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# SCORPIONS OF THE EASTERN MEDITERRANEAN

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*Abstract* — The scorpiofauna of the Eastern Mediterranean region is presented. Taxonomy and distribution data of species are reviewed based on scientific literature until August 2008. We report the presence of 48 valid species in the area, belonging to four families and 16 genera. Examined material of nine buthid species collected from Egypt (including the Sinai Peninsula) and Libya is recorded. The current knowledge on taxonomy, chorotypic status, and origins of species, complexes, and genera in relation to their biogeography and phylogeny is also discussed.

*Key words:* Scorpion taxonomy, E-Mediterranean chorotype, Buthidae, Euscorpiidae, Iuridae, Scorpionidae

## INTRODUCTION

The scorpiofauna of the Eastern Mediterranean area has long ago attracted the interest of scorpiologists worldwide in terms of taxonomy and biogeography, due to the diversiform morphological characters and the high venom toxicity of several genera. The number of publications dealing with the systematics of scorpions of the Eastern Mediterranean since Linnaeus (1758), Amoreux (1789), and Herbst (1800) amounts to several hundred. Reviews have been published on the scorpion species of Syria (Simon, 1892), Egypt (Simon, 1910), Jordan (El-Hennawy, 1988; Amr and El-Oran, 1994), Turkey (Tolunay, 1959), North Africa (Pallary, 1937; Vachon, 1948a, 1948b, 1949a, 1949b, 1950, 1952), the Middle East (sometimes including North African countries) (Vachon, 1966; Levy, and Amitai, 1980; Vachon and Kinzelbach, 1987; El-Hennawy, 1992), the Aegean Archipelago (Kinzelbach, 1975; Fet and Braunwalder, 2000), Europe (Kovařík, 1999), and the Central and Eastern Mediterranean (Stathi and Mylonas, 2001).

Fet et al. (2000b) published the "*Catalog of the Scorpions of the World*" as a taxonomic reference book including distribution data for every scorpion species and sub-species based on published scientific literature from 1758 until 1998. The only

existing complete survey of the world scorpiofauna before Fet et al. (2000 b) was published by Kraepelin (1899). Nevertheless, as was the case before 1998, scorpion taxonomy underwent thorough changes during the last ten years, the most profound of which were presented by Soleglad and Fet (2003). They addressed scorpion systematics and phylogeny above genus level through a cladistic morphological analysis of 90 extant genera and over 150 species of scorpions belonging to all (16 then) recognized families, and the first pilot high-level scorpion DNA phylogeny, including representatives of seven families. These changes were criticized by Prendini and Wheeler (2005) and restored by Fet and Soleglad (2005). Here, the family-group level classification follows the most recent published work (Fet and Soleglad, 2005).

Our aim in this review is to update the information on the scorpiofauna of the Eastern Mediterranean at species level, including new species from the Eastern Mediterranean area discovered after 1998 and adding new distributional records. References to species records in literature are listed only after 1998; for all earlier references, synonymies, and details on systematics, see Fet et al. (2000b). The biogeographical patterns of species and genera distributed in the region and their evolutionary elements are discussed.

## STUDY AREA AND METHODOLOGY

The study area is shown in Fig. 1 (outline 3.03). It was proposed by Vigna Taglianti et al. (1999) as the chorotype of East Mediterranean fauna, east of the Apennine Peninsula and Gulf of Sirte and east to the Black Sea. Extensions of the chorotype may occur east to Iran and the Middle East and southwest to the Sahara. The detailed distribution patterns included in this chorotype are: NE-Mediterranean, Palestino-Cyprioto-Taurian, Palestino-Taurian, and Aegean.

The scorpiofauna of the Eastern Mediterranean presented here includes the species known to be distributed in the region based on published literature until August 2008. Synonymies and references of species published after 1998 are included. All previous records are published in Fet et al. (2000b). Wherever possible, the exact locations of published records are mentioned. Thus, we present two species lists: the first one includes all species known to be distributed in the Eastern Mediterranean (E-Mediterranean chorotype, Fig. 1); the second includes species found in at least one country of the Eastern Mediterranean region, but far from the Mediterranean Coast, and those with dubious records from the study area. Hence, by mentioning Turkey, for example, we do not refer to the geographic limits of the country, but to the part of Turkey included in the E-Mediterranean chorotype.

In addition to published references, some new data are listed under "Material examined" for Buthidae from Egypt (including the Sinai Peninsula) and Libya, based on specimens collected by the first two authors and other members of the staff of the Natural History Museum of Crete (NMHC). These specimens are deposited at the NHMC.

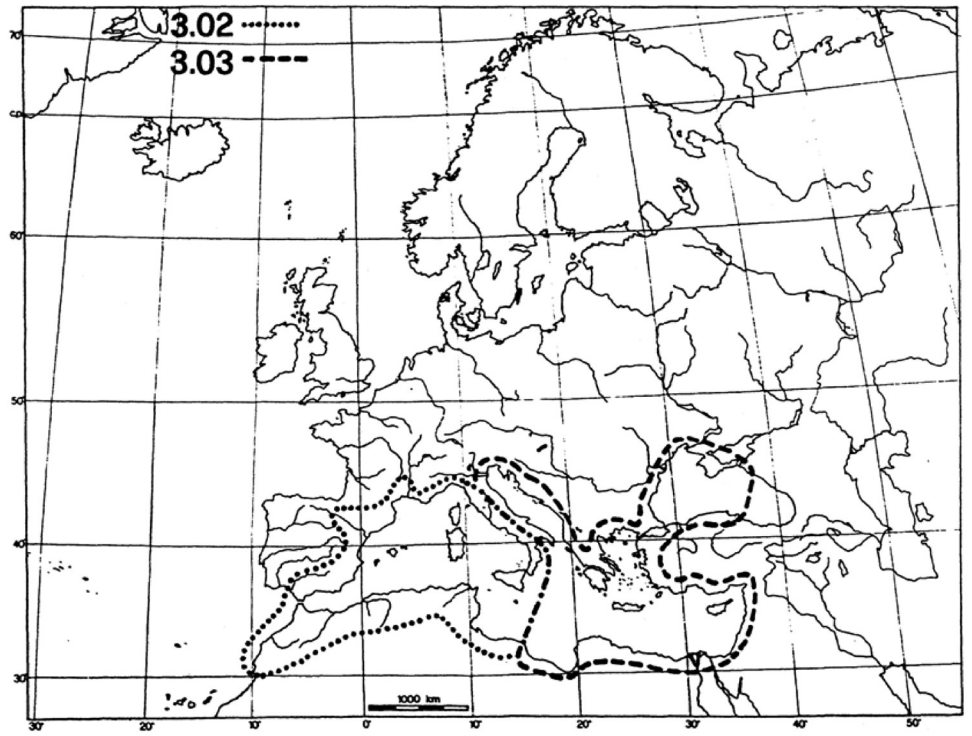


**Fig. 1.** The W-Mediterranean (3.02) and E-Mediterranean (3.03) chorotypes, as proposed by Vigna Taglianti et al. (1999: 49).

## SYSTEMATIC LIST OF THE EASTERN MEDITERRANEAN SCORPIONS

**1.** Family **Buthidae** C.L. Koch, 1837

Type genus: *Buthus* Leach, 1815

**1.1.** Genus ***Androctonus*** Ehrenberg, 1828

**1.1.1.** ***Androctonus amoreuxi*** (Audouin, 1826)

References:

*Androctonus amoreuxi*: Fet and Lowe, 2000: 65-67 (in part.); Kovařík, 2002: 4; Kovařík and Whitman, 2005: 105; Lourenço, 2005: 157-158.

*Androctonus amoreuxi amoreuxi*: Lourenço, 2003: 878, Figs. 14-17.

Distribution: AFRICA: Algeria, Egypt, Libya, N Mauritania, ?Morocco. ASIA: Egypt (Sinai), Israel.

Material examined: Libya: Al Haraba, Detj oasis (440 m alt., 7 May 2007), Gadamesh (320 m alt., 8 May 2007). Egypt (Sinai): Wadi Sudr, 10 km SE of Qa'lat et Jundi (12 March 2004).

Comments: The distribution of this species was restricted by Lourenço (2005) based

on the study of Vachon (1952). We confirm the presence of the species in the Sinai [material not examined by Lourenço (2005)].

**1.1.2. *Androctonus australis*** (Linnaeus, 1758)

Synonyms:

*Androctonus australis garzonii* Goyffon & Lamy, 1973 (syn. by Lourenço, 2005).

*Androctonus australis africanus* Lamy, Le Pape & Weill, 1974 (syn. by Lourenço, 2005).

References:

*Androctonus australis*: Fet and Lowe, 2000: 67-70 (in part.); Stathi and Mylonas, 2001: 288; Kovařík, 2002: 4-5; Kovařík and Whitman, 2005: 105; Lourenço, 2005: 147-149, Figs. 1-4; Hendrixson, 2006: 42.

Distribution: AFRICA: Algeria, Egypt, Libya, Tunisia. ASIA: Egypt (Sinai).

Material examined: Libya: Ain Tagnit (320 m alt., 5 December 2007), Kikla (780 m alt., 6 December 2007).

Comments: Lourenço (2005) limited the distribution of the species, mentioning that previous published records of *A. australis* from the Middle East may refer to a different species.

**1.1.3. *Androctonus bicolor*** (Ehrenberg, 1828)

Synonyms:

*Androctonus aeneas* C.L. Koch, 1839 (syn. by Lourenço, 2005).

References:

*Androctonus bicolor*: Kovařík, 1999: 39; Fet and Lowe, 2000: 70-71 (in part.); Kovařík, 2002: 5; Kovařík and Whitman, 2005: 105, 112; Lourenço, 2005: 161-162, Figs. 32-35.

Distribution: AFRICA: Algeria, Egypt, Libya, Tunisia. ASIA: Egypt (Sinai), Israel, Jordan, ?Lebanon, Syria.

Comments: The distribution of this polymorphic species was limited by Lourenço (2005), who elevated *A. liouvillei* Pallary, 1924 to species level. Thus, currently there are no records of *A. bicolor* from Morocco. Also, Lourenço (2005) synonymized *A. bicolor aeneas* (C.L. Koch, 1839) to the nominotypic subspecies.

**1.1.4. *Androctonus crassicauda*** (Olivier, 1807)

References:

*Androctonus crassicauda*: Crucitti, 1999b: 83-84; Kovařík, 1999: 39; Fet and Lowe, 2000: 72-73; Crucitti and Cicuzza, 2000: 278-280, Figs. 2-4, 7-8; Crucitti and Cicuzza, 2001 a: 231, Fig. 2; Stathi and Mylonas, 2001: 288; Crucitti and Vignoli, 2002: 437-439; Fet and Kovařík, 2003: 180; Karataş and Karataş, 2003: 4; Vignoli et al., 2003: 2; Karataş and Çolak, 2005: 1; Kovařík, 2002: 5; Kovařík and Whitman, 2005: 105; Lourenço, 2005: 149-140, Figs. 5-6; Hendrixson, 2006: 38-42, Fig. 1, Pl. 1; Stewart,

2006: 1-9; Navidpour et al., 2008a: 5, Figs. 5, 12, 44-45; Navidpour et al., 2008b: 3, 5, Figs. 4, 20, 25-28; Navidpour et al., 2008c: 3, 5, Figs. 2, 3, 8, 13-16; Yağmur et al., 2008b: 14-15.

Distribution: AFRICA: Libya. ASIA: Armenia, Azerbaijan, Bahrain, Egypt (Sinai), Iran, Iraq, Israel, Jordan, Kuwait, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen.

Material examined: Libya: Ain Tagnit (300 m alt., 6 May 2007), Al Haraba (7 May 2007), 9 km after Ben Joad, 120 km east of Sirte (25 m alt., 9 May 2007). Egypt (Sinai): Wadi Sudr, 10 km SE of Qa'lat et Jundi (12 March 2004).

Comments: Based on our examined material, these are the first records of *A. crassicauda* from Libya.

### **1.2.** Genus ***Birulatus*** Vachon, 1974

*Birulatus* Vachon, 1974: 949.

#### **1.2.1.** ***Birulatus astartiae*** Stathi & Lourenço, 2003

*Birulatus astartiae* Stathi and Lourenço, 2003: 106-109, Figs. 1-9.

References:

*Birulatus* sp.: Stathi and Mylonas, 2001: 288.

Distribution: ASIA: Syria.

Comments: The female holotype was found about 60 km Southwest of Deir ez Zur, in Syria (Stathi and Lourenço, 2003).

#### **1.2.2.** ***Birulatus haasi*** Vachon, 1974

References:

*Birulatus haasi*: Lourenço, 1999b: 108-111, Figs. 1-5; Fet and Lowe, 2000: 81; Lourenço, 2002 a: 141-142.

Distribution: ASIA: Jordan.

Comments: The female holotype was found south of Tafila, in Jordan (Vachon, 1974).

#### **1.2.3.** ***Birulatus israelensis*** Lourenço, 2002

*Birulatus israelensis* Lourenço, 2002a: 142-144, Figs. 1-10.

Distribution: ASIA: Israel.

Comments: The female holotype was found near Dgania (=Deganya), near Lake Tiberias, in Massada, Israel (Lourenço, 2002a).

### **1.3.** Genus ***Buthacus*** Birula, 1908

#### **1.3.1.** ***Buthacus arenicola*** (Simon, 1885)

References:

*Buthacus arenicola*: Fet and Lowe, 2000: 81-82; Kovařík, 2005: 9-10, Fig. 2; Kovařík and Whitman, 2005: 106.

Distribution: AFRICA: Algeria, Egypt, Libya, Tunisia. ASIA: Egypt (Sinai).

**1.3.2. *Buthacus leptochelys*** (Ehrenberg, 1829)

Synonyms:

*Buthacus granosus* Borelli, 1929 (syn. by Kovařík, 2005).

*Buthacus leptochelys nitzani* Levy et al., 1973 (syn. by Kovařík, 2005).

References:

*Buthacus leptochelys leptochelys*: Kabakibi et al., 1999: 82; Fet and Lowe, 2000: 84.

*Buthacus leptochelys*: Fet and Lowe, 2000: 82-85 (in part.); ICZN, 2000: 7 (in part.); Kovařík, 2001: 80; Stathi and Mylonas, 2001: 288; Kovařík, 2002: 5; Lourenço, 2001: 255; Kovařík, 2003a: 135; Lourenço, 2003: 877-878, Fig. 10; Lourenço, 2004a: 205; Lourenço, 2004b: 229, Figs. 11-15; Kovařík, 2005: 2-3, 9-10, Figs. 1-2, 5, 7.

*Buthacus leptochelys granosus*: Fet and Lowe, 2000: 84.

*Buthacus leptochelys nitzani*: Fet and Lowe, 2000: 84.

Distribution: AFRICA: Algeria, Chad, Egypt, Libya, Mauritania, Morocco, Niger, Sudan. ASIA: Bahrain, Egypt (Sinai), Iran, Iraq, Jordan, Kuwait, Lebanon, Qatar, Saudi Arabia, Syria, United Arab Emirates.

Material examined: Libya: Detj Oasis (440 m alt.), 20 km after Detj Oasis, towards Gedamesh (7 May 2007). Egypt (Sinai): Wadi Sudr, 10 km Southeast of Qa'lat et Jundi (12 March 2004).

**1.3.3. *Buthacus macrocentrus*** (Ehrenberg, 1828)

Synonyms:

*Buthus tadmorensis* Simon, 1892 (syn. by Kovařík, 2005).

*Buthacus yotvatensis* Levy et al., 1973 (syn. by Kovařík, 2001).

References:

*Buthacus tadmorensis yotvatensis*: Kabakibi et al., 1999: 82.

*Buthacus yotvatensis*: Fet and Lowe, 2000: 85-86 (in part.); Crucitti and Vignoli, 2002: 439-441, Figs. 4-5; Soleglad and Fet, 2003: 7.

*Buthacus yotvatensis yotvatensis*: Fet and Lowe, 2000: 85; Lourenço, 2004a: 206.

*Buthacus tadmorensis*: Kovařík, 2001: 80; Fet and Kovařík, 2003: 180; Kovařík and Whitman, 2005: 106.

*Buthacus tadmorensis tadmorensis*: Kovařík, 2002: 5.

*Buthacus macrocentrus*: Kovařík, 2005: 7-10, Fig. 8; Navidpour et al., 2008a: 7, Figs. 3, 6, 12, 56-59; Navidpour et al., 2008 b: 5, Figs. 4, 20, 53-56; Navidpour et al., 2008c: 5, Figs. 2, 3, 8, 25-28; Yağmur et al., 2008b: 16-17.

Distribution: ASIA: Bahrain, Iran, Iraq, Israel, Jordan, Oman, Qatar, Syria, Saudi Arabia, Syria, Turkey, United Arab Emirates.

Comments: Upon designation by Kovařík (2005) of the lectotype of *Androctonus*

(*Leiurus*) *macrocentrus* Ehrenberg, 1828, it became a valid species. The first records of the species for Turkey (southeast) were published by Crucitti and Vignoli (2002), and additions have been made lately by Yağmur et al. (2008b) including three new locations from the Şanlıurfa Province. The westernmost record of the species in Syria is in As Safirah (Kovařík, 2005).

### **1.4.** Genus ***Buthus*** Leach, 1815

**1.4.1.** ***Buthus barcaeus*** Birula, 1909

References:

*Buthus occitanus barcaeus*: Fet and Lowe, 2000: 95; Kovařík, 2002: 5.

*Buthus barcaeus*: Kovařík, 2006: 3, Fig. 6.

Distribution: AFRICA: Libya.

Comments: This taxon was elevated to species level by Kovařík (2006), because of the differently colored mesosoma, more bulbous telson, and more densely hirsute legs, compared to *Buthus chambiensis* Kovařík, 2006. Found at Abu Qurayn, in Libya (Kovařík, 2006).

**1.4.2.** ***Buthus intumescens*** (Ehrenberg in Hemprich and Ehrenberg, 1829)

Synonyms:

*Androctonus (Leiurus) tunetanus intermedius* Ehrenberg in Hemprich and Ehrenberg, 1829 (syn. by Kovařík, 2006).

*Buthus occitanus mardochei* var. *israelis* Shulov & Amitai, 1959 (syn. by Kovařík, 2006).

References:

*Buthus occitanus israelis*: Fet and Lowe, 2000: 95.

*Buthus intumescens*: Kovařík, 2006: 10-11, Fig. 20.

Distribution: ASIA: Egypt (Sinai), Israel, ?Yemen.

Comments: This taxon was raised to species level by Kovařík (2006), although the description of diagnostic morphological characters was not detailed. Kovařík (2006) states that the primary criterion for assessing species of the "*Buthus occitanus* complex" is width of the pedipalp chela and its relation to sexual dimorphism, and that the different chela width shows this taxon to have the status of a species rather than a subspecies, as the chela is narrower than in *Buthus occitanus* (Amoreux, 1789) and *Buthus tunetanus* (Herbst, 1800). The distribution is based only on the localities of the specimens examined by Kovařík (2006).

**1.4.3.** ***Buthus occitanus*** (Amoreux, 1789)

References:

*Buthus occitanus*: Kovařík, 1999: 39; Fet and Lowe, 2000: 92-97 (in part.); Stathi and Mylonas, 2001: 288 (in part.); Kovařík, 2002: 5; Lourenço, 2002c: 110; Lourenço, 2003: 884, Figs. 27-32; Lourenço and Vachon, 2004: 84, Figs. 1-15; Kovařík and

Whitman, 2005: 106; Lourenço and Geniez, 2005: 6.

Distribution: AFRICA: Burkina Faso, Djibouti, Egypt, Ethiopia, Gambia, Ghana, Guinea-Bissau, Mauritania, Morocco, Nigeria, Senegal, Somalia, Sudan. ASIA: Iraq, Israel, Jordan, Lebanon, ?Saudi Arabia, ?Turkey. EUROPE: Southern France, Portugal, Spain (an old record from Italy is likely erroneous).

Material examined: Libya: Ain Tignit (300 to 320 m alt., 6 May and 5 December 2007); Al Haraba (7 May 2007); 9 km after Ben Joad, 120 km east of Sirte (25 m alt, 9 May 2007), Quaminis-Adjedabia, 120 km northeast towards Bengazi (40 m alt., 9 May 2007), Tulmaythah (50 m alt., 10 May 2007), Aboghidan Protected Area (380 m alt., 4 December 2007), Algwalish (760 m alt., 5 December 2007), Kikla (500 m, 780 m alt., 6 December 2007).

### **1.5.** Genus ***Compsobuthus*** Vachon, 1949

#### **1.5.1.** ***Compsobuthus carmelitis*** Levy, Amitai & Shulov, 1973

References:

*Compsobuthus carmelitis*: Fet and Lowe, 2000: 126; Stathi and Mylonas, 2001: 288; Kovařík, 2003 a: 106.

Distribution: ASIA: Israel, Jordan.

#### **1.5.2**. ***Compsobuthus jordanensis*** Levy, Amitai & Shulov, 1973

References:

*Compsobuthus jordanensis*: Fet and Lowe, 2000: 126; Stathi and Mylonas, 2001: 288-289; Kovařík, 2003a: 92, 106; Kovařík and Whitman, 2005: 106.

Distribution: ASIA: Jordan, Syria.

#### **1.5.3.** ***Compsobuthus klaptoczi*** (Birula, 1909)

References:

*Compsobuthus klaptoczi*: Fet and Lowe, 2000: 126; Kovařík, 2003a: 97, 106.

Distribution: AFRICA: Libya.

Comments: Recorded from Barka, 5 km east of Benghazi, in Cyrenaica, Libya.

#### **1.5.4.** ***Compsobuthus longipalpis*** Levy, Amitai & Shulov, 1973

References:

*Compsobuthus longipalpis*: Fet and Lowe, 2000: 127; Kovařík, 2003a: 106.

Distribution: ASIA: Egypt (Sinai), Israel, Jordan.

#### **1.5.5.** ***Compsobuthus schmiedeknechti*** Vachon, 1949

References

*Compsobuthus werneri judaicus*: Kabakibi et al., 1999: 82.

*Compsobuthus werneri schmiedeknechti*: Fet and Lowe, 2000: 129-130; Fet et al., 2000a: 293.

*Compsobuthus schmiedeknechti*: Kovařík, 2003a: 101-102, 106; Kovařík and Whitman, 2005: 107; Varol et al., 2006: 1559-1562; Yağmur et al., 2008a: 59-60, 62-63, Fig. 2.

Distribution: ASIA: Israel, Jordan, Lebanon, Syria, Turkey.

Comments: The taxon was restored to species level by Kovařík (2003a) without formal designation as "n. comb." and with no further explanation. It was originally published as *Compsobuthus schmiedeknechti* sp. n. by Vachon (1949a), differing from *C. werneri* by the presence of intermediate carina in the fourth metasomal segment and the lower number of pectinal teeth. Records of *C. schmiedeknechti* from Western Syria were published by Kabakibi et al. (1999) and Kovařík (2003a). First records from Turkey were published by Varol et al. (2006) (Yayladağı District of Hatay Province, near the southwestern border with Syria); more recently, Yağmur et al. (2008a) added a number of records from Gaziantep, Hatay, and Kilis Provinces.

**1.5.6. *Compsobuthus werneri*** (Birula, 1908)

References:

*Compsobuthus werneri*: Fet and Lowe, 2000: 128 (in part.); Stathi and Mylonas, 2001: 289; Kovařík, 2002: 7; Kovařík, 2003a: 104-106, Fig. 5; Hendrixson, 2006: 66.

Distribution: AFRICA: Burkina Faso, Egypt, Ethiopia, Libya, Mali, Niger, Somalia, Sudan. ASIA: Egypt (Sinai), Israel, Jordan, Saudi Arabia, Syria, Yemen.

Material examined: Libya: Quaminis - Adjedabia, 120 km northeast towards Bengazi (40 m alt., 9 May 2007), Tulmaythah (50 m alt., 10 May 2007). Egypt (Sinai): Gebel Mousa (Mt. Sinai, 2000 m alt., 14 March 2004).

Comments: According to Kovařík (2003a), *C. werneri*, as currently understood, includes more than one species. The unique characters (numerous bristles on metasomal segments and a narrow manus with long fingers of pedipalps) of specimens from Jordan, Israel and probably also Saudi Arabia and Egypt (Sinai) as reported by Kovařík (2003a), are confirmed by our examination of specimens from the Sinai Peninsula.

**1.6.** Genus ***Egyptobuthus*** Lourenço, 1999

*Egyptobuthus* Lourenço, 1999a: 593, 595, Figs. 1-7

**1.6.1. *Egyptobuthus vaissadei*** Lourenço, 1999

*Egyptobuthus vaissadei* Lourenço, 1999a: 595-596, Figs. 1-7.

References:

*Egyptobuthus vaissadei*: Kovařík, 2001: 81.

Distribution: ASIA: Egypt (Sinai).

Comments: The female holotype was found in the north of the Sinai Peninsula, near the coast of the Red Sea (Lourenço, 1999a).

**1.7.** Genus ***Hottentotta*** Birula, 1908

**1.7.1. *Hottentotta judaicus*** (Simon, 1872)

References:

*Hottentotta judaicus*: Crucitti, 1999b: 82; Fet and Lowe, 2000: 140-141; Crucitti and Cicuzza, 2001a: 227; Stathi and Mylonas, 2001: 288; Karatas, 2003: 315; Kovařík, 2007a: 40-43, Figs. 13, 64-67.

*Buthotus judaicus*: Kabakibi et al., 1999: 80.

*Hottentotta judaica*: Kovařík, 1999: 39; 2002: 7.

Distribution: ASIA: Israel, Jordan, Lebanon, Syria, Turkey.

**1.7.2. *Hottentotta minax*** (L. Koch, 1875)

Synonyms:

*Hottentotta acostai* Lourenço, 2004 (syn. by Kovařík, 2007 a).

References:

*Hottentotta minax*: Fet and Lowe, 2000: 141-142; Kovařík, 2002: 7; Kovařík and Whitman, 2005: 104. 106; Kovařík, 2007a: 40-43, Figs. 13, 64-67.

*Hottentotta occidentalis*: Lourenço, 2004 c: 213.

Distribution: AFRICA: Cameroon, Chad, Egypt, Eritrea, Ethiopia, Kenya, Libya, Sudan, ?Tanzania, ?Uganda.

Material examined: Libya: Ain Tignit (300–320 m alt., 6 May and 6 December 2007), Al Haraba (7 May 2007), Aboghidan Protected Area (380 m alt., 4 December 2007), Algwalish (760 m alt., 5 December 2007), Algwalish (pine forest, 712 m alt.), Kikla (500 m alt., 6 December 2007).

**1.8.** Genus ***Leiurus*** Ehrenberg, 1828

**1.8.1. *Leiurus jordanensis*** Lourenço, Modry & Amr, 2002

*Leiurus jordanensis* Lourenço et al., 2002: 637-638, 640, Figs. 2-8.

References:

*Leiurus jordanensis*: Hendrixson, 2006: 82-84, Figs. 17, 20 a, Pl. 12-13; Kovařík, 2007b: 139-140.

Distribution: ASIA: Jordan, Saudi Arabia.

Comments: The female holotype was found in Southern Jordan, northwest of Al-Mudawwarah (700 m alt.) (Lourenço et al., 2002).

**1.8.2. *Leiurus quinquestriatus*** (Ehrenberg, 1828)

References:

*Leiurus quinquestriatus*: Crucitti, 1999 b: 84; Kovařík, 1999: 39; Fet and Lowe, 2000: 155-157; Crucitti and Cicuzza, 2000: 283-284, Fig. 15; Crucitti and Cicuzza, 2001a: 231, Fig. 4; Stathi and Mylonas, 2001: 289; Crucitti and Vignoli, 2002: 451-452; Kovařík, 2002: 8; Karataş and Karataş, 2003: 4; Karataş and Çolak, 2005: 3; Kovařík and Whitman, 2005: 109; Hendrixson, 2006: 84-91, Figs. 19, 20 b-c, Pl. 14-16; Kovařík, 2007b: 139-140, Figs. 9-10.

Distribution: AFRICA: Algeria, Chad, Egypt, Ethiopia, Libya, Mali, Niger, Somalia, Sudan, Tunisia. ASIA: Egypt (Sinai), Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen.

Material examined: Egypt (Sinai): 10 km northeast of Qa'lat el Jundi (12 March 2004).

### **1.9.** Genus ***Mesobuthus*** Vachon, 1950

#### **1.9.1.** ***Mesobuthus cyprius*** Gantenbein & Kropf in Gantenbein et al., 2000

*Mesobuthus cyprius* Gantenbein et al., 2000b: 219-228, Figs. 4-28.

References:

*Mesobuthus cyprius*: Fet et al., 2000a: 292; Karataş, 2005: 2; Fet and Soleglad, 2007: 418.

*Mesobuthus gibbosus*: Kovařík, 2002: 9 (in part.).

Distribution: ASIA: Cyprus.

Comments: *Mesobuthus cyprius* is the only known scorpion species from Cyprus and was earlier reported as *M. gibbosus* before it was recognized as a separate species. The only morphological character that distinguishes *M. cyprius* from *M. gibbosus* is the shape of the basal lobes of the hemispermatophores. In *M. cyprius* these are slender and acutely pointed teeth, while in *M. gibbosus* they form scales with more or less distinct blunt tips (Gantenbein et al., 2000b).

#### **1.9.2.** ***Mesobuthus eupeus*** (C. L. Koch, 1839)

References:

*Mesobuthus eupeus*: Crucitti, 1999 b: 86; Crucitti and Cicuzza, 2000: 287, Figs. 16-18; Gantenbein et al., 2000b: X; Fet and Lowe, 2000: 170-176 (in part.); Gromov, 2001: 301-307; Crucitti and Cicuzza, 2001a: 231-232, Fig. 5; Crucitti and Cicuzza, 2001b: 3-11; Karataş and Karataş, 2001: 297-299; Crucitti and Vignoli, 2002: 453; Kovařík, 2002: 9; Teruel, 2002: 75-76; Karataş and Karataş, 2003: 1-6, Figs. 1-2; Vignoli et al., 2003: 3; Karataş, 2005: 2; Karataş and Çolak, 2005: 3-4; Fet and Soleglad, 2007: 418.

Distribution: ASIA: Afghanistan, Armenia, Azerbaijan, China, Georgia, Iran, Iraq, Kazakstan, Kyrgyzstan, Mongolia, Pakistan, Syria, Tajikistan, Turkey, Turkmenistan, Uzbekistan. EUROPE: Russia (Astrakhan Region).

Comments: Teruel (2002) first published the westernmost record of this species from Anatolia (Manisa Province, historical Magnesia), which does not reach the Aegean Coast but falls within the E-Mediterranean chorotype. Karataş and Karataş (2003) published the first records near the Mediterranean Coast in Southern Turkey (Hatay Province: Antakya, İskenderun), close to the southwest borders with Syria.

#### **1.9.3.** ***Mesobuthus gibbosus*** (Brullé, 1832)

References:

*Mesobuthus gibbosus*: Crucitti and Malori, 1998a: 128; Kovařík, 1998: 114, Crucitti, 1999a: 251-255; Crucitti, 1999b: 86; Kovařík, 1999: 39; Fet, 2000 a: 48-49; Fet and Braunwalder, 2000: 17-18; Fet and Lowe, 2000: 176-177 (in part.); Fet et al., 2000a:

287-288, 292-293; Crucitti and Cicuzza, 2001a: 230, Fig. 5; Karataş and Karataş, 2001: 297-299; Stathi and Mylonas, 2001: 289; Crucitti and Vignoli, 2002: 454; Gantenbein and Largiadèr, 2002: 925-938; Kovařík, 2002: 9 (in part.); Karataş and Karataş, 2003: 4; Teruel et al., 2004: 2-5, Figs. 2-15; Karataş, 2005: 2; Kovařík and Whitman, 2005: 110; Kaltsas et al., 2006; Parmakelis et al., 2006a: 2883-2894; Fet and Soleglad, 2007: 418; Kaltsas and Mylonas, 2007: 1-8; Kaltsas et al., 2008.

*Mesobuthus gibbosus anatolicus*: Crucitti and Malori, 1998b: 132.

Distribution: ASIA: Turkey. EUROPE: Albania, Bulgaria, F.Y.R.O.M., Greece, Montenegro, Turkey (European part).

Comments: The first records of *M. gibbosus* from F.Y.R.O.M. were published by Kovařík (1998, 1999) and from Bulgaria by Teruel et al. (2004).

**1.9.4. *Mesobuthus nigrocinctus*** (Ehrenberg, 1828)

References:

*Buthus gibbosus* (part): Kabakibi et al., 1999: 79.

*Mesobuthus* cf. *gibbosus*: Crucitti and Cicuzza, 2000: 287.

*Mesobuthus nigrocinctus*: Fet et al., 2000a; Crucitti and Vignoli, 2002: 455-457, Fig. 13; Karataş, 2005: 2; Karataş and Çolak, 2005: 4; Fet and Soleglad, 2007: 418; Karataş, 2007: 1-10, Figs. 1-4.

Distribution: ASIA: Israel, Lebanon, Syria, Turkey.

Comments: This taxon was until recently considered a synonym of *M. gibbosus* and was restored from synonymy by Fet et al. (2000a). The first records for Turkey were published by Crucitti and Vignoli (2002); later, Karataş and Çolak (2005) and Karataş (2007) found it north of Syria and near the Mediterranean Coast.

**1.10.** Genus ***Microbuthus*** Kraepelin, 1898

**1.10.1. *Microbuthus flavorufus*** Lourenço & Duhem, 2007

*Microbuthus flavorufus* Lourenço and Duhem, 2007: 441-442, Figs. 1-12.

Distribution: AFRICA: Egypt.

Comments: The female holotype was found 22 km south of Zafarana, in Egypt (Lourenço and Duhem, 2007).

**1.11.** Genus ***Orthochirus*** Karsch, 1891

**1.11.1. *Orthochirus aristidis*** (Simon, 1882)

References:

*Orthochirus aristidis*: Fet and Lowe, 2000: 194.

Distribution: AFRICA: Djibouti, Egypt, Somalia, Sudan. ASIA: Yemen.

Comments: Although the main distribution of the species is in Central Africa, it has been found in Northern Egypt (Vachon, 1952: 224) and its presence near the Mediterranean Sea has not been doubted since.

**1.11.2. *Orthochirus innesi*** Simon, 1910

References:

*Orthochirus innesi*: Fet and Lowe, 2000: 195; Kovařík, 2002: 9; Lourenço, 2003: 876, Figs. 3-5; Kovařík and Whitman, 2005: 110 ("complex"); Hendrixson, 2006: 91-95, Fig. 21, Pl. 16.

Distribution: AFRICA: Algeria, Egypt, Libya, Morocco, Sudan, Tunisia. ASIA: Bahrain, ?Egypt (?Sinai), Oman, Saudi Arabia.

Comments: Kovařík and Whitman (2005) listed "*O. innesi* complex" for Lybia, Jordan and Syria (see below under ?*O. scrobiculosus*).

**1.11.3. ?*Orthochirus scrobiculosus*** (Grube, 1873)

References:

*Orthochirus scrobiculosus*: Fet and Lowe, 2000: 196-199 (in part.); Stathi and Mylonas, 2001: 289.

*Orthochirus scrobiculosus negebensis*: Fet and Lowe, 2000: 199

Distribution: According to Kovařík (2004), *Orthochirus scrobiculosus* is limited to Asia, where it is confirmed only for Afghanistan, Iran, Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan. Kovařík (2004) considered as erroneous all records of this species found in Djubouti, Egypt, India, Iraq, Israel, Pakistan, and Somalia.

Material examined: Libya: Sinoun oasis, 200 km north of Garamesh (400 m alt., 7 May 2007), just before Gadamesh (320 m alt.) (collection date: 8 May 2007). Egypt (Sinai): Wadi Sudr, 10 km southeast of Qa'lat et Jundi (12 March 2004).

Comments: Our specimens fit the diagnostic description of *O. scrobiculosus negebensis* (Egypt, Israel) given by Levy and Amitai (1980). This taxon was originally published as *O. innesi negebensis* Shulov & Amitai, 1960. Kovařík (2004: 27) suspects it to be a separate species; and Kovařík and Whitman (2005) listed the "*O. innesi* complex" for Lybia, Jordan and Syria. However, the differentiation of species-specific morphological characters is not yet defined, since the African and Arabian species of this genus were never revised (Fet and Lowe, 2000; Kovařík, 2004).

**2.** Family **Euscorpiidae** Laurie, 1896

Type genus: *Euscorpius* Thorell, 1876.

**2.1.** Genus ***Euscorpius*** Thorell, 1876

**2.1.1. *Euscorpius beroni*** Fet, 2000

*Euscorpius beroni* Fet, 2000 a: 49-51.

References:

*Euscorpius beroni*: Gantenbein et al., 2001: 301; Soleglad and Sissom, 2001: 90; Fet et al., 2003c: 356; 2004: 50, 55; Fet and Braunwalder, 2005: 19, 24-25; Colombo, 2006: 1; Fet and Soleglad, 2007: 417.

Distribution: EUROPE: Albania.

Comments: It belongs to the Balkan portion of the "*E. mingrelicus* complex" and is known only from the Prokletije Mountains in Albania.

**2.1.2. *Euscorpius concinnus*** (C. L. Koch, 1837)

References:

*Euscorpius carpathicus*: Crucitti et al., 1998: 7 (in part?); Kovařík, 2002: 13 (in part.).

*Euscorpius carpathicus concinnus*: Kovařík, 1999: 43; Fet and Sissom, 2000: 363.

*Euscorpius tergestinus*: Fet and Sissom, 2000: 372 (in part.); Fet and Soleglad, 2002: 16-24 (in part.); Fet et al., 2004: 52, 55 (in part.); Fet and Braunwalder, 2005: 19, 22-23, 47-50, Fig. 12 (in part.).

*Euscorpius concinnus*: Vignoli et al., 2005: 97-113, Figs. 1-5; Colombo, 2006: 2, 17-23, Figs. 12-13, 14-16; Fet and Soleglad, 2007: 419; Salomone et al., 2007: 502-513; Vignoli et al., 2007: 116.

Distribution: EUROPE: Italy.

Comments: This taxon was restored to species level by Vignoli et al. (2005), with a neotype fixed from Tuscany, Italy. The range of the species in Italy includes localities in the eastern part of the Apennine Peninsula (Adriatic Coast).

**2.1.3. *Euscorpius gamma*** Caporiacco, 1950

Synonyms:

*Euscorpius mingrelicus histrorum* Caporiacco, 1950 (syn. by Scherabon et al., 2000).

References:

*Euscorpius mingrelicus gamma*: Kovařík, 1999: 44; Fet and Sissom, 2000: 370.

*Euscorpius gamma*: Gantenbein et al., 2000a: 844; Scherabon et al., 2000: 253-261; Fet et al., 2001: 256-261; Gantenbein et al., 2001: 301; Komposch et al., 2001: 267-269, Figs. 1, 4; Soleglad and Sissom, 2001: 90; Fet et al., 2003 b: 1519-1520; 2003c: 356; 2004: 50, 55; Fet and Braunwalder, 2005: 19, 24-25; Colombo, 2006: 1; Fet and Soleglad, 2007: 417.

Distribution: EUROPE: Austria (south), Croatia, Italy (northeast), ?Montenegro, ?Serbia, Slovenia.

Comments: This taxon, originally described as a subspecies of *E. germanus*, was elevated to species level by Scherabon et al. (2000) based on comparative analyses of the mitochondrial 16S ribosomal RNA and allozymes. Morphological diagnosis was based on comparison of the morphological analyses carried out by Scherabon (1987) with 685 specimens of *E. mingrelicus* from the Caucasus (Fet, 1993). *E. gamma* belongs to the "*E. mingrelicus* complex".

**2.1.4. *Euscorpius germanus*** (C. L. Koch, 1837)

References:

*Euscorpius germanus*: Gantenbein et al., 1999: 54 (in part.); Kovařík, 1999: 40 (in

part.); Fet 2000a: 58; Fet and Braunwalder, 2000: 20; Fet and Sissom, 2000: 366-368 (in part.); Gantenbein et al., 2000a: 843-869; Scherabon et al., 2000: 255; Braunwalder, 2001: 279-285, Fig. 1; Fet et al., 2001: 256-261; Gantenbein et al., 2001: 301; Komposch et al., 2001: 267-269, Figs. 1, 3; Soleglad and Sissom, 2001: 90, Fig. 89; Fet et al., 2002: 143; Kovařík, 2002: 13; Kofler, 2002: 137-145; Fet, 2003: 271; Fet et al., 2003b: 1519-1520; Fet et al., 2003c: 356; Fet et al., 2004: 48, 50, 55; Fet and Braunwalder, 2005: 19, 24-25, 28-34, Figs. 3, 4, 8; Colombo, 2006: 1; Fet and Soleglad, 2007: 417.

Distribution: EUROPE: Austria, Italy, Slovenia, Switzerland.

Comments: *E. germanus alpha* Caporiacco, 1950 and *E. g. gamma* Caporiacco, 1950 from Croatia were elevated to species level by Gantenbein et al. (2000 a) and Scherabon et al. (2000), respectively. *E. germanus croaticus* Caporiacco, 1950 from Croatia was transferred by Gantenbein et al. (2000 a) to the "*E. carpathicus* complex".

**2.1.5. *Euscorpius hadzii*** Caporiacco, 1950

Synonyms:

*Euscorpius carpathicus lagostae* Caporiacco, 1950 (syn. by Fet and Soleglad, 2002).

References:

*Euscorpius carpathicus* "Group B": Fet, 2000a: 53-55.

*Euscorpius carpathicus hadzii*: Kovařík, 1999: 44; Fet and Sissom, 2000: 363.

*Euscorpius carpathicus lagostae*: Kovařík, 1999: 44; Fet and Sissom, 2000: 364.

*Euscorpius hadzii*: Fet and Soleglad, 2002: 24-30, Figs. 23, 36-46, 63, 66; Fet et al., 2002: 141; Fet, 2003: 272; Fet et al., 2003c: 356; Kovařík and Fet, 2003: 191; Fet et al., 2004: 52, 55, Fig. 2; Teruel et al., 2004: 5; Fet and Braunwalder, 2005: 19, 22-23, 48; Vignoli et al., 2005: 98; Colombo, 2006: 1; Fet and Soleglad, 2007: 406-413, 419, Figs. 1-12.

Distribution: EUROPE: Albania, Bosnia and Herzegovina, Bulgaria (southwest), Croatia, F.Y.R.O.M., Greece, Montenegro, Serbia.

Comments: Fet and Soleglad (2002) elevated *E. carpathicus hadzii* Caporiacco, 1950, which belongs to the "*E. carpathicus* complex", from sub-species to species rank and synonymized *E. carpathicus lagostae* Caporiacco, 1950 with *E. hadzii*.

**2.1.6. *Euscorpius italicus*** (Herbst, 1800)

References:

*Euscorpius italicus*: Crucitti and Malori, 1998 a: 129; Crucitti et al., 1998: 10-11; Crucitti, 1999b: 87; Gantenbein et al., 1999: 50; Kovařík, 1999: 40; Fet and Braunwalder, 2000: 20 (in part.); Fet and Sissom, 2000: 373-375 (in part.); Braunwalder, 2001: 279-285, Fig. 1; Komposch et al., 2001: 270; Soleglad and Sissom, 2001: 90, Figs. 91, 165, 179, 193; Stathi and Mylonas, 2001: 290 (in part.); Scherabon et al., 2000: 255; Fet et al., 2001: 256, 258-259; Gantenbein et al., 2001: 301; 2002: 16-25, 32-38, Figs. 6-8, 15-20, 22-25; Kovařík, 2002: 13-14; Fet, 2003: 271; Fet et al., 2003c: 356; Fet and Kovařík, 2003: 179-181; Fet et al., 2004: 52, 55, Fig. 1; Fet and Braunwalder, 2005: 19, 26-27, 40-45, Figs. 5. 6, 10; Vignoli et al., 2005: 98; Colombo, 2006: 2, 23-29, Figs.

17-18, 20; Fet et al., 2006: 248-253; Crucitti et al., 2007: 19-30, Figs. 13-16; Salomone et al., 2007: 503-504.

Distribution: AFRICA: Algeria, Morocco, Tunisia. ASIA: Georgia, Turkey. EUROPE: Albania, Croatia, France, F.Y.R.O.M., Greece, Italy, Monaco, Montenegro, Russia, San Marino, Slovenia, Switzerland, Turkey (European part). Also introduced to Iraq, Yemen, ?Romania.

Comments: The first record of *E. italicus* from Iraq was published by Fet and Kovařík (2003).

**2.1.7. *Euscorpius koschewnikowi*** Birula, 1900

References:

*Euscorpius carpathicus koschevnikovi* (incorrect subsequent spelling): Fet and Sissom, 2000: 364.

*Euscorpius koschewnikowi*: Fet and Soleglad, 2002: 30-35, Figs. 47-56, 61; Fet et al., 2004: 52; Fet and Braunwalder, 2005: 48; Vignoli et al., 2005: 98; Colombo, 2006: 1; Fet and Soleglad, 2007: 419.

Distribution: EUROPE: Greece (north).

Comments: Fet and Soleglad (2002) elevated *E. koschewnikowi* Birula, 1900, which belongs to the "*E. carpathicus* complex", from sub-species to species rank.

**2.1.8. *Euscorpius mingrelicus*** (Kessler, 1874)

References:

*Euscorpius mingrelicus*: Crucitti, 1999b: 87; Kovařík, 1999: 40 (in part.); Fet 2000a: 58; Fet and Braunwalder, 2000: 20; Fet and Sissom, 2000: 368-372 (in part.); Gantenbein et al., 2000a: 855; Scherabon et al., 2000: 255; Crucitti and Cicuzza, 2001a: 227; Gantenbein et al., 2001: 301; Soleglad and Sissom, 2001: 90, Figs. 63, 119, 180; Kovařík, 2002: 13; Fet et al., 2003b: 1518-1520; 2003c: 356; 2004: 48, 50; Fet and Braunwalder, 2005: 19, 24-25; Colombo, 2006: 1; Fet and Soleglad, 2007: 417.

Distribution: ASIA: Georgia, ?Syria, Turkey. EUROPE: Bosnia and Herzegovina, ?Montenegro, Russia, Turkey (European part), ?Serbia.

Comments: *Euscorpius mingrelicus* (Kessler, 1874), as redefined by Bonacina (1980) and listed by Fet and Sissom (2000), is still under revision. It is now addressed as a "*mingrelicus* complex" (part of subgenus *Alpiscorpius*), which at this moment includes three valid species (*E. beroni*, *E. gamma*, and *E. mingrelicus*) and eight sub-species of *E. mingrelicus*. In their review of the taxonomy of the genus *Euscorpius*, Fet et al. (2004) state that "the remaining *E. mingrelicus* most likely will be split further," implying more species-level taxa. The neotype of this species is fixed from Georgia (Gantenbein et al., 2000a).

**2.1.9. *Euscorpius naupliensis*** (C. L. Koch, 1837)

Synonyms:

*Euscorpius italicus zakynthi* Caporiacco, 1950 (syn. by Gantenbein et al., 2002).

References:

*Euscorpius italicus zakynthi*: Kovařík, 1999: 44.

*Euscorpius italicus*: Crucitti, 1999a: 252-255; Fet and Braunwalder, 2000: 20, Fig. 4 (in part.); Fet and Sissom, 2000: 373-375 (in part.); Crucitti and Bubbico, 2001: 48-55, Figs. 1 b, 5-9; Stathi and Mylonas, 2001: 290 (in part.); Kovařík, 2002: 14 (in part.).

*Euscorpius naupliensis*: Gantenbein et al., 2002: 25-38, Figs. 6-8, 15-20, 22-25; Fet et al., 2003c: 356; Fet et al., 2004: 54, 55; Fet and Braunwalder, 2005: 19, 26-27; Colombo, 2006: 3, 29-32, 34, Figs. 21-22, 24; Fet et al., 2006: 249.

Distribution: EUROPE: Greece.

Comments: Gantenbein et al. (2002), based on molecular and morphological data, found that the unusual "oligotrichous" form from Peloponnese (originally described as *Scorpius naupliensis* C. L. Koch, 1837) and sub-species *E. italicus zakynthi* Caporiacco, 1950 from Zakynthos Island (Ionian Archipelago, Greece) were synonymous taxa and deserved species-level rank, differing significantly from *E. italicus*. Crucitti and Bubbico (2001) were the first to study ecology of this endemic species in Peloponnese, and Colombo (2006) made ecological notes on Zakynthos.

**2.1.10. *Euscorpius sicanus*** (C. L. Koch, 1837)

Synonyms:

*Scorpius canestrinii* Fanzago, 1872 (syn. by Fet et al., 2003 c).

*Euscorpius carpathicus argentarii* Caporiacco, 1950 (syn. by Fet et al., 2003c).

*Euscorpius carpathicus calabriae* Caporiacco, 1950 (in part.) (syn. by Fet et al., 2003c).

*Euscorpius carpathicus garganicus* Caporiacco, 1950 (syn. by Fet et al., 2003c).

*Euscorpius carpathicus ilvanus* Caporiacco, 1950 (in part.) (syn. by Fet et al., 2003c).

*Euscorpius carpathicus linosae* Caporiacco, 1950 (syn. by Fet et al., 2003c).

*Euscorpius carpathicus palmarolae* Caporiacco, 1950 (syn. by Fet et al., 2003c).

References:

*Euscorpius carpathicus argentarii*: Kovařík, 1999: 43; Fet and Sissom, 2000: 361.

*Euscorpius carpathicus calabriae*: Kovařík, 1999: 43; Fet and Sissom, 2000: 362.

*Euscorpius carpathicus canestrinii*: Kovařík, 1999: 43; Fet and Sissom, 2000: 362; Kovařík, 2002: 13.

*Euscorpius carpathicus linosae*: Kovařík, 1999: 44; Fet and Sissom, 2000: 364.

*Euscorpius carpathicus ilvanus*: Kovařík, 1999: 44; Fet and Sissom, 2000: 364.

*Euscorpius carpathicus palmarolae*: Kovařík, 1999: 44; Fet and Sissom, 2000: 365.

*Euscorpius carpathicus sicanus*: Kovařík, 1999: 44; Fet and Sissom, 2000: 365.

*Euscorpius carpathicus*: Crucitti, 1999a: 251-255; Fet and Braunwalder, 2000: 19 (in part.); Crucitti and Bubbico, 2001: 43-48, Figs. 1 a, 2-4; Stathi and Mylonas, 2001: 289 (in part.).

*Euscorpius sicanus*: Fet, 2003: 272; Fet et al., 2003c: 357-373, Figs. 2-9; Kovařík and

Fet, 2003: 191; Fet et al., 2004: 52, 55; Fet and Braunwalder, 2005: 19, 22-23; Vignoli et al., 2005: 98; Colombo, 2006: 2, 7-13, Figs. 4-5, 7-8; Fet and Soleglad, 2007: 418; Salomone et al., 2007: 502-513.

Distribution: AFRICA: Egypt, Libya, Madeira (Portugal), Tunisia. EUROPE: Italy (including Sicily and Sardinia), Greece, Malta.

Comments: Based on morphology and DNA data, Fet et al. (2003c) placed a diverse assemblage of populations in Southern Italy, Sicily, Sardinia, Greece, Malta, and North Africa under the restored species *E. sicanus*. This species absorbed part of the populations listed by earlier authors (Kinzelbach, 1975, 1985; Vachon and Kinzelbach, 1987) as "*E. mesotrichus* Hadzii" (invalid name; see Fet and Lowe, 2000: 372).

**2.1.11. *Euscorpius tauricus*** (C. L. Koch, 1837)

References:

*Euscorpius carpathicus tauricus*: Kovařík, 1999: 44; Fet and Sissom, 2000: 365-366.

*Euscorpius tauricus*: Fet, 2003: 271-276; Fet et al., 2004: 50, 55; Vignoli et al., 2005: 98; Colombo, 2006: 1; Fet and Soleglad, 2007: 419.

Distribution: EUROPE: Ukraine (Crimea).

Comments: This taxon was restored to species level by Fet (2003) based on DNA analysis, with morphological investigation pending. It is the northernmost East Mediterranean species.

**2.1.12. *Euscorpius tergestinus*** (C. L. Koch, 1837)

Synonyms:

*Scorpio aquilejensis* C. L. Koch, 1837 (syn. by Fet and Soleglad, 2002).

*Scorpio niciensis* C. L. Koch, 1841 (syn. by Fet and Soleglad, 2002).

*Scorpio tergestinus* var. *austriacus* Ferrari, 1872 (syn. by Fet and Soleglad, 2002).

*Euscorpius carpathicus apuanus* Caporiacco, 1950 (syn. by Fet and Soleglad, 2002).

*Euscorpius carpathicus corsicanus* Caporiacco, 1950 (syn. by Fet and Soleglad, 2002).

*Euscorpius carpathicus picenus* Caporiacco, 1950 (syn. by Fet and Soleglad, 2002).

References:

*Euscorpius tergestinus*: Crucitti et al., 1998: 7 (in part?); Fet and Sissom, 2000: 372-373 (in part, excluding "*E. mesotrichus*"=*E. sicanus*); Gantenbein et al., 2001: 301; Fet and Soleglad, 2002: 16-24, Figs. 24-35, 60, 67 (in part.); Fet et al., 2002: 141; Kovařík and Fet, 2003: 189-192; Fet, 2003: 271; Fet et al., 2003c: 356; 2004: 52, 55 (in part.); Fet and Braunwalder, 2005: 19, 22-23, 47-50, Fig. 12 (in part.); Vignoli et al., 2005: 97-113, Figs. 1-5; Colombo, 2006: 2, 13-17, Figs. 9, 11; Fet and Soleglad, 2007: 419 (in part.); Salomone et al., 2007: 502-513; Vignoli et al., 2007: 116.

*Euscorpius carpathicus aquilejensis*: Kovařík, 1999: 43; Fet and Sissom, 2000: 361.

*Euscorpius carpathicus apuanus*: Kovařík, 1999: 43; Fet and Sissom, 2000: 361; Vignoli et al., 2007: 116.

*Euscorpius carpathicus corsicanus*: Kovařík, 1999: 43; Fet and Sissom, 2000: 363; Vignoli et al., 2007: 116.

*Euscorpius carpathicus niciensis*: Kovařík, 1999: 44; Fet and Sissom, 2000: 364; Vignoli et al., 2007: 116.

*Euscorpius carpathicus picenus*: Kovařík, 1999: 44; Fet and Sissom, 2000: 365.

*Euscorpius carpathicus tergestinus*: Kovařík, 1999: 44.

*Euscorpius carpathicus*: Gantenbein et al., 1999: 54; Fet and Braunwalder, 2000: 19 (in part.); Gantenbein et al., 2001: 302-303 (in part.); Huber et al., 2001: 273-278; Fet et al., 2001: 256-259, Fig. 1; Komposch et al., 2001: 267-272; Kovařík, 2002: 13 (in part.).

Distribution: EUROPE: Albania, Austria, Croatia, Greece, France (with Corsica) Italy, Montenegro, San Marino, Slovenia.

Comments: This taxon was formally restored to species level by Fet and Sissom (2000), and further redefined by Fet and Soleglad (2002). Later, Vignoli et al. (2005, 2007) further separated two Italian species from this taxon: *E. concinnus* and *E. oglasae*.

**3.** Family **Iuridae** Thorell, 1876

Type genus: *Iurus* Thorell, 1876

**3.1.** Genus ***Calchas*** Birula, 1899

**3.1.1. *Calchas nordmanni*** Birula, 1899

References:

*Calchas nordmanni*: Crucitti, 1999b: 87; Kovařík, 1999: 40; Fet and Braunwalder, 2000: 18; Sissom and Fet, 2000 b: 418-419; Crucitti and Cicuzza, 2001a: 227; Stathi and Mylonas, 2001: 290; Crucitti and Vignoli, 2002: 458; Karataş and Karataş, 2003: 4; Karataș and Çolak, 2005: 4.

Distribution: ASIA: Turkey. EUROPE: Greece (southeast).

Comments: The only localities in Greece where *C. nordmanni* was found are the islands of Megisti (Kastellorizo) (collected by the NMHC staff) (Fet and Braunwalder, 2000; Stathi and Mylonas, 2001) and Samos (Sissom, 1987). Despite regular visits of the first author to Samos between 2006 and 2008, including the exact locality (on the south slope of Mt. Spiliani, 2 km north of Pithagorion) where A. Riedel found the only specimen of *C. nordmanni* (a subadult male) (Sissom, 1987), the presence of the species on Samos cannot be supported and is considered dubious.

**3.2** Genus ***Iurus*** Thorell, 1876

**3.2.1. *Iurus dufoureius*** (Brullé, 1832)

References:

*Iurus dufoureius*: Crucitti, 1999a: 251-255; Kovařík, 1999: 40; Fet, 2000 a: 49; Fet

and Braunwalder, 2000: 18-19; Sissom and Fet, 2000 b: 419-420; Crucitti and Cicuzza, 2001a: 227; Stathi and Mylonas, 2001: 290; Kovařík, 2002: 3, 16; Kovařík and Whitman, 2005: 113, Parmakelis et al., 2006b: 251-260; Facheris, 2007: 1-4.

*Iurus asiaticus*: Crucitti and Malori, 1998 b: 133-134; Crucitti, 1999 b: 87-88; Kovařík, 1999: 40; Stathi and Mylonas, 2001: 290; Kovařík, 2002: 16.

Distribution: ASIA: Turkey (southwest). EUROPE: Greece (south).

Comments: Parmakelis et al. (2006 b) studied the phylogeography of *I. dufoureius* and indicated that the level of sequence divergence between all pairwise comparisons of *I. d. dufoureius* (Brullé, 1832) and *I. d. asiaticus* Birula, 1903 (the two sub-species of I. *dufoureius*) justifies elevation of the two subspecies to species rank. These two forms have been treated variably as species or subspecies.

**4.** Family **Scorpionidae** Latreille, 1802

Type genus: *Scorpio* Linnaeus, 1758.

**4.1.** Genus ***Nebo*** Simon, 1878

**4.1.1. *Nebo hierichonticus*** (Simon, 1872)

References:

*Nebo hierichonticus*: Sissom and Fet, 2000a: 353; Kovařík, 2002: 12; Kovařík and Whitman, 2005: 115.

Distribution: ASIA: Egypt (Sinai), Israel, Jordan, Lebanon, Syria.

Comments: Soleglad and Fet (2003) downgraded the family Diplocentridae to subfamily rank in the family Scorpionidae and the subfamily Nebinae to the tribe rank (Nebini) in the subfamily Diplocentrinae.

**4.2.** Genus **Scorpio** Linnaeus, 1758

**4.2.1. *Scorpio maurus*** Linnaeus, 1758

References:

*Scorpio maurus*: Crucitti, 1999b: 88; Fet, 2000 b: 473-480; Fet and Braunwalder, 2000: 19; Stathi and Mylonas, 2001: 290; Kovařík, 2002: 19; Karataş and Karataş, 2003: 4; Lourenço, 2003: 876, Figs. 1-2; Karataş and Çolak, 2005: 4; Kovařík and Whitman, 2005: 114; Hendrixson, 2006: 108-109, Fig. 28, Pl. 21.

Distribution: AFRICA: Algeria, ?Congo, Egypt (Sinai), Libya, Mauritania, Morocco, Senegal, ?Tanganyika, Tunisia. ASIA: Egypt (Sinai), Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Qatar, Saudi Arabia, Syria, Turkey, Yemen.

Material examined: [identified as *S. maurus palmatus* (Ehrenberg, 1828)]: Libya: Quaminis -Adjedabia, 120 km northeast towards Bengazi (40 m alt., 9 May 2007), Aboghidan Protected Area (380 m alt., 4 December 2007), Ain Tagnit (320 m alt., 5 December 2007). Egypt (Sinai): Mt. Ata, 20 km from the junction of Wadi Hagoul and Suez (11 March 2004).

***Scorpion species with the geographic range adjacent to E-Mediterranean***

Below we list species whose distribution includes one or more countries of the Eastern Mediterranean, but not their E-Mediterranean (Fig. 1) part, or which included Mediterranean countries until 1998 and whose records today are considered dubious.

**Fam. Buthidae**

***Buthacus foleyi*** Vachon, 1948

Distribution: AFRICA: Algeria, Libya, Morocco.

Comments: The record of *B. foleyi* from Libya published by Vachon (1948 b) is from Ghat, in Southwest Libya.

***Buthiscus bicalcaratus*** Birula, 1905

Distribution: AFRICA: Algeria, Libya, Tunisia.

Comments: The species is distributed in northwest Libya, west of the Gulf of Sirte (Lourenço, 2002 b).

***Compsobuthus acutecarinatus*** (Simon, 1882)

Distribution: ASIA: Oman, Yemen.

Comments: Stathi and Mylonas (2001: 288) reported the presence of *C. acutecarinatus* in Cyrenaica (Libya). However, re-examination of these samples based on the presence of external granules on the moveble finger, as proposed by Kovařík (2003a), proved that they belong to the "*C. werneri* complex" and specifically to *C. werneri*, as currently understood (Kovařík, 2003a: 98, Fig. 5).

***Compsobuthus kabateki*** Kovařík, 2003

*Compsobuthus kabateki* Kovařík, 2003a: 93-94, Fig. 8.

Distribution: AFRICA: Egypt.

Comments: The only locality reported for the species is Luxor in Egypt (Kovařík, 2003a).

***Compsobuthus matthiesseni*** (Birula, 1905)

Distribution: ASIA: Iran, Iraq, Syria, Turkey.

Comments: The distribution of the species includes localities in Southeast Turkey (Sissom and Fet, 1998) and Eastern Syria (close to the borders with Iraq) (Kovařík, 2003a).

***Hottentotta hottentotta*** (Fabricius, 1787)

Synonyms:

*Hottentotta caboverdensis* Lourenço and Ythier, 2006 (syn. by Kovařík, 2007a).

Distribution: AFRICA: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cape Verde, Congo, Cote d'Ivoire, ?Egypt, ?Ethiopia, Gambia, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, ?Somalia, Togo.

Comments: According to Kovařík (2007a), records from Egypt must be considered dubious.

***Hottentotta saulcyi*** (Simon, 1880)

Distribution: ASIA: Afghanistan, Iran, Iraq, ?Syria, Turkey.

Comments: According to Kovařík (2007a), records for Syria (Kinzelbach, 1985; El-Hennawy, 1992: 118) must be considered dubious. The records of *H. saulcyi* from Turkey (Crucitti and Vignoli, 2002; Karataş, 2003; Karataş and Gharkheloo, 2006) are from the southeastern part of the country.

***Hottentotta scaber*** (Ehrenberg, 1828)

Distribution: AFRICA: Egypt, Eritrea, Ethiopia, Sudan. ASIA: Iraq, Yemen.

Comments: According to Kovařík (2007a), records from Egypt (Vachon and Stockmann, 1968) must be considered dubious.

**?*Hottentotta syrticus*** (Borelli, 1914) (*nomen dubium*)

Distribution: AFRICA: Libya.

Comments: According to Kovařík (2007a), the original description of the species causes suspicion that it could be a synonym of *H. minax* or *H. niloticus* and that it is also possible that the locality is wrong or the name is a synonym of some *Buthus*. Kovařík (2007a) considered it a *nomen dubium* because the MCSN holotype (a male) could not be located and no additional specimens are known.

***Isometrus maculatus*** (DeGeer, 1778)

Distribution: Widely distributed in Africa, Central and South America, South Asia, Australia, and Oceania.

Comments: *Isometrus maculatus* is the most widely distributed scorpion species. It can be characterized as subcosmopolitan (circumtropical with occasional subtropical records) (Fet and Lowe, 2000). The only Syria record (Damascus, see Kovařík, 2003b: 3) is likely an introduction.

***Lissothus bernardi*** Vachon, 1948

Distribution: AFRICA: Libya.

Comments: Vachon (1948 a) mentions among studied specimens one adult female from El Abiod (Fezzan, the southwestern region of Libya, deep in the Sahara).

***Mesobuthus caucasicus*** (Nordmann, 1840)

Distribution: ASIA: Afghanistan, Armenia, Azerbaijan, China, Georgia, Iran, Iraq, Kazakstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, Uzbekistan, Russia, Ukraine.

Comments: The species was moved from the monotypic genus *Olivierus* Farzanpay, 1987 to *Mesobuthus* Vachon, 1950 when Gantenbein et al. (2003) demonstrated that the genus *Olivierus* was paraphyletic in relation to the genus *Mesobuthus* and there-

fore synonymized *Olivierus* with *Mesobuthus*. Most records of *M. caucasicus* from Turkey (see Karataş, 2005) are localities near the borders with Armenia and Iran.

***Parabuthus hunteri*** Pocock, 1895

Distribution: AFRICA: Egypt, Sudan.

Comments: Pocock (1895) found the species on the west coast of the Red Sea (Sudan: Duroor, 60 miles north of Suakin).

***Parabuthus liosoma*** (Ehrenberg, 1828)

Distribution: AFRICA: Egypt, Ethiopia, Kenya, Somalia, Sudan, Tanzania. ASIA: Saudi Arabia, Yemen.

Comments: Fet and Lowe (2000) restored the original spelling "*leiosoma*", but Acosta and Fet (2005: 5) demonstrated that this emendation was unjustified.

**Fam. Euscorpiidae**

***Euscorpius alpha*** Caporiacco, 1950

Distribution: EUROPE: Italy, Switzerland.

Comments: This taxon was elevated to species level from a subspecies of *E. germanus* by Gantenbein et al. (2000a). Distributed in Northern Italy. The easternmost record of the species is Trentino-Alto Adige, near the northwestern limits of the E-Mediterranean chorotype (Fig. 1).

***Euscorpius flavicaudis*** (DeGeer, 1778)

Distribution: AFRICA: Algeria, Tunisia. EUROPE: Great Britain (introduced), France (with Corsica), Italy (with Sardinia), Spain (Baleares). SOUTH AMERICA: Uruguay (introduced).

Comments: The presence of *E. flavicaudis* in Italy is restricted to the western part of the country (Crucitti, 1993; Colombo, 2006).

***Euscorpius oglasae*** Caporiacco, 1950

Distribution: EUROPE: Italy.

Comments: This taxon was elevated to species level from a subspecies of *E. carpathicus* by Vignoli et al. (2007). The distribution of the species is restricted to Montecristo Island (Tuscan Archipelago, Italy).

## SYSTEMATIC COMPLETENESS AND UNRESOLVED ISSUES ON TAXONOMY

Within only 10 years after the most recent bibliographic review of all scorpion species on a systematic and distribution basis (Fet et al., 2000b), which includes data until 1998, scorpion taxonomy has advanced greatly. This was due to the increased number of genus-level revisions, and also to the application of DNA-based molecular phylogenetic techniques. With reference to one of the most complicated biogeographic regions of the world, the Eastern Mediterranean (Oosterbroek and Arntzen,

1992), our knowledge on the scorpiofauna of the area has increased greatly. One genus, *Egyptobuthus* (of the 16 in total) and 19 species (of the 48 which occur in the area with certainty) have been added since 1998.

Family Buthidae

Buthidae is the largest scorpion family in the world, much more diverse on genus-level in the Old World than in the New World, although species-level diversity is higher in the New World (Fet and Lowe, 2000). Fet et al. (2003a) attribute this fact mainly to the clearly derived morphological characters presented by arid Old World scorpion taxa, which have been traditionally used for delineation of genera in scorpions. Eleven of the 19 species that represent new combinations or new species in the Eastern Mediterranean region since 1998 belong to Buthidae. According to their genus, these species are (alphabetically): *Birulatus*: *B. astartiae* and *B. israelensis*; *Buthacus*: *B. macrocentrus*; *Buthus*: *B. barcaeus* and *B. intumescens*; *Compsobuthus*: *C. schmiedeknechti*; *Egyptobuthus*: *E. vaissadei*; *Leiurus*: *L. jordanensis*; *Mesobuthus*: *M. cyprius* and *M. nigrocinctus*; and *Microbuthus*: *M. flavorufus*.

Genus *Androctonus*

In his revision of the genus *Androctonus*, Lourenço (2005) described two new species (not occurring in the Eastern Mediterranean) and provided a key to the genus. We tested the key using several specimens from NHMC collected from North Africa and the Middle East and found that the key is problematic and needs further improvement.

Genus *Buthus*

*Buthus barcaeus*, which was considered as a subspecies of *B. occitanus*, and *Buthus intumescens*, which was considered as a synonym of *B. tunetanus*, were elevated to species-level rank by Kovařík (2006), based on their differentiations compared to *B. chambiensis and B. tunetanus, respectively.* Although Kovařík (2006) explains in detail the reasons for these taxonomic changes based on morphological data, he does not include a detailed description and diagnosis of the two aforementioned species. Identification of species belonging to the genus *Buthus* is difficult, especially those of the "*Buthus occitanus* complex". The use of molecular (DNA) markers may give an answer to the taxonomic problems related to this group.

Genus *Compsobuthus*

The elevation of *Compsobuthus schmiedeknechti* from a subspecies of *C. werneri* to species level was made by Kovařík (2003a), without mentioning it as "n. comb." and with no further explanation and description. A detailed morphological redescription of the species, after the original given by Vachon (1949a), needs to be done, explaining the reasons which justify species rank.

Genus *Orthochirus*

Although our specimens fit the diagnosis description of *O. scrobiculosus negebensis*

published by Levy and Amitai (1980), the characters which distinguish *O. scrobiculosus* and *O. innesi* (and even *O. aristidis*) are not clear (Kovařík, 2004). Granulation on the fourth and fifth metasomal segments and spaces among punctae are variable within specimens of *Orthochirus* sp. from North Africa (Kovařík, 2004). We assume that the introduction of new characters is essential for the identification on species level.

Family Euscorpiidae

The systematics of the genus *Euscorpius* has received a lot of attention from scorpion taxonomists worldwide, starting with Linnaeus (1767) himself. Numerous species and subspecies have been described, but their validity remains inconclusive, and it is certain that many issues concerning "Euroscorpion" (Fet et al., 2004) taxonomy remain unresolved till today. Birula (1900) 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". About 30 years after Birula's statement, the introduction of trichobothriotaxy as a system of taxonomical characters set new standards in scorpion systematics in general and *Euscorpius* among them. It is no coincidence that modern scorpion taxonomy based on trichobothria (Soleglad and Fet, 2001) historically started with *Euscorpius* species (Vachon, 1963). However, the diversiform characters in the genus and the sparse collection of specimens available in museums, especially from the Balkans, the center of *Euscorpius* diversity (Fet and Soleglad, 2002), and Anatolia (Fet et al., 2004), have made it difficult for taxonomists to define all species in the genus. Nevertheless, while only five species belonging to the genus *Euscorpius* were recognized until 1998 (*E. carpathicus*, *E. flavicaudis*, *E. germanus*, *E. tergestinus*, and *E. italicus*), intensive research on this genus has increased this number to 17. A major step towards justification of species rank was the introduction of molecular techniques, the first of which was considered in a publication of Gantenbein et al. (1999). A brief taxonomic review on *Euscorpius* was published by Fet et al. (2004).

Twelve species of the genus *Euscorpius* are known to be distributed in the Eastern Mediterranean today, eight of which are new additions to the scorpiofauna of the area since Fet et al. (2000 b). Both species of the subgenus *Polytrichobothrius* Birula, 1917, *E. italicus* and *E. naupliensis*, are present in the region. The same holds true for the three known species of the "*E. mingrelicus* complex" (subgenus *Alpiscorpius* Gantenbein et al., 1999): *E. beroni*, *E. gamma*, and *E. mingrelicus*, though the complex is still under revision, and it is likely that new species will emerge out of the eight *E. mingrelicus* subspecies (Fet et al., 2004; Fet and Soleglad, 2007) in the near future.

*Euscorpius hadzii*, *E. koschewnikowi*, *E. sicanus*, *E. tauricus*, and *E. tergestinus* are the representatives of the "*E. carpathicus* complex" (=subgenus *Euscorpius* Thorell, 1876) in the Eastern Mediterranean region. Fet et al. (2004) and Fet and Soleglad (2007) mention five valid subspecific forms not assigned to a certain spe-

cies: *E. "carpathicus" aegaeus* Caporiacco, 1950 (Greece), *E. "carpathicus" candiota* Birula, 1903 (Greece: Crete), *E. "carpathicus" croaticus* Caporiacco, 1950 (Croatia), *E. "carpathicus" ossae* Caporiacco, 1950 (Greece), and *E. "carpathicus" scaber* Birula, 1900 (Greece), which may be elevated to species level in the future. Our preliminary findings in analyzing morphology of the "*E. carpathicus* complex" in Greece indicate the probable presence of more than one new species in the area.

A basic aim of our research group is to accomplish a complete revision of the genus *Euscorpius* in Greece, the center of "*E. carpathicus* complex" diversity in the Balkans, based on morphological characters and DNA markers.

Family Iuridae

Although sequencing of a 441-bp segment of the mitochondrial 16S rRNA gene by Parmakelis et al. (2006 b) in seven populations covering the whole distributional range of *Iurus dufoureius* resulted in a high level of sequence divergence between all pairwise comparisons of *I. d. dufoureius* (Brullé, 1832) and *I. d. asiaticus* Birula, 1903, a thorough morphological analysis is needed in order to re-evaluate the taxonomic rank of the two subspecies (or species).

## BIOGEOGRAPHY AND EVOLUTION

The number of species per country in the Eastern Mediterranean region is presented in Fig. 2. The Sinai Peninsula (the Asian part of Egypt) is presented separately from the rest of Egypt (African part) because the two areas are separated by the Suez Canal and have different geological history (e.g., Steckler et al., 1988, 1998; McClusky et al., 2003). Besides, only eight of the 15 scorpion species of the African part of Egypt are present in the Sinai, while 10 of them are present in Libya.

All Asian countries are home to many or relatively many scorpion species near the Meditarranean Coast, except for Cyprus, where only one species is known

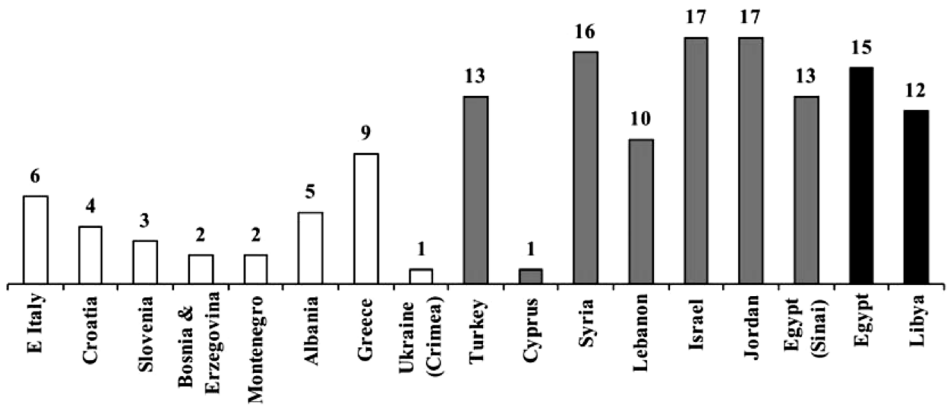


**Fig. 2** The number of species in the E-Mediterranean part of all Eastern Mediterranean countries. □ Europe, ■: Asia, ■: Africa. Doubtful records are not included. .

(*Mesobuthus cyprius*). This could be due to the fact that Cyprus was probably never geologically connected to any mainland (Turkey to the north and the Levant in the east) (Robertson, 1998), making dispersal difficult. The only scorpion species recorded on the island, *M. cyprius*, is a Cypriot endemic (Vigna Taglianti, 1999) due to its evolution in isolation. Turkey, on the other hand, is the only country in the Eastern Mediterranean which houses all four scorpion families present in the region (Buthidae, Euscorpiidae, Iuridae, and Scorpionidae). The main reason is probably the fact that Turkey is located at the junction of the European and the SW-Asiatic chorotypes *sensu* Vigna Taglianti (1999).

The comparatively poor scorpiofauna of European countries, with the exception of Greece, is due to the poor presence of buthid species. Three scorpion families are distributed in the European countries of the Eastern Mediterranean: Euscorpiidae (12 species), Iuridae (both species only in Greece), and Buthidae (one species in Albania and Greece). On the other hand, 24 and 15 buthid species (of the 32 in total) are present in the Asian and African countries of the region, respectively, which explains the comparatively higher scorpion diversity in the south and the easternmost part of the Eastern Mediterranean. Greece has more species (belonging to three families) than any other European country, owing to its position in Southeast Europe close to Asia and due to its habitat heterogeneity (Stathi and Mylonas, 2001). The landbridges which joined Agaeis to Western Anatolia during the Miocene made migrational routes possible between Northern Anatolia and Eastern Europe (where Greece is today) (Dercourt et al., 1986; Stathi and Mylonas, 2001). Besides, in view of recent developments in systematics of the genus *Euscorpius*, it is possible that the center of differentiation of the "*E. carpathicus* complex" lies in continental and insular Greece, where at least six valid species of the genus *Euscorpius* are present, two of which are endemic to Greece (*E. koschewnikowi* and *E. naupliensis*).

In total, 23 of the 48 Eastern Mediterranean scorpion species (47.9%) are limited to the E-Mediterranean region *sensu* Vigna Taglianti (1999), a fact that reflects uniqueness of the study area.

Family Buthidae

All 32 buthid species recorded from the Eastern Mediterranean region are distributed in the southern (North Africa) and easternmost (Levant, Cyprus, Sinai) parts of the region, and many of them have distributions that extends further to Central Africa or/and Arabia.

The only buthid species present in Eastern Europe is *Mesobuthus gibbosus*, distributed in the south of the Balkan Peninsula and Anatolia (the greater part of Turkey, though not reaching the coast of the Black Sea in the north) (Karataş, 2005). *Mesobuthus gibbosus* is a typical Mediterranean species, predominant in the Aegean region (Kaltsas et al., 2008), forming the densest known scorpion population in chaparral or intertidal habitats of Mediterranean-type ecosystems worldwide (Kaltsas and Mylonas, 2007). According to Parmakelis et al. (2006 a), the case of *M. gibbosus* reflects a taxon-oriented 'perception' of the natural history of the Aegean

region. This is due to the fact that its vicariant pattern of differentiation is consistent with the geological events that occurred in the Aegean 12 to 5 Mya and not obscured by more recent paleoevents. Within this autochthonous species of *Mesobuthus* (Gantenbein and Keightly, 2004) in the Eastern Mediterranean, molecular phylogeny based on a pooled maximum likelihood analysis revealed a clear deep splitting between the two western species (*M. gibbosus* and *M. cyprius*) and the "eastern clade" (*M. eupeus* and *M. caucasicus*) (Gantenbein et al., 2003). The evolutionary rate of the 16S rRNA gene of *Mesobuthus gibbosus* (Gantenbein and Largiadèr, 2002) is very close to that of the "*Buthus occitanus* complex" (Gantenbein and Largiadèr, 2003), the phylogeography of which is explained by very old vicariant events.

The origin of the buthid scorpiofauna of North Africa is probably the heritage of ancient faunas since Cenozoic-Middle Cenozoic times (Vachon, 1952; Qi and Lourenço, 2007). According to Lourenço and Duhem (2007), the distribution of scorpion species in North Africa today is a result of paleogeographic factors and palaeoclimates. Although the Sahara has undergone a series of mesic conditions (Cloudsley-Thompson, 1984), arid areas have always existed in North Africa and genera present in these areas today, such as *Androctonus*, *Buthacus*, *Buthiscus*, *Buthus*, and *Leiurus* have evolved in response to aridity (Lourenço and Duhem, 2007). These "ancient lineages" have been present in the area for at least 10-15 Myr (Gantenbein and Largiadèr, 2003; Lourenço, and Vachon, 2004). Other genera, less well adapted to xeric conditions, have sparser populations in oases (Vachon, 1952). Endemic genera, such as *Lissothus* (Southwest Libya) and *Egyptobuthus* (Northern Sinai) are examples of this category (Qi and Lourenço, 2007).

The first extensive phylogenetic study of Buthidae was published by Fet et al. (2003 a), who found strong support for three groups of Old World genera. The representation of Eestern Mediterranean genera in these groups is: a) *Compsobuthus* and *Mesobuthus*, b) *Hottentotta* and *Buthacus*, c) *Orthochirus*. More substantially, for the first time a possible evolutionary scenario for Buthidae was proposed, i. e., separate evolution in Laurasia (Old World taxa) and Gondwana (New World taxa), after the split of Pangaea (Fet et al., 2003 a). The scenario is partially based on the differenatiation of toxins between scorpions of the Old and New World. Thus, the separate mammal-specific $Na^+$ toxins (shared by Old World genera occurring in the Eastern Mediterranean, such as *Androctonus*, *Leiurus*, *Buthus*, *Mesobuthus*, *Hotentotta*, and *Orthochirus*) could have evolved during aridization of the Palearctic in the Tertiary period (Fet et al., 2003 a).

Based on their chorotypes according to Vigna Taglianti (1999), most E-Mediterranean buthids are characterized as Syro-Palestinian endemics (*Birulatus astartiae*, *B. haasi*, *B. israelensis*, *Compsobuthus carmelitis*, *C. jordanensis*, *Hotentotta judaicus*, *Leiurus jordanensis*, *Mesobuthus nigrocinctus*), N-African (*Buthacus arenicola*, *Buthus barcaeus*, *Compsobuthus klaptoczi*, *Egyptobuthus vaissadei*, *Microbuthus flavorufus*), Saharo-Sahelo-Arabian (*Androctonus crassicauda*, *Compsobuthus werneri*, *Leiurus quinquestriatus*, *Orthochirus innesi*), and SW-Asiatic (*Buthacus macrocentrus*, *Compsobuthus longipalpis*, *C. schmiedeknechti*). Three *Androctonus*

species can be characterized as N-African+Syro-Palaestinian (*A. amoreuxi*, *A. australis*, *A. bicolor*). Apart from the species discussed above, the chorotypes of the rest are: Arabian (*Buthus intumescens*), Saharian (*Hottentotta minax*), Saharo-Sindian (*Buthacus leptochelys*), and NE-African-Sindian (*Orthochirus aristidis*).

Family Euscorpiidae

"*Euscorpius germanus* complex"

*Euscorpius germanus* and *E. alpha* are allopatric, sibling Alpine species (Fet et al., 2004). The estimated degree of molecular divergence within the subgenus *Alpiscorpius* leads to the assumption that the two species have evolved in the area before the Pleistocene glaciations, maybe since the orogenesis of the Alps (Gantenbein et al., 2000 a; Fet et al., 2004). It is possible that *E. germanus* also has isolated populations in the Apennines (Guerra, 1979), although it is not known whether they represent relict populations or were introduced by humans (Fet et al., 2004).

"*Euscorpius mingrelicus* complex"

The three species belonging to this complex have been recorded from two separate regions: (a) the Southeast Alps and Western Balkans (*E. beroni*, *E. gamma* and *E. mingrelicus*) and (b) the entire Anatolian Peninsula, Western Georgia (from Adzharia in the south to Abkhazia in the north), and part of the Russian coast of the Black Sea (north to Sochi) (*E. mingrelicus*) (Fet, 1993; Fet et al., 2004). This considerable disjunction and the high genetic diversity of Anatolian populations (Fet et al., 2003b, 2004) are the two main questions that need to be dealt with before the biogeographic pattern of the complex can be further analyzed.

"*Euscorpius carpathicus* complex" [=subgenus *Euscorpius* s.str]

Althrough two of the seven species belonging to the complex are currently considered to be strictly endemic to Greece (*E. koschewnikowi*) and Southern Ukraine (Crimea) (*E. tauricus*), the complex is widespread in the Mediterranean basin. It ranges from the Baleares in the west (*E. balearicus*) to the Crimea in the east (*E. tauricus*) and from the Southeast Alps in the north (*E. tergestinus*) to Tunisia and Libya in the south (*E. sicanus*). Although new species belonging to this complex and more detailed ranges may be published in the near future, a considerable change in the distributional limits of the complex is unlikely to happen. Hence, we establish the chorotype of the complex as typical Mediterranean (Vigna Taglianti, 1999) including extension off the Atlantic coast (Madeira; *E. sicanus*).

"*Euscorpius italicus* complex" [=subgenus *Polytrichobothrius*]

*Euscorpius italicus* is widely distributed in the Mediterranean, from Morocco in the west to the Black Sea Coast to Turkey and the Caucasus in the east and from Italy in the north to Northwest Africa in the south. Based on the genetic divergence between *E. italicus* and its sister species, *E. naupliensis* (endemic to Greece), Gantenbein et al.

(2002) state that the split between these two species predates the Messinian salinity crisis (5.2 Myrs ago) and could be connected with the Alpine Orogeny (as is the case with the "*Euscorpius germanus* complex"). Further findings of Fet et al. (2006) on genetic divergence of the complex allow the suggestion of recent dispersal from a glacial refugium, possibly even in historical time, which could explain puzzling absence of *E. italicus* from all Aegean and Mediterranean islands. The chorotype of the complex can be characterized as Mediterranean (Vigna Taglianti, 1999), not expanding beyond the Central Balkans in the east.

Family Iuridae

Francke and Soleglad (1981) attributed the distribution pattern of the genus *Iurus* to a vicariant process resulting from the tectonic events that occurred between the Turkish Plate and the Anatolian Fault during the Quaternary period (1.8 Mya). Recent findings of Parmakelis et al. (2006 b) revealed that *Iurus* is an old Northeast Mediterranean genus that has been differentiating in the southern region of Agaeis (Southern Greece and Southwest Turkey) at least since the middle Miocene. According to the phylogenetic trees and dating of the divergence times of lineages, *Iurus* dispersed into the Aegean Archipelago when the Aegean was still a uniform land mass, and thus did not use any land bridge to expand its distribution into the Aegean (Parmakelis et al., 2006 b), contrary to what was supposed by Vachon (1953) and Kinzelbach (1975).

In contrast to *Iurus*, the biogeography of the monotypic genus *Calchas* still remains a mystery to scientists (Fet and Braunwalder, 2000). According to Stathi and Mylonas (2001), *C. nordmanni* inhabited Megisti (Kastelorizo) and possibly other Aegean islands as well, during the Pleistocene. The distributional range of this rare species includes five disjunct populations, some of which may be relict. Stathi and Mylonas (2001) ascribe this disjunction to ecological convergence, rather than biogeographical relationship.

Based on the distribution of the two genera, as it is known today, we characterize their chorotype as Aegean-S-Anatolian.

Family Scorpionidae

The family Scorpionidae is represented in the region by the Palearctic (Werner, 1934) species *Nebo hierichonticus* (Diplocentrinae: Nebini) from the Levant and the Sinai Peninsula and the Saharo-Sindian (Vachon, 1953) species *Scorpio maurus* (North and Central Africa, Middle East) (Scorpioninae). According to Prendini et al. (2003), the occurrence of discontinuous populations of *Scorpio maurus* on the West African Coast and in the mountains of Southern Algeria are relicts attributed to range contraction in association with the onset of aridization in North Africa.

## CONCLUDING REMARKS

The scorpiofauna of the Eastern Mediterranean has proved to be a valuable model for explaining and understanding of the natural history of the region, owing to the old

lineages of several genera. The resolution of scorpion taxonomy using morphological characters and molecular markers will improve our knowledge on the phylogeny of scorpions in relation to the multiple and complex paleogeographic events witnessed by these ancient taxa. We hope that this review will help scopiologists to supplement and/or substantially change any unresolved and debatable data included here, in order to advance our general knowledge about scorpions and their environment.

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