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The remarkable peri-Saharan distribution of the genus *Butheoloides* Hirst (Scorpiones, Buthidae), with the description of a new species from Cameroon



Wilson R. Lourenço

Muséum national d'histoire naturelle, département systématique et évolution, UMR 7205, CP 053, 57, rue Cuvier, 75005 Paris, France

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ABSTRACT

A new species belonging to the genus *Butheoloides* Hirst, 1925 (subgenus *Butheoloides* Hirst, 1925) (Scorpiones, Buthidae) is described from northern Cameroon, a region of transition between savannahs and the Sahel. With the description of *Butheoloides* (*Butheoloides*) *savanicola* sp. n., the peri-Saharan pattern of distribution presented by the species of this genus is confirmed.

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R É S U M É

Une nouvelle espèce appartenant au genre *Butheoloides* Hirst, 1825 (sous-genre *Butheoloides* Hirst, 1925) (Scorpiones, Buthidae) est décrite du Nord du Cameroun, une région de transition entre des formations savanicoles et le Sahel. Avec la description de *Butheoloides* (*Butheoloides*) *savanicola* sp. n., un modèle de répartition péri-saharienne est confirmé pour les espèces du genre *Butheoloides*.

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1. Introduction

The genus *Butheoloides* was proposed by Hirst [1] for the species *Butheoloides maroccanus*, distributed in the Atlas Mountains of the region of Amizmiz in the south of Marrakech (Morocco). The genus remained monospecific until the description of *Butheoloides milloti* by Vachon [2] from the hills of Bandiagara in the south of Timbuktu (Mali). Subsequently, Vachon [3] described another new species, *Butheoloides monodi*, from Fissel, in the western Senegal.

More recently, several new species have been described: *Butheoloides* (*B.*) *anniae* Lourenço from the Lamto ecological station in Ivory Coast, *Butheoloides* (*B.*)

wilsoni Lourenço from Ouessa in Burkina Faso, *Butheoloides* (*B.*) *polisi* Lourenço from the Omo Valley in Ethiopia, *Butheoloides* (*B.*) *hirsti* Lourenço from Mvolo in Sudan, *Butheoloides* (*B.*) *charlotteae* Lourenço from Pandam, Plateau State in Nigeria, *Butheoloides* (*B.*) *schwendingeri* Lourenço from Sidi Moussa Oued in Algeria, *Butheoloides* (*B.*) *cimrmani* Kovařík from Sogakofe, Ghana and *Butheoloides* (*B.*) *granulatus* Lourenço, Duhem & Cloudsley-Thompson from the Ennedi mountains in Chad [4–8]. New surveys in Morocco, the country where the genus was originally discovered, have also revealed several new species: *Butheoloides* (*G.*) *aymerichi* Lourenço from the region of Tinerhir, which was placed in the new subgenus *Gigantoloides* [7], *Butheoloides* (*B.*) *occidentalis* Lourenço, Slimani and Berahou from the region of Tan-Tan, near the southern coastal region, *Butheoloides* (*B.*) *slimani* Lourenço

E-mail addresses: arachne@mnhn.fr, wlmicrocharmum@free.fr.



Fig. 1. View of Garoua-Ngong region, showing the typical Savannah/Sahel vegetation. Also visible are some agricultural fields (photo by P. Prudent). Colour online.

in the Atlas mountains from Tanannt to Azilal, and *Butheoloides* (*B.*) *littoralis* Lourenço, Touloun and Boumezough from Lagzira Beach, also in the coastal region [7,9].

Here an additional new species is described from northern Cameroon, a region of transition between savannahs and the Sahel (Fig. 1). Nevertheless, the number of known species in genus *Butheoloides* remains moderate, being raised to 16. Most species appear to be rare, with the possible exception of *B. (B.) annieae* from the Ivory Coast [10].

2. Methods

Illustrations and measurements were produced with the aid of a Wild M5 stereomicroscope equipped with a drawing tube (camera lucida) and an ocular micrometer. Measurements follow Stahnke [11] and are given in mm. Trichobothrial notations follow Vachon [12] and morphological terminology generally follows Vachon [13] and Hjelle [14].

3. Biogeographical pattern of distribution presented by North African scorpions and the particular case of the genus *Butheoloides*

In a symposium of the Society of Biogeography dealing with the origins and distribution of the fauna of North Africa, Furon [15] suggested that the flora and fauna now present in the Sahara may well be very old. Their present patterns of distribution reflect not only the consequences of palaeogeographic factors, but also in large part the results of past palaeoclimates. Palaeoclimatic events had an important impact during the Quaternary, when Europe (and North America) underwent periods of glaciation. During these episodes, Africa experienced periods of

intense rain and, additionally, an increase in the amount of snow cover on the mountains (particularly in Eastern Africa). The last wet period in the Sahara was very recent, only some 3000 years BP.

The present composition of the Saharan fauna is the heritage of ancient faunas present in North Africa since the beginning of or, no later than, middle Cenozoic times [13]. North Africa has experienced numerous palaeoclimatological vicissitudes in the last few million years, some even in more or less recent quaternary periods. The Sahara has undergone a series of wet periods, the most recent occurring 10,000–5000 years BP, and it was not until about 3000 years BP that the Sahara assumed its present arid state [16–18]. Even though recent studies suggest that the Saharan desert may be much older than was previously thought [19], 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 desert regions, a specialized scorpion fauna would have evolved. In contrast, other lineages, less well adapted to drought and previously present only in mesic environments, have regressed markedly in their distribution. They have therefore experienced negative selection and could be on the road to extinction, unless rescued by climatic change. In other cases, populations have been reduced to very limited and patchy zones sometimes with remarkably disjunct distribution patterns.

These “ancient lineages” adapted to arid conditions most certainly have phylogenetic associations with extant groups such as the genera *Androctonus* Ehrenberg, *Buthacus* Birula, *Buthiscus* Birula, *Buthus* Leach, and *Leiurus* Ehrenberg, some of which are typically psammophilic. It is important to emphasise the fact that these lineages have

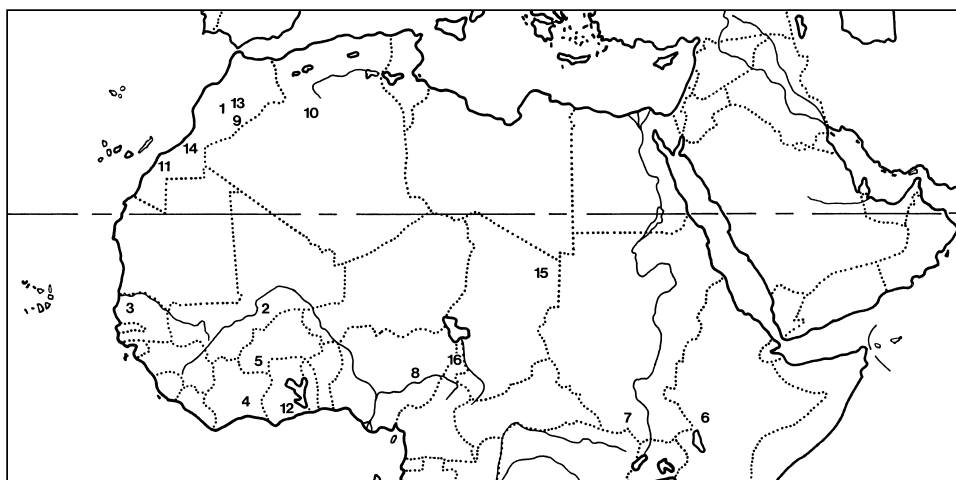


Fig. 2. Map of North Africa, showing the type localities of the known *Butheoloides* species: *B. maroccanus* (1), *B. milloti* (2), *B. monodi* (3), *B. annieae* (4), *B. wilsoni* (5), *B. polisi* (6), *B. hirsti* (7), *B. charlotteae* (8), *B. aymerichi* (9), *B. schwendingeri* (10), *B. occidentalis* (11), *B. cimmani* (12), *B. slimani* (13), *B. littoralis* (14), *B. granulatus* (15), *B. savanicola* sp. n. (16).

no doubt been present in North Africa for at least 10–15 MY years [20,21]. In contrast, other lineages less well adapted to aridity and previously only present in more mesic environments, have regressed markedly in their distribution as a consequence of the expansion of the desert.

The patterns observed today in the distribution of North African scorpions can be divided into the two categories. The first consists of the core Saharan region, which was defined by Vachon [13] as the “central compartment”, in which only the groups best adapted to xeric conditions exist, such as the genera *Androctonus*, *Buthacus*, *Buthiscus*, *Buthus*, and *Leiurus*. The second is a peri-Saharan zone of distribution almost forming a ring around the most arid core region of the Sahara. In this zone, a few groups can be observed, of which *Butheoloides* is the best example. Its distribution follows a circle from the North of Algeria, through the Atlas mountains of Morocco, South via Senegal, and then East through Mali, the Ivory Coast, Nigeria, Sudan and Ethiopia [7,9]. Only one of its species, *B. (B.) granulatus* from the Ennedi mountains in Chad, seems to ‘escape’ from this circle (Fig. 2). In fact the latter mountains are located inside the “central compartment”, but local environmental conditions are totally mesic and hence act as a refuge area for quite a number of species [8].

Vachon [13,22] drew attention to these extremely localized patterns of species distribution and defined peri-Saharan zone as a “disrupted and limited territory”. He attempted to explain the observed patterns and made reference to Braestrup [23], who had suggested a mechanism for exchanges through the Sahara desert. According to this model, southern (Ethiopian) elements were able to reach the northern regions, and northern (Palaeartic) elements were able to disperse to the southern regions of the Sahara. This hypothesis is valid for dynamic elements with a marked capacity for dispersion. Scorpion populations are, in many cases, predictable and stable, showing a weak capacity of re-adaptation to new environments. The present pattern of distribution of several groups of scorpions and, in

particular, those presenting important disjunctions reflect rather large ranges of distribution in the past. The strong palaeoclimatic vicissitudes experienced by the Sahara have constituted an important selective factor for its scorpion populations. The reaction of these to abiotic factors was certainly varied, depending on their own ecological strategies [24,25]. In some cases, the populations showed significant regressions in their distributions, and some populations may well have totally vanished. These regressions led to marked disruptions in their geographic distributions and resulted in their present patchy distribution. As suggested by Vachon [13], several groups, less well adapted to xeric environments, now have their populations limited to refugia. These can be represented by certain oases and, especially, the Saharan massifs. Endemic genera, such as *Cicileus* Vachon, *Lissothus* Vachon, *Egyptobuthus* Lourenço, and *Pseudolissothus* Lourenço, provide useful examples [13,26–28]. In contrast, the



Fig. 3. *Butheoloides savanicola* sp. n., female holotype. A–B. Habitus, dorsal and ventral aspects. Colour online.

presence in mesic environments of species belonging to groups derived from “ancient lineages”, well adapted to arid conditions, may suggest a secondary re-adaptation. This could explain the presence of endemic species of *Androctonus*, *Buthacus*, *Buthus*, *Compsobuthus*, *Hottentotta*, *Orthochirus* and *Scorpio* Linnaeus in the Saharan massifs [8].

4. Taxonomic treatment

Family BUTHIDAE C.L. Koch, 1837.

Genus *Butheoloides* Hirst, 1925.

Subgenus *Butheoloides* Hirst, 1925.

Butheoloides (Butheoloides) savanicola sp. n. (Figs. 3 and 4).

Type Material: Holotype (female). Cameroon, Garoua, Ngong (8°57'33.2"N–13°19'25.8"W), September/October/2012 (P. Prudent leg.). Cotton field, collected with Barber traps. No other material available.

Etymology: The specific name refers to the habitat in which the species was collected.

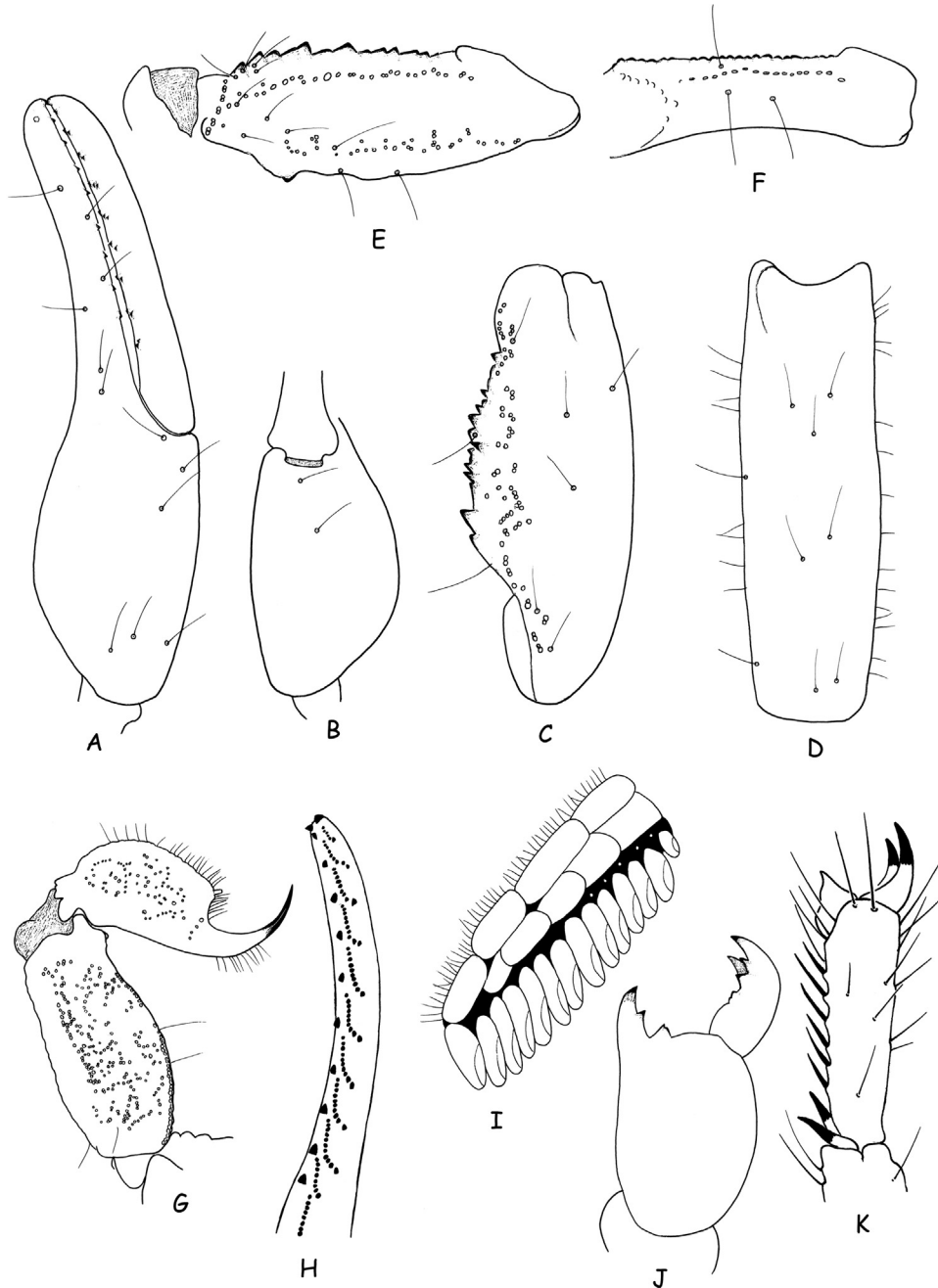


Fig. 4. *Butheoloides savanicola* sp. n., female holotype. A–F. Trichobothrial pattern. A–B. Chela, dorso-external and ventral aspects. C–D. Patella, dorsal and external aspects. E–F. Femur, dorsal and external aspects. G. Metasomal segment V and telson, lateral aspect. H. Movable finger of pedipalp chela with rows of granules. I. Pecten showing reduced proximal tooth. J. Chelicera, dorsal aspect. K. Tarsus of leg IV with typical setation.

Diagnosis: Scorpions of small size relative to other species of the genus; female holotype 17.6 mm in total length. Coloration globally brownish-yellow to dark brown, with brownish pigmentation on chela hands; chelicerae slightly infuscated; femur and patella of pedipalps with the internal and external aspects infuscated. Carapace strongly emarginated. Dorsal carinae of metasomal segments moderately to strongly marked; telson with some spinoid granulation on ventral and lateral aspects; aculeus strongly curved and shorter than vesicle; subaculear tooth strongly marked, with a conical shape. Pectinal tooth count 15–14; most proximal tooth strongly reduced; only minute fulcra present. Fixed and movable fingers of pedipalp with 9–10 rows of granules; internal accessory granules present, conspicuous; distal extremity of movable finger with three teeth. Trichobothrial pattern A- α (alpha), orthobothriotaxy.

Relationships: The new species shows affinities with both *Butheoloides* (*B.*) *anniae* Lourenço and *Butheoloides* (*B.*) *charlotteae* Lourenço, described respectively from the Ivory Coast and Nigeria. It can, however, be distinguished from them by a combination of distinct characters: (i) a darker pigmentation of carapace and tergites, with absence of a yellow longitudinal strip, chelicerae infuscated; (ii) telson with granulation on lateral margin and a strongly curved aculeus, setation strongly marked; (iii) metasomal segments strongly granulated; (iv) pectines with minute fulcra and 15–14 teeth, the most proximal tooth reduced.

Description: Based on female holotype. Coloration. Basically brownish-yellow to dark brown. Prosoma: carapace dark brown with posterior furrow yellowish; median and lateral eyes surrounded by black pigment. Mesosoma dark brown with some confluent yellow spots. Metasomal segments I to III yellow; segments IV–V dark brown; telson yellow with aculeus reddish. Venter yellow; pectines and genital operculum light yellow. Chelicerae yellow with diffused infuscation; fingers yellow, with reddish–yellow teeth. Femur and patella of pedipalps with the internal and external faces slightly infuscated; chela hands brownish; rows of granules on fingers reddish; legs pale yellow with some minute infuscation. Morphology. Carapace weakly granular, almost smooth and punctate; anterior margin strongly emarginated. Carinae and furrows vestigial or absent. Median ocular tubercle anterior to centre of carapace; median eyes separated by a little more than one ocular diameter. Three pairs of lateral eyes. Sternum pentagonal, wider than long. Mesosoma: tergites weakly granulated and punctate; median carina moderately marked on all tergites; tergite VII pentacarinata, with carinae weakly marked. Venter: genital operculum divided longitudinally and formed by two semi-oval plates. Pectinal tooth count 15–14; the proximal most tooth reduced; minute fulcra present. Sternites smooth with small, slit-like spiracles; VII smooth, without carinae. Metasomal segments I to V rounded; dorsal and dorso-lateral carinae present only on segments I–III; all segments strongly granulated; granulation better marked on IV–V. Telson moderately to strongly granular, with spinoid granules on ventral and lateral surfaces; aculeus shorter than vesicle, strongly curved; setation strongly marked; subaculear tooth conical and strongly marked. Cheliceral

dentition characteristic of the family Buthidae [29]; movable fingers with two basal teeth, small and partially fused; ventral aspect of finger and manus with setae. Pedipalps. Femur pentacarinata; patella with dorsal and dorso-internal carinae moderately marked; internal face with 5–6 spinoid granules; chela without carinae, smooth; all faces weakly granular to smooth. Fixed and movable fingers with 9–10 oblique rows of granules, plus accessory granules; three granules on extremity of movable finger. Trichobothriotaxy A- α (alpha) orthobothriotaxy [12,30]. Legs: tarsi with setae ventrally. Tibial and pedal spurs present on legs III–IV, moderately marked.

Morphometric values (in mm) of female holotype. Total length (including telson) 17.6. Carapace: length 1.9; anterior width 0.7; posterior width 1.8. Mesosoma length 6.2. Metasomal segment I length 1.2, width 1.2; II length 1.4, width 1.1; III length 1.5, width 1.1; IV length 1.6, width 1.0; V length 2.0, width 1.0, depth 0.9. Telson length 1.8. Vesicle width 0.8, depth 0.7. Pedipalp: femur length 1.5, width 0.5; patella length 2.0, width 0.7; chela length 3.1, width 0.7, depth 0.6; movable finger length 2.1.

Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

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