
SYSTEMATIC REVISION OF THE EUROPEAN
SPECIES OF *BUTHUS* LEACH, 1815
(SCORPIONES: BUTHIDAE)

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AND LORENZO PRENDINI



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ABSTRACT

The Palearctic buthid scorpion genus *Buthus* Leach, 1815, distributed from southwestern Europe (southern France and the Iberian Peninsula) across Africa north of the Sahara, to the Levant and the Arabian Peninsula, has undergone extensive taxonomic revision in the past two decades. Despite these efforts, its taxonomic composition remains confused, perhaps nowhere more so than in the Iberian Peninsula, where 20 putative species were recognized in the past two decades. Molecular phylogenetic studies of *Buthus* in northwestern Africa and southwestern Europe, based on a few, mostly mitochondrial gene loci, recovered a monophyletic origin for the European clade of *Buthus* and suggested the existence of several distinct lineages on the Iberian Peninsula. However, relationships with the species of *Buthus* from the North African Maghreb remained ambiguous. Morphological descriptions of new or revalidated species of *Buthus*, based in part on the molecular phylogenies but lacking robust diagnoses, and making little attempt to consider geographical variation, compounded the confusion. The present contribution provides a comprehensive, integrative revision of the European species of *Buthus* based on samples, including topotypes, collected across the known distribution, rigorous phylogenetic analyses combining morphology, nuclear and mitochondrial DNA sequences, morphometric analyses, and ecological data. Nine valid species of *Buthus* are recognized across France, Portugal, and Spain, and 10 new synonyms presented: *Buthus delafuentei* Teruel and Turiel, 2020 = *Buthus gonzalezdelavegai* González-Moliné and Armas, 2024, syn. n.; *Buthus elongatus* Rossi, 2021; *Buthus garcialorcai* Teruel and Turiel, 2020; *Buthus halius* (C.L. Koch, 1839) = *Androctonus ajax* C.L. Koch, 1839, syn. n. = *Buthus gabani* Ythier, 2021, syn. n. = *Buthus castellano* Teruel and Turiel, 2022, syn. n.; *Buthus iaspis* Teruel and Turiel, 2022; *Buthus ibericus* Lourenço and Vachon, 2004 = *Buthus baeticus* Teruel and Turiel, 2020, syn. n.; *Buthus manchego* Teruel and Turiel, 2020 = *Buthus alacanti* Teruel and Turiel, 2020, syn. n. = *Buthus serrano* Teruel and Turiel, 2020, syn. n. = *Buthus pedrosousai* Teruel and Turiel, 2021, syn. n.; *Buthus montanus* Lourenço and Vachon, 2004; *Buthus occitanus* (Amoreux, 1789) = *Buthus pyrenaicus* Ythier, 2021, syn. n. = *Buthus balmensis* Ythier and Laborieux, 2022, syn. n. Revised, comparative diagnoses and illustrations are provided for each species, together with a distribution map and key to their identification.

INTRODUCTION

Distributed from southwestern Europe (southern France and the Iberian Peninsula) across Africa north of the Sahara, to the Levant and the Arabian Peninsula, the “common yellow scorpions” of the Palearctic buthid genus *Buthus* Leach, 1815, are often locally abundant in semiarid to arid habitats, including pine forests, dehesas, scrub, steppe and coastal sand dunes (fig. 1). Whereas all species of the genus are fossorial, inhabiting burrows or scrapes constructed under stones or in open ground, different species are pelophilous or semipsammophilous (sensu Prendini, 2001a), their morphology adapted for burrowing in substrates of varying hardness, texture and composition, from clay to semiconsolidated sand.

Buthus species are sit-and-wait predators, exhibiting different foraging strategies depending on their age and sex (Skutelsky, 1996; Sánchez-Piñero and Urbano-Tenorio, 2016; Sánchez-Piñero et al., 2025). Adult females usually remain in the burrow and forage nearby, whereas adult males are errant and cover more territory while seeking shelter, prey or mates (Sánchez-Piñero and Urbano-Tenorio, 2016; Sánchez-Piñero et al., 2025). As in most scorpions, adult *Buthus* exhibit some degree of sexual dimorphism, particularly in the shape of the pedipalp chela, which may be slender or globose in the adult male or female (fig. 2), and a higher pectinal tooth count in the male at all stages.

Long considered a single species, the European species of *Buthus* experienced a dramatic



FIGURE 1. Representative habitats of *Buthus* Leach, 1815, in France and the Iberian Peninsula. **A.** Sierra de Guadarrama, Madrid, Spain, habitat of *Buthus halius* (C.L. Koch, 1839). **B.** Ossa de Montiel, Castilla-La Mancha, Spain, habitat of *Buthus manchego* Teruel and Turiel, 2020. **C.** Desierto de Tabernas, Andalucía, Spain, habitat of *Buthus iaspis* Teruel and Turiel, 2022. **D.** Pompignan, Occitanie, France, habitat of *Buthus occitanus* (Amoreux, 1789). **E.** Sierra de Huétor, Andalucía, Spain, habitat of *Buthus garcialorcai* Teruel and Turiel, 2020. **F.** Cabo São Vicente, Algarve, Portugal, habitat of *B. halius*.



FIGURE 2. Representative species of *Buthus* Leach, 1815, occurring in France and the Iberian Peninsula. **A.** *Buthus occitanus* (Amoreux, 1789), ♂, Souvignargues, Occitanie, France. **B.** *Buthus elongatus* Rossi, 2012, ♂, Sierra de las Nieves, Andalucía, Spain. **C.** *Buthus iaspis* Teruel and Turiel, 2022, ♂, Cabo de Gata-Níjar, Andalucía, Spain. **D.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂, Dehesa Picado, Andalucía, Spain. **E.** *Buthus delafulentei* Teruel and Turiel, 2020, ♂, Pinar del Tableado, Andalucía, Spain. **F.** *Buthus manchego* Teruel and Turiel, 2020, ♂, Embalse de Peñarroya, Castilla-La Mancha, Spain.

increase in diversity during the past two decades (Lourenço and Vachon, 2004; Lourenço, 2021; Rossi, 2012; Teruel and Turiel, 2020, 2021a, 2021b, 2022a, 2022b; Ythier, 2021a, 2021b, 2023; Ythier and Laborieux, 2022; González-Moliné and Armas, 2024; tables 1, 2). *Buthus occitanus* (Amoreux, 1789) was the only species recognized in southwestern France and the Iberian Peninsula for almost two centuries until two new species, *Buthus ibericus* Lourenço and Vachon, 2004, and *Buthus montanus* Lourenço and Vachon, 2004, followed soon after by a third, *Buthus elongatus* Rossi, 2012, were described from southern Spain (Lourenço and Vachon, 2004; Rossi, 2012).

During the same period, extensive molecular systematics studies, based on a few, mostly mitochondrial gene loci were conducted on the *Buthus* of southwestern Europe and the North African Maghreb. The Atlas Mountains, Tell-Atlas and Iberian Peninsula were identified as major areas of diversification (Gantenbein and Largiadèr, 2003; Gantenbein, 2004; Sousa et al. 2010; Habel et al., 2012; Sousa et al., 2012; Pedroso et al., 2013; Sousa, 2017; Klessner et al. 2021). The monophyletic origin of the European species of *Buthus* has been debated since.

Gantenbein and Largiadèr (2003) and Gantenbein (2004) presented the first analyses based on nuclear 18S rDNA/Internal Transcribed Spacer (ITS1) and mitochondrial 16S rDNA (16S) and Cytochrome *c* Oxidase Subunit I (COI) DNA sequences, which suggested the European populations were autochthonous, monophyletic, and genetically divergent from the North African clades inhabiting Morocco, Algeria, and Tunisia. A close connection between the taxa inhabiting Tunisia and the Iberian Peninsula was also suggested, based on the placement of *Buthus tunetanus* (Herbst, 1800) sister to the Iberian *Buthus* samples.

Sousa et al. (2010) subsequently identified five distinct *Buthus* lineages in the Iberian Peninsula, two reported for the first time, in an analysis based entirely on mitochondrial COI sequences. Although, Sousa et al. (2010) recovered the

monophyly of European *Buthus* in a Bayesian Inference analysis, an Iberian sample was placed sister to *B. tunetanus* in a Maximum Likelihood (ML) analysis, albeit with low support, suggesting that the relationships between European and North African *Buthus* populations were far from resolved. Subsequent contributions, also based solely on COI sequences, recovered similar patterns, implying multiple colonizations of the Iberian Peninsula (Habel et al., 2012; Klessner et al., 2021) or suggesting that North Africa was recolonized from Europe on at least one occasion (Sousa et al., 2012; Pedroso et al., 2013; Klessner et al., 2021). Despite the influence of topographic barriers, incomplete lineage sorting in the Iberian Peninsula and Algeria, the lack of a clear nuclear DNA signal, and the possible existence of ancient hybridization, e.g., mitochondrial capture and recombination (Gantenbein, 2004; Gantenbein et al., 2005), complicated the understanding of relationships among the *Buthus* of southwestern Europe and the Maghreb.

The most comprehensive study of European *Buthus* relationships to date—based on nuclear protein kinase and 28S rDNA (28S), and mitochondrial 16S and COI sequences for a more comprehensive sample from Portugal and Spain, together with samples covering an extensive part of northwestern Africa—was presented in the Ph.D. dissertation of Sousa (2017). The European species of *Buthus* were recovered as monophyletic and additional cryptic lineages identified, all with higher support values than studies before or after.

Sousa et al. (2017) followed with a review of the taxonomic status of the *Buthus* species occurring in Europe and the Maghreb. Unfortunately, failure to access the type material of most species and the absence of reliable diagnostic characters restricted this contribution to a simple catalog with some taxonomic updates. Sousa et al. (2017) synonymized *Buthus europaeus* var. *tridentatus* Franganillo, 1918, with *B. occitanus* and revaluated *Buthus halius* (C.L. Koch, 1839) from synonymy with *B. occitanus*, only to synonymize it with *B. ibericus* on the grounds that *B. halius* had

not been used since 1879. Appealing to Article 23.9.2 of the International Code of Zoological Nomenclature (ICZN, 1999), Sousa et al. (2017) maintained the more recent name *B. ibericus* as valid under the category nomen protectum and considered *B. halius* a nomen oblitum to preserve taxonomic stability.

Sousa's (2017) molecular phylogenetic analyses of European and Maghrebian *Buthus* remain unpublished. However, Teruel and Turiel (2020, 2021a, 2021b, 2022a, 2022b) published a series of contributions in which new or revalidated names were assigned to specimens representing Sousa's (2017) unpublished clades. Among other decisions, including poorly justified neotype designations, Teruel and Turiel (2020, 2021a, 2021b, 2022a, 2022b) revalidated *Buthus ajax* (C.L. Koch, 1839) and *B. halius* from synonymy with *B. occitanus* and *B. ibericus* respectively, and synonymized *Buthus lusitanus* Lourenço, 2021, with *B. halius*. The 17 European species of *Buthus* recognized by Teruel and Turiel (2020, 2021a, 2021b, 2022a, 2022b), nine putative new species among them, were separated solely by tables of morphometrics and short diagnoses based on trivial, variable characters. These contributions, followed by others applying a similar approach (Lourenço, 2021; Ythier, 2021a, 2021b; Ythier and Laborieux, 2022; González-Moliné and Armas, 2024), rapidly inflated the number of putative *Buthus* species in France and the Iberian Peninsula to 20 (table 1).

The brief, uninformative diagnoses provided in these studies, along with the absence of identification keys and rigorous analyses of morphological variation underscored the need to reassess the validity of the putative new species and the criteria for their delimitation. Integrative taxonomy (Dayrat, 2005) has provided an effective approach for species delimitation in other complex scorpion taxa (Prendini and Loria, 2020; Cain et al., 2021a; Moreno-González et al., 2021; Barahoei et al., 2022; Ojanguren-Affilastro et al., 2023; Amiri et al., 2024). Combining morphological, molecular and ecological data improves understanding and strengthens support for spe-

cies hypotheses, yielding insights that none of these approaches alone can provide (Wiens, 2007).

The present contribution provides a comprehensive, integrative revision of the European species of *Buthus* based on samples collected across the known distribution, rigorous phylogenetic analyses combining morphology, nuclear and mitochondrial DNA sequences, morphometric analyses, and ecological data. Nine valid species of *Buthus* are recognized across France, Portugal, and Spain, and 10 new synonyms presented (tables 1, 2). Revised, comparative diagnoses and illustrations are provided for each species, together with a distribution map (fig. 3) and key to their identification.

TAXONOMIC HISTORY OF *BUTHUS* LEACH, 1815

Buthus occitanus (Amoreux, 1789), the first species assigned to genus *Buthus* Leach, 1815, was originally placed in *Scorpio* Linnaeus, 1758, for decades the only scorpion genus. Amoreux (1789a) originally created two names for the same species, i.e., *Scorpio occitanus* Amoreux, 1789, and *Scorpio rufus* Amoreux, 1789, but subsequently (Amoreux, 1789b) synonymized *S. rufus* with *S. occitanus*. Although the description of *Buthus occitanus* was based on specimens collected at Souvignargues, France, the species was named after the Occitanie region (also known as "Languedoc"), where the type locality is situated. The diagnosis of *B. occitanus* mentioned only a single character, the pectinal tooth count, which varied from 52 to 60 (fig. 4A, B). Amoreux (1789b) also mentioned the presence of eight eyes, a character used early on to classify different scorpion taxa based on the sum of their median and lateral ocelli (DeGeer, 1778; Fabricius, 1781).

Prior to its formal description by Amoreux (1789b), *B. occitanus* was referred to by the name *Scorpio europaeus* Linnaeus, 1754. However, Linnaeus (1754) did not describe *S. europaeus* as a new species and later (Linnaeus, 1758) used the same name to describe another species, probably

TABLE 1

VALID SPECIES AND SYNONYMS OF *BUTHUS* LEACH, 1815, OCCURRING IN EUROPE*Buthus* Leach, 1815Type species: *Scorpio occitanus* Amoreux, 1789 = *Buthus occitanus* (Amoreux, 1789)*Buthus delafulentei* Teruel and Turiel, 2020= *Buthus gonzalezdelavegai* González-Moliné and Armas, 2024, syn. n.*Buthus elongatus* Rossi, 2021*Buthus garcialorcai* Teruel and Turiel, 2020*Buthus halius* (C.L. Koch, 1839)= *Androctonus ajax* C.L. Koch, 1839, syn. n.= *Buthus gabani* Ythier, 2021, syn. n.= *Buthus lusitanus* Lourenço, 2021; synonymized by Teruel and Turiel (2022b)= *Buthus castellano* Teruel and Turiel, 2022, syn. n.*Buthus iaspis* Teruel and Turiel, 2022*Buthus ibericus* Lourenço and Vachon, 2004= *Buthus baeticus* Teruel and Turiel, 2020, syn. n.*Buthus manchego* Teruel and Turiel, 2020= *Buthus alacanti* Teruel and Turiel, 2020, syn. n.= *Buthus serrano* Teruel and Turiel, 2020, syn. n.= *Buthus pedrosousai* Teruel and Turiel, 2021, syn. n.*Buthus montanus* Lourenço and Vachon, 2004*Buthus occitanus* (Amoreux, 1789)= *Scorpio rufus* Amoreux, 1789; synonymized by Amoreux (1789b)= *Androctonus eurialus* C.L. Koch, 1839; synonymized by Simon (1879)= *Androctonus eurilochus* C.L. Koch, 1839; synonymized by Kraepelin (1891)= *Buthus europaeus* Thorell, 1876; synonymized by Fet and Lowe (2000)= *Buthus europaeus* var. *tridentatus* Franganillo, 1918; synonymized by Sousa et al. (2017)= *Buthus pyrenaicus* Ythier, 2021, syn. n.= *Buthus balmensis* Ythier and Laborieux, 2022, syn. n.

conspecific with *Isometrus maculatus* (DeGeer, 1778). The confusion generated by Linnaeus (1754, 1758) caused Thorell (1876a) and subsequent authors to consider *Buthus europaeus* (Linnaeus, 1758) a valid species, and *S. occitanus*, its junior synonym. The name *Scorpio europaeus* Linnaeus, 1758, was eventually suppressed to avoid further confusion and *Buthus europaeus* Thorell, 1876, synonymized with *B. occitanus* (Fet and Lowe, 2000).

When Leach (1815) created the genus *Buthus* to accommodate all scorpions possessing eight eyes (i.e., three pairs of lateral ocelli), *Scorpio occitanus* Amoreux, 1789, was transferred to it and designated as type species. It is now well established that all species of *Buthus* possess five pairs of lateral ocelli (Loria and Prendini, 2014), not three pairs as claimed by Amoreux (1789) and Leach (1815) (fig. 4C, D). The vague diagno-

sis of *Buthus* created a polyphyletic genus, comprising many unrelated taxa later transferred to different genera and families. Attempting to instill order, Hemprich and Ehrenberg (1828) created two subgenera within *Buthus*, *Heterometrus* Ehrenberg, 1828, and *Isometrus* Ehrenberg, 1828. Once again, the diagnoses of these subgenera were based only on the unreliable eye count, however, leading both subgenera to be temporarily synonymized with *Buthus* by other authors (Simon, 1879; Kraepelin 1891, 1899). These subgenera are now considered genera assigned to the families Scorpionidae Latreille, 1802, and Buthidae C.L. Koch, 1837, respectively.

The composition of *Buthus* remained confused for another century, due in no small part to its simplistic diagnosis. Koch (1837) assigned all eight-eyed scorpion taxa to the new family Buthidae. In applying the same, shallow diagno-

TABLE 2

COUNTRIES AND AREAS OF OCCURRENCE OF VALID SPECIES OF *BUTHUS* LEACH, 1815, IN EUROPE
Abbreviations: *del*, *Buthus delafrontei* Teruel and Turiel, 2020; *elo*, *Buthus elongatus* Rossi, 2012;
gar, *Buthus garciai* Teruel and Turiel, 2020; *hal*, *Buthus halius* (C.L. Koch, 1839); *ias*, *Buthus iaspis* Teruel and Turiel, 2022;
ibe, *Buthus ibericus* Lourenço and Vachon, 2004; *man*, *Buthus manchego* Teruel and Turiel, 2020;
mon, *Buthus montanus* Lourenço and Vachon, 2004; *occ*, *Buthus occitanus* (Amoreux, 1789).

Country	Region	<i>del</i>	<i>elo</i>	<i>gar</i>	<i>hal</i>	<i>ias</i>	<i>ibe</i>	<i>man</i>	<i>mon</i>	<i>occ</i>
France	Occitanie									x
	Provence-Alpes-Côte d'Azur									x
Portugal	Algarve	x								
	Alentejo				x					
	Beira Alta				x					
	Douro Litoral				x					
	Trás-os-Montes e Alto Douro				x					
Spain	Andalucía	x	x	x	x	x	x		x	
	Aragón									x
	Castilla-La Mancha				x			x		x
	Castilla y León				x					
	Catalunya									x
	Com. Valenciana							x		x
	Extremadura				x					
	Galicia				x					
	La Rioja									x
	Madrid				x					
	Murcia					x		x		
	Navarra									x

sis, Koch (1837) created a polyphyletic family comprising several unrelated genera, e.g., *Buthus*, *Brotheas* C.L. Koch, 1837, and *Opisthophthalmus* C.L. Koch, 1837, each later transferred to different families. Koch (1837) also ignored the nominotypical status of *B. occitanus* and designated *Buthus spinifer* Ehrenberg, 1828 (currently the type species of the scorpionid genus *Heterometrus*), as type species of Buthidae. Most authors ignored this decision until Sousa et al. (2017) submitted a petition to fix the type species of Buthidae based on Article 65.2.1 of the ICZN (1999).

Koch (1839a, 1839b) described two new species of *Buthus* but assigned them to another buthid genus, *Androctonus* Ehrenberg, 1828: *Androctonus ajax* C.L. Koch, 1839; *Androctonus halius* C.L. Koch, 1839. Both species were later synonymized with *B. occitanus* by Simon (1879).
Four decades later, Franganillo (1918) published a list of Spanish arachnids, including a new variety of *B. occitanus* from Javier, in the eastern part of Navarra. Misled by the earlier taxonomic confusion, Franganillo (1918) assigned this new variety to *B. europaeus*, as *B. europaeus* var. *tridentatus*.

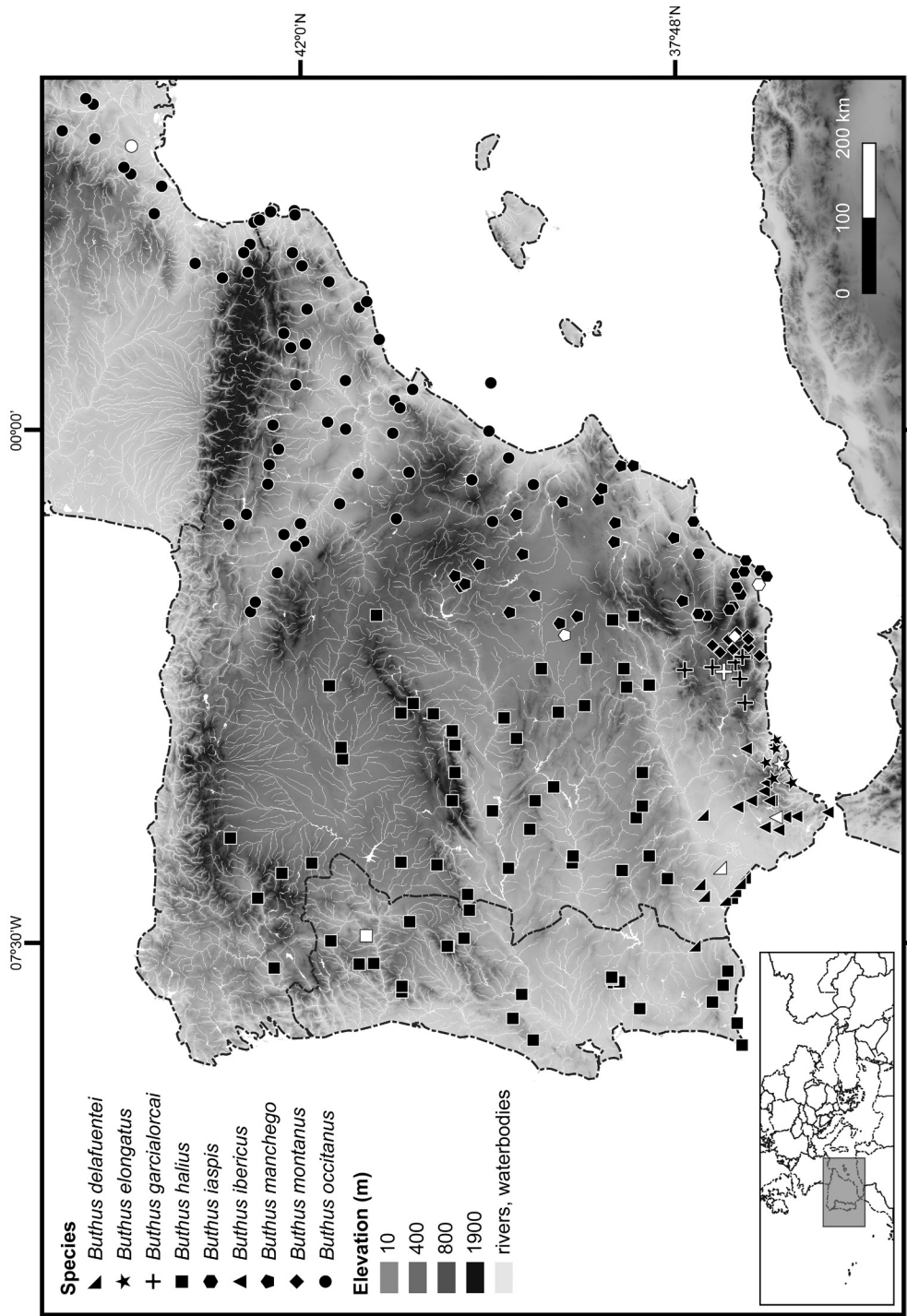


FIGURE 3. Map of the Iberian Peninsula and southeastern France illustrating geographical distribution of nine valid European species of *Buthus* Leach, 1815, based on records from the literature and online repositories. Type localities indicated by white symbols.

After the Second World War, Vachon (1941, 1948a, 1948b, 1949a, 1949b, 1949c, 1950, 1951, 1952a, 1952b, 1952c) brought order to *Buthus*, setting the modern framework that persisted for the next half century (Fet and Lowe, 2000). In a series of contributions addressing North African and European buthids compiled by Vachon (1952c), *Buthus* was redefined and restricted to the taxa resembling *B. occitanus* and separated from other buthid genera by a combination of two characters: fusion of the centrolateral and posteromedian carinae of the carapace into a lyra-shaped structure and three distal denticles on the pedipalp chela movable finger. Vachon (1952c) recognized four species and seven subspecies of *Buthus*. All except one subspecies belonged to *B. occitanus* and only the nominotypical subspecies was restricted to Europe. Five species and 10 subspecies of *Buthus* were listed half a century later by Fet and Lowe (2000).

In addition to providing diagnoses for each species and subspecies of *Buthus*, Vachon (1952c) presented the first key to their identification. Patterns of metasomal setation, length : width ratios of the first and fifth metasomal segments, and shape of the pedipalp chelae, among others, were identified as reliable diagnostic morphological characters. Vachon (1952c: 251) recognized a species complex referred to as “la ligné *atlantis*,” which could be distinguished from all other *Buthus* by the slender shape of the appendages, the metasoma and telson, and various other characters “que nos tableaux de détermination préciseront.” Building on this system, Lourenço (2002: 110) indirectly proposed a second species complex while referring to *B. occitanus* as a “complexe de formes,” a term maintained in subsequent publications (Lourenço, 2003, 2005a, 2005b, 2005c; Lourenço and Vachon, 2004; Lourenço and Geniez, 2005). The two complexes, i.e., *atlantis* and *occitanus*, could allegedly be separated from one another based on carinal development, claimed to be obsolete in the *atlantis* group (Lourenço and Geniez, 2005). However, this assertion was later contradicted by Lourenço (2005a), who claimed that the carinae are less

pronounced in the European species, i.e., the *occitanus* complex, than in the *atlantis* complex.

The molecular systematics revolution ushered in the first phylogenies of *Buthus* and hopes of clarifying their evolutionary history. A pioneering study by Gantenbein and Largiadèr (2003) placed *B. atlantis* within the *occitanus* complex, but this hypothesis was rejected by Lourenço and Vachon (2004), Lourenço and Geniez (2005) and Lourenço (2005a, 2005b, 2005c), who maintained the two historical complexes. Additional molecular phylogenies, mostly based on the mitochondrial COI locus, by Sousa et al. (2012) and Pedroso et al. (2013), defined a series of species groups based on the clades recovered, but did not recover the *atlantis* complex. The major clades, named after the first described species in each clade, were geographically structured: *boumalenii*, occupying southern Morocco, the Drâa Valley and pro-Saharan areas; *mardochei*, inhabiting the High Atlas of western Morocco; *occitanus*, distributed throughout northern Morocco, the Middle Atlas, western Algeria, and across the Strait of Gibraltar to the Iberian Peninsula and southwestern France; *rochati*, extending from southwestern Morocco to Mauritania; and *tunetanus*, covering eastern Algeria and Tunisia, from the Tell-Atlas to the Aures Mts. Lists of species in each clade were compiled by Sousa (2017) and Sousa et al. (2017).

In the past two decades, the number of *Buthus* species described or revalidated soared to 80, including 20 putative species from the Iberian Peninsula, and the known distribution of the genus across North Africa and the Middle East was greatly expanded (Abidi et al., 2020, 2021; Fet and Lowe, 2000; Kovařík, 2006, 2011; Kovařík et al., 2020; Lourenço, 2002, 2003, 2005a, 2005b, 2005c, 2008, 2013, 2015, 2016, 2017, 2021; Lourenço and Cloudsley-Thompson, 2018; Lourenço et al., 2009, 2010, 2012, 2018, 2020; Lourenço and Geniez, 2005; Lourenço and Leguin, 2012; Lourenço and Qi, 2006; Lourenço and Sadine, 2016; Lourenço and Slimani, 2004; Lourenço and Simon, 2012; Lourenço and Vachon, 2004; Rossi, 2012, 2017; Rossi et al., 2013; Rossi and Tropea,

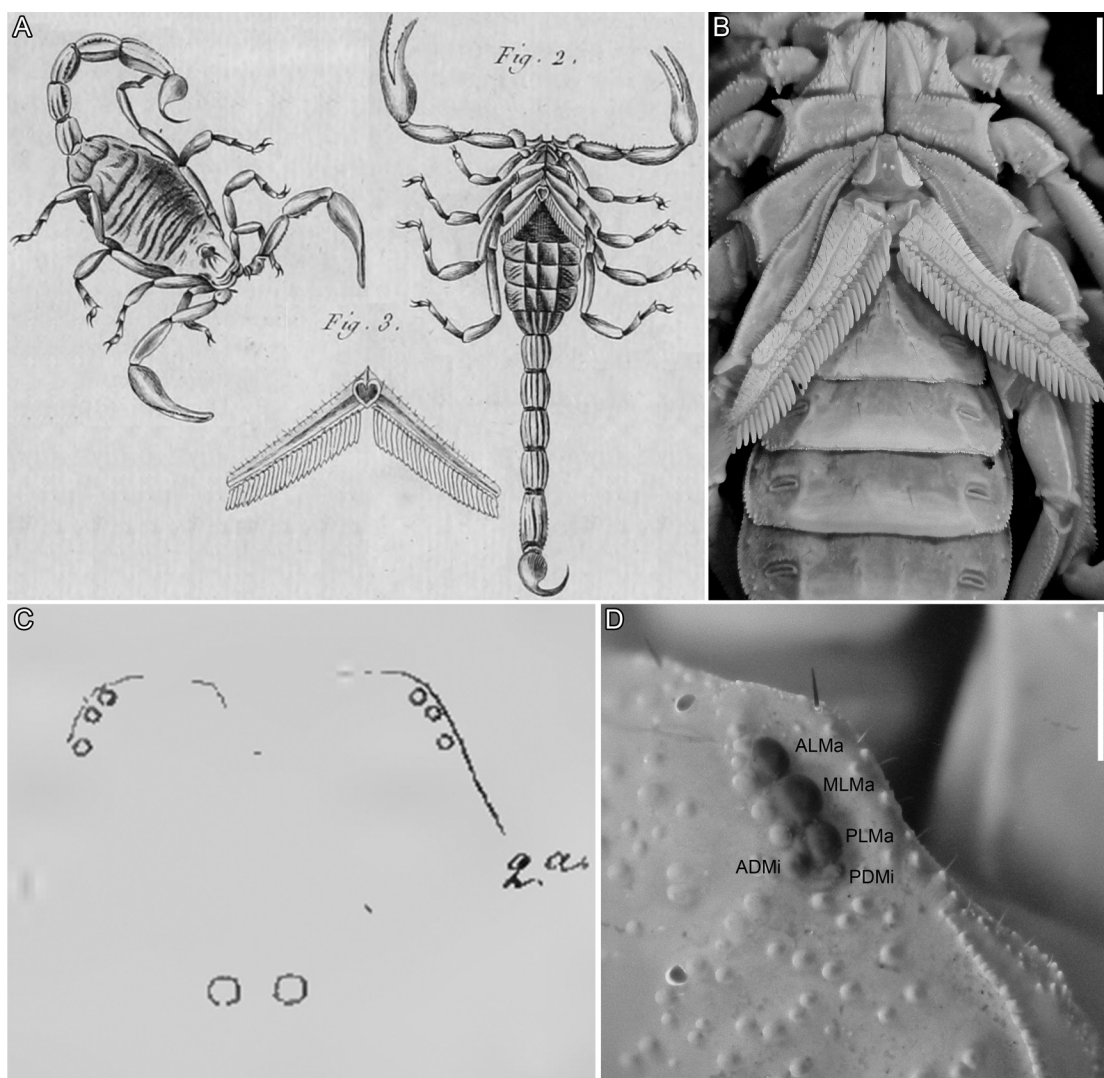


FIGURE 4. Historical depictions of characters of *Buthus occitanus* (Amoreux, 1789). **A.** Habitus of *Scorpio occitanus* Amoreux, 1789, with detail of male sternum and pectines, by Amoreux (1789b: pl. I, figs. 1–3). **B.** Pectines of *B. occitanus*, ♂ (AMNH), Souvignargues, Occitanie, France. **C.** Carapace illustrating two median and three lateral ocelli of *Buthus* Leach, 1815, by Hemprich and Ehrenberg (1828: 153, fig. 2a). **D.** Carapace of *B. occitanus*, ♂ (AMNH), Souvignargues, Occitanie, France, illustrating five lateral ocelli, pattern type 5 of Loria and Prendini (2014). Abbreviations: **ALMa**, anterolateral major ocellus; **MLMa**, mediolateral major ocellus; **PLMa**, posterolateral major ocellus; **PDMi**, posterodorsal minor ocellus; and **ADMi**, anterodorsal minor ocellus. Scale bars = 2 mm (**B**), 1 mm (**D**).

2016a, 2016b; Sadine et al., 2016; Teruel and Turiel, 2020, 2021a, 2021b, 2022a, 2022b; Yağmur et al., 2011; Ythier, 2021a, 2021b, 2021c, 2023; Ythier and Laborieux, 2022; Ythier and Lourenço, 2022; González-Moliné and Armas, 2024).

Due to the tremendous increase in the number of *Buthus* species recognized in the past two decades, Vachon's (1952c) identification key and others created afterwards became obsolete (Lourenço and Vachon, 2004; Rossi, 2012; Teruel and Melic, 2015). The widespread practice of describing new species based on small samples from previously unreported geographical locations, often without considering intraspecific variation more broadly across the distribution or making relevant comparisons to other, previously described species that might be conspecific, resulted in a plethora of superfluous names justified by weak diagnoses, and poorly understood distributions (Sousa, 2017; Sousa et al., 2017). A comprehensive revision of *Buthus*, employing new characters and rigorous analytical approaches to better delimit species and understand their evolutionary relationships, is urgently needed. Considering the complex evolutionary history of the genus (Sousa et al., 2010; Sousa, 2017; Klessner et al., 2021; Blasco-Aróstegui et al., in prep.), new species hypotheses should be based on multiple sources of evidence rather than single gene trees or a handful of variable morphological characters.

MATERIAL AND METHODS

FIELDWORK AND MATERIAL: As it was logistically impossible to examine most of the type specimens, a representative series of topotypes were freshly collected for each putative species. Targeted fieldwork was conducted across the known distribution of *Buthus* in Europe (France, Portugal, and Spain), including the type localities of each putative species. Specimens were collected by hand with forceps from under stones or inside burrows during the day and with ultraviolet (UV) light detection (Stahnke, 1972a) using portable UV light emitting diode flashlights, at

night. Collection localities were georeferenced in the field using the SW Maps – GIS and Data Collector app (<https://aviyaantech.com/swmaps>).

Freshly collected material, including topotypes (appendix 1), preserved in 70% ethanol for morphological examination, is deposited in the collections of the American Museum of Natural History (AMNH), New York. Tissue samples preserved in 95% ethanol are stored in the Ambrose Monell Cryocollection (AMCC) at the AMNH (appendix 2). Collections containing additional material are abbreviated as follows: ALGM, Antonio Luis González Moliné Private Collection, Huelva, Spain; ARPC, Andrea Rossi Private Collection, Massa, Italy; CIBIO-InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos – BIOPOLIS, Porto, Portugal; CRBA, Centre de Recursos de Biodiversitat Animal, Universitat de Barcelona, Spain; EYCP, Eric Ythier Private Collection, Romanèche-Thorins, France; IES, Instituto de Ecología y Sistemática, Havana, Cuba; JPGL, Juan Pablo González de la Vega Private Collection, Huelva, Spain; MHNL, Muséum d'Histoire Naturelle, Lyon, France; MNCN, Museo Nacional de Ciencias Naturales, Madrid, Spain; MNHN, Muséum National d'Histoire Naturelle, Paris, France; MNHNC, Museu Nacional de História Natural e da Ciência, Lisbon, Portugal; MZUF, Museo Zoologico Università di Firenze “La Specola,” Italy; RTO, Rolando Teruel Private Collection, Havana, Cuba.

TAXON SAMPLING: The ingroup comprised topotypes and additional representatives of all putative European species, 51 terminals in total (appendices 1, 2). Three African species were included as outgroups (appendix 2). Two of the outgroup species represented the major North African *Buthus* clades found to be most closely related to the European clade in previous analyses (Gantenbein and Largiadèr, 2003; Gantenbein, 2004; Sousa et al., 2010, 2012; Habel et al., 2012; Pedroso et al., 2013; Sousa, 2017; Klessner, et al. 2021): *Buthus maroccanus* Birula, 1903, part of the Moroccan *occitanus* complex, represented the Atlas clade; and *Buthus tunetanus*

TABLE 3

SYSTEMATIC WORKFLOW INTEGRATING EVIDENCE SUPPORTING TAXONOMIC AMENDMENTS IN EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815

Questions 1–10 (Q1–10): Morphometrics forms separate cluster? (Q1); Diagnostic fixed morphological characters? (Q2); nuDNA forms separate subclade? (Q3); mtDNA forms separate subclade? (Q4); mtDNA average pairwise divergence >5%? (Q5); nuDNA and mtDNA showing discordance? (Q6); Allopatry, physical barriers to gene flow? (Q7); Tentative secondary contact zone? (Q8); Occupies ecoregion distinct from closest relative? (Q9); Exploits unique niche? (Q10).

Light cells indicate hypotheses supported whereas darker cells indicate hypotheses unsupported.

Putative Species	Morphological			Genetic			Biogeographical and Ecological					New Taxonomic Status	
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	matching morphology		
<i>B. ajax</i>	N	N	N	Y	N	N	N	N	N	N	synonym	<i>B. halius</i>	
<i>B. alacanti</i>	N	Y/N	N	N	N	Y	N	Y	N	N	hybrid	<i>B. manchego</i>	
<i>B. baeticus</i>	N	Y/N	N	N	N	Y	N	Y	N	N	hybrid	<i>B. ibericus</i>	
<i>B. balmenis</i>	N	N	N	N	N	N	Y	N	N	N	synonym	<i>B. occitanus</i>	
<i>B. castellano</i>	N	N	N	N	N	Y	N	Y	N	N	synonym	<i>B. halius</i>	
<i>B. delafluentei</i>	Y	Y	Y	Y	N	N	Y	N	Y	Y	species	-	
<i>B. elongatus</i>	Y	Y	Y	Y	Y	N	Y	N	Y	N	species	-	
<i>B. gabani</i>	N	N	N	Y	N	N	Y	N	Y	N	synonym	<i>B. halius</i>	
<i>B. garcialorcai</i>	N	Y	Y	Y	Y	N	Y	N	Y	N	species	-	
<i>B. gonzalezdelavegai</i>	N	N	N	N	N	N	N	N	N	N	synonym	<i>B. delafluentei</i>	
<i>B. halius</i>	Y	Y	Y	Y	Y	N	N	N	Y	N	species	-	
<i>B. iaspis</i>	Y	Y	N	Y	Y	N	Y	Y?	Y	Y	species	-	
<i>B. ibericus</i>	Y	Y	Y	Y	Y	N	Y	Y?	Y	N	species	-	
<i>B. lusitanus</i>	N	N	N	N	N	N	N	N	N	N	synonym	<i>B. halius</i>	
<i>B. manchego</i>	Y	Y	Y	Y	Y	N	N	N	Y	Y	species	-	
<i>B. montanus</i>	Y	Y	Y	Y	Y	N	Y	Y?	Y	N	species	-	
<i>B. aff. occitanus</i>	N	Y/N	N	Y	N	Y	N	Y	N	N	hybrid	<i>B. occitanus</i>	
<i>B. occitanus</i>	Y	Y	Y	Y	Y	N	N	N	Y	N	species	-	
<i>B. pedrosousai</i>	N	Y/N	N	N	N	Y	N	Y	N	N	hybrid	<i>B. manchego</i>	
<i>B. pyrenaicus</i>	N	N	N	N	N	N	N	N	Y	N	synonym	<i>B. occitanus</i>	
<i>B. serrano</i>	N	N	N	N	N	Y	N	Y	N	N	synonym	<i>B. manchego</i>	

(Herbst, 1800), part of the *tunetanus* complex, represented the Tell-Atlas clade. The phylogeny was rooted on *Buthus elizabethae* Lourenço, 2005, a West African species genetically divergent from the clades of northwestern Africa and Europe.

MAPPING: Historical records of sufficient accuracy from the literature (Lourenço and Vachon, 2004; Rossi, 2012; Sousa, 2017; Sousa et al., 2017; Teruel and Turiel 2020, 2021a, 2021b, 2022a, 2022b; Lourenço, 2021; Ythier, 2021a, 2021b; Ythier and Laborieux, 2022; González-Moliné and Armas, 2024) were digitized and georeferenced using Google Earth (<https://earth.google.com>), and combined with records from fieldwork and online repositories such as iNaturalist (<https://www.inaturalist.org>) to create a point locality database for mapping the distributions of European *Buthus* species using QGIS 3.4 (<http://www.qgis.org>). Data on climate, temperature and precipitation in the Iberian Peninsula were obtained from the Agencia Estatal de Meteorología (<https://www.aemet.es>).

MICROSCOPY, IMAGING, AND ILLUSTRATION: Morphological examination of specimens was conducted using a Nikon SMZ1500 stereoscope. Habitat and live habitus photographs were taken in the field using Google Pixel 7 Pro and Nikon D3400 cameras. High-resolution images of preserved specimens illustrating habitus and diagnostic characters were taken under visible and long-wave UV light using a Microptics™ ML-1000 digital photomicrography system at the AMNH Division of Invertebrate Zoology. Line drawings were prepared, digital images edited, and figures arranged using Adobe Photoshop CS6 and Adobe Illustrator 2020.

MORPHOMETRICS AND MULTIVARIATE STATISTICAL ANALYSIS: Forty-three measurements (mm), recorded with Mitutoyo® digital calipers, and two meristic characters (counts), following Stahnke (1970), Sissom et al. (1990), Cain et al. (2021a, 2021b), and Barahoei et al. (2022), were taken from 189 adults, representing all putative European species of *Buthus* and three African outgroup species (tables 6–14).

Twenty-five morphometric ratios were calculated (table 5; appendices 3, 4) for use in statistical and phylogenetic analyses. Key diagnostic morphometrics, i.e., total length: 100, chela manus height : length, metasomal segment I width : length and metasomal segment V width : length, were visualized using box-plots, by species and sex. Linear discriminant analyses (LDA) using the 24 morphometric ratios as predictors (table 5; appendix 5), along with total body length divided by 100 to avoid overweighting (Goloboff et al., 2006), were conducted for males and females with the MASS package (Venables and Ripley, 2002) in R 4.4.3 (R Core Team, 2024). All variables were log10-transformed, and assessed for multidimensional linearity, homoscedasticity, and collinearity (Blasco-Aróstegui et al., in prep.).

MORPHOLOGY: Morphological terminology follows Prendini et al. (2003) for carapace topography and surface ornamentation and Vachon (1952c) for nomenclature of carapacial carinae (fig. 6); Loria and Prendini (2014) for lateral ocelli; Vachon (1952c) and Prendini (2000) for carinae and surfaces of pedipalps and legs, replacing “external” and “internal” with “retrolateral” and “prolateral” respectively; a modified version of Prendini (2004) and Esposito et al. (2017) for metasomal carinae; Stockwell (1989) and Moreno-González et al. (2019) for hemispermaphores; Vachon (1952c) and Stahnke (1970) for most other characters. Due to the very obsolete “basal lobe/notch combination” of the pedipalp chela fingers of European *Buthus*, compared with many other buthid taxa, this character was redescribed in terms of the curvature and emargination of the pedipalp chela fingers, following Lamoral (1979) and Prendini (2001b, 2004). The dorsal setation patterns of metasomal segments I–V, first noted by Vachon (1952c), were found to be useful to distinguish pairs and/or groups of species. A new system of setal classification is presented, based on the number of macrosetae and their distribution across the segments (fig. 7): asetose; sparse, type I; intermediate, type II; and hirsute, type III. Patterns of

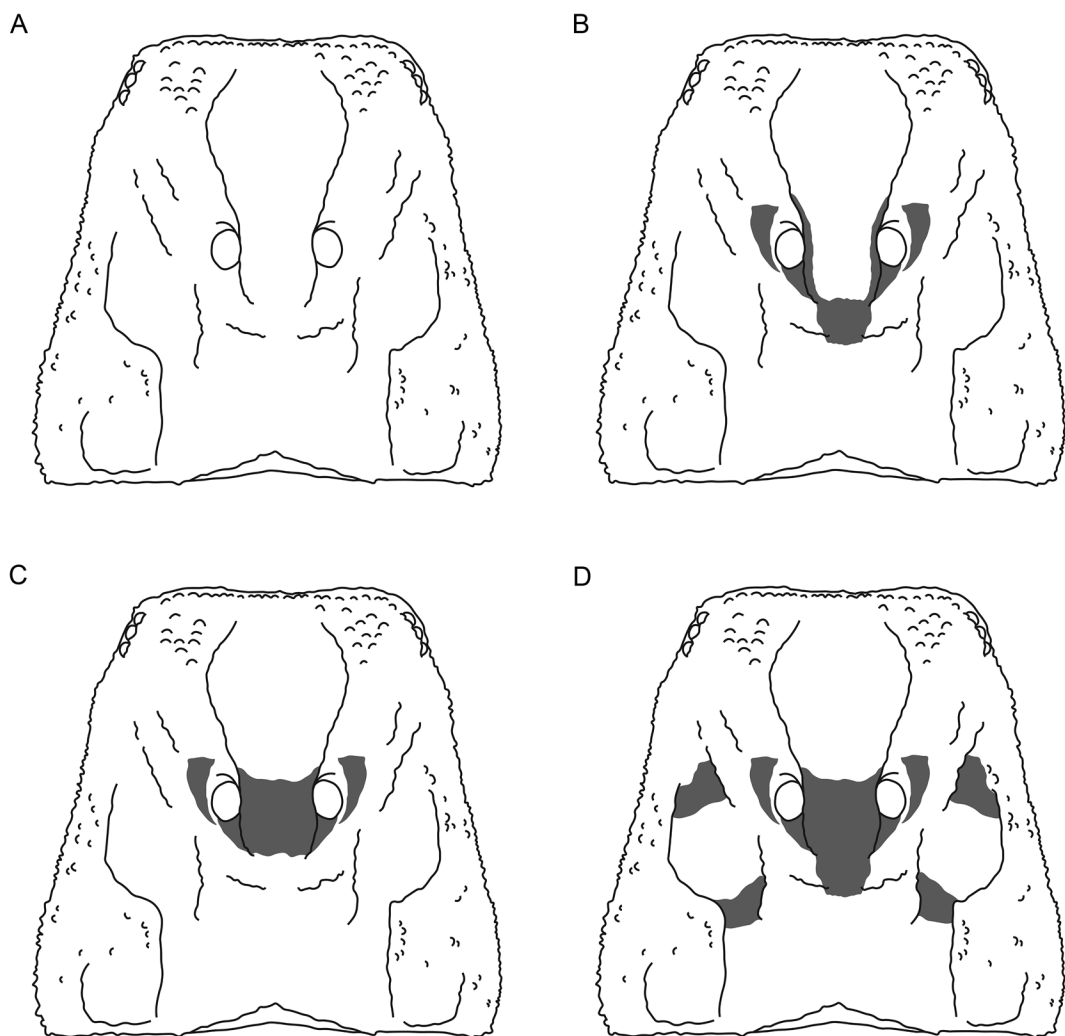


FIGURE 5. Carapace infuscation patterns in European species of *Buthus* Leach, 1815. **A.** Type I: *Buthus elizabethae* Lourenço, 2005. **B.** Type II: *Buthus delafrontei* Teruel and Turiel, 2020, and *Buthus tunetanus* (Herbst, 1800). **C.** Type III: *Buthus occitanus* (Amoreux, 1789). **D.** Type IV: *Buthus elongatus* Rossi, 2012, *Buthus garcialorcai* Teruel and Turiel, 2020, *Buthus halius* (C.L. Koch, 1839), *Buthus iaspis* Teruel and Turiel, 2022, *Buthus ibericus* Lourenço and Vachon, 2004, *Buthus manchego* Teruel and Turiel, 2020, and *Buthus montanus* Lourenço and Vachon, 2004. Scale bar = 2 mm.

carapacial infuscation were classified into four types, according to the extent and distribution of pigmentation (fig. 5).

Twenty-four qualitative characters and 12 quantitative characters, mostly pertaining to the adult stage (especially the adult male), were scored in a morphological matrix that captured variation among the European ingroup species and the three

African outgroup species of *Buthus* (table 4; appendix 3): shape and morphometrics, 9 (25%); coloration, 7 (19%); surface macrosculpture, topography and carination, 15 (42%); metasomal setation, 2 (6%); meristic counts, 3 (8%). Means of quantitative characters were converted to ranges (Goloboff et al., 2006; table 5) for use in phylogenetic analysis. Twenty-five (69%) characters were binary, whereas

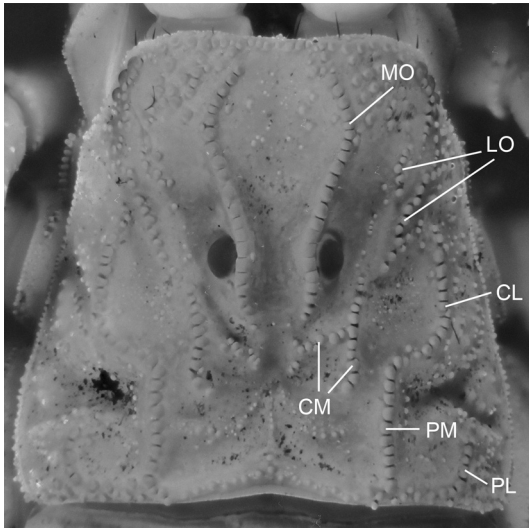


FIGURE 6. Carapace carinal nomenclature in *Buthus* Leach, 1815, based on Vachon (1952c). Abbreviations: **CL**, centrolateral carinae; **CM**, centromedian carinae; **LO**, lateral ocular carinae; **MO**, median ocular carinae; **PL**, posterolateral carinae; **PM**, posteromedian carinae.

11 (31%) characters were multistate and treated as unordered (i.e., nonadditive; Fitch, 1971) to avoid a priori hypotheses of character state transformation. The morphological matrix was constructed using Mesquite 3.81 (Maddison and Maddison, 2023). All characters in the analyses and diagnoses pertain to the adult stage.

DNA SEQUENCING: Three nuclear loci, the small subunit ribosomal RNA or 18S rRNA (18S), the Internal Transcribed Spacer (ITSII) and the D3 region of the large subunit ribosomal RNA or 28S rRNA (28S), and three mitochondrial loci, the small subunit ribosomal RNA or 12S rRNA (12S), the large subunit ribosomal RNA or 16S rRNA (16S), and the Cytochrome *c* Oxidase subunit I (COI), were amplified using standard primers (Loria et al., 2022) and Sanger dideoxy sequenced in an ABI 3730XL automated DNA sequencer (Perkin Elmer, Waltham, CA) at the AMNH Institute for Comparative Genomics. Sequences were edited and assembled using Sequencher 5.4.6 (Gene Codes Corporation, Ann Arbor, MI) and deposited in GenBank (appendix 2).

SEQUENCE ALIGNMENT AND GENETIC DISTANCES: The prealignment sequence length of the different loci was 1762 base pairs (bp) for 18S, 452–478 bp for ITSII, 513 bp for 28S, 344 bp for 12S, 400–487 bp for 16S, and 1078 bp for COI. Sequences of the three length-variable loci, ITSII, 12S and 16S, were aligned using the G-INS-i alignment strategy (Katoh and Toh, 2008) in MAFFT 7.520 (Katoh et al., 2002; Katoh and Standley, 2013). The aligned length of the concatenated sequences was 4575 bp. Intra- and interspecific uncorrected pairwise (*p*) distances of all valid species were calculated for the ITSII, 12S, 16S, and COI loci using MEGA 11 (Tamura et al., 2021).

PHYLOGENETIC ANALYSIS: Phylogenetic reconstruction was performed with ML using IQ-TREE 2.2.2.6 (Minh et al., 2020) and Bayesian Inference (BI) using MrBayes 3.2.7 (Ronquist and Huelsenbeck, 2003; Ronquist et al., 2012). Morphological and molecular data were analyzed separately and simultaneously, with the six molecular markers and 36 morphological characters divided into seven partitions (one per marker and one for morphology). Molecular substitution models were selected using ModelFinder (Kalyaanamoorthy et al., 2017) for ML. The reversible jump Markov chain Monte Carlo algorithm (Huelsenbeck et al., 2004) was applied for BI. An MK evolution model (Lewis, 2001) was applied to the morphological partition. One thousand replicates of ultrafast bootstrap approximation (UFBoot; Minh et al., 2013; Hoang et al., 2018) were conducted for the ML analysis. The BI analysis was terminated after 5 million generations, when the standard deviation of the split frequencies was below 0.01. Synapomorphies were optimized on the preferred phylogenetic hypothesis using delayed transformation (DELTRAN; Farris, 1970; Swofford and Maddison, 1987; Agnarsson and Miller, 2008) in WinClada 1.00.08 (Nixon, 2002).

INTEGRATIVE SPECIES DELIMITATION: Species were delimited using a workflow that integrated four sources of evidence (morphological, molecular, hybridization, and ecological data; table 3),

TABLE 4
DISTRIBUTION OF MORPHOLOGICAL CHARACTERS AND STATES USED IN
PHYLOGENETIC ANALYSIS OF EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815,
WITH THREE AFRICAN SPECIES AS OUTGROUPS
Characters states scored 0–3 or inapplicable (-).

Outgroup	<i>Buthus elizabethae</i>	00000	00000	00000	00000	00000	00000	000000
	<i>Buthus maroccanus</i>	00021	11000	02000	01000	11112	00011	000211
	<i>Buthus tunetanus</i>	00111	10121	10010	10002	01000	00002	011030
Ingroup	<i>Buthus delafulentei</i>	10021	11011	12111	10100	-002-	10002	001110
	<i>Buthus elongatus</i>	10021	00121	10010	10112	10021	00100	003110
	<i>Buthus garcialorcai</i>	00021	00121	10010	10000	00011	00000	003110
	<i>Buthus halius</i>	00020	11011	12100	01100	-1011	00002	003110
	<i>Buthus iaspis</i>	11021	10121	10010	10101	00021	00000	003110
	<i>Buthus ibericus</i>	00011	10011	11110	01003	11212	01110	003110
	<i>Buthus manchego</i>	00011	00121	10010	10101	00011	00002	003110
	<i>Buthus montanus</i>	11021	10121	10010	01101	01011	00010	003110
	<i>Buthus occitanus</i>	00101	00121	10010	10002	11011	00002	112000

following Puillandre et al. (2012), Andújar et al. (2014) and Duran et al. (2024). The primary criteria for species recognition were the presence of fixed diagnostic morphological characters, clustering in morphospace, monophyly in separate molecular and simultaneous analyses, and genetic distances (based on ITSII, 12S, 16S, and COI sequences) higher than 5% between populations. A putative species was deemed valid if it fulfilled three or more primary criteria. If only one or two primary criteria were satisfied, secondary criteria concerning ecology and distribution were considered, e.g., a distinct habitat and/or ecological niche or the presence of a barrier that may have facilitated divergence. If, following this assessment, no more than two criteria were satisfied, the putative species was deemed a synonym of its closest relative. Taxonomic decisions were complicated in four cases where secondary contact was suspected based on profound mitochondrial discordance (Toews and Brelsford, 2012; Després, 2019), evidence of reticulation, morphological variation suggesting that characters were acquired from different parental lineages, pairwise genetic distance less than or equal to 5%

from the closest relative, and/or an apparent absence of barriers in potential contact zones (Blasco-Aróstegui et al., in prep.). Such cases were considered hybrids or admixed populations rather than species.

RESULTS AND DISCUSSION

MULTIVARIATE STATISTICAL ANALYSIS: Linear Discriminant Analysis (LDA) of the morphometric data revealed eight distinct clusters in morphospace (fig. 10), refuting the hypotheses of multiple species in the *halius*, *ibericus*, *manchego*, and *occitanus* complexes proposed by previous authors (Teruel and Turiel, 2020, 2021a, 2021b, 2022a, 2022b; Ythier, 2021a, 2021b; Ythier and Laborieux, 2022; González-Moliné et al., 2023; González-Moliné and Armas, 2024; tables 1, 2). Some ratios exhibited higher weighting values and greater influence on the morphospace, implying greater utility as phylogenetic and/or diagnostic characters (figs. 8–10). Consistent with the sexual dimorphism evident among species of *Buthus*, greater morphological divergence was observed among the

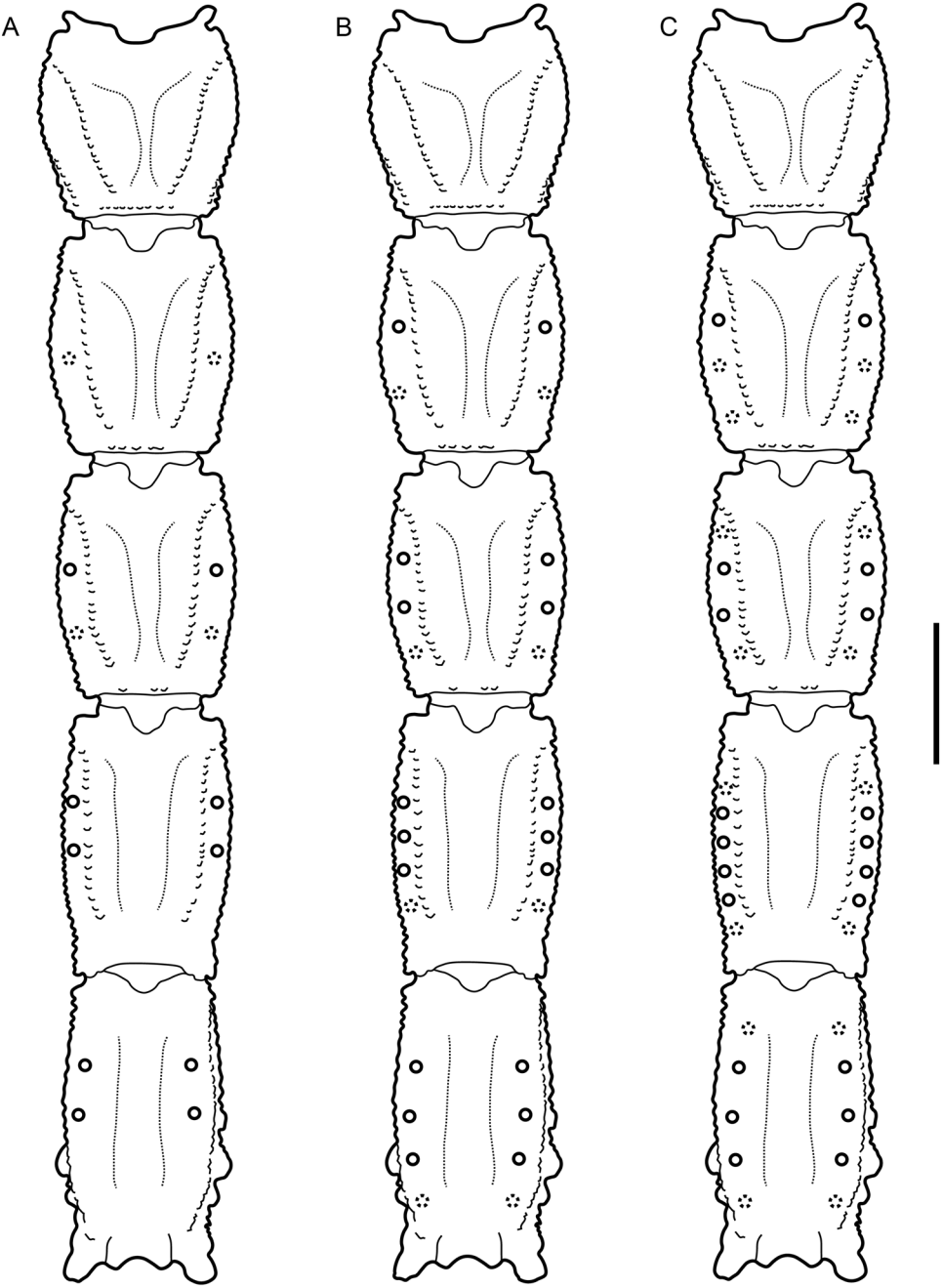


FIGURE 7. Metasomal segments I–V, dorsal setation patterns in European species of *Buthus* Leach, 1815. **A.** Type I, sparse: *Buthus elongatus* Rossi, 2012, and *Buthus occitanus* (Amoreux, 1789). **B.** Type II, intermediate: *Buthus garcialorcai* Teruel and Turiel, 2020, and *Buthus halius* (C.L. Koch, 1839). **C.** Type III, hirsute: *Buthus iaspis* Teruel and Turiel, 2022, *Buthus manchego* Teruel and Turiel, 2020, and *Buthus montanus* Lourenço and Vachon, 2004. Circles indicate fixed (solid lines) or variable (dashed lines) presence of macrosetae. Scale bar = 5 mm.

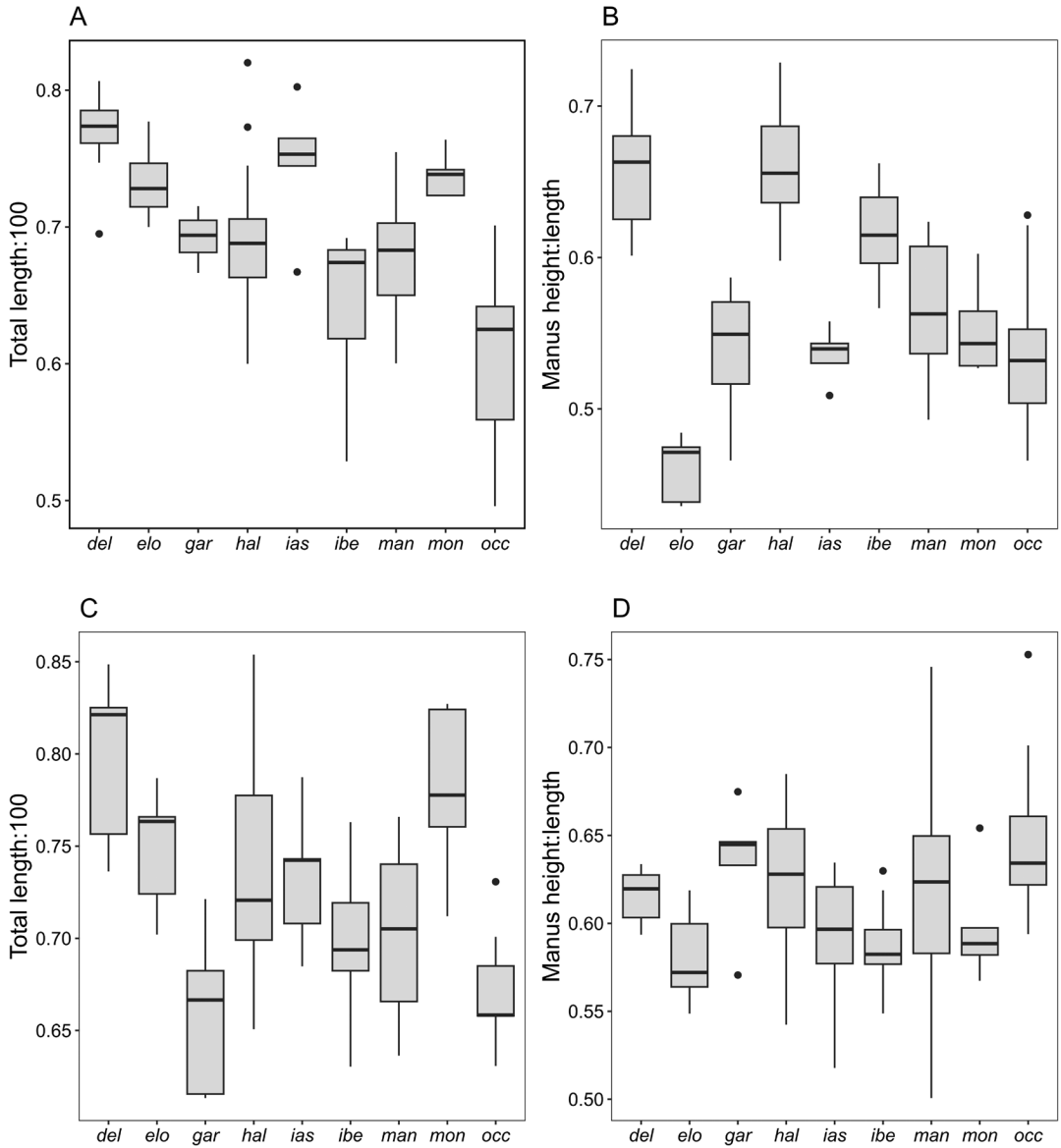


FIGURE 8. Boxplots illustrating diagnostic morphometric characters in males (A, B) and females (C, D) of European species of *Buthus* Leach, 1815. **A, C.** Total length. **B, D.** Pedipalp chela manus height : length. Abbreviations: *del*, *Buthus delafuentei* Teruel and Turiel, 2020; *elo*, *Buthus elongatus* Rossi, 2012; *gar*, *Buthus garcialorcai* Teruel and Turiel, 2020; *hal*, *Buthus halius* (C.L. Koch, 1839); *ias*, *Buthus iaspis* Teruel and Turiel, 2022; *ibe*, *Buthus ibericus* Lourenço and Vachon, 2004; *man*, *Buthus manchego* Teruel and Turiel, 2020; *mon*, *Buthus montanus* Lourenço and Vachon, 2004; and *occ*, *Buthus occitanus* (Amoreux, 1789).

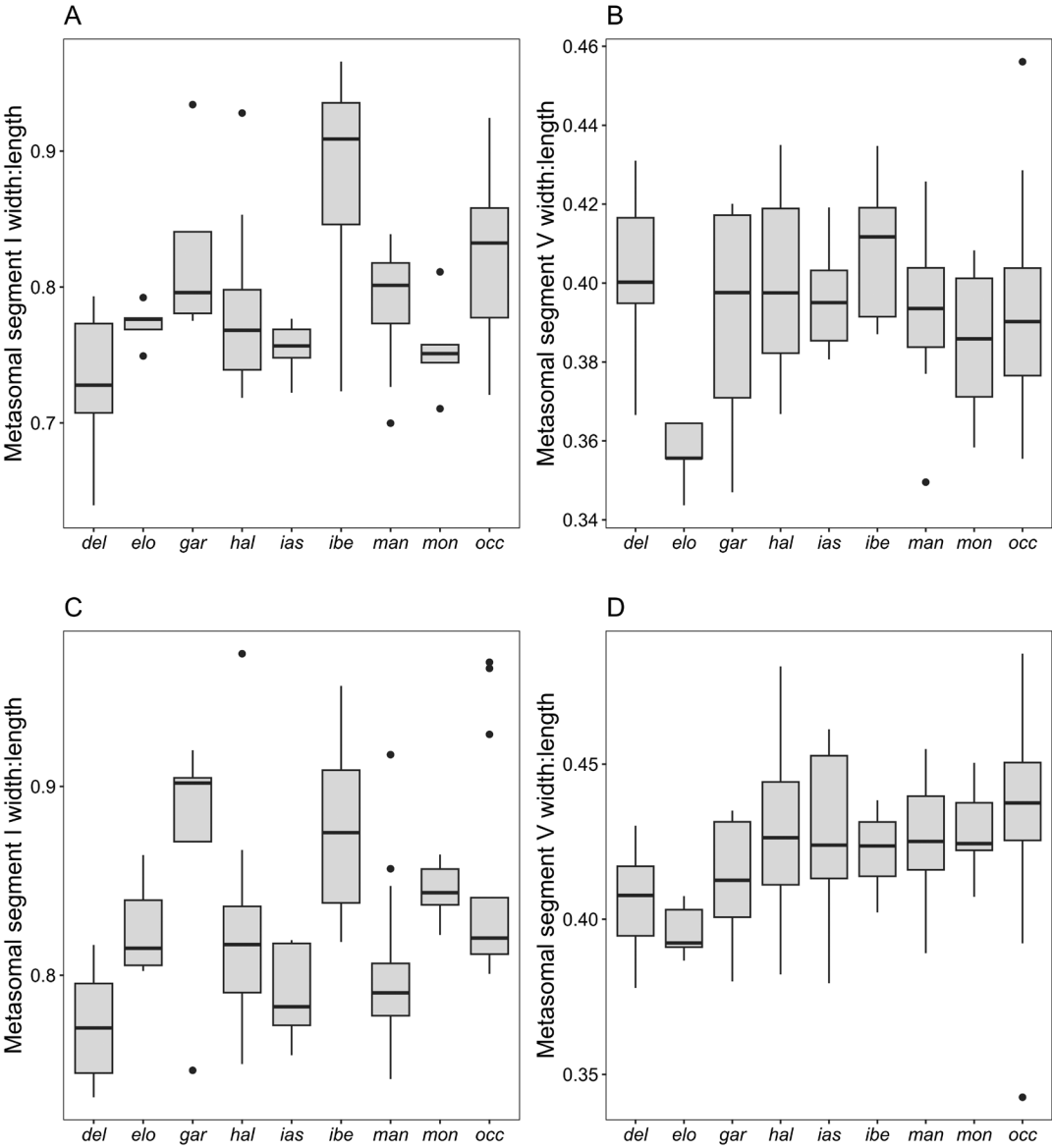


FIGURE 9. Boxplots illustrating diagnostic morphometric characters in males (A, B) and females (C, D) of European species of *Buthus* Leach, 1815. A, C. Metasomal segment I width : length. B, D. Metasomal segment V width : length. Abbreviations: del, *Buthus delafulentei* Teruel and Turiel, 2020; elo, *Buthus elongatus* Rossi, 2012; gar, *Buthus garcialorcai* Teruel and Turiel, 2020; hal, *Buthus halius* (C.L. Koch, 1839); ias, *Buthus iaspis* Teruel and Turiel, 2022; ibe, *Buthus ibericus* Lourenço and Vachon, 2004; man, *Buthus manchego* Teruel and Turiel, 2020; mon, *Buthus montanus* Lourenço and Vachon, 2004; and occ, *Buthus occitanus* (Amoreux, 1789).

TABLE 5
MEAN RATIOS AND COUNTS OF ADULT MALES AND FEMALES OF EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815

Species	n	Sex	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<i>B. delaquentei</i>	10	♂	0.77	0.05	0.73	1.06	0.28	0.38	0.6	0.66	0.74	0.41	0.64	0.36	0.73	0.63	0.58	0.49	0.4	0.9	0.96	0.88	0.91	0.86	0.71	0.38	0.12
	7	♀	0.81	0.05	0.69	1.02	0.28	0.38	0.54	0.61	0.75	0.43	0.6	0.39	0.77	0.64	0.6	0.5	0.41	0.89	0.96	0.86	0.86	0.92	0.73	0.4	0.12
<i>B. elongatus</i>	5	♂	0.73	0.03	0.72	1.03	0.27	0.32	0.44	0.46	0.61	0.35	0.62	0.35	0.77	0.64	0.59	0.45	0.36	0.9	0.98	0.85	0.89	0.89	0.64	0.36	0.11
	5	♀	0.75	0.05	0.71	0.98	0.27	0.37	0.53	0.58	0.69	0.39	0.54	0.39	0.83	0.7	0.65	0.51	0.4	0.91	0.97	0.83	0.84	0.95	0.72	0.37	0.11
<i>B. garcialorcai</i>	3	♂	0.69	0.04	0.65	0.94	0.28	0.37	0.48	0.54	0.69	0.35	0.6	0.35	0.83	0.67	0.65	0.51	0.39	0.89	0.99	0.84	0.9	0.88	0.7	0.35	0.12
	5	♀	0.66	0.05	0.66	0.95	0.27	0.35	0.57	0.63	0.65	0.36	0.52	0.38	0.87	0.71	0.69	0.59	0.41	0.86	0.97	0.9	0.78	0.94	0.72	0.36	0.13
<i>B. halius</i>	18	♂	0.68	0.05	0.69	1.01	0.29	0.39	0.6	0.66	0.74	0.4	0.61	0.38	0.77	0.67	0.63	0.5	0.4	0.91	0.98	0.84	0.88	0.88	0.67	0.35	0.12
	25	♀	0.74	0.05	0.66	0.94	0.3	0.39	0.57	0.63	0.72	0.43	0.59	0.42	0.81	0.71	0.66	0.53	0.42	0.92	0.97	0.84	0.84	0.91	0.73	0.37	0.11
<i>B. iaspis</i>	5	♂	0.75	0.04	0.74	1.00	0.28	0.36	0.47	0.54	0.71	0.37	0.6	0.34	0.75	0.64	0.61	0.49	0.4	0.9	0.99	0.88	0.94	0.9	0.68	0.38	0.12
	5	♀	0.73	0.05	0.71	0.96	0.29	0.39	0.54	0.59	0.76	0.36	0.56	0.39	0.79	0.7	0.65	0.53	0.43	0.93	0.99	0.85	0.85	0.92	0.71	0.39	0.11
<i>B. ibericus</i>	7	♂	0.62	0.05	0.72	1.00	0.3	0.39	0.57	0.62	0.7	0.37	0.56	0.4	0.93	0.77	0.72	0.56	0.42	0.91	0.95	0.84	0.82	0.92	0.63	0.31	0.12
	10	♀	0.7	0.04	0.67	0.98	0.32	0.4	0.5	0.57	0.68	0.44	0.54	0.45	0.91	0.79	0.71	0.56	0.42	0.91	0.95	0.82	0.83	0.96	0.68	0.33	0.1
<i>B. manchego</i>	21	♂	0.68	0.04	0.7	1.02	0.28	0.37	0.48	0.55	0.66	0.36	0.61	0.35	0.78	0.65	0.61	0.48	0.4	0.88	0.97	0.84	0.92	0.89	0.68	0.35	0.12
	24	♀	0.71	0.05	0.68	0.98	0.28	0.38	0.54	0.61	0.7	0.38	0.57	0.39	0.8	0.68	0.64	0.52	0.42	0.89	0.97	0.84	0.87	0.94	0.71	0.36	0.12
<i>B. montanus</i>	5	♂	0.74	0.04	0.73	1.00	0.28	0.37	0.49	0.55	0.78	0.41	0.62	0.37	0.75	0.66	0.63	0.48	0.38	0.93	0.98	0.83	0.89	0.92	0.67	0.34	0.12
	5	♀	0.78	0.05	0.67	0.93	0.29	0.39	0.54	0.6	0.77	0.4	0.55	0.42	0.84	0.72	0.68	0.54	0.43	0.91	0.98	0.82	0.84	0.93	0.73	0.36	0.12
<i>B. occitanus</i>	15	♂	0.61	0.03	0.69	1.00	0.27	0.35	0.46	0.54	0.61	0.36	0.58	0.39	0.82	0.69	0.64	0.51	0.39	0.89	0.96	0.87	0.84	0.83	0.67	0.37	0.13
	13	♀	0.68	0.05	0.67	0.95	0.29	0.36	0.57	0.65	0.66	0.38	0.54	0.44	0.84	0.72	0.66	0.57	0.43	0.89	0.95	0.88	0.81	0.92	0.7	0.38	0.11

adult males than the adult females. Several distinct clusters were evident in the male plot (fig. 10A) compared to the female plot, in which there was more overlap (fig. 10B). Five main clusters observed in the male plot correspond to *B. delafulentei* + *B. halius*, *B. elongatus*, *B. ibericus*, and *B. occitanus* (fig. 10A). A sixth cluster comprised the remaining species—*B. garcialorcai*, *B. iaspis*, *B. manchego*, and *B. montanus*—distributed from central-eastern to southeastern Spain (fig. 10A).

GENETIC DISTANCES: As observed in other scorpion taxa (Cain et al., 2021a, 2021b; Barahoei et al., 2022; Amiri et al., 2024), intra- and interspecific distances among European species of *Buthus* were much lower for the nuclear markers than the mitochondrial markers (table 15). Mean intraspecific pairwise distances ranged from 0.0%–0.6% for ITSII, 0.03%–2.7% for 12S, 0.05%–2.8% for 16S, and 0.08%–3.7% for COI (table 15). The highest intraspecific genetic divergences were observed in *B. delafulentei* for ITSII (0.6%) and *B. halius* for the mitochondrial markers (3.7%; table 15), whereas the lowest were observed in *B. occitanus* for ITSII (0.0%) and *B. ibericus* for the mitochondrial markers (0.03%; table 15). Mean interspecific pairwise distances ranged from 0.6%–5.5% for ITSII, 3.4%–12.7% for 12S, 3.4%–11.3% for 16S, and 4.8%–10.6% for COI (table 15). The highest interspecific genetic divergences were observed between *B. elongatus* and *B. garcialorcai* for ITSII (5.7%) and between *B. iaspis* and *B. ibericus* for the mitochondrial markers (12.7%; table 15), whereas the lowest were observed between *B. iaspis* and *B. montanus* for ITSII (0.4%), and between *B. delafulentei* and *B. halius* for the mitochondrial markers (3.4%; table 15).

PHYLOGENETIC ANALYSIS: Phylogenetic analyses of the six gene loci separately and simultaneously with the morphological matrix of 24 qualitative and 12 quantitative characters (table 4; appendix 4) yielded congruent topologies with moderate to high support values (70%–100% bootstrap support on internal nodes; fig. 11). Trees obtained from separate analyses of the

molecular data were almost identical to those based on simultaneous analysis of the molecular and morphological data, aside from minor positional shifts among closely related terminals (Blasco-Aróstegui et al., in prep.).

Nine subclades were identified (fig. 11), supporting the results of the LDAs and genetic distances (table 15). Unlike recent studies based solely on mitochondrial DNA (Sousa et al., 2010, 2012; Klessner et al., 2021), the results confirmed the monophyly of the European *Buthus*, first recovered by Gantenbein and Largiadèr (2003). The North African species, *B. tunetanus*, was placed sister to the European species of *Buthus*, with *B. maroccanus* forming a sister group to the clade comprising *B. tunetanus* and the European species. *Buthus maroccanus* and *B. tunetanus* represent the two major North African clades identified in previous studies, the Atlas clade and the Tell-Atlas clade, respectively (Gantenbein and Largiadèr, 2003; Gantenbein, 2004; Sousa et al., 2010; Habel et al., 2012; Sousa et al., 2012; Pedroso et al., 2013; Sousa, 2017; Klessner et al., 2021).

Buthus garcialorcai was placed sister to all other European species, which in turn formed two major clades. One of these clades comprised a subclade of three species in which the pedipalp chela manus of the male is globose (*B. delafulentei*, *B. halius* and *B. ibericus*; fig. 15A–C) placed sister to *B. elongatus*, in which the chela manus of the male is slender (fig. 15D). The other clade comprised the remaining species in which the chela manus of the male is slender (*B. iaspis*, *B. manchego*, *B. montanus*, *B. occitanus*; figs. 15E–I).

INTEGRATIVE SPECIES DELIMITATION: The inclusion of morphological characters confirmed the greater explanatory power of the total-evidence approach (Nixon and Carpenter, 1996; Prendini et al., 2003; Cain et al., 2021b; Moreno-González et al., 2021) by raising the bootstrap support values and enhancing the understanding of species relationships within subclades (fig. 11). For example, the combined dataset further supported the distinction between *B. delafulentei* and *B. halius* (fig. 11). A unique synapomorphy—the

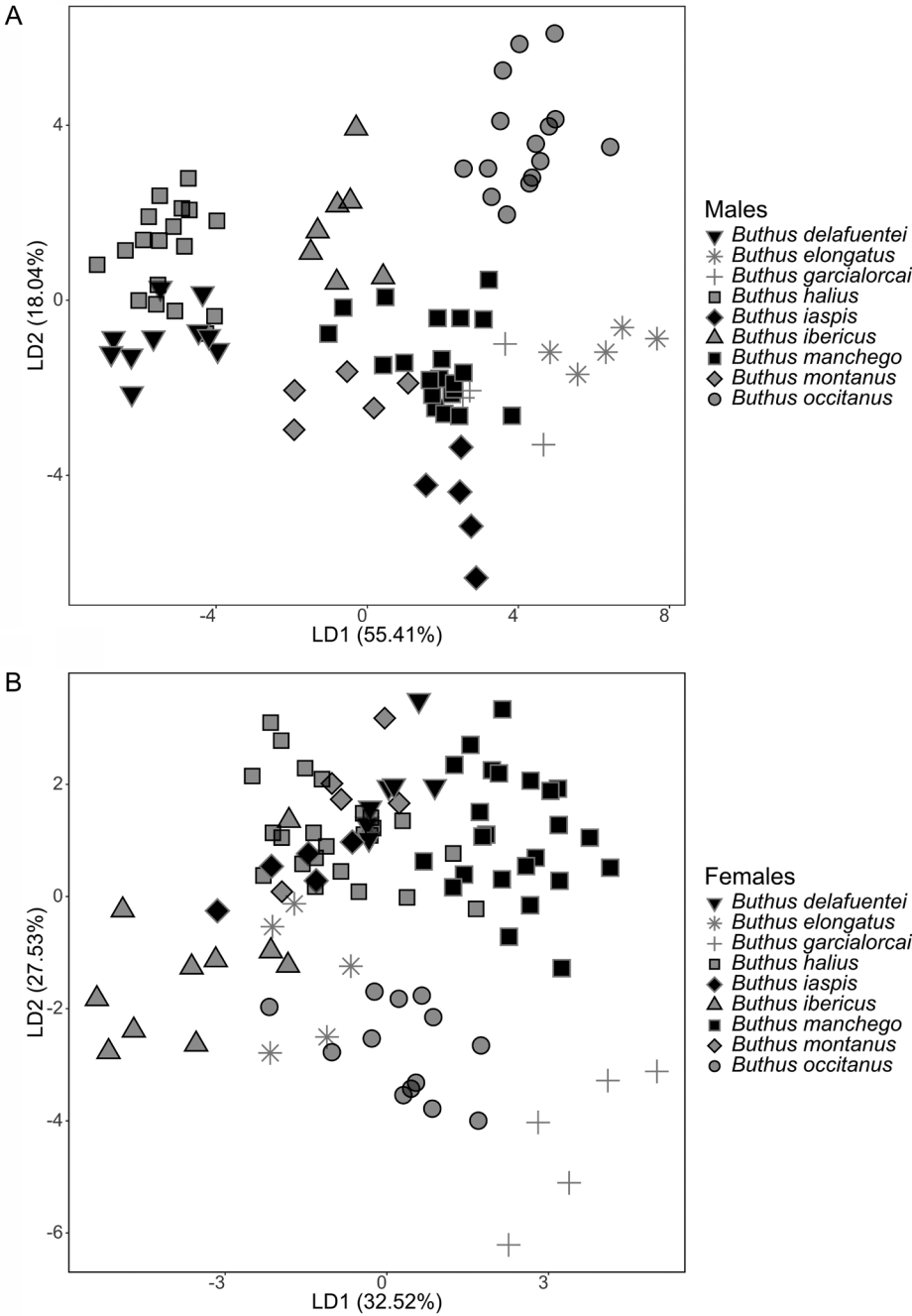


FIGURE 10. Linear discriminant analysis plots for adult males (A) and females (B) of European species of *Buthus* Leach, 1815, based on 25 morphometric ratios for 189 adult specimens (each symbol represents an individual).

densely setose dorsal surface of metasomal segments II–V—was identified in *B. iaspis*, *B. manchego*, and *B. montanus*, but not in *B. occitanus*, which appears to have lost this state secondarily (figs. 7, 11, 19C, 20C, 21, 22). Based on the available evidence and integrative species delimitation criteria, a revised classification of the European species of *Buthus* is presented below (tables 1–3).

SYSTEMATICS

Family Buthidae C.L. Koch, 1837

Subfamily Buthinae C.L. Koch, 1837

Buthus Leach, 1815

Figures 1–45 tables 1–16

Buthus Leach, 1815: 391; type species by original designation *Scorpio occitanus* Amoreux, 1789 [= *Buthus occitanus* (Amoreux, 1789)]; Latreille, 1817: 310; Risso, 1826: 156, 157; Hemprich and Ehrenberg, 1828: 142, 143, 150, 153, pl. I (1–3); Peters, 1861: 513 (part); Simon, 1872: 251, 252; Thorell, 1876a: 7; 1876b: 82 (part); Karsch, 1881a: 8; 1881b: 89; Simon, 1878: 100, 159, 160; Karsch, 1879: 18; Simon, 1879: 96–98, 100; Pavesi, 1880: 312, 313; Simon, 1880: 29; Pavesi, 1884: 450; 1885: 197, 199; Simon, 1885: 51; Karsch, 1886: 77 (part); Pocock, 1889a: 334–337, 340, 341, 343, 344, 346, 348, 351, 394, Pl. XV; 1889b: 116; Kraepelin, 1899: 9 (part), 26–27; Pocock, 1899: 834; 1890: 122 (part); Karsch, 1891: 18; Kraepelin, 1891: 35–42 (part), 54–57 (part), pl. I, fig. 5, pl. II, fig. 18; Pocock, 1893: 312 (part); Thorell, 1893: 358, 359; Kraepelin, 1895: 79, 80; Pocock, 1895: 299; Birula, 1896: 241–244; Laurie, 1896: 131; Lönnberg, 1897: 194 (part); Birula, 1900: 9; Pocock, 1900a: 13 (part); 1900b: 56, 57; Kraepelin, 1901: 266; Werner, 1902: 598; Birula, 1903: 106–108; Kraepelin, 1903: 558–559; Borelli, 1904: 2, 3; Chaignon, 1904: 83, 84; Dalla Torre, 1905:

3; Birula, 1908: 123, 124; 1909: 507–511, figs. A–C; Tullgren, 1909: 2, 3; Birula, 1910: 118–120, 143, 145, 146, 155–157; Simon, 1910: 68–70, figs. 5, 8; Masi, 1912: 101; Birula, 1914: 464–644; Borelli, 1914: 154–156; 1915: 460, 461; Birula, 1917a: 20–24, 38, 39, 164 (part), 199, 213, 223, 228; 1917b: 55 (part); Lampe, 1917: 191; Franganillo, 1918: 122, 123; Borelli, 1919: 363; 1924: 4–7; Pavlovsky, 1924: 77; Borelli, 1925: 9–12; Hirst, 1925: 415, 416; King, 1925: 81; Pavlovsky, 1925: 140; Werner, 1925: 209; Gadeau de Kerville, 1926: 71; Borelli, 1927: 351; Gough and Hirst, 1927: 5, fig. 9; Baccalar, 1928: 191; Giltay, 1929: 196, 197; Hadži, 1929: 31; Pallary, 1929: 140; Werner, 1929: 30–32; Borelli, 1931: 218; Caporiacco, 1932: 395, 196; Schenkel, 1932: 379, 380; Werner, 1932: 299, 300–305, fig. 141; Hugues, 1933: 487–488; Borelli, 1934: 169; Pallary, 1934: 98, 99; Táborský, 1934: 40; Werner, 1934a: 269, fig. 330; 1934b: 84–87, figs. 4, 5; Caporiacco, 1936: 137; Werner, 1936: 173; Bodenheimer, 1937: 235; Caporiacco, 1937: 345; Pallary, 1938: 281, 282; Schenkel, 1938: 4; Sergeant, 1938: 519, 520, pl. 49; Monard, 1939: 82, 83; Feytaud, 1940: 38–39; Vachon, 1940: 242–247, 254–258, figs. 1–9, 29, 33. 61–64; Kästner, 1941: 230, 231; Moriggi, 1941: 84, 85; Sergeant, 1941: 355, figs. IE, 2.7, pl. 35, fig. 7; Vachon, 1941: 52; Roewer, 1943: 206; Frade, 1947: 268; Denis, 1948: 155–156; Vachon, 1948a: 61, fig. 5; 1948b: 206–208; Schenkel, 1949: 186, 187; Vachon, 1949a: 155–169, figs. 331–363, 372–380; 1949b: 281–288, figs. 364–371; 1949c: 336, 344–393, figs. 381–455; Bacelar, 1950: 4; Vachon, 1950, fig. 591; Foley, 1951: 33; Vachon, 1951: figs. 641, 657, 663, 670, 679, 687, 696; 1952a: 621, 623; 1952b: 274–279; 1952c: 241–246, 248, 252, 254–316, figs. 331–455, 554, 579, 591, 641, 657, 663, 670, 679, 687, 696; 1953: 1021–1024, fig. 12; Malhomme, 1954: 25, 28–30; Belfield, 1956: 44;

- Shulov and Amitai, 1959: 219–225, figs. 1–3; Arroyo, 1961: 186–189; Vachon, 1961: 31–32; Vachon, 1963: 164, fig. 10; Bücherl, 1964: 57; Vachon, 1966: 211; Le Corroller, 1967: 63; Gysin, 1970: 65–72, figs. 1–5; Stahnke, 1972b: 132; Probst, 1973: 329; Pérez, 1974: 22, 23; Kinzelbach, 1975: 14, fig. 1; Lamoral and Reynders, 1975: 505, 506; Goulliart, 1979: 2; Levy and Amitai, 1980: 14–21, figs. 25–29, map 1; Kinzelbach, 1982: 53; Prost, 1982: 5; Kinzelbach, 1984: 100; Francke, 1985: 6, 15; Kinzelbach, 1985: map II; Vachon and Kinzelbach, 1987: 101; Amr et al., 1988: 374; El-Hennawy, 1988: 17; Michalis and Dolkeras, 1989: 265, 266; Sis-som, 1990: 92, 101, fig. 3.17C, L; El-Hennawy, 1992: 98, 101, 119–122; Kovařík, 1992a: 183; 1992b: 90; Nenilin and Fet, 1992: 17; Reichholf and Steinbach, 1992: 33, figs. 4, 5; Crucitti, 1993: 51; Amr and El-Oran, 1994: 188; Crucitti et al., 1994: 57–66; Vincent, 1994: 6; Crucitti and Chine, 1995: 15–26; Kovařík, 1995: 20; Braunwalder, 1997: 3; Crucitti and Chine, 1997: 195–200; Kovařík, 1997: 179; Braunwalder and Fet, 1998: 33; Cloudsley-Thompson and Lourenço, 1998: 1, 2; Gantenbein et al., 1998a: 51; 1998b: 33–39; Kovařík, 1998: 106; Fet and Lowe, 2000: 6, 55, 91–97, 662, 667, 670, 675, 678, 680, 681 (in part); Lourenço, 2002: 109–127, figs. 1–14, tables I, II; Fet et al., 2003: 2–6, fig. 1 table 1; Gantenbein and Largiadèr, 2003: 119, 123, fig. 1A, table 1; Lourenço, 2003: 875, 880, 881, 883, 884–911, figs. 18–88; Soleglad and Fet, 2003: 7, 89, tables 1, 2, 9; Gantenbein, 2004: 519–523, 525, 527, figs. 1, 2, tables 1–3; Lourenço and Slimani, 2004: 165–169, figs. 1–8, table I; Lourenço and Vachon, 2004: 81–93, figs. 1–43, table I; Fet and Soleglad, 2005: 11, table 2; Lourenço, 2005a: 229–235, figs. 1–13, table 1; 2005b: 245–250, figs. 1–8, table 1; 2005c: 21–23, 25, figs. 1–12, 34, table I; Lourenço and Geniez, 2005: 1–6, figs. 1–10, table 1; Prendini and Wheeler, 2005: 462, 481, table 10; Teruel and Pérez-Bote, 2005: 273–276, figs. 1–3, tables I–III; Kovařík, 2006: 1–15, figs. 1–20, table 1; Lourenço and Qi, 2006: 287–291, figs. 1–12; Lourenço, 2008: 45–50, figs. 1–8; Armas and González-Moliné, 2009: 553–555, fig. 1, tables I, II; Lourenço et al., 2009: 71–74, figs. 1–20, table I; 2010: 95–98, figs. 1–6; Sousa et al., 2010: 206–210, figs. 1, 2, tables 1, 2; Kovařík, 2011: 1–6, figs. 1–23; Touloun and Boumezzough, 2011: 183–186, figs. 1–8, table I; Yağmur et al. 2011: 27–36, figs. 1–14, table I; Habel et al., 2012: 1–7, figs. 1, 2, tables 1, 2; Husemann et al., 2012: 221–227, figs. 1–4, tables 1, 2; Lourenço and Cloudsley-Thompson, 2012: 11–16, figs. 1–9, table 1; Lourenço and Leguin, 2012: 1–8, figs. 1–17, table 1; Lourenço and Simon, 2012: 8, figs. 1–13, table 1; Lourenço et al., 2012a: 307, 309, 319–321, 334, 336, 337, figs. 35–42, 89, 90; 2012b: 21–24, figs. 1–12, table I; Rossi, 2012: 273–279, figs. 1–7, tables 1, 2; Sousa et al., 2012: 66–73, figs. 1–4, tables 1–3; Lourenço, 2013: 63–67, figs. 1–10; Lourenço and Rossi, 2013: 9–13, figs. 1–10, table I; Pedroso et al., 2013: 298–307, figs. 1–3, tables 1–4; Rossi, 2013: 187–193, figs. 1–3; Rossi et al., 2013: 1–8, figs. 1–11, table 1; Lourenço, 2015: 19, 20, 22, 23, figs. 1–3, 13–22; Teruel and Melic, 2015: 5–12, figs. 1a, 2a, 3a, 4b, 5b, 6b, 7b, 9a, b, 10a, b, lam. 1, table II; Lourenço, 2016: 71–77, figs. 1–12, table I; Lourenço and Sadine, 2016: 13–16, figs. 1–13; Rossi and Tropea, 2016a: 3–9, figs. 1–14, table 1; 2016b: 24–29, figs. 1–12, table 1; Sadine et al., 2016: 44–49, figs. 1–8; Lourenço, 2017: 59–62, figs. 1–13; Rossi, 2017: 9–13, figs. 1–5; Sousa et al., 2017: 15–64, figs. 1–16, tables 1, 2; Lourenço et al., 2018: 15–19, figs. 1–17; Abidi et al., 2020: 176–181, figs. 1–4, tables 1, 2; Kovařík et al., 2020: 1–31, figs. 1–211, tables 1–3; Lourenço et al., 2020: 103–107, figs.

TABLE 6
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS DELAFUENTEI* TERUEL AND TURIEL, 2020
Material deposited in the American Museum of Natural History (AMNH), New York,
and the Museo Nacional de Ciencias Naturales de Madrid (MNCN), Madrid, Spain.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
	Collection	AMNH	AMNH	AMNH	AMNH	MNCN	AMNH	AMNH	AMNH	MNCN	MNCN
	Number	103					106				
Total L		76.86	74.7	75.89	79.61	78.63	74.48	73.63	76.84	84.85	82.21
Carapace	L	7.69	7.63	7.89	7.93	7.83	8.12	8.02	8.44	9.41	8.97
	anterior W	5.37	5.45	5.23	5.22	5.31	5.93	5.57	5.93	5.85	6.05
	posterior W	7.15	6.82	7.53	7.1	7.57	7.87	7.78	8.16	9.46	9.01
Mesosoma	total L	18.6	17.41	18.1	18.4	19.89	19.17	19.15	18.45	21.09	20.8
Tergite VI	L	3.35	3.29	3.21	3.27	3.26	3.01	3.74	3.78	4.48	3.61
	W	8.58	8.22	8.99	8.88	9.04	8.42	8.34	8.99	11.55	9.97
Tergite VII	L	5.13	4.99	5.15	5.78	5.86	4.89	5.29	5.87	7.03	5.95
	W	7.35	7.39	7.99	7.52	8.28	7.67	7.95	8.57	9.43	8.84
Sternite VII	L	4.52	4.29	4.71	5.3	5.5	4.23	4.71	5.06	5.93	5.1
	W	7.07	7.02	7.53	7.58	8.06	7.47	7.42	8.48	9.26	8.78
Metasoma	total L	50.57	49.66	49.9	53.28	50.91	47.19	46.46	49.95	54.35	52.44
Metasoma I	L	7.08	7.18	7.24	7.6	7.12	6.3	6.23	6.84	7.45	7.32
	W	5.05	5.33	5.11	4.86	5.4	4.95	4.81	5.03	5.48	5.57
	H	4.56	4.49	4.63	4.94	4.73	4.28	4.37	4.48	4.87	4.65
Metasoma II	L	7.77	7.63	7.87	8.55	8.15	7.12	6.83	7.67	8.14	7.97
	W	4.94	5.15	5.01	4.57	5.14	4.78	4.69	4.88	5.14	5.07
	H	4.5	4.37	4.37	4.3	4.65	4.3	4.34	4.44	4.81	4.7
Metasoma III	L	8.07	7.86	8.11	8.61	8.36	7.26	7	7.97	8.58	8.33
	W	4.8	4.83	4.89	4.64	5.01	4.48	4.59	4.8	5.05	5.03
	H	4.47	4.35	4.36	4.27	4.57	4.24	4.36	4.34	4.66	4.66
Metasoma IV	L	9.29	9.53	9.25	9.8	9.7	8.79	8.55	8.81	10.09	9.68
	W	4.61	4.45	4.62	4.28	4.9	4.47	4.5	4.6	4.79	4.88
	H	3.98	3.94	3.9	3.8	4.12	3.93	3.85	3.92	4.18	4.2
Metasoma V	L	10.66	10.13	10.04	10.72	10.62	10.12	10.02	10.56	11.77	11.01
	W	4.39	4.02	4.23	3.93	4.44	4.13	4.31	4.29	4.51	4.69
	H	3.24	3.38	3.31	3.22	3.46	3.49	3.22	3.36	3.66	3.66
Telson	L	7.7	7.33	7.39	8	6.96	7.6	7.83	8.1	8.32	8.13
	vesicle L	4.78	4.73	4.64	4.89	4.18	4.76	4.71	4.96	4.95	4.86
	vesicle W	3.76	3.58	3.61	3.42	3.6	3.85	3.6	4.08	4.23	4.04
	vesicle H	3.37	3.28	3.35	3.12	3.3	3.52	3.35	3.4	3.69	3.57
	aculeus L	2.92	2.6	2.75	3.11	2.78	2.84	3.12	3.14	3.37	3.27
Pedipalp	total L	29.37	28.21	29.13	30.02	29.51	29.87	28.63	30.18	33.7	33.66
Femur	L	6.52	6.64	6.74	7.07	6.84	6.56	5.98	6.62	7.65	7.63
	W	1.94	1.89	1.92	1.86	1.9	1.94	1.87	1.99	2.05	2.07
Patella	L	7.5	7.22	7.48	7.55	7.87	7.92	7.54	7.62	8.06	8.42
	W	2.95	2.94	2.77	2.74	2.99	2.94	2.9	3.01	3.06	3.23
Chela	total L	15.35	14.35	14.91	15.4	14.8	15.39	15.11	15.94	17.99	17.61
	manus L	6.6	6.3	6.13	6.6	6.69	6.24	6.33	6.85	7.8	7.62
	manus W	3.85	3.9	3.91	3.73	3.99	3.53	3.62	3.61	3.78	4.23
	manus H	4.31	4.24	4.44	4.12	4.56	3.95	3.85	4.26	4.63	4.56
	mov. finger L	8.75	8.05	8.78	8.8	8.11	9.15	8.78	9.09	10.19	9.99
Pectines	L	8.7	8.68	9.1	9.22	8.93	8.79	8.55	8.62	10.04	9.41
Mov. finger	subrows	13/13	12/13	13/13	13/13	12/12	12/12	12/12	13/13	12/12	12/12
Pectines	tooth count	32/30	34/34	29/30	31/33	33/33	27/26	27/28	27/28	28/29	29/29

TABLE 7
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS ELONGATUS* ROSSI, 2012
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		77.71	70	74.65	72.81	71.47	78.69	76.34	76.59	72.41	70.21
Carapace	L	7.59	7	7.49	7.16	7.09	8.66	8.2	8.35	7.89	7.44
	anterior W	5.3	4.8	5	5.1	5.03	5.97	5.92	5.88	5.96	5.57
	posterior W	7.44	6.79	7.03	6.97	6.88	8.87	8.35	8.48	8.05	7.55
Mesosoma	total L	18.06	15.26	17.28	16.53	17.75	19.92	20.11	18.37	17.65	18.07
Tergite VI	L	2.7	2.56	2.83	2.67	2.88	4.16	4.23	3.07	2.97	3.16
	W	8.38	8.36	8.27	7.95	7.85	10.28	9.96	10.38	9.05	8.51
Tergite VII	L	5.57	4.62	5.08	4.87	4.92	5.96	6.13	5.07	4.88	4.76
	W	7.89	7.65	7.81	7.81	7.69	9.78	9.09	9.63	8.59	8.33
Sternite VII	L	5.08	4.45	4.77	4.48	4.56	4.68	5.33	4.54	4.38	4.31
	W	7.8	7.42	7.76	7.37	7.5	9.46	8.62	9.32	7.94	7.95
Metasoma	total L	52.06	47.74	49.88	49.12	46.63	50.11	48.03	49.87	46.87	44.7
Metasoma I	L	7.05	6.73	6.98	6.74	6.57	6.89	6.32	6.74	6.37	5.87
	W	5.42	5.23	5.23	5.34	5.1	5.95	5.07	5.66	5.13	4.78
	H	4.78	4.54	4.46	4.34	4.52	5.21	4.65	5.04	4.55	4.39
Metasoma II	L	8.25	7.17	7.83	7.44	7.22	7.53	7.15	7.25	6.76	6.62
	W	4.96	4.91	4.66	4.79	4.7	5.38	4.78	5.17	4.83	4.56
	H	4.72	4.44	4.44	4.32	4.37	5.19	4.59	4.91	4.48	4.36
Metasoma III	L	8.39	7.31	8.01	7.79	7.27	7.63	7.23	7.6	7.15	6.91
	W	4.84	4.61	4.35	4.69	4.52	5.29	4.73	5	4.58	4.3
	H	4.58	4.29	4.41	4.25	4.3	5.09	4.44	4.86	4.41	4.14
Metasoma IV	L	9.5	9.16	9.2	9.25	8.65	9.25	8.69	9.18	8.77	8.16
	W	4.32	4.15	4.16	3.99	4.1	4.8	4.39	4.69	4.44	4.28
	H	4.01	3.7	3.93	3.78	3.77	4.74	4.12	4.39	3.95	3.86
Metasoma V	L	10.86	10.04	10.32	10.3	9.85	11.04	10.45	10.97	10.37	9.82
	W	3.96	3.57	3.67	3.54	3.59	4.45	4.1	4.47	4.01	3.84
	H	3.57	3.07	3.13	3.32	3.22	3.83	3.39	3.81	3.36	3.05
Telson	L	8.01	7.33	7.54	7.6	7.07	7.77	8.19	8.13	7.45	7.32
	vesicle L	5.1	4.6	4.79	4.98	4.68	4.92	5.25	4.95	4.79	4.53
	vesicle W	3.56	3.18	3.24	3.25	3	3.79	4.06	4.26	3.87	3.75
	vesicle H	3.22	3	3.06	3.34	2.92	3.8	3.44	3.57	3.51	3.23
	aculeus L	2.91	2.73	2.75	2.62	2.39	2.85	2.94	3.18	2.66	2.79
Pedipalp	total L	28.05	26.9	28.17	27.26	26.64	32.79	31.13	32.88	31.08	29.34
Femur	L	6.69	6.39	6.37	6.32	6.3	7.27	6.94	7.4	7.12	6.73
	W	1.85	1.72	1.75	1.6	1.72	1.86	2.01	2.06	1.92	1.81
Patella	L	7.57	7.23	7.38	7.23	7.12	8.73	8.15	8.93	7.92	7.35
	W	2.55	2.44	2.38	2.23	2.25	3.21	3.11	3.21	3.08	2.74
Chela	total L	13.79	13.28	14.42	13.71	13.22	16.79	16.04	16.55	16.04	15.26
	manus L	5.1	5.04	5.41	5.33	5.14	7.03	6.45	6.62	6.65	6.16
	manus W	2.45	2.3	2.36	2.29	2.16	3.86	3.44	3.71	3.38	3.03
	manus H	2.47	2.21	2.55	2.53	2.24	4.35	3.69	3.97	3.75	3.38
	mov. finger L	8.69	8.24	9.01	8.38	8.08	9.76	9.59	9.93	9.39	9.1
Pectines	L	8.78	8.29	8.99	8.31	7.55	8.52	8.07	8.49	8.31	8.17
Mov. finger	subrows	12/12	12/12	12/12	12/12	11/12	13/12	13/13	12/9	12/12	12/12
Pectines	tooth count	32/33	34/33	33/33	31/31	31/31	28/28	29/27	26/28	26/26	28/29

TABLE 8

MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS GARCIALORCAI* TERUEL AND TURIEL, 2020

Material deposited in the American Museum of Natural History (AMNH), New York,
the Centro de Investigação em Biodiversidade e Recursos Genéticos – BIOPOLIS (CIBIO), Porto, Portugal,
and the Museo Nacional de Ciencias Naturales de Madrid (MNCN), Madrid, Spain.

Specimen	Sex	♂	♂	♂	♂	♀	♀	♀	♀	♀
	Collection	AMNH	CIBIO	MNCN	MNCN	AMNH	AMNH	AMNH	AMNH	AMNH
	Number		1755	9497	9500					
Total L		66.64	71.52	70.14	68.64	72.13	68.24	66.66	61.34	61.57
Carapace	L	6.39	6.8	7.7	7.24	8.41	7.58	7.56	7	7.07
	anterior W	4.83	4.72	4.85	4.96	5.61	5.46	5.42	5.02	4.8
	posterior W	6.86	6.86	8.07	8.02	8.56	7.98	8.1	7.44	7.5
Mesosoma	Total L	16.63	18.23	14.67	15.01	15.99	16.14	16.15	16.14	15.3
Tergite VI	L	2.72	2.62	2.74	2.66	3.01	2.76	2.81	2.93	2.63
	W	8.27	7.8	9.14	8.63	9.52	9.35	10.23	8.72	8.11
Tergite VII	L	4.32	5.01	5.01	4.62	4.57	4.54	4.28	3.91	3.89
	W	7.21	7.39	8.5	7.6	7.97	7.66	8.74	7.46	7.12
Sternite VII	L	3.98	4.44	4.44	4.36	3.94	3.88	3.65	3.65	3.52
	W	7.56	6.58	7.87	7.02	7.9	6.9	7.88	6.88	6.73
Metasoma	total L	43.62	46.49	47.77	46.39	47.73	44.52	42.95	38.2	39.2
Metasoma I	L	5.78	6.39	6.82	6.85	6.71	5.5	5.55	4.7	5.11
	W	5.4	5	5.52	5.31	5.03	4.96	5.02	4.32	4.45
	H	4.76	4.28	4.66	4.56	4.52	4.4	3.95	3.77	3.69
Metasoma II	L	6.81	7.21	7.72	7.27	6.97	6.64	6.39	5.69	6.18
	W	5.05	4.7	5.21	4.44	5.09	4.63	4.67	4.12	4.06
	H	4.54	4.28	4.9	4.58	4.34	4.54	4.48	3.85	3.96
Metasoma III	L	6.82	7.46	7.89	7.11	7.27	6.85	6.52	5.91	6.47
	W	4.86	4.34	5.13	4.77	5.14	4.77	4.73	4.09	4.13
	H	4.55	4.17	4.77	4.52	4.04	4.63	4.54	3.82	3.92
Metasoma IV	L	8.33	8.96	8.92	8.8	8.18	8.16	7.1	6.75	6.76
	W	4.52	4.03	4.75	4.39	4.84	4.41	4.48	3.93	3.98
	H	4.25	3.68	4.15	3.98	4.29	3.95	4.12	3.52	3.51
Metasoma V	L	9.26	10	9.85	9.58	10.27	10.18	9.77	8.71	8.58
	W	3.89	3.47	4.1	3.63	4.43	4.2	4.25	3.49	3.26
	H	3.41	3.01	3.33	3.26	3.51	3.37	3.59	3.03	2.99
Telson	L	6.62	6.67	6.57	6.78	8.33	7.19	7.62	6.56	6.1
	vesicle L	4.34	4.51	4.27	4.09	5.3	4.48	4.7	4.37	4.01
	vesicle W	3.27	3.12	3.63	3.19	4.27	3.83	3.86	3.27	3.21
	vesicle H	2.73	3.01	3.19	3.08	3.73	3.62	3.3	3	2.88
	aculeus L	2.28	2.16	2.3	2.69	3.03	2.71	2.92	2.19	2.09
Pedipalp	total L	24.08	26.32	27.32	25.85	29.4	29.98	28.63	26.17	24.77
Femur	L	5.92	6.29	6.6	6.36	7.09	6.9	6.37	5.92	5.82
	W	1.81	1.61	1.72	1.83	1.91	1.95	1.77	1.42	1.58
Patella	L	6.5	7.08	7.03	6.99	8.06	7.88	7.68	7.13	6.79
	W	2.59	2.36	2.62	2.54	2.72	2.51	2.88	2.55	2.59
Chela	total L	11.66	12.95	13.69	12.5	14.25	15.2	14.58	13.12	12.16
	manus L	4.83	5.3	5.42	5.1	5.72	5.94	5.57	5.24	4.73
	manus W	2.54	2.24	2.84	2.33	3.32	3.46	3.24	2.86	2.73
	manus H	2.73	2.47	3.18	2.72	3.86	3.76	3.6	2.99	3.05
	mov. finger L	6.83	7.65	8.27	7.4	8.53	9.26	9.01	7.88	7.43
Pectines	L	8.48	8.69	8.33	7.78	9.57	8.81	8.92	7.87	7.42
Mov. finger	subrows	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12
Pectines	tooth count	33/33	32/32	33/32	33/32	27/27	27/27	26/27	27/28	26/26

TABLE 9

MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)

FOR ADULTS OF *BUTHUS HALIUS* (C.L. KOCH, 1839)

Material deposited in the American Museum of Natural History (AMNH), New York,
the Centro de Investigação em Biodiversidade e Recursos Genéticos – BIOPOLIS (CIBIO), Porto, Portugal,
and the Museu Nacional de História Natural e da Ciência (MNHNC), Lisbon, Portugal.

Specimen	Sex	Collection Number	♂	♂	♂	♂	♂	♀	♀	♀	♀
			AMNH	AMNH	MNHNC	MNHNC	CIBIO	AMNH	AMNH	AMNH	MNHNC
Total L			68.12	74.48	66.16	60.01	69.23	80.65	77.56	71.15	72.07
Carapace	L		7.04	7.85	6.81	6.15	6.88	8.55	8.39	7.71	7.75
	anterior W		4.99	5.38	4.36	4.49	4.86	6.14	6	5.48	5.84
	posterior W		7.15	7.4	6.85	6.37	7.26	9.05	9.13	7.96	8.49
Mesosoma	Total L		16.98	18.55	16.47	14.45	17.87	22.56	21.44	19.8	18.78
Tergite VI	L		2.71	3.03	3.19	2.68	3.7	3.59	3.87	3.89	4.04
	W		8.73	9.14	7.2	7.64	8.34	10.52	11.28	10.12	9.65
Tergite VII	L		4.52	4.91	5.08	4.15	5.04	5.35	5.63	5.76	5.17
	W		7.63	8.36	6.72	7.46	7.5	9.12	9.21	8.45	8.61
Sternite VII	L		3.75	4.71	3.81	3.92	4.45	5.21	5.17	4.93	4.95
	W		7.53	8.11	6.66	6.43	7.28	9.05	8.79	7.5	8.32
Metasoma	total L		44.1	48.08	42.88	39.41	44.48	49.54	47.73	43.64	45.54
Metasoma I	L		6.14	6.2	6.04	5.47	6.24	6.16	6.61	5.92	6.1
	W		4.92	5.29	4.34	4.03	4.77	5.33	5.49	4.8	4.81
	H		4.14	4.49	3.99	3.63	4.14	4.5	4.91	4.21	4.49
Metasoma II	L		6.77	7.24	6.67	6.04	6.85	6.98	7.18	6.48	6.82
	W		4.69	5.03	4.21	3.83	4.5	5.02	5.3	4.67	4.74
	H		4.05	4.29	3.87	3.57	3.88	4.45	4.85	4.27	4.29
Metasoma III	L		6.97	7.32	6.66	6.13	6.68	7.77	7.3	6.66	6.9
	W		4.37	4.87	4.11	3.85	4.36	4.93	4.85	4.48	4.42
	H		3.88	4.28	3.71	3.37	4.04	4.51	4.78	4.28	4.19
Metasoma IV	L		8.1	9.33	8.16	7.34	8.18	8.6	8.81	7.63	8.34
	W		4.14	4.58	3.84	3.51	4.03	4.67	4.73	4.35	4.46
	H		3.71	3.77	3.3	3.1	3.59	4.08	4.25	3.83	3.86
Metasoma V	L		9.26	10.27	9.13	8.45	9.77	11.04	10.76	10	9.97
	W		3.94	4.23	3.44	3.19	3.7	4.5	4.35	4.02	4.12
	H		2.95	3.22	2.94	2.77	3.16	3.67	3.42	3.2	3.48
Telson	L		6.86	7.72	6.22	5.98	6.76	8.99	7.07	6.95	7.41
	vesicle L		4.49	4.98	3.95	3.91	4.24	5.49	4.51	4.16	4.59
	vesicle W		3.23	3.54	3.15	2.92	3.52	4.02	3.94	3.88	3.73
	vesicle H		3.03	3.26	2.83	2.68	3.07	3.61	3.64	3.32	3.27
	aculeus L		2.37	2.74	2.27	2.07	2.52	3.5	2.56	2.79	2.82
Pedipalp	total L		26.32	29.47	26.47	25.01	27.69	32.07	28.94	27.34	31.44
Femur	L		5.93	6.58	5.96	5.6	6.35	7.06	6.49	5.85	7.05
	W		1.76	1.91	1.8	1.64	1.8	2.25	2.18	1.93	1.93
Patella	L		6.46	7.47	6.57	6.47	6.98	8.25	7.93	7.4	7.93
	W		2.79	2.83	2.4	2.48	2.68	3.09	3.11	2.83	2.96
Chela	total L		13.93	15.42	13.94	12.94	14.36	16.76	14.52	14.09	16.46
	manus L		5.76	6.59	5.96	5.62	6.33	6.9	5.68	5.89	6.92
	manus W		3.46	3.74	3.45	3.1	3.59	3.86	3.36	3.15	3.58
	manus H		3.81	4.26	3.59	3.36	3.93	4.27	3.89	3.68	3.94
	mov. finger L		8.17	8.83	7.98	7.32	8.03	9.86	8.84	8.2	9.54
Pectines	L		8.1	8.82	7.47	7.71	7.72	9.56	8.79	7.72	8.35
Mov. finger	subrows		12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12
Pectines	tooth count		30/29	31/30	28/28	32/31	28/28	29/19	25/24	24/26	27/26

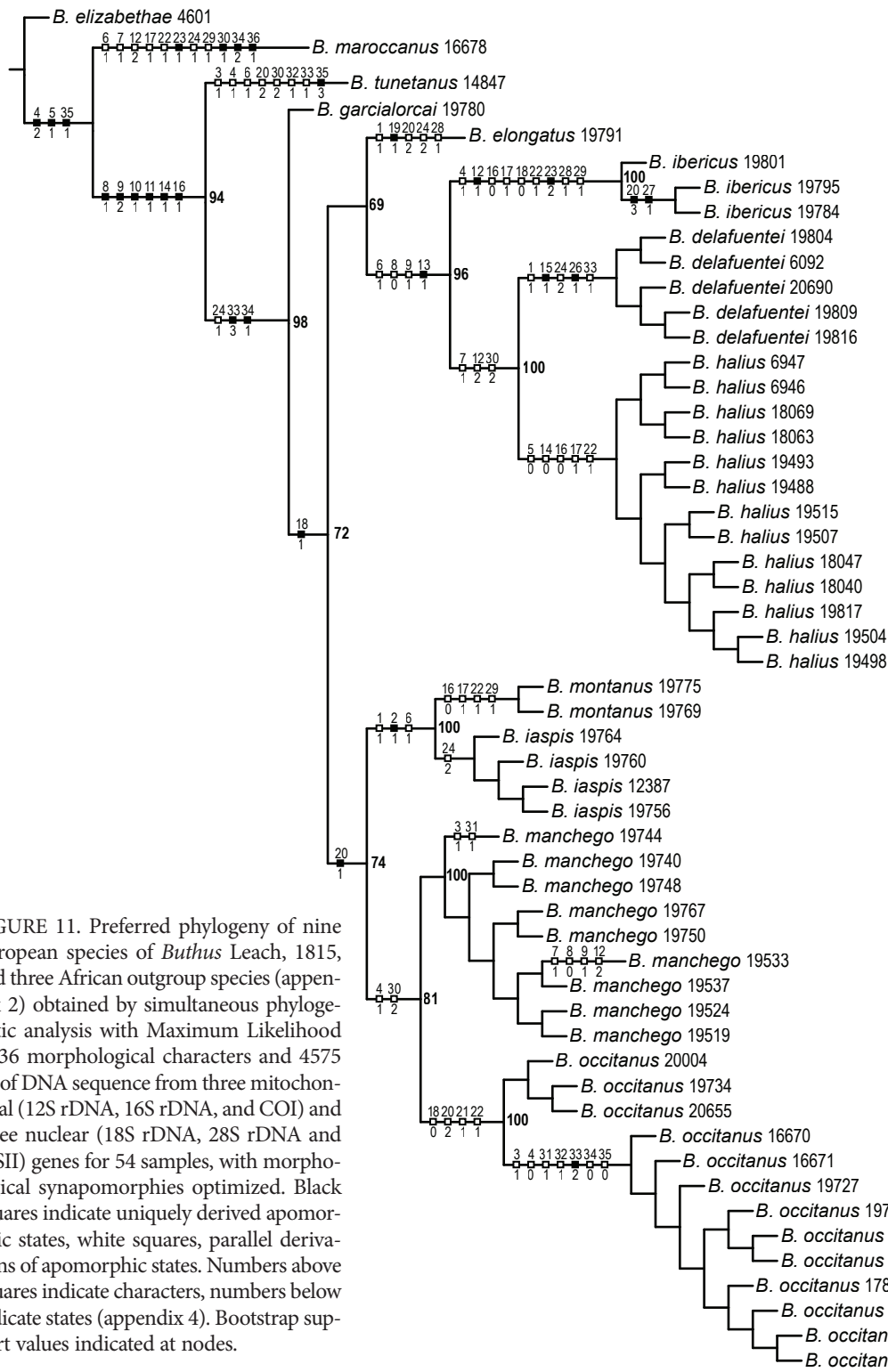


FIGURE 11. Preferred phylogeny of nine European species of *Buthus* Leach, 1815, and three African outgroup species (appendix 2) obtained by simultaneous phylogenetic analysis with Maximum Likelihood of 36 morphological characters and 4575 bp of DNA sequence from three mitochondrial (12S rDNA, 16S rDNA, and COI) and three nuclear (18S rDNA, 28S rDNA and ITSII) genes for 54 samples, with morphological synapomorphies optimized. Black squares indicate uniquely derived apomorphic states, white squares, parallel derivations of apomorphic states. Numbers above squares indicate characters, numbers below indicate states (appendix 4). Bootstrap support values indicated at nodes.

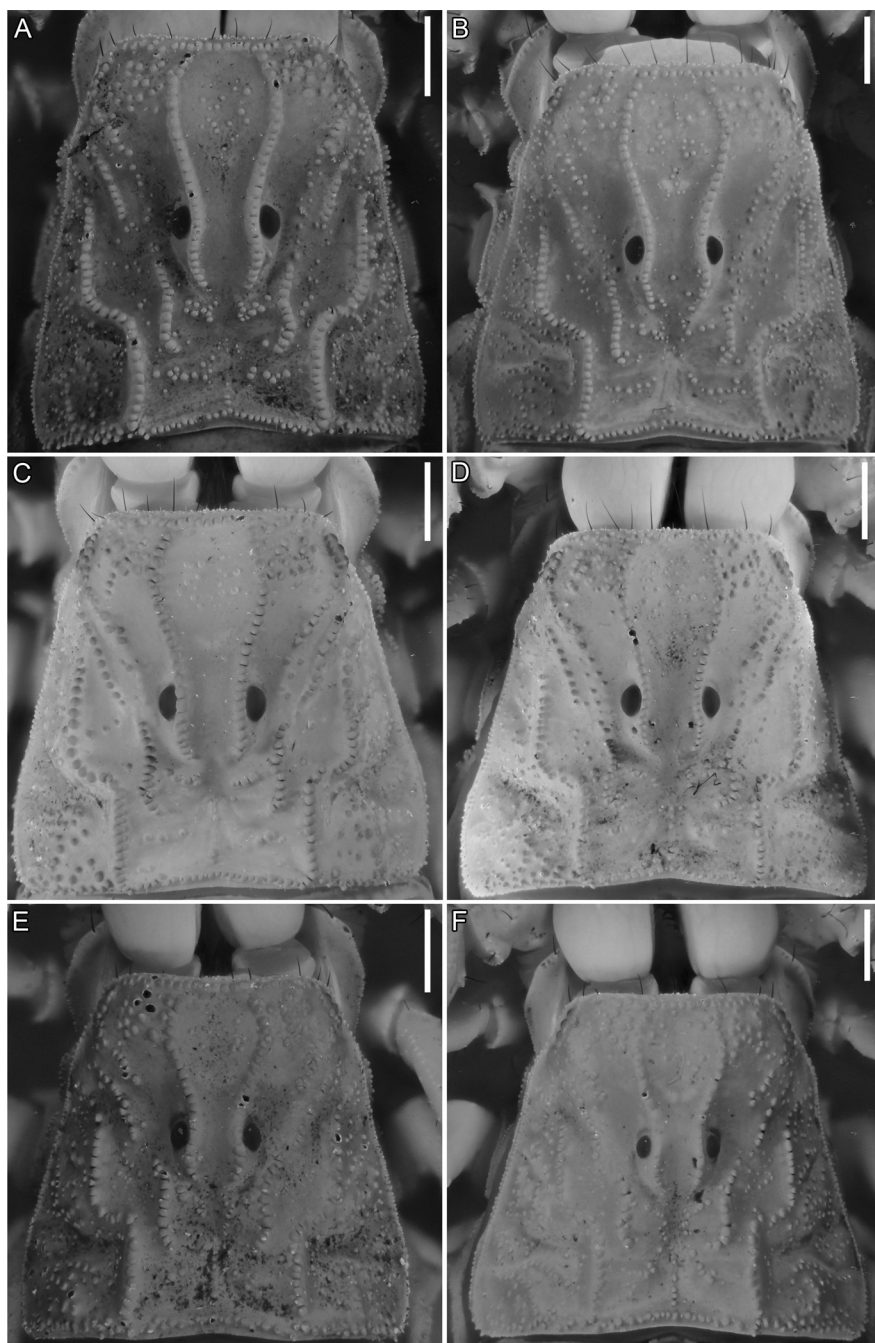


FIGURE 12. *Buthus* Leach, 1815, carapace. **A, B.** *Buthus delafulentei* Teruel and Turiel, 2020, **A.** ♂ (AMNH), Doñana, Andalucía, Spain, **B.** ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. **C, D.** *Buthus halius* (C.L. Koch, 1839), **C.** ♂ (AMNH), Herrera de Duero, Castilla y León, Spain, **D.** ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. **E, F.** *Buthus ibericus* Lourenço and Vachon, 2004, **E.** ♂ (AMNH), Dehesa Picado, Andalucía, Spain, **F.** ♀ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 2 mm.

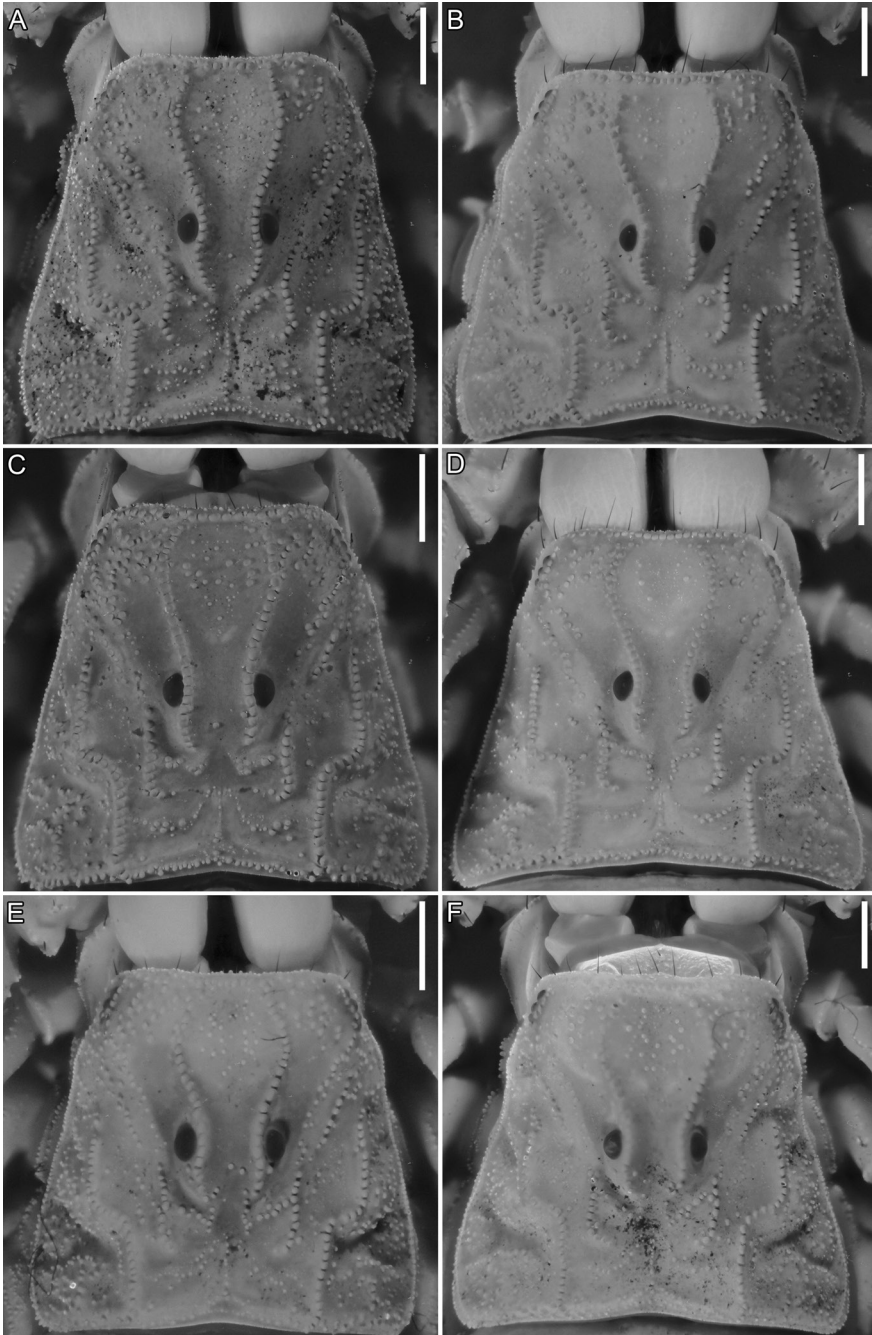


FIGURE 13. *Buthus* Leach, 1815, carapace. **A, B.** *Buthus elongatus* Rossi, 2012, **A.** ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain, **B.** ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. **C, D.** *Buthus garcialorcai* Teruel and Turiel, 2020, **C.** ♂ (AMNH), Sierra de Huétor, Andalucía, Spain, **D.** ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. **E, F.** *Buthus occitanus* (Amoreux, 1789), **E.** ♂ (AMNH), Souvignargues, Occitanie, France, **F.** ♀ (AMNH), Souvignargues, Occitanie, France. Scale bars = 2 mm.

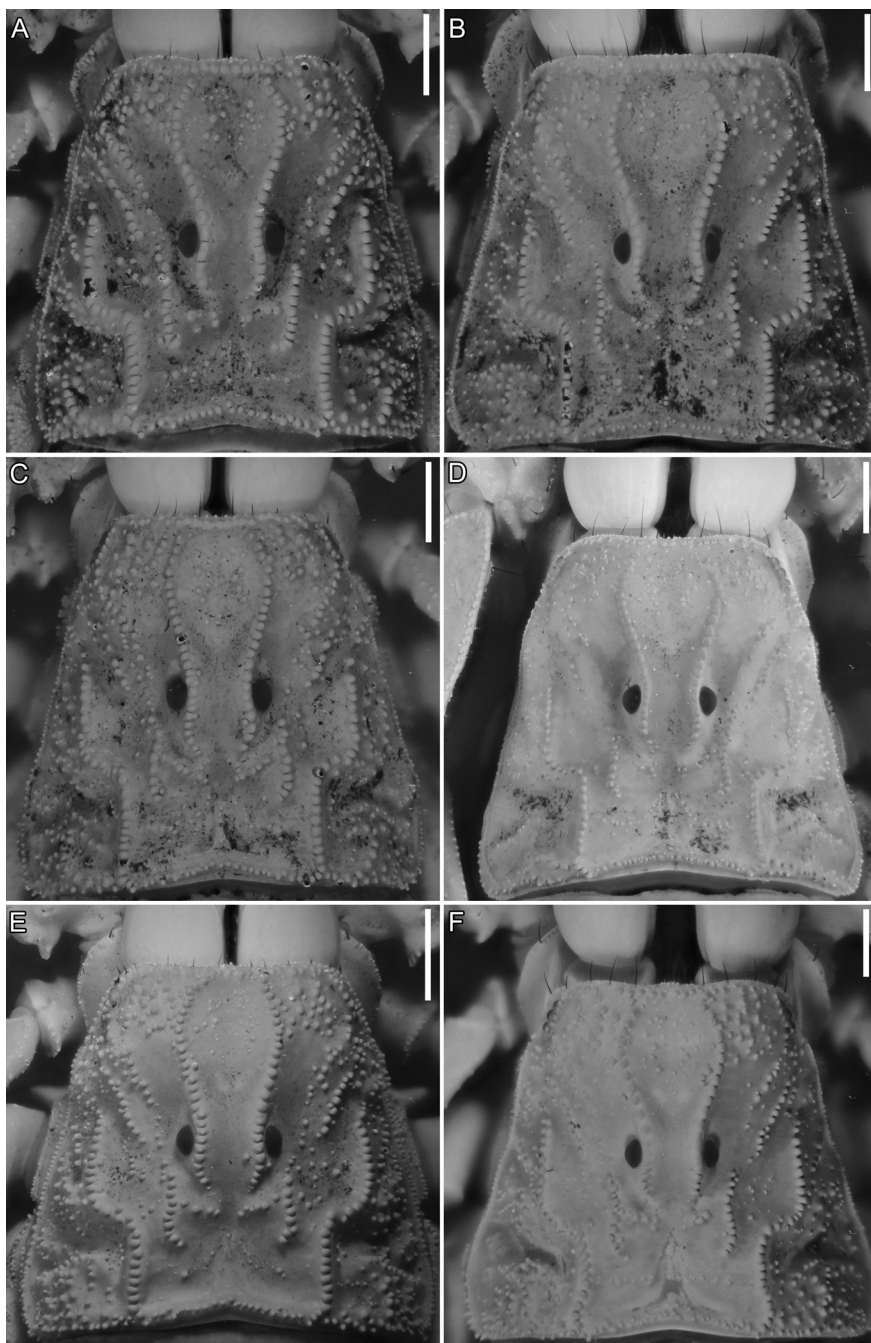


FIGURE 14. *Buthus* Leach, 1815, carapace. **A, B.** *Buthus iaspis* Teruel and Turiel, 2022, **A.** ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain, **B.** ♀ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **C, D.** *Buthus manchego* Teruel and Turiel, 2020, **C.** ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain, **D.** ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **E, F.** *Buthus montanus* Lourenço and Vachon, 2004, **E.** ♂ (AMNH), Sierra Nevada, Andalucía, Spain, **F.** ♀ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 2 mm.

1–13; Ouici et al., 2020: 87, 90–93, table 2; Teruel and Turiel, 2020: 3–32, figs. 1–35, tables I–XIV; Abidi et al., 2021: 81–86, figs. 1–25, table I; Klessner et al., 2021: 166–175, figs. 1–3; Lourenço, 2021: 1–6, figs. 1–19; Lourenço et al., 2021: 168–176, figs. 1–4, table 1; Teruel and Turiel, 2021a: 3–20, figs. 1–12, tables I–IV; 2021b: 3–10, figs. 1–4, table I–III; Ythier, 2021a: 1–6, figs. 1–13, table I; 2021b: 1–10, figs. 1–22, tables I–III; 2021c: 1–5, figs. 1–8; Kamel et al., 2022: 31–35, 40–43, graphs 3, 6, figs. 12–21; Teruel and Turiel, 2022a: 19–29, figs. 1–14, tables I–III; 2022b: 15–36, figs. 1–26, tables I–III; Ythier and Laborieux, 2022: 1–13, figs. 1–26, tables I–III; Ythier and Lourenço, 2022: 1–5, figs. 1–11; Zekri et al., 2022: 400–408, figs. 1–4, tables 3, 4; González-Moliné et al., 2023: 215–223, figs. 1–5, table I–IV; Mairif and Guemou, 2023: 229–232, figs. 1–3; Ythier, 2023: 1–7, figs. 1–7, tables I, II; González-Moliné and Armas, 2024: 75–84, figs. 1–21, tables I–IV; Hajri et al., 2024: 1390–1395, figs. 1–3, tables 1–4.

DIAGNOSIS: *Buthus* is most closely related to the Palearctic buthid genera *Leiurus* Ehrenberg, 1828, and *Odontobuthus* Vachon, 1950, with which it shares the following characters (Vachon, 1952c; Sissom, 1990; Lowe et al., 2014; Barahoei et al., 2022): carapacial centrolateral and posteromedian carinae fused into a lyra-shaped configuration; metasomal segments I–IV decreasing in height and width posteriorly; dorsolateral carinae on metasomal segment IV granular to obsolete.

Buthus may be separated from these genera as follows. The pedipalp chela movable finger bears three distal denticles in *Buthus* but two denticles in *Leiurus* and *Odontobuthus*. The anterior mesosomal tergites each bear no more than three carinae in *Buthus* but five carinae in *Leiurus*. Processes on the ventrosubmedian carinae of metasomal segments II and III, if present, are only slightly enlarged and subspiniform in *Buthus*, but greatly enlarged and toothlike in *Odontobuthus*.

DISTRIBUTION: AFRICA: Algeria; Burkina Faso; Cameroon; Central African Republic; Chad; Cyprus; Djibouti; Egypt; Eritrea; Ethiopia; the Gambia; Ghana; Guinea; Guinea-Bissau; Ivory Coast; Kenya; Libya; Mali; Mauritania; Morocco (including Western Sahara); Niger; Nigeria; Senegal; Somalia (including Somaliland); South Sudan; Sudan; Tunisia. ASIA: Iraq; Israel; Jordan; Lebanon; Yemen. EUROPE: France; Italy?; Portugal; Spain.

The specimens described as *Buthus trinacrius* Lourenço and Rossi, 2013, allegedly collected in Sicily by E. Simon between 1870 and 1880 and declared as possibly extinct by Lourenço and Rossi (2013), probably represent a mislabelling error or an anthropogenic introduction.

INCLUDED SPECIES: *Buthus* currently accommodates 70 species: *Buthus adrianae* Rossi, 2013; *Buthus ahaggar* Ythier et al., 2021; *Buthus albengai* Lourenço, 2003; *Buthus amri* Lourenço et al., 2010; *Buthus apiatus* Lourenço et al., 2020; *Buthus atlantis* Pocock, 1889; *Buthus aures* Lourenço and Sadine, 2016; *Buthus awashensis* Kovařík, 2011; *Buthus barcaeus* Birula, 1909; *Buthus berberensis* Pocock, 1900; *Buthus bobo* Ythier, 2021; *Buthus bonito* Lourenço and Geniez, 2005; *Buthus boumalenii* Touloun and Boumezzough, 2011; *Buthus boussaadi* Lourenço et al., 2018; *Buthus brignolii* Lourenço, 2003; *Buthus centroafricanus* Lourenço, 2016; *Buthus chambiensis* Kovařík, 2006; *Buthus confluens* Lourenço, Touloun, and Boumezzough, 2012; *Buthus danyii* Rossi, 2017; *Buthus delafuentei* Teruel and Turiel, 2020; *Buthus draa* Lourenço and Slimani, 2004; *Buthus dunlopi* Kovařík, 2006; *Buthus duprei* Rossi and Tropea, 2016; *Buthus egyptiensis* Lourenço, 2012; *Buthus elhennawyi* Lourenço, 2005; *Buthus elizabethae* Lourenço, 2005; *Buthus elmoutaouakili* Lourenço and Qi, 2006; *Buthus elongatus* Rossi, 2012; *Buthus garcial-orcai* Teruel and Turiel, 2020; *Buthus goyffoni* Abidi, Sadine, and Lourenço, 2021; *Buthus halius* (C.L. Koch, 1839); *Buthus hassanini* Lourenço, Duhem, and Cloudsley-Thompson, 2012; *Buthus iaspis* Teruel and Turiel, 2022; *Buthus ibericus* Lourenço and Vachon, 2004; *Buthus intermedius* (Ehrenberg, 1829); *Buthus intumescens* (Ehren-

berg, 1829); *Buthus israelis* Shulov and Amitai, 1959; *Buthus jianxinae* Lourenço, 2005; *Buthus karoraensis* Rossi and Tropea, 2016; *Buthus kunti* Yağmur, Koç, and Lourenço, 2011; *Buthus labuschagnei* Lourenço, 2015; *Buthus lienhardi* Lourenço, 2003; *Buthus lourencoi* Rossi, Tropea, and Yağmur, 2013; *Buthus maamora* Ythier, 2023; *Buthus malhommei* Vachon, 1949; *Buthus manchego* Teruel and Turiel, 2020; *Buthus mardochei* Simon, 1878; *Buthus mariefranceae* Lourenço, 2003; *Buthus maroccanus* Birula, 1903; *Buthus montanus* Lourenço and Vachon, 2004; *Buthus nabataeus* Lourenço, Abu Afifeh, and Al-Saireh, 2021; *Buthus nigrovesiculosus* Hirst, 1925; *Buthus occidentalis* Lourenço, Sun, and Zhu, 2009; *Buthus occitanus* (Amoreux, 1789); *Buthus orientalis* Lourenço and Simon, 2012; *Buthus oudjanii* Lourenço, 2017; *Buthus paris* (C.L. Koch, 1839); *Buthus parroti* Vachon, 1949; *Buthus pococki* Kovařík, Štáhlavský, and Elmi, 2020; *Buthus prudenti* Lourenço and Leguin, 2012; *Buthus pusillus* Lourenço, 2013; *Buthus rochati* Lourenço, 2003; *Buthus saharicus* Sadine, Bissati, and Lourenço, 2015; *Buthus somalilandus* Kovařík, Štáhlavský, and Elmi, 2020; *Buthus tassili* Lourenço, 2002; *Buthus trinacrius* Lourenço and Rossi, 2013; *Buthus tunetanus* (Herbst, 1800); *Buthus turkana* Ythier and Lourenço, 2022; *Buthus yemenensis* Lourenço, 2008; and *Buthus zeylensis* Pocock, 1900.

Key to Identification of the European Species
of *Buthus* Leach, 1815

1. Pedipalp chela manus globose, incrassate (♂, ♀), more so in ♂; fixed and movable fingers (♂) curved basally, emarginate when closed (figs. 15A–C, 16A–C).....2
- Pedipalp chela manus slender, not incrassate (♂) or globose, incrassate (♀); fixed and movable fingers (♂) sublinear basally, not emarginate when closed (figs. 15D–I, 16D–I).....3
2. Pedipalp chela fixed and movable fingers markedly curved basally, deeply emarginate when closed (♂, ♀) (figs. 15A–C, 16A–C); metasomal segments, dorsal surfaces setose,

pattern type II (figs. 7B, 17A, B, 18A, B); segment V, dorsal and lateral intercarinal surfaces finely granular (figs. 17A, B, 18A, B, 23A, B, 24A, B)4

- Pedipalp chela fixed and movable fingers slightly curved basally, shallowly emarginate when closed (♂) or sublinear basally, not emarginate when closed (♀) (figs. 15C, 16C); metasomal segments, dorsal surfaces asetose (figs. 17C, 18C); segment V, dorsal and lateral intercarinal surfaces smooth (figs. 17C, 18C, 23C, 24C)*B. ibericus*
- 3. Metasomal segment V, lateral surfaces densely setose, with more than three pairs of macrosetae.....5
- Metasomal segment V, lateral surfaces sparsely setose, with no more than three pairs of macrosetae6
- 4. Legs slender, with slightly elongated femora, patellae, tibiae, and tarsi; leg tibiae and tarsi densely setose; metasomal segments elongate and slender, segment I width : length 73% (♂) or 77% (♀), segment II width : length, 63% (♂) or 64% (♀), segment III width : length 58% (♂) or 60% (♀); segments II and III each with posterior granules of ventrosubmedian carinae obsolete (♂); segment V ventrolateral carinae each with at most one enlarged process posteriorly.....*B. delafulentei*
- Legs robust, with short femora, patellae, tibiae, and tarsi; leg tibiae and tarsi sparsely setose; metasomal segments short and broad, segment I width : length 77% (♂) or 81% (♀), segment II width : length 67% (♂) or 71% (♀), segment III width : length 63% (♂) or 66% (♀); segments II and III each with posterior granules of ventrosubmedian carinae slightly enlarged into subspiniiform processes (♂); segment V ventrolateral carinae each with at least two enlarged processes posteriorly.....*B. halius*
- 5. Metasomal segments, dorsal surfaces moderately setose (figs. 7B, 19B, 20B); segment I broad, width : length >80% (♂)*B. garcialorcai*

- Metasomal segments, dorsal surfaces densely setose (figs. 7C, 21, 22); segment I slender, width : length <80% (♂)7
- 6. Total length >70 mm (♂); carapace intercarinal surfaces, infuscation pattern type IV (fig. 5D); median ocular carinae entirely infusate, comprising granules similar in size to other carapacial carinae (fig. 13A); metasomal segment V narrow, width : V length <38% (♂)*B. elongatus*
- Total length <70 mm (♂); carapace intercarinal surfaces, infuscation pattern type III (fig. 5C); median ocular carinae infusate in anterior half only, comprising granules noticeably larger than granules of other carapacial carinae and progressively reducing in size anteriorly (fig. 13E); metasomal segment V broad, width : length ≥38% (♂).....*B. occitanus*
- 7. Base color dark orange; carapace shape conical trapezoid, lateral margins curved (♂) (fig. 14A, E); prolateral secondary carinae reduced to few granules, not reaching lateral ocelli (fig. 14A, E); pedipalp chela short, manus length : movable finger length ≥70%8
- Base color yellow to dark yellow; carapace shape quadrangular trapezoid, lateral margins sublinear (♂) (fig. 14C); prolateral secondary carinae often reaching lateral ocelli (fig. 14C); pedipalp chela elongate, manus length : movable finger length <70%.....*B. manchego*
- 8. Metasomal segments II and III, ventrosubmedian carinae each with posterior granules slightly enlarged into subspini-form processes (♂); pectinal tooth count ≤30 (♂) or ≤26 (♀).....*B. montanus*
- Metasomal segments II and III, ventrosubmedian carinae each with posterior granules obsolete (♂); pectinal tooth count >30 (♂) or >26 (♀).....*B. iaspis*

Buthus delafulentei Teruel and Turiel, 2020

Figures 2E, 3, 5B, 7B, 8–11, 12A, B, 15A, 16A, 17A, 18A, 23A, 24A, 29A, 30A, 35A, 36A, 37; tables 1–6, 15, 16

Buthus delafulentei Teruel and Turiel, 2020: 1, 22, 24, 29, 37–39, 50, 57, 59, figs. 19, 20, 27, 30b, 34b, tables X, XIII, XIV; 2021a: 3, 6, 10, 12–14, fig. 1; 2021b: 3, 4, 8, 9, fig. 1; Ythier, 2021a: 1, 4, fig. 11; Ythier, 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 15, 17, 19, 36, fig. 26, tables II, III; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215–223, figs. 1, 3, 4, tables I–IV; González-Moliné and Armas, 2024: 75, 76, 80, 82–84, figs. 14c, d, g, h, 15, 17, 18, tables III, IV.

Buthus gonzalezdelavegai González-Moliné and Armas, 2024: 75–84, figs. 1–21, tables I–IV; syn. n.

TYPE MATERIAL: **SPAIN: Andalucía: Huelva Prov.:** Holotype ♂ (RTO), Depresión Bética, Pinos de Hinojos, 37°16'54"N 06°24'11"W, 78 m, 4.vii.2019, C. Turiel. Paratypes: same data as holotype, 3 ♂, 3 ♀ (RTO), 1 ♀ (ARPC); Playa del Alicante [36°30'N 04°49'W], 26–27.v.1983, M. Borri, 1 ♂, 1 ♀ (MZUF 875). *Buthus gonzalezdelavegai*: Holotype ♂ (MNCN 38140), Municipio Matalascañas en el limite del P.N. de Doñana, 15 m, 22.vi.2002, A.L. González-Moliné, pinar de *Pinus pinea* L. Paratypes: Almonte, Laguna del Jaral, 31 m, 11.vii.2023, A.L. González-Moliné, 2 ♀ (ALGM 115, 118), 33 m, 11.vii.2023, A.L. González-Moliné, 2 ♂ (ALGM 114, 116), 1 ♀ (ALGM 117); arenas detrás de Hotel El Coto, 15.vi.2023, A.L. González-Moliné, 1 ♂ (ALGM 102); Mazagón, El Vigía, 10 m, 10.v.2000, A.L. González-Moliné, 1 subad. ♂ (JPGV 303), 4 m, 15.v.2009, J.P. González de la Vega, 1 subad. ♂ (JPGV 1003), 20.vi.2022, A.L. González-Moliné, 1 ♂ (MNCN 38141 [ALGM 98]); Municipio Matalascañas en el limite del P.N. de Doñana, 17 m, 10.x.1996, J.P. González de la Vega, 1 ♂ (JPGV 886), 15 m, 22.vi.2002,

A.L. González-Moliné, pinar de *Pinus pinea*, 1 ♂ (ALGM 103), 2 ♀ (ALGM 97, 106), 22.vi.2022, A.L. González-Moliné, 4 ♂ (ALGM 107–109, 113), 3 ♀ (ALGM 99, 110, 111), 1 subad. ♂ (ALGM 112), 22.ix.2022, A.L. González-Moliné, 1 ♀ (MNCN 8142 [ALGM 104]).

DIAGNOSIS: *Buthus delafulentei* most closely resembles *B. halius* and *B. ibericus*. All three species possess a globose, incrassate pedipalp chela with the chela fixed and movable fingers curved basally and emarginate when closed in both sexes (figs. 8B, D, 11, 15A–C, 16A–C) and 13 denticle rows often present on the movable finger.

The three species are readily distinguished as follows, however. At 76.9 mm (69.5–80.67 mm, $n = 10$; tables 5, 6; appendix 5) (♂) and 80.8 mm (73.6–84.9 mm, $n = 7$) (♀) in total length, *B. delafulentei* (fig. 37) is considerably larger than *B. halius* (fig. 40), at 67.8 mm (60–74.5 mm, $n = 18$; tables 5, 9; appendix 5) (♂) and 73.5 mm (65.1–85.4 mm, $n = 25$) (♀), and *B. ibericus* (fig. 42), at 62.4 mm (52.9–67.9 mm, $n = 5$; tables 5, 11; appendix 5) (♂) and 70.4 mm (63.8–76.3 mm, $n = 5$) (♀). The posterolateral carinae of the male carapace are distinct and granular in *B. delafulentei* (figs. 6, 12A) but obsolete, reduced to discontinuous granules in *B. halius* (figs. 7, 12A, B). The pedipalp chela fixed and movable fingers are markedly curved basally and deeply emarginate when closed in both sexes of *B. delafulentei* (figs. 15A, 16A), whereas the fingers are slightly curved basally and shallowly emarginate when closed in the male or sublinear basally and not emarginate when closed in the female of *B. ibericus* (figs. 15C, 16C). The legs are slender, with slightly elongate femora, patellae, tibiae, and tarsi in *B. delafulentei* (fig. 37) but robust, with short femora, patellae, tibiae, and tarsi in *B. halius* (fig. 40) and *B. ibericus* (fig. 42). The retrolateral margins of the leg tibiae and tarsi are densely setose, with elongated macrosetae in *B. delafulentei*, but sparsely setose, with short macrosetae in *B. halius* and *B. ibericus*. The pectinal tooth counts are higher in *B. delafulentei*, i.e., 32/33 (31–34/30–34, $n = 10$; tables 5, 6; appendix 5) (♂) and 28/27 (27–29/26–29, $n = 7$) (♀) than in *B. ibericus*, i.e., 28/28 (26–29/27–29,

$n = 5$; tables 5, 11; appendix 5) (♂) and 23/23 (22–24/22–24, $n = 5$) (♀). The metasoma of *B. delafulentei* is longer, especially in the male (figs. 17A, 18A, 23A, 24A, 29A, 30A), with mesosoma length : metasoma length, 36% (32.9%–36.8%, $n = 7$; tables 5, 6; appendix 5) (♂) or 39% (36.9%–41.1%, $n = 7$) (♀), than that of *B. halius* (figs. 17B, 18B, 23B, 24B, 29B, 30B), with mesosoma length : metasoma length, 38% (33.8%–40.1%, $n = 18$; tables 5, 9; appendix 5) (♂) or 42% (35.9%–46.3%, $n = 25$) (♀), and *B. ibericus* (figs. 17C, 18C, 23C, 24C, 29C, 30C), with mesosoma length : metasoma length, 40% (35.9%–41.6%, $n = 5$; tables 5, 11; appendix 5) (♂) or 45% (40%–48.2%, $n = 5$) (♀). The metasoma of *B. delafulentei* is also slenderer, more so in the male (figs. 9, 17A, 18A, 23A, 24A, 29A, 30A), with segment I width : length 73% (63.9%–79.3%, $n = 10$; tables 5, 6; appendix 5) (♂) or 77% (73.6%–81.6%, $n = 7$) (♀), segment II width : length, 63% (62%–77.8%) (♂) or 64% (57.7%–76.6%) (♀), segment III width : length 58% (53.9%–68.9%) (♂) or 60% (55.6%–65.6%) (♀), and segment IV width : length 49% (43.7%–52.3%) (♂) or 50% (47.4%–52.6%) (♀), than that of *B. halius* (figs. 9, 17B, 18B, 23B, 24B, 29B, 30B), with segment I width : length 77% (71.8%–92.8%, $n = 18$; table 3, 9; appendix 5) (♂) or 81% (75.9%–86.6%, $n = 25$) (♀), segment II width : length 67% (63.1%–75.6%) (♂) or 71% (64.7%–81.2%) (♀), segment III width : length 63% (59.9%–66.9%) (♂) or 66% (59.3%–73.8%) (♀), and segment IV width : length 50% (46.6%–53.9%) (♂) or 53% (47%–62.3%) (♀), and *B. ibericus* (figs. 9, 17C, 18C, 23C, 24C, 29C, 30C), with segment I width : length 93% (89%–96.6%, $n = 5$; tables 5, 11; appendix 5) (♂) or 91% (87.4%–95.3%, $n = 5$) (♀), segment II width : length 77% (71%–80.6%) (♂) or 79% (76.5%–83.9%) (♀), segment III width : length 72% (69.3%–72.7%) (♂) or 71% (68%–75.4%) (♀), and segment IV width : length 56% (53.2%–57.%) (♂) or 56% (51.6%–58.2%) (♀). The dorsal surfaces of the metasoma are moderately setose in *B. delafulentei* (type II; figs. 7B, 17A, 18A) but asetose in *B. ibericus* (figs. 17C, 18C). The dorsosubmedian carinae of metasomal segments I–III are granular in *B. delafulentei* (figs.

17A, 18A) but obsolete in *B. ibericus* (figs. 17C, 18C). The ventrolateral carinae of metasomal segment V each bear at most one enlarged process posteriorly in *B. delafuentei* (figs. 23A, 24A) but two or more enlarged lobate or spiniform processes posteriorly in *B. halius* (figs. 23B, 24B) and *B. ibericus* (figs. 23C, 24C). The dorsal and lateral intercarinal surfaces of segment V are sparsely granular in *B. delafuentei* (figs. 17A, 18A, 23A, 24A) but smooth in *B. ibericus* (figs. 17C, 18C, 23C, 24C).

INTRASPECIFIC VARIATION: Populations of *B. delafuentei* from coastal sand habitats in southern Spain exhibit more psammophilous characters than conspecific populations from compacted soil habitats (e.g., pine forests, Mediterranean shrublands) farther inland. For example, populations exclusively occupying sandy substrates lack enlarged processes posteriorly on the ventrolateral carinae of metasomal segment V (fig. 23A), unlike populations from compacted soils in which a single, slightly enlarged process is present on each of the ventrolateral carinae (fig. 24A). Other variable characters include the slightly more pronounced ventrosubmedian carinae on metasomal segments I–IV of the female (fig. 24A) and slightly shorter setae along the retrolateral margins of the leg tibiae and tarsi in populations from compacted soil habitats (González-Moliné and Armas, 2024). Although this minor phenotypic variation led González-Moliné and Armas (2024) to propose splitting *B. delafuentei* into two species, these differences fall within the normal range of intraspecific variation. The highest intraspecific genetic distance observed in *B. delafuentei* was lower than the lowest interspecific genetic distance among the European species of *Buthus* (table 15).

DISTRIBUTION: *Buthus delafuentei* is endemic to the Iberian Peninsula, where it is distributed across southeastern Portugal and southwestern Spain. It has not been recorded west of the Guadiana River, suggesting a potential barrier to gene flow with populations of *B. halius* in Portugal. In Spain, *B. delafuentei* has been recorded exclusively in Andalucía, specifically in the

provinces of Huelva and Sevilla (fig. 3) whereas, in Portugal, it has been recorded only in the Alentejo region.

ECOLOGY: *Buthus delafuentei* excavates shallow burrows in sandy or gravelly substrates, including dune systems, in Mediterranean shrublands, pine or juniper forests at low elevations (0–150 m) along the coast and in the Guadalquivir Basin (fig. 3). The climate in the area inhabited by this species is predominantly hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters (Köppen, 1936; Nunes, 2023). The habitat and habitus are consistent with the semipsammophilous ecomorphotype (Prendini, 2001a).

REMARKS: The decision by Teruel and Turiel (2020) to describe *B. delafuentei* was questionable, considering that the old names *B. ajax* and *B. halius*, with their broad and ambiguous type localities (i.e., Spain and Portugal, respectively) were already available. A direct comparison with specimens of *B. ajax* and *B. halius*, s. str. (i.e., Portuguese samples), along with the designation of neotypes for both putative species, was only undertaken subsequently, when Teruel and Turiel (2021a) revalidated both species from synonymy with *B. occitanus* (Simon, 1879) and *B. ibericus* (Sousa et al., 2017), respectively.

Teruel and Turiel (2020) differentiated *B. delafuentei* based on five quantitative characters (i.e., total length, secondary sexual dimorphism, chela shape, telson shape and pectinal tooth count) and two qualitative characters (i.e., cheliceral coloration and surface granulation). Although the putative diagnostic characters proposed by Teruel and Turiel (2020) turned out to be inconsistent or overlapping when compared across a larger sample of populations deemed heterospecific by these authors (tables 5–14; appendix 5), several consistent characters were identified for delimiting *B. delafuentei* (figs. 8–11; table 4; appendix 5) in the present investigation.

González-Moliné and Armas (2024: 75) described *B. gonzalezdelavegai* as a new species “geográfica y morfológicamente es muy cercana a

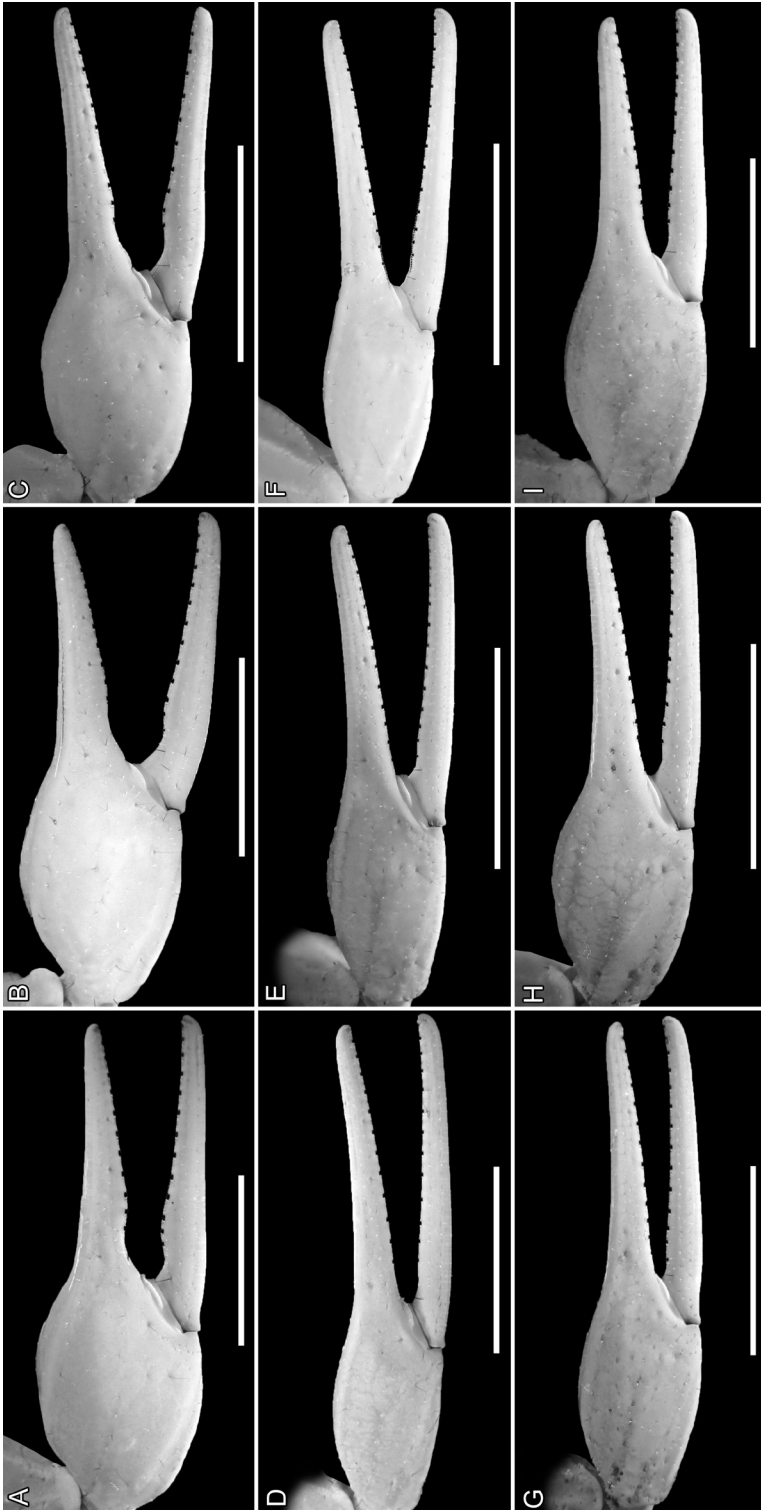


FIGURE 15. *Buthus* Leach, 1815, pedipalp chela, retrodorsal aspect. **A.** *Buthus delafluentei*, Teruel and Turiel, 2020, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. **D.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **E.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **F.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. **G.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **H.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **I.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.

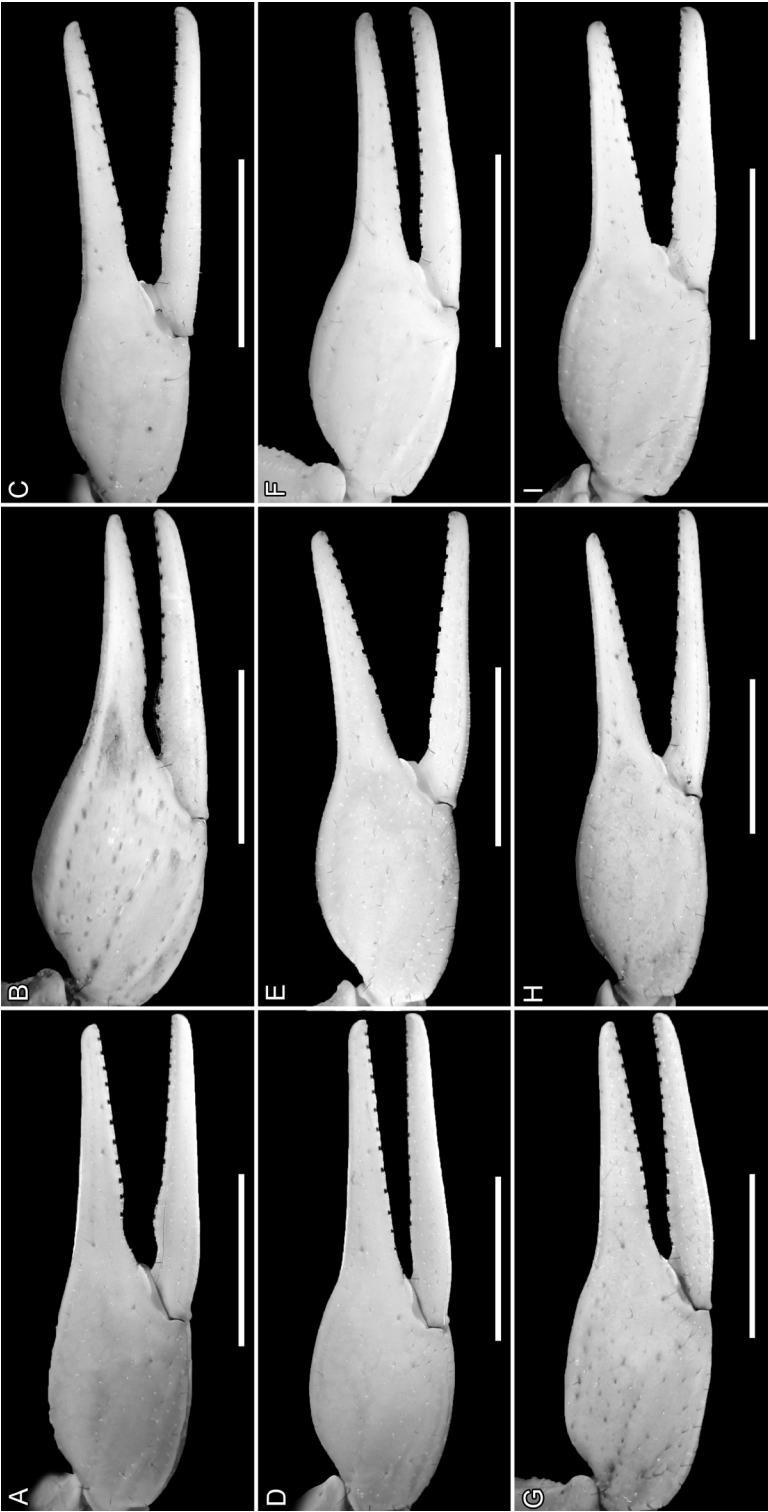


FIGURE 16. *Buthus* Leach, 1815, pedipalp chela, retrodorsal aspect. **A.** *Buthus delafuentei*, Teruel and Turiel, 2020, ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♀ (AMNH), Dehesa Picado, Andalucía, Spain. **D.** *Buthus elongatus* Rossi, 2012, ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. **E.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. **F.** *Buthus occitanus* (Amoreux, 1789), ♀ (AMNH), Souvignargues, Occitanie, France. **G.** *Buthus iaspis* Teruel and Turiel, 2022, ♀ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **H.** *Buthus manchego* Teruel and Turiel, 2020, ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **I.** *Buthus montanus* Lourenço and Vachon, 2004, ♀ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.



FIGURE 17. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus delafuentei*, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 5 mm.



FIGURE 18. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus delafulentei* Teruel and Turiel, 2020, ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♀ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 5 mm.

TABLE 10
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS IASPIS* TERUEL AND TURIEL, 2022
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		80.24	76.48	66.71	74.47	75.32	74.3	74.24	78.74	68.48	70.81
Carapace	L	7.78	7.67	6.77	7.55	7.41	8.22	8.31	8.63	7.27	7.95
	anterior W	5.63	5.55	5.03	5.52	5.22	6.35	6.24	6.35	5.31	5.88
	posterior W	7.64	7.58	6.61	7.4	7.09	8.64	8.71	8.76	7.55	8.48
Mesosoma	total L	18.79	16.54	15.93	16.38	17.38	18.53	17.78	19.75	17.09	18.21
Tergite VI	L	3.12	2.77	2.65	2.76	3.07	3.03	2.93	3.43	2.69	3.59
	W	8.71	8.74	7.83	8.72	8.82	10.42	9.69	10.34	8.41	9.13
Tergite VII	L	5.42	5.11	4.65	5.1	5.18	5.22	5.09	5.71	4.46	5
	W	8.2	8.07	6.88	7.85	8.05	9.24	8.69	9.47	7.5	8.31
Sternite VII	L	4.91	4.68	4.07	4.54	4.72	4.93	4.71	5.17	4.05	4.47
	W	7.95	7.9	6.79	7.65	7.79	8.89	8.56	9.26	7.25	8.05
Metasoma	total L	53.67	52.27	44.01	50.54	50.53	47.55	48.15	50.36	44.12	44.65
Metasoma I	L	7.83	7.44	6.27	7.38	7.38	6.66	6.78	7.2	5.9	6.27
	W	6.02	5.63	4.87	5.52	5.33	5.44	5.55	5.64	4.47	4.85
	H	5.11	4.96	4.03	4.76	4.7	4.78	4.63	4.87	4.02	4.09
Metasoma II	L	8.62	8.38	7.08	7.99	8.19	7.04	7.35	7.55	6.63	6.67
	W	5.72	5.27	4.53	5.2	5.25	5.25	5.15	5.22	4.3	4.87
	H	5.12	4.91	4.21	4.87	4.57	4.76	4.8	4.71	3.97	4.48
Metasoma III	L	8.67	8.58	7.16	8.19	8.21	7.18	7.25	7.65	6.79	6.81
	W	5.48	5.14	4.44	5.1	4.92	4.95	4.83	4.9	4.09	4.6
	H	5	4.75	4.04	4.76	4.55	4.65	4.62	4.64	3.86	4.39
Metasoma IV	L	9.86	9.68	8.29	9.26	9.51	8.6	8.61	8.86	7.83	8.27
	W	4.96	4.62	4.07	4.73	4.65	4.72	4.79	4.61	3.91	4.38
	H	4.38	4.26	3.63	4.26	3.91	4.2	4.09	4.18	3.83	3.91
Metasoma V	L	10.64	10.56	8.66	10.1	9.93	10.25	9.93	10.43	9.54	9.46
	W	4.29	4.07	3.63	3.99	3.78	4.64	4.58	4.31	3.62	4.01
	H	3.55	3.44	2.85	3.41	3.2	3.72	3.5	3.71	2.92	3
Telson	L	8.05	7.63	6.55	7.62	7.31	7.82	8.23	8.67	7.43	7.17
	vesicle L	5.02	4.59	4.09	4.79	4.39	4.78	4.79	5.36	4.59	4.45
	vesicle W	3.91	3.76	3.24	3.49	3.34	4.19	4.31	4.11	3.35	3.55
	vesicle H	3.45	3.35	2.76	3.18	2.93	3.47	3.43	3.72	3.25	3.2
	aculeus L	3.03	3.04	2.46	2.83	2.92	3.04	3.44	3.31	2.84	2.72
Pedipalp	total L	28.59	28.13	24.66	28.73	27.38	30.67	30.85	31.55	28.48	29.65
Femur	L	6.8	6.48	5.83	6.75	6.42	7.09	6.81	7.15	6.18	6.64
	W	1.96	1.94	1.61	1.88	1.81	2.15	2.03	2.09	1.82	1.89
Patella	L	7.49	7.55	6.42	7.31	7.2	7.84	7.75	8.11	7.24	7.46
	W	2.66	2.81	2.29	2.69	2.53	3.14	3.14	3.08	2.68	2.93
Chela	total L	14.3	14.1	12.41	14.67	13.76	15.74	16.29	16.29	15.06	15.55
	manus L	6.13	5.88	4.96	6.21	5.67	6.84	7.04	7.19	6.43	6.57
	manus W	2.94	3.04	2.32	2.74	2.65	3.87	4.03	3.83	3.01	3.62
	manus H	3.33	3.28	2.63	3.16	3.06	4.34	4.37	4.15	3.33	3.92
	mov. finger L	8.17	8.22	7.45	8.46	8.09	8.9	9.25	9.1	8.63	8.98
Pectines	L	9.06	9.14	7.86	8.69	8.23	8.42	8.54	9.01	8.28	7.57
Mov. finger	subrows	12/12	12/12	12/12	13/12	12/12	13/12	13/12	13/13	13/13	12/13
Pectines	tooth count	31/30	32/32	32/33	31/32	32/31	27/26	28/28	29/29	28/28	27/27

TABLE 11
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS IBERICUS* LOURENÇO AND VACHON, 2004
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		63.13	52.88	60.56	67.87	67.4	69.91	68.32	63.75	73.85	76.29
Carapace	L	6.7	6.09	6.51	7.35	7.24	7.76	7.7	7.14	8.22	8.49
	anterior W	4.9	4.29	4.65	5.04	4.87	5.14	5.46	5.07	5.76	5.54
	posterior W	6.62	5.68	6.29	7.3	7.21	7.8	7.95	7.18	8.6	8.53
Mesosoma	total L	16.31	12.36	15.88	17.6	17.33	19.56	18.28	18.43	20.4	19.4
Tergite VI	L	2.63	2.22	2.68	3.48	2.92	3.76	3.2	3.65	4.06	3.65
	W	8.48	6.72	7.48	9.37	8.43	8.63	9.3	8.48	10.48	10.28
Tergite VII	L	4.19	3.73	4.15	5.01	4.7	4.68	4.26	4.47	5.26	5.09
	W	7.54	6.3	6.95	8.5	7.79	8.01	8.48	7.58	9.55	8.54
Sternite VII	L	4	3.55	3.86	4.54	4.11	4.42	4.32	4.23	4.81	4.43
	W	7.38	5.98	6.86	8.24	7.53	7.92	8.24	7.37	9.36	8.02
Metasoma	total L	40.12	34.43	38.17	42.92	42.83	42.59	42.34	38.18	45.23	48.4
Metasoma I	L	5.38	4.55	4.97	5.87	5.49	5.35	5.52	4.99	6.09	6.28
	W	4.89	4.05	4.8	5.4	5.22	5.1	5.05	4.44	5.62	5.49
	H	4.14	3.54	3.86	4.38	4.48	4.32	4.36	4.04	4.87	4.8
Metasoma II	L	5.86	5.04	5.48	6.32	6.2	6.12	6.16	5.32	6.42	6.89
	W	4.47	3.58	4.41	4.93	5	4.72	4.76	4.24	5.39	5.27
	H	4.12	3.6	4.01	4.41	4.49	4.38	4.4	4.07	4.87	4.86
Metasoma III	L	6.17	5.1	5.82	6.67	6.6	6.48	6.34	5.73	6.8	7.23
	W	4.28	3.7	4.23	4.73	4.8	4.5	4.37	4.14	5.13	4.92
	H	3.99	3.51	4.03	4.32	4.47	4.38	4.34	4.03	4.86	4.89
Metasoma IV	L	7.31	6.42	6.92	7.68	7.92	8.08	7.71	6.92	8.31	8.84
	W	4.17	3.42	3.89	4.37	4.46	4.17	4.32	3.99	4.84	4.83
	H	3.75	3.27	3.7	3.94	4.12	3.9	3.85	3.74	4.41	4.51
Metasoma V	L	8.84	7.77	8.58	9.57	9.46	9.43	9.48	8.58	9.81	10.79
	W	3.68	3.06	3.73	3.94	3.99	3.87	3.96	3.54	4.3	4.34
	H	3.29	2.61	3.29	3.53	3.37	3.35	3.44	2.96	3.7	3.84
Telson	L	6.56	5.55	6.4	6.81	7.16	7.13	7.13	6.64	7.8	8.37
	vesicle L	4.56	3.88	4.33	4.91	4.86	4.79	4.69	4.5	5.16	5.65
	vesicle W	3.64	2.75	3.42	3.56	3.54	3.75	3.8	3.37	4.18	4.21
	vesicle H	3.06	2.3	2.74	2.99	3.13	3.13	3.33	3.04	3.57	3.67
	aculeus L	2	1.67	2.07	1.9	2.3	2.34	2.44	2.14	2.64	2.72
Pedipalp	total L	25.88	23.85	24.41	28.33	27.87	28.8	29.07	25.59	30.28	31.82
Femur	L	5.72	5.22	5.63	6.33	6.12	6.45	6.62	5.75	6.61	6.98
	W	1.74	1.54	1.65	1.93	1.99	1.98	2.04	1.9	2.11	2.2
Patella	L	6.31	6.22	6.19	7.31	7.34	7.37	7.51	6.2	7.77	8.12
	W	2.66	2.22	2.52	2.84	2.78	2.81	2.73	2.82	3.08	3.11
Chela	total L	13.85	12.41	12.59	14.69	14.41	14.98	14.94	13.64	15.9	16.72
	manus L	5.58	5.03	5.15	6.24	5.99	6.05	5.91	5.4	6.56	6.9
	manus W	3.35	2.56	3	3.51	3.61	2.78	3.01	2.73	3.14	3.81
	manus H	3.43	2.85	3.41	3.89	3.93	3.32	3.42	3.23	3.78	3.88
	mov. finger L	8.27	7.38	7.44	8.45	8.42	8.93	9.03	8.24	9.34	9.82
Pectines	L	7.15	6.83	6.99	7.52	7.86	7	7.35	6.6	7.8	7.46
Mov. finger	subrows	10/13	13/13	13/12	13/12	13/13	12/12	12/12	13/13	13/13	13/13
Pectines	tooth count	29/29	29/29	28/29	27/27	26/28	24/23	24/24	23/24	23/23	22/22

TABLE 12
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS MANCHEGO* TERUEL AND TURIEL, 2020
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		68.36	69.73	70.27	67.78	66.24	75.62	73.91	70.43	74.36	66.72
Carapace	L	6.84	6.93	7.01	6.79	6.55	8.1	8.09	7.81	7.93	7.25
	anterior W	4.74	4.69	4.79	4.53	4.63	5.44	5.7	5.57	5.48	4.96
	posterior W	6.55	6.77	6.82	6.36	6.36	8.48	8.7	8.1	8.09	7.57
Mesosoma	total L	15.34	15.08	16.55	16.77	15.64	18.94	18.57	17.53	21.15	17.35
Tergite VI	L	2.3	2.43	2.87	2.65	2.7	4.09	3.28	3.93	3.89	2.75
	W	7.24	7.92	7.89	7.75	6.98	9.45	9.41	9.53	9.25	8.52
Tergite VII	L	4.22	4.63	5.13	4.3	4.4	5.48	5.01	5.89	6.01	4.14
	W	6.89	7.47	7.53	6.91	6.96	8.91	8.37	8.42	8.09	7.57
Sternite VII	L	3.66	4.1	4.64	3.95	4.06	4.8	4.64	4.48	5.37	4.14
	W	6.54	6.98	6.85	6.64	6.88	8.56	8.26	8.26	8.11	7.09
Metasoma	total L	46.18	47.72	46.71	44.22	44.05	48.58	47.25	45.09	45.28	42.12
Metasoma I	L	6.3	6.91	6.3	6	5.75	6.74	6.52	6.02	6.44	5.71
	W	4.74	5.15	5.16	4.64	4.79	5.31	4.89	4.92	5.11	4.59
	H	4.11	4.19	4.63	4.09	4.37	4.61	4.32	4.39	4.48	4.13
Metasoma II	L	7.37	7.38	7.39	7	7.06	7.35	7.24	6.79	6.9	6.27
	W	4.47	4.92	4.83	4.47	4.42	4.96	4.75	4.65	4.68	4.45
	H	4.03	4.46	4.57	4.01	4.35	4.63	4.3	4.37	4.53	4.11
Metasoma III	L	7.47	7.7	7.4	7.11	7.2	7.41	7.36	7.04	6.79	6.42
	W	3.97	4.66	4.68	4.39	4.42	4.91	4.66	4.38	4.64	4.23
	H	3.6	4.41	4.43	3.97	4.04	4.6	4.16	4.25	4.44	4.12
Metasoma IV	L	8.76	9.2	9.16	8.29	8.47	8.93	8.66	8.25	8.47	7.81
	W	3.94	4.27	4.22	3.95	4	4.84	4.32	4.31	4.32	4.05
	H	3.63	3.91	3.96	3.55	3.67	4.12	3.85	3.86	3.97	3.72
Metasoma V	L	9.87	9.56	9.51	9.3	9.15	10.56	9.77	9.87	9.95	9.22
	W	3.45	3.96	3.65	3.66	3.63	4.32	4.15	4.27	4.28	3.71
	H	2.55	3.26	3.06	2.9	3.19	3.49	3.16	3.33	3.4	3.12
Telson	L	6.41	6.97	6.95	6.52	6.42	7.59	7.7	7.12	6.73	6.69
	vesicle L	3.92	4.34	4.27	4.17	4.27	4.85	4.9	4.52	4.28	4.16
	vesicle W	3.26	3.38	3.36	3.38	3.45	4.2	4.07	4.07	4.18	3.94
	vesicle H	2.37	3.03	3.04	2.96	2.96	3.51	3.54	3.41	3.43	3.28
	aculeus L	2.49	2.63	2.68	2.35	2.15	2.74	2.8	2.6	2.45	2.53
Pedipalp	total L	24.46	25.94	26.33	24.81	24.8	30.83	31.09	29.37	29.03	27.31
Femur	L	5.67	6.17	6	5.77	5.69	7.23	7.14	6.57	6.6	6.24
	W	1.43	1.64	1.56	1.53	1.55	1.92	1.93	2	1.93	1.81
Patella	L	6.56	6.62	6.71	6.91	6.26	7.83	7.94	7.38	7.34	7.23
	W	2.01	2.43	2.42	2.21	2.43	2.98	2.96	2.93	2.85	2.61
Chela	total L	12.23	13.15	13.62	12.13	12.85	15.77	16.01	15.42	15.09	13.84
	manus L	5.07	5.47	5.68	5.03	5.16	6.87	7.03	6.61	6.5	6
	manus W	2.22	2.54	2.71	2.19	2.58	3.69	3.39	3.55	3.54	2.95
	manus H	2.67	2.91	2.8	2.55	2.8	4.27	3.94	4.12	3.76	3.58
	mov. finger L	7.16	7.68	7.94	7.1	7.69	8.9	8.98	8.81	8.59	7.84
Pectines	L	8.22	8.52	8.55	8.9	8.2	9.48	8.84	8.63	8.97	7.69
Mov. finger	subrows	12/12	12/12	12/12	11/11	11/-	12/12	11/11	11/12	12/11	11/12
Pectines	tooth count	34/32	31/31	31/31	34/34	31/31	28/28	28/29	29/28	27/28	29/28

TABLE 13
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS MONTANUS* LOURENÇO AND VACHON, 2004
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		76.38	72.3	74.19	73.85	72.27	82.71	82.4	77.77	76.05	71.2
Carapace	L	7.8	7.59	7.85	7.33	7.14	8.95	8.98	8.46	8.4	7.77
	anterior W	5.72	5.26	5.4	5.37	5.07	6.29	6.29	6.12	6.2	5.52
	posterior W	7.69	7.3	7.47	7.15	7.11	9.19	9.17	9.28	9.16	8.72
Mesosoma	total L	16.27	17.65	17.74	19.14	18.04	24.08	21.3	21.29	19.4	17.51
Tergite VI	L	3.18	3.14	3.33	3.34	3.25	4.61	3.71	4.23	3.53	3.31
	W	9.56	8.23	8.59	8.48	9.02	10.85	10.91	10.03	10.6	10.19
Tergite VII	L	4.85	5.19	5.15	5.79	5.31	6.81	5.66	6.16	5.56	4.7
	W	8.03	7.71	7.87	7.81	8.43	9.61	10	9.38	10.08	9.11
Sternite VII	L	4.43	4.9	4.77	4.98	4.76	5.7	5	5.06	4.58	4.46
	W	7.8	7.61	7.61	7.51	8	9.35	9.1	9.15	8.83	8.26
Metasoma	total L	52.31	47.06	48.6	47.38	47.09	49.68	52.12	48.02	48.25	45.92
Metasoma I	L	7.6	6.62	6.93	6.65	6.83	6.7	7.13	6.59	6.12	6.27
	W	5.4	5.37	5.25	4.95	5.13	5.61	6.16	5.56	5.24	5.15
	H	4.62	4.54	4.52	4.33	4.46	4.78	5.1	4.76	4.71	4.38
Metasoma II	L	8.16	7.12	7.34	7.31	7.34	7.24	7.54	7.07	7.38	6.81
	W	5.25	5.02	4.83	4.74	4.85	5.13	5.64	5.51	5.13	4.66
	H	4.61	4.52	4.57	4.31	4.37	4.78	5.09	4.74	4.77	4.44
Metasoma III	L	8.33	7.38	7.44	7.42	7.41	7.53	7.74	7.34	7.46	6.77
	W	4.87	4.83	4.75	4.58	4.72	4.87	5.49	5.19	5.04	4.57
	H	4.49	4.35	4.39	4.24	4.3	4.73	5.06	4.73	4.73	4.33
Metasoma IV	L	9.92	8.95	9.31	8.86	8.71	9.03	9.5	9.15	9	8.18
	W	4.42	4.32	4.42	4.33	4.4	4.78	5.04	4.95	4.74	4.51
	H	4.16	4.03	4.05	3.82	3.89	4.32	4.59	4.41	4.19	3.97
Metasoma V	L	11.05	9.92	10.47	10.13	9.92	10.91	11.29	10.48	10.51	10.35
	W	3.96	3.98	4.04	3.76	4.05	4.63	4.94	4.72	4.28	4.37
	H	3.22	3.04	3.46	3.14	3.27	3.61	4.06	3.74	3.45	3.16
Telson	L	7.25	7.07	7.11	7.01	6.88	8.27	8.92	7.39	7.78	7.54
	vesicle L	4.8	4.48	4.73	4.55	4.6	5.17	5.57	4.67	5.06	5.08
	vesicle W	3.69	3.73	3.8	3.4	3.68	4.36	4.68	4.35	4.13	3.91
	vesicle H	3.11	3.23	3.04	2.92	3.21	3.71	4.14	3.75	3.63	3.28
	aculeus L	2.45	2.59	2.38	2.46	2.28	3.1	3.35	2.72	2.72	2.46
Pedipalp	total L	29.15	27.46	28.27	27.45	28.01	32.27	33.58	31.73	31.29	29.91
Femur	L	7.02	6.6	6.64	6.48	6.63	7.2	7.63	7.17	7.09	6.76
	W	1.86	1.89	1.82	1.91	1.89	2.02	2.3	1.96	2.04	1.91
Patella	L	7.47	7.15	7.34	7.44	7.16	8.42	8.45	8.02	8.23	7.39
	W	2.84	2.67	2.77	2.73	2.61	3.15	3.41	3.14	2.99	2.92
Chela	total L	14.66	13.71	14.29	13.53	14.22	16.65	17.5	16.54	15.97	15.76
	manus L	6.66	5.86	6.43	5.91	5.94	7.42	7.2	7.29	6.98	6.89
	manus W	3.31	2.9	3.26	2.96	2.8	3.83	4.25	3.98	3.58	3.74
	manus H	3.52	3.53	3.63	3.21	3.13	4.21	4.71	4.29	4.17	4.01
	mov. finger L	8	7.85	7.86	7.62	8.28	9.23	10.3	9.25	8.99	8.87
Pectines	L	8.8	9.1	8.62	8.33	8.78	9.37	9.65	8.62	9.28	8.35
Mov. finger	subrows	12/12	12/12	12/12	12/11	11/12	12/12	12/12	12/11	12/12	12/12
Pectines	tooth count	29/29	30/31	28/29	29/30	30/31	26/25	29/29	26/25	26/25	26/26

TABLE 14
MEASUREMENT DATA AND MERISTIC COUNTS (DEXTRAL/SINISTRAL)
FOR ADULTS OF *BUTHUS OCCITANUS* (AMOREUX, 1789)
Material deposited in the American Museum of Natural History, New York.

Specimen	Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Total L		57.1	63.59	62.51	55.23	68.49	65.84	65.83	67.25	68.5	70.08
Carapace	L	5.9	6.3	6.3	5.97	6.93	6.94	7.26	7.88	7.66	7.38
	anterior W	4.18	4.3	4.61	4.36	5.12	4.8	4.94	5.21	5.42	5.24
	posterior W	6.12	6.43	6.36	6.09	7.06	7.37	7.63	8.03	8.89	7.42
Mesosoma	total L	15.01	15.38	14.69	13.91	15.87	22.27	18.27	16.94	17.2	19.98
Tergite VI	L	1.88	1.92	1.93	1.84	2.02	2.78	2.98	2.83	2.95	2.33
	W	6.78	7.35	7.76	7.03	7.94	9.43	9.69	9.14	9.92	8.68
Tergite VII	L	4.12	4.6	4.27	3.62	4.54	4.72	5	4.57	4.98	4.52
	W	6.29	6.83	7.12	5.75	6.83	8.06	8.89	8.42	8.8	8.35
Sternite VII	L	2.52	3.71	3.51	2.79	3.49	3.89	3.94	3.67	3.29	3.68
	W	6.29	6.64	7.08	5.92	6.95	8.06	8.57	7.98	8.53	7.88
Metasoma	total L	36.19	41.91	41.52	35.35	45.69	36.63	40.3	42.43	43.64	42.72
Metasoma I	L	4.74	5.43	5.63	4.76	6.02	5.18	5.4	4.97	5.07	4.97
	W	4.31	4.52	4.77	4.4	5.23	4.22	4.53	4.61	4.88	4.8
	H	3.94	3.77	4.23	3.81	4.58	4.06	4.29	4.43	4.15	4.27
Metasoma II	L	5.79	6.71	6.03	5.38	6.95	5.24	6.23	6.33	6.24	6.54
	W	4.16	4.36	4.36	4.14	4.93	4.06	4.41	4.69	4.71	4.41
	H	3.89	4.14	4.24	3.74	4.5	4.01	4.12	4.62	4.44	3.62
Metasoma III	L	6	6.66	6.6	5.68	7.51	5.42	6.35	6.65	6.86	6.73
	W	4.1	4.05	4.19	4.06	4.69	3.78	4.17	4.38	4.61	4.27
	H	3.78	4.03	4.11	3.71	4.31	3.69	4.17	4.5	4.18	4.06
Metasoma IV	L	6.53	7.44	7.18	6.27	8.12	6.35	6.58	6.91	7.84	7.72
	W	3.7	3.63	3.72	3.54	4.39	3.91	4.18	4.32	4.23	4.17
	H	3.46	3.47	3.66	3.29	3.78	3.33	3.79	3.95	3.98	3.63
Metasoma V	L	7.63	9.03	9.34	7.56	9.99	7.93	8.32	9.8	9.31	8.72
	W	3.48	3.58	3.4	3.24	3.85	3.58	4.04	4.09	3.19	3.88
	H	2.86	3.05	3.21	2.49	2.79	3.03	3.4	3.46	3.06	3.2
Telson	L	5.5	6.64	6.74	5.7	7.1	6.51	7.15	7.77	8.32	8.04
	vesicle L	3.41	4.31	4.53	3.5	4.29	3.59	4.43	4.92	5.42	4.74
	vesicle W	2.82	2.98	2.96	2.75	3.22	3.43	3.63	3.78	4.07	3.62
	vesicle H	2.67	2.8	2.88	2.53	2.83	2.93	3.19	3.62	3.54	3.43
	aculeus L	2.09	2.33	2.21	2.2	2.81	2.92	2.72	2.85	2.9	3.3
Pedipalp	total L	21.41	24.33	24.89	21.83	25.15	23.88	27.14	28.16	30.2	27.89
Femur	L	5.04	5.39	5.74	4.97	5.92	5.61	6.06	6.08	6.72	6.16
	W	1.51	1.51	1.49	1.27	1.49	1.6	1.93	1.93	1.86	1.85
Patella	L	5.83	6.63	6.64	5.8	6.49	6.25	7.47	7.44	7.93	7.5
	W	2.21	2.28	2.24	1.98	2.29	2.34	2.58	2.89	3.01	2.73
Chela	total L	10.54	12.31	12.51	11.06	12.74	12.02	13.61	14.64	15.55	14.23
	manus L	4.08	4.53	4.7	4.33	4.94	4.41	5.56	5.9	6.48	5.76
	manus W	2.11	2.16	2.13	1.78	2.42	3.05	3.26	3.26	3.43	3.26
	manus H	2.35	2.4	2.5	2.05	2.71	3.32	3.59	3.7	4.11	3.52
	mov. finger L	6.46	7.78	7.81	6.73	7.8	7.61	8.05	8.74	9.07	8.47
Pectines	L	7.51	8.5	8.12	7.7	8.31	6.71	7.85	8.11	8.24	7.76
Mov. finger	subrows	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12	12/12
Pectines	tooth count	31/34	33/34	33/31	32/31	31/31	29/29	27/28	29/28	28/29	29/29

B. delafulentei.” Among the diagnostic characters distinguishing the putative new species, González-Moliné and Armas (2024) analyzed a series of morphometrics, e.g., total length, pedipalp chela manus shape, and metasomal segments width : length. Three phenetic clusters, considered species, were recovered by testing the ratios against a limited sample of the same morphometrics from specimens identified as *B. castellano* and *B. delafulentei*, in a discriminant analysis. However, González-Moliné and Armas (2024: 83) acknowledged the limitations of their analysis, noting that “A partir exclusivamente del análisis de los ratios morfométricos, hay tres ejemplares que no fueron correctamente clasificados por el método Jack-knifed.” This inconsistency underscores the need for caution when using morphometrics for species delimitation on a small sample.

Acquisition of material from the type locality of *B. gonzalezdelavegai* for the present investigation enabled an assessment of the diagnostic utility of the characters proposed by González-Moliné and Armas (2024) and the validity of *B. gonzalezdelavegai*. The morphometric analyses failed to support the quantitative characters proposed by González-Moliné and Armas (2024), instead grouping the topotypes of *B. gonzalezdelavegai* with *B. delafulentei* (figs. 8–10; table 4; appendices 1, 5). Qualitative characters claimed to be apomorphies for *B. gonzalezdelavegai*, i.e., attenuation of the legs, tarsal and tibial spurs; dense setation of the leg tibiae and tarsi, and a single posterior spiniform process on each of the ventrolateral carinae on metasomal segment V, were also observed in topotypes (appendix 1) and adjacent populations of *B. delafulentei*, albeit less pronounced in some cases, along with other characters, e.g., absence or reduction of the posterior processes of the ventrolateral carinae on metasomal segment V. Molecular data corroborated the morphological findings, recovering low genetic divergence between the topotypes of *B. gonzalezdelavegai* and samples of *B. delafulentei* (fig. 11; table 15; appendices 1, 2). Based on the available evidence, the following synonym is proposed: *Buthus gonzalezdelavegai* González-Moliné

and Armas, 2024 = *Buthus delafulentei* Teruel and Turiel, 2020, syn. n.

MATERIAL EXAMINED: **PORTUGAL:** **Alentejo Prov.:** Pomarão village, plot area 1 km N, 37°34'32.9"N 07°32'05.6"W, 19.v.2006, J. Birkedal-Schmidt and T. Szüts, 1 juv. ♂ (AMCC [LP 6092]). **SPAIN:** **Andalucía:** **Huelva Prov.:** Laguna del Jaral, El Asperillo (Almonte), 11.vii.2023, A.L. González-Moliné, 1 ♂ (MNCN 114), 1 ♀ (MNCN 115); Matalascañas, 21.ix.2022, 1 ♂ (MNCN 103), 1 ♀ (MNCN 106), 22.ix.2022, 1 ♂ (MNCN 107), 1 ♀ (MNCN 110); Matalascañas, 19.viii.2024, A.L. González-Moliné, 1 ♂ (AMNH), 2 juv. ♂, 2 juv. ♀ (AMCC [LP 20690]); Parque Nacional de Doñana, vicinities, 37°06'18.9"N 06°44'13.6"W, 105 m, 21.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, sandy pine forest accompanied by Mediterranean shrubs, 4 ♂, 6 ♀ (AMNH), 2 ♂ (AMCC [LP 19807, 19808]), 1 subad. ♂ (AMCC [LP 19810]), 1 juv. ♂, 1 juv. ♀ (AMCC [LP 19811]), 2 juv. ♀ (AMCC [LP 19809]); Pinar del Tableado, Hinojos, 37°16'52.5"N 06°24'02.3"W, 151 m, 21.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, pine forest with abundant understorey, 3 ♂, 4 ♀ (AMNH), 3 subad. ♀ (AMCC [LP 19812–19814]), 2 juv. ♀ (AMCC [LP 19815, 19816]). **Sevilla Prov.:** Carmona, 37°29'09"N 05°37'30"W, 150 m, 20.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, earthen slopes in dry Mediterranean meadow, 3 ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19804]), 1 juv. ♂ (AMCC [LP 19805]), 1 juv. ♀ (AMCC [LP 19806]).

Buthus elongatus Rossi, 2012

Figures 2B, 3, 5D, 7A, 8–11, 13A, B, 15D, 16D, 19A, 20A, 25A, 26A, 31A, 32A, 35B, 36B, 38; tables 1–5, 7, 15, 16

Buthus elongatus Rossi, 2012: 273–279, figs. 1–3, 4a, 5a, 6, 7, tables 1, 2; Teruel and Melic, 2015: 5–7, 9–12, figs. 2a, 3a, 4b, 5b, pl. 18, table II; Sousa et al., 2017: 25, 26, 29–31, 34, 43, figs. 9–11, tables 1, 2; Teruel and Turiel, 2020: 3–5, 7, 10, 13, 15, 26, 34, 38–40, 55,

58, figs. 2, 3, 27, 28a, b, 31a, b, tables I, II, XIII, XIV; 2021a: 3, 6, fig. 1; 2021b: 3, 4, 8, 10, fig. 1; Ythier, 2021a: 1; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.

TYPE MATERIAL: SPAIN: Andalucía: Málaga Prov.: Holotype ♂ (MZUF 1432), paratype ♀ (ARPC), Sierra Blanca, Refugio de Juanar, along road from Ojén to Monda, 36°34'25"N 04°53'04"W–36°36'56"N 04°42'19"W, 300–848 m, 2008–2012, C. Turiel; 1 ♂, 1 ♀ paratypes (MZUF 875), Playa del Alicante [36°30'N 04°49'W], 26–27.v.1983, M. Borri.

DIAGNOSIS: *Buthus elongatus* most closely resembles *B. garcialorcai* and *B. occitanus*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15D–F, 16D–F), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 8B, D, 15D–F, 16D–F), and 12 denticle rows are often present on the movable finger. These species also share the following characters: the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 38, 39, 45); the dorsosubmedian carinae on metasomal segments I–III are granular in both sexes (figs. 19, 20); and the posterior granules of the ventrosubmedian carinae on metasomal segments II and III are enlarged into subspiniiform processes in the female (fig. 26).

The three species are readily distinguished as follows. At 73.3 mm (70–77.7 mm, $n = 5$; tables 5, 7; appendix 5) (♂) and 74.8 mm (70.2–78.7 mm, $n = 5$) (♀) in total length, *B. elongatus* (fig. 8A, C) is slightly larger than *B. garcialorcai* (fig. 8A, C), at 69.24 mm (66.6–71.5 mm, $n = 4$; tables 5, 8; appendix 5) (♂) and 65.9 mm (61.3–72.1 mm, $n = 5$) (♀), and *B. occitanus* (fig. 8A, C), at 60.85 mm (49.6–70.1 mm, $n = 15$; tables 5, 14; appendix 5) (♂) and 67.52 mm (63.1–73.07 mm, $n = 13$) (♀). The base color of *B. elongatus* is dark orange

with a trivittate pattern of infuscation across the tergites (fig. 2B) whereas the base color of *B. occitanus* is pale yellow with the tergites immaculate or faintly infusate (fig. 2A). The infuscation pattern of the carapace intercarinal surfaces is type IV in *B. elongatus* (fig. 5D) and type III in *B. occitanus* (fig. 5C). All carapacial carinae are infusate and comprise granules of similar size in *B. elongatus* (figs. 7, 13A, C) whereas only the median ocular carinae are pigmented, in the anterior half, and comprise granules noticeably larger than those of other carapacial carinae in *B. occitanus* (figs. 7, 13E). Metasomal segment I of the male is longer and narrower in *B. elongatus* (figs. 9A, 19A, 25A, 31A), with segment I width : length 77% (74.9%–79.2%, $n = 5$; tables 5, 7; appendix 5) than in *B. garcialorcai* (figs. 9A, 19B, 25B, 31B), 83% (77.5%–93.4%, $n = 4$; tables 5, 8; appendix 5) and *B. occitanus* (figs. 9A, 19C, 25C, 31C), 82% (72%–92.4%, $n = 15$; tables 5, 14; appendix 5). Metasomal segment V of the male is also narrower in *B. elongatus* (figs. 9C, 19A, 25A, 31A), with segment V width : length, 36% (34.3%–36.4%, $n = 5$; tables 5, 7; appendix 5), than in *B. garcialorcai* (figs. 9C, 19B, 25B, 31B), with segment V width : length, 39% (34.7%–42%, $n = 4$; tables 5, 8; appendix 5) and *B. occitanus* (figs. 9C, 19C, 25C, 31C), with segment V width : length, 39% (35.5%–45.6%, $n = 15$; tables 5, 14; appendix 5). The dorsal surfaces of metasomal segments II–V and lateral surfaces of segment V are sparsely setose, each with no more than three pairs of macrosetae, in *B. elongatus* (type I; figs. 7A, 19A, C, 25A, C), whereas the dorsal surfaces of segments II–V are moderately setose, and the lateral surfaces of segment V, densely setose, each with more than three pairs of macrosetae, in *B. garcialorcai* (type II; figs. 7B, 19B, 25B). The posterior granules of the ventrosubmedian carinae on metasomal segments II and III of the male are unmodified in *B. elongatus* (fig. 25A) but slightly enlarged into subspiniiform processes, especially on segment III, in *B. garcialorcai*

(fig. 25B) and *B. occitanus* (fig. 25C). The telson vesicle of the male is slightly compressed in *B. elongatus* (fig. 25A), with vesicle height : length, 64% (62.4%–67.1%, $n = 5$; tables 5, 7; appendix 5), whereas it is more globose in *B. garcialorcai* (fig. 25B), with vesicle height : length, 70% (62.9%–75.3%, $n = 4$; tables 5, 8; appendix 5), and *B. occitanus* (fig. 25C), with vesicle height : length, 67% (54.9%–78.2%, $n = 15$; tables 5, 14; appendix 5).

DISTRIBUTION: *Buthus elongatus* is endemic to the Iberian Peninsula, specifically Andalucía in southern Spain. It has been recorded only from the province of Málaga, where it inhabits the Sierra de las Nieves, Sierra Blanca and vicinity (fig. 3).

ECOLOGY: *Buthus elongatus* excavates shallow burrows under stones in loamy or clayey soils in broadleaf, sclerophyllous and coniferous forests in mountainous areas (Teruel and Turiel, 2020). The coniferous forests inhabited by this species include stands of *Abies pinsapo* Boiss, 1838, an Iberian endemic restricted to the Sierra de las Nieves, Sierra Blanca and two adjacent mountain ranges (Pérez-Latorre et al., 1998). The climate of this area is predominantly hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters (Köppen, 1936; Nunes, 2023). The maritime influence of the Atlantic Ocean and the Mediterranean Sea, together with the pronounced elevation, subjects the area to frequent precipitation fronts, increasing the annual rainfall to an average of 825 mm. The habitats and habitus are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

MATERIAL EXAMINED: **SPAIN: Andalucía: Málaga Prov.:** Sierra Blanca, Ojén, 36°34'34.1"N 04°52'58.2"W, 918 m, 19.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, semihumid pine forest with distinct understorey and many stones, 8 ♂, 6 ♀ (AMNH), 1 ♂ (AMCC [LP 19787]), 1 ♀ (AMCC [LP 19789]), 1 subad. ♂, 2 juv. ♂, 1 juv. ♀ (AMCC [LP 19792]), 2 subad. ♀ (AMCC [LP 19788, 19791]), 2 juv. ♀ (AMCC [LP 19790]).

Buthus garcialorcai Teruel and Turiel, 2020

Figures 1E, 3, 5D, 7B, 8–11, 13C, D, 15E, 16E, 19B, 20B, 25B, 26B, 31B, 32B, 35C, 36C, 39; tables 1–5, 8, 15, 16

Buthus garcialorcai Teruel and Turiel, 2020: 3, 24, 26, 27, 29, 36, 38–39, 51, 59, figs. 21, 22, 27, 34c, tables VIII, XIII, XIV; 2021a: 3, fig. 1; 2021b: 3, 4, 8, fig. 1; Ythier, 2021a: 1; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.
Buthus occitanus: Rossi, 2012: 277 [misidentification, part].
Buthus sp. Granada lineage: Sousa, 2017: 204, 205, 211–214, 216, 218, 224, 231, 286, tables V-1, V-3, V-4, supp. able 5.1, figs. V-1–V-4, supp. fig. 5.4–5.12.

TYPE MATERIAL: Holotype ♂, paratype ♀ (RTO), **SPAIN: Andalucía: Granada Prov.:** Víznar Municipality: Sierra de la Alfaguara, Víznar, 1 km N of road A-92, 37°14'06"N 03°32'05"W, 1212 m, 25.vi.2016, C. Turiel.

DIAGNOSIS: *Buthus garcialorcai* most closely resembles *B. elongatus* and *B. occitanus*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15D–F, 16D–F), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 8B, D, 15D–F, 16D–F), and 12 denticle rows are often present on the movable finger. The three species also share the following characters: the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 38, 39, 45); the dorsosubmedian carinae on metasomal segments I–III are granular in both sexes (figs. 19, 20); and the posterior granules of the ventrosubmedian carinae on metasomal segments II and III are enlarged into subspiniiform processes in the female (fig. 26).

The three species are readily distinguished as follows. At 69.24 mm (66.6–71.5 mm, $n = 4$; tables 5, 8; appendix 5) (♂) and 65.9 mm (61.3–72.1



FIGURE 19. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. Scale bars = 5 mm.



FIGURE 20. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus elongatus* Rossi, 2012, ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♀ (AMNH), Souvignargues, Occitanie, France. Scale bars = 5 mm.



FIGURE 21. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.



FIGURE 22. *Buthus* Leach, 1815, metasoma and telson, dorsal aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♀ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♀ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.



FIGURE 23. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus delafulentei*, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), Sc216 ♂ (CIBIO-InBIO), São Pedro de Agostém, Alto-Douro, Portugal. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 2 mm.



FIGURE 24. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus delafulentei* Teruel and Turiel, 2020, ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♀ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 5 mm.

mm, $n = 5$) (♀) in total length, *B. garcialorcai* (fig. 8A, C) is slightly smaller than *B. elongatus*, at 73.3 mm (70–77.7 mm, $n = 5$; tables 5, 7; appendix 5) (♂) and 74.8 mm (70.2–78.7 mm, $n = 5$) (♀). The base color of *B. garcialorcai* is dark orange with a trivittate pattern of infuscation across the tergites (fig. 2B), whereas the base color of *B. occitanus* is pale yellow with the tergites immaculate or faintly infusate (fig. 2A). The infuscation pattern of the carapace intercarinal surfaces is type IV in *B. garcialorcai* (fig. 5D) and type III in *B. occitanus* (fig. 5C). All carapacial carinae are infusate and comprise granules of similar size in *B. garcialorcai* (figs. 6, 13A, C) whereas only the median ocular carinae are pigmented, in the anterior half, and comprise granules noticeably larger than those of other carapacial carinae in *B. occitanus* (figs. 6, 13E). Metasomal segment I of the male is shorter and broader in *B. garcialorcai* (figs. 9A, 19B, 25B, 31B), with segment I width : length 83% (77.5%–93.4%, $n = 4$; table 8; appendix 5), than in *B. elongatus* (figs. 9A, 19A, 25A, 31A), with segment I width : length 77% (74.9%–79.2%, $n = 5$; tables 5, 7; appendix 5). Metasomal segment V of males is also broader in *B. garcialorcai* (figs. 9B, 19B, 25B, 31B), with segment V width : length, 39% (34.7%–42%, $n = 4$; tables 5, 8; appendix 5), than in *B. elongatus* (figs. 9B, 19A, 25A, 31A), with segment V width : length, 36% (34.3%–36.4%, $n = 5$; tables 5, 7; appendix 5). The dorsal surfaces of metasomal segments II–V are moderately setose, and the lateral surfaces of segment V, densely setose, each with more than three pairs of macrosetae, in *B. garcialorcai* (type II; figs. 7B, 19B, 25B), whereas the dorsal surfaces of segments II–V and lateral surfaces of segment V are sparsely setose, each with no more than three pairs of macrosetae in *B. elongatus* and *B. occitanus* (type I; figs. 7A, 19A, C, 25A, C). The posterior granules of the ventrosubmedian carinae on metasomal segments II and III of the male are slightly enlarged into subspiniiform processes, especially on segment III, in *B. garcialorcai* (fig. 25B) but unmodified in *B. elongatus* (fig. 25A). The telson vesicle of the male is slightly globose in *B. garcialorcai* (fig. 25B), with vesicle height : length, 70% (62.9%–75.3%, $n = 4$; tables

5, 8; appendix 5), whereas it is more compressed in *B. elongatus* (fig. 25A), with vesicle height : length, 64% (62.4%–67.1%, $n = 5$; tables 5, 7; appendix 5).

DISTRIBUTION: *Buthus garcialorcai* is endemic to the Iberian Peninsula, specifically to Andalucía in southern Spain. It has been recorded from the provinces of Almería and Granada, where it inhabits several adjacent mountain ranges including the Sierras de Tejeda, Almijara y Alhama, Sierra de Huétor and Sierra Nevada.

ECOLOGY: *Buthus garcialorcai* excavates shallow burrows in silty soils, on bare slopes or under stones in high elevation (1000–2500 m) coniferous forests (fig. 3; table 16) (Sousa, 2017; Teruel and Turiel, 2020). The climate of the area inhabited by this species is predominantly warm-summer Mediterranean (Csb), characterized by hot, dry summers and cold winters (Köppen, 1936; Nunes, 2023), with precipitation in the form of snow above 2000 m. The habitat and habitus are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

MATERIAL EXAMINED: SPAIN: Andalucía: Granada Prov.: Granada, 2 ♂ (MNCN 9497, 9500); Parque Natural Sierra de Huétor, 37°14'09.2"N 03°32'02.7"W, 1291 m, 18. viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, rocky pine forest with abundant litter (pine needles), 1 ♂, 6 ♀ (AMNH), 1 ♀, 1 subad. ♀, 1 juv. ♀ (AMCC [LP 19783]), 4 subad. ♀ (AMCC [LP 19778, 19780–19782]), 1 juv. ♂ (AMCC [LP 19779]).

Buthus halius (C.L. Koch, 1839)

Figures 1A, F, 3, 5D, 7B, 8–11, 12C, D, 15B, 16B, 17B, 18B, 23B, 24B, 29B, 30B, 35D, 36D, 40; tables 1–5, 9, 15, 16

Androctonus halius C.L. Koch, 1839a: 69, 70, 155, pl. 163, fig. 383; Gervais, 1844: 43; C.L. Koch, 1850: 90; Teruel and Turiel, 2020: 3, 4; 2021a: 3, 4, 8, 11.

- And. ajax* C.L. Koch, 1839a: 127, 128 [*nomen nudum*].
- Androctonus ajax* C.L. Koch, 1839b: 53; pl. 193, fig. 467, syn. n.; Teruel and Turiel, 2020: 3, 4; 2021a: 3, 4, 7.
- Buthus occitanus* [as *B. europaeus* from *Scorpio europaeus*, the “Rejected and Invalid Specific Name” in *Zoology* #381]: Simon, 1879: 96, 98 [misidentification]; Lourenço and Rossi, 2013: 13, fig. 10 [misidentification].
- Buthus ibericus*: Lourenço and Vachon, 2004: 93 [misidentification, part]; Teruel and Pérez-Bote, 2005: 275, 276 [misidentification]; Stockmann and Ythier, 2010: 338 [misidentification]; Sousa et al., 2010: 207–209, figs. 1–2, table 1 [misidentification, part]; Rossi, 2012: 273, 274, 276–279, figs. 6a, 7; Sousa et al., 2017: 15, 44, 45, fig. 13 [misidentification, part].
- Buthus ajax*: Teruel and Turiel, 2021a: 3, 4, 6–8, 10, 12–13, 15–18, 20, figs. 1b, 2–5, 10a, b, 11, tables I, III–IV; 2021b: 3, 4, 8, fig. 1 [misidentification]; Ythier, 2021a: 1; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.
- Buthus halius*: Teruel and Turiel, 2021a: 3, 4, 6–8, 10, 11, 13, 14, 17, 18, 20, figs. 1b, 6–9, 10c, d, 12, tables II–IV; 2021b: 3, 4, 8–10, fig. 1; Ythier, 2021a: 1, 4; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 15, 20, 28–33, 35, 36, figs. 12–21, 23, 25, 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.
- Buthus lusitanus* Lourenço, 2021: 1–7, figs. 1–8, 14–17 (synonymized by Teruel and Turiel, 2022b: 15, 19, 20, 28–33, 35, 36, figs. 12b, d, 13b, c, e, f, 15, 18–21, 23, 25, 26); Ythier, 2021a: 1; Ythier and Laborieux, 2022: 1.
- Buthus gabani* Ythier 2021a: 1–6, figs. 1–10, table I, syn. n.; Teruel and Turiel, 2021b: 3, 4, 8, 9, fig. 1; Ythier, 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.
- Buthus castellano* Teruel and Turiel, 2022b: 15–17, 19, 22–28, 33, 34, 36, figs. 1–11, 22, 24, 26, tables I–III, syn. n.; González-Moliné et al., 2023: 215; González-Moliné and Armas, 2024: 82, 83, tables III, IV.
- TYPE MATERIAL:** Holotype [possibly ♀, according to Teruel and Turiel (2021a: 11)], **PORTUGAL:** [lost]. Neotype ♂ (IES [CIBIO-InBIO Sc094]), **Trás-os-Montes e Alto Douro Prov.: Vila Real Distr.:** Tua riverbank facing Santa Luzia train station, 41°16'58"N 07°23'34"W, 164 m, 23.vii.2006, P.R. de Sousa. *Androctonus ajax*: Holotype [possibly subad. ♀, according to Teruel and Turiel, 2021a: 7] (Jakob Sturm Private Collection, Nüremberg). **SPAIN:** [lost]. Neotype ♂ (IES); **Castilla-La Mancha: Toledo Prov.:** Montes de Toledo, 1 km SE of Porzuna, along road CM-403, 39°08'11"N 04°07'36"W, 706 m, 13.vi.2018, C. Turiel. *Buthus castellano*: **SPAIN: Castilla y León: Valladolid Prov.:** Holotype ♂ (RTO), Pinar de Herrera, 1 km SE of Herrera de Duero, near road CL-600, 41°33'22.5"N 4°38'32.1"W, 700 m, 11.xiii.2022, C. Turiel; 1 ♂, 4 ♀, 14 juv. ♂, 8 juv. ♀ paratypes (RTO), Pinar del Esparragal, 1.9 km SW of Puente Duero, near road CL-610, 41°32'27.4"N 4°48'38.4"W, 700 m, 12.viii.2022, C. Turiel. *Buthus gabani*: Holotype ♂ (MHNL 47037912), paratype ♀ (MHNL 47037911). **PORTUGAL: Algarve Prov.: Faro Distr.:** Cape St. Vincent, 15.viii.1993, S. Rojko. *Buthus lusitanus*: Holotype ♀, 2 juv. ♂ paratypes (MNHN). **Beira Prov.: Guarda Dist.:** Parque Natural da Serra da Estrela, Vallée du Zêzere, zone rocailleuse, 990 m, vii.1982, A. de Barros Machado.
- DIAGNOSIS:** *Buthus halius* most closely resembles *B. delafontei* and *B. ibericus*. All three species possess a globose, incrassate pedipalp chela with the chela fixed and movable fingers curved basally and emarginate when closed in both sexes (figs. 8B, C, 11, 15A–C, 16A–C) and 13 denticle rows are often present on the movable finger.

TABLE 15

MEAN INTERSPECIFIC AND INTRASPECIFIC (BOLD) UNCORRECTED PAIRWISE DISTANCES
OF THE INTERNAL TRANSCRIBED SPACER (ITSII), 12S rDNA (12S), 16S rDNA (16S) AND
CYTOCHROME *c* OXIDASE SUBUNIT I (COI) LOCI FOR THE EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815
Interspecific and intraspecific pairwise distances for ITSII were assigned based on nuDNA tree to account for
mtDNA introgression. Abbreviations: *del*, *Buthus delafluentei* Teruel and Turiel, 2020; *elo*, *Buthus elongatus* Rossi, 2012;
gar, *Buthus garcialorcai* Teruel and Turiel, 2020; *hal*, *Buthus halius* (C.L. Koch, 1839); *ias*, *Buthus iaspis* Teruel and
Turiel, 2022; *ibe*, *Buthus ibericus* Lourenço and Vachon, 2004; *man*, *Buthus manchego* Teruel and Turiel, 2020;
mon, *Buthus montanus* Lourenço and Vachon, 2004; *occ*, *Buthus occitanus* (Amoreux, 1789).

		<i>del</i>	<i>elo</i>	<i>gar</i>	<i>hal</i>	<i>ias</i>	<i>ibe</i>	<i>man</i>	<i>mon</i>	<i>occ</i>
ITSII	<i>del</i>	0.0067								
	<i>elo</i>	0.0331	–							
	<i>gar</i>	0.0538	0.0575	–						
	<i>hal</i>	0.0429	0.0420	0.0320	0.0020					
	<i>ias</i>	0.0335	0.0322	0.0506	0.0320	0.0052				
	<i>ibe</i>	0.0347	0.0095	0.0518	0.0362	0.0264	0.0024			
	<i>man</i>	0.0441	0.0434	0.0319	0.0078	0.0380	0.0376	0.0023		
	<i>mon</i>	0.0305	0.0315	0.0473	0.0291	0.0041	0.0267	0.0352	0.0024	
	<i>occ</i>	0.0342	0.0334	0.0463	0.0233	0.0096	0.0278	0.0295	0.0060	0.0008
12S	<i>del</i>	0.0201								
	<i>elo</i>	0.0944	–							
	<i>gar</i>	0.1071	0.0744	–						
	<i>hal</i>	0.0343	0.0890	0.1023	0.0272					
	<i>ias</i>	0.0933	0.1068	0.0952	0.0972	0.0079				
	<i>ibe</i>	0.0919	0.0976	0.0942	0.0896	0.1273	0.0039			
	<i>man</i>	0.1023	0.0907	0.0906	0.1053	0.1236	0.0992	0.0203		
	<i>mon</i>	0.0905	0.0947	0.0789	0.0906	0.0467	0.1085	0.1123	0.0118	
	<i>occ</i>	0.0846	0.0924	0.0889	0.0865	0.1037	0.0912	0.0926	0.0888	0.0152
16S	<i>del</i>	0.0169								
	<i>elo</i>	0.0994	–							
	<i>gar</i>	0.0734	0.0874	–						
	<i>hal</i>	0.0342	0.1000	0.0780	0.0282					
	<i>ias</i>	0.0814	0.1093	0.0775	0.0800	0.0051				
	<i>ibe</i>	0.0861	0.1013	0.0862	0.0831	0.0899	0.0214			
	<i>man</i>	0.0902	0.0988	0.0937	0.0927	0.1135	0.1113	0.0236		
	<i>mon</i>	0.0804	0.0990	0.0679	0.0831	0.0423	0.0895	0.1057	0.0127	
	<i>occ</i>	0.0946	0.0991	0.0904	0.0937	0.1041	0.1035	0.0995	0.1044	0.0254
COI	<i>del</i>	0.0228								
	<i>elo</i>	0.0933	–							
	<i>gar</i>	0.0840	0.0853	–						
	<i>hal</i>	0.0484	0.0968	0.0880	0.0371					
	<i>ias</i>	0.1019	0.0881	0.0967	0.1028	0.0086				
	<i>ibe</i>	0.0803	0.0761	0.0776	0.0849	0.0871	0.0179			
	<i>man</i>	0.0991	0.0935	0.0966	0.1044	0.1012	0.1025	0.0250		
	<i>mon</i>	0.1016	0.0937	0.0909	0.0959	0.0826	0.0968	0.0933	0.0194	
	<i>occ</i>	0.0927	0.0920	0.0855	0.0916	0.0992	0.0950	0.1066	0.1029	0.0221

The three species are readily distinguished as follows. At 67.8 mm (60–74.5 mm, $n = 18$; tables 5, 9; appendix 5) (♂) and 73.5 mm (65.1–85.4 mm, $n = 25$) (♀) in total length, *B. halius* (fig. 40) is slightly larger than *B. ibericus* (fig. 42), at 62.4 mm (52.9–67.9 mm, $n = 5$; tables 5, 11; appendix 5) (♂) and 70.4 mm (63.8–76.3 mm, $n = 5$) (♀), but considerably smaller than *B. delafulentei* (fig. 37), at 76.9 mm (69.5–80.67 mm, $n = 10$; tables 5, 6; appendix 5) (♂) and 80.8 mm (73.6–84.9 mm, $n = 7$) (♀). The posterolateral carinae of the male carapace are obsolete, reduced to discontinuous granules in *B. halius* (figs. 6, 12C) but distinct and granular in *B. delafulentei* (fig. 6, 12A). The pedipalp chela fixed and movable fingers are markedly curved basally and deeply emarginate when closed in both sexes of *B. halius* (figs. 15A, B, 16A, B), whereas the fingers are slightly curved basally and shallowly emarginate when closed in the male or sublinear basally and not emarginate when closed in the female of *B. ibericus* (figs. 15C, 16C). The legs are robust, with short femora, patellae, tibiae, and tarsi in *B. halius* (fig. 40) but slender, with slightly elongate femora, patellae, tibiae, and tarsi in *B. delafulentei* (fig. 37). The retrolateral margins of the leg tibiae and tarsi are sparsely setose, with short macrosetae in *B. halius*, but densely setose, with elongated macrosetae in *B. delafulentei*. The pectinal tooth counts are higher in *B. halius*, i.e., 30/31 (28–33/28–33, $n = 18$; tables 5, 9; appendix 5) (♂) and 26/27 (24–29/24–29, $n = 25$) (♀), than in *B. ibericus*, i.e., 28/28 (26–29/27–29, $n = 5$; tables 5, 11; appendix 5) (♂) and 23/23 (22–24/22–24, $n = 5$) (♀). The metasoma of *B. halius* is shorter, especially in the female (figs. 27B, 18B, 23B, 24B, 29B, 30B), with mesosoma length : metasoma length, 38% (33.8%–40.1%, $n = 18$; tables 5, 9; appendix 5) (♂) or 42% (35.9%–46.3%, $n = 25$) (♀), than that of *B. delafulentei* (figs. 17A, 18A, 23A, 24A, 29A, 30A), with mesosoma length : metasoma length, 36% (32.9%–36.8%, $n = 7$; tables 5, 6; appendix 5) (♂) or 39% (36.9%–41.1%, $n = 7$) (♀). The metasoma of *B. halius* is also broader, more so in the female (figs. 9, 17B, 18B, 23B,

24B, 29B, 30B), with segment I width : length 77% (71.8%–92.8%, $n = 18$; tables 5, 9; appendix 5) (♂) or 81% (75.9%–86.6%, $n = 25$) (♀), segment II width : length 67% (63.1%–75.6%) (♂) or 71% (64.7%–81.2%) (♀), segment III width : length 63% (59.9%–66.9%) (♂) or 66% (59.3%–73.8%) (♀), and segment IV width : length 50% (46.6%–53.9%) (♂) or 53% (47%–62.3%) (♀), than that of *B. delafulentei* (figs. 9, 17A, 18A, 23A, 24A, 29A, 30A), with segment I width : length 73% (63.9%–79.3%, $n = 10$; tables 5, 6; appendix 5) (♂) or 77% (73.6%–81.6%, $n = 7$) (♀), segment II width : length, 63% (62%–77.8%) (♂) or 64% (57.7%–76.6%, $n = 7$) (♀), segment III width : length 58% (53.9%–68.9%) (♂) or 60% (55.6%–65.6%) (♀), and segment IV width : length 49% (43.7%–52.3%) (♂) or 50% (47.4%–52.6%) (♀). The dorsal surfaces of the metasoma are moderately setose in *B. halius* (type II; figs. 7B, 17B, 18B) but asetose in *B. ibericus* (figs. 17C, 18C). The dorsosubmedian carinae of metasomal segments I–III are granular in *B. halius* (figs. 17B, 18B) but obsolete in *B. ibericus* (fig. 17C, 18C). The ventrolateral carinae of metasomal segment V each bear two or more enlarged, lobate or spiniform processes posteriorly in *B. halius* (figs. 23B, 24B) but at most one enlarged process posteriorly in *B. delafulentei* (figs. 23A, 24A). The dorsal and lateral intercarinal surfaces of metasomal segment V are sparsely granular in *B. halius* (figs. 17B, 18B, 23B, 24B) but smooth in *B. ibericus* (figs. 17C, 18C, 23C, 24C).

INTRASPECIFIC VARIATION: Given the broad geographical range of *B. halius*, conspecific populations might be expected to exhibit phenotypic variation, as in other species of *Buthus* (Vachon, 1952c; Habel et al., 2012). Specimens from the northern and northwestern parts of the distribution are typically light to dark yellow in base color, compared with specimens from central and southern parts of the distribution, which are more orange. The count of denticle rows on the movable finger of the pedipalp chela varies from 12 to 13 between southern and northern populations. However, this pattern is inconsistent: some northern specimens

display 13 rows and some southern specimens, 12 (table 9; appendix 5). The variation observed across the distribution of *B. halius* led some authors (Teruel and Turiel, 2020, 2021a; Lourenço, 2021; Ythier, 2021a) to mistakenly recognize several species (see below).

In addition to phenotypic variation, *B. halius* exhibits some genetic structure across its range (fig. 11; Blasco-Aróstegui et al., in prep.). However, the genetic distance between populations of *B. halius* is lower than the distances between this species and other European species of *Buthus* (table 15; Blasco-Aróstegui et al., in prep.). Putative glacial refugia, river systems, and substrate variation may have contributed to local differentiation.

DISTRIBUTION: *Buthus halius* is endemic to the Iberian Peninsula, where it is widespread across Portugal and most of western and central Spain. In Portugal, it has been recorded in the provinces of Alentejo, Algarve, Beira, Tras-os-Montes e Alto Douro and Douro Litoral (fig. 3) but probably occurs throughout the country. In Spain, it has been recorded from the regions of Castilla-La Mancha, Castilla y León, Extremadura and Madrid (fig. 3), and probably reaches southern Galicia.

ECOLOGY: *Buthus halius* excavates shallow burrows under stones and on bare, rocky slopes in coarse substrates in mixed, sclerophyllous and coniferous forests or Mediterranean shrublands along river valleys, mountain ranges (e.g., the Serra da Estrela, Guadarrama, Gredos or Montes de Toledo) and capes, at altitudes of 105–1717 m (fig. 3; table 16) (Sousa, 2017; Lourenço, 2021; Teruel and Turiel, 2020, 2021a; 2022b; Ythier, 2021a). The climate across its distribution varies between warm-summer Mediterranean (Csb), influenced by precipitation fronts from the Atlantic Ocean, and hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters (Köppen, 1936; Nunes, 2023). The habitat and habitus are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

REMARKS: Teruel and Turiel (2021a) revalidated *B. halius*, previously synonymized with *B.*

ibericus by Sousa et al. (2017) and, before that, with *B. occitanus* by Simon (1879). The validity of *B. halius* has been the subject of considerable debate (Sousa et al., 2017; Teruel and Turiel, 2021a) due to its vague description and imprecise type locality, alleged to be in Portugal. Compounding the problem, the type material is lost, leaving only a few illustrations in the original description as primary evidence. Koch's (1839a: 155) figure 383 clearly depicts an emarginate movable finger of the pedipalp chela (i.e., a shallow lobe), a key diagnostic character distinguishing *B. halius* from all other European *Buthus* species, except *B. delafulentei* and *B. ibericus*. Teruel and Turiel (2021a) therefore designated a neotype for *B. halius* from Portugal, where *B. ibericus* is not present (fig. 3).

The validity of *B. halius* was upheld in the present investigation, based on analyses which included samples from the vicinity of the neotype locality. However, after reevaluation of topotypes (appendix 1) and additional material of other putative species, described or revalidated in the past decade, the diagnostic characters proposed to delimit the allegedly heterospecific populations were found to be overly subtle, inconsistent or overlapping (figs. 8–10; tables 5, 9; appendices 1, 5). Furthermore, the genetic distances between these populations and *B. halius* were lower than those between other European species of *Buthus*, failing to support their recognition as distinct species (table 15; Blasco-Aróstegui et al., in prep.). Arguments justifying the taxonomic decisions regarding each putative species are presented below.

Teruel and Turiel (2021b) revalidated *B. ajax* from synonymy with *B. occitanus* (Simon, 1879) and designated a neotype for the species. Separately, Teruel and Turiel (2021a: 7) presented four qualitative characters (i.e., coloration, pedipalp carination, pedipalp chela dentition, and sternite surface texture) and three quantitative characters (i.e., pedipalp chela dimensions, pectinal tooth count, and metasomal dimensions) to distinguish *B. ajax* from other morphologically similar species, including *B. halius*. None

of the proposed diagnostic characters withstand scrutiny, however. The qualitative characters are ambiguous, either too subtle or falling within the range of intraspecific variation, the quantitative characters concerning pedipalp chelal and metasomal dimensions were unsupported in the morphometric analyses (fig. 10), and the pectinal tooth count overlaps among allegedly heterospecific populations (Teruel and Turiel, 2020; 2021a, 2021b; 2022a, 2022b; tables 5, 9; appendices 1, 5). Molecular data corroborated the morphological findings, recovering low genetic divergence between the topotypes of *B. ajax* and *B. halius* (fig. 8–11; tables 5, 9, 15; appendices 1, 5). Based on the available evidence, the following synonym is proposed: *Buthus ajax* (C.L. Koch, 1839) = *Buthus halius* (C.L. Koch, 1839), syn. n. Although the two names were published contemporaneously, the name *B. halius* is prioritized due to its more extensive usage in the literature.

Lourenço (2021) described *B. lusitanus* from the Vale Glaciar do Zêzere in Portugal. According to Lourenço (2021: 2, 3, fig. 1), *B. lusitanus* possesses a unique dark spot on the carapace, illustrated and described as the primary diagnostic character: “Plaque prosomienne jaune clair avec une tache dans la région centrale, allant des carènes antérieures aux sillons postérieurs.” Despite correctly identifying differences in infuscation between *B. lusitanus* and *B. occitanus* (fig. 5C, D), Lourenço (2021) failed to compare the most morphologically similar species, i.e., *B. halius*, in which this infuscation is consistently present and, as noted by Teruel and Turiel (2022b), the holotype female is immature, not adult as claimed by Lourenço (2021). Based on the mistaken assumption that the holotype was an adult with the pedipalp chela fingers sublinear and not emarginate, i.e., lacking the “basal lobe/notch combination,” Lourenço (2021) instead considered *B. lusitanus* closely related to *B. alacanti* and *B. occitanus*. Teruel and Turiel (2022b) later demonstrated that adult male and female specimens identified as *B. lusitanus* exhibit globose chelae with the fixed and mov-

able fingers curved basally and emarginate when closed. The remaining putatively diagnostic characters proposed for *B. lusitanus* are either imprecise or overlap among different species (tables 5, 9; appendix 5), which in combination with its chela configuration, led these authors to synonymize it with *B. halius*.

Ythier (2021a) described *B. gabani* based on old, desiccated material from the MHNL. The new species, allegedly endemic to Portugal and restricted to the Algarve region, was differentiated from *B. halius* by a series of dubious characters (Ythier, 2021a: 4). Acquisition of material from the type locality of *B. gabani* (appendix 1) for the present investigation enabled an assessment of the diagnostic utility of the characters proposed by Ythier (2021) and the validity of *B. gabani*. Size and morphometric differences were not found to be statistically significant in the multivariate analyses (figs. 8–10; tables 5, 9; appendix 5), and counts of denticle rows on the pedipalp chela movable finger overlapped with those observed in heterospecific populations. Molecular data corroborated the morphological findings, recovering low genetic divergence between the topotypes of *B. gabani* and *B. halius* (figs. 8–11; tables 5, 9, 15; appendices 1, 5). Based on the available evidence, the following synonym is proposed: *Buthus gabani* Ythier, 2021 = *Buthus halius* (C.L. Koch, 1839), syn. n.

Teruel and Turiel (2022b) described *B. castellano* based on specimens from the Spanish region of Castilla y León. Although *B. castellano* was considered psammophilous based on a photograph of a specimen *in situ* on a sandy substrate, conspecific populations examined in the present investigation were not found to exhibit any psammophilous characters compared with other *Buthus* species. Teruel and Turiel’s (2022b) diagnosis also failed to compare the geographically proximate species, *B. halius*, instead focusing the comparison on *B. delafluentei*, only found in southern Spain. When topotypes of *B. castellano* were compared with topotypes and additional material of *B. halius*, the putative diagnostic characters were a close



FIGURE 25. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. Scale bars = 2 mm.



FIGURE 26. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus elongatus* Rossi, 2012, ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♀ (AMNH), Souvignargues, Occitanie, France. Scale bars = 5 mm.



FIGURE 27. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.



FIGURE 28. *Buthus* Leach, 1815, metasoma and telson, lateral aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♀ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♀ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.

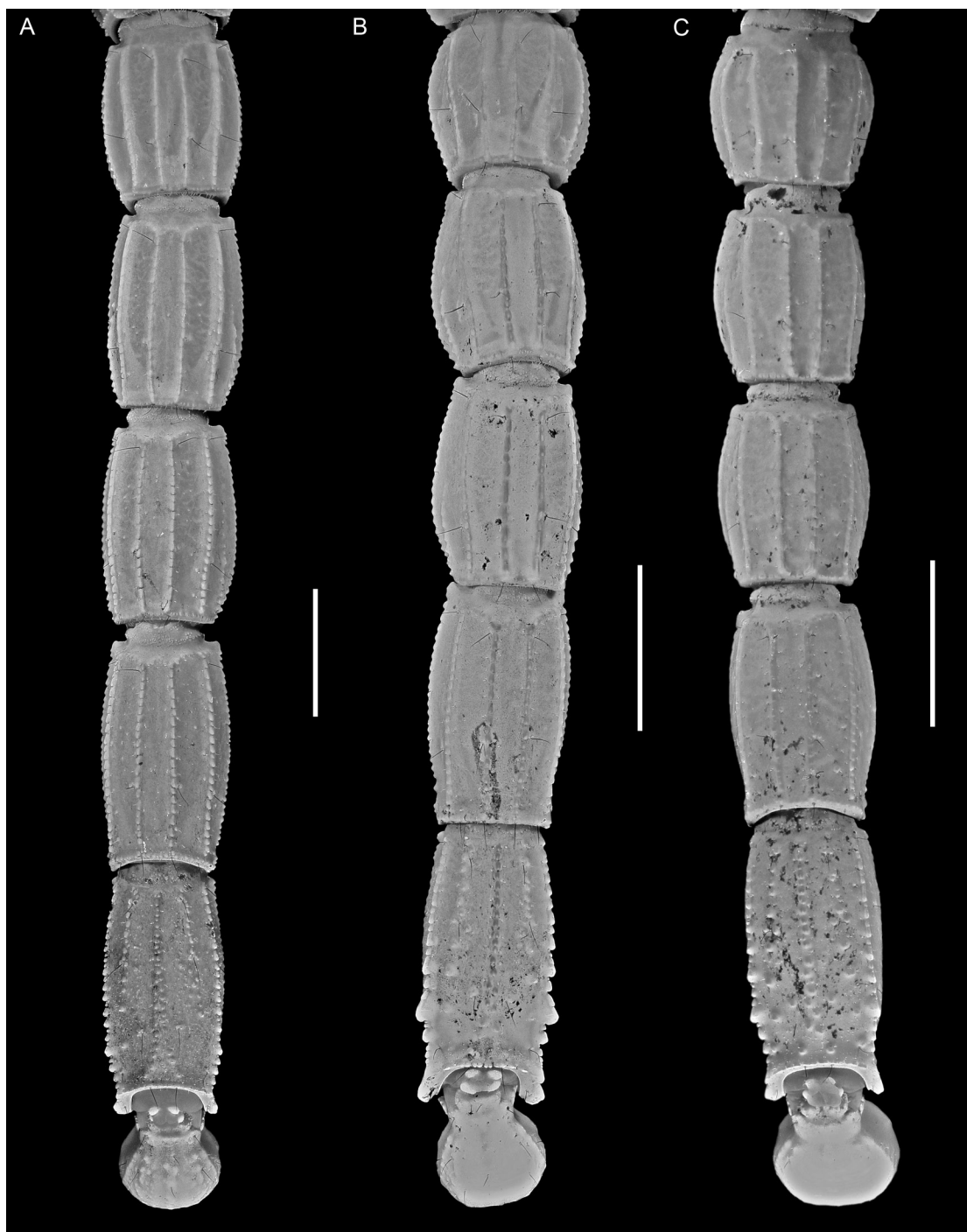


FIGURE 29. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus delafuentei*, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 5 mm.

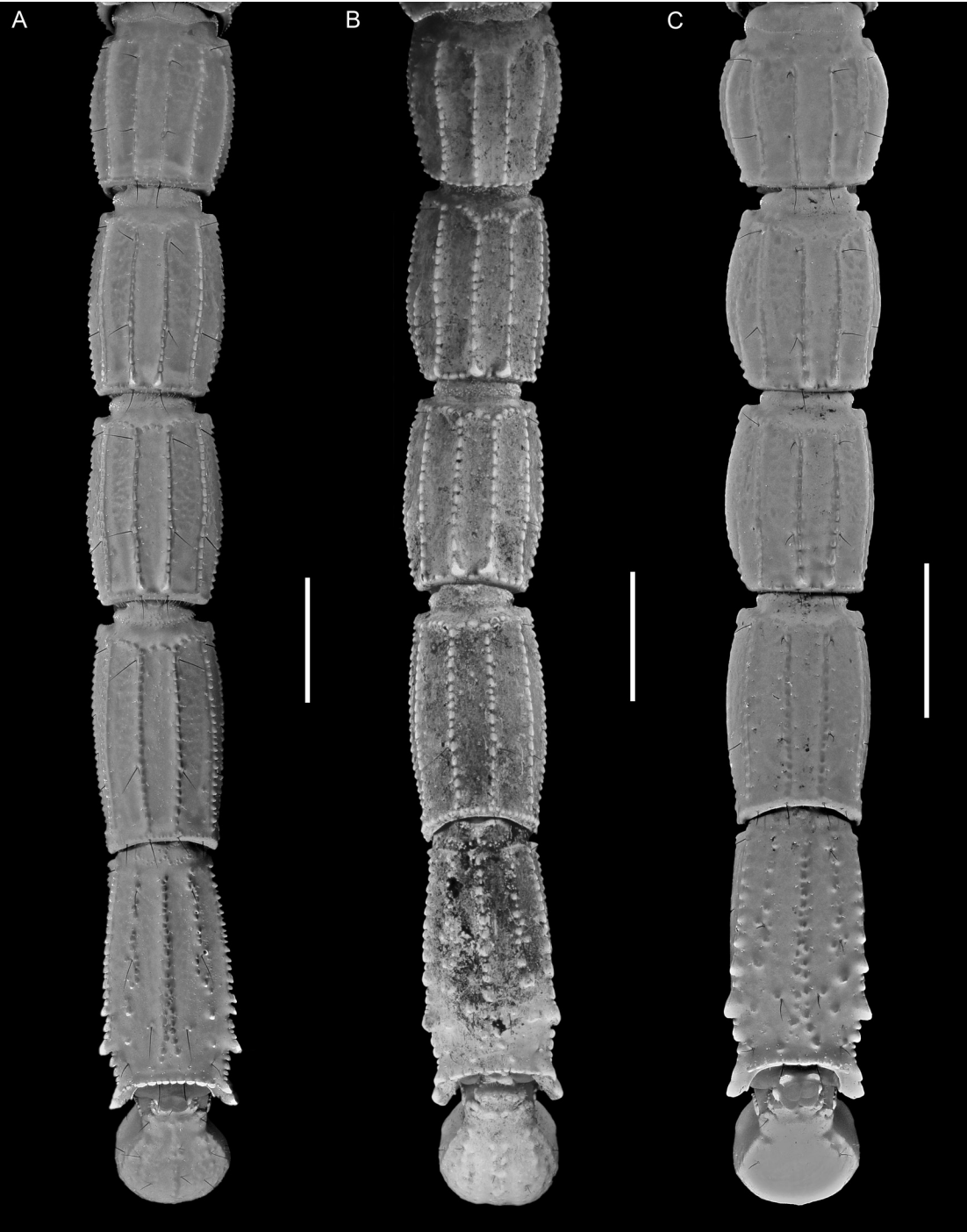


FIGURE 30. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus delafluentei* Teruel and Turiel, 2020, ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. **B.** *Buthus halius* (C.L. Koch, 1839), ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. **C.** *Buthus ibericus* Lourenço and Vachon, 2004, ♀ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 5 mm.

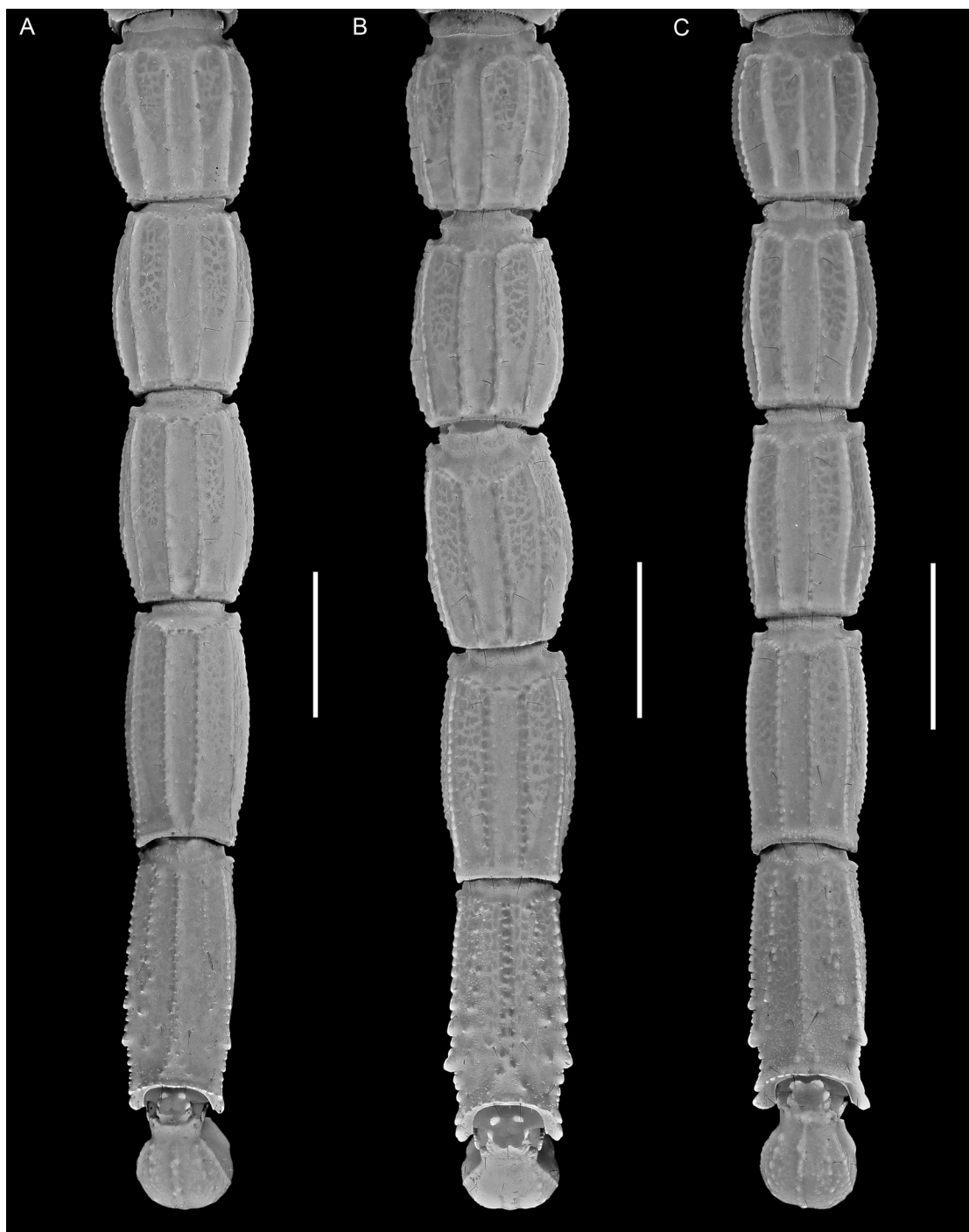


FIGURE 31. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. Scale bars = 5 mm.

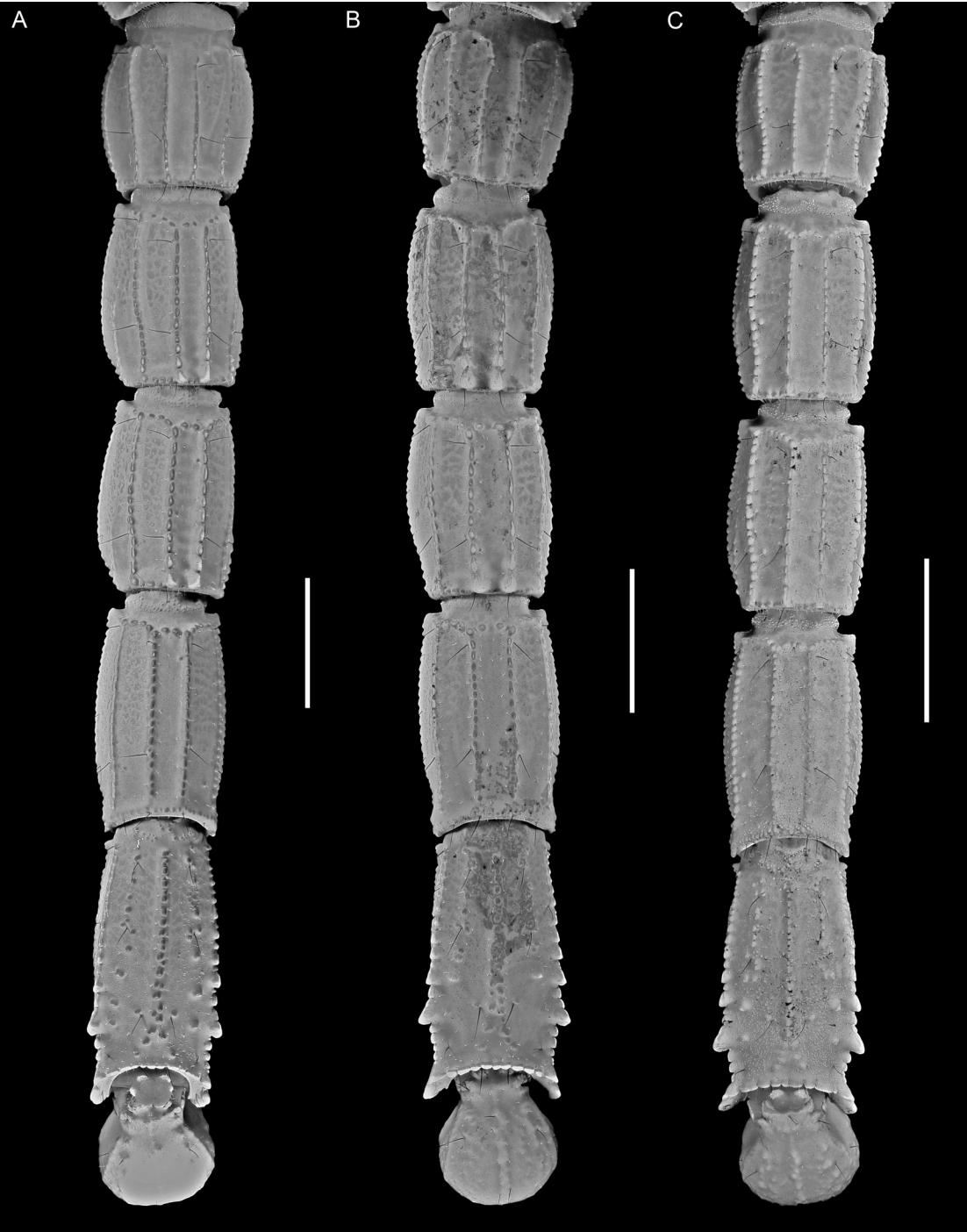


FIGURE 32. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus elongatus* Rossi, 2012, ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. **B.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. **C.** *Buthus occitanus* (Amoreux, 1789), ♀ (AMNH), Souvignargues, Occitanie, France. Scale bars = 5 mm.

TABLE 16

ECOLOGICAL CLASSIFICATION OF EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815
 BASED ON ECOREGION, HABITAT, ELEVATION RANGE AND NICHE PREFERENCES

Follows Blasco-Aróstegui et al. (in prep.). Abbreviations and symbols:

A, annual; DM, driest month; SI, seasonality index; ↑, high; ↓, low; ∅, positive range; ∪, negative range.

<i>Buthus delafulentei</i> :	Ecoregion: SW Iberian Mediterranean sclerophyllous and mixed forests; habitat: dune systems, sandy pine forests; elevation: 9–150 m; niche preferences: ↑ mean temperature (A), ↑ precipitation (SI), ↑ sand, ∪ isothermality, ↓ precipitation (A); class: semipsammophilous
<i>Buthus elongatus</i> :	Ecoregion: SW Iberian Mediterranean sclerophyllous and mixed forests; habitat: mixed forests; elevation: 169–1277 m; niche preferences: ↑ precipitation (SI), ↑ elevation, ∅ precipitation (A), ∅ pH, ↑ temperature (SI); class: pelophilous
<i>Buthus garcialorcai</i> :	Ecoregion: Iberian sclerophyllous and semideciduous forests; habitat: pine forests, alpine forests/plateaus; elevation: 917–2276 m; niche preferences: ↓ precipitation (DM), ↑ elevation, ↑ mean diurnal range, ↑ coarse, ∅ silt; class: pelophilous
<i>Buthus halius</i> :	Ecoregion: Cantabrian mixed forests, NW Iberian montane forests, Iberian coniferous forests; habitat: mixed forests, shrublands, capes; elevation: 98–1555 m; niche preferences: ∅ precipitation (SI), ∅ pH, ∪ precipitation (A), ∅ elevation, ∅ coarse; class: pelophilous
<i>Buthus iaspis</i> :	Ecoregion: SE Iberian shrubs and woodlands; habitat: semisteppes, semideserts; elevation: 8–920 m; niche preferences: ↑ isothermality, ↓ precipitation (A, DM), ∪ elevation, ∅ mean temperature (A); class: semipsammophilous
<i>Buthus ibericus</i> :	Ecoregion: SW Iberian Mediterranean sclerophyllous and mixed forests; habitat: semideciduous forests, dehesas; elevation: 45–1236 m; niche preferences: ↑ precipitation (A), ∅ precipitation (DM), ↑ pH, ∪ isothermality, ∅ precipitation (SI); class: pelophilous
<i>Buthus manchego</i> :	Ecoregion: Iberian sclerophyllous and semideciduous forests; habitat: dehesas, salt marshes, halophilous shrublands, pine forests; elevation: 5–1301 m; niche preferences: ↑ pH, ↑ temperature (A), ∅ elevation, ∅ precipitation (DM), ∅ mean diurnal range; class: pelophilous
<i>Buthus montanus</i> :	Ecoregion: Iberian coniferous forests; habitat: conifer montane forests; elevation: 969–2293 m; niche preferences: ↑ elevation, ∪ precipitation (DM), ∅ precipitation (SI), ∅ temperature (SI), ↑ coarse; class: pelophilous
<i>Buthus occitanus</i> :	Ecoregion: NE Spain and S France Mediterranean forests; habitat: dry lands, macchia, pine forests, Mediterranean shrublands, barren rocky hills; elevation: 4–1004 m; niche preferences: ∅ precipitation (DM), ↑ mean temperature (A), ↑ coarse, ↓ isothermality, ∅ clay; class: pelophilous
<i>Buthus ibericus</i> :	Ecoregion: SW Iberian Mediterranean sclerophyllous and mixed forests; habitat: semideciduous forests, dehesas; elevation: 45–1236 m; niche preferences: ↑ precipitation (A), ∅ precipitation (DM), ↑ pH, ∪ isothermality, ∅ precipitation (SI); class: pelophilous
<i>Buthus manchego</i> :	Ecoregion: Iberian sclerophyllous and semideciduous forests; habitat: dehesas, salt marshes, halophilous shrublands, pine forests; elevation: 5–1301 m; niche preferences: ↑ pH, ↑ temperature (A), ∅ elevation, ∅ precipitation (DM), ∅ mean diurnal range; class: pelophilous
<i>Buthus montanus</i> :	Ecoregion: Iberian coniferous forests; habitat: conifer montane forests; elevation: 969–2293 m; niche preferences: ↑ elevation, ∪ precipitation (DM), ∅ precipitation (SI), ∅ temperature (SI), ↑ coarse; class: pelophilous
<i>Buthus occitanus</i> :	Ecoregion: NE Spain and S France Mediterranean forests; habitat: dry lands, macchia, pine forests, Mediterranean shrublands, barren rocky hills; elevation: 4–1004 m; niche preferences: ∅ precipitation (DM), ↑ mean temperature (A), ↑ coarse, ↓ isothermality, ∅ clay; class: pelophilous

match to the latter (fig. 11; table 4; appendices 1, 5). Other characters proposed by Teruel and Turiel (2022b), e.g., pectinal tooth counts, were similarly unreliable for separating *B. castellano* from *B. halius* (table 4; appendix 5). Topotypes of *B. castellano* clustered with *B. halius* in the morphometric analyses (fig. 10). Molecular data corroborated the morphological findings,

recovering low genetic divergence between the topotypes of *B. castellano* and *B. halius* (figs. 8–11; tables 5, 9, 15; appendices 1, 5). Based on the available evidence, the following synonym is proposed: *Buthus castellano* Teruel and Turiel, 2022 = *Buthus halius* (C.L. Koch, 1839), syn. n.

MATERIAL EXAMINED: **PORTUGAL:**
Algarve Prov.: Faro Distr.: Albufeira, ca. 50 km

N, 37°22'11"N 08°21'51.8"W, 160 m, 23.x.2006, 843 m, S. Huber, 1 juv. ♂, (AMCC [LP 6946]); east of Alte, 37°14'37.1"N 08°07'03.6"W, 300 m, 19.v.2006, S. Huber, 1 ♀ (AMCC [LP 6947]); Lagos, Ponta da Piedade, 37°04'57.4"N 08°40'17.5"W, 98 m, 20.v.2022, J. Blasco-Aróstegui, Y. Simone and I. Avella, earthy area of cape, dominated by *Carpobrotus edulis* (L.) N.E.Br. (alien plant species) and thistle, 4 ♂, 3 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 18067, 18069]), 2 subad. ♀ (AMCC [LP 18068, 18070]), 3 juv. ♀ (AMCC [LP 18064–18066]); Sagres, Cabo de São Vicente, 37°01'24.3"N 08°59'35.6"W, 119 m, 18.v.2022, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, rocky cape covered by Mediterranean vegetation (undergrowth dominated by *Lithodora prostrata* subsp. *lusitanica* (Samp.) Valdés, thyme, rosemary, thistle and gorse among others), 2 ♂, 4 ♀, 1 subad. ♀ (AMNH), 1 ♂ (AMCC [LP 18061]), 4 subad. ♂ (AMCC [LP 18057, 18059, 18060, 18063]), 2 subad. ♀ (AMCC [LP 18058, 18062]), 2 juv. ♂ (AMCC [LP 18054, 18056]), 2 juv. ♀ (AMCC [LP 18053, 18055]). **Beira Prov.: Guarda Distr.:** Agaiteira na estrada Malpartida-Vermiose, 19.vii.1997, A. Almaça, I. Marques and M.A. Vienês, 2 ♂, 1 ♀ (MNHNC 4284, 4288); Manteigas, Abrigo do Faíscas, 40°23'08.9"N 07°32'47"W, 897 m, 30.iv.2023, J. Blasco-Aróstegui, Y. Simone and C. Figueiredo-Vázquez, pine forest with rocky slopes and sparse Mediterranean vegetation, 5 ♀ (AMNH), 1 ♂ (AMCC [LP 19509]), 3 subad. ♀ (AMCC [LP 19505–19507]), 1 juv. ♂ (AMCC [LP 19508]); Manteigas, Vale Glaciador do Zêzere, 40°22'21.5"N 07°32'57.5"W, 1012 m, 30.iv.2023, J. Blasco-Aróstegui, Y. Simone and C. Figueiredo-Vázquez, granitic rocky slopes with sparse Mediterranean vegetation, 5 ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19510]), 2 subad. ♀ (AMCC [LP 19511, 19513]), 2 juv. ♂ (AMCC [LP 19512, 19514]), 1 juv. ♀ (AMCC [LP 19515]). **Douro Litoral Prov.: Aveiro Distr.:** Covelo de Paivó e Janarde, road to Regoufe, 40°53'21.1"N 08°08'04.3"W, 809 m, 3.v.2022, J. Blasco-Aróstegui, Y. Simone and A.V. Liz, rocky hills next to road, under rocks

and sometimes in burrows, 2 ♀ (AMNH), 3 subad. ♂ (AMCC [LP 18044, 18047, 18049]), 2 subad. ♀ (AMCC [LP 18046, 18048]), 2 juv. ♂ (AMCC [LP 18043, 18045]), 2 juv. ♀ (AMCC [LP 18042, 18050]). **Trás-os-Montes e Alto Douro Prov.: Bragança Distr.:** Candoso, 9.viii.2015, L.F. Lopes, 1 ♀ (MNHNC 2845). **Vila Real Distr.:** Carlão e Amieiro, along riverbank of Tua River, 41°16'54.4"N 07°23'44.8"W, 273 m, 28.iv.2022, J. Blasco-Aróstegui, Y. Simone and C. Figueiredo-Vázquez, muddy and rocky slopes with xeric vegetation, dominated by *Cistus salviifolius* L., 1 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 18036, 18037]), 1 subad. ♀ (AMCC [LP 18040]), 4 juv. ♂, 1 juv. ♀ (AMCC [LP 18035]), 1 juv. ♂ (AMCC [LP 18038]), 2 juv. ♀ (AMCC [LP 18034, 18039]); Lagarelhos, 41°40'12"N 07°28'12"W, 674 m, P.R. de Sousa, 1 ♂ (CIBIO-InBIO Sc2126); Tua riverbank facing Santa Luzia train station, 41°16'58"N 07°23'34"W, 164 m, 23.vii.2006, P.R. de Sousa, 1 ♀ (RTO [CIBIO-InBIO Sc087]). **SPAIN: Castilla-La Mancha: Ciudad Real Prov.:** Almadén, 2 ♂ (MNCN 9513), 2 ♀ (MNCN 17067); Montes de Toledo, Porzuna, 39°08'13.4"N 04°07'40"W, 748 m, 12.vi.2023, J. Blasco-Aróstegui, Mediterranean pasture with many rocks and moderately steep slopes, 1 ♂, 4 ♀ (AMNH), 2 juv. ♂ (AMCC [LP 19493]), 3 juv. ♀ (AMCC [LP 19490–19492]); Montes de Toledo, Puerto Lápice, 39°19'42.4"N 03°29'28.8"W, 12.vi.2023, 843 m, J. Blasco-Aróstegui, rocky slopes with Andújar L., *Thymus* sp. and other Mediterranean shrubs, 1 ♂, 1 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 19487, 19488]), 2 subad. ♀ (AMCC [LP 19485, 19486]), 1 juv. ♂ (AMCC [LP 19489]). **Castilla y León: Valladolid Prov.:** Herrera de Duero, 41°33'28.2"N 04°38'25"W, 6.vi.2023, 762 m, J. Blasco-Aróstegui and J. García-Gila, pine forest (*Pinus pinea*) with loose, sandy soil, 3 ♂, 4 ♀ (AMNH), 1 ♀ (AMCC [LP 19495]), 3 subad. ♂ (AMCC [LP 19496–19498]), 2 juv. ♂ (AMCC [LP 19499, 19500]); Puente Duero, 41°32'31"N 04°48'33"W, 6.vi.2023, 768 m, J. Blasco-Aróstegui and J. García-Gila, pine forest (*Pinus pinea*) with loose, sandy soil, 1 ♂, 4 ♀ (AMNH), 2

subad. ♂ (AMCC [LP 19502, 19503]), 1 subad. ♀ (AMCC [LP 19501]), 1 juv. ♀ (AMCC [LP 19504]). **Comunidad de Madrid:** *Madrid Prov.:* Sierra de Guadarrama, Mirador de las Canchas, 40°45'47.2"N 03°59'59.8"W, 22.viii.2023, 1717 m, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, rocky glade in pine forest, 5 ♂, 4 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 19818, 19819]), 1 subad. ♀ (AMCC [LP 19817]).

Buthus iaspis Teruel and Turiel, 2022

Figures 1C, 2C, 3, 5D, 7C, 8–11, 14A, B, 15G, 16G, 21A, 22A, 27A, 28A, 33A, 34A, 35E, 36E, 41; tables 1–5, 10, 15, 16

Buthus occitanus: Lourenço and Vachon, 2004: 93 [misidentification, part]; Lourenço and Rossi, 2013: 13, fig. 10 [misidentification, part].

Buthus montanus: Barrientos et al., 2017: 132 [misidentification, part].

Buthus iaspis Teruel and Turiel, 2022a: 19–29, figs. 1–4, tables I–IV; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.

TYPE MATERIAL: Holotype ♂, 7 ♂, 3 ♀, 4 juv. ♂ paratypes (RTO), **SPAIN: Andalucía: Almería Prov.:** Parque Natural de Cabo de Gata-Níjar: Refugio de Aves Esteparias de Las Amoladeras, near road AL-3115, 36°49'41"N 02°15'50"W, 20–40 m, 13.vi.2021, C. Turiel.

DIAGNOSIS: *Buthus iaspis* most closely resembles *B. manchego* and *B. montanus*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15G–I, 16G–I), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 8B, D, 15G–I, 16G–I), and 12 denticle rows are often present on the movable finger. In addition to often exhibiting marked infuscation of the pedipalpal and metasomal carinae, the three species share the following characters: type IV infuscation pattern of the carapace intercarinal surfaces (fig. 5D); all carapacial carinae are infus-

cate and comprise granules of similar size (fig. 14); the carapace lateral ocular carinae are distinct and granular, and the prolateral secondary carinae often reach the lateral ocelli (fig. 14); the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 41, 43, 44); the dorsal surfaces of metasomal segments II–V and lateral surfaces of segment V are densely setose, each with more than three pairs of macrosetae (type III; figs. 7C, 21, 22, 27, 28); the posterior granules of the ventrosubmedian carinae on metasomal segments II and III of the female are enlarged into spiniform processes (figs. 27, 28); and the telson vesicle of the male is globose (fig. 27; tables 10, 12, 13; appendix 5).

The three species are readily distinguished as follows. At 74.6 mm (66.7–80.2 mm, $n = 5$; tables 5, 10; appendix 5) (♂) and females 73.3 mm (68.5–78.7 mm, $n = 5$) (♀) in total length, *B. iaspis* (fig. 8A, C) is slightly larger than *B. manchego* (fig. 8A, C), at 68.4 mm (60–75.5 mm, $n = 21$; tables 5, 12; appendix 5) (♂) and 71.4 mm (63.6–76.6 mm, $n = 24$) (♀). The base color of *B. iaspis* is dark orange (fig. 2C) whereas the base color of *B. manchego* varies from yellow to dark yellow (fig. 2F). The carapace of the male is conical trapezoid in shape, the lateral margins curved in *B. iaspis* (fig. 14A) but quadrangular trapezoid in shape, the lateral margins sublinear in *B. manchego* (fig. 14C). The pedipalp chela manus of the male is shorter in *B. iaspis*, with manus length : movable finger length, 71% (66.5%–75%, $n = 5$; tables 5, 10; appendix 5) than in *B. manchego*, with manus length : movable finger length, 66% (57.5%–71.5%, $n = 21$; tables 5, 12; appendix 5). The pectinal tooth counts are higher in *B. iaspis*, i.e., 32/32 (31–32/30–33, $n = 5$; tables 5, 10; appendix 5) (♂) and 28/28 (27–29/26–29, $n = 5$) (♀), than in *B. montanus*, i.e., 29/30 (28–30/29–31, $n = 5$; tables 5, 13; appendix 5) (♂) and 27/26 (26–29/25–29, $n = 5$) (♀). The metasoma is longer, with mesosoma length : metasoma length, 34% (31.6%–36.1%, $n = 5$; tables 5, 10; appendix 5) (♂) or 39% (36.9%–40.8%, $n = 5$) (♀), in *B. iaspis* (figs. 21A, 22A, 27A, 28A, 33A, 34A) than in *B. montanus* (figs. 21C, 22C, 27C, 28C, 33C,

34C), with mesosoma length : metasoma length, 37% (31.1%–40.4%, $n = 5$; tables 5, 13; appendix 5) (♂) or 42% (38.1%–48.4%, $n = 5$) (♀). The posterior granules of the ventrosubmedian carinae on metasomal segments II and, especially, III of the male are unmodified in *B. iaspis* (figs. 27A, 28A) but slightly enlarged into subspiniiform processes in *B. manchego* (figs. 27B, 28B) and *B. montanus* (figs. 27C, 28C).

DISTRIBUTION: *Buthus iaspis* is endemic to the Iberian Peninsula, specifically Andalucía and Murcia in southern Spain. In Andalucía, it has been exclusively recorded from the province of Almería, where it inhabits the Cabo de Gata-Níjar and Desierto de Tabernas.

ECOLOGY: *Buthus iaspis* excavates shallow burrows under bushes or stones in coarse volcanic soils, primarily in steppe and semidesert habitats in the southeasternmost part of Spain (Teruel and Turiel, 2022a; fig. 3; table 16). The areas around Cabo de Gata-Níjar and the Desierto de Tabernas are the most arid in Europe, with the warmest and driest climate on the Iberian Peninsula, a mean annual temperature of 18°–20° C and annual rainfall less than 150 mm. The climate is predominantly semiarid Mediterranean (BSk and BSh), influenced by hot, dry air masses from North Africa and characterized by hot, dry summers and warm, cool winters (Kooen, 1923; Nunes, 2023). High levels of floristic and faunistic endemism occur in the region (Aranda and Oyonarte, 2005). The habitat and habitus are consistent with the semipsammophilous ecomorphotype (Prendini, 2001a).

MATERIAL EXAMINED: SPAIN: Andalucía: Almería Prov.: Desierto de Tabernas, 37°05'06.7"N 02°18'12.3"W, 558 m, 17.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, semidesert steppe with abundant rocks, 2 ♂, 2 ♀ (AMNH), 1 ♀ (AMCC [LP 19763]), 1 subad. ♀ (AMCC [LP 19764]); La Isleta del Moro, 36°48'42.7"N 02°03'28.4"E, 5 m, 27.v.2013, R. Predel, 1 ♂ (AMCC [LP 12387]); Parque Natural del Cabo de Gata-Níjar, 36°44'02.8"N 02°08'35"W, 66 m, 17.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, rocky hill

with semidesert vegetation, 1 ♂, 2 ♀ (AMNH), 1 ♀ (AMCC [LP 19755]), 3 subad. ♀ (AMCC [LP 19754, 19756, 19757]), 1 juv. ♂, 3 juv. ♀ (AMCC [LP 19758]); Refugio de Aves Esteparías las Amoladeras, 36°49'41.3"N 02°15'47.2"W, 83 m, 17.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, semidesert steppe with sparse vegetation, 6 ♂, 4 ♀ (AMNH), 1 ♀ (AMCC [LP 19759]), 1 subad. ♀ (AMCC [LP 19760]), 2 juv. ♂, 1 juv. ♀ (AMCC [LP 19762]), 3 juv. ♀ (AMCC [LP 19761]).

Buthus ibericus Lourenço and Vachon, 2004

Figures 2D, 3, 5D, 8–11, 12E, F, 15C, 16C, 17C, 18C, 23C, 24C, 29C, 30C, 35F, 36F, 42; tables 1–5, 11, 15, 16

Androctonus halius: Sousa et al., 2017: 44 [as a senior synonym of *B. ibericus* deemed nomen oblitum].

Buthus halius: Sousa et al., 2017: 15, 44–45, fig. 13 (except 13a, c) [as a junior synonym of *B. ibericus* deemed nomen oblitum].

Buthus occitanus: Cruz and Armas, 1980: 2, 3, 4, 5, 6, figs. 2E, 3C, 4A [misidentification]; Armas and González-Moliné, 2009: 553 [misidentification].

Buthus occitanus occitanus: Gantenbein and Lardièr, 2003: 119–130, figs. 1a, 2–4, table 1 [misidentification].

Buthus ibericus Lourenço and Vachon, 2004: 81, 88–93, figs. 31–43, table I [part]; Sousa et al., 2010: 206–211 [part]; Teruel and Melic, 2015: 6, 8–12, figs. 6b, 8b, 9a, 10b, pl. I4–6, table II [part]; Rojas and Rojas, 2017: 82, 95, fig. 1d; Sousa et al., 2017: 15, 26, 29–31, 34, 40, 44, 45, 64, figs. 9–11, tables 1, 2 [part]; Teruel and Turiel, 2020: 3, 4, 7, 8, 10, 13, 15, 16, 21, 22, 24, 29, 34, 35, 38, 39, 41, 42, 55, 58, figs. 4–6, 27, 28c–e, 32, tables III, IV, XIII, XIV; 2021a: 3, 4, 6–8, 10, 11, fig. 1; 2021b: 3, 8–10, fig. 1; Ythier, 2021a: 1, 2, 4, 5, fig. 11; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and



FIGURE 33. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.

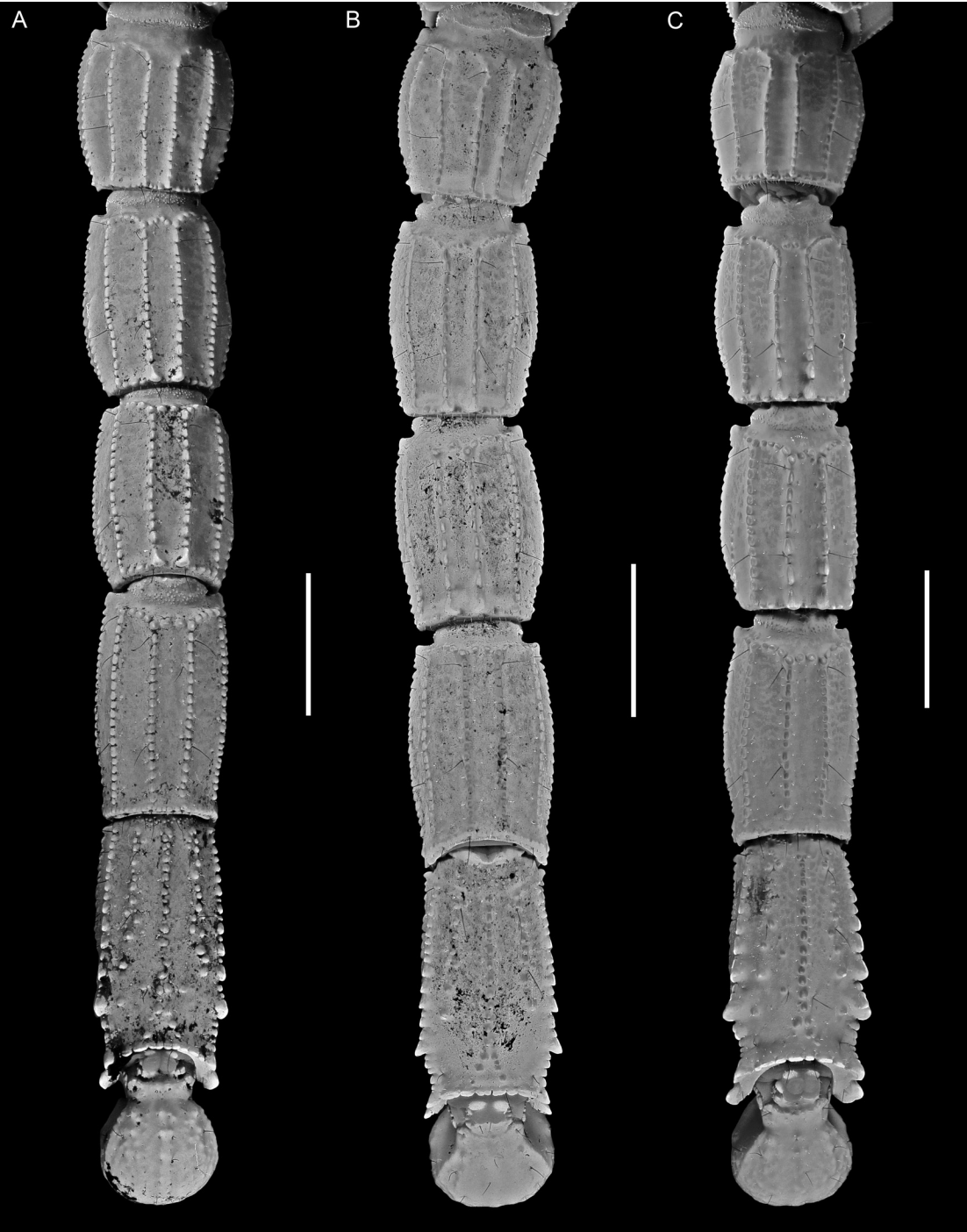


FIGURE 34. *Buthus* Leach, 1815, metasoma and telson, ventral aspect. **A.** *Buthus iaspis* Teruel and Turiel, 2022, ♀ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **B.** *Buthus manchego* Teruel and Turiel, 2020, ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **C.** *Buthus montanus* Lourenço and Vachon, 2004, ♀ (AMNH), Sierra Nevada, Andalucía, Spain. Scale bars = 5 mm.

Laborieux, 2022: 1; González-Moliné et al., 2023: 215–217, 221, figs. 1, 4; González-Moliné and Armas, 2024: 75.

Buthus baeticus Teruel and Turiel, 2020: 3, 19, 21, 22, 24, 29, 36, 38, 39, 48, 49, 57, 60, figs. 6–18, 27, 30c, 35a, b, tables IX, XIII, XIV, syn. n.; 2021a: 3, 6, 14, fig. 1; 2021b: 3, 8–10, fig. 1; Ythier, 2021a: 1, 2, 4, fig. 11; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215–223, figs. 1–5, tables I–IV; González-Moliné and Armas, 2024: 75, 83.

TYPE MATERIAL: SPAIN: Andalucía: Holotype ♂, 2 ♀ paratypes (MNHN), 1 ♂, 2 ♀ paratypes (CRBA 21826), 2 ♀ paratypes (MNCN) [examined], *Cádiz Prov.*: Dehesa Picado Farm, 36°37'29"N 05°39'53"W, 200 m, 7.ix.2003, Í. Sánchez. *Buthus baeticus*: Holotype ♂, 1 ♂, 1 ♀, 2 juv. ♂ paratypes (RTO), paratype ♀ (ARPC), *Sevilla Prov.*: Morón de la Frontera, 3 km S, along road A-361, 37°04'43"N 05°30'52"W, 217 m, 12.vi.2018, C. Turiel.

DIAGNOSIS: *Buthus ibericus* most closely resembles *B. delafulentei* and *B. halius*. All three species possess a globose, incrassate pedipalp chela with the chela fixed and movable fingers curved basally and emarginate when closed in both sexes (figs. 8B, D, 11, 15A–C, 16A–C) and 13 denticle rows are often present on the movable finger.

The three species are readily distinguished as follows. At 62.4 mm (52.9–67.9 mm, $n = 5$; tables 5, 11; appendix 5) (♂) and 70.4 mm (63.8–76.3 mm, $n = 5$) (♀) in total length, *B. ibericus* (fig. 8A, C) is slightly smaller than *B. halius*, at 67.8 mm (60–74.5 mm, $n = 18$; tables 5, 11; appendix 5) (♂) and 73.5 mm (65.1–85.4 mm, $n = 25$) (♀), and considerably smaller than *B. delafulentei* (fig. 8A, C), at 76.9 mm (69.5–80.67 mm, $n = 10$; tables 5, 6; appendix 5) (♂) and 80.8 mm (73.6–84.9 mm, $n = 7$) (♀). The posterolateral carinae of the male carapace are distinct and granular in *B. ibericus* (figs. 6, 12E) but obsolete, reduced to discontinuous granules in *B. halius* (figs. 6, 12C). The

pedipalp chela fixed and movable fingers are slightly curved basally and shallowly emarginate when closed in the male or sublinear basally and not emarginate when closed in the female of *B. ibericus* (figs. 15C, 16C), whereas the fingers are markedly curved basally and deeply emarginate when closed in both sexes of *B. delafulentei* and *B. halius* (figs. 15A, B, 16A, B). The legs are robust, with short femora, patellae, tibiae, and tarsi in *B. ibericus* (fig. 42) but slender, with slightly elongated femora, patellae, tibiae, and tarsi in *B. delafulentei* (fig. 37). The retrolateral margins of the leg tibiae and tarsi are sparsely setose, with short macrosetae in *B. ibericus*, but densely setose, with elongated macrosetae in *B. delafulentei*. The pectinal tooth counts are lower in *B. ibericus*, i.e., 28/28 (26–29/27–29, $n = 5$; tables 5, 11; appendix 5) (♂) and 23/23 (22–24/22–24, $n = 5$) (♀), than in *B. delafulentei*, i.e., 32/33 (31–34/30–34, $n = 10$; tables 5, 6; appendix 5) (♂) and 28/27 (27–29/26–29, $n = 7$) (♀), and *B. halius*, i.e., 30/31 (28–33/28–33, $n = 18$; tables 5, 9; appendix 5) (♂) and 26/27 (24–29/24–29, $n = 25$) (♀). The metasoma of *B. ibericus* is shorter, especially in the female (figs. 17C, 18C, 23C, 24C, 29C, 30C), with mesosoma length : metasoma length, 40% (35.9%–41.6%, $n = 5$; tables 5, 11; appendix 5) (♂) or 45% (40%–48.2%, $n = 5$) (♀), than that of *B. delafulentei* (figs. 17A, 18A, 23A, 24A, 29A, 30A), with mesosoma length : metasoma length, 36% (32.9%–36.8%, $n = 7$; tables 5, 6; appendix 5) (♂) or 39% (36.9%–41.1%, $n = 7$) (♀). The metasoma of *B. ibericus* is also broader, more so in the female (figs. 9C, G, 17C, 18C, 23C, 24C, 29C, 30C), with segment I width : length 93% (89%–96.6%, $n = 5$; tables 5, 11; appendix 5) (♂) or 91% (87.4%–95.3%, $n = 5$) (♀), segment II width : length 77% (71%–80.6%) (♂) or 79% (76.5%–83.9%) (♀), segment III width : length 72% (69.3%–72.7%) (♂) or 71% (68%–75.4%) (♀), and segment IV width : length 56% (53.2%–57.%) (♂) or 56% (51.6%–58.2%) (♀), than that of *B. delafulentei* (figs. 9, 17A, 18A, 23A, 24A, 29A, 30A), with segment I width : length 73% (63.9%–79.3%, $n = 10$; tables 5, 6; appendix 5) (♂) or 77% (73.6%–81.6%, $n = 7$) (♀), segment II width : length, 63% (62%–



FIGURE 35. *Buthus* Leach, 1815, hemispermatophore, ectal view. **A.** *Buthus delaigueri* Teruel and Turiel, 2020, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **C.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **D.** *Buthus halius* (C.L. Koch, 1839), ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. **E.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **F.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. **G.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **H.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. **I.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. Scale bar = 1 mm.

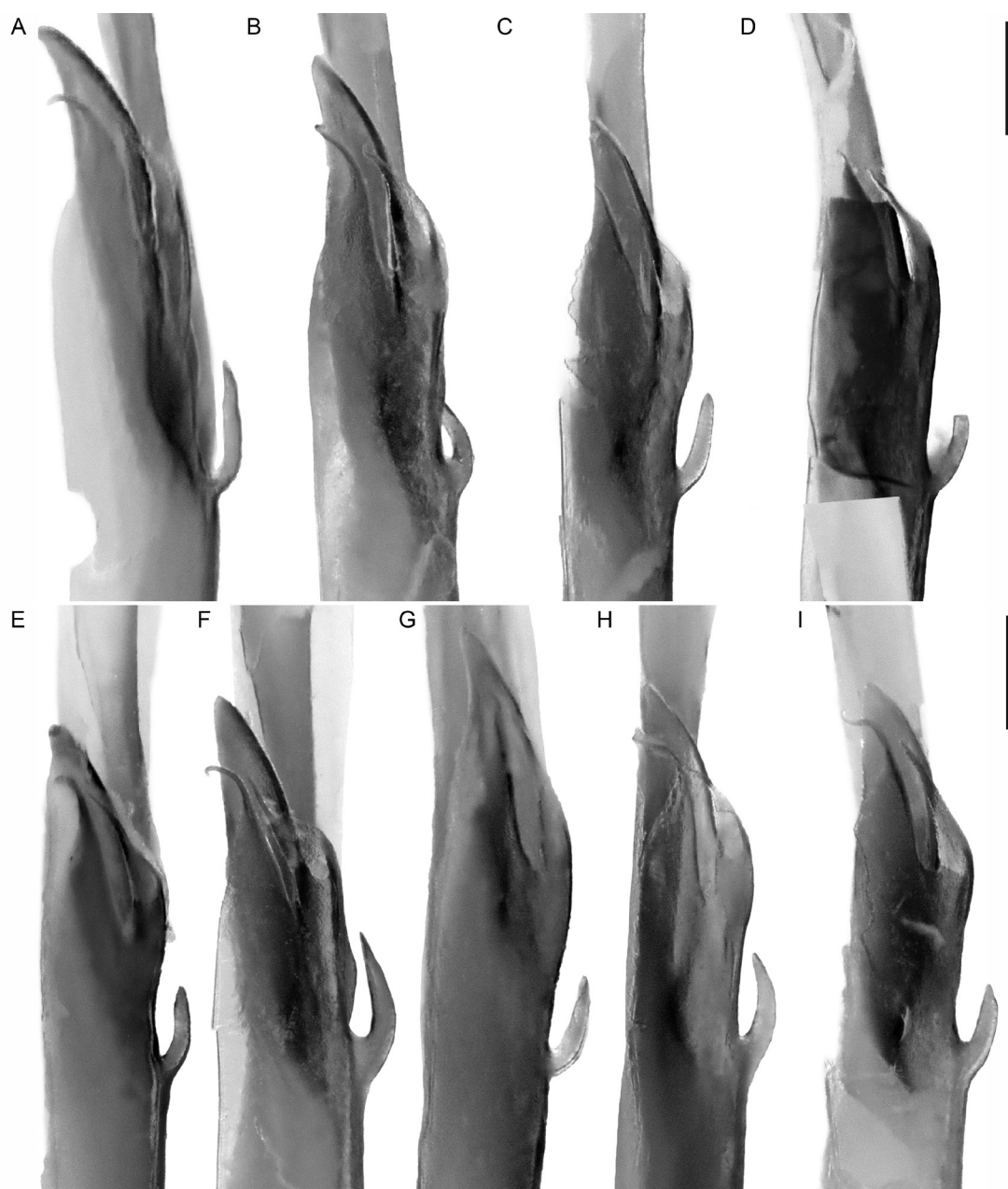


FIGURE 36. *Buthus* Leach, 1815, hemispermatotheca capsule, ectal view. **A.** *Buthus delafulentei* Teruel and Turiel, 2020, ♂ (AMNH), Doñana, Andalucía, Spain. **B.** *Buthus elongatus* Rossi, 2012, ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. **C.** *Buthus garcialorcai* Teruel and Turiel, 2020, ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. **D.** *Buthus halius* (C.L. Koch, 1839), ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. **E.** *Buthus iaspis* Teruel and Turiel, 2022, ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. **F.** *Buthus ibericus* Lourenço and Vachon, 2004, ♂ (AMNH), Dehesa Picado, Andalucía, Spain. **G.** *Buthus manchego* Teruel and Turiel, 2020, ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. **H.** *Buthus montanus* Lourenço and Vachon, 2004, ♂ (AMNH), Sierra Nevada, Andalucía, Spain. **I.** *Buthus occitanus* (Amoreux, 1789), ♂ (AMNH), Souvignargues, Occitanie, France. Scale bar = 0.25 mm.

77.8%) (♂) or 64% (57.7%–76.6%) (♀), segment III width : length 58% (53.9%–68.9%) (♂) or 60% (55.6%–65.6%) (♀), and segment IV width : length 49% (43.7%–52.3%) (♂) or 50% (47.4%–52.6%) (♀). The dorsal surfaces of the metasoma are aetose in *B. ibericus* (figs. 17C, 18C) but moderately setose in *B. delafuentei* (type II; figs. 7B, 17A, 18A) and *B. halius* (type II; figs. 7B, 17B, 18B). The dorsosubmedian carinae of metasomal segments I–III are obsolete in *B. ibericus* (fig. 17C, 18C) but granular in *B. delafuentei* (figs. 17A, 18A) and *B. halius* (figs. 17B, 18B). The ventrolateral carinae of metasomal segment V each bear two or more greatly enlarged, lobate or spiniform processes posteriorly in *B. ibericus* (figs. 23C, 24C) but at most one enlarged process posteriorly in *B. delafuentei* (figs. 23A, 24A). The dorsal and lateral intercarinal surfaces of metasomal segment V are smooth in *B. ibericus* (figs. 17C, 18C, 23C, 24C) but sparsely granular in *B. delafuentei* (figs. 17A, 18A, 23A, 24A) and *B. halius* (figs. 17B, 18B, 23B, 24B).

INTRASPECIFIC VARIATION: *Buthus ibericus* exhibits a distinct and homogeneous morphology across its distribution on which basis it may be easily differentiated from other European species of *Buthus*. Populations previously recognized as *B. baeticus* (see below) do not fully conform to the diagnostic character combination of *B. ibericus*, however. Some character states observed in these populations, e.g., dorsal setation on metasomal segments II–V (type II, intermediate; fig. 7B), higher pectinal tooth counts, and granulation on metasomal segment V, are shared with *B. delafuentei* (figs. 17A, 18A), whereas others, e.g., shallowly curved chela fingers (figs. 15C, 16C) and morphometrics, are shared with *B. ibericus* (fig. 10 and samples from Esparteros in appendix 5). Considering the morphological stasis of the reproductive structures (figs. 35, 36) and genetic evidence (Blasco-Aróstegui et al., in prep.), these populations may represent an admixed form that arose from hybridization between *B. delafuentei* and *B. ibericus*.

DISTRIBUTION: *Buthus ibericus* is endemic to the Iberian Peninsula, specifically Andalucía in

southern Spain. It has been recorded from the provinces of Cádiz, Málaga and Sevilla.

ECOLOGY: *Buthus ibericus* excavates shallow burrows in open ground or under stones in coarse soils in dehesas and mixed oak and cork-oak forests in the southernmost mountain ranges of Spain (Teruel and Turiel, 2020). The climate of the area is predominantly hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters (Köppen, 1936; Nunes, 2023). The maritime influence of the Atlantic Ocean and the Mediterranean Sea, together with the pronounced elevation, subjects the area to frequent precipitation fronts, increasing the average annual rainfall to 2000 mm. The presence of this species in the Sierra de Grazalema, an area that experiences some of the highest spring rainfall in Spain (up to 200 mm in a single day), suggests that *B. ibericus* may have a greater tolerance for humidity than other European *Buthus* species. The habitat and habitus are consistent with the pelophilous ecomorphotype (Pren-dini, 2001a).

REMARKS: *Buthus baeticus* was described from two populations in Andalucía, one in Morón de la Frontera and another in Navahermosa (Teruel and Turiel, 2020; appendix 1), which overlap the distributions of two other species, *B. delafuentei* and *B. ibericus*. Separate analyses of nuclear and mitochondrial DNA sequences conflicted regarding the placement of samples from the type locality of *B. baeticus*, which grouped with the *delafuentei* subclade or the *ibericus* subclade, respectively (Blasco-Aróstegui et al., in prep.). As noted above, some of the morphological characters of these samples appear to be shared with *B. delafuentei*. According to the simultaneous analysis of the morphology, nuclear and mitochondrial DNA, as well as the morphometric analyses, however, *B. baeticus* is conspecific with *B. ibericus* (figs. 8–11), consistent with the low mitochondrial DNA distances between samples from the type locality and *B. ibericus* (table 15; appendices 1, 5). Consequently, the following synonym is proposed: *Buthus bae-*

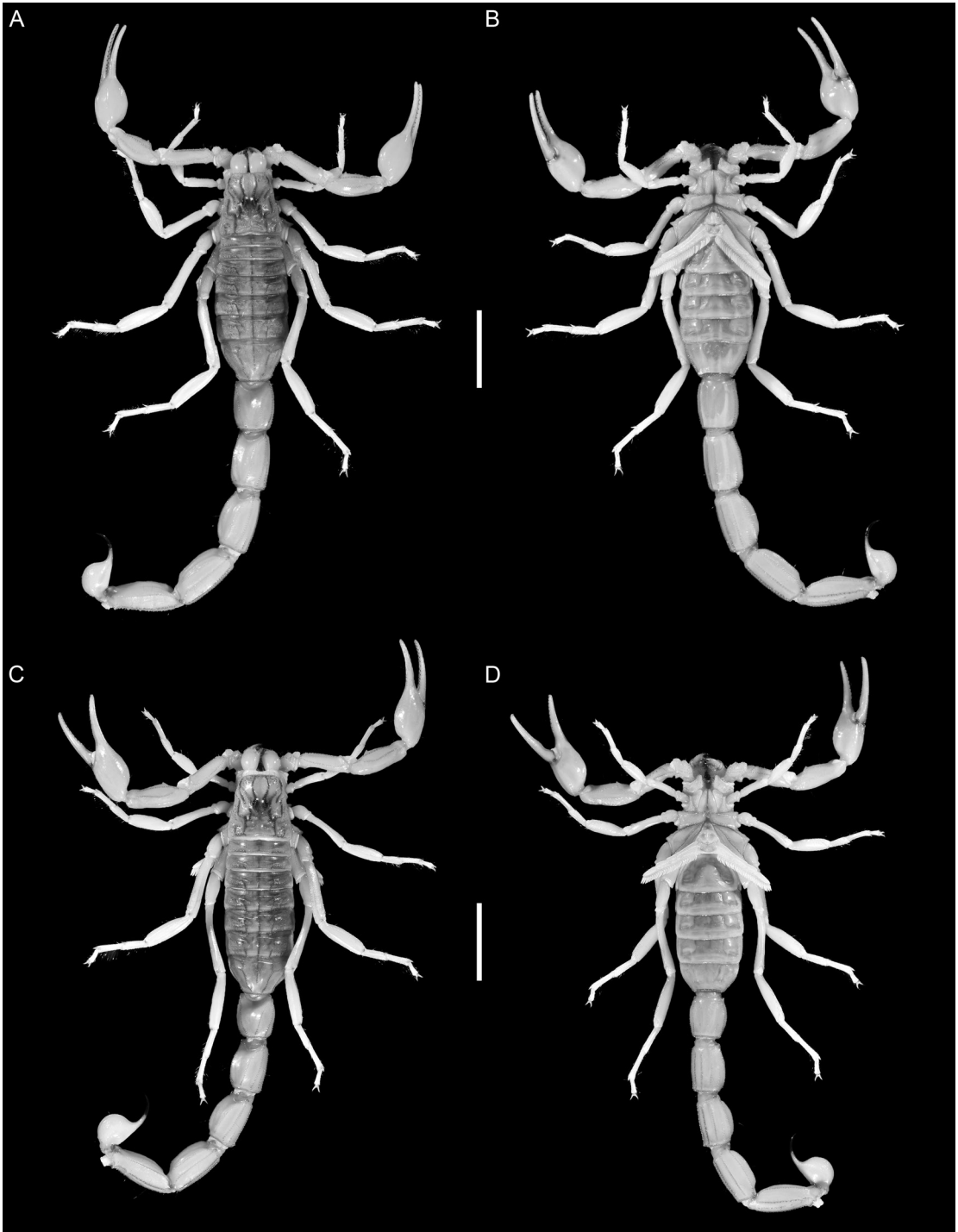


FIGURE 37. *Buthus delafulentei* Teruel and Turiel, 2020, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Parque Nacional de Doñana, Andalucía, Spain. C, D. ♀ (AMNH), Pinar del Tableado, Andalucía, Spain. Scale bars = 10 mm.

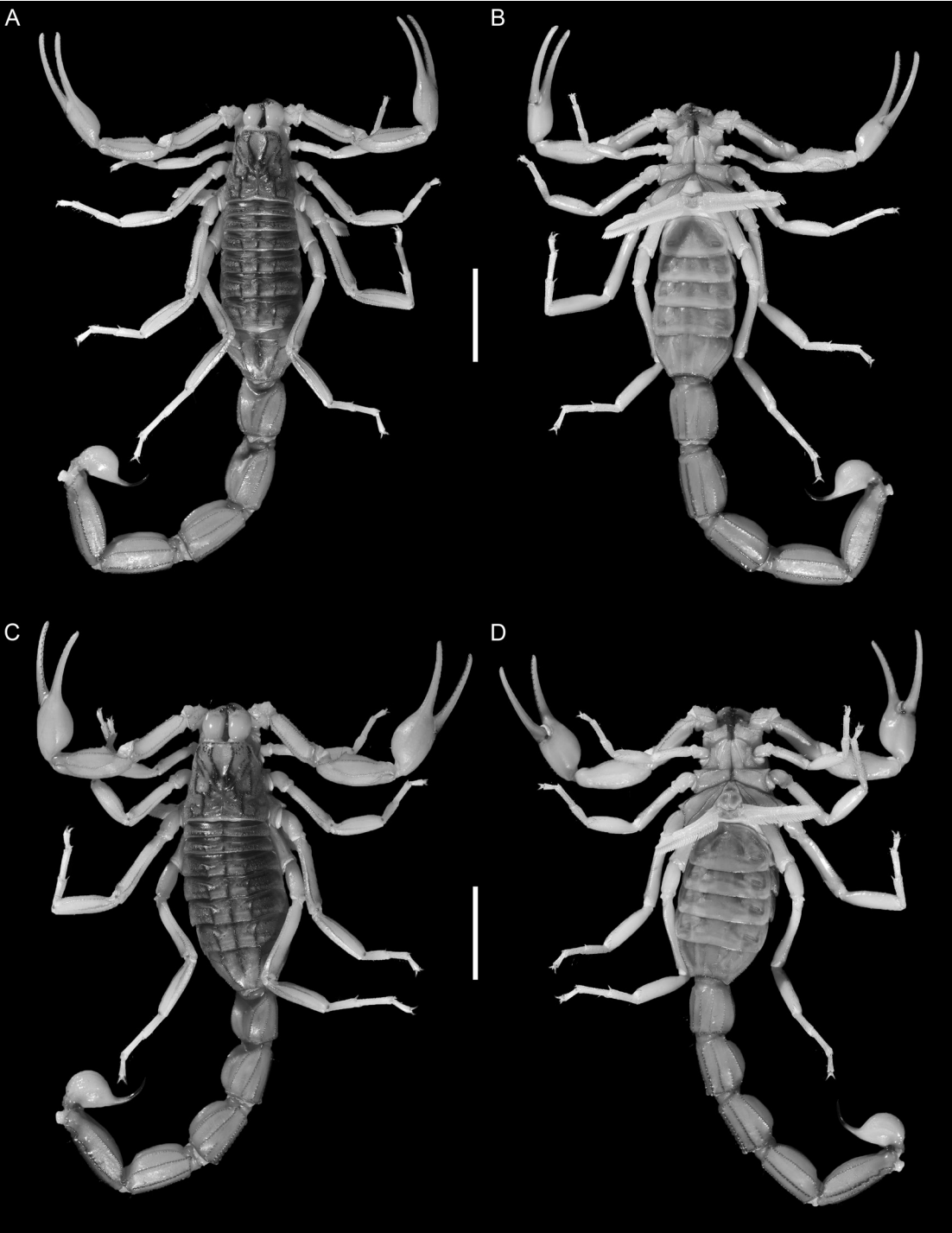


FIGURE 38. *Buthus elongatus* Rossi, 2012, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Sierra de las Nieves, Andalucía, Spain. C, D. ♀ (AMNH), Sierra de las Nieves, Andalucía, Spain. Scale bars = 10 mm.

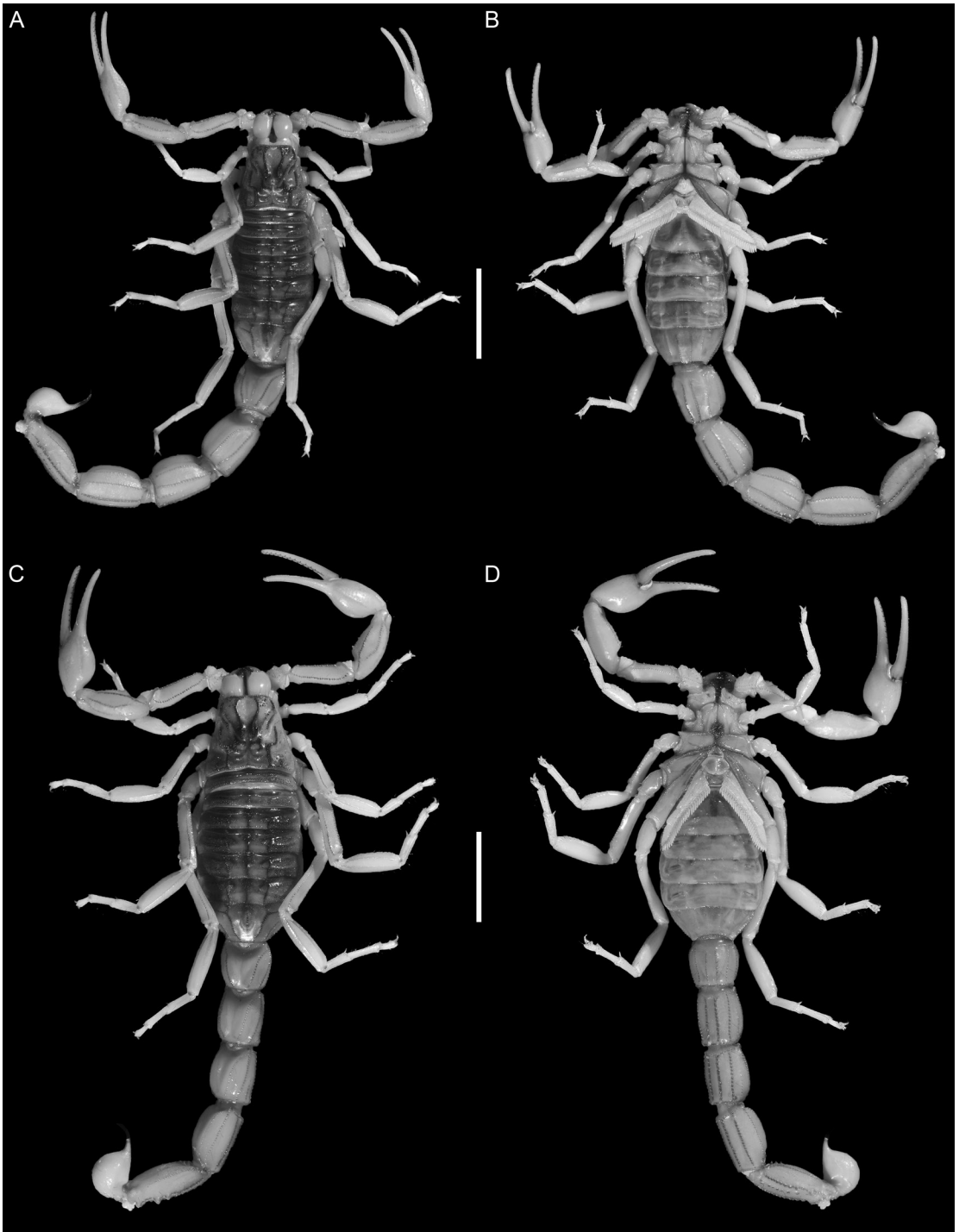


FIGURE 39. *Buthus garcialorcai* Teruel and Turiel, 2020, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Sierra de Huétor, Andalucía, Spain. C, D. ♀ (AMNH), Sierra de Huétor, Andalucía, Spain. Scale bars = 10 mm.

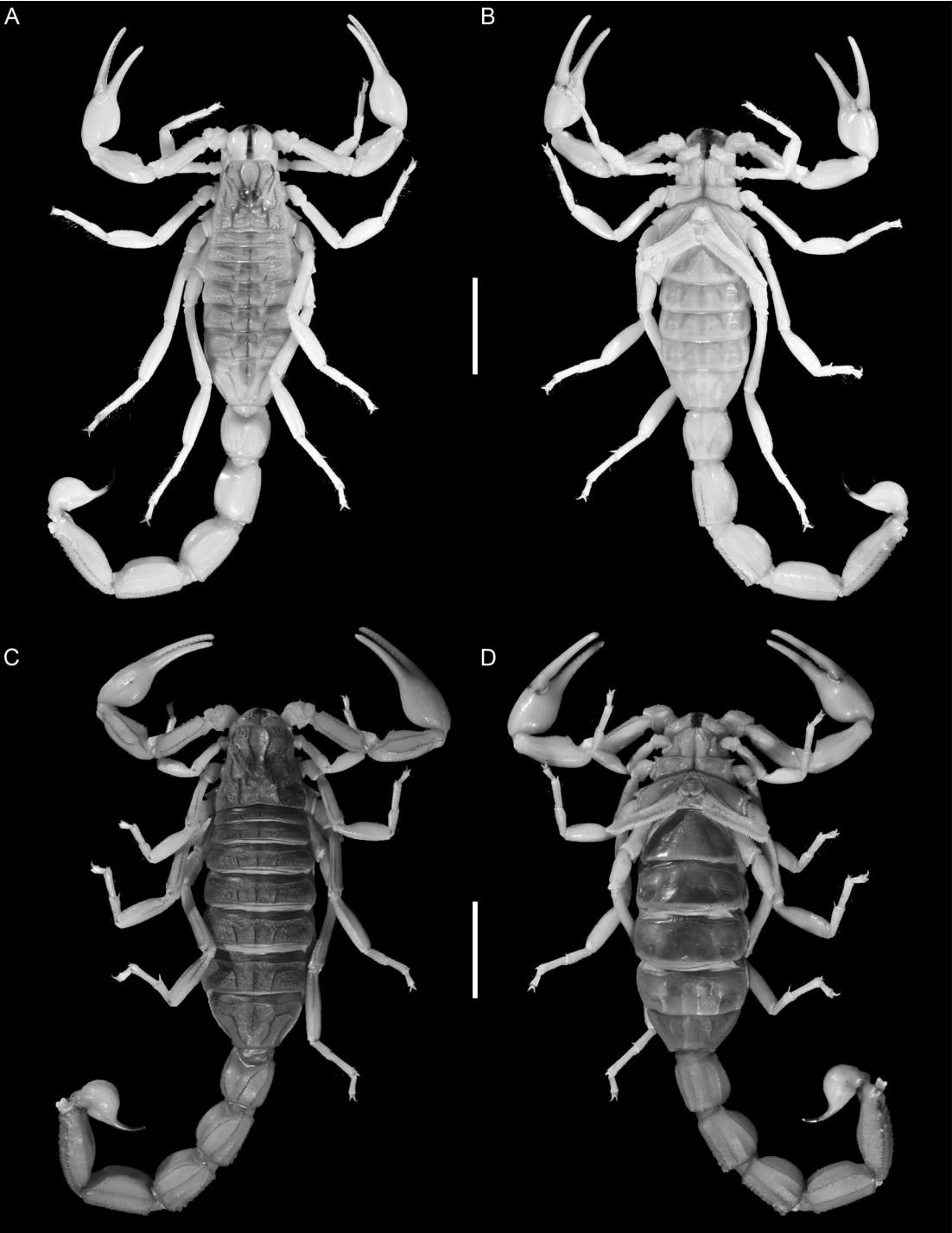


FIGURE 40. *Buthus halius* (C.L. Koch, 1839), habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Herrera de Duero, Castilla y León, Spain. C, D. ♀ (AMNH), Tua riverbank, Alto-Douro, Portugal. Scale bars = 10 mm.

ticus Teruel and Turiel, 2020 = *Buthus ibericus* Lourenço and Vachon, 2004, syn. n.

MATERIAL EXAMINED: SPAIN: Andalucía: *Cádiz Prov.:* Guadalcacín Dam, Dehesa Picado, 36°37'40.3"N 05°39'52.5"W, 184 m, 20.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, Mediterranean dehesa, 6 ♂, 6 ♀ (AMNH), 2 ♂ (AMCC [LP 19794, 19796]), 2 subad. ♀ (AMCC [LP 19793, 19795]), 2 juv. ♀ (AMCC [LP 19797, 19798]); Parque Natural Sierra de Grazalema: Benaocaz, 36°42'26.4"N 05°25'24.5"W, 814 m, 19.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, stone wall along trail, 6 ♂, 4 ♀ (AMNH), 1 ♂ (AMCC [LP 19785]), 1 subad. ♀ (AMCC [LP 19784]), 1 juv. ♀ (AMCC [LP 19786]). *Sevilla Prov.:* Sierra de Esparteros, 37°04'46.9"N 05°30'49.3"W, 267 m, 20.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, rocky hill with some Mediterranean vegetation, 2 ♂, 6 ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19801]), 3 juv. ♂ (AMCC [LP 19799, 19800, 19802]), 2 juv. ♀ (AMCC [LP 19803]).

Buthus manchego Teruel and Turiel, 2020

Figures 1B, 2F, 3, 5D, 7C, 8–11, 14C, D, 15H, 16H, 21B, 22B, 27B, 28B, 33B, 34B, 35G, 36G, 43; tables 1–5, 12, 15, 16

Buthus occitanus: Simon, 1879: 96, 98 [misidentification]; Lourenço and Rossi, 2013: 13, fig. 10 [misidentification, part].

Buthus alacanti Teruel and Turiel, 2020: 3, 19, 29, 31, 32, figs. 14, 15, 27, 30a, 34a, tables VIII, XIII, XIV, syn. n.; 2021a: 3, fig. 1; 2021b: 3, 8, 9, fig. 1 [misidentification]; Ythier, 2021a: 1; 2021b: 1, 2, 5, 6, 10, figs. 4, 11, 18, tables II, III; Teruel and Turiel, 2022a: fig. 14; 2022b: 19, 20, fig. 26; Ythier and Laborieux, 2022: 1.

Buthus alicanti: Lourenço, 2021: 4.

Buthus manchego: Teruel and Turiel, 2020: 3, 27, 29, figs. 23, 24, 27, 30d, 35c, tables XI, XIII, XIV; 2021a: 3, 7, fig. 1; 2021b: 3, 8, 10, fig. 1; Ythier, 2021a: 1; 2021b: 1; Teruel and Turiel,

2022a: 19, 22, 23, fig. 14, tables II, III;

2022b: 36, fig. 26; Ythier and Laborieux,

2022: 1; González-Moliné et al., 2023: 215.

Buthus pedrosousai Teruel and Turiel, 2021b: 3, 4, 8, 9, figs. 1–4, tables I–III, syn. n.; 2022a: 36, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1.

Buthus serrano Teruel and Turiel, 2020: 3, 29, 31, 32, figs. 25, 26, 27, 30e, f, 35d, tables XII–XIV, syn. n.; 2021a: 3, fig. 1; 2021b: 3, 8, 10 fig. 1; Ythier, 2021a: 1; 2021b: 1; Teruel and Turiel, 2022a: 29, fig. 14; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1.

TYPE MATERIAL: SPAIN: Holotype ♂, 2 ♀, 1 juv. ♂, 1 juv. ♀ paratypes (RTO), **Castilla-La Mancha:** *Ciudad Real Prov.:* Lagunas de Ruidera: Peñarroya Castle, along road CM-3115, 39°03'47"N 03°00'10"W, 751 m, 10.vi.2018, C. Turiel. *Buthus alacanti:* **Valencia:** *Alicante Prov.:* Holotype ♂, 1 ♀, 1 juv. ♂, 2 juv. ♀ paratypes (RTO), Sant Vicent del Raspeig, 2 km N, 38°25'30"N 00°31'40"W, 163 m, 26.x.2017, C. Domènech. *Buthus pedrosousai:* Holotype ♂, 2 ♂, 1 juv. ♂, 3 juv. ♀ paratypes (RTO), **Castilla-La Mancha:** *Cuenca Prov.:* between Ribatajadilla and Zarzuela, along road CUV-9118, 40°17'53"N 02°08'20"W, 23–24.vi.2016, C. Turiel. *Buthus serrano:* Holotype ♂, 1 ♂, 3 ♀, 1 juv. ♂ paratypes (RTO), **Andalucía:** *Granada Prov.:* Sierra de Orce, 1 km SW of Orce, 37°42'53"N 02°30'09"W, 1002 m, 25.vi.2016, C. Turiel.

DIAGNOSIS: *Buthus manchego* most closely resembles *B. iaspis* and *B. montanus*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15G–I, 16G–I), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 9B, D, 15G–I, 16G–I), and 12 denticle rows are often present on the movable finger. In addition to often exhibiting marked infuscation of the pedipalpal and metasomal carinae, the three species share the following characters: type IV infuscation pattern of the carapace intercarinal surfaces (fig. 5D); all carapacial carinae are infus-

cate and comprise granules of similar size (fig. 14); the carapace lateral ocular carinae are distinct and granular, and the prolateral secondary carinae often reach the lateral ocelli (fig. 14); the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 41, 43, 44); the dorsal surfaces of metasomal segments II–V and lateral surfaces of segment V are densely setose, each with more than three pairs of macrosetae (type III; figs. 7C, 21, 22, 27, 28); the posterior granules of the ventrosubmedian carinae on metasomal segments II and III of the female are enlarged into spiniform processes (figs. 27, 28); and the telson vesicle of the male is globose (fig. 27; tables 10, 12, 13; appendix 5).

The three species are readily distinguished as follows. At 68.4 mm (60–75.5 mm, $n = 21$; tables 5, 12; appendix 5) (♂) and 71.4 mm (63.6–76.6 mm, $n = 24$) (♀) in total length, *B. manchego* (fig. 43) is slightly smaller than *B. iaspis* (fig. 41), at 74.6 mm (66.7–80.2 mm, $n = 5$; tables 5, 10; appendix 5) (♂) and 73.3 mm (68.5–78.7 mm, $n = 5$) (♀), and *B. montanus* (fig. 44), at 73.8 mm (72.3–76.4 mm, $n = 5$; tables 5, 13; appendix 5) (♂) and 78 mm (71.2–82.7 mm, $n = 5$) (♀). The base color of *B. manchego* varies from yellow to dark yellow (fig. 2F) whereas the base color of *B. iaspis* and *B. montanus* is dark orange (fig. 2C). The carapace of the male is quadrangular trapezoid in shape, the lateral margins sublinear in *B. manchego* (fig. 14C), but conical trapezoid in shape, the lateral margins curved in *B. iaspis* (fig. 14A) and *B. montanus* (fig. 14E). The pedipalp chela manus of the adult male is longer in *B. manchego*, with manus length : movable finger length, 66% (57.5%–71.5%, $n = 21$; tables 5, 12; appendix 5), than that of *B. iaspis*, with manus length : movable finger length, 71% (66.5%–75%, $n = 5$; tables 5, 10; appendix 5) and *B. montanus*, with manus length : movable finger length, 78% (71.7%–83.2%, $n = 5$; tables 5, 13; appendix 5). The pectinal tooth counts are higher in *B. manchego*, i.e., 32/32 (30–34/30–34, $n = 21$; tables 5, 12; appendix 5) (♂) and 28/28 (26–30/26–30, $n = 24$) (♀), than in *B. montanus*, i.e., 29/30 (28–30/29–31, $n = 5$; tables 5, 13; appendix 5) (♂)

and 27/26 (26–29/25–29, $n = 5$) (♀). The metasoma is longer, with mesosoma length : metasoma length, 35% (29.7%–39.5%, $n = 21$; tables 5, 12; appendix 5) (♂) or 39% (38.2%–46.7%, $n = 24$) (♀), in *B. manchego* (figs. 21B, 22B, 27B, 28B, 33B, 34B) than in *B. montanus* (figs. 21C, 22C, 27C, 28C, 33C, 34C), with mesosoma length : metasoma length, 37% (31.1%–40.4%, $n = 5$; tables 5, 13; appendix 5) (♂) or 42% (38.1%–48.4%, $n = 5$) (♀). The posterior granules of the ventrosubmedian carinae on metasomal segments II and, especially, III of the male are slightly enlarged into subspiniform processes in *B. manchego* (figs. 27B, 28B) but unmodified in *B. iaspis* (figs. 27A, 28A).

INTRASPECIFIC VARIATION: Given the broad geographical range of this species, conspecific populations might be expected to exhibit phenotypic variation, as in other species of *Buthus* (Vachon, 1952c; Habel et al., 2012). As in *B. halius*, the base color of *B. manchego* varies, although no clear geographical pattern is evident. Darker color and more pronounced infuscation are observed in populations from central Spain, some of which display infuscation on the legs, pedipalpal and metasomal carinae, e.g., three stripes of infuscation along the obsolete chelal carinae, not observed in other European species of *Buthus*. The variation observed across the distribution of *B. manchego* led Teruel and Turiel (2020, 2021b) to mistakenly recognize several species (see below).

In addition to phenotypic variation, *B. manchego* exhibits some genetic structure across its range (Blasco-Aróstegui et al., in prep.). However, the genetic distances among populations of *B. manchego* are lower than the distances between this species and other European species of *Buthus* (table 15; Blasco-Aróstegui et al., in prep.). Putative glacial refugia, river systems, and substrate variation may have contributed to local differentiation.

One population, originally recognized as *B. alacanti*, does not fully conform to the diagnostic character combination of *B. manchego*. Males from Sant Vicent del Raspeig display

coarsely granular median ocular carinae, whose infuscation is restricted to the anterior half, and the other carapacial carinae are finely granular, diagnostic characters of *B. occitanus* (figs. 6, 13E, F). However, the type IV infuscation pattern of the carapace intercarinal surfaces (fig. 5D), the densely setose dorsal surfaces of metasomal segments II–V (type III; fig. 7C), and morphometrics are consistent with *B. manchego* (fig. 10; samples from Sant Vicent del Raspeig in appendices 1, 5). Another population, previously recognized as *B. pedrosousai* (see below), also does not fully conform to the diagnostic character combination of *B. manchego*. Males from the Serranía de Cuenca region display a globose, incrassate pedipalp chela manus with the chela fixed and movable fingers curved basally and emarginate when closed (fig. 10; samples from Serranía de Cuenca in appendices 1, 5), characteristic of *B. delafulentei*, *B. halius* and *B. ibericus* (figs. 15A–C, 16A–C), whereas the morphometrics and the densely setose dorsal surfaces of metasomal segments II–V (type III; fig. 7C) are characteristic of *B. manchego* (fig. 10; samples from Serranía de Cuenca in appendices 1, 5). Considering the morphological stasis of the reproductive structures (figs. 35, 36) and genetic evidence (fig. 11; Blasco-Aróstegui et al., in prep.), these populations may represent admixed forms that arose from hybridization between *B. manchego* and *B. halius* and *B. occitanus*, respectively.

DISTRIBUTION: *Buthus manchego* is endemic to the Iberian Peninsula, and widespread across most of eastern and central-eastern Spain (fig. 3). It has been recorded from the regions of Andalucía, Castilla-La Mancha, Comunidad Valenciana and Región de Murcia.

ECOLOGY: *Buthus manchego* excavates shallow burrows in highly alkaline soils at the base of shrubs or under stones, across a range of Mediterranean vegetation types, including maquis, pine and oak forests, and dehesas (Teruel and Turiel, 2020; 2021b; table 16). In coastal areas, it has been recorded in salt marshes and sodic sites (J. B.-A., personal obs.). The climate across its

distribution varies widely from cold semiarid (Bsk), influenced by hot, dry air masses from North Africa, to hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters. In the central part of its distribution, the climate shifts to Oceanic (Cfb), marked by moderate temperatures and evenly distributed rainfall throughout the year (Köppen, 1936; Nunes, 2023). The habitat and habitus are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

REMARKS: Sousa (2017: 212) identified a genetically distinct clade, referred to as the “Jucar lineage,” occupying most of central-eastern Spain. Subsequently, Teruel and Turiel (2020, 2021b) described three species, *B. alacanti*, *B. pedrosousai*, and *B. serrano*, from the area inhabited by this clade, claiming “unequivocal” morphological diversity. After reevaluation of topotypes (appendix 1) and additional material of the three putative species, the diagnostic characters proposed to delimit the allegedly heterospecific populations were found to be trivial, inconsistent, or overlapping (figs. 8–10, table 12; appendix 5). Furthermore, the genetic distances between these populations and *B. manchego* were lower than those between other European species of *Buthus*, failing to support their recognition as distinct species (table 15; Blasco-Aróstegui et al., in prep.). The matter was further complicated by the presence of multiple reticulation events that appear to have shaped their evolutionary history (Blasco-Aróstegui et al., in prep.).

Arguments justifying the taxonomic decisions regarding each putative species are presented below. In accordance with the “First Reviser” principle, Article 24.2 of the ICZN (1999), *manchego* was selected as the prevailing name with which to synonymize *alacanti* and *serrano*, published in the same article, as it best reflects the distribution of the species; *alacanti* is too restrictive geographically to accurately reflect the distribution of the species and *serrano* is misleading, as the species is not confined to mountainous regions.

Teruel and Turiel (2020: 29) differentiated *B. alacanti* from *B. manchego* based on four quantitative characters (i.e., total length, secondary sexual dimorphism, chela shape and telson shape) and three qualitative characters (i.e., coloration, carapacial carination and the absence of the pedipalp chela “lobe/notch combination”). The morphometric characters were unsupported by the box-plots and LDA plots (figs. 8–10) which revealed no significant differences among putatively heterospecific populations (appendices 1, 5). Coloration was also found to be inconsistent and/or overlapping among populations of each putative species. Genetic distances between topotypes (appendix 1) of *B. alacanti* and *B. manchego* were lower than those between other European species of *Buthus* (table 15; Blasco-Aróstegui et al., in prep.). Teruel and Turiel (2020) correctly noted that *B. occitanus* is most similar morphologically to *B. alacanti* but mistakenly stated that it possesses weaker carapacial carinae. Examination of topotypes of *B. alacanti* (appendix 1) falsified this assertion and revealed the same pattern of infuscation, restricted to the anterior half of the median ocular carinae, in both species (see Teruel and Turiel, 2020: 47, fig. 14a).

Separate analyses of nuclear and mitochondrial DNA sequences conflicted regarding the placement of samples from the type locality of *B. alacanti* (appendix 1), which grouped with the *montanus* subclade (nuDNA almost identical to the *occitanus* subclade; table 15) or the *manchego* subclade, respectively (Blasco-Aróstegui et al., in prep.). According to the simultaneous analysis of the morphology, nuclear and mitochondrial DNA, as well as the morphometric analyses, however, *B. alacanti* is conspecific with *B. manchego* (figs. 8–11), consistent with the low mitochondrial DNA distances between samples from the type locality and *B. manchego* (table 15; appendix 1). Based on the available evidence, the following synonym is proposed: *Buthus alacanti* Teruel and Turiel, 2020 = *Buthus manchego* Teruel and Turiel, 2020, syn. n.

Teruel and Turiel (2020: 31) separated *B. serrano* from *B. alacanti* (= *B. manchego*) based on

three quantitative characters (i.e., male metasoma shape, female pedipalp chela manus shape and telson shape) and three qualitative characters (i.e., coloration, pedipalp chela setation, and absence of the pedipalp chela “lobe/notch combination”). However, the proposed characters failed to separate topotype material of *B. serrano* (appendix 1) and *B. manchego* (fig. 11; appendices 1, 5). No observable differences in the coloration and pedipalp chelal setation of populations assigned to the two putative species were detected. Genetic distances between topotypes (appendix 1) of *B. serrano* and *B. manchego* were lower than those between other European species of *Buthus* (table 15; Blasco-Aróstegui et al., in prep.). Based on the available evidence, the following synonym is proposed: *Buthus serrano* Teruel and Turiel, 2020 = *Buthus manchego* Teruel and Turiel, 2020, syn. n.

Teruel and Turiel (2021b) based *B. pedrosousai* on a population from Castilla-La Mancha, near Ribatajadilla in the foothills of Serranía de Cuenca, situated between the distributions of *B. halius* and *B. manchego*. As a diagnostic character, Teruel and Turiel (2021b: 5, 6, 8) noted the “unique shape of adult pedipalp chelae, which combines a globose chela manus with fingers essentially lacking basal lobe/notch combination.” Examination of topotypes of *B. pedrosousai* (appendix 1) confirmed the presence of a globose pedipalp chela manus in the male but not the absence of a “lobe/notch combination.” Although somewhat less pronounced than in typical specimens of *B. halius* (appendix 1), the chela fixed and movable fingers were found to be sublinear basally and emarginate when closed in all males examined (table 4; Blasco-Aróstegui et al., in prep.).

Separate analyses of nuclear and mitochondrial DNA sequences conflicted regarding the placement of samples from the type locality of *B. pedrosousai* (appendix 1), which grouped with the *halius* subclade or the *manchego* subclade, respectively (Blasco-Aróstegui et al., in prep.). As noted above, the globose chela manus is shared with *B. halius* (figs. 8–10). According to the



FIGURE 41. *Buthus iaspis* Teruel and Turiel, 2022, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Cabo de Gata-Níjar, Andalucía, Spain. C, D. ♀ (AMNH), Las Amoladeras, Andalucía, Spain. Scale bars = 10 mm.

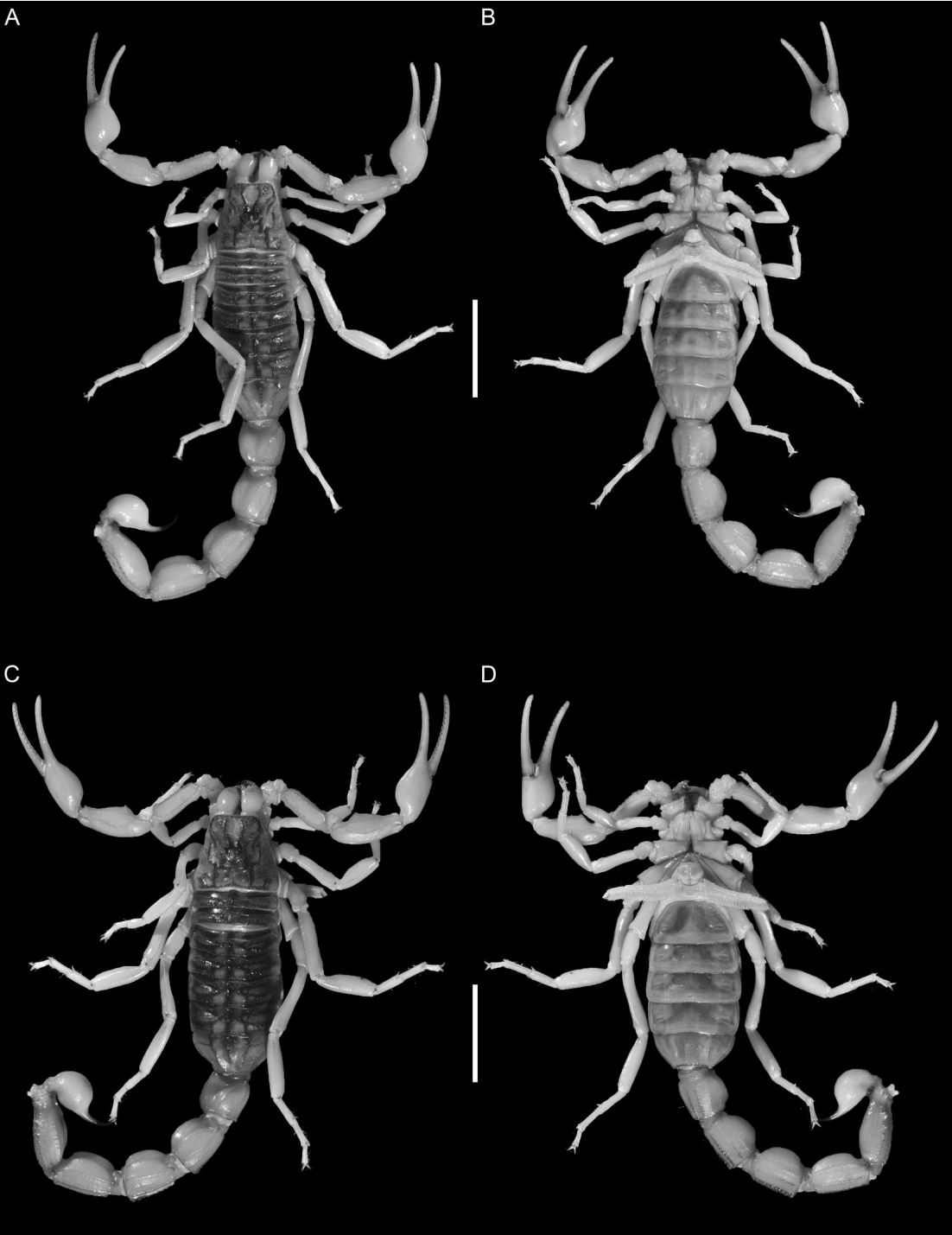


FIGURE 42. *Buthus ibericus* Lourenço and Vachon, 2004, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Dehesa Picado, Andalucía, Spain. C, D. ♀ (AMNH), Dehesa Picado, Andalucía, Spain. Scale bars = 10 mm.

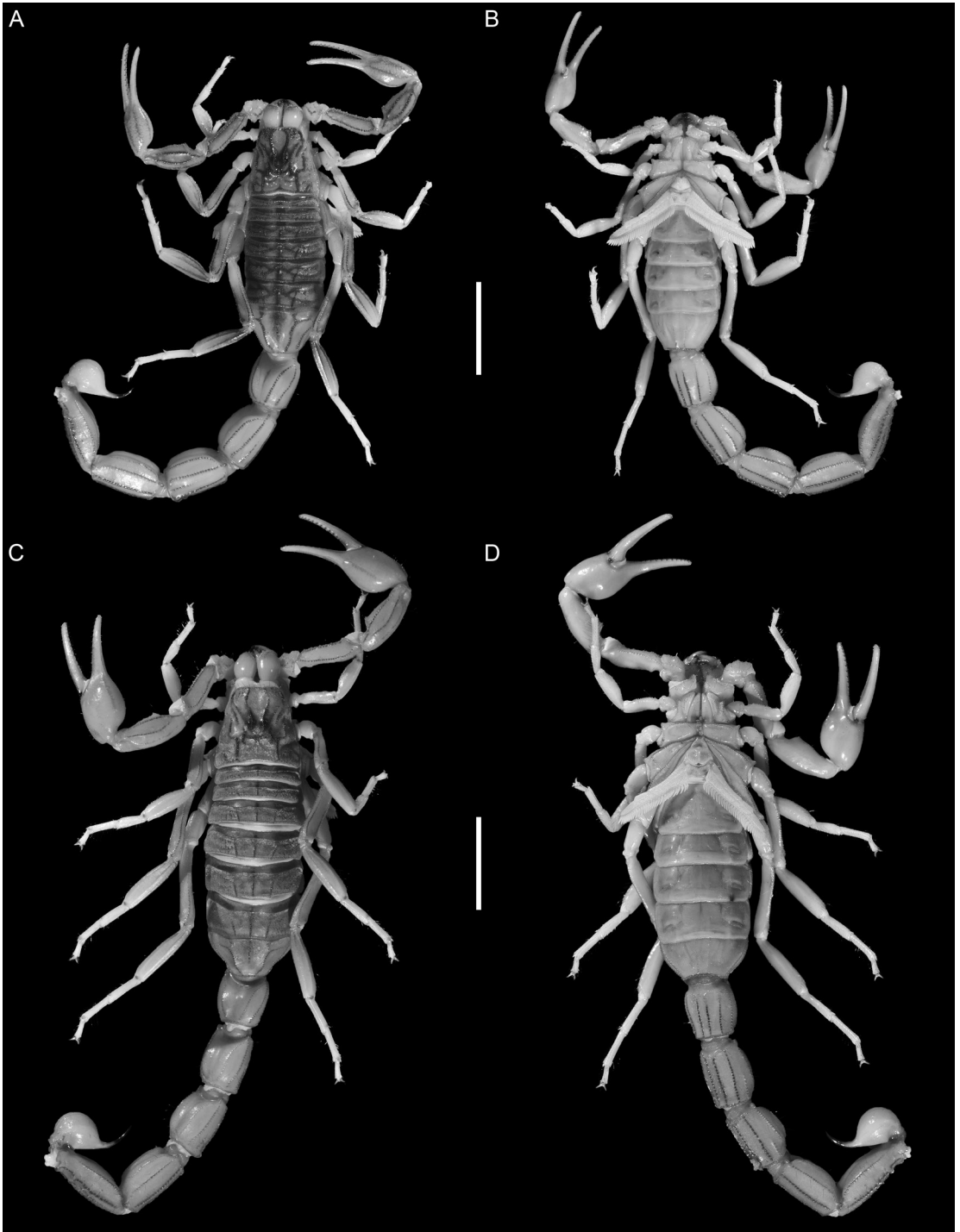


FIGURE 43. *Buthus manchego* Teruel and Turiel, 2020, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. C, D. ♀ (AMNH), Embalse de Peñarroya, Castilla-La Mancha, Spain. Scale bars = 10 mm.

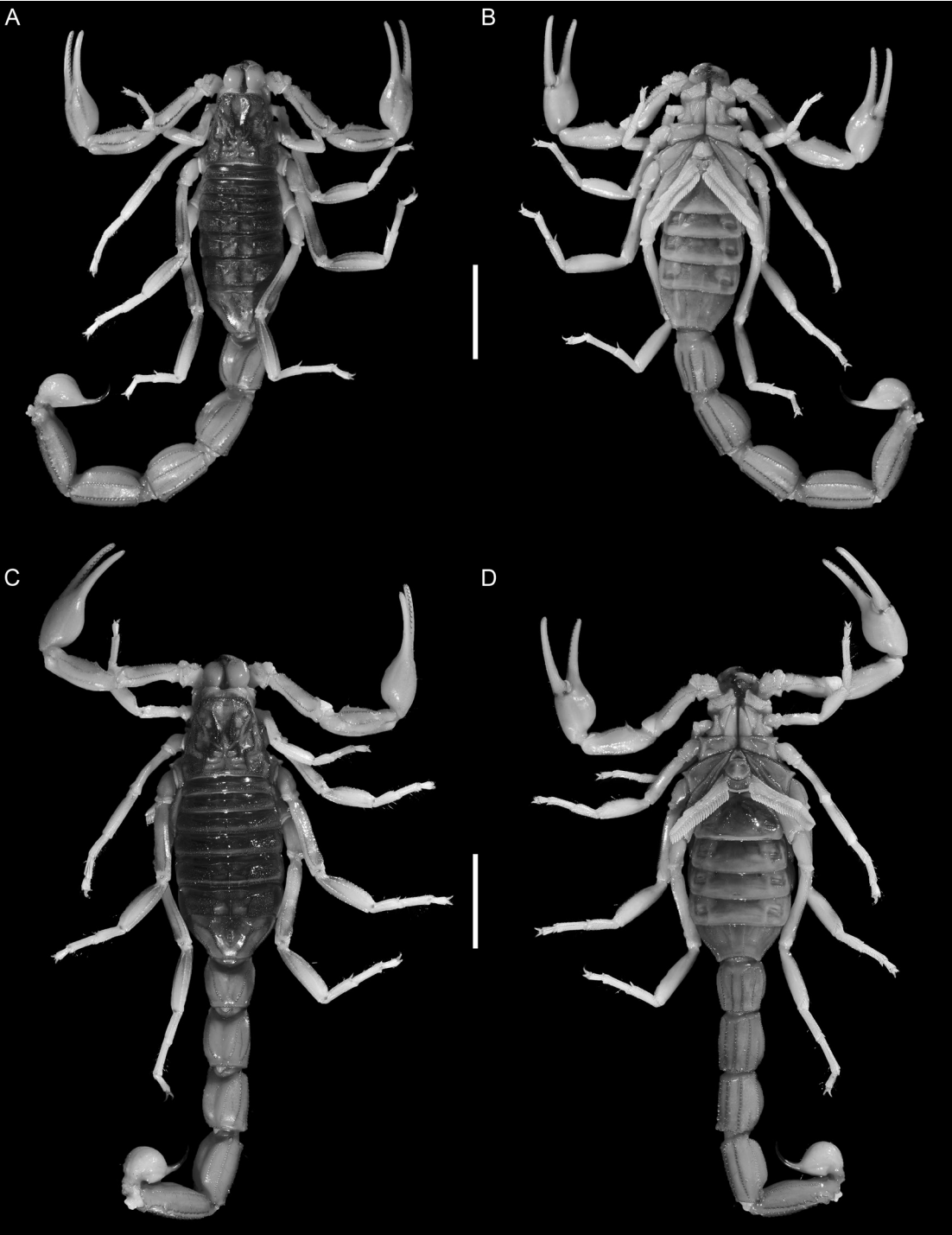


FIGURE 44. *Buthus montanus* Lourenço and Vachon, 2004, habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Puerto de La Ragua, Andalucía, Spain. C, D. ♀ (AMNH), Puerto de La Ragua, Andalucía, Spain. Scale bars = 10 mm.

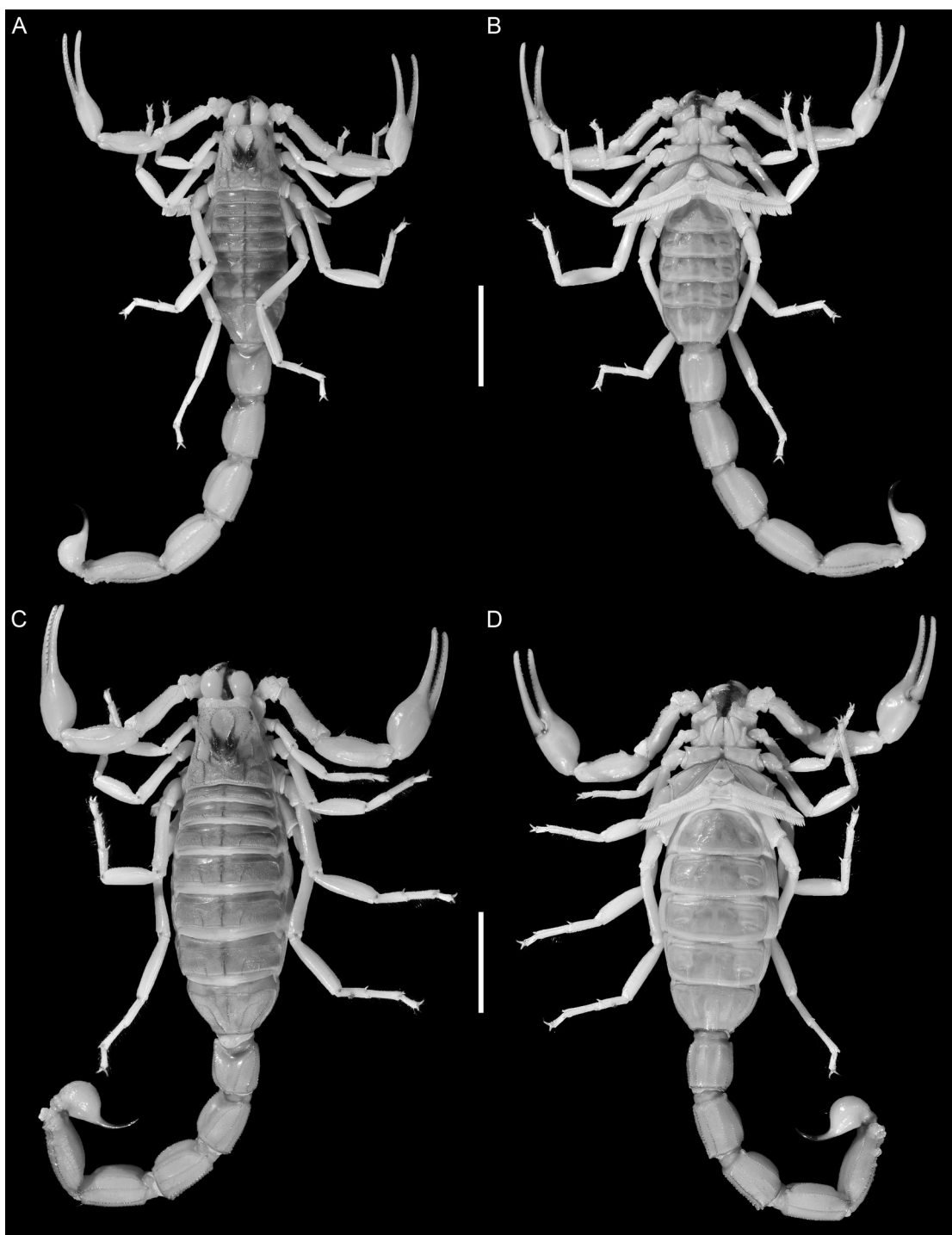


FIGURE 45. *Buthus occitanus* (Amoreux, 1789), habitus, dorsal (A, C) and ventral (B, D) aspects. A, B. ♂ (AMNH), Souvignargues, Occitanie, France. C, D. ♀ (AMNH), Souvignargues, Occitanie, France. Scale bars = 10 mm.

simultaneous analysis of the morphology, nuclear and mitochondrial DNA, as well as the morphometric analyses, however, *B. pedrosousai* is conspecific with *B. manchego* (figs. 8–11), consistent with the low mitochondrial DNA distances between samples from the type locality and *B. manchego* (table 15; appendix 1). Consequently, the following synonym is proposed: *Buthus pedrosousai* Teruel and Turiel, 2021 = *Buthus manchego* Teruel and Turiel, 2020, syn. n.

MATERIAL EXAMINED: SPAIN: Andalucía: *Granada Prov.:* Orce, 37°42'51.2"N 02°30'06.3"W, 1043 m, 17.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, pine forest with abundant rocks and sparse understorey, 1 ♂, 5 ♀, 1 subad. ♀ (AMNH), 3 ♀ (AMCC [LP 19765–19767]), 1 juv. ♂ (AMCC [LP 19768]), 1 juv. ♀ (AMCC [LP 19768]). **Castilla-La Mancha:** *Albacete Prov.:* Ossa de Montiel, 38°55'08.7"N 02°43'35.4"W, 1003 m, 12.vi.2023, J. Blasco-Aróstegui, Mediterranean meadow dominated by *Quercus coccifera* and *Thymus* sp., 1 ♂, 2 subad. ♀ (AMNH), 1 subad. ♀ (AMCC [LP 19516]), 3 juv. ♂ (AMCC [LP 19517, 19518, 19520]), 1 juv. ♀ (AMCC [LP 19519]), 18.vi.2024, J. Blasco-Aróstegui, 6 ♂, 2 ♀ (AMNH). *Ciudad Real Prov.:* Argamasilla de Alba, Embalse de Peñarroya, 38°55'08.7"N 02°43'35.4"W, 805 m, 12.vi.2023, J. Blasco-Aróstegui, Mediterranean rocky meadow dominated by *Quercus coccifera* and lacustrine vegetation, 1 ♂, 2 ♀, 3 subad. ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19522]), 1 subad. ♀ (AMCC [LP 19521]), 2 juv. ♂ (AMCC [LP 19523, 19524]); 18.vi.2024, J. Blasco-Aróstegui, 5 ♂, 3 ♀, 1 subad. ♀ (AMNH). *Cuenca Prov.:* Cañada del Hoyo, Torcas de Palancares y Tierra Muerta, 40°01'44.3"N 01°57'59.4"W, 1301 m, 10.vi.2023, J. Blasco-Aróstegui, pine forest with abundant rocks and Mediterranean understorey, 1 juv. ♂ (AMNH), 1 subad. ♂ (AMCC [LP 19535]), 3 juv. ♂ (AMCC [LP 19536–19538]), same data except: 17.vi.2024, J. Blasco-Aróstegui, 3 ♂, 1 ♀ (AMNH); Parque Natural de la Serranía de Cuenca: Ribatajadilla, 40°17'53.6"N

02°08'14.3"W, 1282 m, 10.vi. 2023, J. Blasco-Aróstegui, pine forest with abundant rocks and Mediterranean understorey, 1 ♀ (AMNH), 2 juv. ♂ (AMCC [LP 19532, 19534]), 1 juv. ♀ (AMCC [LP 19533]); 17.vi.2024, J. Blasco-Aróstegui, 5 ♂, 2 ♀ (AMNH). **Comunidad Valenciana:** *Alicante Prov.:* Muchamiel, 1 ♂ (MNCN 9385); Saint Vicent del Raspeig, 42°24'46.7"N 11°10'56.6"E, 228 m, 16.viii.2023, J. Blasco-Aróstegui, Y. Simone, and N. Lucchini, lot covered with Mediterranean vegetation, 3 ♂, 7 ♀ (AMNH), 1 ♀ (AMCC [LP 19742]), 1 subad. ♂ (AMCC [LP 19745]), 2 subad. ♀ (AMCC [LP 19743, 19744]), 2 juv. ♀ (AMCC [LP 19746]); Saladar de Agua Amarga, 38°16'57"N 00°31'30.7"W, 55 m, 16.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, salt marsh with halophilous vegetation such as *Limonium* sp., 1 ♂, 3 ♀, 1 subad. ♀ (AMNH), 2 ♀ (AMCC [LP 19747, 19748]), 1 juv. ♂ (AMCC [LP 19749]); Villena, 38°38'27.4"N 00°51'36.8"W, 19 m, 15.viii.2023, rocky hill with Mediterranean vegetation, 4 ♂, 7 ♀ (AMNH), 1 ♂ (AMCC [LP 19739]), 1 ♀ (AMCC [LP 19740]), 1 subad. ♂ (AMCC [LP 19738]), 2 subad. ♀ (AMCC [LP 19736, 19737]), 1 juv. ♂, 1 juv. ♀ (AMCC [LP 19741]). **Región de Murcia:** *Bajo Guadalentín Prov.:* Aledo, 37°48'52"N 01°34'49.2"W, 720 m, 16.viii.2023, pine forest with abundant rocks and sparse understorey, J. Blasco-Aróstegui, Y. Simone, and N. Lucchini, 1 ♂, 5 ♀ (AMNH), 1 ♀ (AMCC [LP 19750]), 1 subad. ♀ (AMCC [LP 19751]), 2 juv. ♂ (AMCC [LP 19752, 19753]).

Buthus montanus Lourenço and Vachon, 2004

Figures 3, 5D, 7C, 8–11, 14E, F, 15I, 16I, 21C, 22C, 27C, 28C, 33C, 34C, 35H, 36H, 44; tables 1–4, 13, 15, 16

Buthus montanus Lourenço and Vachon, 2004:

81, 84, 86–88, 91–93, figs. 16–30, 43, table I; Rossi, 2012: 273–279, fig. 7; Teruel and Melic, 2015: 5, 6, 8–12, fig. 10a, pl. I7, table

II; Sousa et al., 2017: 26, 29–31, 35, 51, figs. 9–11, tables 1, 2; Teruel and Turiel, 2020: 3, 11, 35, 43, 54, 58, figs. 7, 8, 27, 28f, 31c, d, tables V, XIII, XIV; 2021a: 3, fig. 1; 2021b: 3, 4, 8, 10, fig. 1; Ythier, 2021a: 1; Ythier, 2021b: 1; Teruel and Turiel, 2022a: 19, 23, 29, fig. 1; 2022b: 36, fig. 26; Ythier and Laborieux, 2022: 1; González-Moliné et al., 2023: 215.

TYPE MATERIAL: Holotype ♂, 1 ♂, 3 ♀ paratypes (MNHN) [examined], **SPAIN: Andalucía: Granada and Almería Provinces:** Sierra Nevada, trail from Puerto de La Ragua to Cerro Pelado, 2600–2700 m, 2.vii.1951, G. Colas.

DIAGNOSIS: *Buthus montanus* most closely resembles *B. iaspis* and *B. manchego*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15G–I, 16G–I), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 8B, D, 15G–I, 16G–I), and 12 denticle rows are often present on the movable finger. In addition to often exhibiting marked infuscation of the pedipalpal and metasomal carinae, the three species share the following characters: type IV infuscation pattern of the carapace intercarinal surfaces (fig. 5D); all carapacial carinae are infuscate and comprise granules of similar size (fig. 14); the carapace lateral ocular carinae are distinct and granular, and the prolateral secondary carinae often reach the lateral ocelli (fig. 14); the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 41, 43, 44); the dorsal surfaces of metasomal segments II–V and lateral surfaces of segment V are densely setose, each with more than three pairs of macrosetae (type III; figs. 7C, 21, 22, 27, 28); the posterior granules of the ventrosubmedian carinae on metasomal segments II and III of the female are enlarged into subspiniform processes (figs. 27, 28); and the telson of the male is globose (fig. 27; tables 10, 12, 13; appendix 5).

The three species are readily distinguished as follows. At 73.8 mm (72.3–76.4 mm, $n = 5$;

tables 5, 13; appendix 5) (♂) and 78 mm (71.2–82.7 mm, $n = 5$) (♀) in total length, *B. montanus* (fig. 8A, C) is slightly larger than *B. manchego* (fig. 8A, C), at 68.4 mm (60–75.5 mm, $n = 21$; tables 5, 12; appendix 5) and 71.4 mm (63.6–76.6 mm, $n = 24$; tables 5, 12; appendix 5) (♀). The base color of *B. montanus* is dark orange (fig. 2C), whereas the base color of *B. manchego* varies from yellow to dark yellow (fig. 2F). The carapace of the male is conical trapezoid in shape, the lateral margins curved in *B. montanus* (fig. 14E), but quadrangular trapezoid in shape, the lateral margins sublinear in *B. manchego* (fig. 14C). The pedipalp chela manus of the male is shorter in *B. montanus*, with manus length : movable finger length, 78% (71.7%–83.2%, $n = 5$; tables 5, 13; appendix 5), than in *B. manchego*, with manus length : movable finger length, 66% (57.5%–71.5%, $n = 21$; tables 5, 12; appendix 5). The pectinal tooth counts are lower in *B. montanus*, i.e., 29/30 (28–30/29–31, $n = 5$; tables 5, 13; appendix 5) (♂) and 27/26 (26–29/25–29, $n = 5$) (♀), than in *B. iaspis*, i.e., 32/32 (31–32/30–33, $n = 5$; tables 5, 10; appendix 5) (♂) and 28/28 (27–29/26–29, $n = 5$) (♀), and *B. manchego*, i.e., 32/32 (30–34/30–34, $n = 21$; tables 5, 12; appendix 5) (♂) and 28/28 (26–30/26–30, $n = 24$) (♀). The metasoma is shorter, with mesosoma length : metasoma length, 37% (31.1%–40.4%, $n = 5$; tables 5, 13; appendix 5) (♂) or 42% (38.1%–48.4%, $n = 5$) (♀), in *B. montanus* (figs. 21C, 22C, 27C, 28C, 33C, 34C), than in *B. iaspis* (figs. 21A, 22A, 27A, 28A, 33A, 34A), with mesosoma length : metasoma length, 34% (31.6%–36.1%, $n = 5$; tables 5, 10; appendix 5) (♂) or 39% (36.9%–40.8%, $n = 5$) (♀), and *B. manchego* (figs. 21B, 22B, 27B, 28B, 33B, 34B), with mesosoma length : metasoma length, 35% (29.7%–39.5%, $n = 21$; tables 5, 12; appendix 5) (♂) or 39% (38.2%–46.7%, $n = 24$) (♀). The posterior granules of the ventrosubmedian carinae on metasomal segments II and, especially, III of the male are slightly enlarged into subspiniform processes in *B. montanus* (fig. 27C, 28C) but unmodified in *B. iaspis* (figs. 27A, 28A).

DISTRIBUTION: *Buthus montanus* is endemic to the Iberian Peninsula, specifically Andalucía in southern Spain. It has been recorded from the Sierra Nevada and vicinity in the provinces of Almería and Granada (fig. 3).

ECOLOGY: *Buthus montanus* excavates burrows in open ground or under large stones embedded in the coarse substrates of mixed forests (Teruel and Turiel, 2020; Sousa, 2017). The climate of the area it inhabits is predominantly warm-summer Mediterranean (Csb), characterized by hot, dry summers and cold winters (Köppen, 1936; Nunes, 2023), with precipitation in the form of snow above 2000 m. The presence of this species at high elevations (up to 2200 m; table 16), characterized by heavy winter snowfall, suggests that it may have diverged through niche isolation and developed mechanisms to survive prolonged cold periods. The depth of the burrows exceeds that of other European *Buthus* species (J. Blasco-Aróstegui, pers. obs.). The habitat and habitus are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

REMARKS: Lourenço and Vachon (2004) diagnosed *Buthus montanus* based on morphological characters, supported by illustrations. Lourenço and Vachon's (2004: 87) fig. 20 depicted a single carina situated almost centrally on the carapace, parallel to its posterior margin, considered diagnostic for the species: "Clé d'identification pour les espèces connues de *Buthus* d'Europe...carènes médianes centrales reliées par plusieurs gros granules qui forment une carène transversal...*Buthus montanus* sp. n." Examination of the type material deposited at the MNHN, along with additional specimens from the type locality revealed that the carina depicted in the figure is absent. Furthermore, no European species of *Buthus* exhibit this carina. The orientation of the central median carinae (figs. 7, 14E, F) was misrepresented in the illustration.

MATERIAL EXAMINED: SPAIN: Andalucía: Almería Prov.: Sierra Nevada, Puerto de La Ragua, 37°06'35.5"N 03°01'23.4"W, 2118 m, 18.viii.2023, J. Blasco-Aróstegui, Y. Simone and

N. Lucchini, alpine forest slopes dominated by pines, 7 ♂, 7 ♀, 1 subad. ♀ (AMNH), 1 ♀ (AMCC [LP 19769]) 1 ♀, 1 juv. ♀ (AMCC [LP 19773]), 1 subad. ♀ (AMCC [LP 19771]), 1 juv. ♂ (AMCC [LP 19770]), 2 juv. ♀ (AMCC [LP 19772, 19777]). *Granada Prov.:* Francisco Abelán Dam, 37°16'46.1"N 03°15'11.7"W, 1119 m, 18.viii.2023, J. Blasco-Aróstegui, Y. Simone and N. Lucchini, earthen slopes with Mediterranean vegetation on trail, 3 ♂, 1 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 19774, 19776]), 1 juv. ♀ (AMCC [LP 19775]).

Buthus occitanus (Amoreux, 1789)

Figures 1D, 2A, 3, 4, 5, 5C, 7A, 8–11, 13E, F, 15F, 16F, 19C, 20C, 25C, 27C, 31C, 32C, 35I, 36I, 45; tables 1–5, 14–16

Buthus europaeus Thorell, 1876a: 7 [*Scorpio europaeus* Linnaeus, 1758] (synonymized by Fet and Lowe, 2000: 93); Karsch, 1879: 18; Simon, 1879: 96–98; Pavesi, 1880: 312, 313; Simon, 1880: 29; Pavesi, 1884: 450; 1885: 197, 199; Simon, 1885: 51; Pocock, 1889b: 116; Thorell, 1893: 358, 359; Pocock, 1895: 299; Birula, 1896: 241–243; 1900: 9; Simon, 1910: 68–70, figs. 5, 8; Hirst, 1925: 415, 416; Gadeau de Kerville, 1926: 71; Bacelar, 1928: 191; Hugues, 1933: 487, 488.

Scorpio rufus Amoreux, 1789a: 43, 295; pl. I; fig. 2 (synonymized by Amoreux, 1789b: 10).

Scorpio occitanus Amoreux, 1789b: 41–43. 1789b: 9–15; pl. I; figs. 1–3.

Androctonus eurialus C.L. Koch, 1839b: 25–27, pl. CLXXXVII [not pl. CXXXVII, as listed in text], fig. 448 (synonymized by Simon, 1879: 96).

Androctonus eurilochus C.L. Koch, 1839b: 27–28, pl. CLXXXVII, fig. 449 (synonymized by Kraepelin, 1891: 196).

Buthus occitanus Leach, 1815: 391; Risso, 1826: 156, 157; Peters, 1861: 513; Simon, 1879: 96; Karsch, 1881a: 8; 1881b: 89; Kraepelin, 1891: 54–57 (part), pl. I, fig. 5, pl. II, fig. 18; 1895: 80; Pocock, 1899: 834; Kraepelin, 1899: 26;

- 1901: 266; Werner, 1902: 598; Chaignon, 904: 83–84; Tullgren, 1909: 2, 3; Birula, 1910: 118–120; Masi, 1912: 101; Borelli, 1915: 460; Lampe, 1917: 191; Borelli, 1924: 4; Pavlovsky, 1924: 77; King, 1925: 81; Pavlovsky, 1925: 140; Werner, 1925: 209; Gough and Hirst, 1927: 5, fig. 9; Pallary, 1929: 140; Werner, 1932b: 300–305; Pallary, 1934: 98, 99; Werner, 1934a: 269, fig. 330; 1936: 173; Pallary, 1938: 281, 282; Schenkel, 1938: 4; Sergeant, 1938: 519, 520, pl. 49; Monard, 1939: 82, 83; Feytaud, 1940: 38, 39; Vachon, 1940: 242–247, 254–258, figs. 1–9, 29, 33, 61–64; Kästner, 1941: 231; Moriggi, 1941: 84; Sergeant, 1941: 355, fig. IE, 2.7, pl. 35, fig. 7; Vachon, 1941: 52; Denis, 1948: 155, 156; Vachon, 1948a: 61, fig. 5; 1949a: 156–160, fig. 331–344, 348, 372–380; Bacelar, 1950: 4; Vachon, 1950, fig. 591; 1951: figs. 641, 657, 663, 679, 687, 696; 1952a: 621–623; 1952b: 274–279; 1952c: 73, 262–271, figs. 331–344, 348, 372–380, 591, 641, 657, 663, 679, 687, 696; 1953: 1021–1024, fig. 12; Malhomme, 1954: 28; Belfield, 1956: 44; Vachon, 1961: 31, 32; Bücherl, 1964: 57; Pérez, 1974: 22; Kinzelbach, 1975: 14, fig. 1; Goulliart, 1979: 2; Levy and Amitai, 1980: 15, 16; Lamoral and Reyniers, 1975: 505; Kinzelbach, 1982: 53; Prost, 1982: 5; Kinzelbach, 1984: 100; 1985: map II; El-Hennawy, 1988: 17; Amr et al., 1988: 374; Michalis and Dolkeras, 1989: 265, 266; Sissom, 1990a: 92, fig. 3.17C, L; El-Hennawy, 1992: 98, 101, 119–120; Kovařík, 1992a: 183; 1992b: 90; Reichholf and Steinbach, 1992: 33, figs. 4, 5; Crucitti, 1993: 51; Amr and El-Oran, 1994: 188; Crucitti et al., 1994: 57–66; Vincent, 1994: 6; Crucitti and Chine, 1995: 15–26; Braunwalder, 1997: 3; Crucitti and Chine, 1997: 195–200; Kovařík, 1997: 179; Cloudsley-Thompson and Lourenço, 1998: 1, 2; Kovařík, 1998: 106; Fet and Lowe, 2000: 6, 91–97, 662, 667, 670, 673, 675, 678, 680, 681 (part); Lourenço and Vachon, 2004: 81–85, 88, 92, 93, table I, fig. 43 (part); Teruel and Pérez-Bote, 2005: 273, 276; Sousa et al., 2010: 206, 207 (part), 208, 210, table 1 (part), figs. 1, 2; Teruel and Melic, 2015: 10, 11, figs. 1a, 6b, 9b, lam. 1 (1–3), table II; Sousa et al., 2017: 15, 18, 19, 21, 23–26, 29–33, 35, 44, 51, 53–55, figs. 3, 6b, 9–11, tables 1, 2 (part); Teruel and Turiel, 2020: 3, 4, 7, 10, 13, 15–17, 19, 22, 24, 27, 29, 31, 32, figs. 9–13, 27, 29, 33, tables VI–VII, XIII, XIV; Teruel and Turiel, 2021a: 3, 4, 6–8, 11, fig. 1; 2021b: 3, 4, 8–10, fig. 1; Ythier, 2021a: 1; 2021b: 1–8, figs. 3, 7, 8, 10, 13, 15, 17, tables II, III; Teruel and Turiel, 2022a: 23, 29, fig. 14; 2022b: 19, 20, 36, fig. 26; Ythier and Laborieux, 2022: 1, 2, 6, 8, fig. 17, tables II, III; González-Moliné and de Armas, 2024: 75.
- Buthus europaeus* var. *tridentatus* Franganillo, 1918: 122, 123 (synonymized by Sousa et al., 2017: 53).
- Buthus occitanus occitanus*: Fet and Lowe, 2000: 94–97 (part).
- Buthus occitanus tridentatus*: Fet and Lowe, 2000: 97.
- Buthus pyrenaeus* Ythier, 2021b: 1–10, figs. 1, 2, 5, 6, 12, 14, 16, tables I–III, syn. n.; Teruel and Turiel, 2022a: 29; 2022b: 36; Ythier and Laborieux, 2022: 1, 2, 4, 6–9, 11–13.
- Buthus balmensis* Ythier and Laborieux, 2022: 1–13, 1–16, tables I–III, syn. n.
- TYPE MATERIAL: Syntypes [sex unknown, depository unknown], **FRANCE**: “in Gallia Narbonensi [southern France], loco Souvignargues” [lost]. Neotype ♂ (IES), **Languedoc-Roussillon**: *Gard Department*: Souvignargues, 43°48′33″N 04°08′44″E, 125 m, 23.ix.2017, C. Turiel and M. Stockmann. *Buthus europaeus*: Holotype [sex and depository unknown, lost]. *Androctonus eurialus*: Holotype [sex and depository unknown], **FRANCE** [lost]. *Androctonus eurilochus*: Holotype [sex and depository unknown, lost]. *Buthus europaeus tridentatus*: **SPAIN**: **Comunidad Foral de Navarra**: *Navarra Prov.*: Holotype [sex and depository unknown], Javier. Neotype ♂ (IES), Javier Cas-

tle, 1 km SW, 42°35'N 01°14'08"W, 554 m, 22.vi.2016, C. Turiel. *Buthus pyrenaicus*: **FRANCE: Pyrénées-Orientales**: Holotype ♂ (MHNL 47036301), Cerbère, 25.ix.1938, A. Primot. Paratypes: 2 ♀ (MHNL 47023075, 47023076), Cerbère, v.1950, P. Cauchois; 2 juv. ♀ (EYCP 244), Massif des Albères, 1993, J.-B. Lacroix; 1 ♀ (MHNL 47023076), Montauriol, Mas Julia (St. Michel), 23.viii.1980, P. Cauchois. *Buthus balmensis*: Holotype ♂ (MNHNL), 2 ♀ paratypes (MNHNL [EYCP 390]), **FRANCE: Var**: Sainte-Baume Massif, on mountain crest, 1000 m, 17.vi.2022, L. Laborieux.

DIAGNOSIS: *Buthus occitanus* most closely resembles *B. elongatus* and *B. garcialorcai*. All three species possess a slender pedipalp chela manus in the male, a globose, incrassate chela manus in the female (figs. 8B, D, 15D–F, 16D–F), the chela fixed and movable fingers are sublinear basally and emarginate when closed in both sexes (figs. 8B, D, 15D–F, 16D–F), and 12 denticle rows are often present on the movable finger. The three species also share the following characters: the legs are slender, with slightly elongated femora, patellae, tibiae, and tarsi (figs. 38, 39, 45); the dorsosubmedian carinae on metasomal segments I–III are granular in both sexes (figs. 19, 20); and the posterior granules of the ventrosbmedian carinae on metasomal segments II and III are enlarged into subspiniiform processes in the female (fig. 26).

The three species are readily distinguished as follows. At 60.85 mm (49.6–70.1 mm, $n = 15$; tables 5, 14; appendix 5) (♂) and 67.52 mm (63.1–73.07 mm, $n = 13$) (♀) in total length, *B. occitanus* (fig. 45) is slightly smaller than *B. elongatus* (fig. 38), at 73.3 mm (70–77.7 mm, $n = 5$; tables 5, 7; appendix 5) (♂) and 74.8 mm (70.2–78.7 mm, $n = 5$) (♀). The base color of *B. occitanus* is pale yellow with the tergites immaculate or faintly infuscate (fig. 2A), whereas the base color of *B. elongatus* and *B. garcialorcai* is dark orange with a trivittate pattern of infuscation across the tergites (fig. 2B). The infuscation pattern of the carapace intercarinal surfaces is type III in *B. occitanus* (fig. 5C) and type IV in *B. elongatus*

and *B. garcialorcai* (fig. 5D). Only the median ocular carinae are pigmented, in the anterior half, and comprise granules noticeably larger than the granules of other carapacial carinae in *B. occitanus* (figs. 7, 13E) whereas all carapacial carinae are infusate and comprise granules of similar size in *B. elongatus* and *B. garcialorcai* (figs. 7, 13A, C). Metasomal segment I of the male is shorter and broader in *B. occitanus* (figs. 9A, 19C, 25C, 31C), with segment I width : length 82% (72%–92.4%, $n = 15$; tables 5, 14; appendix 5), than in *B. elongatus* (figs. 9A, 19A, 25A, 31A), with segment I width : length 77% (74.9%–79.2%, $n = 5$; tables 5, 7; appendix 5). Metasomal segment V of the male is also broader in *B. occitanus* (figs. 9B, 19C, 25C, 31C), with segment V width : length, 39% (35.5%–45.6%, $n = 15$; tables 5, 14; appendix 5), than in *B. elongatus* (figs. 9B, 19A, 25A, 31A), with segment V width : length, 36% (34.3%–36.4%, $n = 5$; tables 5, 7; appendix 5). The dorsal surfaces of metasomal segments II–V and lateral surfaces of segment V are sparsely setose, each with no more than three pairs of macrosetae, in *B. occitanus* (type I; figs. 7A, 19A, C, 25A, C), whereas the dorsal surfaces of segments II–V are moderately setose, and the lateral surfaces of segment V, densely setose, each with more than three pairs of macrosetae, in *B. garcialorcai* (type II; figs. 7B, 19B, 25B). The posterior granules of the ventrosbmedian carinae on metasomal segments II and III of the male are slightly enlarged into subspiniiform processes, especially on segment III, in *B. occitanus* (fig. 25C) but unmodified in *B. elongatus* (fig. 25A). The telson vesicle of the male is slightly globose, with vesicle height : length, 67% (54.9%–78.2%, $n = 15$; tables 5, 14; appendix 5), in *B. occitanus* (fig. 25C) whereas it is more compressed (fig. 25A), with vesicle height : length, 64% (62.4%–67.1%, $n = 5$; tables 5, 7; appendix 5), in *B. elongatus*.

INTRASPECIFIC VARIATION: *Buthus occitanus* exhibits a distinct and homogeneous morphology across its distribution on which basis it may be easily differentiated from other European species of *Buthus*. Populations from Albentosa and Sierra

Calderona, located between the distributions of *B. manchego* and *B. occitanus*, do not fully conform to the diagnostic character combination of *B. occitanus*, however. Whereas the morphometrics and sparsely setose dorsal surfaces of metasomal segments II–V (type I; figs. 7A, 8–10) are consistent with *B. occitanus* (samples from Sierra Calderona in appendix 5), other character states observed in these populations, e.g., dark yellow coloration with trivittate pattern of infuscation across the mesosomal tergites, type IV infuscation pattern of the carapace intercarinal surfaces (fig. 5D), and all carapacial carinae infuscate and similarly developed (figs. 6, 14C), are shared *B. manchego*. Considering the morphological stasis of the reproductive structures (figs. 35, 36) and genetic evidence (Blasco-Aróstegui et al., in prep.), these populations may represent an admixed form that arose from hybridization between *B. manchego* and *B. occitanus*.

DISTRIBUTION: *Buthus occitanus* has one of the broadest distributions of European *Buthus*, extending from the province of Castellón in eastern Spain, to the foothills of the Alps in Provence-Alpes-Côte d'Azur of southeastern France (fig. 3). It has also been recorded from the Spanish regions of Catalunya, La Rioja, and Navarra, and on Ilha Grossa in the Islas Columbretes, off the eastern coast of Spain.

ECOLOGY: *Buthus occitanus* excavates shallow burrows in coarse, clayey substrates under stones or in open ground, in a broad range of Mediterranean vegetation types, including maquis, pine and oak forests, and dehesas (Teruel and Turiel, 2020; fig. 3; table 16). It has been reported from sea level on the capes and dune systems of the eastern coast of Spain to higher elevations in valleys of the Pyrenees. The climate across its distribution varies widely, from cold semiarid (Bsk), to hot-summer Mediterranean (Csa), characterized by hot, dry summers and cool, wet winters (Köppen, 1936; Nunes, 2023). In the central and northern regions of its distribution, the climate shifts to Oceanic (Cfb), marked by moderate temperatures and rainfall occurring throughout the year. The habitat and habitus of *B. occitanus*

are consistent with the pelophilous ecomorphotype (Prendini, 2001a).

REMARKS: The syntypes of *B. occitanus* have long been considered lost (Fet and Lowe, 2000). A neotype from the vicinity of the type locality, “Souvignargues,” was therefore designated by Teruel and Turiel (2020), along with a neotype for *B. europaeus* var. *tridentatus* from Javier (Navarra, Spain), previously synonymized by Sousa et al. (2017). This synonymy was confirmed in the present study by morphological and genetic data obtained from topotypes (fig. 11; appendix 1).

Ythier (2021b) and Ythier and Laborieux (2022) described two new species, *B. balmensis* and *B. pyrenaeus*, both closely related to *B. occitanus* and allegedly endemic to France. Although the type material was not examined in the present investigation, the analyses included topotypes (appendix 1) of both putative species and additional material from nearby localities. Morphometric and genetic analyses revealed a close match with *B. occitanus* (fig. 11; table 15; Blasco-Aróstegui et al., in prep.) and the putatively diagnostic characters were found to be too inconsistent to justify distinct species.

The quantitative differences alleged by Ythier (2021b) to differentiate *B. pyrenaeus* from *B. occitanus* were invalidated by the morphometric analyses presented herein, which included samples spanning the distributions of *B. occitanus* and the putative new species (table 14; appendix 5). The single qualitative character of *B. pyrenaeus*, i.e., metasoma more incrassate in males than females and possessing vestigial to weakly subcrenulate dorsolateral carinae, was found to overlap significantly with *B. occitanus* and other European species, rendering it unsuitable for reliable diagnosis. Based on the morphological data, combined with the extremely low or non-existent genetic divergence among topotypical populations of both species (fig. 11; table 14; appendix 1; Blasco-Aróstegui et al., in prep.), the following synonym is proposed: *Buthus pyrenaeus* Ythier, 2021 = *Buthus occitanus* (Amoreux, 1789), syn. n.

Ythier and Laborieux (2022: 6) differentiated *B. balmensis* from *B. occitanus* based on a morphometrics and dubious qualitative characters, arguing that a vicariance event drove the divergence between the two species. As in the previous case, the alleged quantitative differences were unsupported by morphometric analyses based on samples from across the distributions of *B. occitanus* and *B. balmensis* (figs. 8–10, table 14; appendices 1, 5). Qualitative characters concerning carapace granulation and metasomal carination were found to be inconsistent and/or overlapped significantly between populations belonging to each putative species. Based on the morphological data, combined with the extremely low or nonexistent genetic divergence among topotypes of both species (fig. 11; table 14; appendix 1; Blasco-Aróstegui et al., in prep.), the following synonym is proposed: *Buthus balmensis* Ythier and Laborieux, 2022 = *Buthus occitanus* (Amoreux, 1789), syn. n.

Separate analyses of nuclear and mitochondrial DNA sequences conflicted regarding the placement of samples from Albentosa and Sierra Calderona, which grouped with the *manchego* subclade or the *occitanus* subclade, respectively (Blasco-Aróstegui et al., in prep.). As noted above, some of the morphological characters of these samples appear to be shared with *B. manchego*. According to the simultaneous analysis of the morphology, nuclear and mitochondrial DNA, as well as the morphometric analyses, however, these samples are conspecific with *B. occitanus* (figs. 7A, 8–11), consistent with the moderate to low mitochondrial DNA distances between these samples and the topotypes (appendix 1) of *B. occitanus* (table 15).

MATERIAL EXAMINED: FRANCE: Occitanie: Gard Department: Souvignargues, 43°48'34.8"N 04°08'44"E, 195 m, 13.viii.2023, J. Blasco-Aróstegui and Y. Simone, pine forest, with Mediterranean understorey and abundant rocks, 1 ♂, 1 ♀ (AMNH), 1 ♂ (AMCC [LP 19718]), 1 ♀ (AMCC [LP 19717]). **Hérault Department:** Notre-Dame-de-Londres, le Ravin des Arcs, along trail, 43°48'53.4"N 03°44'19.9"E – 43°48'51.6"N 03°44'26.3"E, 180–

206 m, 1.viii.2019, S.F. Loria, under stones or in burrows under stones, 1 juv. ♂, 1 juv. ♀ (AMCC [LP 16670]); Pompignan, S of Route de Ferrières (D181), along canyon by Ruisseau des Croses, 43°53'19.2"N 03°50'10.5"E – 43°53'17.8"N 03°50'11.1"E, 212–217 m, 1.viii.2019, S.F. Loria, in burrows or on canyon walls, 2 juv. ♀ (AMCC [LP 16671]). **Pyrénées-Orientales Department:** Correc Gros, 42°36'46.8"N 02°35'24.9"E, 649 m, 13.viii.2023, J. Blasco-Aróstegui and Y. Simone, mixed forest slope, rocky and earthen walls, wandering and under rocks, 1 ♂, 8 ♀ (AMNH), 2 ♀ (AMCC [LP 19722, 19725]), 2 juv. ♂ (AMCC [LP 19724, 19726]), 1 juv. ♀ (AMCC [LP 19723]). **Provence-Alpes-Côte d'Azur: Var Department:** Massif de la Sainte-Baume, 43°19'38.9"N 05°46'12.1"E, 1004 m, 12.viii.2023, J. Blasco-Aróstegui and Y. Simone, montane plateau with Mediterranean shrubs, 4 ♂, 6 ♀ (AMNH), 1 ♂ (AMCC [LP 19714]), 1 subad. ♂ (AMCC [LP 19712]), 3 subad. ♀ (AMCC [LP 19711, 19713, 19715]), 1 juv. ♀ (AMCC [LP 19716]). **SPAIN: Aragón: Teruel Prov.:** Albentosa, Venta del Aire, 40°06'42.6"N 00°43'53.4"W, 988 m, 19.vi.2024, J. Blasco-Aróstegui, pine forest with Mediterranean understorey and many rocks, juv. ♂ (AMCC [LP 20655]). **Catalunya: Barcelona Prov.:** Parc del Garraf, 41°16'38.4"N 01°52'27.8"E, 358 m, 14.viii.2023, J. Blasco-Aróstegui and Y. Simone, Mediterranean shrubland, with pine trees and abundant rocks, 2 ♂, 3 ♀ (AMNH), 2 juv. ♂ (AMCC [LP 19728, 19729]), 1 juv. ♀ (AMCC [LP 19727]). **Comunidad Foral de Navarra: Navarra Prov.:** Balsa de Pulguer, 42°03'06.8"N 01°42'16.4"E, 373 m, 2.ix.2021–7.ix.2023, J. Blasco-Aróstegui, dry lands around small lake, 2 subad. ♂ (AMNH, AMCC [LP 17972]), 1 juv. ♂ (AMCC [LP 17847]); Bardenas Reales, surroundings of Bardenas Reales de Navarra Natural Park, 42°00'01.4"N 01°22'17.8"E, 475 m, 7.x.2021, J. Blasco-Aróstegui and L. Barea, clay and rocky ground, with dry vegetation 1 ♀ (AMCC [LP 17846]), 1 juv. ♂ (AMCC [LP 17848]), 14.vii.2022, J. Blasco-Aróstegui, V. Marqués and I. Llorca, clayey, rocky ground, with dry, Maquis vegetation, 5 ♂, 3 ♀, 1 subad. ♀ (AMNH), 3 ♂ (AMCC [LP 18488–18490]), 1 juv. ♀ (AMCC [LP 18491]); Javier, 42°35'03.6"N

01°14'03.3"W, 627 m, 29.v.2023, J. Blasco-Aróstegui, Mediterranean shrubland, with many rocks, near pine forest, 6 ♀ (AMNH), 2 ♀ (AMCC [LP 19527, 19530]), 2 juv. ♂ (AMCC [LP 19528, 19531]), 3 juv. ♀ (AMCC [LP 19525, 19526, 19529]). **Comunidad Valenciana:** *Castellón Prov.*: Columbrete Grande, 1 ♂, 8 ♀, 6 juv. (MNCN 9722), 7 ♂ (MNCN 17070); *Ilha Grossa*, 39°53'53.7"N 00°41'06.9"E, 20 m, 20.ix.2023, Y. Simone, 2 ♂, 1 ♀ (AMNH), 3 ♀ (AMCC [LP 20003–20005]), 1 juv. ♂ (AMCC [LP 20007]), 1 juv. ♀ (AMCC [LP 20006]); *Islas Columbretes*, 1 ♀, 1 subad. ♀, 1 juv. (MNCN 17059); *Islas Columbretes*, *La Ferrera*, 2 ♂, 1 ♀ (MNCN 9721); *Parque Natural de la Sierra Calderona*, 39°41'55.3"N 00°24'38"W, 683 m, 15.viii.2023, J. Blasco-Aróstegui, Y. Simone, and N. Lucchini, pine forest, with Mediterranean understorey and abundant rocks, 5 ♂, 3 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 19731, 19732]), 1 subad. ♀ (AMCC [LP 19730]), 6 juv. ♂ (AMCC [LP 19733–19735]), 19.vi.2024, J. Blasco-Aróstegui, 5 ♂ (AMNH).

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APPENDIX 1

TOPOTYPES OF PUTATIVE EUROPEAN SPECIES
OF *BUTHUS* LEACH, 1815, USED IN MOLECULAR
AND MORPHOLOGICAL ANALYSES

***Buthus ajax* (C.L. Koch, 1839):** Spain: Porzuna, 1 ♂, 4 ♀ (AMNH), 2 juv. ♂ (AMCC [LP 19493])

***Buthus alacanti* Teruel and Turiel, 2020:** Spain: Sant Vicent del Raspeig, 3 ♂, 7 ♀ (AMNH), 1 ♀ (AMCC [LP 19742]), 1 subad. ♂ (AMCC [LP 19745]), 2 subad. ♀ (AMCC [LP 19743, 19744]), 2 juv. ♀ (AMCC [LP 19746])

***Buthus baeticus* Teruel and Turiel, 2020:** Spain: Esparteros, 2 ♂, 6 ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19801])

***Buthus balmensis* Ythier and Laborieux, 2022:** France: Sainte-Baume, 4 ♂, 6 ♀ (AMNH), 1 ♂ (AMCC [LP 19714]), 1 subad. ♂ (AMCC [LP 19712]), 3 subad. ♀ (AMCC [LP 19711, 19713, 19715]), 1 juv. ♀ (AMCC [LP 19716])

***Buthus castellano* Teruel and Turiel, 2022:** Spain: Herrera, 3 ♂, 4 ♀ (AMNH), 1 ♀ (AMCC [LP 19495]), 3 subad. ♂ (AMCC [LP 19496–19498]), 2 juv. ♂ (AMCC [LP 19499, 19500])

***Buthus delafulentei* Teruel and Turiel, 2020:** Spain: Pinar del Tableado, 3 ♂, 4 ♀ (AMNH), 3 subad. ♀ (AMCC [LP 19812–19814]), 2 juv. ♀ (AMCC [LP 19815, 19816])

***Buthus elongatus* Rossi, 2012:** Spain: Sierra Blanca, 8 ♂, 6 ♀ (AMNH), 1 ♂ (AMCC [LP 19787]), 1 ♀ (AMCC [LP 19789]), 1 subad. ♂, 2 juv. ♂, 1 juv. ♀ (AMCC [LP 19792]), 2 subad. ♀ (AMCC [LP 19788, 19791]), 2 juv. ♀ (AMCC [LP 19790])

***Buthus europeus* var. *tridentatus* Franganillo, 1918:** Spain: Javier, 6 ♀ (AMNH), 2 ♀ (AMCC [LP 19527, 19530]), 2 juv. ♂ (AMCC [LP 19528, 19531]), 3 juv. ♀ (AMCC [LP 19525, 19526, 19529])

***Buthus gabani* Ythier, 2021:** Portugal: Cabo São Vicente, 2 ♂, 4 ♀, 1 subad. ♀ (AMNH), 1 ♂ (AMCC [LP 18061]), 4 subad. ♂ (AMCC [LP 18057, 18059, 18060, 18063]), 2 subad. ♀ (AMCC [LP 18058, 18062]), 2 juv. ♂ (AMCC [LP 18054, 18056]), 2 juv. ♀ (AMCC [LP 18053, 18055])

***Buthus garcialorcai* Teruel and Turiel, 2020:** Spain: Huétor, 1 ♂, 6 ♀ (AMNH), 1 ♀, 1 subad. ♀, 1 juv. ♀ (AMCC [LP 19783]), 4 subad. ♀ (AMCC [LP 19778, 19780–19782]), 1 juv. ♂ (AMCC [LP 19779])

***Buthus gonzalezdelavegai* González-Moliné and Armas, 2024:** Spain: Matalascañas, 1 ♂, 1 ♀ (MNCN [103, 106]), 1 ♂ (MNCN 107), 1 ♀ (MNCN, 110), 1 ♂ (AMNH), 2 juv. ♂, 2 juv. ♀ (AMCC [LP 20690])

***Buthus halius* (C.L. Koch, 1839):** Portugal: Tua River, 1 ♀ (AMNH), 2 subad. ♂ (AMCC [LP 18036, 18037]), 1 subad. ♀ (AMCC [LP 18040]), 4 juv. ♂, 1 juv. ♀ (AMCC [LP 18035]), 1 juv. ♂ (AMCC [LP 18038]), 2 juv. ♀ (AMCC [LP 18034, 18039])

***Buthus iaspis* Teruel and Turiel, 2022:** Spain: Las Amoladeras, 6 ♂, 4 ♀ (AMNH), 1 ♀ (AMCC [LP 19759]), 1 subad. ♀ (AMCC [LP 19760]), 2 juv. ♂, 1 juv. ♀ (AMCC [LP 19762]), 3 juv. ♀ (AMCC [LP 19761])

***Buthus ibericus* Lourenço and Vachon, 2004:** Spain: Dehesa Picado, 6 ♂, 6 ♀ (AMNH), 2 ♂ (AMCC [LP 19794, 19796]), 2 subad. ♀ (AMCC [LP 19793, 19795]), 2 juv. ♀ (AMCC [LP 19797, 19798])

***Buthus lusitanus* Lourenço, 2021:** Portugal: Vale Glaciar do Zêzere 5 ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19510]), 2 subad. ♀ (AMCC [LP 19511, 19513]), 2 juv. ♂ (AMCC [LP 19512, 19514]), 1 juv. ♀ (AMCC [LP 19515])

***Buthus manchego* Teruel and Turiel, 2020:** Spain: Peñarroya, 6 ♂, 5 ♀, 4 subad. ♀ (AMNH), 1 subad. ♂ (AMCC [LP 19522]), 1 subad. ♀ (AMCC [LP 19521]), 2 juv. ♂ (AMCC [LP 19523, 19524])

***Buthus montanus* Lourenço and Vachon, 2004:** Spain: Puerto de la Ragua, 7 ♂, 7 ♀, 1 subad. ♀ (AMNH), 1 ♀ (AMCC [LP 19769]), 1 ♀, 1 juv. ♀ (AMCC [LP 19773]), 1 subad. ♀ (AMCC [LP 19771]), 1 juv. ♂ (AMCC [LP 19770]), 2 juv. ♀ (AMCC [LP 19772, 19777])

***Buthus pedrosousai* Teruel and Turiel, 2021:** Spain: Serranía de Cuenca, 5 ♂, 3 ♀ (AMNH), 2 juv. ♂ (AMCC [LP 19532, 19534]), 1 juv. ♀ (AMCC [LP 19533])

***Buthus pyrenaicus* Ythier, 2021:** France: Correc

Gros, 1 ♂, 8 ♀ (AMNH), 2 ♀ (AMCC [LP 19722, 19725]), 2 juv. ♂ (AMCC [LP 19724, 19726]), 1 juv. ♀ (AMCC [LP 19723])

***Buthus occitanus* (Amoureux, 1789):** France:

Souvignargues, 1 ♂, 1 ♀ (AMNH), 1 ♂ (AMCC [LP 19718]), 1 ♀ (AMCC [LP 19717]).

***Buthus serrano* Teruel and Turiel, 2020:** Spain:

Orce, 1 ♂, 5 ♀, 1 subad. ♀ (AMNH), 3 ♀ (AMCC [LP 19765–19767]), 1 juv. ♂ (AMCC [LP 19768]), 1 juv. ♀ (AMCC [LP 19768]).

APPENDIX 2

TISSUE SAMPLES AND GENBANK ACCESSION CODES FOR DNA SEQUENCES USED IN PHYLOGENETIC ANALYSES
AND HYBRIDIZATION NETWORK RECONSTRUCTION OF EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815

Sequences of the 18S rDNA (18S), 28S rDNA, Internal Transcribed Spacer (ITSII), 12S rDNA (12S), 16S rDNA (16S) and Cytochrome *c* Oxidase Subunit I (COI) loci. Tissue samples deposited in the Ambrose Monell Cryocollection (AMCC) at the American Museum of Natural History, New York.

Species	AMCC	Country	Georeference	18S	ITSII	28S	12S	16S	COI
Outgroup									
<i>Buthus elizabethae</i>	LP 4601	Senegal	14°23'22.9"N 12°21'30.9"W	PV828518	PV828311	PV828572	PV828203	PV828257	PV831780
<i>Buthus maroccanus</i>	LP 16678	Morocco	33°58'36.5"N 06°48'05.5"W	PV828519	PV828312	PV828573	PV828204	PV828258	PV831781
<i>Buthus tunetanus</i>	LP 14847	Tunisia	33°35'46.6"N 07°37'26.3"E	PV828520	PV828312	PV828574	PV828205	PV828259	PV831782
Ingroup									
<i>Buthus delafuentei</i>	LP 6092	Portugal	37°34'41.9"N 07°32'01.9"W	PV828479	PV828272	PV828533	PV828164	PV828218	PV831741
	LP 19804	Spain	37°29'09"N 05°37'30"W	PV828478	PV828271	PV828532	PV828163	PV828217	PV831740
	LP 19809		37°06'18.9"N 06°44'13.6"W	PV828476	PV828269	PV828530	PV828161	PV828215	PV831738
	LP 19816		37°16'52.5"N 06°24'02.3"W	PV828477	PV828270	PV828531	PV828162	PV828216	PV831739
	LP 20690		36°59'48.3"N 06°31'09.3"W	PV828489	PV828282	PV828543	PV828174	PV828228	PV831751
<i>Buthus elongatus</i>	LP 19791	Spain	36°34'34.1"N 04°52'58.2"W	PV828483	PV828276	PV828537	PV828168	PV828222	PV831745
<i>Buthus garcialorcai</i>	LP 19780	Spain	37°14'09.2"N 03°32'02.7"W	PV828488	PV828281	PV828542	PV828173	PV828227	PV831750
<i>Buthus halitus</i>	LP 6946	Portugal	37°22'11.0"N 08°21'51.8"W	PV828486	PV828279	PV828540	PV828171	PV828225	PV831748
	LP 6947		37°14'37.1"N 08°07'03.6"W	PV828487	PV828280	PV828541	PV828172	PV828226	PV831749
	LP 18040		41°16'54.4"N 07°23'44.8"W	PV828490	PV828283	PV828544	PV828175	PV828229	PV831752
	LP 18047		40°53'21.1"N 08°08'04.3"W	PV828491	PV828284	PV828545	PV828176	PV828230	PV831753
	LP 18063		37°01'24.3"N 08°59'35.6"W	PV828484	PV828277	PV828538	PV828169	PV828223	PV831746
	LP 18069		37°04'57.4"N 08°40'17.5"W	PV828485	PV828278	PV828539	PV828170	PV828224	PV831747
	LP 19507		40°23'08.9"N 07°32'47"W	PV828498	PV828291	PV828552	PV828183	PV828237	PV831760
	LP 19515		40°22'21.5"N 07°32'57.5"W	PV828499	PV828292	PV828553	PV828184	PV828238	PV831761
	LP 19488	Spain	39°19'42.4"N 03°29'28.8"W	PV828470	PV828263	PV828524	PV828155	PV828209	PV831732
	LP 19493		39°08'13.4"N 04°07'40"W	PV828471	PV828264	PV828525	PV828156	PV828210	PV831733
	LP 19498		41°33'28.2"N 04°38'25"W	PV828473	PV828266	PV828527	PV828158	PV828212	PV831735
	LP 19504		41°32'31"N 04°48'33"W	PV828474	PV828267	PV828528	PV828159	PV828213	PV831736
	LP 19817		40°45'47.2"N 03°59'59.8"W	PV828475	PV828268	PV828529	PV828160	PV828214	PV831737

APPENDIX 2 continued

Species	AMCC	Country	Georeference	18S	ITSII	28S	12S	16S	COI
Ingroup <i>Buthus iaspis</i>	LP 12387	Spain	36°48'44"N 02°03'26"E	PV828494	PV828285	PV828548	PV828179	PV828233	PV831756
	LP 19756		36°44'02.8"N 02°08'35"W	PV828492	PV828286	PV828546	PV828177	PV828231	PV831754
	LP 19760		36°49'41.3"N 02°15'47.2"W	PV828493	PV828287	PV828547	PV828178	PV828232	PV831755
	LP 19764		37°05'06.7"N 02°18'12.3"W	PV828495	PV828288	PV828549	PV828180	PV828234	PV831757
<i>Buthus ibericus</i>	LP 19784	Spain	36°42'26.4"N 07°32'01.9"W	PV828496	PV828289	PV828550	PV828181	PV828235	PV831758
	LP 19795		36°37'40.3"N 05°39'52.5"W	PV828497	PV828290	PV828551	PV828182	PV828236	PV831759
	LP 19801		37°04'46.9"N 05°30'49.3"W	PV828472	PV828265	PV828552	PV828183	PV828211	PV831762
	LP 19519		38°55'08.7"N 02°43'35.4"W	PV828500	PV828293	PV828554	PV828185	PV828239	PV831763
<i>Buthus manchego</i>	LP 19524	Spain	38°55'08.7"N 02°43'35.4"W	PV828501	PV828294	PV828555	PV828186	PV828240	PV831764
	LP 19533		40°17'53.6"N 02°08'14.3"W	PV828514	PV828307	PV828568	PV828199	PV828255	PV831776
	LP 19537		40°01'44.3"N 01°57'59.4"W	PV828515	PV828308	PV828569	PV828200	PV828256	PV831777
	LP 19740		38°38'27.4"N 00°51'36.8"W	PV828467	PV828260	PV828521	PV828152	PV828206	PV831729
<i>Buthus montanus</i>	LP 19744	Spain	38°25'34.5"N 00°31'41.7"W	PV828468	PV828262	PV828522	PV828153	PV828207	PV831731
	LP 19748		38°16'57"N 00°31'30.7"W	PV828517	PV828309	PV828571	PV828202	PV828254	PV831779
	LP 19750		37°48'52"N 01°34'49.2"W	PV828516	PV828310	PV828570	PV828201	PV828253	PV831778
	LP 19767		37°06'35.5"N 03°01'23.4"W	PV828502	PV828295	PV828556	PV828187	PV828241	PV831764
<i>Buthus occitanus</i>	LP 19775	France	37°16'46.1"N 03°15'11.7"W	PV828503	PV828296	PV828557	PV828188	PV828242	PV831765
	LP 16670		43°48'53.4"N 03°44'19.9"E	PV828504	PV828297	PV828558	PV828189	PV828243	PV831766
	LP 16671		43°53'19.2"N 03°50'10.5"E	PV828505	PV828298	PV828559	PV828190	PV828244	PV831767
	LP 19715		43°19'38.9"N 05°46'12.1"E	PV828512	PV828303	PV828566	PV828197	PV828251	PV831774
	LP 19717	Spain	43°48'34.8"N 04°08'44"E	PV828510	PV828304	PV828564	PV828195	PV828249	PV831772
	LP 19725		42°36'46.8"N 02°35'24.9"E	PV828513	PV828305	PV828567	PV828198	PV828252	PV831775
	LP 17847		42°03'06.8"N 01°42'16.4"E	PV828506	PV828299	PV828568	PV828191	PV828245	PV831768
	LP 17972		42°00'01.4"N 01°22'17.8"E	PV828507	PV828300	PV828561	PV828192	PV828246	PV831769
	LP 18488		42°00'01.4"N 01°22'17.8"E	PV828508	PV828301	PV828562	PV828193	PV828247	PV831770
	LP 19529		42°35'03.6"N 01°14'03.3"W	PV828509	PV828302	PV828563	PV828194	PV828248	PV831771
	LP 19727		41°16'38.4"N 01°52'27.8"E	PV828511	PV828306	PV828565	PV828196	PV828250	PV831773
	LP 19734		39°41'55.3"N 00°24'38"W	PV828480	PV828274	PV828534	PV828165	PV828219	PV831742
	LP 20004		39°53'53.7"N 00°41'06.9"E	PV828481	PV828273	PV828535	PV828166	PV828220	PV831743
	LP 20655		40°06'42.6"N 00°43'53.4"W	PV828482	PV828275	PV828536	PV828167	PV828221	PV831744

APPENDIX 3

DESCRIPTIONS OF MORPHOLOGICAL
CHARACTERS AND STATES USED IN
PHYLOGENETIC ANALYSIS OF EUROPEAN
SPECIES OF *BUTHUS* LEACH, 1815

Character states scored 0–3 or inapplicable (-).

Character matrix in table 4.

Total length

1. Total length (♂): small, <70 mm (0); large, >70 mm (1).

Carapace

2. Carapace shape (♂): quadrangular trapezoid, lateral margins sublinear (0); conical trapezoid, lateral margins curved (1).
3. Carapace carinae texture: all carinae coarsely granular (0); median ocular carinae coarsely granular, other carinae finely granular (1).
4. Carapace lateral ocular and prolateral secondary carinae (♂): obsolete, reduced to fine granules (0); distinct, lateral ocular carinae granular, prolateral secondary carinae reduced to few granules (1); distinct, lateral ocular carinae granular, prolateral secondary carinae often reaching lateral ocelli (2).
5. Carapace posterolateral carinae (♂): obsolete, reduced to row of discontinuous granules merging with surface granulation (0); well developed, continuous granular (1).

Pedipalps

6. Pedipalp chela length (♂): long, manus length : movable finger length <70% (0); short, manus length : movable finger length ≥70% (1).
7. Pedipalp chela width (♂): narrow, manus width : length <60% (0); broad, manus width : length ≥60% (1).

8. Pedipalp chela height (♂): globose, manus height : length ≥ 60% (0); slender, manus height : length <60% (1).
9. Pedipalp chela sexual dimorphism: male and female chelae similar (globose or slender) (0); male chela similar to female chela but slightly more globose (1); male and female chelae different (male chela slender, female chela globose) (2).
10. Pedipalp femur and patella, shape: short, broad (0); elongate, slender (1).
11. Pedipalp femur dorsal intercarinal surface: sparsely granular (0); smooth (1).
12. Pedipalp chela fingers, curvature and emargination when closed (♂): fingers sublinear basally, not emarginate when closed (0); fingers slightly curved basally, shallowly emarginate when closed (1); fingers markedly curved basally, deeply emarginate when closed in both sexes (2).
13. Pedipalp chela movable finger, number of median denticle subrows: ≤12 (0); >12 (1).

Legs

14. Legs shape: robust, with short femora, patellae, tibiae, and tarsi (0); slender, with slightly elongated femora, patellae, tibiae, and tarsi (1).
15. Leg tibiae and tarsi, setation: sparsely setose (0); densely setose, with slightly elongate macrosetae (1).

Pectines

16. Pectinal tooth count (♂): ≤30 (0); >30 (1).
17. Pectinal tooth count (♀): >26 (0); ≤26 (1).

Metasoma

18. Metasomal segment I width : length (♂): width : length >80% (0); width : metasomal segment I length <80% (1).
19. Metasomal segment V width : length (♂): width : length ≥38% (0); width : length <38% (1).

20. Metasomal segments dorsal setation (more evident in ♀): intermediate (0); hirsute (1); sparse (2); absent (3).
21. Metasomal segment V lateral setation: hirsute, more than six macrosetae (0); sparse, six or fewer macrosetae (1); inapplicable (-).
22. Mesosoma length : metasoma length (♂): metasoma markedly longer than mesosoma, mesosoma length : metasoma length $\leq 36\%$ (0); metasoma slightly longer than mesosoma, mesosoma length : metasoma length $> 36\%$ (1).
23. Metasomal segments I–IV dorsosubmedian carinae, texture: granular becoming obsolete posteriorly (0); costate-granular becoming granular posteriorly (1); obsolete (2).
24. Metasomal segments II and III ventro-submedian carinae, posterior processes (♂): several granules slightly enlarged and subspiniiform especially on segment III (0); posterior granules slightly enlarged and subspiniiform especially on segment III (1); obsolete, posterior granules similar to preceding granules (2).
25. Metasomal segments II and III ventro-submedian carinae, posterior processes (♀): well developed, several granules enlarged and subspiniiform especially on segment III (0); well developed, posterior granules enlarged and spiniiform (1); moderately developed, posterior granules similar to preceding granules (2); inapplicable (-).
26. Metasomal segment V ventrolateral carinae, posterior processes: variable in size, with two or more greatly enlarged, lobate or spiniiform (0); relatively uniform in size, with at most one enlarged (1).
27. Metasomal segment V dorsal and lateral intercarinal surfaces, texture: sparsely granular (0); entirely smooth (1).

Telson

28. Telson shape, vesicle height : length (♂): globose, height : length $> 65\%$ (0); flattened, height : length $< 65\%$ (1).
29. Aculeus length : telson length (♂): long, aculeus length : telson length $\geq 35\%$ (0); short, aculeus length : telson length $< 35\%$ (1).

Coloration

30. Carapace, pedipalps and metasoma, base color: orange to dark orange (0); dark brown (1); pale to dark yellow (2).
31. Carapace median ocular carinae, infuscation: complete (0); restricted to anterior half (1).
32. Carapace lateral ocular, central median, central lateral, posteromedian and posterolateral carinae, infuscation: weak to well developed (0); absent (1).
33. Carapace surfaces, infuscation (♂): immaculate (0); infusate, pattern type II (1); infusate, pattern type III (2); infusate, pattern type IV (3).
34. Mesosomal tergites, base color and infuscation: pale yellow, orange or greyish, tergites with infuscation obsolete or absent (0); dark yellow to orange, tergites with trivittate infuscation (1); dark brown (2).
35. Mesosomal tergites I–VI, infuscation, median stripe: obsolete or almost absent (0); narrow (1); broad (2).
36. Pectines coloration: pale (0); dark (1).

APPENDIX 4

RATIOS AND COUNTS USED IN LINEAR DISCRIMINANT ANALYSES
OF EUROPEAN SPECIES OF *BUTHUS* LEACH, 1815

Raw data in appendix 4.

-
- 1 Total body length : 100
 - 2 Pedipalp chela manus width : total body length
 - 3 Carapace anterior width : posterior width
 - 4 Carapace length : posterior width
 - 5 Pedipalp femur width : length
 - 6 Pedipalp patella width : length
 - 7 Pedipalp chela manus width : chela total length
 - 8 Pedipalp chela manus height : chela total length
 - 9 Pedipalp chela manus length : movable finger length
 - 10 Tergite VI length : tergite VII length
 - 11 Sternite VII length : width
 - 12 Mesosoma length : metasoma length
 - 13 Metasomal segment I width : length
 - 14 Metasomal segment II width : length
 - 15 Metasomal segment III width : length
 - 16 Metasomal segment IV width : length
 - 17 Metasomal segment V width : length
 - 18 Metasomal segment I length : segment II length
 - 19 Metasomal segment II length : segment III length
 - 20 Metasomal segment III length : segment IV length
 - 21 Metasomal segment IV length : segment V length
 - 22 Telson vesicle width : metasomal segment V width
 - 23 Telson vesicle height : length
 - 24 Telson aculeus length : telson length
 - 25 Pecten length : total body length
-

APPENDIX 5

RATIO AND COUNT DATA
FOR MALES AND FEMALES OF EUROPEAN
SPECIES OF *BUTHUS* LEACH, 1815,
USED IN LINEAR DISCRIMINANT ANALYSES

Character descriptions in appendix 2.

***Buthus dela Fuentei* Teruel and Turiel, 2020**

- ♂ (AMNH), Matalascañas: 0.8 0.05 0.74 1.12
0.26 0.36 0.57 0.62 0.75 0.43 0.7 0.35 0.64 0.53
0.54 0.44 0.37 0.89 0.99 0.88 0.91 0.87 0.64
0.39 0.12 13/13 31/33
- ♂ (MNCN 103), Matalascañas: 0.79 0.05 0.7 1.03
0.28 0.38 0.6 0.68 0.82 0.39 0.68 0.39 0.76 0.63
0.6 0.51 0.42 0.87 0.97 0.86 0.91 0.81 0.79 0.4
0.11 12/12 33/33
- ♂ (MNCN 107), Matalascañas: 0.77 0.05 0.73
1.07 0.28 0.41 0.56 0.62 0.79 0.41 0.69 0.35
0.71 0.61 0.58 0.48 0.4 0.88 1 0.87 0.92 0.87
0.74 0.42 0.11 13/13 33/33
- ♂ (MNCN 110), Matalascañas: 0.81 0.05 0.69
0.96 0.27 0.37 0.56 0.63 0.77 0.35 0.65 0.33
0.78 0.69 0.57 0.52 0.4 0.9 0.88 0.94 0.89 0.87
0.75 0.42 0.12 12/12 32/33
- ♂ (MNCN 114), Laguna del Jaral: 0.78 0.05 0.73
1.03 0.27 0.36 0.56 0.6 0.72 0.45 0.67 0.36 0.7
0.57 0.55 0.47 0.39 0.88 0.97 0.89 0.93 0.87
0.77 0.43 0.12 12/12 32/34
- ♂ (AMNH), Pinar del Tableado: 0.77 0.05 0.75
1.08 0.3 0.39 0.58 0.65 0.75 0.46 0.64 0.37 0.71
0.64 0.59 0.5 0.41 0.91 0.96 0.87 0.87 0.86 0.71
0.38 0.11 13/13 32/30
- ♂ (AMNH), Pinar del Tableado: 0.75 0.05 0.8
1.12 0.28 0.41 0.62 0.67 0.78 0.45 0.61 0.35
0.74 0.67 0.61 0.47 0.4 0.94 0.97 0.82 0.94 0.89
0.69 0.35 0.12 12/13 34/34
- ♂ (AMNH), Pinar del Tableado: 0.7 0.05 0.76 1.1
0.3 0.37 0.66 0.7 0.65 0.36 0.58 0.34 0.78 0.68
0.61 0.5 0.43 0.9 0.92 0.9 0.91 0.8 0.65 0.33
0.12 13/13 29/30
- ♂ (AMNH), Doñana: 0.76 0.05 0.69 1.05 0.28
0.37 0.64 0.72 0.7 0.4 0.63 0.36 0.71 0.64 0.6
0.5 0.42 0.92 0.97 0.88 0.92 0.85 0.72 0.37 0.12
13/12 32/32

- ♂ (AMNH), Doñana: 0.78 0.05 0.72 1.07 0.26
0.35 0.64 0.68 0.68 0.37 0.6 0.36 0.79 0.62 0.55
0.48 0.37 0.86 0.91 0.9 0.93 0.93 0.64 0.36 0.13
13/13 34/34
- ♀ (AMNH), Pinar del Tableado: 0.74 0.05 0.75
1.03 0.3 0.37 0.57 0.63 0.68 0.39 0.57 0.41 0.79
0.67 0.62 0.51 0.41 0.88 0.98 0.83 0.87 0.93
0.74 0.37 0.12 12/12 27/26
- ♀ (AMNH), Pinar del Tableado: 0.74 0.05 0.72
1.03 0.31 0.38 0.57 0.61 0.72 0.47 0.63 0.41
0.77 0.69 0.66 0.53 0.43 0.91 0.98 0.82 0.85
0.84 0.71 0.4 0.12 12/12 27/28
- ♀ (AMNH), Pinar del Tableado: 0.77 0.05 0.73
1.03 0.3 0.4 0.53 0.62 0.75 0.44 0.6 0.37 0.74
0.64 0.6 0.52 0.41 0.89 0.96 0.9 0.83 0.95 0.69
0.39 0.11 13/9 27/28
- ♀ (AMNH), Doñana: 0.83 0.05 0.72 1.06 0.28
0.36 0.58 0.63 0.75 0.4 0.63 0.41 0.81 0.58 0.56
0.48 0.38 0.8 0.98 0.9 0.87 1.01 0.7 0.41 0.11
13/13 29/29
- ♀ (AMNH), Doñana: 0.82 0.05 0.72 1.05 0.3 0.38
0.59 0.62 0.75 0.38 0.56 0.38 0.82 0.62 0.57
0.49 0.41 0.83 0.94 0.89 0.87 0.92 0.74 0.43
0.11 13/13 21/28
- ♀ (MNCN 106), Matalascañas: 0.85 0.04 0.62
0.99 0.27 0.38 0.48 0.59 0.77 0.48 0.64 0.39
0.74 0.63 0.59 0.47 0.38 0.92 0.95 0.85 0.86
0.94 0.75 0.41 0.12 12/12 28/29
- ♀ (MNCN 115), Laguna del Jaral: 0.82 0.05 0.67
1 0.27 0.38 0.56 0.6 0.76 0.41 0.58 0.4 0.76
0.64 0.6 0.5 0.43 0.92 0.96 0.86 0.88 0.86 0.73
0.4 0.11 12/12 29/29

***Buthus elongatus* Rossi, 2012**

- ♂ (AMNH), Sierra Blanca: 0.78 0.03 0.71 1.02
0.28 0.34 0.48 0.48 0.59 0.34 0.65 0.35 0.77 0.6
0.58 0.45 0.36 0.85 0.98 0.88 0.87 0.9 0.63 0.36
0.11 12/12 32/33
- ♂ (AMNH), Sierra Blanca: 0.7 0.03 0.71 1.03
0.27 0.34 0.46 0.44 0.61 0.33 0.6 0.32 0.78 0.68
0.63 0.45 0.36 0.94 0.98 0.8 0.91 0.89 0.65 0.37
0.12 12/12 34/33
- ♂ (AMNH), Sierra Blanca: 0.75 0.03 0.71 1.07
0.27 0.32 0.44 0.47 0.6 0.36 0.61 0.35 0.75 0.6
0.54 0.45 0.36 0.89 0.98 0.87 0.89 0.88 0.64
0.36 0.12 12/12 33/33

♂ (AMNH), Sierra Blanca: 0.73 0.03 0.73 1.03
0.25 0.31 0.43 0.47 0.64 0.34 0.61 0.34 0.79
0.64 0.6 0.43 0.34 0.91 0.96 0.84 0.9 0.92 0.67
0.34 0.11 12/12 31/31

♂ (AMNH), Sierra Blanca: 0.71 0.03 0.73 1.03
0.27 0.32 0.42 0.44 0.64 0.37 0.61 0.38 0.78
0.65 0.62 0.47 0.36 0.91 0.99 0.84 0.88 0.84
0.62 0.34 0.11 11/12 31/31

♀ (AMNH), Sierra Blanca: 0.79 0.05 0.67 0.98
0.26 0.37 0.55 0.62 0.72 0.43 0.49 0.4 0.86 0.71
0.69 0.52 0.4 0.92 0.99 0.82 0.84 0.85 0.77 0.37
0.11 13/12 28/28

♀ (AMNH), Sierra Blanca: 0.76 0.05 0.71 0.98
0.29 0.38 0.53 0.57 0.67 0.47 0.62 0.42 0.8 0.67
0.65 0.51 0.39 0.88 0.99 0.83 0.83 0.99 0.66
0.36 0.11 13/13 29/27

♀ (AMNH), Sierra Blanca: 0.77 0.05 0.69 0.98
0.28 0.36 0.56 0.6 0.67 0.32 0.49 0.37 0.84 0.71
0.66 0.51 0.41 0.93 0.95 0.83 0.84 0.95 0.72
0.39 0.11 12/12 26/28

♀ (AMNH), Sierra Blanca: 0.72 0.05 0.74 0.98
0.27 0.39 0.51 0.56 0.71 0.35 0.55 0.38 0.81
0.71 0.64 0.51 0.39 0.94 0.95 0.82 0.85 0.97
0.73 0.36 0.11 12/12 26/26

♀ (AMNH), Sierra Blanca: 0.7 0.04 0.74 0.99
0.27 0.37 0.49 0.55 0.68 0.38 0.54 0.4 0.81 0.69
0.62 0.52 0.39 0.89 0.96 0.85 0.83 0.98 0.71
0.38 0.12 12/12 28/29

***Buthus garcialorcai* Teruel and Turiel, 2020**

♂ (AMNH), Huétor: 0.67 0.04 0.7 0.93 0.31 0.4
0.53 0.57 0.71 0.38 0.53 0.38 0.93 0.74 0.71
0.54 0.42 0.85 1 0.82 0.9 0.84 0.63 0.34 0.13
12/12 33/33

♂ (CIBIO-InBIO Sc1755), Alhama de Granada:
0.72 0.03 0.69 0.99 0.26 0.33 0.42 0.47 0.69
0.35 0.67 0.39 0.78 0.65 0.58 0.45 0.35 0.89
0.97 0.83 0.9 0.9 0.67 0.32 0.12 12/12 32/32

♂ (MNCN 9497), Granada: 0.7 0.04 0.6 0.95 0.26
0.37 0.52 0.59 0.66 0.32 0.56 0.31 0.81 0.67
0.65 0.53 0.42 0.88 0.98 0.88 0.91 0.89 0.75
0.35 0.12 12/12 33/32

♂ (MNCN 9500), Granada: 0.69 0.03 0.62 0.9
0.29 0.36 0.46 0.53 0.69 0.35 0.62 0.32 0.78
0.61 0.67 0.5 0.38 0.94 1.02 0.81 0.92 0.88 0.75
0.4 0.11 12/12 33/32

♀ (AMNH), Huétor: 0.72 0.05 0.66 0.98 0.27
0.34 0.58 0.67 0.67 0.38 0.5 0.34 0.75 0.73 0.71
0.59 0.43 0.96 0.96 0.89 0.8 0.96 0.7 0.36 0.13
12/12 27/27

♀ (AMNH), Huétor: 0.68 0.05 0.68 0.95 0.28
0.32 0.58 0.63 0.64 0.36 0.56 0.36 0.9 0.7 0.7
0.54 0.41 0.83 0.97 0.84 0.8 0.91 0.81 0.38 0.13
12/12 27/27

♀ (AMNH), Huétor: 0.67 0.05 0.67 0.93 0.28
0.38 0.58 0.65 0.62 0.32 0.46 0.38 0.9 0.73 0.73
0.63 0.44 0.87 0.98 0.92 0.73 0.91 0.7 0.38 0.13
12/12 26/27

♀ (AMNH), Huétor: 0.61 0.05 0.67 0.94 0.24
0.36 0.55 0.57 0.66 0.39 0.53 0.42 0.92 0.72
0.69 0.58 0.4 0.83 0.96 0.88 0.77 0.94 0.69 0.33
0.13 12/12 27/28

♀ (AMNH), Huétor: 0.62 0.04 0.64 0.94 0.27
0.38 0.58 0.64 0.64 0.37 0.52 0.39 0.87 0.66
0.64 0.59 0.38 0.83 0.96 0.96 0.79 0.98 0.72
0.34 0.12 12/12 26/26

***Buthus halius* (C.L. Koch, 1839)**

♂ (CIBIO Sc2126), Lagarelos: 0.69 0.05 0.67
0.95 0.28 0.38 0.57 0.62 0.79 0.49 0.61 0.4 0.76
0.66 0.65 0.49 0.38 0.91 1.03 0.82 0.84 0.95
0.72 0.37 0.11 12/12 28/28

♂ (MNHNC 4288), Malpartida-Vermiose: 0.66
0.05 0.64 0.99 0.3 0.37 0.58 0.6 0.75 0.47 0.57
0.38 0.72 0.63 0.62 0.47 0.38 0.91 1 0.82 0.89
0.92 0.72 0.36 0.11 12/12 28/28

♂ (MNHNC 4288), Malpartida-Vermiose: 0.6
0.05 0.7 0.97 0.29 0.38 0.55 0.6 0.77 0.36 0.61
0.37 0.74 0.63 0.63 0.48 0.38 0.91 0.99 0.84
0.87 0.92 0.69 0.35 0.13 12/12 32/31

♂ (AMNH), Porzuna: 0.65 0.05 0.69 1.02 0.32
0.38 0.66 0.73 0.71 0.35 0.62 0.37 0.77 0.7 0.67
0.52 0.39 0.95 0.98 0.83 0.85 0.93 0.65 0.32
0.12 13/13 31/31

♂ (AMNH), Puerto Ládice: 0.7 0.05 0.7 1.03 0.32
0.4 0.66 0.72 0.67 0.46 0.65 0.4 0.79 0.66 0.65
0.53 0.4 0.9 0.99 0.84 0.85 0.96 0.69 0.31 0.12
13/13 30/31

♂ (MNCN 17067), Almadén: 0.77 0.06 0.62 0.88
0.26 0.38 0.58 0.64 0.77 0.31 0.55 0.35 0.8 0.74
0.66 0.5 0.4 0.98 0.92 0.81 0.88 0.9 0.76 0.38
0.12 13/13 31/30

APPENDIX 5 *continued*

♂ (MNCN 17067), Almadén: 0.82 0.05 0.6 0.93 0.26 0.37 0.61 0.73 0.66 0.41 0.57 0.36 0.77 0.69 0.63 0.52 0.38 0.93 0.94 0.85 0.83 0.88 0.73 0.37 0.12 13/13 32/30	♂ (AMNH), Abrigo do Faíscas: 0.62 0.05 0.7 1.06 0.29 0.37 0.6 0.69 0.75 0.36 0.62 0.36 0.73 0.67 0.62 0.5 0.39 0.93 0.97 0.84 0.89 0.88 0.6 0.33 0.13 12/12 27/28
♂ (AMNH), Herrera de Duero: 0.66 0.05 0.72 1.02 0.3 0.4 0.6 0.64 0.73 0.34 0.54 0.39 0.84 0.66 0.62 0.49 0.39 0.84 0.99 0.86 0.86 0.86 0.6 0.32 0.12 12/12 30/32	♀ (AMNH), Tua River: 0.81 0.05 0.68 0.94 0.32 0.37 0.56 0.62 0.7 0.39 0.58 0.46 0.87 0.72 0.63 0.54 0.41 0.88 0.9 0.9 0.78 0.89 0.66 0.39 0.12 12/12 29/19
♂ (AMNH), Herrera de Duero: 0.68 0.05 0.68 1.02 0.31 0.43 0.61 0.68 0.73 0.42 0.57 0.39 0.93 0.68 0.62 0.51 0.4 0.82 0.95 0.84 0.87 0.84 0.65 0.33 0.12 12/12 31/30	♀ (AMNH), Covelo de Paivó: 0.78 0.04 0.66 0.92 0.34 0.39 0.59 0.68 0.64 0.42 0.59 0.45 0.83 0.74 0.66 0.54 0.4 0.92 0.98 0.83 0.82 0.91 0.81 0.36 0.11 12/12 25/24
♂ (AMNH), Puente Duero: 0.68 0.05 0.7 0.98 0.3 0.43 0.6 0.66 0.71 0.36 0.5 0.39 0.8 0.69 0.63 0.51 0.43 0.91 0.97 0.86 0.87 0.82 0.67 0.35 0.12 12/12 30/29	♀ (AMNH), Covelo de Paivó: 0.71 0.04 0.69 0.97 0.33 0.38 0.53 0.62 0.72 0.46 0.66 0.45 0.81 0.72 0.67 0.57 0.4 0.91 0.97 0.87 0.76 0.97 0.8 0.4 0.11 12/12 24/26
♂ (AMNH), Sierra de Guadarrama: 0.74 0.05 0.73 1.06 0.29 0.38 0.57 0.65 0.75 0.36 0.58 0.39 0.85 0.69 0.67 0.49 0.41 0.86 0.99 0.78 0.91 0.84 0.65 0.35 0.12 12/12 31/30	♀ (MNHNC 2845), Candoso: 0.72 0.05 0.69 0.91 0.27 0.37 0.52 0.57 0.73 0.47 0.59 0.41 0.79 0.7 0.64 0.53 0.41 0.89 0.99 0.83 0.84 0.91 0.71 0.38 0.12 12/12 27/26
♂ (AMNH), Sierra de Guadarrama: 0.71 0.05 0.74 1.02 0.28 0.38 0.62 0.68 0.68 0.39 0.63 0.39 0.75 0.65 0.59 0.47 0.37 0.93 0.97 0.85 0.88 0.9 0.66 0.32 0.12 12/12 31/31	♀ (MNHNC 4284), Malpartida-Vermiose: 0.7 0.05 0.63 0.92 0.31 0.42 0.52 0.59 0.77 0.48 0.61 0.43 0.81 0.7 0.7 0.52 0.43 0.93 0.97 0.81 0.85 0.9 0.78 0.42 0.11 12/12 26/25
♂ (AMNH), Cabo São Vicente: 0.69 0.05 0.69 1.01 0.29 0.39 0.59 0.64 0.79 0.37 0.62 0.33 0.75 0.67 0.62 0.5 0.4 0.92 0.98 0.85 0.9 0.87 0.69 0.39 0.12 13/12 30/30	♀ (AMNH), Porzuna: 0.71 0.05 0.57 0.92 0.29 0.39 0.54 0.62 0.68 0.39 0.56 0.4 0.85 0.76 0.7 0.62 0.41 0.87 1.01 0.87 0.74 0.96 0.84 0.31 0.12 13/13 26/25
♂ (AMNH), Ponta da Piedade: 0.72 0.05 0.74 1.03 0.29 0.39 0.56 0.65 0.79 0.46 0.67 0.4 0.73 0.68 0.66 0.51 0.43 0.92 0.97 0.81 0.91 0.77 0.69 0.36 0.11 13/13 32/32	♀ (AMNH), Porzuna: 0.7 0.05 0.63 0.94 0.32 0.4 0.58 0.64 0.66 0.36 0.59 0.41 0.87 0.72 0.67 0.57 0.42 0.86 0.97 0.85 0.8 0.93 0.76 0.35 0.12 13/13 26/26
♂ (AMNH), Ponta da Piedade: 0.69 0.05 0.75 1.01 0.31 0.36 0.59 0.63 0.79 0.52 0.72 0.45 0.8 0.7 0.67 0.52 0.42 0.93 1 0.83 0.86 0.83 0.69 0.37 0.11 13/12 31/31	♀ (AMNH), Porzuna: 0.67 0.05 0.65 0.96 0.31 0.41 0.59 0.65 0.65 0.39 0.58 0.46 0.84 0.76 0.69 0.54 0.45 0.93 0.96 0.81 0.82 0.84 0.72 0.34 0.12 13/13 26/27
♂ (AMNH), Ponta da Piedade: 0.7 0.05 0.74 1.03 0.3 0.39 0.63 0.71 0.75 0.45 0.66 0.42 0.73 0.64 0.64 0.54 0.43 0.89 1 0.86 0.88 0.87 0.69 0.38 0.11 13/12 31/31	♀ (AMNH), Porzuna: 0.69 0.05 0.61 0.97 0.27 0.41 0.56 0.59 0.7 0.32 0.57 0.36 0.79 0.81 0.66 0.53 0.4 1.08 0.85 0.82 0.79 0.93 0.72 0.33 0.12 13/13 26/26
♂ (AMNH), Ponta da Piedade: 0.67 0.06 0.73 1.01 0.3 0.42 0.59 0.66 0.77 0.35 0.59 0.34 0.76 0.66 0.63 0.52 0.43 0.9 0.95 0.89 0.9 0.87 0.76 0.43 0.12 13/13 32/32	♀ (AMNH), Puerto Lápite: 0.68 0.05 0.63 0.94 0.32 0.4 0.59 0.66 0.71 0.49 0.56 0.46 0.97 0.81 0.72 0.59 0.44 0.85 0.92 0.84 0.81 0.95 0.72 0.33 0.12 13/12 29/26

APPENDIX 5 *continued*

♀ (AMNH), Herrera de Duero: 0.69 0.05 0.64
0.94 0.26 0.36 0.48 0.6 0.75 0.36 0.52 0.41 0.8
0.72 0.66 0.54 0.41 0.92 0.93 0.85 0.79 0.91
0.71 0.36 0.12 12/12 26/26

♀ (AMNH), Herrera de Duero: 0.7 0.04 0.66
0.93 0.32 0.38 0.49 0.54 0.7 0.4 0.5 0.44 0.8
0.74 0.68 0.53 0.43 0.95 0.96 0.82 0.86 0.89
0.66 0.33 0.12 12/12 25/24

♀ (AMNH), Puente Duero: 0.79 0.05 0.65 0.96
0.3 0.39 0.55 0.64 0.72 0.48 0.57 0.43 0.83 0.7
0.69 0.53 0.44 0.91 0.99 0.82 0.85 0.94 0.7 0.34
0.11 11/12 25/26

♀ (AMNH), Puente Duero: 0.72 0.05 0.71 0.98
0.29 0.39 0.56 0.56 0.71 0.46 0.54 0.42 0.82
0.71 0.67 0.47 0.43 0.88 0.97 0.82 0.88 0.94
0.68 0.37 0.12 12/12 28/28

♀ (AMNH), Sierra de Guadarrama: 0.83 0.05
0.64 0.95 0.33 0.41 0.59 0.65 0.72 0.37 0.52
0.42 0.8 0.74 0.68 0.54 0.46 0.96 0.97 0.83 0.84
0.88 0.7 0.36 0.12 12/12 26/27

♀ (AMNH), Cabo São Vicente: 0.74 0.05 0.68
0.95 0.29 0.39 0.62 0.66 0.74 0.43 0.6 0.44 0.82
0.71 0.68 0.54 0.45 0.92 0.98 0.82 0.86 0.86 0.7
0.4 0.11 13/13 26/25

♀ (AMNH), Cabo São Vicente: 0.74 0.05 0.68
0.96 0.33 0.39 0.58 0.64 0.76 0.48 0.61 0.46
0.78 0.69 0.67 0.52 0.44 0.93 1.01 0.82 0.85
0.88 0.7 0.4 0.11 13/12 27/26

♀ (AMNH), Cabo São Vicente: 0.73 0.05 0.7
0.97 0.29 0.41 0.56 0.59 0.69 0.44 0.55 0.4 0.76
0.67 0.59 0.49 0.38 0.93 0.96 0.84 0.82 0.95
0.72 0.42 0.11 12/12 27/27

♀ (AMNH), Ponta da Piedade: 0.65 0.05 0.69
0.95 0.26 0.42 0.57 0.62 0.72 0.49 0.63 0.41
0.75 0.65 0.61 0.5 0.41 0.9 0.99 0.84 0.86 0.9
0.75 0.37 0.11 12/12 25/27

♀ (AMNH), Ponta da Piedade: 0.66 0.05 0.65
0.92 0.29 0.37 0.56 0.62 0.72 0.44 0.57 0.43
0.82 0.67 0.66 0.53 0.43 0.89 0.99 0.85 0.85
0.96 0.72 0.37 0.11 13/13 26/27

♀ (AMNH), Vale Glaciar Do Zêzere: 0.79 0.05
0.66 0.93 0.29 0.38 0.58 0.63 0.78 0.48 0.55
0.44 0.83 0.71 0.66 0.54 0.44 0.89 0.97 0.83
0.85 0.9 0.72 0.36 0.11 12/12 25/25

♀ (AMNH), Vale Glaciar do Zêzere: 0.78 0.05
0.68 0.94 0.33 0.42 0.61 0.67 0.74 0.46 0.54
0.44 0.84 0.75 0.7 0.55 0.45 0.94 0.96 0.81 0.84
0.91 0.75 0.36 0.1 12/12 24/25

♀ (AMNH), Vale Glaciar do Zêzere: 0.73 0.05
0.68 0.95 0.29 0.41 0.58 0.65 0.71 0.47 0.99
0.42 0.84 0.71 0.71 0.56 0.48 0.91 0.98 0.84
0.85 0.85 0.71 0.35 0.1 12/12 25/25

♀ (AMNH), Abrigo do Faíscas: 0.85 0.05 0.68
0.97 0.28 0.4 0.59 0.66 0.73 0.41 0.52 0.44 0.79
0.71 0.66 0.53 0.45 0.94 0.99 0.81 0.85 0.85
0.76 0.37 0.11 12/12 24/25

♀ (AMNH), Abrigo do Faíscas: 0.8 0.05 0.67
0.93 0.32 0.38 0.56 0.63 0.79 0.37 0.51 0.43
0.77 0.69 0.68 0.54 0.42 0.94 0.96 0.84 0.85
0.94 0.75 0.37 0.1 12/12 25/25

***Buthus iaspis* Teruel and Turiel, 2022**

♂ (AMNH), Las Amoladeras: 0.8 0.04 0.74 1.02
0.29 0.36 0.48 0.54 0.75 0.38 0.62 0.35 0.77
0.66 0.63 0.5 0.4 0.91 0.99 0.88 0.93 0.91 0.69
0.38 0.11 12/12 31/30

♂ (AMNH), Las Amoladeras: 0.76 0.04 0.73 1.01
0.3 0.37 0.52 0.56 0.72 0.34 0.59 0.32 0.76 0.63
0.6 0.48 0.39 0.89 0.98 0.89 0.92 0.92 0.73 0.4
0.12 12/12 32/32

♂ (AMNH), Las Amoladeras: 0.67 0.03 0.76 1.02
0.28 0.36 0.47 0.53 0.67 0.39 0.6 0.36 0.78 0.64
0.62 0.49 0.42 0.89 0.99 0.86 0.96 0.89 0.67
0.38 0.12 12/12 32/33

♂ (AMNH), Cabo de Gata: 0.74 0.04 0.75 1.02
0.28 0.37 0.44 0.51 0.73 0.35 0.59 0.32 0.75
0.65 0.62 0.51 0.4 0.92 0.98 0.88 0.92 0.87 0.66
0.37 0.12 13/12 31/32

♂ (AMNH), Tabernas: 0.75 0.04 0.74 1.05 0.28
0.35 0.47 0.54 0.7 0.38 0.61 0.34 0.72 0.64 0.6
0.49 0.38 0.9 1 0.86 0.96 0.88 0.67 0.4 0.11
12/2 32/31

♀ (AMNH), Las Amoladeras: 0.74 0.05 0.73 0.95
0.3 0.4 0.57 0.63 0.77 0.33 0.55 0.39 0.82 0.75
0.69 0.55 0.45 0.95 0.98 0.83 0.84 0.9 0.73 0.39
0.11 13/12 27/26

APPENDIX 5 *continued*

♀ (AMNH), Las Amoladeras: 0.74 0.05 0.72 0.95
0.3 0.41 0.57 0.62 0.76 0.34 0.55 0.37 0.82 0.7
0.67 0.56 0.46 0.92 1.01 0.84 0.87 0.94 0.72
0.42 0.12 13/12 28/28

♀ (AMNH), Cabo de Gata: 0.79 0.05 0.72 0.99
0.29 0.38 0.53 0.58 0.79 0.36 0.56 0.39 0.78
0.69 0.64 0.52 0.41 0.95 0.99 0.86 0.85 0.95
0.69 0.38 0.11 13/13 29/29

♀ (AMNH), Cabo de Gata: 0.68 0.04 0.7 0.96
0.29 0.37 0.47 0.52 0.75 0.36 0.56 0.39 0.76
0.65 0.6 0.5 0.38 0.89 0.98 0.87 0.82 0.93 0.71
0.38 0.12 13/13 28/28

♀ (AMNH), Tabernas: 0.71 0.05 0.69 0.94 0.28
0.39 0.55 0.6 0.73 0.43 0.56 0.41 0.77 0.73 0.68
0.53 0.42 0.94 0.98 0.82 0.87 0.89 0.72 0.38
0.11 12/13 27/27

***Buthus ibericus* Lourenço and Vachon, 2004**

♂ (AMNH), Dehesa Picado: 0.63 0.05 0.74 1.01
0.3 0.42 0.6 0.61 0.67 0.35 0.54 0.41 0.91 0.76
0.69 0.57 0.42 0.92 0.95 0.84 0.83 0.99 0.67 0.3
0.11 10/13 29/29

♂ (AMNH), Dehesa Picado: 0.53 0.05 0.76 1.07
0.3 0.36 0.51 0.57 0.68 0.35 0.59 0.36 0.89 0.71
0.73 0.53 0.39 0.9 0.99 0.79 0.83 0.9 0.59 0.3
0.13 13/13 29/29

♂ (AMNH), Dehesa Picado: 0.61 0.05 0.74 1.03
0.29 0.41 0.58 0.66 0.69 0.39 0.56 0.42 0.97 0.8
0.73 0.56 0.43 0.91 0.94 0.84 0.81 0.92 0.63
0.32 0.12 13/12 28/29

♂ (AMNH), Benaocaz: 0.68 0.05 0.69 1.01 0.3
0.39 0.56 0.62 0.74 0.41 0.55 0.41 0.92 0.78
0.71 0.57 0.41 0.93 0.95 0.87 0.8 0.9 0.61 0.28
0.11 13/12 27/27

♂ (AMNH), Benaocaz: 0.67 0.05 0.68 1 0.33 0.38
0.6 0.66 0.71 0.37 0.55 0.4 0.95 0.81 0.73 0.56
0.42 0.89 0.94 0.83 0.84 0.89 0.64 0.32 0.12
26/28 13/13

♂ (AMNH), Esparteros: 0.69 0.04 0.73 1.02 0.29
0.39 0.53 0.59 0.72 0.44 0.62 0.4 0.72 0.66 0.6
0.5 0.39 0.94 0.95 0.86 0.88 0.91 0.66 0.35 0.11
30/30 12/12

♂ (AMNH), Esparteros: 0.69 0.04 0.74 1.02 0.29
0.42 0.52 0.61 0.68 0.39 0.58 0.38 0.8 0.68 0.62
0.51 0.39 0.91 0.97 0.85 0.86 0.95 0.66 0.37
0.11 31/31 12/12

♀ (AMNH), Dehesa Picado: 0.7 0.04 0.66 0.99
0.31 0.38 0.46 0.55 0.68 0.47 0.56 0.46 0.95
0.77 0.69 0.52 0.41 0.87 0.94 0.8 0.86 0.97 0.65
0.33 0.1 12/12 24/23

♀ (AMNH), Dehesa Picado: 0.68 0.04 0.69 0.97
0.31 0.36 0.51 0.58 0.65 0.38 0.52 0.43 0.91
0.77 0.69 0.56 0.42 0.9 0.97 0.82 0.81 0.96 0.71
0.34 0.11 12/12 24/24

♀ (AMNH), Dehesa Picado: 0.64 0.04 0.71 0.99
0.33 0.45 0.51 0.6 0.66 0.48 0.57 0.48 0.89 0.8
0.72 0.58 0.41 0.94 0.93 0.83 0.81 0.95 0.68
0.32 0.1 13/13 23/24

♀ (AMNH), Benaocaz: 0.74 0.04 0.67 0.96 0.32
0.4 0.48 0.58 0.7 0.43 0.51 0.45 0.92 0.84 0.75
0.58 0.44 0.95 0.94 0.82 0.85 0.97 0.69 0.34
0.11 13/13 23/23

♀ (AMNH), Benaocaz: 0.76 0.05 0.65 1 0.32 0.38
0.55 0.56 0.7 0.43 0.55 0.4 0.87 0.76 0.68 0.55
0.4 0.91 0.95 0.82 0.82 0.97 0.65 0.32 0.1 13/13
22/22

♀ (AMNH), Esparteros: 0.72 0.04 0.71 1.02 0.31
0.38 0.52 0.59 0.66 0.37 0.55 0.44 0.83 0.74
0.68 0.52 0.42 0.95 0.97 0.82 0.85 0.92 0.72
0.36 0.12 13/10 27/28

♀ (AMNH), Esparteros: 0.72 0.05 0.7 1 0.32 0.38
0.52 0.58 0.72 0.36 0.5 0.38 0.82 0.71 0.65 0.53
0.42 0.92 0.98 0.85 0.83 0.82 0.71 0.36 0.11
12/12 27/28

♀ (AMNH), Esparteros: 0.68 0.04 0.7 1 0.31 0.42
0.52 0.63 0.69 0.4 0.53 0.42 0.86 0.76 0.71 0.53
0.43 0.94 0.98 0.79 0.85 0.91 0.68 0.38 0.11
12/12 27/27

♀ (AMNH), Esparteros: 0.69 0.05 0.67 0.93 0.32
0.43 0.58 0.62 0.72 0.43 0.62 0.45 0.82 0.72 0.7
0.56 0.44 0.91 0.99 0.82 0.82 0.87 0.72 0.37
0.11 9/12 27/28

♀ (AMNH), Esparteros: 0.63 0.05 0.66 0.9 0.32
0.41 0.53 0.59 0.71 0.36 0.49 0.39 0.88 0.76
0.72 0.58 0.43 0.92 0.98 0.81 0.83 0.88 0.73
0.36 0.12 12/12 28/28

APPENDIX 5 *continued****Buthus manchego* Teruel and Turiel, 2020**

♂ (AMNH), Peñarroya: 0.68 0.03 0.72 1.04 0.25 0.31 0.44 0.53 0.71 0.33 0.56 0.33 0.75 0.61 0.53 0.45 0.35 0.85 0.99 0.85 0.89 0.94 0.6 0.39 0.12 12/12 34/32	♂ (AMNH), Sant Vicent del Raspeig: 0.68 0.04 0.72 1.02 0.29 0.37 0.5 0.59 0.62 0.37 0.6 0.38 0.8 0.68 0.64 0.51 0.42 0.86 0.95 0.87 0.89 0.85 0.64 0.3 0.13 12/12 32/33
♂ (AMNH), Peñarroya: 0.7 0.04 0.69 1.02 0.27 0.37 0.46 0.53 0.71 0.33 0.59 0.32 0.75 0.67 0.61 0.46 0.41 0.94 0.96 0.84 0.96 0.85 0.7 0.38 0.12 12/12 31/31	♂ (AMNH), Sant Vicent del Raspeig: 0.72 0.03 0.74 1.06 0.28 0.42 0.48 0.56 0.6 0.39 0.63 0.36 0.81 0.66 0.61 0.5 0.38 0.85 0.98 0.86 0.9 0.96 0.68 0.33 0.12 12/12 32/33
♂ (AMNH), Peñarroya: 0.7 0.04 0.7 1.03 0.26 0.36 0.48 0.49 0.72 0.38 0.68 0.35 0.82 0.65 0.63 0.46 0.38 0.85 1 0.81 0.96 0.92 0.71 0.39 0.12 12/12 31/31	♂ (MNCN 9385), Muchamiel: 0.65 0.04 0.67 0.94 0.27 0.39 0.45 0.54 0.7 0.28 0.6 0.3 0.7 0.66 0.61 0.47 0.39 0.94 0.95 0.82 0.94 0.84 0.71 0.36 0.11 12/12 34/33
♂ (AMNH), Ossa de Montiel: 0.68 0.03 0.71 1.07 0.27 0.32 0.44 0.51 0.71 0.38 0.59 0.38 0.77 0.64 0.62 0.48 0.39 0.86 0.98 0.86 0.89 0.92 0.71 0.36 0.13 11/11 34/34	♂ (AMNH), Orce: 0.61 0.04 0.77 1.09 0.32 0.35 0.57 0.61 0.58 0.39 0.6 0.35 0.81 0.7 0.61 0.48 0.38 0.84 0.95 0.83 0.88 0.9 0.68 0.33 0.13 12/12 30/32
♂ (AMNH), Ossa de Montiel: 0.66 0.04 0.73 1.03 0.27 0.39 0.5 0.54 0.67 0.39 0.59 0.36 0.83 0.63 0.61 0.47 0.4 0.81 0.98 0.85 0.93 0.95 0.69 0.33 0.12 11/- 31/31	♂ (AMNH), Aledo: 0.6 0.03 0.71 1.05 0.26 0.34 0.43 0.55 0.64 0.37 0.58 0.34 0.82 0.65 0.62 0.51 0.39 0.88 0.94 0.87 0.88 0.88 0.63 0.34 0.13 12/12 32/31
♂ (AMNH), Villena: 0.66 0.04 0.71 1.08 0.31 0.33 0.54 0.61 0.61 0.39 0.6 0.37 0.82 0.73 0.65 0.5 0.43 0.9 0.95 0.81 0.93 0.78 0.65 0.31 0.13 12/11 31/33	♂ (AMNH), Serranía de Cuenca: 0.72 0.04 0.71 1.04 0.29 0.4 0.53 0.62 0.75 0.38 0.65 0.37 0.8 0.69 0.65 0.51 0.4 0.92 0.98 0.84 0.88 0.9 0.73 0.37 0.12 12/12 31/32
♂ (AMNH), Villena: 0.65 0.03 0.64 0.94 0.29 0.36 0.48 0.54 0.67 0.36 0.61 0.4 0.77 0.61 0.61 0.48 0.38 0.86 1.02 0.82 0.92 0.94 0.7 0.37 0.13 12/12 33/33	♂ (AMNH), Serranía de Cuenca: 0.71 0.05 0.7 1.04 0.27 0.38 0.54 0.62 0.74 0.35 0.59 0.35 0.83 0.69 0.65 0.5 0.39 0.91 0.98 0.83 0.86 0.96 0.74 0.39 0.12 12/12 30/30
♂ (AMNH), Villena: 0.64 0.04 0.67 0.99 0.28 0.35 0.51 0.56 0.65 0.31 0.57 0.36 0.79 0.62 0.58 0.47 0.39 0.85 0.99 0.84 0.92 0.93 0.69 0.31 0.12 12/12 31/30	♂ (AMNH), Serranía de Cuenca: 0.65 0.05 0.68 1.01 0.31 0.39 0.55 0.61 0.72 0.38 0.6 0.37 0.84 0.77 0.72 0.56 0.4 0.95 0.99 0.83 0.84 0.9 0.69 0.35 0.13 12/12 33/33
♂ (AMNH), Villena: 0.64 0.04 0.65 0.98 0.29 0.35 0.49 0.57 0.64 0.29 0.6 0.33 0.76 0.65 0.62 0.47 0.41 0.91 0.96 0.86 0.9 0.89 0.67 0.31 0.13 12/12 31/30	♂ (AMNH), Torcas: 0.69 0.04 0.68 1.01 0.27 0.37 0.46 0.56 0.69 0.38 0.6 0.38 0.8 0.7 0.66 0.49 0.38 0.92 0.96 0.83 0.91 0.91 0.76 0.4 0.13 12/12 30/33
♂ (AMNH), Saladar: 0.75 0.03 0.7 1.05 0.28 0.38 0.48 0.57 0.66 0.44 0.61 0.35 0.73 0.67 0.6 0.5 0.41 0.96 0.92 0.87 0.91 0.86 0.77 0.38 0.13 12/12 32/34	♂ (AMNH), Torcas: 0.7 0.04 0.67 1.02 0.27 0.36 0.51 0.56 0.67 0.39 0.62 0.37 0.81 0.7 0.67 0.51 0.4 0.91 1 0.86 0.86 0.86 0.72 0.38 0.13 12/12 33/34
♂ (AMNH), Sant Vicent del Raspeig: 0.73 0.03 0.72 1.06 0.28 0.41 0.51 0.61 0.62 0.39 0.63 0.35 0.79 0.66 0.62 0.49 0.4 0.88 0.97 0.86 0.93 0.87 0.62 0.33 0.12 12/12 33/33	♀ (AMNH), Peñarroya: 0.76 0.05 0.64 0.96 0.27 0.38 0.54 0.62 0.77 0.46 0.56 0.39 0.79 0.67 0.66 0.54 0.41 0.92 0.99 0.83 0.85 0.97 0.72 0.36 0.13 12/12 28/28

APPENDIX 5 *continued*

♀ (AMNH), Peñarroya: 0.74 0.05 0.66 0.93 0.27
0.37 0.48 0.56 0.78 0.39 0.56 0.39 0.75 0.66
0.63 0.5 0.42 0.9 0.98 0.85 0.89 0.98 0.72 0.36
0.12 11/11 28/29

♀ (AMNH), Peñarroya: 0.7 0.05 0.69 0.96 0.3 0.4
0.54 0.62 0.75 0.47 0.54 0.39 0.82 0.68 0.62
0.52 0.43 0.89 0.96 0.85 0.84 0.95 0.75 0.37
0.12 11/12 29/28

♀ (AMNH), Ossa de Montiel: 0.74 0.05 0.68 0.98
0.29 0.39 0.54 0.58 0.76 0.48 0.66 0.47 0.79
0.68 0.68 0.51 0.43 0.93 1.02 0.8 0.85 0.98 0.8
0.36 0.12 12/11 27/28

♀ (AMNH), Ossa de Montiel: 0.67 0.04 0.66 0.96
0.29 0.36 0.49 0.6 0.77 0.36 0.58 0.41 0.8 0.71
0.66 0.52 0.4 0.91 0.98 0.82 0.85 1.06 0.79 0.38
0.12 11/12 29/28

♀ (AMNH), Villena: 0.71 0.05 0.74 1.04 0.29
0.39 0.6 0.65 0.72 0.29 0.51 0.37 0.8 0.67 0.63
0.52 0.42 0.89 0.98 0.82 0.86 0.99 0.7 0.34 0.12
12/12 28/28

♀ (AMNH), Villena: 0.69 0.05 0.62 0.94 0.27
0.37 0.58 0.65 0.7 0.33 0.52 0.36 0.86 0.72 0.7
0.54 0.44 0.88 0.99 0.81 0.83 0.98 0.73 0.35
0.13 12/12 27/27

♀ (AMNH), Villena: 0.65 0.05 0.66 0.94 0.28
0.38 0.56 0.62 0.7 0.4 0.52 0.41 0.85 0.69 0.67
0.53 0.45 0.87 0.97 0.84 0.86 0.88 0.68 0.36
0.12 12/12 28/28

♀ (AMNH), Saladar: 0.7 0.05 0.68 0.97 0.3 0.34
0.58 0.65 0.68 0.38 0.57 0.38 0.78 0.7 0.65 0.57
0.43 0.93 0.95 0.88 0.84 0.92 0.72 0.38 0.13
12/12 30/30

♀ (AMNH), Saladar: 0.72 0.05 0.65 0.97 0.28
0.37 0.58 0.63 0.7 0.36 0.53 0.43 0.8 0.67 0.63
0.52 0.42 0.88 0.99 0.85 0.86 0.91 0.68 0.4 0.12
12/12 30/29

♀ (AMNH), Sant Vicent: 0.75 0.05 0.72 0.99 0.27
0.37 0.62 0.65 0.66 0.44 0.52 0.41 0.83 0.64
0.61 0.5 0.45 0.86 0.96 0.85 0.86 0.92 0.68 0.38
0.13 12/12 30/30

♀ (AMNH), Sant Vicent: 0.73 0.05 0.64 0.97 0.28
0.38 0.62 0.71 0.67 0.37 0.54 0.39 0.78 0.67
0.64 0.52 0.42 0.93 0.97 0.86 0.82 0.95 0.72
0.35 0.13 12/12 30/29

♀ (AMNH), Sant Vicent: 0.73 0.05 0.65 0.96 0.27
0.39 0.58 0.68 0.7 0.37 0.53 0.38 0.77 0.7 0.65
0.55 0.45 0.97 0.98 0.84 0.81 0.9 0.81 0.39 0.14
12/12 30/28

♀ (AMNH), Sant Vicent: 0.73 0.05 0.66 0.98 0.28
0.37 0.56 0.64 0.68 0.47 0.64 0.41 0.75 0.7 0.66
0.51 0.45 0.95 0.96 0.83 0.87 0.95 0.71 0.34
0.13 12/12 27/27

♀ (AMNH), Sant Vicent: 0.69 0.05 0.65 0.96 0.32
0.38 0.62 0.75 0.66 0.38 0.58 0.41 0.79 0.68
0.66 0.54 0.45 0.94 0.99 0.83 0.84 0.88 0.68
0.37 0.12 12/12 30/28

♀ (AMNH), Orce: 0.68 0.05 0.67 0.97 0.24 0.37
0.55 0.58 0.7 0.34 0.53 0.42 0.75 0.68 0.66 0.51
0.42 0.95 0.99 0.83 0.84 1.01 0.78 0.36 0.12
12/12 26/27

♀ (AMNH), Orce: 0.65 0.05 0.7 0.96 0.27 0.37
0.51 0.57 0.77 0.4 0.61 0.42 0.78 0.68 0.63 0.55
0.42 0.94 0.96 0.87 0.82 1.01 0.77 0.36 0.11
12/12 26/26

♀ (AMNH), Orce: 0.65 0.05 0.71 0.99 0.29 0.39
0.53 0.63 0.73 0.4 0.52 0.41 0.81 0.7 0.64 0.53
0.41 0.93 0.97 0.85 0.84 1.03 0.76 0.37 0.12
12/13 27/27

♀ (AMNH), Aledo: 0.75 0.05 0.69 0.99 0.3 0.39
0.61 0.66 0.7 0.39 0.58 0.39 0.8 0.67 0.66 0.54
0.45 0.93 0.99 0.86 0.84 0.98 0.81 0.37 0.12
11/12 26/27

♀ (AMNH), Aledo: 0.66 0.05 0.67 0.9 0.26 0.36
0.53 0.57 0.72 0.37 0.49 0.41 0.79 0.71 0.64
0.52 0.42 0.97 0.94 0.83 0.83 0.93 0.69 0.33
0.12 12/12 27/28

♀ (AMNH), Serranía de Cuenca: 0.66 0.05 0.63
0.87 0.31 0.38 0.53 0.6 0.76 0.43 0.58 0.4 0.8
0.71 0.66 0.55 0.43 0.94 0.94 0.84 0.84 0.94
0.72 0.38 0.11 12/12 28/27

♀ (AMNH), Serranía de Cuenca: 0.77 0.05 0.69
0.93 0.28 0.37 0.57 0.6 0.74 0.48 0.64 0.41 0.78
0.67 0.64 0.51 0.39 0.92 0.99 0.83 0.83 1 0.72
0.38 0.12 12/12 26/27

♀ (AMNH), Serranía de Cuenca: 0.64 0.05 0.65
0.95 0.34 0.37 0.5 0.56 0.77 0.42 0.56 0.44 0.92
0.72 0.71 0.57 0.43 0.86 0.99 0.82 0.83 0.92
0.72 0.37 0.12 12/12 28/28

APPENDIX 5 *continued*

♀ (AMNH), Torcas: 0.75 0.05 0.61 0.87 0.26 0.35
0.51 0.5 0.79 0.39 0.53 0.37 0.77 0.67 0.64 0.51
0.41 0.95 0.75 0.05 0.61 0.87 0.26 0.35 0.51
12/12 27/28

***Buthus montanus* Lourenço and Vachon, 2004**

♂ (AMNH), Puerto de La Ragua: 0.76 0.04 0.74
1.01 0.26 0.38 0.5 0.53 0.83 0.4 0.57 0.31 0.71
0.64 0.58 0.45 0.36 0.93 0.98 0.84 0.9 0.93 0.65
0.34 0.12 12/12 29/29

♂ (AMNH), Puerto de La Ragua: 0.72 0.04 0.72
1.04 0.29 0.37 0.49 0.6 0.75 0.41 0.64 0.38 0.81
0.71 0.65 0.48 0.4 0.93 0.96 0.82 0.9 0.94 0.72
0.37 0.13 12/12 30/31

♂ (AMNH), Puerto de La Ragua: 0.74 0.04 0.72
1.05 0.27 0.38 0.51 0.56 0.82 0.42 0.63 0.37
0.76 0.66 0.64 0.47 0.39 0.94 0.99 0.8 0.89 0.94
0.64 0.33 0.12 12/12 28/29

♂ (AMNH), Francisco Abellán: 0.74 0.04 0.75
1.03 0.29 0.37 0.5 0.54 0.78 0.43 0.66 0.4 0.74
0.65 0.62 0.49 0.37 0.91 0.99 0.84 0.87 0.9 0.64
0.35 0.11 12/12 29/30

♂ (AMNH), Francisco Abellán: 0.72 0.04 0.71 1
0.29 0.36 0.47 0.53 0.72 0.39 0.6 0.38 0.75 0.66
0.64 0.51 0.41 0.93 0.99 0.85 0.88 0.91 0.7 0.33
0.12 11/12 30/31

♀ (AMNH), Puerto de La Ragua: 0.83 0.05 0.68
0.97 0.28 0.37 0.52 0.57 0.8 0.48 0.61 0.48 0.84
0.71 0.65 0.53 0.42 0.93 0.96 0.83 0.83 0.94
0.72 0.37 0.11 12/12 26/25

♀ (AMNH), Puerto de La Ragua: 0.82 0.05 0.69
0.98 0.3 0.4 0.59 0.65 0.7 0.37 0.55 0.41 0.86
0.75 0.71 0.53 0.44 0.95 0.97 0.81 0.84 0.95
0.74 0.38 0.12 12/12 29/29

♀ (AMNH) Puerto de La Ragua: 0.78 0.05 0.66
0.91 0.27 0.39 0.55 0.59 0.79 0.45 0.55 0.44
0.84 0.78 0.71 0.54 0.45 0.93 0.96 0.8 0.87 0.92
0.8 0.37 0.11 12/11 26/25

♀ (AMNH), Puerto de La Ragua: 0.76 0.05 0.68
0.92 0.29 0.36 0.51 0.6 0.78 0.35 0.52 0.4 0.86
0.7 0.68 0.53 0.41 0.83 0.99 0.83 0.86 0.96 0.72
0.35 0.12 12/12 26/25

♀ (AMNH), Puerto de La Ragua: 0.71 0.05 0.63
0.89 0.28 0.4 0.54 0.58 0.78 0.36 0.54 0.38 0.82
0.68 0.68 0.55 0.42 0.92 1.01 0.83 0.79 0.89
0.65 0.33 0.12 12/12 26/26

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

♂ (AMNH), Souvignargues: 0.57 0.04 0.68 0.96
0.3 0.38 0.52 0.58 0.63 0.3 0.4 0.41 0.91 0.72
0.68 0.57 0.46 0.82 0.97 0.92 0.86 0.81 0.78
0.38 0.13 12/12 31/34

♂ (AMNH), Bardenas Reales: 0.64 0.03 0.67 0.98
0.28 0.34 0.48 0.53 0.58 0.28 0.56 0.37 0.83
0.65 0.61 0.49 0.4 0.81 1.01 0.9 0.82 0.83 0.65
0.35 0.13 12/12 33/34

♂ (AMNH), Sainte-Baume: 0.63 0.03 0.72 0.99
0.26 0.34 0.45 0.53 0.6 0.27 0.5 0.35 0.85 0.72
0.63 0.52 0.36 0.93 0.91 0.92 0.77 0.87 0.64
0.33 0.13 12/12 33/31

♂ (AMNH), Correc Gros: 0.55 0.03 0.72 0.98
0.26 0.34 0.41 0.47 0.64 0.32 0.47 0.39 0.92
0.77 0.71 0.56 0.43 0.88 0.95 0.91 0.83 0.85
0.72 0.39 0.14 12/12 32/31

♂ (AMNH), Garraf: 0.68 0.04 0.73 0.98 0.25 0.35
0.49 0.55 0.63 0.3 0.5 0.35 0.87 0.71 0.62 0.54
0.39 0.87 0.93 0.92 0.81 0.84 0.66 0.4 0.12
12/12 31/31

♂ (AMNH), Columbretes: 0.56 0.03 0.66 1.01
0.28 0.34 0.45 0.56 0.56 0.36 0.63 0.42 0.79
0.69 0.63 0.5 0.41 0.83 0.96 0.86 0.84 0.78 0.68
0.39 0.12 12/12 31/31

♂ (AMNH), Columbretes: 0.55 0.03 0.65 1.02
0.27 0.37 0.5 0.63 0.57 0.36 0.53 0.41 0.84 0.7
0.64 0.52 0.43 0.88 0.96 0.9 0.85 0.76 0.66 0.38
0.12 12/12 31/33

♂ (MNCN 17070), Columbrete Grande: 0.64
0.03 0.67 0.99 0.28 0.36 0.45 0.52 0.62 0.5 0.69
0.43 0.77 0.68 0.63 0.47 0.4 0.91 0.97 0.86 0.91
0.8 0.68 0.39 0.12 12/12 33/33

♂ (MNCN 17070), Columbrete Grande: 0.56
0.03 0.68 0.99 0.28 0.35 0.45 0.51 0.66 0.41
0.59 0.37 0.85 0.72 0.64 0.5 0.4 0.92 0.95 0.84
0.88 0.79 0.7 0.37 0.11 12/12 30/31

APPENDIX 5 *continued*

♂ (MNCN 9721), La Ferrera: 0.5 0.03 0.74 1 0.25 0.34 0.41 0.48 0.56 0.4 0.73 0.4 0.73 0.63 0.6 0.46 0.37 0.9 1.01 0.81 0.89 0.77 0.57 0.38 0.12 12/12 32/31	♀ (AMNH), Columbrete: 0.63 0.05 0.65 0.94 0.31 0.37 0.57 0.64 0.69 0.34 0.59 0.41 0.84 0.7 0.63 0.53 0.44 0.91 0.92 0.88 0.88 0.84 0.7 0.36 0.11 12/12 28/26
♂ (AMNH), Sierra Calderona: 0.66 0.03 0.67 1.03 0.27 0.3 0.45 0.54 0.62 0.33 0.58 0.36 0.88 0.76 0.65 0.49 0.39 0.91 0.88 0.87 0.81 0.81 0.68 0.36 0.14 12/12 32/33	♀ (MNCN 9722), Columbrete Grande: 0.65 0.04 0.66 0.96 0.3 0.35 0.53 0.62 0.66 0.51 0.66 0.44 0.8 0.71 0.65 0.53 0.45 0.94 0.98 0.84 0.82 0.81 0.69 0.39 0.11 12/12 26/25
♂ (AMNH), Sierra Calderona: 0.64 0.03 0.69 1 0.29 0.35 0.52 0.62 0.51 0.4 0.57 0.42 0.82 0.68 0.65 0.51 0.39 0.92 0.96 0.83 0.83 0.83 0.55 0.35 0.12 12/12 31/31	♀ (MNCN 9722), Columbrete Grande: 0.68 0.04 0.68 0.94 0.28 0.34 0.52 0.62 0.64 0.48 0.65 0.42 0.81 0.7 0.67 0.54 0.43 0.94 0.96 0.82 0.86 0.84 0.69 0.4 0.12 12/12 29/28
♂ (AMNH), Sierra Calderona: 0.7 0.04 0.7 1.02 0.23 0.36 0.49 0.55 0.62 0.39 0.62 0.36 0.82 0.69 0.65 0.49 0.39 0.92 0.96 0.84 0.86 0.92 0.71 0.37 0.12 12/12 33/33	♀ (MNCN 9722), Columbrete Grande: 0.66 0.04 0.72 0.97 0.31 0.39 0.53 0.59 0.7 0.39 0.6 0.43 0.84 0.75 0.69 0.55 0.43 0.95 0.96 0.82 0.83 0.88 0.72 0.38 0.11 12/12 28/27
♂ (AMNH), Sierra Calderona: 0.64 0.03 0.71 1.04 0.24 0.36 0.36 0.47 0.64 0.43 0.65 0.41 0.72 0.63 0.61 0.5 0.36 0.94 0.98 0.84 0.84 0.91 0.69 0.4 0.13 12/12 32/32	♀ (MNCN 17059), Islas Columbretes: 0.65 0.05 0.65 0.91 0.28 0.35 0.53 0.66 0.71 0.32 0.61 0.42 0.81 0.76 0.66 0.56 0.46 0.98 0.9 0.87 0.83 0.82 0.69 0.39 0.12 12/12 27/30
♂ (AMNH), Sierra Calderona: 0.61 0.04 0.71 1.04 0.28 0.35 0.44 0.49 0.69 0.38 0.64 0.35 0.75 0.65 0.6 0.48 0.36 0.89 0.97 0.88 0.84 0.86 0.67 0.39 0.12 12/12 31/31	♀ (AMNH), Sierra Calderona: 0.66 0.04 0.69 0.99 0.3 0.34 0.52 0.63 0.61 0.33 0.49 0.37 0.82 0.73 0.65 0.53 0.39 0.92 0.91 0.88 0.78 0.98 0.71 0.36 0.12 12/12 27/29
♀ (AMNH), Souvignargues: 0.66 0.05 0.65 0.94 0.29 0.37 0.69 0.75 0.58 0.34 0.48 0.61 0.81 0.77 0.7 0.62 0.45 0.99 0.97 0.85 0.8 0.96 0.82 0.45 0.1 12/12 29/29	♀ (AMNH), Sierra Calderona: 0.73 0.05 0.72 0.95 0.25 0.33 0.59 0.7 0.62 0.41 0.57 0.48 0.8 0.7 0.66 0.57 0.43 0.9 0.96 0.9 0.78 0.93 0.7 0.36 0.11 12/12 27/28
♀ (AMNH), Bardenas Reales: 0.66 0.05 0.65 0.95 0.32 0.35 0.59 0.65 0.69 0.34 0.46 0.45 0.84 0.71 0.66 0.64 0.49 0.87 0.98 0.97 0.79 0.9 0.72 0.38 0.12 12/12 27/28	♀ (AMNH), Sierra Calderona: 0.7 0.05 0.7 0.97 0.3 0.33 0.6 0.7 0.65 0.43 0.59 0.42 0.82 0.67 0.69 0.6 0.44 0.87 1.02 0.91 0.76 0.9 0.63 0.39 0.12 12/12 27/27
♀ (AMNH), Sainte-Baume: 0.67 0.05 0.65 0.98 0.32 0.39 0.55 0.63 0.68 0.34 0.46 0.4 0.93 0.74 0.66 0.63 0.42 0.79 0.95 0.96 0.71 0.92 0.74 0.37 0.12 12/12 29/28	
♀ (AMNH), Correc Gros: 0.69 0.05 0.61 0.86 0.28 0.38 0.53 0.63 0.71 0.34 0.39 0.39 0.96 0.75 0.67 0.54 0.34 0.81 0.91 0.88 0.84 1.28 0.65 0.35 0.12 12/12 28/29	
♀ (AMNH), Garraf: 0.7 0.05 0.71 0.99 0.3 0.36 0.57 0.61 0.68 0.28 0.47 0.47 0.97 0.67 0.63 0.54 0.44 0.76 0.97 0.87 0.89 0.93 0.72 0.41 0.11 12/12 29/29	

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