*. Further investigation of the

“*Euscorpius carpathicus*” species complex is warranted, first of all for a number of poorly studied (both named and unnamed) populations in the Balkans, Turkey, and Italy.

## Methods and Material

All measurements (i.e., morphometrics) presented in this paper are in millimeters (*mm*). For meristic and morphometric statistical data presented in this paper the following conventions are used:

*min - max (mean) (±SD) [n] {cmin - cmax} § cv*

for the above *statistical data group*, *min* = minimum value, *max* = maximum value, *SD* = standard deviation, *n* = number of samples, *cmin* = corrected minimum (*mean-SD*), *cmax* = corrected maximum (*mean+SD*), *cv* = coefficient of variability (*SD/mean*). The range established by the corrected minimum and maximum is referred to as the *plus/minus standard error* range. Each statistical data group represents a dataset based on some specified partitioning (e.g., a species, a subspecies, a population, a genus, a gender, etc.).

Terminology describing chelal finger dentition and pedipalp ornamentation follows that described and illustrated in Soleglad & Sissom (2001).

## Morphometric Ratios

The *Euscorpius* morphometric database is a project in progress, additional measurement sets are being added as more material becomes available and new studies are pursued. Presently, we have collected over 195 sets of measurements from sexually mature specimens representing over 4400 separate measurements — all known species of *Euscorpius* are represented. In this study 71 morphometric sets were processed across the five *Euscorpius* species addressed in this paper, 62 complete measurement sets (26 separate structure morphometrics each) and 9 representing sparse measurement sets (a set where all morphometrics are not present), in all, 38 females and 33 males were measured. Individual morphometrics comprising the measurement set are presented in Tables 1-3. The 26 morphometrics do not include *total length*, *mesosoma length* or *aculeus length*. The *metasoma length* is the sum of the lengths of its five segments and the *pedipalp length* is the sum of the lengths of the femur, patella and chela. Finally, the width of the pedipalp patella does not include the dorsal patellar spur (DPS).

Only measurements from sexually mature specimens were collected for the database. Sexual maturity of *Euscorpius* male specimens is quite apparent due to the exaggerated basal scalloping found on the pedipalpal

fingers and the considerably swollen telson vesicle, present both ventrally and laterally. Other indications are well developed pectines, exhibiting elongated teeth, and the genital papillae extending from the genital operculum. It is interesting to note that the swollen telson is not as exaggerated in the species of subgenus *Alpiscorpius*, nor in the subgenus *Tetratrachobothrius* (which includes the unique species *E. flavicaudis*), otherwise, sexually mature males of *E. italicus* and members of the *E. carpathicus* complex are quite apparent by the swollen telson alone. Maturity in female specimens is not as easy to determine, in general, only “large” specimens were used unless, based on the establishment of small sexually mature males within a population, smaller females were then utilized from that same population. Although ontogenetic differences in morphometric proportions certainly exist in *Euscorpius* to one degree or another, it clearly is the most defined in male specimens. Therefore, using sexually mature males is the most essential in conducting morphometric analysis.

In order to isolate potential morphometric ratio diagnostic characters, all possible morphometric ratios are first calculated and compared across two datasets for differences within some specified threshold. The number of possible ratios is  $n!/(n-r)!r!$ , where  $n$  is the number of morphometrics and  $r = 2$  (i.e.,  $n$  measurements taken two at a time). For this study 26 morphometrics were gathered for a large majority of specimens (considered a “full morphometric set”), therefore 325 unique ratios were calculated and compared across all possible combinations of all datasets taken two at a time (i.e., the comparison always involves two datasets). The datasets in this study were partitioned into sexually mature females and males, five species, thus ten possible dataset comparisons per gender, a total of twenty. For sexual dimorphism analysis, males and females were compared within each species, five possible dataset combinations. Also, where appropriate, subspecies and/or populations of a species were also segregated into datasets for comparison.

In this approach we calculate all possible ratios using a specific morphometric, thus determining the percentage that the morphometric is deemed “relatively large” (or “small”). A morphometric is considered “relatively large” if it is involved in a ratio whose mean value is larger in comparison and where one of the following is true: 1) it is the numerator of the ratio that is larger, or, 2) it is the denominator of the ratio that is smaller (note that, the notion of “relatively small” is equally valid, except one must reverse the conditions stated above). The ratio mean value is used since it is based on all specimens of a particular dataset. This process is initiated for all morphometrics. If the percentage of “being larger” for a particular morphometric is high, then it can be assumed with some confidence that the morphometric is in general larger (or

smaller) with respect to the other morphometrics for that dataset as compared to the same morphometric in the other dataset. For example, when we state that the carapace of one dataset is “larger” than the carapace of the other dataset — we are really stating that when used in ratios calculated from all possible morphometrics, it was “relatively larger” in a significant majority of the comparisons. We only concentrate on those morphometrics that exhibit the highest percentage of compliance to being “larger” (or “smaller”). Once these unique morphometrics are identified, meaningful ratios by combining these morphometrics across datasets can be constructed which provide the maximum differences that can be then established as significant diagnostic characters — the ultimate goal of this process. In general we consider any ratio based diagnostic character “significant” if the resulting ratio ranges based on plus/minus standard error show separation. The larger the separation (i.e., the “gap”) the more significant the diagnostic character. Finally, we are only interested in morphometric ratios that hold true for both male and female specimens thus making them optimal as useful diagnostic characters.

### Abbreviations

BG, private collection of B. Gantenbein; BMNH, Natural History Museum, London, UK; CAS, California Academy of Sciences, California, USA; LSL, Linnean Society of London, UK; MES, private collection of M. E. Soleglad; MZUF, Museo Zoologico “La Specola” dell’Università de Firenze, Florence, Italy; NMM, Naturhistorisches Museum, Mainz, Germany; NMW, Naturhistorisches Museum Wien, Vienna, Austria; NMNHS, Natural History Museum, Sofia, Bulgaria; PAN, Polish Academy of Science, Warsaw, Poland; UL, University of Ljubljana, Slovenia; USNM, United States National Museum (Smithsonian Institution, Washington, DC, USA); VF, private collection of V. Fet, Huntington, West Virginia, USA; ZISP, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia; ZMB, Zoologisches Museum, Humboldt Universität, Berlin, Germany; ZMH, Zoologisches Museum Universität Hamburg, Hamburg, Germany; ZMMSU, Zoological Museum, Moscow State University, Moscow, Russia. Specimen numbers from MZUF are given as AAA/BBBB, where AAA is the “collection number” and BBBB is the “catalog number”.

### Systematics

The phylogenetic reevaluation of the genus *Euscorpius* is presently comprised of several joint efforts involving many research specialists (listed above) spanning molecular, morphological and biogeographic knowledge, together aiming for a revised taxonomy based on, pri-

marily, cladistic techniques. The *Euscorpius* “database” is in actuality a set of disjoint information, much of it in digital form, comprised of molecular sequences, tabulations of important meristic data such as trichobothria and pectinal tooth counts, morphometrics (i.e., measurements) extracted from sexually mature material, other structural characteristics, and detailed correlated geographic locality data. These data have been gathered from several sources — material collected by the research specialists themselves, material borrowed from colleagues and museums throughout the world, and from the massive literature that addresses the genus *Euscorpius*.

The most significant effort in the morphology portion of this analysis is the establishment of individual homologies across all major accessory trichobothria found in *Euscorpius*, in particular, those found on the external aspect of the patella. These homologues, in conjunction with other characters both morphological and molecular in nature, will be used in a comprehensive reevaluation of the genus using cladistic techniques aimed specifically at the upper intrageneric phylogeny of the genus (Fet, Soleglad & Gantenbein, in progress). Based on preliminary results from this ongoing analysis, it was clear that trichobothrial patterns involving the external *eb*, *eb<sub>a</sub>* and *em* series were of particular importance in the phylogeny of this genus, and in particular series *eb*. This emphasis on the basal series is intuitive, in part, by reflecting on the stability of the basal series exhibited within other family members of Euscorpiidae (this was discussed in detail by Soleglad & Sissom (2001: 49-54) in their revision of Euscorpiidae). The more distal external series (i.e., *et*) and ventral series show much more variability and therefore are less important, only providing species level distinctions. In general the patellar external basal trichobothrial series in *Euscorpius* are quite stable within designated subclades thus providing significant characters at the highest intrageneric levels. Although we will not present established homologies for these important series in this paper (the analysis is still in progress), we can state here however, that based on preliminary results, we can segregate the five species discussed in this study into three groups based on the presence or absence of accessory trichobothria in these three external series: *eb* = 4, *eb<sub>a</sub>* = 4 and *em* = 4; *eb* = 4, *eb<sub>a</sub>* = 4 and *em* = 3; and *eb* = 5, *eb<sub>a</sub>* = 7, and *em* = 4. These three basic configurations and their relationships to the species covered in this study are discussed in detail elsewhere in this paper.

Considerable analysis involving morphometrics and subsequent derived ratios was also conducted, uncovering several good diagnostic characters for species differentiation, as well as identifying specific sexual dimorphism distinctions within a species.

Our analysis of this new morphological data suggests that several clearly separate lineages are present within

*Euscorpius carpathicus* (L.). At this time, based on the large material available, we introduce four diagnosable species: *E. carpathicus* (L., 1767) (*sensu stricto*); *E. tergestinus* (C.L. Koch, 1837); *E. hadzii* Caporiacco, 1950; and *E. koschewnikowi* Birula, 1900. These four species are compared here in detail to the recently re-described species *E. balearicus* Caporiacco, 1950 (Gantenbein et al., 2001), another member of the *E. carpathicus* complex.

### *Euscorpius carpathicus* (Linnaeus, 1767), *sensu stricto*

(Figs. 1, 3-12, 62, 65 and Table 1)

*Scorpio carpathicus* Linnaeus, 1767: 1038. **Holotype:** female, permanently deposited in the Linnean Society of London, No. 58. This female specimen (personally examined by V. F.), apparently subadult, was dried and pinned, and the right pedipalp and metasoma were detached and kept in a separate glass vial. Linnaeus (1767) states it originated from “Montibus Carpathicis”, which most likely refers to the Transylvanian Alps in modern southwestern Romania.

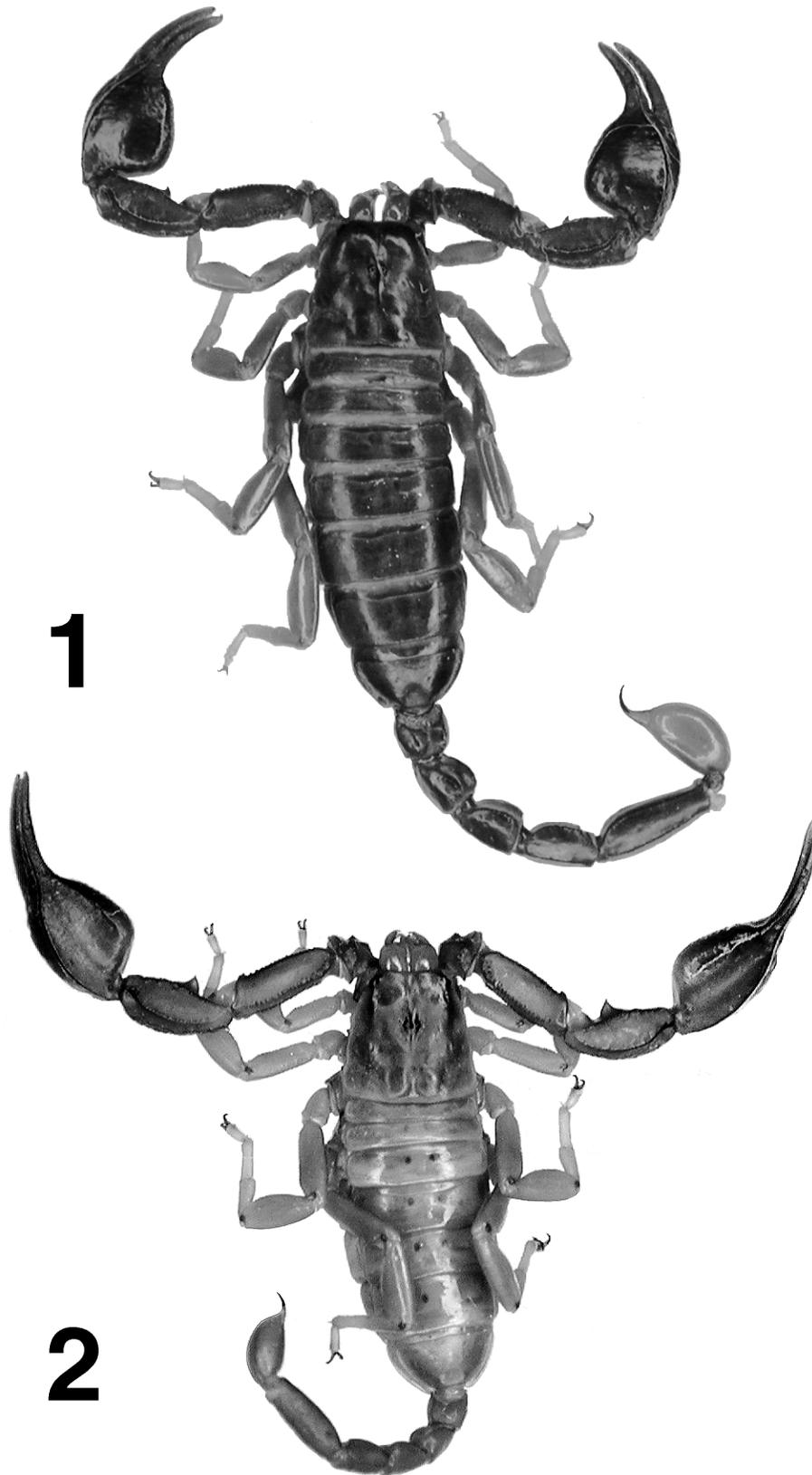
#### Synonyms.

*Scorpius banaticus* C. L. Koch, 1841: 111-112, pl. CCLXXXIII, Fig. 679-680. **Lectotype** (designated here): male (BMNH), Oravit[z]a, Banat, Hungary, now Romania (Rosenhauer). **Paralectotype:** 1 female (BNMH), same label. **Notes:** Fet & Sissom (2000: 362) considered types of this taxon lost, but in December 2000 two syntypes were discovered by V.F. in London; according to the accompanying information, these specimens were donated to BMNH by Ludwig Koch in 1913. The male syntype was dismembered between metasomal segments I and II and the left pedipalp. The female was dismembered between metasomal segments I and II. Four labels were found in the vial: 1) Ungarn Rosenhauer (handwritten); 2) (four lines) *Euscorp. carpathicus* L., *banaticus* C. Koch, types, Ungarn Rosenhauer (handwritten); 3) 13.9.1.100.101 (handwritten); 4) *Euscorpius carpathicus* L (handwritten).

*Scorpius oravitensis* C. L. Koch, 1842: 17-18, pl. CCCXXX, Fig. 765. Holotype (female; lost); Oravit[z]a, Hungary, now Romania (Rosenhauer).

#### References (selected).

- Euscorpius carpathicus*: Zottu, 1927: 101-103; Bunesco, 1959: 90, 93-94, Fig. 1 (map).  
*Euscorpius carpathicus carpathicus*: Caporiacco, 1950: 201-202 (part); Fet & Sissom, 2000: 361.



**Figures 1-2:** 1. *Euscorpius carpathicus* (Linnaeus), male, Mehadija, Romania. 2. *Euscorpius balearicus* Caporiacco, female, Puerto Alcudia, Mallorca, Balearic Islands, Spain.

*Euscorpium germanus banaticus*: Vachon & Jaques, 1977: 409-436, Figs. 1-17; Lacroix, 1991a: 20, Fig. 94, 105-107, 117-119.

*Euscorpium carpathicus banaticus*: Bonacina, 1983: 3-10, Figs. 1-8; Fet & Sissom, 2000: 362.

**Taxonomic history.** The Linnean holotype specimen (a dried, pinned subadult female) is kept in the collection of the Linnean Society of London (LSL). According to Linnaeus (1767), it originated from “Montibus Carpathicis”. This most likely refers to the Transylvanian Alps in modern southwestern Romania (Fet et al., 2002a). It is the only species of scorpion inhabiting this area, where it appears to be common in at least three isolated drainages in the Danube watershed as far east as the upper reaches of Buzeu River; see detailed map of Bunescu (1959). Scorpions are not found anywhere else in the Carpathian Mountains (Fet & Sissom, 2000).

The Linnean *Scorpio carpathicus* became the type species of the genus *Euscorpium* (Thorell, 1876); it is also the oldest published name for this genus (see Fet et al., 2002a for the detailed analysis of the scorpion species described by Linnaeus). A large number of other species described from Europe was later synonymized with *Euscorpium carpathicus* (L.), and this name became widely accepted since the 1870s (Kraepelin, 1899; Birula, 1917; Fet & Sissom, 2000). Fet & Sissom (2000) give the geographic range of this species in southern Europe from Spain to the Balkan Peninsula and further east (Crimea, Turkey). Among numerous subspecific forms deemed valid by Caporiacco (1950), the nominotypic subspecies, “*E. carpathicus carpathicus*” was poorly defined both in morphology and geographic range.

Populations of *E. carpathicus* from Romania (easternmost boundary of the genus’ continuous range in Europe) have been recorded and studied for many years by a number of zoologists since Linnaeus (1767). However, these disparate data were never collated or compared to the Linnean specimen. C. L. Koch (1841, 1842) described two new species of *Euscorpium* from nearly the same place in modern Romania (territory of Hungary in the 1830s), *Scorpius banaticus* and *S. oravitzensis*. Both of these were synonymized to *E. carpathicus* (see e.g. Kraepelin, 1899) and Romanian populations were addressed as such, without any comparative analysis (Zottu, 1927; Calinescu & Calinescu, 1930; Bunescu, 1959).

Hadži (1929, 1930), Caporiacco (1950) and Valle (1975) did not study Romanian specimens in detail. Caporiacco (1950) analyzed only a single specimen from “Hungary” (now Romania) and was not conclusive as of the geographic range of the nominotypic subspecies. Kinzelbach (1975) published a short information (based on a letter of Dr. O. Kraus) on the Linnean holotype, deposited in the Linnean Society of London (LSL).

There was, however, no detailed data on morphology of the Romanian population.

Such data appeared in abundance in the late 1970s, when Vachon & Jaques (1977) analyzed a very large series (403 specimens) of “*Scorpius banaticus*” collected by C. Chyzer from Herkulesfürdo, now Baile Herculane, in Romania (historical Banat). Vachon & Jaques (1977) concluded, however, that this population belongs to *E. germanus* because of the character *em* (= 3). Bonacina (1983) studied a new series from Romania (Mt. Cozia), with *em* (= 4), and refuted opinion of Vachon & Jaques (1977); he placed *Scorpius banaticus* back in *E. carpathicus*, without a discussion of subspecies status. Fet & Sissom (2000) noted that the scope and range of the nominotypic subspecies of *E. carpathicus* were not clear.

Our current analysis of the available types of both *Scorpio carpathicus* Linnaeus, 1767 and *Scorpius banaticus* C. L. Koch, 1841, together with the study of additional material, shows clearly that these forms belong to the same species.

**Diagnosis.** Medium sized species, dark brown in overall coloration, no distinct patterns present. Metasomal segments and chelae somewhat stocky in appearance. Dorsal patellar spur (DPS) of reduced to medium development (see detailed morphometric analysis presented elsewhere). Pedipalp patellar external trichobothria numbers: *eb* = 4, *eb<sub>a</sub>* = 4, *esb* = 2, *em* = 3, *est* = 4, and *et* = 5-7 (6); ventral aspect of patella 7-9 (8). Metasomal inferior lateral carinae obsolete on segments I-III and inferior median carina obsolete on segments I-IV. Pectinal tooth counts: male 7-10 (8+), female 6-9 (7). Trichobothria *em* series (= 3) and the reduced DPS are key diagnostic characters for this species.

**Male.** Redescription based on *Euscorpium carpathicus banaticus* male lectotype (structure details not available from this type are supplied from a mature male from Mehadija, Romania and noted as such). Measurements of male and female syntypes and other material provided in Table 1. All illustrations are based on mature specimens originating from Mehadija, Romania. Dorsal view of a sexually mature male is shown in Fig. 1.

**Coloration.** Overall basic color dark brown; legs, chelicerae and telson yellow-orange; pectines yellow. Pedipalp carinae slightly darker than segments. Void of any patterns.

**Carapace.** Smooth and shiny at 10x (Fig. 3); anterior edge straight, lacking setae. Two lateral eyes, anterior eye slightly larger; median eyes and tubercle situated anterior of middle with following length and width formulas: 262|575 (anterior edge to median tubercle center|carapace length) and 79|492 (width of median tubercle|width of carapace at that point).

	Banat, Romania ( <i>E.c. banaticus</i> types)		Baile Herculane, Romania			Mehadija, Romania	
	Male	Female	Male	Female	Female	Male	Female
<b>Total length</b>	37.15	32.75	30.00	40.00	33.65	34.90	30.95
<b>Carapace length</b>	5.75	5.20	5.00	5.45	4.90	4.75	4.70
<b>Mesosoma length</b>	9.95	10.90	6.80	16.75	12.55	12.15	10.50
<b>Metasoma length</b>	15.85	12.55	13.15	13.30	12.00	13.15	11.75
<b>Metasomal segment I</b>							
<b>length</b>	2.05	1.70	1.70	1.75	1.50	1.70	1.55
<b>width</b>	2.25	1.95	1.85	2.05	1.85	1.95	1.95
<b>Metasomal segment II</b>							
<b>length</b>	2.45	1.95	2.05	2.05	1.90	2.05	1.80
<b>width</b>	1.95	1.75	1.70	1.85	1.60	1.80	1.70
<b>Metasomal segment III</b>							
<b>length</b>	2.70	2.15	2.25	2.30	2.10	2.30	2.00
<b>width</b>	1.85	1.70	1.60	1.75	1.50	1.70	1.60
<b>Metasomal segment IV</b>							
<b>length</b>	3.30	2.60	2.80	2.85	2.50	2.80	2.50
<b>width</b>	1.75	1.55	1.55	1.60	1.45	1.60	1.45
<b>Metasomal segment V</b>							
<b>length</b>	5.35	4.15	4.35	4.35	4.00	4.30	3.90
<b>width</b>	1.75	1.55	1.45	1.60	1.50	1.60	1.50
<b>Telson length</b>	5.60	4.10	5.05	4.50	4.20	4.85	4.00
<b>Vesicle length</b>	4.20	2.70	3.55	3.15	2.95	3.55	2.85
<b>width</b>	2.15	1.50	1.85	1.70	1.50	2.10	1.50
<b>depth</b>	2.40	1.45	2.05	1.70	1.45	2.10	1.40
<b>Aculeus length</b>	1.40	1.40	1.50	1.35	1.25	1.30	1.15
<b>Pedipalp length</b>	20.00	16.95	16.15	17.75	16.00	16.20	15.75
<b>Femur length</b>	4.75	4.10	3.95	4.35	3.95	3.90	3.75
<b>width</b>	1.80	1.55	1.55	1.80	1.55	1.55	1.55
<b>Patella length</b>	4.75	4.25	4.05	4.50	4.00	4.20	4.05
<b>width</b>	2.00	1.85	1.80	2.10	1.90	1.70	2.05
<b>Chela length</b>	10.50	8.60	8.15	8.90	8.05	8.10	7.95
<b>Palm length</b>	5.35	4.40	4.10	4.55	4.20	4.10	4.20
<b>width</b>	3.65	3.20	2.95	3.45	2.90	3.00	2.95
<b>depth</b>	4.40	3.75	3.40	4.10	3.50	3.55	3.45
<b>Movable finger length</b>	6.40	4.90	4.90	5.25	4.60	4.90	4.50
<b>Pectines</b>							
<b>teeth</b>	10-9	7-7	9-9	8-7	7-7	8-7+	7-7
<b>middle lamellae</b>	5-5	x-x	5-6	5-5	4-4+	5+-5+	4-4

**Table 1:** Morphometrics (mm) of *Euscorpium carpathicus* (Linnaeus).

**Mesosoma.** Tergites smooth lacking carination on segment VII; sternites smooth and shiny, carinae absent on segment V; stigmata quite small, slit-like to sub-oval.

**Metasoma.** Generally stocky in proportions. Carinae — Segments I-IV: dorsal rounded and slightly granulose on I, granulose on II-IV; dorsal lateral obsolete on I, weak and slightly granulose on II-IV; lateral obsolete; inferior lateral obsolete on I-III, smooth on IV; inferior median obsolete. Carinae — Segment V (Fig. 10): dorsal lateral rounded and rough; lateral slightly rounded; infe-

rior lateral and median with slight granulation. Intercarinal areas smooth.

**Telson.** Vesicle smooth, swollen both laterally and ventrally (Figs. 6-7, male, Figs. 8-9, female). Aculeus forming a short conspicuous curve; 4-5 pairs of setae at vesicle/aculeus juncture. See Figs. 6-7 for lateral and ventral views of male telson from Mehadija, Romania.

**Pectines.** Length|width formula 403|147 (length taken at anterior lamellae|width at widest point including teeth). Pectinal tooth counts 10/9 and middle lamellae

counts 5/5; fulcra well developed; numerous fine setae situated on anterior lamellae. Sensorial areas of teeth developed along approximately 1/3 their length. Basal piece anterior edge slightly concave, length|width formula 73|136 (damaged on lectotype, data taken from sexually mature male from Mehadija, Romania).

**Genital operculum.** Separated most of length, genital papillae extends proximally (damaged on lectotype, data taken from sexually mature male from Mehadija, Romania).

**Sternum.** Pentagonal, wider than long, length|width formula 178|199.

**Chelicerae.** Movable finger: dorsal distal denticle considerably shorter than ventral distal denticle; dorsal edge with two subdistal denticles; ventral edge smooth, lacking serrulae, and covered with heavy brush-like setae for most of its length. Fixed finger: four denticles configured normally (basal two denticles conjoined on a common trunk).

**Pedipalps.** Pedipalps with somewhat stocky chelae exhibiting prominent scalloping at finger bases. Femur: dorsal and ventral internal and external carinae crenulate to serrulate; dorsal and ventral surfaces granulose, internal surface with numerous enlarged granules, and external surface smooth. Patella (Fig. 11, female): dorsal internal and ventral external and internal carinae granulate, dorsal external smooth, and exteromedian rounded and irregularly granulate. Dorsal surface granulose, ventral granulose external half, and dorsal patellar spur (DPS) of weak to medium development, ventral patellar spur (VPS) very weak, represented as small granule. Chela carinae (Figs. 4-5): digital very strong and smooth; subdigital in relief, represented by 1-2 granules; dorsal secondary obsolete; dorsal marginal rounded, continuous and with rough surface; dorsal internal rounded and smooth; ventroexternal strong extending to external condyle of finger, external to trichobothrium  $Et_1$  and smooth with some shiney granulation on proximal one-half; ventromedian essentially obsolete; ventrointerior rounded and smooth; and external secondary strong and irregularly granulose. Chelal finger dentition: Median denticle row straight; 6/7 inner denticles, 6/7 outer denticles, and 4/5 inner accessory denticles for fixed and movable fingers respectively. Trichobothria patterns: Type C, neobothriotaxic (major additive) on patella. Femur: trichobothrium  $d$  positioned proximal in relation to  $i$ ,  $e$  situated on dorsoexternal carina. Patella: ventral series number 9/8 and external series number  $eb = 4/4$ ,  $eb_a = 4/4$ ,  $esb = 2/2$ ,  $em = 3/3$ ,  $est = 4/4$ , and  $et = 6/6$ . Chela: Ventral series number 4/4,  $V_4$  on external surface set in small dimple but removed from ventroexternal carina.

**Legs.** Two pairs of pedal spurs present, tarsal spines absent, ungues medium length with average curve. Tarsus III: ventral median spinule row formed by 9 elongated spinules; one pair of ventral distal spinules. Basitarsus I-IV: five proventral spinules on legs I and II.

gated spinules; one pair of ventral distal spinules. Basitarsus I-IV: five proventral spinules on legs I and II.

**Hemispermaphore.** Well developed lamina with conspicuous basal constriction, tapered distally (Fig. 65); truncal flexure present; capsular lobe complex well developed, with small acuminate process; ental channel spinose distally, exhibiting six delicate variable sized spines (data based on specimen from Mehadija, Romania).

**Female.** *E. c. banaticus* female paralectotype used for comparison. Granulation of carapace, metasoma and pedipalps same as in male.

Metasoma and telson morphometrics: We compared morphometrics of six sexually mature males and females. Males and females did not exhibit undue differences in overall size, carapace lengths ranged 4.20 – 5.75 (4.75) for males and 4.30 – 5.45 (4.85) for females. The metasoma of the male is slightly thinner than it is on the female, but only exhibiting slight mean value differences (MVD) when all segment length/width ratios are compared, a range of 2 – 6.5%; plus/minus standard error overlap was considerable, exhibiting 31 – 100%. However, the considerably inflated telson vesicle of sexually mature males is quite conspicuous when compared to the thinner “teardrop” shaped telson of the female. This was dramatically illustrated using morphometrics: Morphometric ratios calculated from the carapace length divided by the vesicle width and depth showed considerable mean value differences and plus/minus standard error separation (compare Figs. 6-9):

*Carapace Length/Telson Width*

MVD = 30.7% Separation Gap = 189.3%

Female

3.10-3.41 (3.233) ( $\pm 0.117$ ) [6]: {3.12-3.35}§ 0.036

Male

2.22-2.71 (2.473) ( $\pm 0.202$ ) [6]: {2.27-2.68}§ 0.082

*Carapace Length/Telson Depth*

MVD = 42.8% Separation Gap = 408.2%

Female

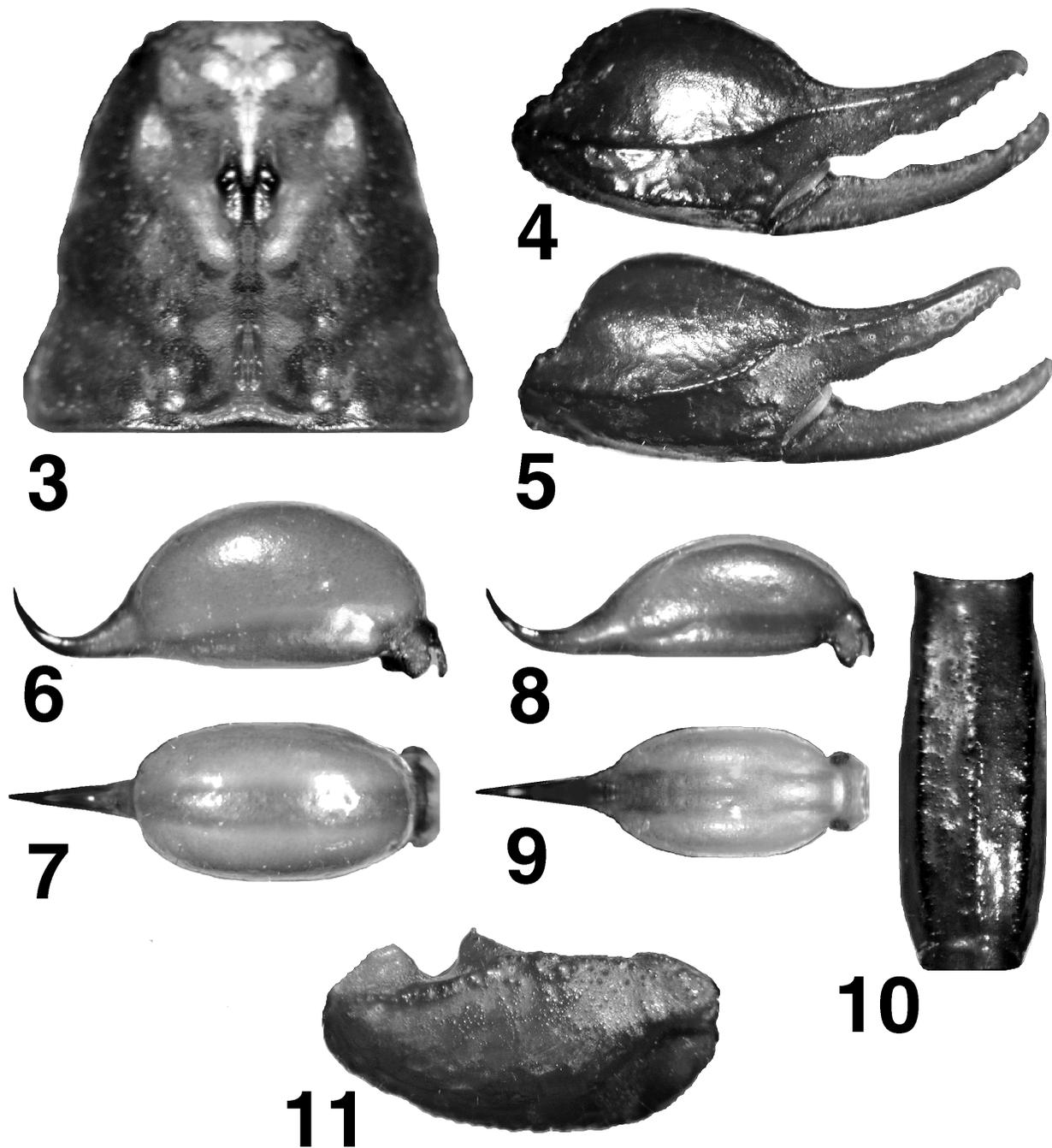
3.22-3.57 (3.377) ( $\pm 0.144$ ) [6]: {3.23-3.52}§ 0.042

Male

2.22-2.46 (2.366) ( $\pm 0.095$ ) [6]: {2.27-2.46}§ 0.040

**Genital operculum/genital papillae:** On the female, the genital operculum is connected for its entire length by a membrane, whereas on males, it is separated for most of its length, exposing protruding genital papillae.

**Pectinal tooth counts:** The pectines are more prominent on the male, teeth longer as well as larger in number:



**Figures 3-11:** *Euscorpius carpathicus*, Mehadija, Romania. **3.** Carapace, male. **4.** Chela, male. **5.** Chela, female. **6.** Telson, lateral view, male. **7.** Telson, ventral view, male. **8.** Telson, lateral view, female. **9.** Telson, ventral view, female. **10.** Metasomal segment V, ventral view, male. **11.** Pedipalp patella, dorsal view, female.

Male

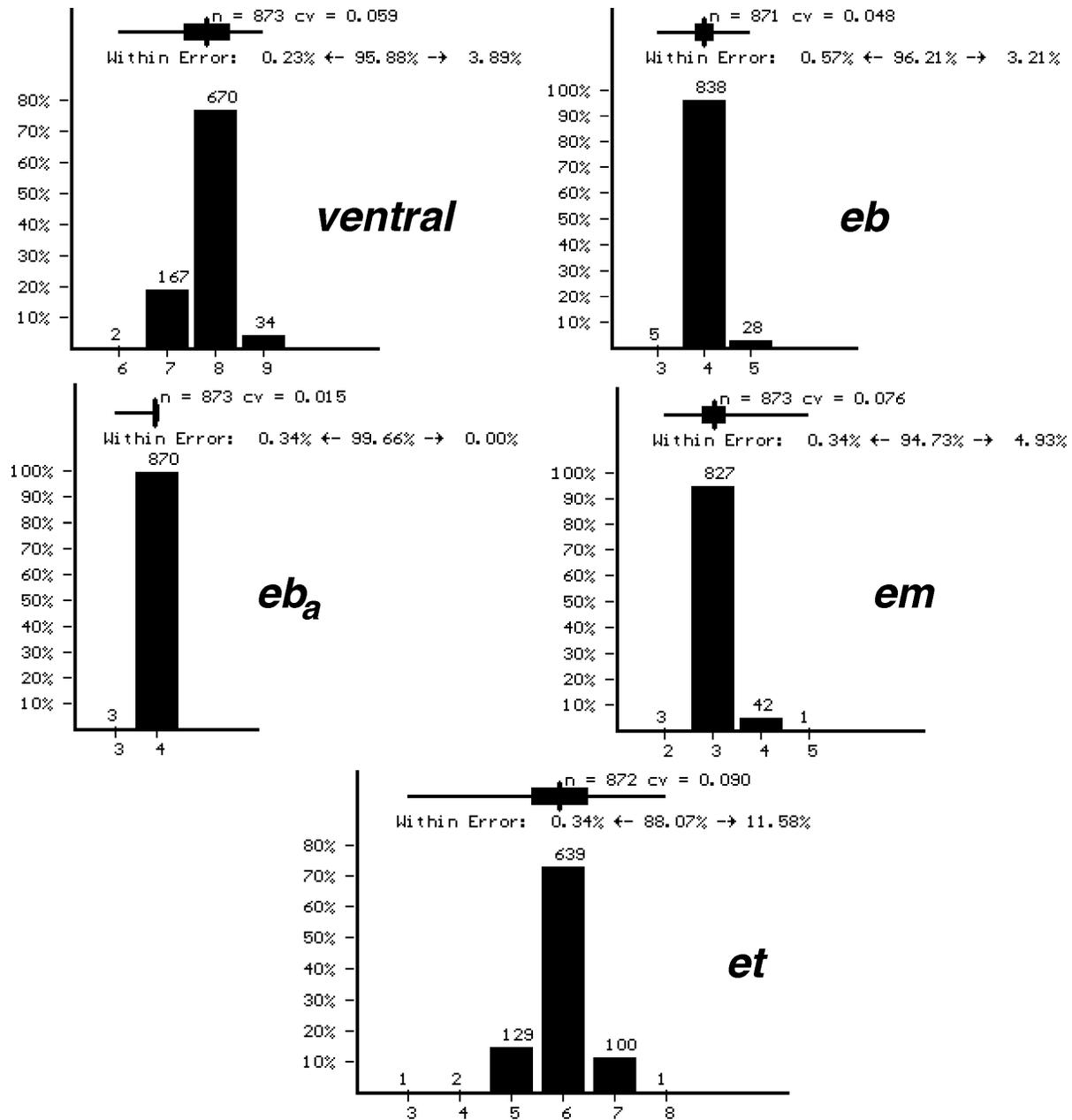
7-10 (8.562) ( $\pm 0.696$ ) [288]: {7.867-9.258}§ 0.081

Female

6-9 (7.088) ( $\pm 0.572$ ) [536]: {6.516-7.659}§ 0.081

The mean value difference is 20.8%, roughly a 1.5 tooth difference between the male and female.

**Comparison of type material.** V. F. had the opportunity to examine the *E. carpathicus* type deposited in the Linnean Society of London. The subadult female is somewhat small in size, measuring 25.8 mm. We compared key diagnostic characters between this type specimen and the two *E. c. banaticus* syntypes, male and female, from the BMNH. In addition, we also compared both sets of type material statistically to a large database



**Figure 12:** Statistical data for pedipalp patella trichobothrial counts of *Euscorpium carpathicus*. Horizontal bar: minimum, maximum, corrected minimum/maximum (mean-SD and mean+SD), and mean;  $n$  = number of samples,  $cv$  = coefficient of variability ( $SD/mean$ ); vertical bars: percentage per count, number of samples per count on top and count value on bottom. *eb* = external basal, *eba* = external basal-a, *em* = external median, *et* = external terminal.

of Romanian scorpion material generated from other material examined and data extracted from Vachon & Jaques (1977). The trichobothrial patterns of the pedipalp patella external and ventral surfaces and the pectinal tooth counts of the type material exhibit close if not exact matches to the data contained in the database, as follows:

- **Patella ventral series.** *E. carpathicus* = 8/8 (left and right patellae), *E. c. banaticus* = 8/8, 8/9 (male and female, respectively), and database exhibits 8 at 76.7% (read “the count 8 occurred 76.7% of the time”) and 9 at 3.9% – thus 83.3% of type sampling matched the majority database sampling of 8 at 76.7%.

- **Patella et series.** *E. carpathicus* = 6/6, *E. c. banaticus* = 6/6, 6/7, and database exhibits 6 at 73.3% and 7 at 11.5% – thus 83.3% of type sampling matched the majority database sampling of 6 at 73.3%.
- **Patella em series.** *E. carpathicus* = 3/3, *E. c. banaticus* = 3/3, 3/3, and database exhibits 3 at 94.7% – thus 100% of type sampling matched the majority database sampling of 3 at 94.7%.
- **Pectinal tooth counts.** *E. carpathicus*, female = 7/7, *E. c. banaticus*, female = 7/7, male = 10/9, and database sampling shows 7 for female at 68.3% and 9 and 10 for male at 50.3% and 5.9%, respectively – thus 100% of type sampling for the female matched the majority database sampling of 7 at 68.3% and for the male, 50% type sampling matched 50.3 of database sampling for 9.

These numbers show close statistical compliance between the two type materials, *E. carpathicus* and *E. c. banaticus*, as well as to the large database based primarily on Vachon & Jaques (1977). Of particular importance is the patellar *em* series containing three trichobothria, a major diagnostic character for this species in the context of the *E. carpathicus* complex. The two type materials also match in another important diagnostic character, both exhibiting reduction and/or obsolescence of the metasomal lateral and inferior carinae on segments I-III. Finally, all type material appears to have originated from southwestern Romania, the same general area as the other material examined.

**Variation within species.** Besides the type material of *E. carpathicus* and *E. c. banaticus*, we examined additional 37 specimens from southwestern Romania. This data plus a large population sample from Banat, Romania analyzed by Vachon & Jaques (1977), totaling 403 specimens, was also factored into this analysis, the latter for statistical comparisons. See Fig. 12 for the statistical ranges of the trichobothrial series of the patella involving well over 850 samples per series. Of particular importance is the high support for external series *em* (= 3), exhibiting a 94.7% compliance for 873 samples. Series *eb* (= 4), *eb<sub>a</sub>* (= 4) show 95+% compliance and *et* (= 6) and ventral (= 8) show 70+% compliance. Fig. 62 illustrates a typical trichobothrial pattern of the external surface of the patella.

**Material examined. ROMANIA.** Baile Herculane, 1 male, 2 females (VF), 25 June 2001 (V. Popa); Herkulesbad (now Baile Herculane), 2 females (NMW 1896); Banat, 1 adult female (NMW); Drenkova, 4 males, 10

females (NMW 1896), 1892 (H. R. Lorenz von Liburnau); Mehadija, 11 specimens (NMW 1931), 2 males (NMW 1903); Orsova, 2 males, 1 female (ZMH), 24 December 1908 (“Mus. Frankfurt”); Saska, 1 female (NMW 1907).

**Other source data.** Our statistical database was fortified considerably with the 403 specimens (137 males and 266 females) analyzed by Vachon and Jaques (1977). Trichobothria and pectinal tooth numbers were extracted from this source. All material was from Baile Herculane (=Herkulesfürdo, =Herkulesbad), the historical area of Banat, Romania. This series is largely deposited in the Hungarian Natural History Museum in Budapest (122 males and 251 females), with some specimens also in the Muséum d’Histoire naturelle de Genève (7 males, 8 females) and the Muséum national d’Histoire naturelle, Paris (8 males, 7 females).

**Geographical distribution.** We restrict the geographic range of this species to Romania, i.e. area north of Danube. See map in Figure 57.

### *Euscorpius balearicus* Caporiacco, 1950

(Figs. 2, 13-22, 59 and Table 5)

*Euscorpius carpathicus balearicus* Caporiacco, 1950: 187, 227; Vachon & Jaques 1977: 431; Bartolozzi et al., 1987: 295; Lacroix, 1991a: 19; Dupré, 1997: 15; Fet & Sissom, 2000: 361-362.

*Euscorpius balearicus* Gantenbein et al., 2001: 301-320.

**Diagnosis** (after Gantenbein et al., 2001). This species is small to medium in size, the largest mature female examined was only 37 mm. in length and the largest male 34 mm. Its coloration is light brownish-tan with little contrasting patterns. Proportionally, this species has a reduced metasoma and unusually large pedipalps (see morphometric ratio comparisons below). The metasomal carinae are essentially obsolete on segments I-IV except for weakly granulated dorsal carinae. Pedipalp patellar external trichobothria numbers are *eb* = 4, *eb<sub>a</sub>* = 4, *esb* = 2, *em* = 4, *est* = 4 and *et* = 6 – 10; ventral aspect of patella 9 – 14. The number of trichobothria occurring in the *et* and ventral series are among the largest found in the genus as a whole. Pectinal tooth counts: female 6 – 8, male 7 – 9.

The data presented in this paper for *E. balearicus* is based almost entirely on the analysis conducted in Gantenbein et al. (2001); this work has to be consulted on the type material data and detailed information on *E. balearicus*. A few additional specimens (see below) were added to the statistics gathered in the aforementioned paper. For completeness with the other data pre-