

Notes on the distribution of the species of the genus *Buthus* (Leach, 1815) (Scorpiones, Buthidae) in Europe, with a description of a new species from Spain

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Summary

Two new species of the genus *Buthus* (Leach, 1815) were described in 2004 in Spain: *B. montanus* Lourenço & Vachon, 2004 and *B. ibericus* Lourenço & Vachon, 2004. Gantenbein & Larijadèr (2003) distinguished divergent clades among European *Buthus* in their phylogenetic analysis. Subsequently, Sousa *et al.* (2010) reported five distinct mtDNA lineages within *Buthus* from the Iberian Peninsula, two of which they reported for the first time. In the present work, a new species, *Buthus elongatus* n. sp., is described, which is most similar to one of the two lineages of Sousa *et al.* (2010): samples Sc 98 and Sc 99, lineage 3 in their study, from southern Spain, which resemble *Buthus occitanus* morphologically, but differ from the other specimens of this species by 8.6%. A key for all European *Buthus* and a summary of their distribution are provided.

Introduction

Buthus occitanus was originally described as *Scorpio occitanus* by Amoreux (1789) from southern France (Sauvignargues) and, until 2004, was the only recognized species of the genus *Buthus* (Leach, 1815) in Europe. Two additional species were recognized by Lourenço & Vachon (2004): *B. montanus* from Sierra Nevada, in the province of Granada and Almeria, and *B. ibericus* from Cadiz province. *B. ibericus* was redescribed in the following year (Teruel & Pérez-Bote 2005). According to Sousa *et al.* (2010), the known range of *B. ibericus* was greatly expanded, with the species widespread in most of the western part of the Iberian peninsula (Spain and Portugal) and it is the only scorpion species present in Portugal.

Vachon (1952) proposed a classification for *Buthus occitanus* species complex with several subspecies from Africa and only one subspecies from Europe: *Buthus occitanus occitanus*. Shulov & Amitai (1959) proposed the subspecies *B. occitanus israelis* from Israel, and Levy & Amitai (1980) confirmed its validity. Lourenço, Yağmur & Duhem (2010) raised it to species status as *Buthus israelis* (Shulov & Amitai, 1959). Lourenço elevated several African subspecies to species rank and described some new species from Africa (Lourenço 2003), Asia (Lourenço 2008) and two new species from Europe (Lourenço & Vachon 2004). Also, Kovařík described new species from Tunisia (Kovařík 2006) and Ethiopia (Kovařík 2011). Recently, a new species was discovered in southern Jordan (Lourenço, Yağmur & Duhem 2010) and another new species, *Buthus kunti*, was described from Cyprus (Yağmur, Koç & Lourenço 2011).

Gantenbein & Larijadèr (2003) found that European samples could be divided into three distinct subclades,

which were highly distinct from North African populations, but sampling in Europe was limited to only 12 individuals from eight populations: four from southern Spain and Portugal, and four from the northeastern limit of the range in northeastern Spain (Catalonia region) and southern France. However, Sousa *et al.* (2010) examined many examples from southern France, northeastern Spain (Catalonia), central Spain (Castiglia La Mancia), western Spain (Estremadura), northwestern Spain (Castiglia and Leon), southern Spain (Andalusia) and different populations in Portugal. From southern Spain, in the vicinity of Gibraltar, they found two lineages, significantly separated from the three known species. One is probably related to *B. ibericus*, but differs from the other specimens of this species by 4.3%. Unfortunately, the examples are young scorpions so the authors could not identify them. Sousa *et al.*'s (2010) other lineage resembles *B. occitanus* morphologically, but differs from the other specimens of this species by 8.6%. In this paper, four examples (two males and two females), referable to the latter lineage, are available for study, and they also present morphological characteristics which justify their elevation to species rank. Thus, the presence of a new species, *Buthus elongatus* n. sp. from Andalusia (Malaga province) in Spain is described (Fig. 1A,B).

Material and methods

Specimens were photographed using a camera Nikon D50. Digital images were edited with the assistance of Gimp 2.6 and Adobe Photoshop.

The new species is compared with all three species of the genus *Buthus* that occur in Europe: *B. occitanus* from France and Spain, *B. ibericus* from Portugal, and *B. montanus* from the highest peaks of the Sierra Nevada in Spain. *B. kunti* was not included because the island of Cyprus is geographically part of Asia.

A total of 38 specimens were analysed in this study from different sites. Principally specimens of *B. occitanus* were analysed, screening virtually the entire distribution of this species, because *B. elongatus* n. sp. is closely related to *B. occitanus*. All morphometric analyses confirm a clear difference between *B. occitanus* and *B. elongatus* n. sp. in both sexes.

Measurements are given in mm and descriptions mostly follow Vachon (1952), except for the telson characters, which follows Sissom, Polis & Watt (1990).

Abbreviations: L = length; W = width; ARPC = Andrea Rossi Private Collection; MCSNB = Museo Civico di Scienze Naturali di Bergamo “E. Caffi”; MCVR = Museo Civico di Storia Naturale di Verona; MZUF = Museo Zoologico Università di Firenze “La Specola”; SRSN = Società Romana di Scienze Naturali.

Buthus elongatus n. sp.

Type material: Sierra Blanca, Marbella, Malaga province, Spain (approx 36°32'N, 4°54'W), 1 adult ♂ holotype (Fig. 2A,B), deposited in MZUF (1432), and 1 adult ♀ paratype (Fig. 3A,B) in the author's collection (ARPC), leg.

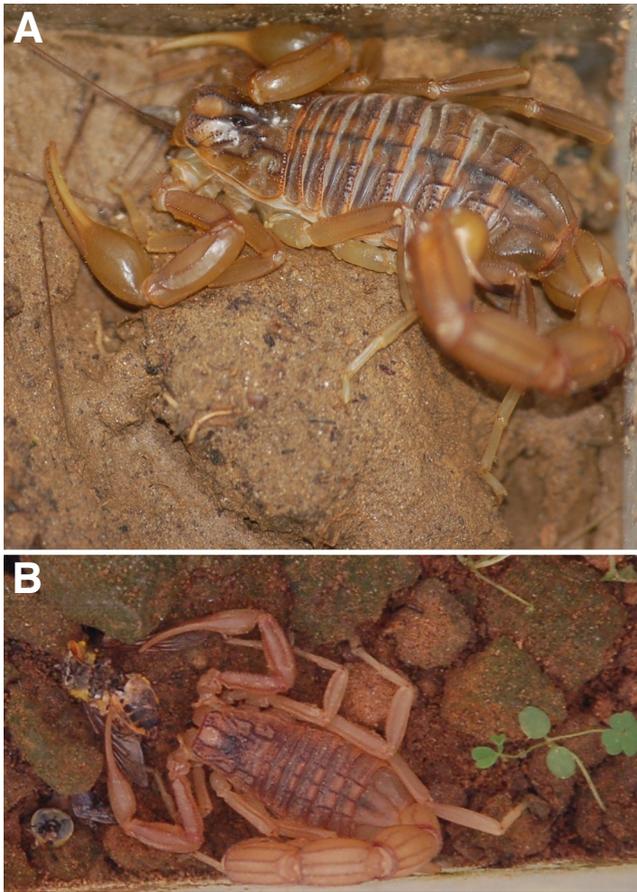


Fig. 1: *Buthus elongatus* n. sp. from Sierra Blanca, Spain, habitus. **A** ♀ paratype; **B** ♂ holotype.

C. Turiel, April 2008. Other material: Alicante, Marbella, Malaga province, Spain (36°30' N, 4°49'W), ♂ and ♀ (875) paratypes (MZUF), leg. M. Borri, 26–27 May 1983. Note: the male holotype and the female paratype from Sierra Blanca lived for almost a year in captive conditions.

Etymology: the name makes reference to the elongated fifth metasomal segment of the males and the very long aculeus of the females.

Diagnosis: scorpion of medium-large size, probably largest European species of genus *Buthus*, exceeding 75 mm in total length in ♀ and 68 mm in ♂ (Table 1). General coloration yellowish-orange with darker prosoma and mesosoma. Carinae moderately to strongly marked. Fixed and movable fingers with 12 rows of granules. Pectines with 26–28 teeth in ♀ and 31–36 in ♂.

Relationships: *Buthus elongatus* n. sp. belongs to the *Buthus occitanus* species-complex and is closely related to *B. occitanus occitanus* from France and Spain. It can be distinguished from the other species of *Buthus* in Europe by: 1) *B. ibericus* has a lobe on the movable finger of pedipalps; 2) *B. montanus* has very marked ventral carinae on the second and third metasomal segment; 3) *B. occitanus* has marked tubercles on the latero-ventral carinae of the fifth metasomal segment, while *B. elongatus* n. sp. has very small tubercles (Fig. 4A,B); males of *B. occitanus* have a lower L/W ratio of the fifth metasomal segment (always < 2.15) than *B. elongatus* n. sp. (always > 2.4); also, females of *B. occitanus* have a lower L/W ratio (usually < 2), while females of *B. elongatus* n. sp. always have a L/W ratio > 2 (Tables 1 and 2); moreover, females of *B. occitanus* have a shorter aculeus, always shorter than the vesicle, while

	<i>B. occitanus</i> ♂ France	<i>B. occitanus</i> ♀ France	<i>B. elongatus</i> n. sp. ♂ holotype Spain	<i>B. elongatus</i> n. sp. ♀ paratype Spain
Carapace L	7.5	6.6	7.5	9.0
Carapace posterior W	7.2	8.3	8.0	10.4
Mesosoma I L	0.7	0.6	0.8	1.3
Mesosoma II L	0.8	0.7	0.9	1.5
Mesosoma III L	1.4	1.1	1.4	1.9
Mesosoma IV L	1.6	1.7	1.8	2.4
Mesosoma V L	1.8	2.0	2.2	2.8
Mesosoma VI L	2.0	2.3	2.5	3.2
Mesosoma VII L	4.0	4.4	5.3	5.7
Mesosoma total L	12.3	12.8	14.9	18.8
Metasoma I L	4.9	5.1	6.1	6.1
Metasoma I W	4.5	4.9	5.4	5.9
Metasoma II L	5.6	5.7	6.9	7.0
Metasoma II W	4.1	4.6	4.9	5.4
Metasoma III L	5.9	6.0	7.2	7.3
Metasoma III W	4.0	4.5	4.8	5.2
Metasoma IV L	6.7	7.2	8.1	8.3
Metasoma IV W	3.8	4.2	4.4	4.9
Metasoma V L	7.7	7.7	9.8	9.9
Metasoma V W	3.7	3.9	3.9	4.8
Metasoma total L	30.8	31.7	38.1	38.6
Telson L	6.4	6.7	8.3	8.8
Vesicle W	2.8	3.1	3.5	4.5
Aculeus L	3.0	3.0	3.9	4.5
Chela L	10.4	10.6	13.0	15.4
Chela W	2.0	2.3	2.3	3.9
Chela depth	2.4	2.7	2.9	4.3
Movable finger L	7.1	7.1	8.9	10.4
TOTAL LENGTH	57.0	57.8	68.8	75.2

Table 1: Measurements of *Buthus occitanus*, ♂ and ♀, from Uzès, France and ♂ holotype and ♀ paratype of *Buthus elongatus* n. sp. from Sierra Blanca, Spain.



Fig. 2: *Buthus elongatus* n. sp. ♂ holotype from Sierra Blanca, Spain. **A** dorsal; **B** ventral.

females of *B. elongatus* n. sp. have a very long aculeus, always longer than the vesicle (Fig. 5A,B).

In females of *B. occitanus*, the fifth metasomal segment is usually wider than the fourth metasomal segment, but in females of *B. elongatus* n. sp. the fifth metasomal segment is always narrower than the fourth metasomal segment.

Taxonomic note: in recent years, many subspecies of the *Buthus occitanus* species complex were elevated to species status, and also several new species were discovered in Africa, Asia and Europe. In fact, in Europe there are four species: *B. occitanus*, which is restricted to southern France and eastern Spain (east of 4°W meridian); *B. montanus* is endemic to the Sierra Nevada (southern Spain), above

	<i>B. occitanus</i> ♂ Spain	<i>B. occitanus</i> ♀ Spain	<i>B. elongatus</i> n. sp. ♂ paratype Spain	<i>B. elongatus</i> n. sp. ♀ paratype Spain
Carapace L	7.0	8.5	7.1	7.4
Carapace posterior W	6.9	9.1	7.4	8.0
Mesosoma I L	0.6	1.0	0.5	0.9
Mesosoma II L	0.8	1.3	0.8	1.1
Mesosoma III L	0.9	1.7	1.1	1.4
Mesosoma IV L	1.1	2.2	1.7	2.0
Mesosoma V L	1.9	2.5	2.1	2.2
Mesosoma VI L	2.4	2.9	2.5	2.6
Mesosoma VII L	4.6	5.0	4.8	4.9
Mesosoma total L	12.3	16.6	13.5	15.1
Metasoma I L	5.3	5.4	5.5	4.9
Metasoma I W	5.0	5.2	5.1	4.6
Metasoma II L	6.0	6.2	6.5	5.6
Metasoma II W	4.8	4.8	4.7	4.2
Metasoma III L	6.4	6.4	6.9	5.8
Metasoma III W	4.5	4.6	4.6	4.2
Metasoma IV L	7.2	7.6	7.8	6.8
Metasoma IV W	4.4	4.6	4.2	4.0
Metasoma V L	8.0	8.8	8.7	7.8
Metasoma V W	4.0	4.7	3.6	3.9
Metasoma total L	32.9	34.4	35.4	30.9
Telson L	7.1	7.9	7.0	7.0
Vesicle W	3.3	4.0	3.2	3.6
Aculeus L	3.2	3.7	3.0	3.6
Chela L	11.6	14.0	12.0	12.1
Chela W	2.3	3.8	2.3	3.0
Chela depth	2.7	4.1	2.7	3.4
Movable finger L	7.6	9	8.2	8.0
TOTAL LENGTH	59.3	67.4	63.0	60.4

Table 2: Measurements of *Buthus occitanus*, ♂ and ♀, from Port-Bou, Spain, and ♂ and ♀ paratypes of *Buthus elongatus* n. sp. from Alicante, Marbella, Spain.

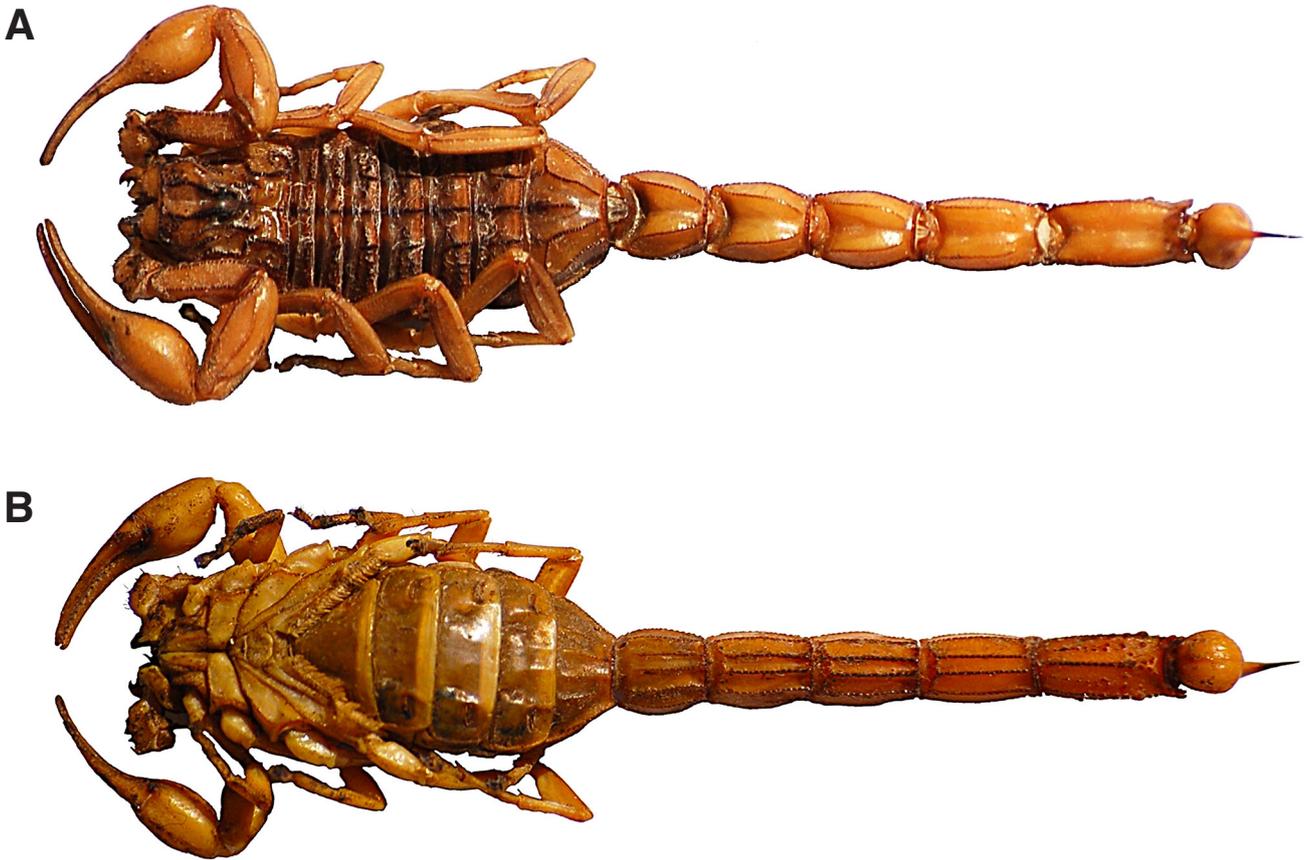


Fig. 3: *Buthus elongatus* n. sp. ♀ paratype from Sierra Blanca, Spain. **A** dorsal; **B** ventral.

2000 m a.s.l.; *B. ibericus* is widely distributed in all of Portugal (most common in the central-south) and in western Spain; *B. elongatus* n. sp. is known only from the provinces of Malaga, and possibly Cadiz, in Andalusia, southern Spain.

Description: based on ♂ holotype and one ♂ and two ♀ paratypes from Malaga province. See measurements in Tables 1 and 2. Coloration basically yellowish-orange. Prosoma: anterior carapace lighter (orangish) and strongly granular; ocular area and posterior carapace darker and grayish. Carinae marked by dark pigment and strongly granular with configuration like a lyre, typical of the genus *Buthus*. Median eyes and three pairs of lateral eyes black. Chelicerae: yellow, not reticulated; typical dentition of family Buthidae. Legs: yellowish-orange; coxa, femur and patella with marked carinae; tarsus with two ventrally longitudinal rows of setae. Tibial spurs present on legs III and IV. Pedipalps: femur with five marked carinae while patella with eight marked carinae; all carinae with a little darker pigmentation. Dorsal trichobothria of femur arranged in β -configuration. Chela smooth, without carinae. Fixed and movable fingers with 12 oblique rows of granules. Chela with evident sexual dimorphism: slender in males, much wider in females. (Fig. 2A,B). Left pedipalp of male paratype from Alicante (MZUF) has a malformation with a shorter fixed finger with the end split in two different fingers. The fixed finger also has no oblique rows of granules.

Mesosoma orange-gray with three longitudinal moderate carinae also marked by dark pigment. Posterior borders of tergites are full orange, especially the longitudinal axis of the mesosoma and on the posterior corners of the tergites.

Only tergite VII has five carinae. Venter yellow with genital operculum and pectines pale yellow. Pectinal teeth count: 31-31 in male holotype (35-36 in male paratype) and 26-28 in the females paratypes. Sternum triangular, longer than wide. Sternites smooth except for sternite VII which bears three carinae. Other sternites show two vestigial furrows. Spiracles elongated.

Metasoma: segment I with 10 complete carinae; segments II and III with 10 carinae but lateral carinae incomplete and ventrally scarcely marked and granulated; segment IV with eight carinae. Segment V with five carinae, with tubercles of latero-ventral carinae very small in comparison with those of *B. occitanus*, and very slender especially in males: L/W ratio always > 2.4 in males and 2.0 in females. Anus with two lateral lobes. Telson almost smooth. Vesicle and base of aculeus yellowish, not much lighter than metasoma. Extremity of aculeus black. Aculeus curved and shorter than the vesicle in males, but very elongated and always longer than the vesicle in females. Subaculear tubercle not noticeable. Additional materials:

Other material examined: Besides to the holotype and the three paratypes of *Buthus elongatus* n. sp., 29 specimens of *B. occitanus*, five of *B. ibericus*, and one of *B. montanus* from different localities have been studied (Fig. 6A,B).

B. occitanus (Amoreux, 1789): 2♂♂, 1♀, France: Uzès (Gard), 10–15 February 2005 (ARPC); 1♀, France: Uzès (Gard), 20–25 February 2009 (ARPC); 1♂, 4♀♀, 1 juv. (872), Spain: Port-Bou, 07 July 1960, leg. B. Lanza & S. Carfi (MZUF); 1♂, 1♀, (873), Spain: Campillo di Altobuey, Cuenca, 31 August 1968, leg. D. Capolongo (MZUF); 1♀, (874), Spain: El Montañar, Javea (Alicante), 22 June 1967,



Fig. 4: Ventral view of telson and metasomal segments IV and V. **A** *Buthus elongatus* n. sp. ♀ paratype from Sierra Blanca, Spain; **B** *Buthus occitanus* ♀ from El Montañar, Javea, Spain.

leg. D. Capolongo (MZUF); 1♂, (13881), Spain: El Saler, Valencia, 31 July 1991, leg. D. Capolongo (MCSNB); 1♂, (20), Spain: Embalse de los Bermejales, 15 August 1991, leg. P. Crucitti (SRSN); 1♀, (23), Spain: Valico presso Puerto de la mora, tra Granada e Guadix, 10 August 1991, leg. P. Crucitti (SRSN); 1♂ (28), Spain: Prado Claro, tra Granada e Pico de Veleta, 13 August 1991, leg. P. Crucitti (SRSN); 1♀, (144), Spain: El Saler, Valencia, 31 July 1991, leg. P. Crucitti (SRSN); 1♀, (145), Spain: El Saler, Valencia, 31 July 1991, leg. P. Crucitti (SRSN); 1♂, (157), Spain: Borriol, 22 July 1992, leg. P. Crucitti (SRSN); 1♀, (159), Spain: Borriol, 22 July 1992, leg. P. Crucitti (SRSN); 1♀, (209), Spain: tra Masriudomus e Masboquera, 18 July 1992, leg. P. Crucitti (SRSN); 1♂, (223), Spain: Mostals dels Pins, Caldaques, 03 August 1991, leg. P. Crucitti (SRSN); 1♂, (224), Spain: Mostals dels Pins, Caldaques, 03 August 1991, leg. P. Crucitti (SRSN); 1♀, (241), France: Aigne, Narbonne, 07 August 1991, leg. P. Crucitti (SRSN); 1♂, (242), France: Aigne, Narbonne, 07 August 1991, leg. P. Crucitti (SRSN); 1♀, (243), France: Mas Parer, 08 April 1993, leg. P. Crucitti (SRSN); 1♀, (254), France: Cases-de-Pène, 09 April 1993, leg. P. Crucitti (SRSN); 1♀, (255), France: Cases-de-Pène, 09 April 1993, leg. P. Crucitti (SRSN);

B. ibericus Lourenço & Vachon, 2004: 1♂, Portugal: Lousada, 41°20'46.67"N 8°19'12.14"W, 04 October 2011, leg. P. Ribeiro (ARPC); 1♂, Portugal: Lousada, 41°20'47.38"N 8°19'11.77"W, 04 October 2011, leg. P.

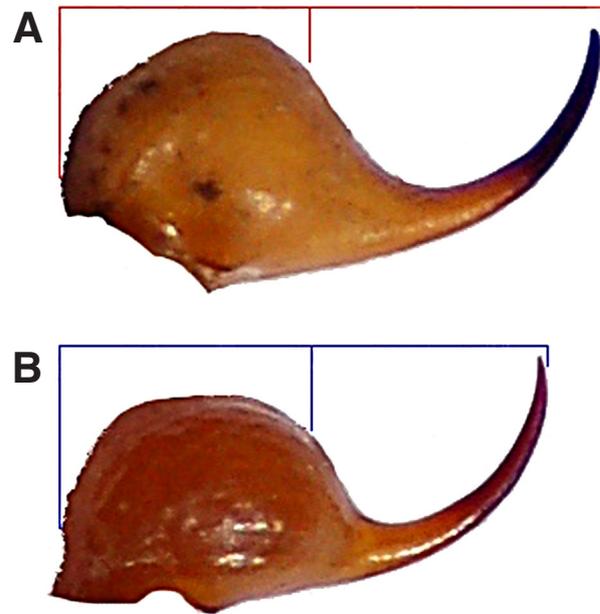


Fig. 5: Lateral view of telson. **A** *Buthus elongatus* n. sp. ♀ paratype from Sierra Blanca, Spain; **B** *Buthus occitanus* ♀ from Port-Bou, Spain.

Ribeiro (ARPC); 1♀, Portugal: Santo Tirso, 41°21'15.50"N 8°20'39.04"W, 01 August 2011, leg. P. Ribeiro (ARPC); 1♀, Portugal: Santo Tirso, 41°21'26.83"N 8°20'37.67"W, 01 August 2011, leg. P. Ribeiro (ARPC); 1♀, Portugal: Lousada, 41°20'50.24"N 8°19'7.06"W, 04 October 2011, leg. P. Ribeiro (ARPC).

B. montanus Lourenço & Vachon, 2004: 1♂, (12825), Spain: Puerto de la Ragua, Sierra Nevada (Granada) 2000–2600 m a.s.l., 15 July 1979, leg. Osella (MCVR).

Ecological and biogeographical notes: *Buthus elongatus* n. sp. is found under stones from sea level, Alicante (Marbella), to the mountains of the Sierra Blanca, behind the city of Marbella; both localities are in Malaga province (Andalusia). The Sierra Blanca is a massif of the Cordón Montañoso Litoral in the Costa del Sol, with four mountains (La Concha, Lastronar, Salto del Lobo, Juanar) whose peaks variable from 1141 m to 1275 m a.s.l. It is a rocky area (the name “Blanca” comes from the white colour of the rocks) with bushes, ferns and several kind of trees: oaks, chestnut, pines, olive, and cherry trees.

Probably the new lineage discovered by Sousa *et al.* (2010) from 36.639°N 5.248°W on the border between the provinces of Malaga and Cadiz, in Andalusia, can be referred to *Buthus elongatus* n. sp. because of the short distance between the localities where the specimens were collected. *B. elongatus* n. sp. is, nevertheless, reported only from Malaga province with a sufficient level of confidence (Fig. 7).

As reported for other species of genus *Buthus* (Skutelsky, 1995), the diet of *B. elongatus* n. sp. is varied and includes crickets, grasshoppers, and other insects, spiders, and also small lizards (personal observations), as also reported for *B. occitanus* on the Columbretes islands (Castilla, Herrel & Gosà 2009). The venom is quite potent, killing prey in a few seconds but, as suggested by Keegan (1980), not as potent as *Buthus* species from North-Africa.

Buthus ibericus is distributed in all of Portugal from the south to the north-east (Sousa *et al.* 2010) and north-west

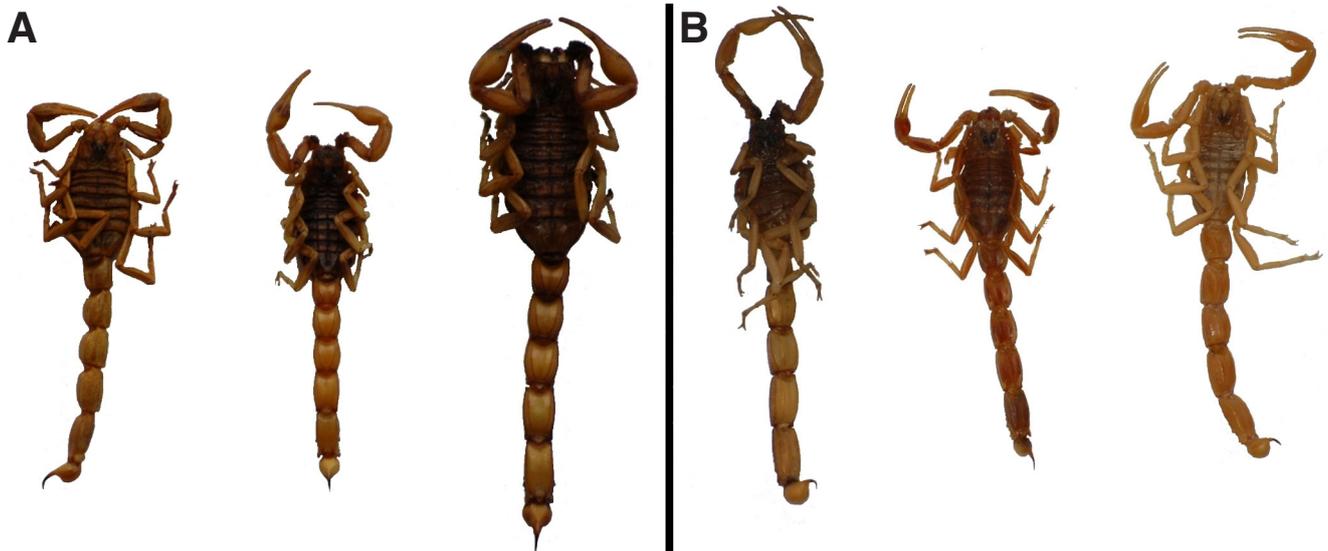


Fig. 6: *Buthus elongatus* n. sp. in comparison with other European species of the genus *Buthus*. **A** from left to right: females of *B. occitanus* (Uzès, France), *B. ibericus* (Lousada, Portugal), and *B. elongatus* n. sp. paratype (Sierra Blanca, Spain); **B** from left to right: males of *B. elongatus* n. sp. holotype (Sierra Blanca, Spain), *B. occitanus* (Uzès, France), and *B. occitanus* (Cuenca, Spain).

(reported here for the first time), and also for western Spain (Lourenço & Vachon 2004; Teruel & Pérez-Bote 2005; Sousa *et al.* 2010). It lives from sea level, only 500 m from the shore, to hills with a typical Mediterranean habitat of grassland and oak forest. It can dig burrows and tunnel up to 20 cm deep. It is a medium-sized scorpion between 55–71 mm (maximum length reported by Teruel & Pérez-Bote 2005, for females). Sexual dimorphism is not noticeable in the chela manus.

Buthus montanus is endemic to the Sierra Nevada (provinces of Granada and Almería in Andalusia) and occupies a dry habitat in the highest peaks over 2000 m. In the same region, at lower levels and near to the sea, *B. occitanus* is also present (W. Lourenço, personal communication); this is also confirmed by material analysed by the author (Fig. 7). It is a medium-large species for the genus *Buthus*, length 60–74 mm, second in Europe only to *Buthus elongatus* n. sp., with very marked ventrally carinae on the second and third metasomal segments. The chela manus is much wider in females than in males.

Buthus occitanus is now limited to southern France, from Provence (probably from the city of Mandelieu-la-Napoule) to the Pyrenees, and in eastern and southern Spain from Port-Bou to Almería province. It is a medium-sized scorpion with an average length of 50–70 mm. Lourenço & Vachon (2004) reported a maximum length of 60 mm, and Castilla & Herrel (2009) of about 65 mm, while Stockmann & Ythier (2010) reported 80 mm. This last datum clearly concerns the *Buthus occitanus* species complex as a whole (they included North Africa in their distribution) and it is thus not referable to *Buthus occitanus occitanus*. Usually, Spanish specimens are bigger on average than French specimens (Tables 1 and 2), possibly due to the higher temperatures in Spain. I have examined material with a maximum length of 63 mm for French females and > 70 mm for Spanish females. This species lives under stones in Mediterranean habitats and is known for its cannibalism (Colombo 2011). The record from Cáceres concerning predation on a small turtle (Bejarano & Pérez-Bote 2002) is likely due to

B. ibericus, because Cáceres is in the range of *B. ibericus*. While *B. occitanus* is a predator of young lizards it is also profitable prey for larger lizards (Castilla & Herrel 2009). The chela manus is wider in females; generally more noticeable in Spanish populations.

Key to European species of *Buthus*

1. Movable fingers of pedipalps with a basal lobe in both sexes *B. ibericus* Lourenço & Vachon, 2004
Movable fingers of pedipalps without a basal lobe in both sexes 2
2. Ventral carinae of second and third metasomal segment strongly marked with 4 and 6 big granules; endemic to highest peaks (> 2000 m) of Sierra Nevada (Spain)
..... *B. montanus* Lourenço & Vachon, 2004
Ventral carinae of second and third metasomal segment scarcely marked 3
3. Latero-ventral carinae of fifth metasomal segment with marked big tubercles; L/W ratio of fifth metasomal segment in ♂♂ always < 2.15 and in ♀♀ usually < 2; aculeus always shorter than vesicle in both sexes
..... *B. occitanus* (Amoreux, 1789)
Latero-ventral carinae of fifth metasomal segment with small and less developed tubercles; L/W ratio of fifth metasomal segment in ♂♂ always > 2.4 and in ♀♀ always > 2; aculeus of ♀♀ always longer than vesicle ...
..... *B. elongatus* n. sp.

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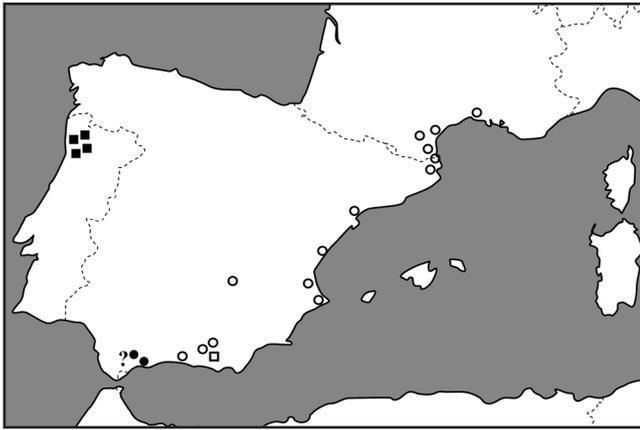


Fig. 7: Distribution map of *Buthus* material examined in this study: ○ = *B. occitanus*; ■ = *B. ibericus*; ● = *B. elongatus* n. sp.; □ = *B. montanus*; ? = new genetic lineage in Sousa *et al.* (2010).

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