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A new species of *Buthus* Leach, 1815 from Algeria (Scorpiones: Buthidae) and an interesting new case of vicariance

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Keywords:

Scorpion; *Buthus*; *ahaggar*; *tassili*; taxonomy; new species; description; morphology; vicariants; Algeria; Southern Massifs; Hoggar.

Abstract. – A new species of *Buthus* is described from the Hoggar Massif located in the South of Algeria. This new species most certainly represents a vicariant element of *Buthus tassili* Lourenço, species equally described from a Massif formation, the Tassili N'Ajjer, in the South of Algeria. Both species are distributed in high altitudes in these massifs. The studies performed up to now on the Algerian *Buthus* have a major advantage over those performed for other regions in Africa since done with more precise methods and a better definition of the populations. The number of confirmed species of *Buthus* in Algeria is raised to ten.

Ythier E., Sadine S. E., Haddadi M. H. & Lourenço W. R., 2021. – A new species of *Buthus* Leach, 1815 from Algeria (Scorpiones: Buthidae) and an interesting new case of vicariance. *Faunitaxys*, 9(21): 1 – 9.

ZooBank: http://zoobank.org/0660DB46-6AEA-4DCE-B4BD-5139C2B3DDA2

Introduction

In the last twenty years, an impressive number of publications attested of the remarkable progress in the number of species described in the genus *Buthus* Leach, 1815 which had remained constant during the previous fifty years (Lourenço, 2002a, 2003). More precise information is available in Lourenço et al. (2020) and Abidi et al. (2021). It was also emphasized in several previous publications that the studies performed for the genus *Buthus* in Algeria presented a singular advantage over those performed for other regions of Africa mainly since done with more precise methods and a better definition of the populations.

Recent examination of *Buthus* specimens collected in the Hoggar Massif in the South of Algeria (Fig. 1) lead to a better comparative study with *Buthus tassili* Lourenço, 2002, species described from another massif in the South of Algeria, the Tassili N'Ajjer. Naturally, the Hoggar population of *Buthus* was already cited by previous authors such as Pallary (1929) and Vachon (1952), but merely associated to *Buthus occitanus* typicus or partially to *Buthus tunetanus* (Herbst, 1800), species in fact distributed only in the North range of the country (Fig. 1). Precise analysis of these specimens confirmed that the populations of the Hoggar and Tassilis N'Ajjer are most certainly different. The populations from the two massifs clearly show a number of affinities, but some morphological differences can also be outlined (see taxonomic section). Consequently, a new species of *Buthus* is described at present. The populations of the two species certainly correspond to a new case of vicariance between elements inhabiting habitats previously in contact during past climatic periods, but now isolated by the expansion of aridity (Lourenço et al., 2018).

Methods

Illustrations and measurements were made with the aid of a Wild M5 stereo-microscope with a drawing tube (camera lucida) and an ocular micrometer, as well as with a Motic SMZ-1713 digital stereo-microscope together with a Canon EOS 7D camera and a Wacom Intuos drawing tablet. Map was made using Google Maps and Adobe Photoshop software. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Vachon (1952) and Hjelle (1990). Specimens studied herein are deposited in the Muséum national d'Histoire naturelle, Paris and the University of Ghardaïa, Algeria.

Check-list of the *Buthus* species present in Algeria (in order of description)

- *Buthus tunetanus* (Herbst, 1800)
- *Buthus paris* (C. L. Koch, 1839)
- *Buthus tassili* Lourenço, 2002
- *Buthus pusillus* Lourenço, 2013
- *Buthus saharicus* Sadine, Bissati & Lourenço, 2016
- *Buthus aures* Lourenço & Sadine, 2016
- *Buthus boussaadi* Lourenço, Chichi & Sadine, 2018
- *Buthus apiatus* Lourenço, El Bouhissi & Sadine, 2020
- *Buthus goyffoni* Abidi, Sadine & Lourenço, 2021
- *Buthus ahaggar* **sp**. **n**.

Reviewer: Hisham K. El-Hennawy (Egypt).

Taxonomic treatment

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

Genus ***Buthus*** Leach, 1815

Buthus tassili Lourenço, 2002 - Revised diagnosis

(Fig. 2-9, Tab. I)

Buthus tassili Lourenço, 2002a: 113.

The revised diagnosis is based on the type material which remains the only available material. However, new illustrations not presented in the original description are provided.

Diagnosis. – Scorpion of moderate size, with a total length of 59.0 mm for the male holotype; the female paratype is an immature and has only 40.4 mm in total length. General coloration yellow to pale yellow; carapace and tergites yellow without spots; metasomal segments yellow, excepted for the segment V and telson which are dark brown to blackish; pedipalps and legs pale yellow, without spots; chelicerae yellow, without any variegated spots. Carinae and granulations moderately marked on carapace, tergites and metasomal segments; ventral carinae of metasomal segments II, III and V better marked. Fixed and movable fingers with 10-11 rows of granules. Pectines with respectively 23-25 and 32-32 teeth in female paratype and male holotype. Tibial spurs strongly developed. Trichobothrial pattern of type A-Beta (Fig. 3-9).

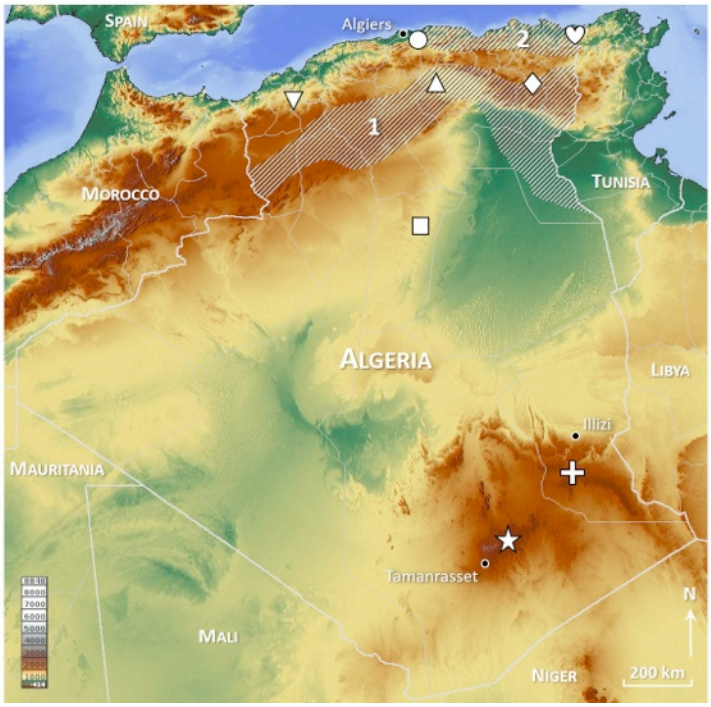

Fig. **1**. Map of Algeria: distribution of the known *Buthus* species.
Buthus tunetanus (dashed area 1),
Buthus paris (dashed area 2),
Buthus tassili (cross),
Buthus pusillus (circle),
Buthus saharicus (square),
Buthus aures (rhombus),
Buthus boussaadi (triangle),
Buthus apiatus (inverted triangle),
Buthus goyffoni (heart),
Buthus ahaggar **sp**. **n**. (star).

Buthus ahaggar **sp**. **n**.

(Fig. 10-22, Tab. I)

ZooBank: http://zoobank.org/B10C2960-9F73-416D-B4A7-439A3B07C780

Buthus occitanus tunetanus: Giltay, 1929: 196; Pallary, 1929: 134; Vachon, 1952: 279.

Holotype, ♀, Algeria, Hoggar Massif, possible altitude around 2000 m, ca. 1960 (J.-B. Lacroix), deposited in the Muséum national d'Histoire naturelle, Paris.

Paratype, 1 ♀, Algeria, Hoggar Massif, Tazrouk region (23º27'N, 06º11'E), in Wadi bed with stony bottom, altitude 1860 m, 18/VIII/2019 (M. L. Haddadi), deposited in the University of Ghardaïa, Algeria.

Etymology. – The specific name is placed in apposition to the generic name and refers to the Hoggar in Tuareg language, where the new species was found.

Diagnosis. – Scorpion of moderate to large size, with a total length of 59.9 mm for the female holotype and 63.0 mm for the female paratype. General coloration yellowish orange; carapace and tergites densely spotted; tergites with conspicuous confluent spots, well observable on living specimens; metasomal segments yellowish orange with blackish spots over metasomal segment V and telson; legs and pedipalps yellowish orange without spots; chelicerae yellow with minute spots on the anterior zone. Carinae and granulations strongly marked on carapace, tergites and metasomal segments; in particular the ventral carinae of metasomal segments II, III and V. Fixed and movable fingers with 10-11 rows of granules. Pectines with respectively 24-25 and 25-25 teeth in female holotype and paratype. Tibial spurs moderately to strongly developed.

Description (based on holotype and paratype; measurements on Table I)

Coloration. – Basically yellow to yellowish orange. Prosoma: Carapace yellow with dark spots on the anterior edge; carinae and ocular tubercle marked with dark pigments. Mesosoma yellow with conspicuous dark to blackish confluent spots. Metasomal segments yellow to yellowish orange with conspicuous blackish spots over segment V and telson; aculeus yellowish at its base and dark red at its extremity. Venter yellow to yellowish orange; genital operculum and pectines paler than the other zones. Chelicerae yellow

Fig. **2**. *Buthus tassili* Lourenço, 2002, holotype, ♂. Habitus, dorsal aspect.

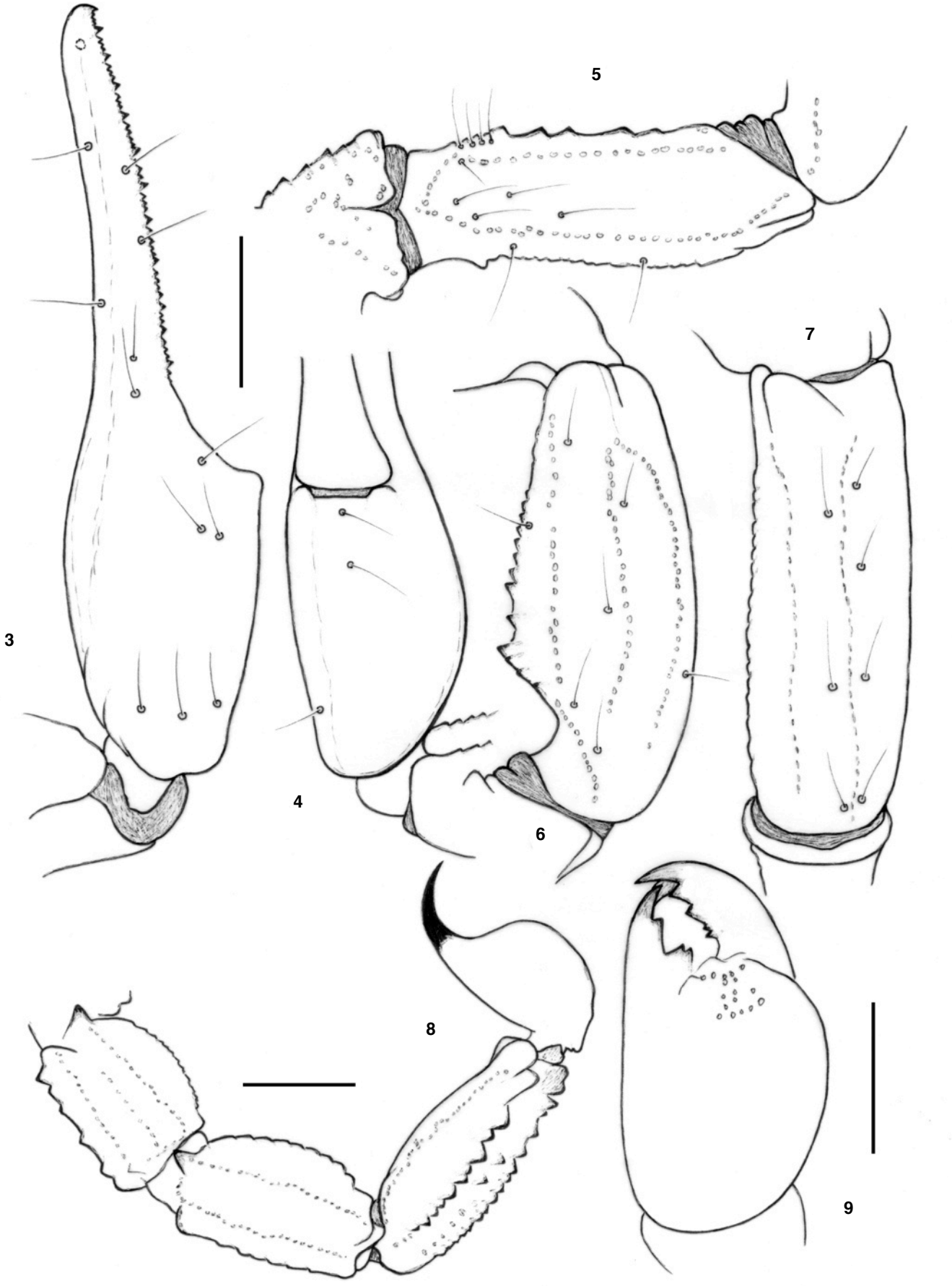

Fig. **3**-**9**. *Buthus tassili* Lourenço, 2002, paratype, ♀ (Scale bars = 2 mm except chelicera 1 mm).

3-**7**. Trichobothrial pattern. **3**-**4**. Chela dorso-external and ventral aspects. **5**. Femur, dorsal aspect. **6**-**7**. Patella, dorsal and external aspects. **8**. Metasomal segments III to V and telson, lateral aspect. **9**. Chelicera, dorsal aspect.

with minute spots at the base of the fingers; fingers yellow with dark red teeth. Pedipalps yellowish orange without spots; fingers with the oblique rows of granules dark red. Legs yellow without spots.

Morphology. – Carapace moderately to strongly granular; anterior margin with a weak concavity. Carinae strongly marked; anterior median, central median and posterior median carinae strongly granular, with 'lyre' configuration. All furrows moderate. Median ocular tubercle located in the centre of the carapace. Eyes separated by about two ocular diameters. Three pairs of lateral eyes of moderate size in relation to median eyes. Sternum triangular, weakly narrowed; slightly wider than long. Mesosoma: tergites moderately to strongly granular. Three longitudinal carinae moderately to strongly crenulate in all tergites; lateral carinae reduced in tergites I and II. Tergite VII pentacarinate. Venter: genital operculum divided longitudinally, each plate with a semi-oval shape. Pectines: pectinal tooth count 24-25 in holotype and 25-25 in paratype; middle basal lamella of the pectines not dilated. Sternites without granules, smooth with elongated spiracles; four moderate carinae on sternite VII; two weak on VI; other sternites acarinated and with two vestigial furrows. Metasomal segments with a weak setation; segments I to III with ten crenulated carinae; intermediate incomplete on II and III; ventral carinae strongly marked on II-III with lobate granules; segment IV with eight carinae, crenulated; the first four segments with a smooth dorsal depression; segment V with five carinae; the latero-ventral carinae crenulate with 5-6 lobate denticles posteriorly; ventral median carina largely divided posteriorly, over 1/3 of the total length; anal arc composed of 8-9 ventral teeth, and two lateral lobes. Intercarinal spaces weakly granular. Telson with some granulations ventrally and laterally; aculeus curved and slightly shorter than the vesicle, without a subaculear tubercle. Cheliceral dentition as defined by Vachon (1963) for the family Buthidae; external distal and internal distal teeth approximately the same length; basal teeth on movable finger small and not fused; ventral aspect of both fingers and manus covered with long dense setae. Pedipalps with a weak setation; femur pentacarinate; patella with 9 carinae, moderately to strongly marked; internal with 6-7 spinoid granules; all faces weakly granular; chela short and globular, with vestigial carinae, almost smooth. Fixed and movable fingers with 10-11 oblique rows of granules. Internal and external accessory granules present, moderately strong; three accessory granules on the distal end of the movable finger next to the terminal denticle. Legs: tarsus with two longitudinal rows of moderately long setae ventrally; tibial spurs strong on legs III and IV; pedal spurs strong on legs I to IV. Trichobothriotaxy: trichobothrial pattern of Type A, orthobothriotaxic as defined by Vachon (1974). Dorsal trichobothria of femur arranged in **β** (beta) configuration (Vachon, 1975).

Relationships. – *Buthus ahaggar* **sp**. **n**. shows unquestionable similarities with *Buthus tassili* Lourenço in respect to several characters but also by a common zone of distribution in the South of Algeria. Both species can however be distinguished by the following main features: (i) some distinct morphological values (Tab. I); chela is short and globular in the new species, (ii) a somewhat different pattern of coloration; the new species shows marked confluent dark spots on tergites which are absent in *B. tassili*, (iii) ventral carinae on metasomal segments II and III are more conspicuous in the new species, (iv) ventral median carina is largely divided posteriorly, over 1/3 of the total length in the new species. More important however seems to be the disjointed pattern of geographical distribution presented by the two species, suggesting the existence of vicariant populations (Fig. 29).

Fig. **10-11**. *Buthus ahaggar* **sp**. **n**., holotype, ♀. **10**. Dorsal aspect. **11**. Ventral aspect.

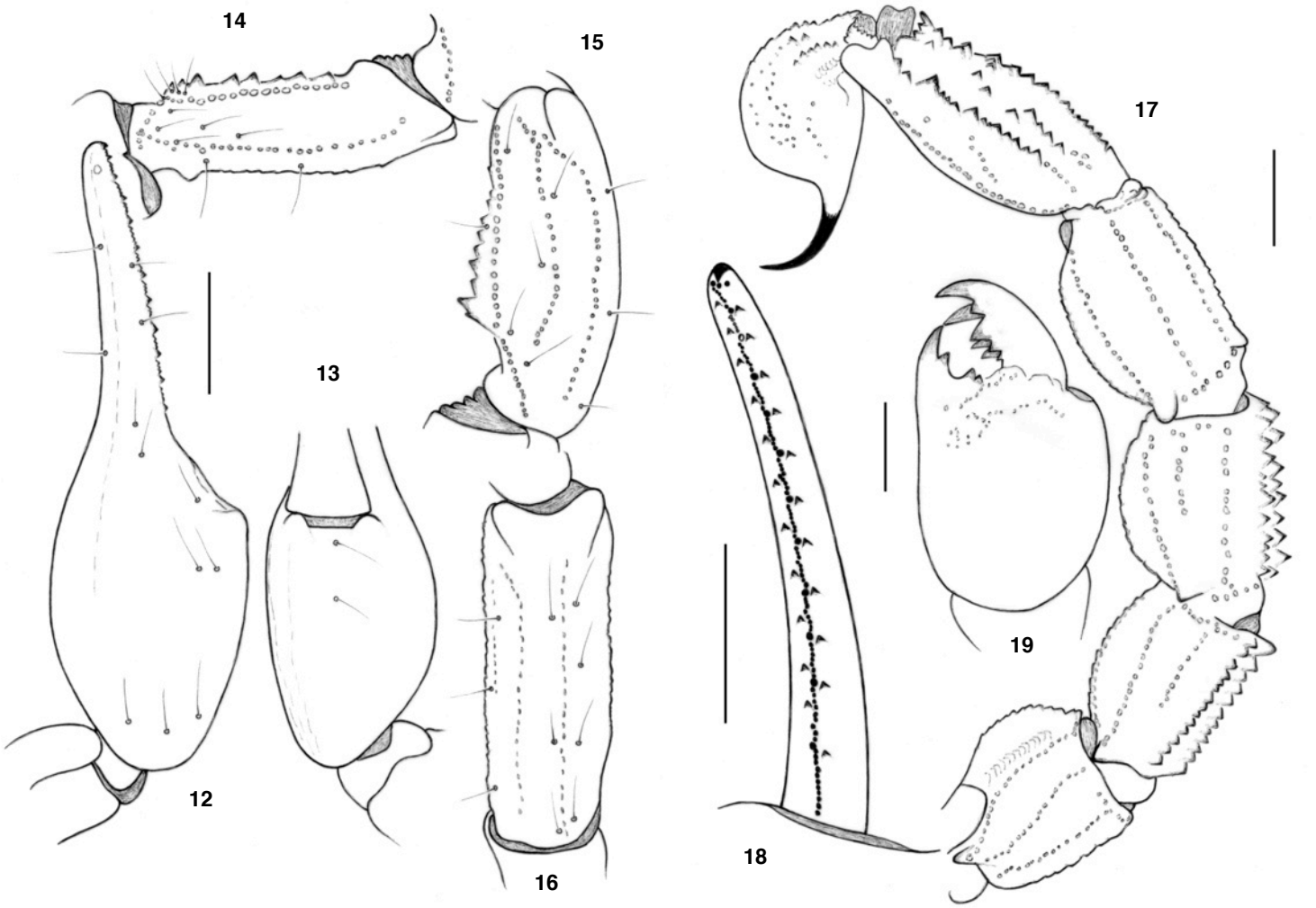

Fig. **12-19**. *Buthus ahaggar* **sp**. **n**., holotype, ♀ (Scale bars = 2 mm except chelicera 1 mm).

12-16. Trichobothrial pattern. **12-13**. Chela, dorso-external and ventral aspects. **14**. Femur, dorsal aspect. **15-16**. Patella, dorsal and external aspects. **17**. Metasomal segments I to V and telson, lateral aspect, showing the strongly marked granulations on segments II and III. **18**. Cutting edge of chela movable finger with rows of granules. **19**. Chelicera, dorsal aspect.

Ecological characteristics of the Hoggar and Tassili N'Ajjer and the arid plains separating the two massifs

As clearly exposed by Barry (1991), rainfall and temperature diversity in the mountains of the central but also western Sahara and the corresponding succession of vegetation zones can only be found at high altitudes (± 1800 m). Basically, rainfall is the fundamental factor. The thermo-Mediterranean bioclimate is dominant on nearly all the plains near the mountain ranges, while the absence of phanerophytes makes it possible to identify a Saharan-eremic zone. Depending on the relative proportion of floristic elements (Mediterranean, Saharo-Sindian or Sudano-Zambezian), which is related to the climatic events which took place during the Quaternary, this Saharan-eremic zone gives way to either a Saharo-Mediterranean eremic or Saharo-Sahelian zone on the piemonts and lower slopes. Chorology thus prevails over climatology. Above 1700-1800 m, temperature is the dominant factor. For m<+3°C (m = mean daily minimum temperature of the coldest month; Emberger, 1936), a meso-Mediterranean bioclimate has made it possible for many relic Mediterranean species to develop, which are evidence of the existence of a humid Quaternary. The required altitudinal levels for this scenario can only be found in the Hoggar and Tassili N'Ajjer massifs (Barry, 1991). These characteristics of a typical meso-climatic conditions, today found in both massifs, clearly suggest that a more mesic climate equally prevailed in the today arid zones which separates the two massifs, previously to the Quaternary climatic vicissitudes which took place in the area during the glaciation periods (Swezey, 2009; see also next section). It can therefore be suggested that the today isolated populations of *Buthus* in the two massifs, most certainly represented a single population over a much larger zone of distribution covering all the area including the massifs but also the zones in between. This type of picture clearly corresponds to a classical model of vicariance between the two today isolated populations (Fig. 23-24, 25-28).

Biogeographic considerations

As previously discussed by several authors (see Lourenço & Duhem, 2009), the present composition of the Saharan fauna is, in fact, the heritage of ancient faunas present in North Africa since the beginning or, at least, Middle Cenozoic times (Vachon, 1952). North African regions experienced numerous paleoclimatological vicissitudes during the last few million years, some even in more or less recent Quaternary periods. The Sahara, for example, has undergone a series of wet periods, the most recent occurring 10,000-5,000 years BP, and it was not until about 3,000 years BP that the Sahara assumed its present arid state (Cloudsley-Thompson, 1984). Even though recent studies suggest that the Sahara Desert may be much older than was previously thought (Schuster et al.,

2006), it seems reasonable to postulate that extremely arid areas have always existed as patchy desert enclaves, even when the general climate of North Africa enjoyed more mesic conditions.

In these arid and desert regions of North African Sahara, a specialized scorpion fauna would have evolved in response to the aridity. From 'ancient lineages' probably pre-adapted to arid conditions, more recent groups evolved such as genera *Androctonus* Ehrenberg, *Buthacus* Birula, *Buthiscus* Birula, *Leiurus* Ehrenberg and possibly even some particular species of *Buthus* (Sadine et al., 2016); some of these extant elements are in fact typically psammophilic. Most certainly several of these lineages were already present in North Africa for at least 10 to 15 MY (Gantenbein & Largiadèr, 2003; Lourenço & Vachon, 2004). In contrast, other lineages less well adapted to aridity and, previously, only present in more mesic environments, have regressed markedly in their distribution with the expansion of the desert. Consequently, some elements probably have, in some cases experienced negative selection and have even vanished since. In other cases, populations have been reduced to very limited and patchy zones of distribution, sometimes with important disjunctions in their patterns of distribution (Fig. 29).

The patterns in the distribution of North African scorpions observed today can be summarised as follows: a core Saharan region, which was described by Vachon (1952) as the 'central compartment', in which only the groups best adapted to xeric conditions are distributed. In the Peri-Saharian zone, surrounding most of the central compartment, some remarkable disjunctions occur. One of them is presented by the genus *Microbuthus* Kraepelin, with species in Mauritania and Morocco in the West and other species in Eritrea, Djibouti and Egypt in the East (Lourenço, 2002b; Lourenço & Duhem, 2007). Finally, as indicated by Vachon (1952), several groups (sometimes less well adapted to xeric environments) have their populations limited to refugia. These refugia are in particular represented by the Saharan massifs, such as Hoggar and Tassili N'Ajjer in Algeria, but also several other elevated regions in Mauritania, Niger, Chad and Libya. Some examples are provided by endemic genera, such as *Cicileus* Vachon, *Lissothus* Vachon, *Egyptobuthus* Lourenço and *Pseudolissothus* Lourenço (Vachon, 1952; Lourenço, 1999a,b, 2001). The new *Buthus* species described here, as well as *Buthus tassili*, probably correspond to this type of endemic and relictual pattern of distribution (Fig. 29).

The dating of the last events preceding the global isolation of the Hoggar and Tassili N'Ajjer populations can be somewhat difficult to be established. Nevertheless, according to Swezey (2009), the appearance of persistent and widespread eolian sediments in the Sahara is coincident with the onset of major glaciation in the northern hemisphere at approximately 2.5 million years ago, and then the Sahara has oscillated between arid and semi-arid/temperate conditions since then (with the semi-arid/temperate conditions occurring during interglacial maxima). The most recent semi-arid/temperate interval occurred approximately 11,000-5,000 years ago (Swezey, 2001; Bristow & Armitage, 2016). The onset of glaciation in the northern hemisphere certainly is a major climate perturbation for the planet, and it is always reasonable to explain the onset of aridification in the Sahara as being part of this major climate perturbation.

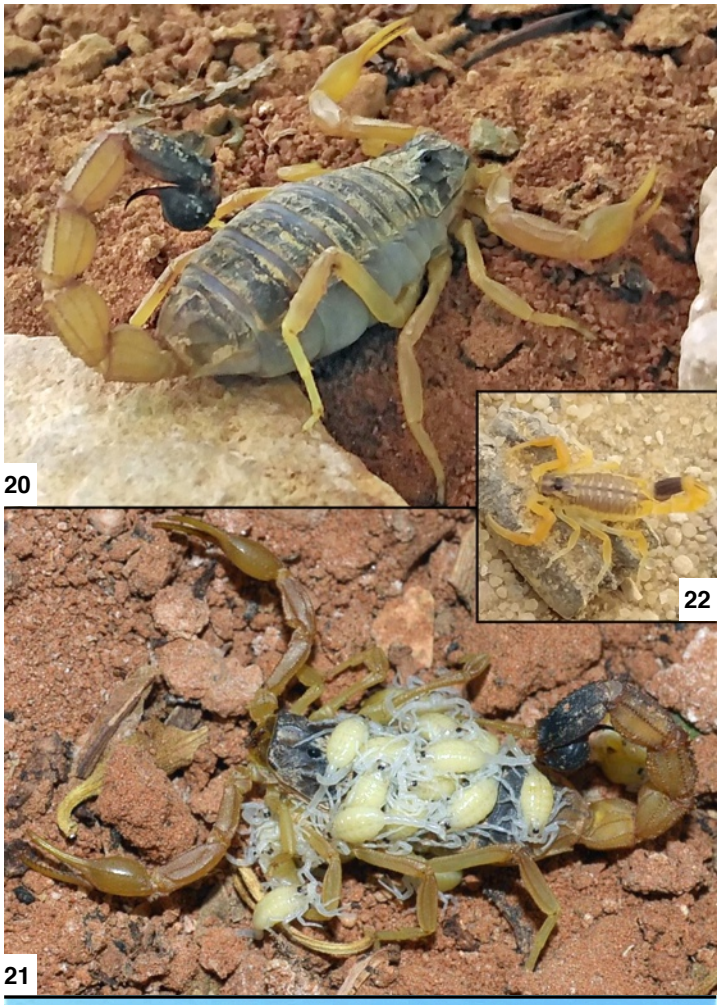

Fig. **20-22**. *Buthus ahaggar* **sp**. **n**. alive in its natural habitat.
20. ♀ paratype.
21. ♀ paratype giving birth to pre-juveniles (instar I).
22. Second instar juvenile.

Fig. **23-24**. Hoggar Massif, in the South of Algeria.

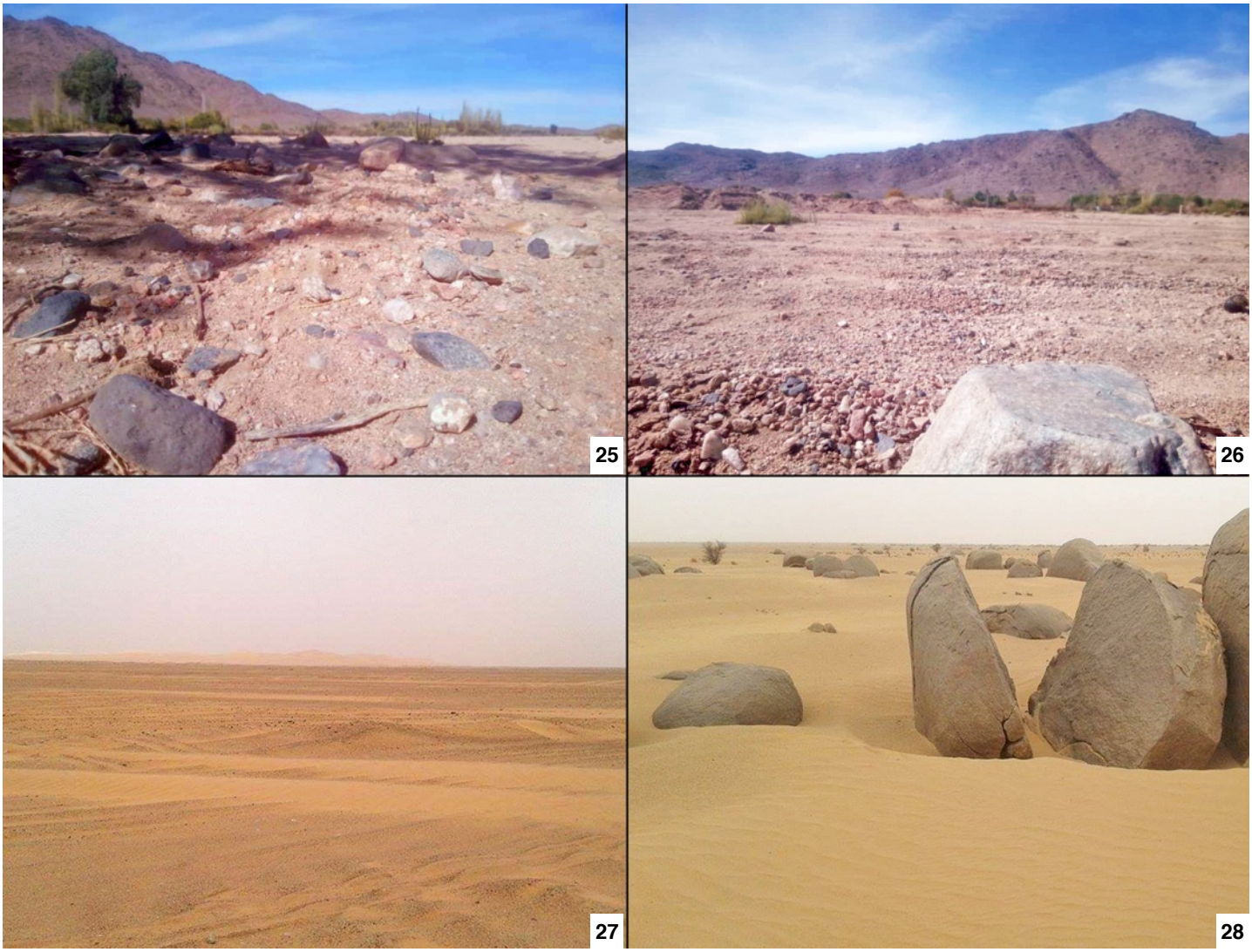

Fig. **25-26**. Natural habitat of *Buthus ahaggar* **sp**. **n**., in the Hoggar Massif. **25**. High altitude plateau with stony grounds. **26**. High altitude plateau with gravely grounds.

Fig. **27-28**. Low altitude arid plains separating the Hoggar and Tassili N'Ajjer Massifs. **27**. Reg with gravely grounds. **28**. Erg.

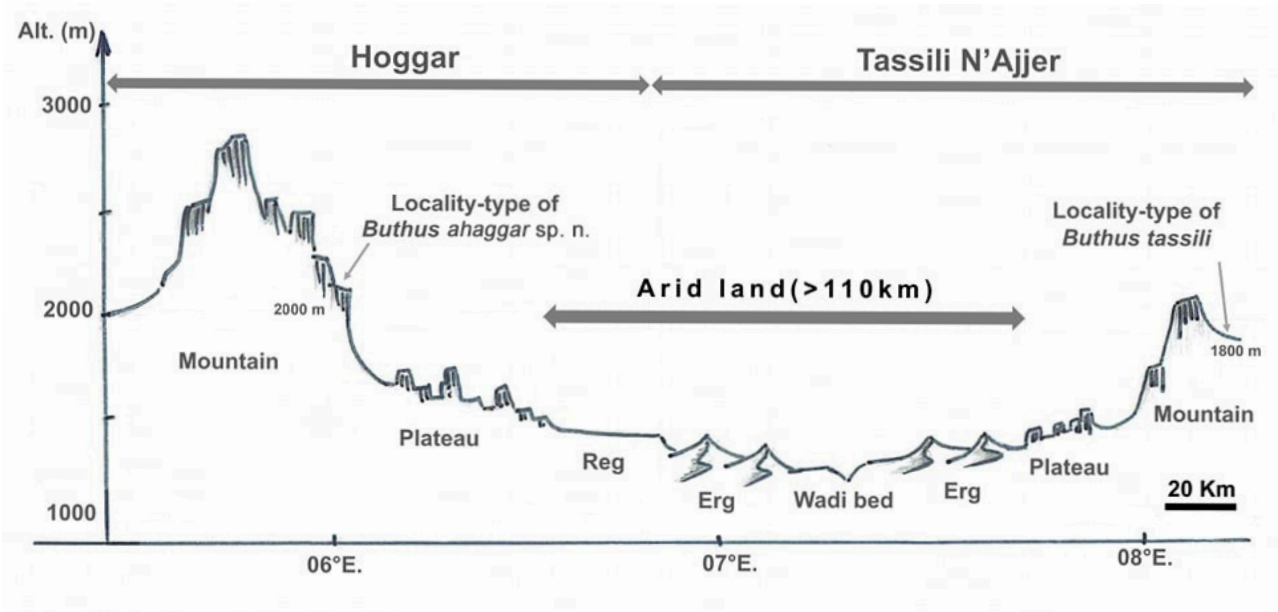

Fig. **29**. Schematic relief showing the ecological gradients between the Hoggar and Tassili N'Ajjer Massifs.

Table I. Morphometric values (mm) of the *Buthus* species treated in this study

	Buthus tassili ♂ holotype	***Buthus ahaggar* sp. n.** ♀ holotype
Total length (including telson)	59.0	59.9
Carapace:		
- Length	6.2	6.8
- Anterior width	4.4	5.3
- Posterior width	6.7	7.8
Mesosoma length	18.1	18.4
Metasomal segment I:		
- Length	4.6	4.4
- Width	4.2	4.5
Metasomal segment II:		
- Length	5.1	5.0
- Width	4.2	4.2
Metasomal segment III:		
- Length	5.3	5.4
- Width	4.1	4.1
Metasomal segment IV:		
- Length	6.3	5.8
- Width	3.8	4.0
Metasomal segment V:		
- Length	7.2	7.3
- Width	3.4	3.8
- Depth	2.7	3.3
Telson:		
- Length	6.2	6.8
- Width	2.9	3.5
- Depth	2.6	3.1
Femur:		
- Length	5.3	5.6
- Width	1.5	1.8
Patella:		
- Length	6.0	6.2
- Width	2.1	2.7
Chela:		
- Length	9.8	10.9
- Width	1.9	3.0
- Depth	2.2	3.0
Movable finger length	6.0	6.7

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Résumé

Ythier E., Sadine S. E., Haddadi M. H. & Lourenço W. R., 2021. – Un nouveau *Buthus* Leach, 1815 d'Algérie (Scorpiones: Buthidae) et un nouveau cas intéressant de vicariance. *Faunitaxys*, 9(21): 1 – 9.

Une nouvelle espèce appartenant au genre *Buthus* est décrite du Massif du Hoggar, dans le sud de l'Algérie. Cette nouvelle espèce représente très probablement un vicariant géographique de *Buthus tassili* Lourenço, espèce également décrite d'un massif du sud de l'Algérie, le Tassili N'Ajjer. Les deux espèces sont présentes à haute altitude dans ces massifs. Les études réalisées jusqu'à présent sur les *Buthus* d'Algérie, en comparaison des autres études réalisées sur ce même genre dans d'autres régions d'Afrique, présentent l'avantage majeur qu'elles sont effectuées de façon plus précise et comprennent une meilleure définition des populations. Ce nouveau taxon représente la 10e espèce de *Buthus* décrite pour l'Algérie.

Mots clés. – Scorpion, *Buthus*, *ahaggar*, *tassili*, taxonomie, nouvelle espèce, description, morphologie, vicariants, Algérie, Massifs du Sud, Hoggar.

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