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A REVIEW OF AND ADDITIONS TO THE CURRENT KNOWLEDGE OF THE SCORPION GENUS *EUSCORPIUS* THORELL, 1876 (Scorpiones, Euscorpiidae)

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INTRODUCTION

Certainly the most studied European scorpions belong to the genus *Euscorpius* Thorell, 1876, which is widespread in southern Europe. Euscorpiids are common from the Iberic Peninsula to southwestern Russia, both in corticolous and lapidicolous habitats. They can live from the seashore to more than 2000 m a.s.l. The type species of the genus was the taxon that Linnaeus (1767) described from Transylvania in Romania and named as *Scorpio carpathicus*. Only later was the genus called *Euscorpius* (Thorell, 1876). Since then several species and subspecies have been described but this was done on the basis of qualitative characteristics, such as color and morphosculpture, which are often ambiguous and difficult to interpret. High morphological polymorphism has been evident since the first studies at the beginning of the XIX century (C. L. Koch, 1837) and several taxa were described, resulted in the description of a large number of taxa (more than 40). With the introduction of the trichobothriotaxy and more recently with molecular techniques, the systematics of the genus *Euscorpius* is becoming more clear. The first results for this modern point of view are that before 1999 there were four valid *Euscorpius* species (*E. carpathicus* (Linnaeus, 1767), *E. flavicaudis* (De Geer, 1778), *E. italicus* (Herbst, 1800) and *E. germanus* (C. L. Koch, 1837)) divided into several subspecies, while the species are now 17, following a reduction of the subspecies which were put in synonymy (Fet 2000, 2003; Fet & Soleglad 2002, Fet et al. 2003; Gantenbein et al. 1999, 2000, 2001, 2002; Scherabon et al. 2000; Vignoli et al. 2005, 2007).

A review of the "Euroscorpion", as the genus *Euscorpius* was de-

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fined by Fet et al. (2004), was recently elaborated, giving a comprehensive picture of the genus, with particular emphasis on taxonomy. The present paper is intended to build on Fet et al. (2004), but focusing more on different aspects at the species level. Each species is briefly summarized, with notes on taxonomy, morphology, geographic distribution and ecology. Moreover, the distributions and diagnostic characters are shown in easy to read tables and an identification key is provided. All the species of *Euscorpius* are illustrated (except *E. koschewnikowi* Birula, 1903), with the first images of *E. beroni* Fet, 2000 and several peculiar morphotypes, constituting the most complete and comprehensive atlas of the genus. The taxonomy of this scorpion genus is complex and in continuous evolution, leading sometimes to disagreement among researchers on what is considered a valid status for *Euscorpius* taxa.

Trying to be impartial in these discussions, the main aim of this work is to provide a complete review which will be useful both to have clearance on current systematics of the genus *Euscorpius* and to interpret possible future taxonomic rearrangements more easily.

Material and methods

For trichobothrial approach we follow the conventions of Vachon (1974) and Valle (1975). All measurements are in millimeters (mm) and follow Stahnke (1970) and Sissom (1990). All the photographs were elaborated by the first author and prepared with the following equipments: Canon AE1, Nikon Cp 4500, Pentax S50 and Olympus Camedia Zoom 4040 mounted to an optical stereomicroscope Wild Heerbrugg. Abbreviations: imm.: immature; carL: carapace length; V: total number of trichobothria on pedipalp manus ventral surface Pv: total number of trichobothria on pedipalp patella ventral surface; Pe: total number of trichobothria on pedipalp patella external surface; DPS: dorsal pedipalp patellar spur; Dp: pectinal tooth count; L: left; R: right; *et*: external terminal; *est*: external subterminal; *em*: external median; *esb*: external suprabasal; esb_a: external suprabasal-a; eb_a: external basal-a; *eb*: external basal.

This work is based on the original descriptions and published bibliography with supplementary observations of several material. Abbreviations of studied collections are as follows: VVZC collection, V. Vignoli Zoological Collection, Department of Evolutionary Biol-

ogy, University of Siena, Italy; MZUF, Museo Zoologico "La Specola", University of Florence, Italy; NMNHS, National Museum of Natural History, Sofia, Bulgaria; MCSNB, Museo civico di Scienze Naturali "E. Caffi", Bergamo, Italy; MNHN, Muséum National d'Histoire naturelle, Paris, France; SRSN, Società Romana di Scienze Naturali, Rome, Italy; AMNH, American Museum of Natural History, New York, USA.

TYPE SPECIMENS STUDIED. MZUF: Italy: labeled as *E. c. concinnus* (C. L. Koch, 1837): 1 female (138/5653), Modena, Emilia Romagna, 1874, Carruccio coll.; 1 male (139/5621), Casinalbo, Formigine, Emilia Romagna, 1880, Fiori coll.; labeled as *E. carpathicus*: 1 female (158/5661), Marzano, Lippiano, Perugia, Umbria, VII.1925, A. Andreini coll.; 1 male (157/5639), Lippiano, Perugia, Umbria, 09.X.1934 (? coll.); 1 male (305/9490), Tuscany, Monti Pisani, no data, Carrara coll.; 1 female (187/6275), Friuli Venezia Giulia, Nabresina (Trieste), VIII.1879, Paolucci coll.; 1 female (168/6019), Basilicata, Rionero in Vulture (Potenza), 14-15.VII.1880, G. Cavanna coll.; 1 male, 1 female (31/6242-6247), Sicily, Linosa Island (Agrigento), IV.1884, Zarv. (?) coll.; 2 females, 1 male (163/6002-6009-5997), Abruzzo, Caramanico (Pescara) Falde del Monte Morone, IV.08.1878, G. Cavanna coll.; 2 females (125/5938-5945), Toscana, M. Corchia, Vallecchia, Pietrasanta, Levigliani (Alpi Apuane, Lucca), 03.VIII.1875, Del Prete & G. Cavanna coll.; 1 female (189/6266), Veneto, Treviso, 1879, Isp. Forestale coll.; 1 female (135/5699), Tuscany, Resceto, Massa Carrara, 10.VI.1879, Del Prete coll. Croatia: 1 female (71-5829), Curzola Island, 13.X.1879, Giglioli coll. *E. c. corsicanus*: Di Caporiacco, 1950, Grotte di Sisco, Corsica, France (MZUF, syntype n° 1168). NMNHS: *E. beroni* Fet, 2000, 1 female (syntype n° 134), Shkoder District, Mt. Radohimës, Albania, 29.V.1993, P. Beron coll.

Other material observed (no types) belonging to Museum collections: MNHN: *E. c. niciensis* (C. L. Koch, 1841) (61 specimens, Maritime Alps, France): 7 females, 2 subadults, 1 male (RS 5330), St. Paul a Vence, III.1970, M. Willaume coll.; 9 males, 2 females, Trans en Provence (Var), 5 km from Draguignan, 14.XII.1970, M. Willaume coll., Entrée n° 4 1972; 1 imm., 5 females, 4 males, Roquefort des Pins, 08.I.1970, M. Willaume coll.; 19 females, 3 males, 7 imm. (RS 3722), St. Beaume, Sospel, Nice, (no other data specified). *E. balearicus* Di Caporiacco, 1950 (92 specimens, Majorca, Spain): 2 imm., 30 females (RS 7935) Puerto Sóller, tour Picada, ?, VI.1975, E. Frèchin coll., entrée n°11; 26 males (RS 7818), 35 females (RS 7815), Sóller, VI.1974, E. Frèchin coll., entrée n°45. *Euscorpius "carpathicus"* (8 specimens, Turkey): 2 males, 6 females, Heybeli, 16.VIII.1951, J. Wahrman coll., Sc. 65-72 (Hebr. Univ.), IS W 182 (MNHN). *Euscorpius "carpathicus"* (1 specimen, Tunisia): 1 subadult male, Galite island, XII.1979, M. Thomas coll. AMNH: *Euscorpius cf. tergestinus*: (1 specimen, Turkey): 1 juvenile, Aydin Söke Dovuttar, 44 m a.s.l., 28.IV.2005, H. Koc coll. *E. mingrelicus* (5 specimens, Turkey): 2 males, 3 females, Afyon Derecine, 1728 m a.s.l., 14.IV.2004, 28.IV.2005; H. Koc, coll. *Euscorpius. cf. sicanus* (2 specimens, Macedonia): 2 females "Petrich Distr.", Village Kamena, Mt. Belasica, Macedonia, 300 m a.s.l., 02.V.2003.

VVZC, MZUF, MCSNB, SRSN: detailed data are given in the following references: Vignoli 2002, 2006; Vignoli et al. 2005; Vignoli et al. 2007.

TAXONOMY

Euscorpius appears for the first time in "Sistema Naturae" (Lin-

Tab. 1 – Trichobothrial typical counts of all current valid species of *Euscorpius* (see "Material and methods" for abbreviations).

Species	**V**	**Pv**	**Pe**	***eb***	***eb*$_a$**	***esb***	***esb*$_a$**	***em***	***est***	***et***
E. carpathicus s. s. (Linnaeus, 1767)	3+ Et$_1$	7-9 (8)	22-24	4	4	2	/	3	4	5-7 (7)
E. tergestinus (C. L. Koch, 1837)	3+ Et$_1$	7-11 (9)	23-26	4	4	2	/	4	4	5-8
E. concinnus (C. L. Koch, 1837)	3+ Et$_1$	8	26	4	4	2	/	4	4	7
E. sicanus (C. L. Koch, 1837)	3+ Et$_1$	9-11 (9)	24-28	5	4-5	2	/	4	4	5-8 (7)
E. hadzii Di Caporiacco, 1950	3+ Et$_1$	9-13 (11)	27-33	5	6-8 (7)	2	/	4-5 (4)	4	6-9 (7+)
E. koschewnikowi Birula, 1900	3+ Et$_1$	8	23-24	4	4	2	/	4	4	5-6
E. balearicus Di Caporiacco, 1950	3+ Et$_1$	9-14	24-34	4	4	2	/	4	4	6-10
E. tauricus (C. L. Koch, 1837)	3+ Et$_1$	7-8	24	4	4	2	/	4	4	6
E. oglasae Di Caporiacco, 1950	3+ Et$_1$	7	23	4	4	2	/	4	4	5
E. germanus (C. L. Koch, 1837)	3+ Et$_1$	5	21	4	4	2	/	3	4	4
E. alpha Di Caporiacco, 1950	3+ Et$_1$	6 (5 rare)	21	4	4	2	/	3	4	4
E. mingrelicus (Kessler, 1874)	3+ Et$_1$	6	22	4	4	2	/	3	4	5
E. gamma Di Caporiacco, 1950	3+ Et$_1$	5 (6 rare)	20-22	4	4	2	/	3	4	4
E. beroni Fet, 2000	3+ Et$_1$	5	21	4	4	2	/	3	4	4
E. italicus (Herbst, 1800)	(6+)+ Et$_1$	10-14	23-43	3-4	4-8	2	4-11	5	4	5-9
E. naupliensis (C. L. Koch, 1837)	(6+)+ Et$_1$	10-14	27-33	4	5-6	2	/ (2 rare)	5	4	7-10
E. flavicaudis (De Geer, 1778)	4+ Et$_1$	10-13	26-29	5	6	2	/	4-5 (5)	4	6-9

Tab. 2 – Geographic distribution of all current valid species of *Euscorpius*.

Species	Geographic distribution
E. carpathicus s. s. (Linnaeus, 1767)	Romania (Transylvania);
E. tergestinus (C. L. Koch, 1837)	north and central Italy (Elba, Capraia, and Montecristo islands included), France (south east and Corsica), Croatia, Slovenia, Bulgaria (?) and southern Austria;
E. concinnus (C. L. Koch, 1837)	Italy: Lombardy, Liguria, Friuli V. Giulia, Emilia Romagna, Tuscany, Marche, Umbria, Latium and Campania; Slovenia (?);
E. sicanus (C. L. Koch, 1837)	southern and central Italy, Sardinia, Gorgona, Cerboli, Giglio, and Giannutri islands, Sicily, Eolie, Pelagie, Pantelleria and Tremiti islands; Malta, Greece, Bulgaria (?), Tunisia, Libya, Egypt, Madeira island;
E. hadzii Di Caporiacco, 1950	Albania, Bosnia-Herzegovina, Croatia, Macedonia, Yugoslavia (Kosovo, Montenegro, Serbia), north west Greece and south west Bulgaria;
E. koschewnikowi Birula, 1900	north east Greece (Chalkidiki peninsula, Athos Mountain);
E. balearicus Di Caporiacco, 1950	Spain, Balearic islands: Majorca, Minorca, Cabrera;
E. tauricus (C. L. Koch, 1837)	Ukraine, Crimea;
E. oglasae Di Caporiacco, 1950	Italy, Montecristo island, Tuscan Archipelago, northern Tyrrhenian Sea;
E. germanus (C. L. Koch, 1837)	north east Italy (Trentino Alto Adige, Friuli), Austria (south east), Switzerland and eastern Slovenia;
E. alpha Di Caporiacco, 1950	north west Italy (Piemonte, Valle d'Aosta and Lombardy), Switzerland;
E. mingrelicus (Kessler, 1874)	Croatia, Bosnia-Herzegovina, Yugoslavia (Montenegro, Serbia) Macedonia, Slovenia, Albania, Greece (?), Bulgaria (?), Turkey, Georgia, Russia (Caucasus);
E. gamma Di Caporiacco, 1950	north east Italy (Friuli), southern Austria (Carinthia), Slovenia and Croatia;
E. beroni Fet, 2000	Albania (Prokletija and Radohimes Mountains);
E. italicus (Herbst, 1800)	France, Monaco, Italy (north, center east), San Marino, Algeria, Morocco, Tunisia, Switzerland (Ticino and Valais), Slovenia, Croatia, Macedonia, Yugoslavia (Montenegro), Albania, Greece, Hungary, Romania, Russia (western Caucasus), Turkey (Black Sea regions), Yemen;
E. naupliensis (C. L. Koch, 1837)	south west Greece (Peloponnesus, Zante and Pelouzo islands);
E. flavicaudis (De Geer, 1778)	France (Corsica included), England, Italy (Tyrrhenian coast, from Liguria to Calabria, minor islands and Sardinia included), Algeria, Tunisia, Brazil, Yemen, Uruguay.

naeus, 1758) under the name *Scorpio*, which was considerate not usable to designate a genus due to the "generic" form (together with the term: *Scorpius* Poda, 1761) and since the 1870s the generic name *Euscorpius* Thorell, 1876 won definitely the general acceptance (Fet & Sissom 2000). Since the first modern classification (Peters 1861) this taxonomical group has belonged to the "Chactoid group" Thorell (1876). The Peters classification was subsequently changed by Pocock (1893), who described a new genus and introduced new diagnostic characters in scorpiology. Pocock introduced the genus *Euscorpius* into the "B" group of the subfamily Chactini. Laurie (1896) later elevated this entity to family level, with two subfamilies: the Chactini and Euscorpiini, including euscorpiids in the latter group. Revision of the "Chactoid group" was carried out by Kraepelin (1899, 1905) and Birula (1917) who retained the superfamily Chactoidea. Stockwell (1989) eliminated this superfamily on the evidence of his cladistic results and divided the "Chactoid group" into superfamilies, with the genus *Euscorpius* (Euscorpiidae) included among the Chactoidea Pocock, 1893. In more recent studies another taxonomy is accepted and the family Euscorpiidae includes three subfamilies (Euscorpiinae (Laurie, 1896); Megacorminae Kraepelin, 1899; Scorpiopinae Kraepelin, 1905) with nine genera (Soleglad & Sissom 2001, Soleglad & Fet 2003; Fet & Soleglad 2005). A different classification was given by Prendini & Wheeler (2005) where the family Euscorpiidae includes only four genera. Scorpions belonging to the subfamily Euscorpiinae can be distinguished from the other subfamilies both by the trichobothriotaxy and by pedipalp chela finger dentition (Soleglad & Sissom 2001). Euscorpiidae have a broad geographic distribution which includes the following regions: Africa (Mediterranean regions), Europe (southern and central), Asia, North America (Mexico), central (Guatemala) and southern America (Brazil, Peru and Venezuela) (Soleglad & Sissom 2001).

The genus *Euscorpius* is divided into 4 subgenera (*Polythricobothrius* Birula, 1917; *Tetrathricobothrius* Birula, 1917; *Euscorpius* Thorell, 1876; *Alpiscorpius* Gantenbein et al., 1999) and 17 species (*E. italicus* (Herbst, 1800); *E. naupliensis* (C. L. Koch, 1837); *E. flavicaudis* (De Geer, 1778); *E. carpathicus* (L., 1767); *E. balearicus* Di Caporiacco, 1950*; E. hadzii* Di Caporiacco, 1950; *E. koschewnikowi* Birula, 1903; *E. tergestinus* (C. L. Koch, 1837); *E. concinnus* (C. L. Koch, 1837); *E. sicanus* (C. L. Koch, 1837); *E. tauricus* (C. L. Koch, 1837); *E.*

oglasae Di Caporiacco, 1950*; E. alpha* Di Caporiacco, 1950*; E. germanus* (C. L. Koch, 1837); *E. gamma* Di Caporiacco, 1950; *E. beroni* Fet, 2000; *E. mingrelicus* (Kessler, 1874)). It is the only scorpion group of the Euscorpiidae present in Europe and its distribution covers three continents; Africa (Algeria, Egypt, Libya, Madeira, Morocco, Tunisia), Europe (Albania, Austria, Bulgaria, Bosnia-Herzegovina, Croatia, England, Greece, France, Italy, Yugoslavia, Macedonia, Monaco, Czech Republic, Romania, Russia, San Marino, Slovenia, Spain, Switzerland, Turkey, Ukraine, Hungary) and Asia (Russia, Georgia, Syria, eastern Turkey, Yemen).

CURRENT CLASSIFICATION OF THE GENUS *EUSCORPIUS*

Subgenus **Euscorpius** Thorell**,** 1876 (fig. 44)
Euscorpius Thorell, 1876: 15.

Selected references: Fet & Sissom 2000; Fet & Soleglad 2002; Fet et al. 2004.

Diagnosis. Characterized by 4 trichobothria (V_1–V_3, Et_1) on ventral pedipalp chela manus and pedipalp ventral patella surface with more than 6 trichobothria. This taxon includes at present eight species.

Distribution. Circum Mediterranean distribution; not well defined in the eastern part. See species.

Euscorpius carpathicus (Linnaeus, 1767) (fig. 1)

Scorpio carpathicus Linnaeus, 1767, Syst. Nat., Ed. XII, tav. 1038. Loc. Typ.: Transylvanian Alps, Romania.
Euscorpius carpathicus (selected references): Fet & Sissom 2000; Fet & Soleglad 2002.

Taxonomy. The holotype was described in the eighteenth century and was collected in "Montibus Carpathicus". The description was superficial, which has caused some taxonomical confusion: from 1766 to 1903 several different authors described 40 different species (Vachon 1981) of *Euscorpius* and most of these are at present considered synonymous. *Euscorpius carpathicus* is now considered a complex of sibling species. *Euscorpius carpathicus* in sensu stricto remains valid

but only for the populations of the type locality in Romania (Fet and Sissom 2000; Fet and Soleglad 2002). Revision of the "*E. carpathicus* complex" is still evolving and despite the possibility of using molecular techniques to investigate, some taxonomical entities are still unresolved (e.g. *E. c. fanzagoi* Simon, 1879, described for France and Spain; *E. c. candiota* Birula, 1903, endemic to Crete, Greece (fig. 4)).

Diagnosis. A detailed redescription was elaborated by Fet & Soleglad (2002). Medium sized euscorpiid with a dark brown colored pattern and with short and squat metasomal segments (fig. 1). The diagnostic characters are as follows: short distance between trichobothrium d_2, presence of a row of dorsal external tubercles on the pedipalp patella (fig. 69, Fet & Soleglad 2002); *em* series of Pe, always with 3 trichobothria. The ventral surface of the chela has the typical formula: V = 3 + 1 (Et_1); while Pv always shows more than 8 trichobothria. Adult males are easy to distinguish from females due to their swollen telson, pedipalp chela movable finger notch more pronounced and slender body.

Distribution. This species is known only for Romania, where it occurs in three areas on the north side of the Danube river. Its distribution can be considered as marginal if compared with the other species which are present at lower latitudes with a circum-Mediterranean distribution (Fet & Soleglad 2002). *E. carpathicus* as a species complex is the taxon with the widest geographical distribution of the entire genus; it can be regarded as a European-Mediterranean chorotype (*sensu* Vigna Taglianti et al. 1993) with some fragmentary eastern areas.

Ecology. No specific ecological data are available on the Romanian populations.

Euscorpius sicanus (C. L. Koch, 1837) (figs 2, 3, 5, 34)

Scorpius sicanus C. L. Koch, 1837, C.M.A. Deutschls., 106, tav. CVII, fig. 249. Loc. Typ.: Messina, Sicily, Italy.
Selected references: Fet & Sissom 2000; Fet et al. 2003; Salomone et al. 2007.

Taxonomy. The holotype of *Scorpius sicanus* was collected in

Messina (type locality), in the north-eastern corner of Sicily, Italy. It was first placed in synonymy with *E. carpathicus* and later recognized as a subspecies (*E. c. sicanus*) by the Italian arachnologist Di Caporiacco (1950), who described it as a taxon of southern Italian distribution. At present, *E. sicanus* is considered a valid species according to the results of a study based both on morphological and molecular evidence; this study emphasized the genetic similarity between 7 "old" subspecies (*Euscorpius canestrinii* (Fanzago, 1872) (fig. 3); *E. c. linosae* Di Caporiacco, 1950 (fig. 5); *E. c. garganicus* Di Caporiacco, 1950; *E. c. ilvanus* Di Caporiacco, 1950; *E. c. argentarii* Di Caporiacco, 1950 (fig. 2); *E. c. palmarolae* Di Caporiacco, 1950; *E. c. calabriae* Di Caporiacco, 1950) and consequently synonymized them (Fet et al. 2003).

Diagnosis. This species is extremely variable in morphology, especially in color and biometry, and may be considered medium to large for the genus *Euscorpius* (sometimes exceeding 40 mm in total length). The diagnostic character is the *eb* = 5/5 territory of the Pe series (eb_a= 4-5). The color is highly variable, from yellowish to light or dark brown. The most yellow form (fig. 3) is present in Sardinia, Italy (*E. c. canestrinii* Fanzago, 1872); *E. c. argentarii* Di Caporiacco, 1950 is olive green (fig. 2), while a brown pattern is common in central and southern Italy (Apulia). Calabria (South Italy) is inhabited by a dark morphotype. The sexual dimorphism is strongly evident in the dimensions of the telson (fig. 34).

Distribution. The geographic distribution includes Italy (from northern Tuscany to Sicily), Malta, Greece, the island of Madeira (Atlantic Ocean) and some north African countries such as Tunisia, Libya and Egypt. The distribution of *E. sicanus* in the Aegean area is still unresolved and seems to be very intriguing because of the richness of distinct forms, all with *eb*: 5/5 (Fet et al. 2003; Brewer et al. 2005). The distribution in Greece is more western and comprises the following regions: Thessaly, Peloponnesus, the Sporades islands. *Euscorpius sicanus* has the most southern distribution of the entire genus and is characterized by a high tolerance to arid climates, such as the torrid summers typical of the Mediterranean climate. Although this species is resistant to hot climates and dry periods, it is concentrated in humid microhabitats during summer months.

Ecology. Characterized by high adaptability, this taxon may colonize different habitats, which may be either corticolous or lapidicolous. Moreover, they are common in anthropic sites when there are no other syntopic species larger in size as *E. italicus* and *E. flavicaudis* (Vignoli 2002). They live inside crevices in walls or under wood, stones and other objects such as plant pots. The high anthropotolerance of this scorpion could be the main reason for unexpected findings in northern Italy, eastern Greece and the Madeira islands.

Euscorpius tergestinus (C. L. Koch, 1837) (figs 4, 6-11)

Scorpius tergestinus C. L. Koch, 1837, C.M.A. Deutschls., 106, tavv. CVII-CVIII, figs 247-248. Loc. Typ.: Trieste, Italy.

Selected references: Fet & Sissom 2000; Fet & Soleglad 2002; Vignoli et al. 2005; Salomone et al. 2007.

Taxonomy. This species was first placed in synonymy with *E. carpathicus* (Linnaeus, 1767) by Simon (1879) and later considered as a subspecies of the same specific entity (Di Caporiacco, 1950).

E. tergestinus belongs to the western lineage of the highly variable "*carpathicus* complex" and in Fet & Soleglad (2002) includes four different (synonymous) subspecies described by Di Caporiacco (1950): *E. carpathicus oglasae* of the island of Montecristo (Tuscany, Italy) (fig. 12), *E. c. picenus* of Abruzzo, Marche and part of Tuscany, *E. c. apuanus* (fig. 8) described for the Apuan Alps (northern Tuscany) and *E. c. corsicanus* (fig. 9) from Corsica (France). *E. tergestinus* was also synonymized by the same authors (Fet & Soleglad 2002) with three further subspecies: *E. c. aquilejensis* (C. L. Koch, 1837), widespread in Trentino, Brescia, Ferrara and Trieste, *E. c. niciensis* (C. L. Koch, 1841) (fig. 11) from the Maritime Alps and *E. c. concinnus* (C. L. Koch, 1837) with a more western and southern distribution on the Italian Peninsula (this taxon has been recently elevated to the species level, see *E. concinnus*). The "*E. tergestinus* complex" seems to be very complicated and far from being resolved. For this reason, we retain valid the use of a "complex" for this group, as proposed by Fet & Soleglad (2002), although we consider only the reddish morphotype (fig. 7) as a synonym of *E. tergestinus s.s.* (= *S. aquilejensis* C. L. Koch, 1837; *E. c. aquilejensis sensu* Di Caporiacco, 1950 and the neotype of *E. tergestinus* described by Fet & Soleglad 2002) on both molecular

and morphological evidences (see discussion in Vignoli et al. 2005 and Salomone et al. 2007).

Diagnosis. A redescription of *E. tergestinus* was published by Fet & Soleglad (2002); the presence of 4 trichobothria in the *eb* series of the external patella surface is considered diagnostic. The Aegean morphotypes with *eb* = 4/4, such as *E. c. candiota* (fig. 4), *E. c. aegaeus* (fig. 6) and peculiar morphotypes e.g. the morphotype of Samos (fig. 10), in the north-east Aegean (small in size with stocky pedipalps, patella trichobothria formula (oligotrichous): *et* = 5/5; *est* = 4/4; *em* = 4/4; *esb* = 2/2; eb_a = 4/4; *eb* = 4/4; Dp = 7-7 females, 8-8 males; telson vesicle in males weakly swollen and Pv = 5/5) has not yet been assigned to certain species and their taxonomic status is still under study (Fet et al. 2004; Brewer et al. 2005; Vignoli 2006).

Distribution. The geographic distribution is not well defined. It includes northern regions (type locality: Trieste), central regions and parts of southern Italy such as Latium (Vignoli & Crucitti 2003; Vignoli et al. 2005). Other places where this taxon can be found are Slovenia, Croatia, southern Austria and central Bohemia (Czech Republic) (Kovařík & Fet 2003). The presence of enigmatic forms with the typical *eb* = 4/4 ("*E. tergestinus* complex") is known in the Aegean area (Fet 2000; Fet et al. 2003; Vignoli 2006; Fet & Soleglad 2007) and in the Balkan Peninsula (Teruel et al. 2004; Fet & Soleglad 2007); the Greek populations are currently under study (Brewer et al. 2005).

Ecology. This species is characterized by great adaptability and lives both in natural habitats (corticolous and lapidicolous microhabitats) and in anthropic areas.

Euscorpius concinnus (C. L. Koch, 1837) (figs 13, 37, 41)

Scorpius concinnus C. L. Koch, 1837: 105-103, pl. CVI, fig. 246. Loc. Typ.: Italy.
Euscorpius carpathicus concinnus: Di Caporiacco, 1950: 190-194.
Selected references: Fet & Sissom 2000; Fet & Soleglad 2002; Vignoli et al. 2005; Salomone et al. 2007.

Taxonomy. Fet & Soleglad (2002) considered *E. c. concinnus* synonymous of *E. tergestinus*, together with 9 other "old" taxa. This tax-

onomical change is based on the presence of a "standard" character, i.e. the trichobothrial formula of the external aspect of the pedipalp patella, with *eb* = 4/4. Later, a study on the "*E. carpathicus* complex" from the Italian peninsula based on nuclear and mitochondrial sequence data clearly identified two deeply divergent lineages (Salomone et al. 2007) corresponding to *E. tergestinus* and *E. c. concinnus*. A subsequent comparative morphological analysis distinguished *E. tergestinus* from *E. c. concinnus*, with the elevation to the rank of species of this subspecies (Vignoli et al. 2005).

Diagnosis. Medium-sized euscorpiid with a generally squat aspect with stocky pedipalp chela. Dark blackish body, with slightly reddish chela and pale brown legs and chelicerae. Dorsal patellar spur quite developed, as is the granulation on leg femurs. The pedipalp patellar external trichobothria as *E. tergestinus* with Pv prevalently 8/8 and angle between trichobothria 1 and 4 of *em* series (Pe) wide (Vignoli et al. 2005, Vignoli 2006). Dp = 8-8 males, 7-7 females.

Distribution. *Euscorpius concinnus* has a broad geographic distribution; *E. c. concinnus* was considered one of the most common and widely distributed "*carpathicus*" subspecies in Italy (Di Caporiacco 1950). This species is certainly known in 9 Italian regions (Lombardy, Liguria, Friuli V. Giulia, Emilia Romagna, Tuscany, Marche, Umbria, Latium and Campania), over an area of more than 650 km (Bergamo-Salerno) along the Italian Peninsula (Vignoli et al. 2005).

Ecology. Eurytopic species, inhabiting habitats from sea level to 1500 m a.s.l., where they are mainly corticolous and lapidicolous.

Euscorpius hadzii Di Caporiacco, 1950 (figs 14-15, 43)

Euscorpius carpathicus hadzii Di Caporiacco, 1950: 180. Loc. Typ.: Bosnia-Herzegovina.

Selected references: Fet & Sissom 2000; Fet & Soleglad 2002; Vignoli et al. 2005; Fet & Soleglad 2007; Salomone et al. 2007.

Taxonomy. A preliminary description of this taxon was made by Hadži (1929), who emphasized a morphotype of *carpathicus* with a high number of trichobothria (*polytrichus*), the series Pv = 14 and

Pe variable from 28 to 34. Later, Di Caporiacco (1950) modified its taxonomic status, establishing a new subspecies: *E. c. hadzii,* instead of *polytrichus,* because this name was homonymous with *E. italicus polytrichus*. Since then this taxonomic entity has never been cited again, although various authors have cited some polytrichous euscorpiid populations in the Balkans, in particular in Macedonia, Croatia, Bosnia-Herzegovina (Ivan Pass, type locality), Albania, Bulgaria and north-western Greece (Ćurčić 1971; Kinzelbach 1975; Valle 1975; Michalis & Dolkeras 1989; Fet 2000). A morphological study of the syntypes of *E. carpathicus lagostae* Di Caporiacco, 1950 (fig. 15), endemic to the island of Lastovo in Croatia and neighboring islands, highlighted similar morphometrics and trichobothrial values as *E. hadzii* and therefore synonymized with this species (Fet & Soleglad 2002).

Diagnosis. The description of the neotype emphasized a heavy body structure with a long metasoma (Fet & Soleglad 2002). The color is variable from black (fig. 14) to reddish brown (fig. 15), while the trichobothrial pattern is typical, in particular the territory eb_a = 6-8 (high for the genus) and *eb* = 5 (see tab. 1). Dp = 7-11 males, 7-9 females.

Distribution. The species seems to be widespread and its provisory distribution extends from Croatia to northern Greece and Bulgaria.

Ecology. Knowledge of the ecology of *E. hadzii* is poor. In Albania it can be found under stones in beech forests (pers. comm. G. Trezzi).

Euscorpius koschewnikowi Birula, 1903

Euscorpius koschewnikowi Birula, 1903: 19-20. Loc. Typ.: north-eastern Greece. Selected references: Fet & Sissom 2000; Fet & Soleglad 2002.

Taxonomy. Described by Birula (1903) and later considered by Kinzelbach (1975) as synonymous of *E. carpathicus*. Di Caporiacco (1950) did not consider this taxon and both Fet (1986) and Fet & Sis-

som (2000) considered the taxonomic status of *E. koschewnikowi* to be unclear. At present it is considered as a distinct species by Fet & Soleglad (2002).

Diagnosis. Analysis has been performed on only 4 specimens with a particular morphology (Fet & Soleglad 2002). The metasoma segments and the pedipalp chela are extremely long and give the specimens a slender appearance, while the dorsal patellar spine is particularly well developed. The morphosculpture of the carapace is smooth and the metasoma carinae are weakly granulate. Body color is brown with lighter legs and metasoma. This taxon is considered a large euscorpiid and one specimen used in the redescription measured 46.05 mm in total length. Dp = 8 males, 6-7 females.

Distribution. Known only for the type locality, on Mount Athos on the Chalkidiki peninsula (Greece).

Ecology. Ecological notes are not available in the literature.

Euscorpius balearicus Di Caporiacco, 1950 (fig. 16)

Euscorpius carpathicus balearicus Di Caporiacco, 1950: 187, 227. Loc. Typ.: Balearic Islands, Spain.
Selected references: Fet & Sissom 2000; Gantenbein et al. 2001.

Taxonomy. Described by Di Caporiacco (1950) as a subspecies of *E. carpathicus* and considered very similar to two other subspecies: *E. c. canestrinii* Fanzago, 1872, endemic of Sardinia (Italy), and *E. c. aegaeus* Di Caporiacco 1950, from the island of Antiparos (Greece). The correlation among these subspecies was based on poorly reliable characters, such as the coloration ("yellow scorpions", Di Caporiacco 1950), and on a small number of specimens. About twenty years later, the Balearic population was placed together with *E. mesotrichus* (Hadži, 1929) by Kinzelbach (1975), but this taxonomical arrangement is considered erroneous because of cases of homonymy (Fet & Sissom 2000). Gantenbein et al. (2001) began a molecular study and observed a large genetic divergence in addition to morphological differences following a comparative analysis with other mainland populations, such as those of Italy and France.

DIAGNOSIS. The size range of adults is 37-40 mm. The color is yellow and can vary to light yellowish brown. The metasoma is short, while the pedipalps are large: this particular morphology is regarded as diagnostic. Metasomal segments I-IV have very weak carination and Dp ranges from 7 to 9 in males, and from 6 to 8 in females. Pv is high with a range of 9-14 and the *et* series of the external side (Pe) is the highest in number of the entire genus (*et* = 6-10).

DISTRIBUTION. Endemic to the Balearic Islands (Majorca, Minorca and Cabrera islands).

ECOLOGY. See *E. sicanus*.

Euscorpius tauricus (C. L. Koch, 1837) (figs 25, 40)

Scorpius tauricus C. L. Koch, 1837: 6-8, pl. CXI, fig. 255. Loc. Typ.: Crimea, Ukraine.
Selected references: Fet 1997; Fet & Sissom 2000; Fet 2003.

TAXONOMY. This species, which previously belonged to the "*E. carpathicus* species complex", was recently elevated to species status (Fet 2003) on the evidence of genetic divergence between populations of Greece, Romania, France and Croatia.

DIAGNOSIS. The pedipalp patellar external trichobothrial formula is: *eb* = 4/4, eb_a = 4/4, *esb* = 2/2, *em* = 4/4, *est* = 4/4, *et* = 6. This is a standard pattern of the complex and the series *eb* and eb_a = 4 is a characteristic that is shared with other species such as *E. balearicus*, *E. concinnus*, *E. koschewnikowi* and *E. tergestinus*. According to Fet (2003), this species cannot be identified with a solely morphological approach, except by using the collection site. This taxon is similar to *E. concinnus*, but it can be distinguished by more elongated metasomal segments and with the inner proximal surface of pedipalp movable finger with a more reduced lobe (fig. 40).

DISTRIBUTION. Ukraine, on the southern coast of Crimea. This species is quite isolated from other related *Euscorpius* populations, the closest being the Romanian populations of *E. carpathicus,* 500 km westward.

Ecology. Common under stones in anthropic areas (Kukushkin 2004).

Euscorpius oglasae Di Caporiacco, 1950 (fig. 12)

Euscorpius carpathicus oglasae Di Caporiacco [8]: 180; Loc. Typ.: Montecristo island, Italy.
Selected references: Valle 1975; Fet & Soleglad 2002; Vignoli et al. 2007.

Taxonomy. This taxon was described as an oligotrichous subspecies (*E. c. oglasae* Di Caporiacco, 1950). Some considerations were given by Valle (1975) and by Fet & Soleglad (2002) that synonymized with *Euscorpius tergestinus* (C. L. Koch, 1837).

Diagnosis. It is an oligotrichous form with series *et* = 5/5 and Pv = 7/7 with a short dorsal patellar spur and the pectinal tooth low count (7-7 males, 6-6 females). Large species (females can range 43 mm in total length) with overall body light in color with reddish pedipalp chela fingers and the V metasomal segment darker. It can be distinguished from the other species belonging to the "*tergestinus* complex" by the following characters: inner proximal surface of pedipalp movable finger with reduced lobe in male and obsolete in female; the telson vesicle in males is slightly swollen; the hemispermatophore is small with the basal lobe bearing a short spine at the posterior extremity (Vignoli et al. 2007).

Distribution. Endemic of Montecristo island, Tuscan Archipelago in the northern Tyrrhenian Sea (Italy).

Ecology. Both corticicolous or lapidicolous ecology was observed under *Pinus* and *Eucaliptus* trees (Vignoli et al. 2007).

Subgenus **Alpiscorpius** Gantenbein et al. 1999 (fig. 42)
Euscorpius Thorell, 1876: 15.

Selected references: Gantenbein et al. 1999, 2000; Fet 2000; Fet & Sissom 2000; Fet et al. 2004.

Diagnosis. This taxon includes at present five species and can be

separate from the other subgenera by oligotrichy. Ventral patellar series with maximum six trichobothria.

Distribution. From western north Italy to the Balcan regions and Caucasus. Most of the eastern distributions are still not defined. See species.

Euscorpius germanus (C. L. Koch, 1837) (figs 28, 42)

Scorpius germanus C. L. Koch, 1837, C.M.A. Deutschls., 110-112, tav. CVIII, figs 250-252. Loc. Typ.: Tyrol, Austria.
Euscorpius germanus (selected references): Fet & Sissom 2000; Gantenbein et al. 2000; Scherabon et al. 2000.

Taxonomy. Considered as a valid species by Kraepelin (1899) and subsequently split into different subspecies, *E. germanus* has become a real "taxonomic complex" (Fet 2000). Further studies, mainly based on the use of molecular markers, have elevated two of the subspecies to species level: *E. germanus alpha* Di Caporiacco, 1950 (Gantenbein et al. 2000) and *E. germanus gamma* Di Caporiacco, 1950 (Scherabon et al. 2000). *Euscorpius germanus marcuzzii* Valle et al. 1975 is still under consideration (Fet et al. 2004).

Diagnosis. Pv with five trichobothria. The pectinal sensilla have a particular narrow and elongated shape; the ratio between the trichobothria *et-est/est-dsb* is 1 (in *E. mingrelicus, est* is closer to *dsb*, and as result gives a higher *et-est/est-dsb* ratio). Dp ranges from 7 to 8 in males.

Distribution. The complicated taxonomical history and the resulting rearrangements of this species has greatly reduced the original distribution area. This scorpion was originally described for a large territory which included Italy and the Caucasus (Hadži 1929; Di Caporiacco 1950; Ćurčić 1971; Kinzelbach 1975); Bonacina (1980) later reduced the area to the Alpine region, including northern Italy (Piedmont and Friuli V. Giulia), Switzerland, Austria and some Balkan populations. Finally, the most recent revisions (Gantenbein et al. 2000; Scherabon et al. 2000) have further reduced the area, which now includes the region between Belluno and southern Innsbruck,

from the river Adige (Trentino Alto-Adige) to Gorizia (Friuli V. Giulia) on the border with Slovenia. The extension into the Balkan regions of *E. germanus* has yet to be defined.

Ecology. This species can be found in humid sites in thermophilic habitats. It has even been found in rocky mountain habitats, under rock debris and ruins or stones in meadows situated more than 2000 m a.s.l. (2250 m) (Braunwalder 1996; Braunwalder & Tschudin 1997).

Euscorpius alpha Di Caporiacco, 1950 (figs 29, 35)

Euscorpius germanus alpha Di Caporiacco, 1950: 211. Loc. Typ.: Lombardy, Italy.
Selected references: Fet & Sissom 2000; Gantenbein et al. 2000; Braunwalder 2005.

Taxonomy. Described by Di Caporiacco as a subspecies of *E. germanus*, on the basis of previous studies by Capra (1939) which divided *E. germanus* in 4 groups: A, B, C and the typical form. These groups were differentiated by different numbers of trichobothria (Pv) and pectinal teeth count. Bonacina (1980) agrees with the validity of *E. germanus alpha* with the typical Pv = 6, but also with the existence of a hybrid form present in the Alps near Bergamo. These specimens are characterized by intermedium (Pv = 5/5-6/6) and asymmetric patterns (Pv = 5/6-6/5), in comparison with the typical subspecies *E. g. germanus* with Pv = 5/5. A molecular study recently emphasized a high genetic divergence among the two subspecies and *E. g. alpha* was therefore elevated to species level (Gantenbein et al. 2000) and considered parapatric with *E. g. germanus*.

Diagnosis. The trichobothria number of the ventral patellar is mostly Pv = 6, but homogeneously variable from Pv = 6 near Bergamo (Valle Brembana), through an intermediate pattern (specimens with both Pv = 6 and Pv = 5) in the suburbs to a prevalently Pv = 5 pattern in more distant regions both east (river Adige) and west (Valle d'Aosta) of Bergamo. *E. alpha* is a small scorpion (total length 31 mm) (Di Caporiacco 1950) of dark brown color. The metasomal segments are characterized by a smooth ventral aspect which gives the metasoma a rounded appearance. Pv with 5 to 6 trichobothria and Dp var-

iable in females from 5-6/6-6, and 7-7 in males. Sexual dimorphism is weakly accentuated in the telson shape (fig. 35). The analysis of this species using only the morphological features as Pv and pectinal tooth count values is not sufficient to distinguish it from *E. germanus*. For these reasons, identification is currently based on genetic results and specific diagnostic morphological characters are required.

Distribution. This species is localized in northern Italy, on the border with Switzerland, between the Valle d'Aosta region and the river Adige; the typical distribution area is the Italian region of Lombardy.

Ecology. *E. alpha* is prevalently present in natural habitats such as chestnut woods or other deciduous forests. Within these habitats, is common in very humid microhabitats and can be found in stone walls or under tree bark. The species seems to tolerate different altitudes and can be found from 520 to 1880 m a.s.l. or even higher (Braunwalder 2001, 2005; Colombo 2006).

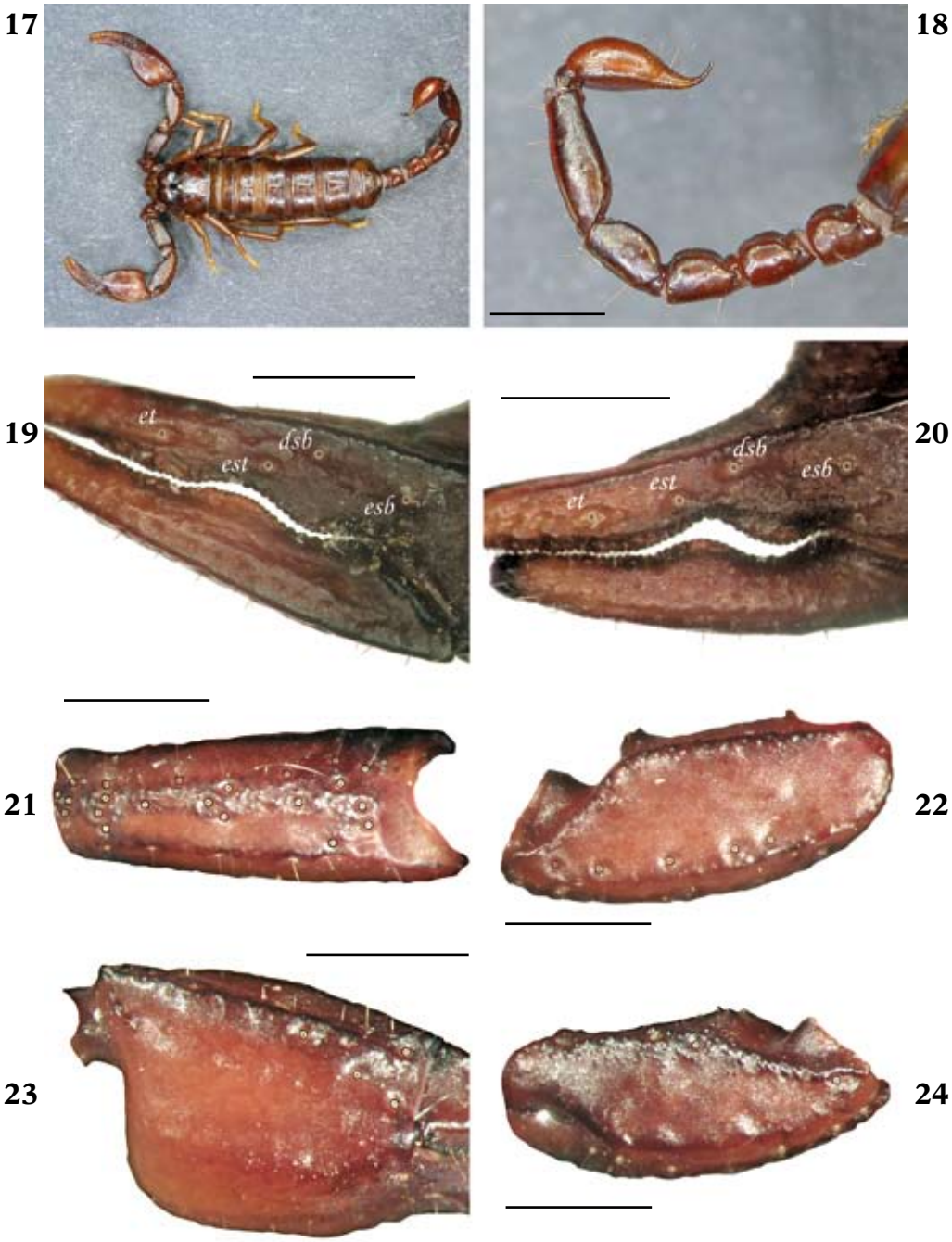
Euscorpius mingrelicus (Kessler, 1874) (fig. 26)

Scorpio mingrelicus Kessler, 1874: 25-26. Loc. Typ.: Georgia.
Selected references: Fet 1993; Fet & Sissom 2000; Scherabon et al. 2000.

Taxonomy. Both Di Caporiacco (1950) and Kinzelbach (1975) listed this species as a subspecies of *E. germanus*; only later they were split into different species by Bonacina (1980). With this taxonomical change, the distribution of *E. mingrelicus* was extended from the river Isonzo, between Italy and Slovenia, to Georgia (type locality), where this euscorpiid was originally described (Birula 1917; Capra 1939). This taxon seems to be extremely polymorphic in different populations on the Balkan peninsula (Croatia, Bosnia-Herzegovina, Serbia, Albania, Montenegro, Macedonia, Slovenia), in Greece (to be confirmed) and in Turkey and Georgia; therefore even this species is considered as a "species complex", currently including 7 different subspecies (see tab. 1 in Fet et al. 2004) and the typical form (Fet & Sissom 2000; Fet et al. 2004). The taxonomy is still incomplete not only for the Balkans but also for the Turkish subspecies described in

Figs 1-8 – *Euscorpius carpathicus* Linnaeus, 1767, male, Baila Herculaine, Romania, carL: 5.4 (1); *E. sicanus* (C. L. Koch, 1837) (*E. carpathicus argentarii* Di Caporiacco, 1950), male, Monte Argentario, Tuscany, Italy, carL: 5.1 (2); *E. sicanus* (*E. sicanus canestrinii* Fanzago, 1872), female, Olbia, Sardinia, Italy, carL: 4.8 (3); *E. c. candiota* Birula, 1903 (*E. tergestinus* complex), male, Neriana, Crete island, Greece, carL: 4.9 (4); *E sicanus* (*E. c. linosae* Di Caporiacco, 1950), female, Linosa island, Sicily, Italy (MZUF, syntype n° 6242), carL: 5.2 (5); *E. c. aegaeus* Di Caporiacco, 1950, (*E. tergestinus* complex), female, Paros island, Greece, carL: 5.1 (6); *E. tergestinus* (C. L. Koch, 1837), male, Trieste, Italy, carL: 5.5 (7); *E. c. apuanus* Di Caporiacco, 1950, (*E. tergestinus* complex), female, Levigliani, Tuscany, Italy (MZUF, syntype n° 5938), carL: 6.6 (8).

Figs 9-16 – *E. c. corsicanus* Di Caporiacco, 1950, (*E. tergestinus* complex), female, Solenzara, Corsica, France, carL: 4.6 (9); *E. tergestinus* (?) (*E. tergestinus* complex), male, Agios Konstantinus, Samos island, northeastern Aegean, Greece, carL: 2.9 (10); *E. c. niciensis* (C. L. Koch, 1841), (*E. tergestinus* complex), male, Bormida, Savona, Liguria, Italy, carL: 4.1 (11); *E. oglasae* Di Caporiacco, 1950, male, Montecristo island, Tuscany, Italy, carL: 5.5 (12); *E. concinnus* (C. L. Koch, 1837), male, Siena, Tuscany, Italy, carL: 4.1 (13)*; E. hadzii* Di Caporiacco, 1950, male, Boga, Albania, carL: 6.5 (14); *E. hadzii* (*E. c. lagostae* Di Caporiacco, 1950), female, Kurcola island, Croatia (MZUF, syntype n° 5829), carL: 6.3 (15); *E. balearicus* Di Caporiacco, 1950, female, Majorca island, Spain, carL: 4.2 (16).



Figs 17-24 – *E. beroni* Fet, 2000, female, Mt. Radohimës, Albania (NMNHS, syntype n° 134); dorsal habitus, carL: 3.2 (17); lateral view of metasoma, scale bar: 2.3 (18); external view of pedipalp fixed finger, scale bar: 1.025 (19). *E. gamma* Di Caporiacco, 1950, female, external view of pedipalp fixed finger, scale bar: 0.625 (20); external surface of pedipalp chela, scale bar: 1.35 (21); ventral surface of pedipalp patella, scale bar: 1.35 (22); external view of patella, scale bar: 1.35 (23); dorsal view of patella, scale bar: 1.35 (trichobothria are highlighted with circles) (24).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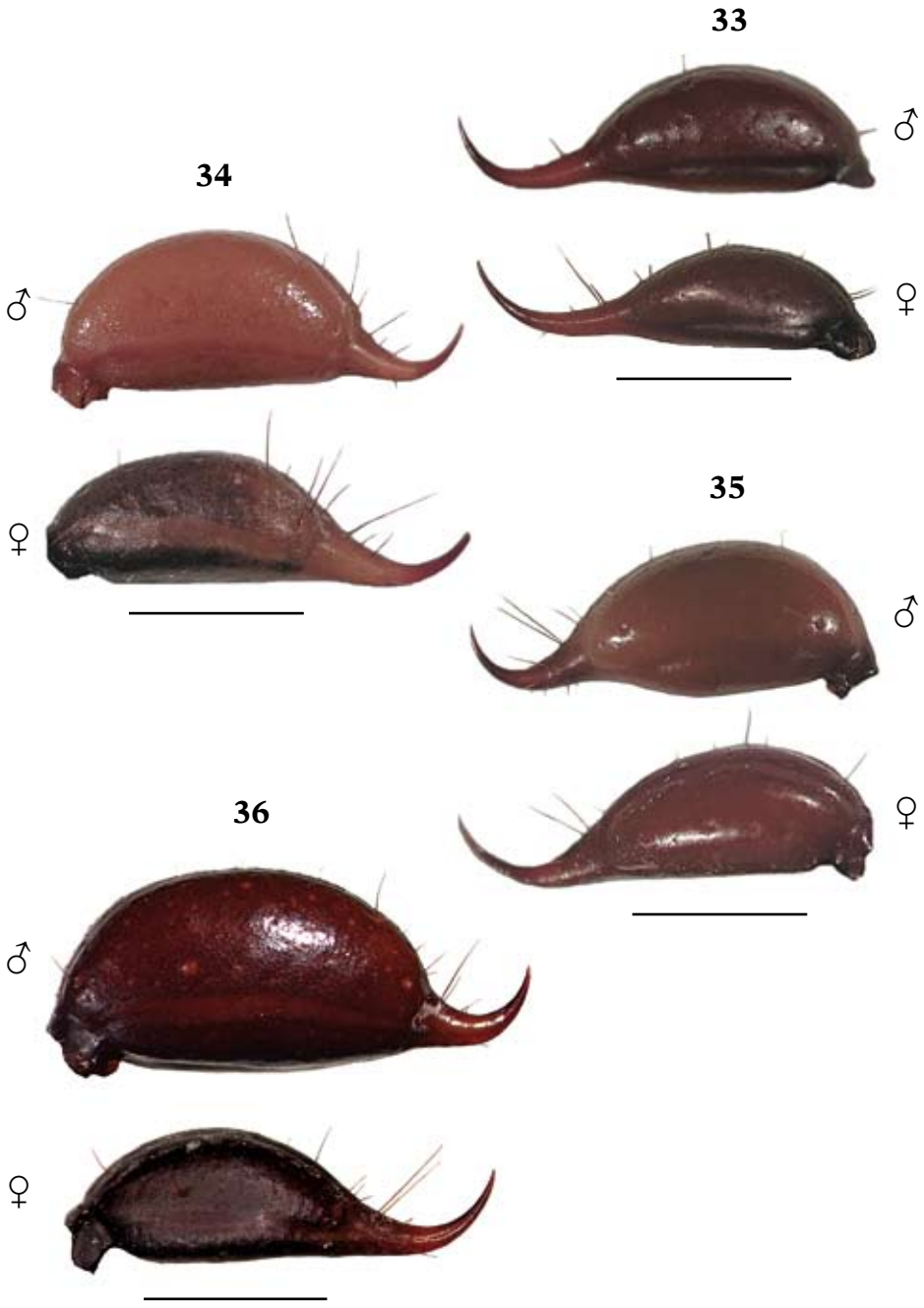
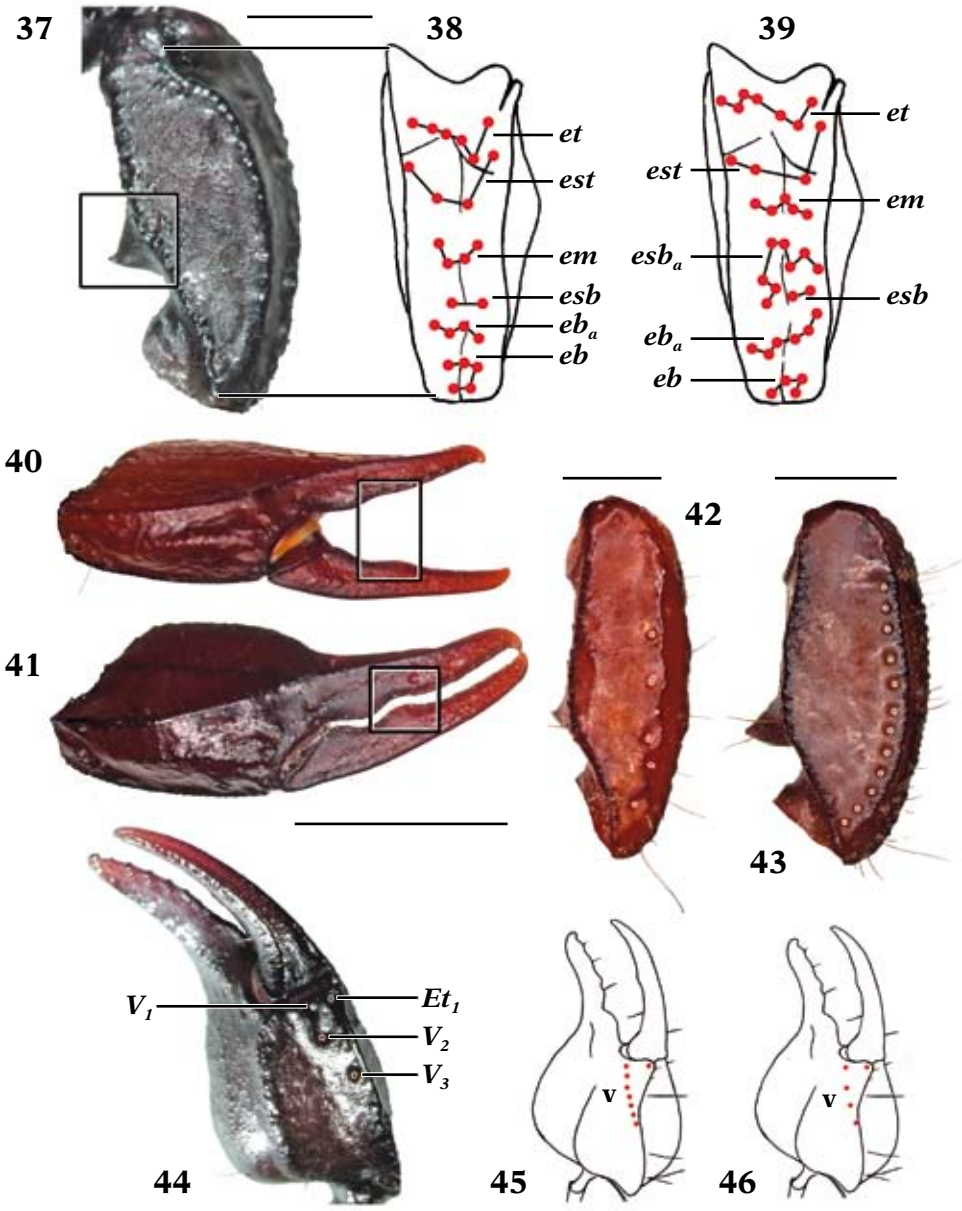
Figs 25-32 – *E. tauricus* (C. L. Koch, 1837), female, Sevastopol, Crimea, Ukraine, carL: 5.0 (25); *E. mingrelicus* (Kessler, 1874), male, Abdnoz, Turkey, carL: 3.6 (26); *E. gamma* Di Caporiacco, 1950, Udine, Friuli V. Giulia, Italy, carL: 2.8 (27); *E. germanus* (C. L. Koch, 1837) Udine, Friuli V. Giulia, Italy, carL: 3.4 (28); *E. alpha* Di Caporiacco, 1950, Bergamo, Lombardy, Italy, carL: 3.5 (29); *E. flavicaudis* (De Geer, 1778), male, Porto Ercole, south Tuscany, Italy, carL: 6.9 (30); *E. italicus* (Herbst, 1800), female, Siena, Tuscany, Italy, carL: 7.4 (31); *E. naupliensis* (C. L. Koch, 1837), female, Zakynthos island, Greece, carL: 5.1 (32).



Figs 33-36 – Lateral aspect of telson of male and female: subgenus *Tetratrichobothrius* Birula, 1917, *E. flavicaudis* (De Geer, 1778), scale bar: 4.2 (33); subgenus *Euscorpius* Thorell, 1876, *E. sicanus* (C. L. Koch, 1837), scale bar: 2.9 (34); subgenus *Alpiscorpius* Gantenbein et al. 1999, *E. alpha* Di Caporiacco, 1950, scale bar: 2.0 (35); subgenus *Polytrichobothrius* Birula, 1917, *E. italicus* (Herbst, 1800), scale bar: 1.9 (36).



Figs 37-46 – Dorsal aspect of right pedipalp patella with dorsal patellar spine highlighted (square) of *E. concinnus* (C. L. Koch, 1837), female, scale bar: 1.2 (37); distribution of trichobothria on external aspect of right pedipalp patella of *E. sicanus* (C. L. Koch, 1837) (38); same aspect of *E. italicus* (Herbst, 1800) (39); external aspect of right pedipalp chela with inner proximal surface of pedipalp highlighted (square) of *E. tauricus* (C. L. Koch, 1837), female (40); same aspect of *E. concinnus* (C. L. Koch, 1837), female, scale bar: 3.9 (41); ventral aspect of left pedipalp patella of *E. germanus* (C. L. Koch, 1837), scale bar: 1.0 (42); same aspect of *E. hadzii* Di Caporiacco, 1950, scale bar: 1.8 (trichobothria are highlighted with white circles) (43); distribution of trichobothria on ventral aspect of pedipalp chela of the subgenus *Euscorpius* Thorell, 1876 and *Alpiscorpius* Gantenbein et al. 1999 (44); same aspect of the subgenus *Polytrichobothrius* Birula, 1917 (45); same aspect of the subgenus *Tetratrichobothrius* Birula, 1917 (46).

different regions of Anatolia (e.g. *E. m. mingrelicus*, *E. m. phrygius* Bonacina, 1980 and *E. m. ciliciensis* Birula, 1898 (Bonacina 1980; Fet 1986, 1993; Lacroix 1995)).

DIAGNOSIS. Small scorpion with maximum total length rarely above 38 mm; brown in color. To discriminate this taxon from *E. germanus*, trichobothriotaxy needs to be analyzed. In *E. mingrelicus* the value of the ratio *et-est/est-dsb* is high (1.5-2.0) and the metasomal carinae are weakly present, in contrast to their absence in *E. germanus*. Bonacina (1980) also gave evidence of the different shape of the pectinal sensilla between the two similar species; they are more squat in *E. mingrelicus* in comparison to *E. germanus* (character only visible with scanning electron microscopy).

DISTRIBUTION. *E. mingrelicus* is the taxon with the most eastern distribution (see tab. 2). In Italy this species is no longer present because an old *E. mingrelicus* subspecies is currently regarded as a species (*E. gamma* Di Caporiacco, 1950). The systematics of the Balkan, Greek (Tinos, Ikaria Islands) and Russian populations remain to be resolved.

ECOLOGY. Species that prefers humid habitats and lives in deciduous or pine forests, also in mountainous habitats. The absence of *E. mingrelicus* in central-southern Turkey may be explained by its strong relationship with very humid biotopes (Crucitti 1999; Fet & Braunwalder 2000).

Euscorpius gamma Di Caporiacco, 1950 (figs 20, 27)

Euscorpius mingrelicus gamma Di Caporiacco, 1950: 214, 230. Loc. Typ.: Istria, Slovenia.

Selected references: Fet & Sissom 2000; Scherabon et al. 2000; Komposch 2004.

TAXONOMY. Originally described as a subspecies of *E. germanus* and subsequently by Bonacina (1980) as a subspecies of *E. mingrelicus*, *E. gamma* only became a species following the discovery of a high genetic divergence (Scherabon et al. 2000) from the typical *E. germanus* (also called "T" form (Scherabon 1987)). The discrimination of *E. gamma* from *E. mingrelicus* and other taxa belonging to

the "*E. mingrelicus* complex" (populations from Anatolia and the Balkans) is based on morphological features.

DIAGNOSIS. Brown scorpion that rarely measures more than 30 mm in total length (32 mm) (fig. 27). Pv with 5 trichobothria (rare Pv = 6), while the territory *et* = 4 (Pe).

DISTRIBUTION. The geographic distribution covers the extreme north-eastern border of Italy near the river Risana (north of Istria), part of Slovenia (type locality) and Croatia. The presence of *E. gamma* in southern Carinthia (Austria) is regarded as a case of allochthony (Komposch & Scherabon 1999).

ECOLOGY. Hygrophilous species, both lapidicolous and saprophilous (Komposch 2004). See *E. mingrelicus*.

Euscorpius beroni Fet, 2000 (figs 17-19, 21-24)

Euscorpius beroni Fet, 2000: 49-51. Loc. Typ.: Albania.
Selected references: Fet 2000.

TAXONOMY. This species was described as belonging to the "*E. mingrelicus* complex" due to the presence of a similar trichobothrial pattern (figs 21-24) and the absence of metasomal carinae.

DIAGNOSIS. The body color of this small scorpion is brown (fig. 17) with darker legs, pedipalps and chelicerae. The tergites, pedipalp femur and patella are slightly granulate; Dp = 9-10 males. Pedipalp trichobothria formulas are the following: Pv = 5/5 (fig. 22), Pe = 21, *et* = 4; *est* = 4; *em* = 3; *esb* = 2; eb_a = 4; *eb* = 4 (fig. 21). Sexual dimorphism is weakly evident besides the Dp and shape of telson (more swollen in males). Metasomal carination is very weak (fig. 18). *E. beroni* differs from *E. mingrelicus* by a higher *et-est/est-dsb* ratio (average = 2.10) (figs 19-20) and by a different trichobothrial number (Fet 2000). It differs in particular from the other two Balkan forms described, *E. m. caporiaccoi* Bonacina, 1980 by Pv = 6/6, and *E. m. dinaricus* Di Caporiacco, 1950 by Pe = 22 and Pv = 6-7. Although this taxon likely represent a distinct species, a more detailed comparative analysis should be carried out, since in our opinion current evidences are too weak.

Moreover, molecular evidence may confirm this population as a distinct species and provide information on its phylogenetic relationships with the other taxa.

Distribution. It is the only species belonging to the "*E. mingrelicus* complex" described for Albania. The type material was collected 2569 m a.s.l. on the Radohimës Mountains which are situated in the north of the country and are part of the Prokletija Massif.

Ecology. No ecological data available.

Subgenus **Polytrichobothrius** Birula, 1917 (fig. 45)

Euscorpius (*Polytrichobothrius*) Birula, 1917: 105.
Selected references: Fet & Sissom 2000; Gantenbein et al. 2002; Fet et al. 2004.

Diagnosis. This taxon includes at present two species which can be separate from the other subgenera by the presence of a high number of trichobothria on ventral part of pedipalp chela (V_1–$V_{6\text{-}10}$, Et_1).

Distribution. Central Mediterranean area; the distribution of the eastern (Anatolia) populations is not defined. See species.

Euscorpius italicus (Herbst, 1800) (figs 31, 36, 39)

Euscorpius italicus Herbst, 1800: 70, fig. 2, tab. I. Loc. Typ.: Italy.
Selected references: Fet & Sissom 2000; Gantenbein et al. 2002.

Taxonomy. *Euscorpius italicus* belongs to a separate taxonomical group, the subgenus *Polytricobothrius* Birula, 1917, due to the high number of trichobothria on its pedipalps. Of the 8 different subspecies described (*E. i. italicus* Di Caporiacco, 1950; *E. i. oligotricus* Hadži, 1929; *E. i. mesotrichus* Hadži, 1929; *E. i. polytrichus* Hadži, 1929; *E. i. etruriae* Di Caporiacco, 1950; *E. i. zakynthi* Di Caporiacco, 1950; *E. i. awhasicus* Di Caporiacco, 1950 (= *Scorpio awhasicus* Nordmann, 1840) and *E. i. naupliensis* Birula, 1917), only the typical form is considered as a valid taxon (Vachon 1981; Bonacina 1982). Apart from this, *E. i. naupliensis* has recently been elevated to the species level (see *E. naupliensis*). Although this species is regarded as stable

from a taxonomical point of view, some populations (Italian, Greek, Anatolian and Russian) are still of interest as they show peculiar phenotypes (Fet & Braunwalder 2000; Gantebein et al. 2002).

Diagnosis. Easy to distinguish due to its polytrichous trichobothria formula, with a patellar external series esb_a = 5-13 and more trichobothria on the ventral pedipalp chela. Adult specimens can measure more than 50 mm (55 mm) in total length, and this is the largest known species of the entire genus. The color is variable but they are generally dark brown with a slightly lighter telson. Sexual dimorphism is evident in males, which have a more swollen telson. In accordance with Bonacina's morphological study (1982), *E. italicus* is characterized by high intra-population variability. Therefore, the author highlighted that the analysis of single specimens or studies on a low number samples can cause confusion, which was the result of old studies that led to the description of several subspecies. If we compare Dp and trichobothrial values of different populations from distant localities, we can observe a relatively homogeneous morphology (Kinzelbach 1975; Bonacina 1983) among them despite the geographic distance.

Distribution. The distribution of *E. italicus* is widespread in the northern Mediterranean, from France to the Caucasus (Di Caporiacco 1950; Kinzelbach 1975), Switzerland, Austria, Romania, territories of former Yugoslavia, Albania, Greece and around the southern Black Sea coasts (northern Turkey and Georgia). In Italy this scorpion can be found from L'Aquila (Abruzzo) to Campobasso (Molise) (southern limit) and in the northern area comprising the Alps, prevalently to the east (Adriatic coast), while it is absent on the large Tyrrhenian Islands. This taxon inhabits north-eastern Italy and Latium, where distribution reaches the Tyrrhenian coast (Crucitti et al. 1998a, b). Nevertheless, the presence of allochthonous populations seems to occur in Italy. The first author detected a small population for the first time in Siena (Tuscany, central Italy) in a stony wall around a house (loc. Bottega Nuova); this unusual western Italian distribution is probably due to anthropogenic origin. Including this new record, the species that live in Siena are four (*E. sicanus*, *E. concinnus*, *E. tergestinus* and *E. italicus*). This is a relatively high number of sympatric species compared to other Italian regions and each taxon seems to have a precise and

distinct habitat. *Euscorpius italicus* has also been found in countries where its autochthony is very doubtful (its presence there could be due to passive transport of anthropogenic origin), for example, in some localities in Algeria, Tunisia, and even on the Arabian Peninsula (Yemen). This scorpion has even been collected in central-northern Europe, in Belgium (Verstraeten 1990), in Germany (Kinzelbach 1975), in Iraq (Fet & Kovařík 2003) and in Lithuania (Fet & Gruodis 1987).

Ecology. This species can be found from sea level to an altitude of 1200 m a.s.l.; it is common in natural habitats but is often present also inside houses (Crucitti et al. 1998b). Recent studies (Fet et al. 2001) have highlighted a specific climatic adaptation of *E. italicus*. For example, in Slovenia the distribution area extends exclusively along the Adriatic coast regions, which are characterized by a different climate to that of the rest of the country. The temperature near the coast is higher with warmer winters and the annual rainfall is lower in comparison to inland Slovenian regions. If we compare the distribution of *E. italicus* in Slovenia with other Euscorpiidae, such as *E. gamma* and *E. germanus* (which are strictly hygrophilous), it seems clear that *E. italicus* is more sensible to low temperatures but more tolerant to dryer conditions (Fet et al. 2001).

Euscorpius naupliensis (C. L. Koch, 1837) (fig. 32)

Scorpius naupliensis C. L. Koch, 1837, C.M.A. Deutschls., 93-95, tav. CIV, fig. 240, Loc. Typ.: Greece.
Selected references: Fet & Sissom 2000; Gantenbein et al. 2002.

Taxonomy. The name "*naupliensis*" comes from the place named Nauplia, situated in the eastern region of Peloponnesus (Greece). Described by C. L. Koch as a subspecies of *E. italicus*, and recently elevated to species rank because it is genetically and morphologically different (Gantenbein et al. 2002). *Euscorpius carpathicus zakynthi* Di Caporiacco, 1950 is retained by the same authors to be a synonym.

Diagnosis. This species shows the typical features of the subgenus *Polythricobothrius,* very high trichobothria counts of the *et* series of the external patella and the V series of chela. The absence of the esb_a series (if present, only with less than 3 trichobothria) represent

the main diagnostic character. The body color is homogeneous and prevalently dark brown, but morphotypes with legs and telson lighter can be found (fig. 32); the adults are large euscorpiids and both females and males can measure around 45 mm in total length. Even the sexual dimorphism is similar to *E. italicus*. As emphasized by Vachon (1981), the trichobothria *est* is nearer to *dsb,* while in *E. italicus* the pattern is opposite; the different *et-est/est-dsb* ratio is an additional diagnostic character of this species. There are even some differences in the carination on the metasomal segments in particular, which are smoother than in *E. italicus*.

Distribution. south-western Greece, including Peloponnesus, Zakynthos and Pelouzo island in the Ionian Sea.

Ecology. The ecology is similar to the species *E. italicus*. These scorpions live on stone walls or rocky areas often covered with vegetation. It is not rare to find this species around abandoned houses (Crucitti & Bubbico 2001; Colombo 2006).

Subgenus **Tetratrichobothrius** Birula, 1917 (fig. 46)

Euscorpius (*Tetratrichobothrius*) Birula, 1917: 104.
Acanthothraustes Mello-Leitão, 1945: 94.
Selected references: Fet & Sissom 2000; Fet et al. 2004.

Diagnosis. Monospecific taxon which is characterized by 5 trichobothria on ventral pedipalp surface (V_1–V_4, Et_1). The sexual dimorphism is slightly evident in the globosity of the telson (fig. 33).

Distribution. Wide distributed taxon, from southern Spain to southern Italy.

Euscorpius flavicaudis (De Geer, 1778) (Figs 30, 33, 46)

Scorpio flavicaudis De Geer, 1778: 339-340, tav. XL, fig. 11-13. Loc. Typ.: unknown.
Selected references: Vachon 1969, 1983; Bonacina & Rivellini 1986; Fet & Sissom 2000.

Taxonomy. Besides the typical species, only four different subspe-

cies, have been described: one of the Galite island of Tunisia (*E. flavicaudis galitae*, Di Caporiacco, 1950), distinguishable by its peculiar yellowish color and less accentuated metasomal carinae. The second, *E. flavicaudis massiliensis* (L. C. Koch, 1837), is typical of Liguria, northern Italy. This taxon was first described as a species (*E. massiliensis* (L. C. Koch, 1837)), but was later placed in synonymy with *E. flavicaudis* and therefore considered as a subspecies (Di Caporiacco, 1950). Another taxon, *E. flavicaudis algeriacus* (C. L. Koch, 1838), was found in Algeria, but this was also synonymous of the typical form. Finally, *E. flavicaudis cereris* Bonacina & Rivellini, 1986 was described on the basis of some trichobothrial differences in specimens belonging to a population of Salerno (Campania) in southern Italy (Bonacina & Rivellini, 1986). These subspecies are currently not taken into consideration because genetically similar (Gantenbein et al. 2001).

Diagnosis. *Euscorpius flavicaudis* belongs to the subgenus *Tetrathricobothrius* (Birula, 1917) due to the presence of 4 trichobothria (V_1–V_4 + Et_1) on the ventral surface of the pedipalp patella: character that makes this species very easy to identify. Evident crenulate metasomal carination (dorso-lateral) is considered diagnostic of the species (Kraepelin 1899). The most frequent coloration is dark brown to blackish on the body with lighter coloured and often yellow legs and telson; nevertheless, some populations can be more concolorous (*E. f. cereris*). The sexual dimorphism is less accentuated in the telson shape (fig. 33), but is evident in the pectinal tooth count (Dp = 8-8 in females and 10-10 in males).

Distribution. It has a western Mediterranean-European distribution, from the western Pyrenees (Catalonia, Spain) to south-west Italy (Calabria). In both France and Italy the distribution is limited to the Tyrrhenian coast, islands included. The presence on Sardinia and Corsica, as well as in some north African countries (Algeria, Libya, Tunisia) could be of autochthonous origin, if we consider the geological history of the Mediterranean Sea, as proposed by Giusti & Manganelli (1984). The presence in other countries (Brazil, Uruguay, Yemen) is presumably allochthonous. Some disjunctive populations in south-east England (Sheerness) could have been transported by maritime traffic (Benton 1992).

Ecology. This species is anthropotolerant (Vachon 1983) and this peculiarity could be the principal reason for the passive dispersal and the collecting of these scorpions even in territories very far from the original distribution area. Vachon (1969) gives the definition of "petit scorpion voyageur" due to the casual distribution of this scorpion in the whole of metropolitan France. An ecological study carried out by Benton (1992) on the population present in the harbour of Sheerness (Kent), in England, has highlighted the sedentary behavior of this species. The males are errant in the reproduction period, at the beginning of summer season, but their exploration activity seems to be influenced by specific climatic conditions such as air temperature, rainfall and moon phases. Their diet is prevalently opportunistic (Benton 1992). Habitat ranges from sea level to around 1000 m a.s.l. (Vignoli 2007) and specimens are quite common on stone walls (which are not too exposed to the sunshine and which are often covered with vegetation), under the bark of rotten trees and inside houses. *Euscorpius flavicaudis* can also colonize habitats very close to the seashore and it is therefore considered a halophilous species (Vachon 1951).

APPENDIX

Key to identification of the subgenera and species of *Euscorpius* Thorell, 1876

1. Pedipalp with 4 trichobothria (V_1–V_3, Et_1) on ventral surface of chela manus (fig. 44) 2
- Pedipalp with 5 or more trichobothria (V_1–$V_{4\text{-}11}$, Et_1) on ventral surface of chela manus (figs 45, 46) 15
2. Pedipalp with more than 6 trichobothria on ventral surface of patella (fig. 43) . . . . . subgenus *Euscorpius* . . . 3
- Pedipalp with less than 6 (5-6) trichobothria on ventral surface of patella (fig. 42) . . . . . subgenus *Alpiscorpius* . . . 11
3. Pedipalp with trichobothria series *em* = 3 on external surface of patella (endemic to Romania) . . . . . *Euscorpius carpathicus*
- Pedipalp with trichobothria series *em* = 4 on external surface of patella 4
4. Pedipalp with 9 (7-11) or more trichobothria on ventral surface of patella 8
- Pedipalp with less than 9 (7-8) trichobothria on ventral surface of patella 5
5. Pedipalp patella with large dorsal patellar spine; metasomal segments elongated with carinae smooth (endemic to north east Greece) . . . . . *Euscorpius koschewnikowi*
- Pedipalp patella with short dorsal patellar spine (fig. 37) 6
6. Pedipalp manus with fingers not stocky in aspect; pedipalp with trichobothria series *et* = 5 on external surface of patella (endemic to Montecristo island, Italy) . . . . . *Euscorpius oglasae*
- Pedipalp manus with short fingers, stocky aspect 7
7. Pedipalp with trichobothria series *et* = 7 on external surface of patella; inner prox-

imal surface of pedipalp movable finger with a weak lobe (fig. 41) . . . . . *Euscorpius concinnus*

- Pedipalp with trichobothria series *et* = 6 (mostly) on external surface of patella; inner proximal surface of pedipalp movable finger with a vestigial lobe (fig. 40) (endemic to Ukraine) . . . . . *Euscorpius tauricus*

8. Pedipalp with trichobothria series *eb* = 5 on external surface of patella 9
- Pedipalp with trichobothria series *eb* = 4 on external surface of patella 10

9. Pedipalp with trichobothria series eb_a = 4-5 on external surface of patella (fig. 38) . . . . . *Euscorpius sicanus*
- Pedipalp with trichobothria series $eb_a \geq 7$ on external surface and with 9-13 (11) trichobothria on ventral surface of patella (fig. 43) . . . . . *Euscorpius hadzii*

10. Pedipalp with trichobothria series *et* = 6 on external surface and with 9 (7-11) trichobothria on ventral surface of patella; coloration reddish brown . . . . . *Euscorpius tergestinus*
- Pedipalp with trichobothria series *et*> 6 (7-9) (rarely 6) on external surface and with more than 9 (9-14) trichobothria on ventral surface of patella; coloration light brown to yellowish (endemic to Balearic islands, Spain) . . . . . *Euscorpius balearicus*

11. Pedipalp with trichobothria *est* distant from *dsb* (*et-est/est-dsb* = around 1.0) on external surface; metasomal segments without carinae and circular in aspect 12
- Pedipalp with trichobothria *est* close to *dsb (et-est/est-dsb* = 1.5-2.0) on external surface; metasomal segments with dorso-lateral carinae weakly visible 13

12. Pedipalp with 5 trichobothria on ventral surface of patella (fig. 42); pectines sensilla elongated with narrow extremity (visible only with scanning electron microscopy) . . . . . *Euscorpius germanus*
- Pedipalp with 6 trichobothria (prevalently) on ventral surface of patella; separate on genetic evidence . . . . . *Euscorpius alpha*

13. Pedipalp with trichobothria series *et* = 5 on external surface of patella; pectines sensilla stocky (visible only with scanning electron microscopy) . . . . . *Euscorpius mingrelicus*
- Pedipalp with trichobothria series *et* = 4 on external surface of patella . . . . . *Euscorpius gamma*
- Similar with higher trichobothria ratio *et-est*/*est-dsb* (fig. 19) (endemic to Albania) . . . . . *Euscorpius beroni*

15. Pedipalp with 5 trichobothria (V_1–V_4, Et_1) on ventral surface of patella (fig. 46) . . . . . subgenus *Tetratrichobothrius*: *Euscorpius flavicaudis*
- Pedipalp with more than 5 trichobothria (V_1–$V_{6\text{-}11}$, Et_1) on ventral surface of patella (fig. 45) . . . . . subgenus *Polytrichobothrius* . . . 16

16. Pedipalp with supplementary trichobothria series esb_a = 4-11 on external surface of patella (fig. 39) . . . . . *Euscorpius italicus*
- Pedipalp lacking (rarely present but with at least 2 trichobothria) supplementary trichobothria series esb_a on external surface of patella (endemic to north west Greece) . . . . . *Euscorpius naupliensis*

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SUMMARY

The present work provides a general survey of the scorpion genus *Euscorpius* Thorell, 1876. Each species is briefly summarized, with notes on taxonomy, morphology, geographic distribution and ecology. The distribution and diagnostic characters are shown in easy to read tables and an identification key is provided. All the current valid species of *Euscorpius* (except *Euscorpius koschewnikowi* Birula, 1903) and several peculiar morphotypes are illustrated, with the first images of *Euscorpius beroni* Fet, 2000. The main aim of this work is to provide a complete review which will be useful both to have clearance on current systematics of the complex genus *Euscorpius* and to interpret possible future taxonomic rearrangements. *Euscorpius italicus* (Herbst, 1800) was found for the first time in Siena (central-western Italy), a record that represents a new allochthonous population, probably due to anthropogenic origin.

RIASSUNTO

In questo lavoro viene presentata una rassegna sugli scorpioni appartenenti al genere *Euscorpius* Thorell, 1876. Ciascuna specie è brevemente descritta, con note di tassonomia, morfologia, distribuzione geografica ed ecologia. Distribuzione e caratteri diagnostici sono riportati anche in tabelle, e viene presentata una chiave all'identificazione delle specie. Sono illustrate tutte le specie ad oggi descritte (eccetto *Euscorpius koschewnikowi* Birula, 1903) e diversi morfotipi peculiari, con le prime immagini di *Euscorpius beroni* Fet, 2000. Scopo principale di questo lavoro è fornire una descrizione completa del genere *Euscorpius*, che potrà essere utile per capire la complessa sistematica del taxon e a interpretare possibili modifiche future. *Euscorpius italicus* (Herbst, 1800), segnalato per la prima volta a Siena (Italia centrale), rappresenta una nuova popolazione di probabile origine antropogenica.

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