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Review of the distribution of *Androctonus amoreuxi* (Audouin, 1825) (Scorpiones: Buthidae) in Morocco

Mohamed Mousaid¹ & Victoria Tang^{2*}

¹ Department of Biology, Faculty of Sciences and Technics, Fez, Morocco;
e-mail: mousaid.mohamed2023@gmail.com

² Zhangyang Rd. 200120, Pudong New District, Shanghai, China;
e-mail: jibril.flueqel@gmail.com

* Corresponding author

Abstract

This is a brief synoptic review of *Androctonus amoreuxi* (Audouin, 1825) in Morocco. A summary of its morphological description is provided. Five new localities of this species in Morocco from Errachidia (1 station) and Tinghir (4 stations) provinces are reported, substantiated by photos of live specimens observed therein. Based on previous ecological study of this species, with its observation records on iNaturalist and geographical references from satellite images, we suggest that *A. amoreuxi* may spread more widely in the extreme southern Morocco, a Saharan area with vast arid regions of suitable ecological conditions for its dispersal, into the north of Mauritania. An updated distribution map of this species in Morocco is provided as per these new records and previous studies. Finally, after comparing its morphology with its congeners, we urge a more systematic review of this species giving the ambiguity of its true identity and the likelihood of being a species-complex comprising three cryptic lineages.

Keywords: scorpion, *Androctonus amoreuxi*, distribution, Morocco.

Introduction

Androctonus amoreuxi (Audouin, 1825), Amoreux's man-killer scorpion, is one of the most distinctive, large-sized and yellow-coloured species within the genus *Androctonus* Ehrenberg, 1828, where a majority of congeners are typically dark in colour (dark brown to black). This species is particularly characterized by its elongated and

slender metasoma that distinguishes it from most congeners, giving rise to its common name, “the North African long-tailed scorpion”. Ecologically, it is colloquially considered as a desert scorpion, giving that its presence is primarily associated with sandy substrates (Touloun *et al.*, 2014b: 18). However, subsequent studies revealed that this species also dwells upon loam to sand-clay loam without specific tendency, suggesting a high ecological adaptation ability (e.g., El Hidan *et al.*, 2017: fig. 3). In any case, *A. amoreuxi* shows its preference towards the Saharan bioclimatic floor with an altitude ranging from 400 to 800 m a.s.l. (El Hidan *et al.*, 2017: table 2; total range 0-1600 m a.s.l., as per El Hidan *et al.*, 2017: table 1). This large arachnid is a powerful nocturnal predator with the capacity of preying upon small reptiles. A notable instance of its predatory prowess is manifested in a predation event involving a juvenile *Acanthodactylus* lizard in western Algeria (Sadine & El Bouhissi, 2021).

A. amoreuxi was originally described as *Scorpio amoreuxii* (an obsolete spelling for its specific epithet) from Egypt based on a female holotype which is probably lost (Fet & Lowe, 2000: 65); subsequent studies confirmed its wider distribution beyond Egypt (see below for discussions). Within Morocco, former studies showed that this species was predominantly found in Tafilalet region in the north, along the Anti-Atlas mountain ranges, to the Draa Valley in the southeast (Touloun *et al.*, 2014b: 18), and also occurring in other regions. As illustrated by Kamel *et al.* (2022: fig. 1; however most data of this species were disputable), *A. amoreuxi* has been previously recorded from Alnif (Tinghir Province) and Aoufous (Errachidia Province). In this study, we further present five new localities of this species from these two provinces as a formal confirmation, with an updated map of the species’ distribution within Morocco and comments on its distribution unlimited to the country. Finally, we discuss the taxonomic status of this species in association with other congeners.

Material and Methods

Material. The five specimens collected by the first author of this study were all from Tinghir Province (1♂ from Achdad, 1♀ and 1♂ from Taghzoute N’Ait Atta, and 1♀ from Tarya), with the exception of one female collected from Ksar Lbour in Errachidia Province. The specimens were preserved in 96% ethanol and examined microscopically by the first author in the Functional Ecology and Environmental Engineering Laboratory at the Faculty of Science and Technics in Fez, Morocco. The fifth new locality was from another area of Tinghir Province, Ait Zeggane (near Alnif town). More than 10 live specimens have been observed so far from that region by Mr. Abdesslam Souiri, who provided us with the coordinates of the station (Table 1) and photos of some of the specimens he took (Fig. 12; not examined).

Methods. Records of *A. amoreuxi* in Morocco were based on the personal observations of the first author, observations by other people (supported by photos and coordinates), and previous documentations in papers (see below for comments). Particularly, several records on the website iNaturalist that did not fall within the formally reported distribution area of this species were adopted (Table 2). SimpleMapp (Shorthouse, 2010) was used for illustrating exact known records of this species in Morocco by the second author (Fig. 1). Google Earth (satellite images) and ArcGIS were used to construct a map of potential spatial coverage (by tracking the desert area) of this species by the first author (Fig. 2). The potential distribution area illustrated in this study only represents a crude measure as it does not take into account the precise climatic and geographic information. A more accurate approach can be applying the Maximum Entropy method.

Abbreviations. DSC = pedipalp chela denticle subrow count, PTC = pectinal tooth count.
Specimens Depository. MM = personal collection of Mohamed Mousaid, Fez, Morocco.

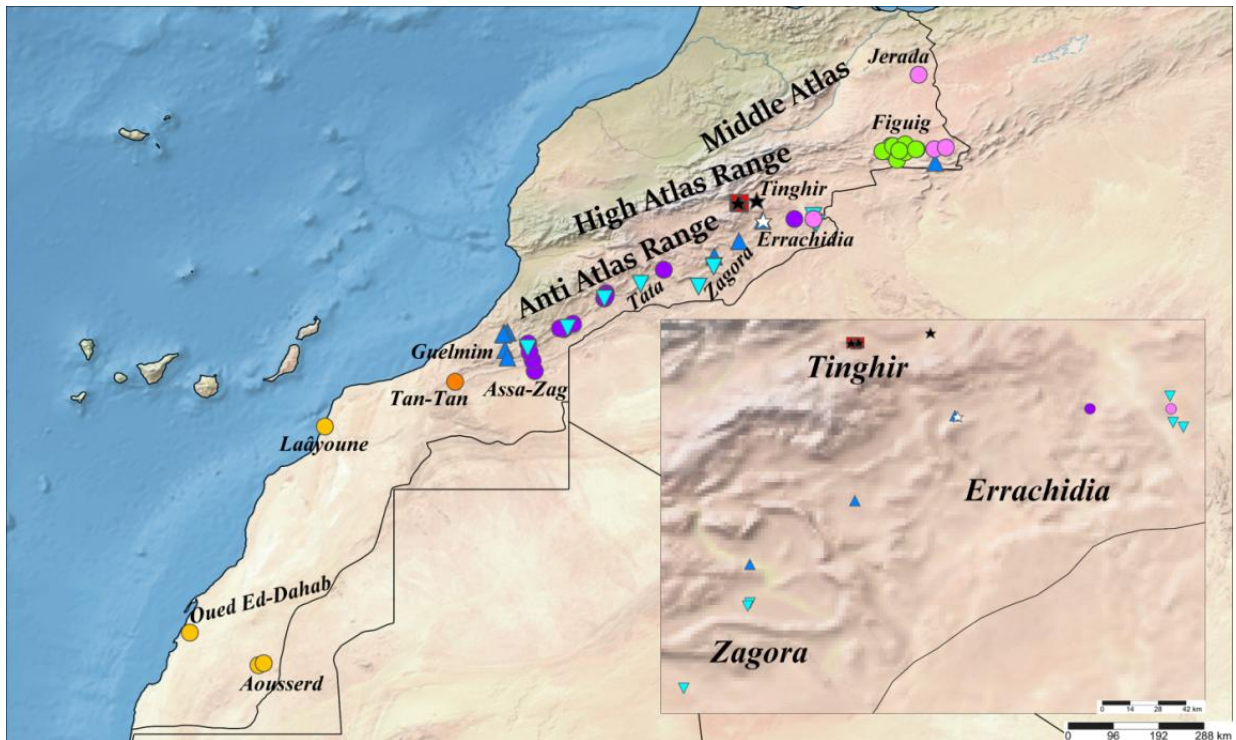


Fig. 1. Map showing part of the known records (not exhaustive) of *Androctonus amoreuxi* (Audouin, 1825) in Morocco with provinces labeled. ★: records of examined specimens in this study by the first author; ☆: record of specimens by Mr. Abdesslam Souiri; ■: records of unexamined specimens in this study by the first author (Figs. 3-7, 13-18); ▲: records of selected iNaturalist observations in this study (Table 2); ▼: records of unselected iNaturalist observations in this study; ●: records in Moroccan Sahara based on the provided coordinates in Touloun *et al.* (2014b: 18; 2016: table 1); ●: records of sympatric *A. amoreuxi* with *Buthacus stockmanni* in Kovařík *et al.* (2016: 6), one record is covered by a record of AM1 clade in Assa-Zag; ●: records taken from Ythier & François (2023: 2); ●: records of AM1 clade identified by Coelho *et al.* (2014: table 1); ●: records of AM2 clade identified by Coelho *et al.* (2014: table 1).

Systematics

Family **Buthidae** C.L. Koch, 1837
 Genus *Androctonus* Ehrenberg, 1828
Androctonus amoreuxi (Audouin, 1825)
 (Figs. 3-18; Tables 1-2)

[<http://zoobank.org/?lsid=urn:lsid:zoobank.org:act:479A74AF-465C-45D0-B5C6-BBE1C4E44960>]

Table 1. Records of observations of *Androctonus amoreuxi* (Audouin, 1825) by the first author and Mr. Abdesslam Souiri who observed specimens that were not examined.

Locality	Latitude	Longitude	Observer	Date
Ksar Lbour (Errachidia Province)	31°29'29.7132"N (31.4915870)	5°06'12.5568"W (-5.1034884)	Mousaid Mohamed	3 rd VII 2023
Achdad (Tinghir Province)	31°26'36.6792"N (31.4435216)	5°26'08.7972"W (-5.4357772)	Mousaid Mohamed	20 th VIII 2023
Ait Zeggane (Tinghir Province)	31°06'21.2"N (31.105878)	4°58'53.0"W (-4.981380)	Souiri Abdesslam	24 th VIII 2021
Taghzoute N'Ait Atta (Tinghir Province)	31°26'49.884"N (31.4471895)	5°25'36.12"W (-5.4267003)	Mousaid Mohamed	4 th VII 2022
Tarya (Tinghir Province)	31°26'39.2028"N (31.4442233)	5°27'35.5428"W (-5.4598735)	Mousaid Mohamed	19 th VII 2023

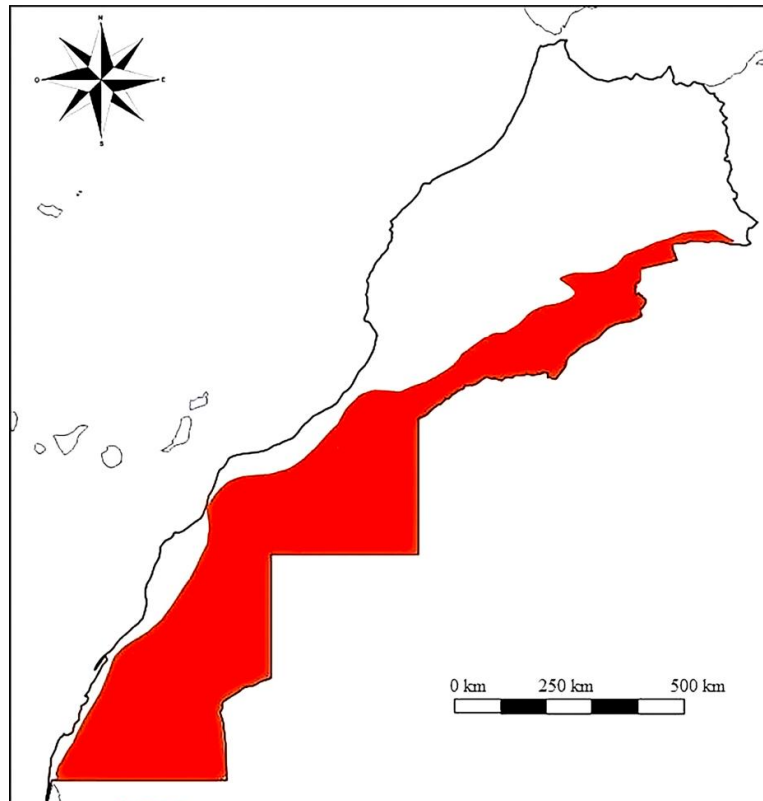


Fig. 2. Map showing the potential distribution area of *Androctonus amoreuxi* (Audouin, 1825) in Morocco.

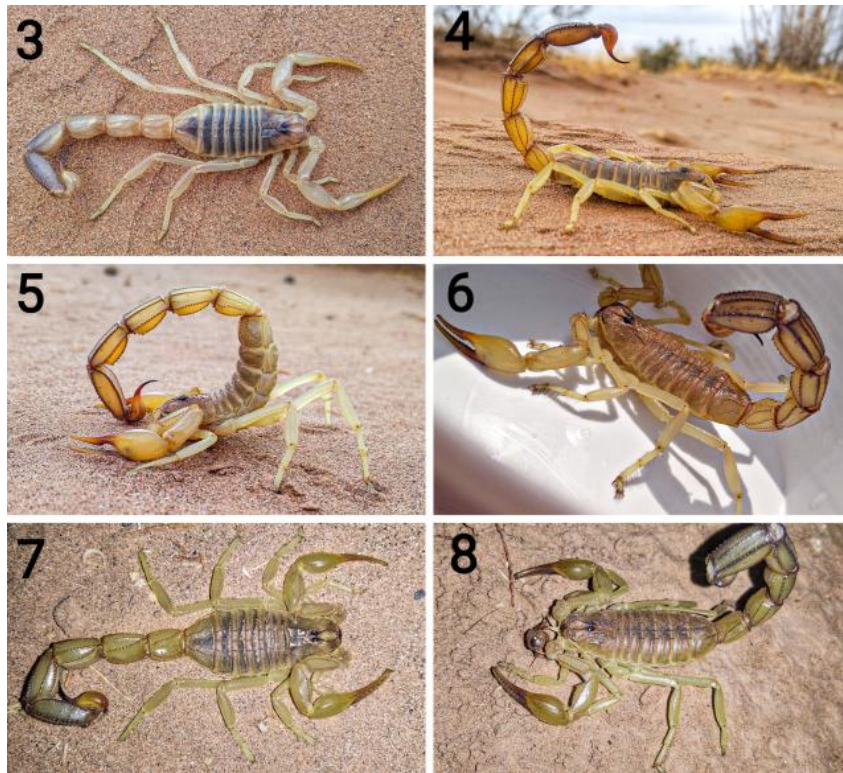
Material Examined (MM). Morocco, *Errachidia Province*, Ksar Lbour, 31°29'29.7132"N, 5°06'12.5568"W (31.4915870°N, -5.1034884°W), 3rd July 2023, 1♀, leg. M. Mousaid; *Tinghir Province*, Douar Achtat (Achdad), 31°26'36.6792"N, 5°26'08.7972"W (31.4435216°N, -5.4357772°W), 20th August 2023, 1♂, leg. M. Mohamed; *Tinghir Province*, Taghzoute N'Ait Atta, 31°26'49.884"N, 5°25'36.12"W (31.4471895°N, -5.4267003°W), 14th July 2022, 1♂ 1♀, leg. M. Mousaid; *Tinghir Province*, Tarya Village, 31°26'39.2028"N, 5°27'35.5428"W (31.4442233°N, -5.4598735°W), 19th July 2023, 1♀, leg. M. Mousaid.

Table 2. Records of adopted observations of *Androctonus amoreuxi* (Audouin, 1825) by the observers on iNaturalist. The iNaturalist ID is the observation ID at the end of the address: <https://www.inaturalist.org/observations/>.

Locality	Latitude	Longitude	Observer	Date	iNaturalist ID
Jboub Zoulai (Figuig Province)	32°13'00.4"N (32.216781)	1°42'22.1"W (-1.706149)	Olivier Fortune	23rd V 1996	144446234
Aouinet Lahna (Guelmim Province)	28°30'15.6"N (28.504336)	9°51'19.4"W (-9.855376)	Laurent Barthe	28th V 2017	147320646
El Borj (Guelmim Province)	28°38'56.5"N (28.649023)	9°53'53.1"W (-9.898089)	Julien Rouard	16th XI 2022	142465487
Fask (Guelmim Province)	28°59'00.4"N (28.983451)	9°50'54.1"W (-9.848369)	Vojtěch Víta	29th IV 2017	145416888
Fask (Guelmim Province)	28°59'15.8"N (28.987722)	9°51'17.5"W (-9.854862)	Justin Philbois	8th VI 2023	168177373
Tightmert (Guelmim Province)	28°56'31.9"N (28.942197)	9°56'17.3"W (-9.938126)	Jandetka	13th IX 2018	64538051
Tightmert (Guelmim Province)	28°49'58.6"N (28.972030)	9°55'29.2"W (-9.909766)	Julien Rouard	XI 2022	142481082
Ait Zeggane (Tinghir Province)	31°06'40.3"N (31.111192)	4°59'35.5"W (-4.993183)	Al Zawahifmag	22nd VII 2019	87203450
Ait Oulhyane (Zagora Province)	30°43'11.0"N (30.719722)	5°26'36.8"W (-5.443553)	Alex Frood	4th VII 2022	124866298
Tafraoute (Zagora Province)	30°25'37.5"N (30.42709)	5°54'56.2"W (-5.915602)	Bouazza Abdellah	8th IV 2019	109212317

Description. *A. amoreuxi* is a large species that can reach 110 mm in total length (Lourenço, 2005: 157). It is particularly polymorphic in terms of its colouration. Typically, a general pattern is followed by all observed individuals: basic colouration yellowish (mesosoma somewhat darker due to the underlying viscera), with fingers of pedipalp chela reddish yellow to reddish brown and metasomal carinae somewhat darkened at least on segment V. However, the colouration may differ intraspecifically in several specific areas: (1) overall colouration vary from light yellow to brownish yellow (rarely; cf. iNaturalist: obs. ID = 145498618), with juveniles often being greyish yellow to greyish brown; (2) metasoma may be progressively infusate, and particularly darkened on the lateral and ventral surfaces of metasoma V; (3) pedipalp chelae may be darkened; (4) pedipalp patella and femur, as well as those of the legs may be somewhat infusate (mainly in juveniles); (5) the two triangular granular areas located interior to the lateral ocelli at the anterior margin of carapace may be darkened; (6) vesicle of telson may vary from light yellow to dark brown (cf. Touloun *et al.*, 2014b: fig. 1A). The overall profile of its body is rather slender, with elongated legs comprising highly hirsute tarsi (especially the basitarsi) and pedal spur specialized for locomotion on loose sands. Carapace and tergites are finely granulated, with tergites I-VI bearing three longitudinal carinae and VII being pentacarinata. Carinae on pedipalps and metasoma segments are formed by small, rounded, discrete granules without prominent spinoid granules. The ventrolateral carinae of metasoma V are replaced by sharper denticles, increasing in size posteriorly. Telson consists of a moderate-sized vesicle and a relatively long aculeus. Sexual dimorphism in adults (besides PTC) is represented as males being more slender (especially the mesosoma), with a more prominent notch at the base of the fixed finger of

the pedipalp, forming a conspicuous gap when closed. Despite the fact that there have been many specimens identified as *A. amoreuxi*, a critical redescription based on its topotypes is urged to clarify the strict diagnostic characters of this species (see below). Our report here is only based on the current consensus regarding this species.



Figs. 3-8. Live specimens of *Androctonus amoreuxi* (Audouin, 1825) observed in the wildness of Morocco by the first author, uploaded on iNaturalist (coordinates and observation IDs in parentheses). 3-7. from Tinghir Province. 3. A juvenile from Tarya Village (31°26'53.2"N, 5°27'22.6"W; 133072909). 4-7. from Taghzoute N'Ait Atta. 4. An adult female (31°26'47.5"N, 5°25'36.6"W; 185356622). 5. An adult male (31°26'47.3"N, 5°25'38.7"W; 133063626). 6. An adult male (31°26'47.6"N, 5°25'38.6"W; 126466576). 7. An adult female (31°26'48.8"N, 5°25'36.5"W; 185315589). 8. An adult female, examined in this study, from Ksar Lbour, Errachidia Province (31°29'29.7132"N, 5°6'12.5568"W; 186260987).

Ecology. The observed specimens from Tinghir province are all from an area characterized by a predominantly sandy substrate with a dominance of the *Tamarix* sp. and *Phoenix dactylifera* L., 1753 formation. Unlike other species that share the same region, such as *Hottentotta gentili* (Pallary, 1924) and *Androctonus liouvillei* (Pallary, 1924) which mainly colonize palm oases (personal observation of the first author), *A. amoreuxi* is more adapted to anthropic environments. This species is also sympatric with a variety of its congeners across its distribution area, including *A. liouvillei* in the east, to *A. bourdoni* Vachon, 1948 in the southwest, and to *A. gonneti* Vachon, 1948 in the extreme southwest Saharan region. In their study of the ecology of *Buthacus stockmanni* Kovařík, Lowe & Šťáhlavský, 2016, the authors point out that this species shares its habitat with a variety of other scorpions in its type locality (north of Zag, Assa-Zag Province), including *A. amoreuxi*. In addition, *A. amoreuxi* was commonly found in a sandy flat area with scarce rocks and sparse shrubs, north of Msied, in Tan-Tan Province (Kovařík *et al.*, 2016: 12). Scorpions are nocturnal animals, and they are easy to

encounter or to find using the ultraviolet light. After sunset, *A. amoreuxi* emerge from their burrows, in front of which they stay for an extended period to inspect the external environment. Predation behaviour takes place when they experience the arrival of hunger. Scorpions were found most active during midnight, roaming freely in search of food, especially in open places. Oued Toudgha is a vast open sandy environment dominated by trees of *Tamarix* sp. Scorpions were occasionally found lying motionlessly on the ground (Fig. 7), among dry grasses or the fallen branches of *Tamarix* sp.

Comments on localities. Tinghir is considered an important province, as it provides a corridor to the southeast, characterized by an arid climate. In recent years, it has experienced a major drought which has radically changed the vegetation structure of the region and significantly contributed to the degradation of the palm groves. Currently, five scorpion species are reported from Tinghir: *A. amoreuxi*, *A. liouvillei*, *H. gentili*, *Buthus* cf. *boumalenii* Touloun & Boumezzough, 2011, and *Scorpio* sp. As for the western Moroccan Sahara, it is a vast arid desert area that covers a large proportion of the total area of the country. In general, the arachnological research in this region has been poorly conducted. Touloun *et al.* (2014b, 2016) are the only studies that focused on the distribution of these scorpion fauna in the farthest area of this region, near the border between Morocco and Mauritania.

Discussion

Former distribution records of *A. amoreuxi*

A. amoreuxi was considered to occupy an extensive area from Africa to Asia (Fet & Lowe, 2000: 65; Dupré *et al.*, 2023). However, most of those records appear to be rather suspicious (Lourenço, 2005: 157), particularly the following countries in Asia: Afghanistan, Iran, Pakistan, and Uzbekistan. Records from Afghanistan and Pakistan might align with several subsequently described species (e.g., *A. afghanus* Lourenço & Qi, 2006, *A. cholistanus* Kovařík & Ahmed, 2013 and *A. finitimus* (Pocock, 1897)). The record from Iran is most likely the misidentified *A. baluchicus* (Pocock, 1900) [now *A. sistanus* by Barahoei *et al.* (2022)] which by then was placed as a subspecies of *A. amoreuxi*. Report of this species from Uzbekistan could represent *Olivierus* sp. in reality. Its occurrences in several African countries (in parentheses) might correspond to several distinct species: *A. burkinensis* Ythier, 2021 (Burkina Faso; suggested by the author of description), *A. dekeyseri* Lourenço, 2005 (Senegal; also from Mauritania), *A. pallidus* Lourenço, Duhem & Cloudsley-Thompson, 2012 (Chad), and *A. simonettai* Rossi, 2015 (Ethiopia; suggested by the author of description). Additionally, its records from Sudan and Niger (Fet & Lowe, 2000: 67) warrant further confirmation. Conclusively, the most reliable coverage area of *A. amoreuxi* is currently limited within the following countries: Algeria (plentiful recent records, including Ait Hammou *et al.*, 2023: fig. 5), Egypt (including Sinai Peninsula), Israel (possibly Jordan and northern Saudi Arabia as well; for the subspecies *A. a. levyi* Fet, 1997), Libya, Mauritania (north region), and Morocco (including western Moroccan Sahara). However, it is still likely that the records from those regions may comprise more than one species (*A. amoreuxi*), given the phylogenetic findings by Coelho *et al.* (2014) (see below). It is worth noting that a specimen (MNHN-RS-RS2026) under the name “*Androctonus amoreuxi* Audouin & Savigny, 1825” was allegedly considered the holotype of *A. amoreuxi* from Djanet, Algeria, by the National Museum of Natural History, Paris, France. However, previous publications (including Audouin’s original description) suggested that this species was based on the material from Egypt.



Figs. 9-12. Live specimens of *Androctonus amoreuxi* (Audouin, 1825) observed in the wildness of Morocco by others: 9. Near Merdane and Mfis, Errachidia Province (31°03'30.5"N, 3°58'02.4"W), ©Max Prins. 10-11. El Borj Desert (28°38'56.5"N, 9°53'53.1"W) and near Tighmert (28°49'58.6"N, 9°55'29.2"W), Guelmim Province, © Julien Rouard. 12. Ait Zeggane, Tinghir Province (31°06'21.2"N, 4°58'53.0"W), © Abdesslam Souiri.

Within Morocco, it was previously believed that the distribution of *A. amoreuxi* was restricted to the far southeastern of the country, bordering Algeria where it does not exceed Zagora towards the north (Vachon, 1952: fig. 228; Lourenço *et al.*, 2009: fig. 12; Ythier & Lourenço, 2022: fig. 20). Recent records confirmed its presence in the further north of Morocco, with one being somewhere near Bouârfâ (750-1500 m a.s.l.) from Figuig Province. In their study of the scorpion fauna of the eastern region of Morocco, Ythier & François (2023: 2, fig. 1) collected numerous specimens of *A. amoreuxi* from different sites in this region, which is mainly deserted and featured by an ideal arid climate for this species. Several new localities of *A. amoreuxi* were confirmed by different observers in southeast of Errachidia Province, somewhere near Merzouga (Figs. 1, 9-11). Coelho *et al.* (2014: fig. 1) have also reported this species from those two regions. Doubts are cast upon the illustrated extensive distribution of *A. amoreuxi* populations in the northern Morocco by Kamel *et al.* (2022: fig. 1), which was highly discordant with previous knowledge pertaining to its dispersal ability within this country. Their map illustrated plentiful localities of *A. amoreuxi* to the west of the High-Atlas mountain range. This is neither congruent with the known ecological preferences of this species or the records by most researchers. Their records of other congeners were also highly questionable. Therefore, we chose to ignore those dubious reports. Conversely, Lourenço (2008: fig. 11) had previously suggested the potential distribution of *A. amoreuxi* in the Moroccan Sahara, the extreme south of Morocco, but did not list explicit

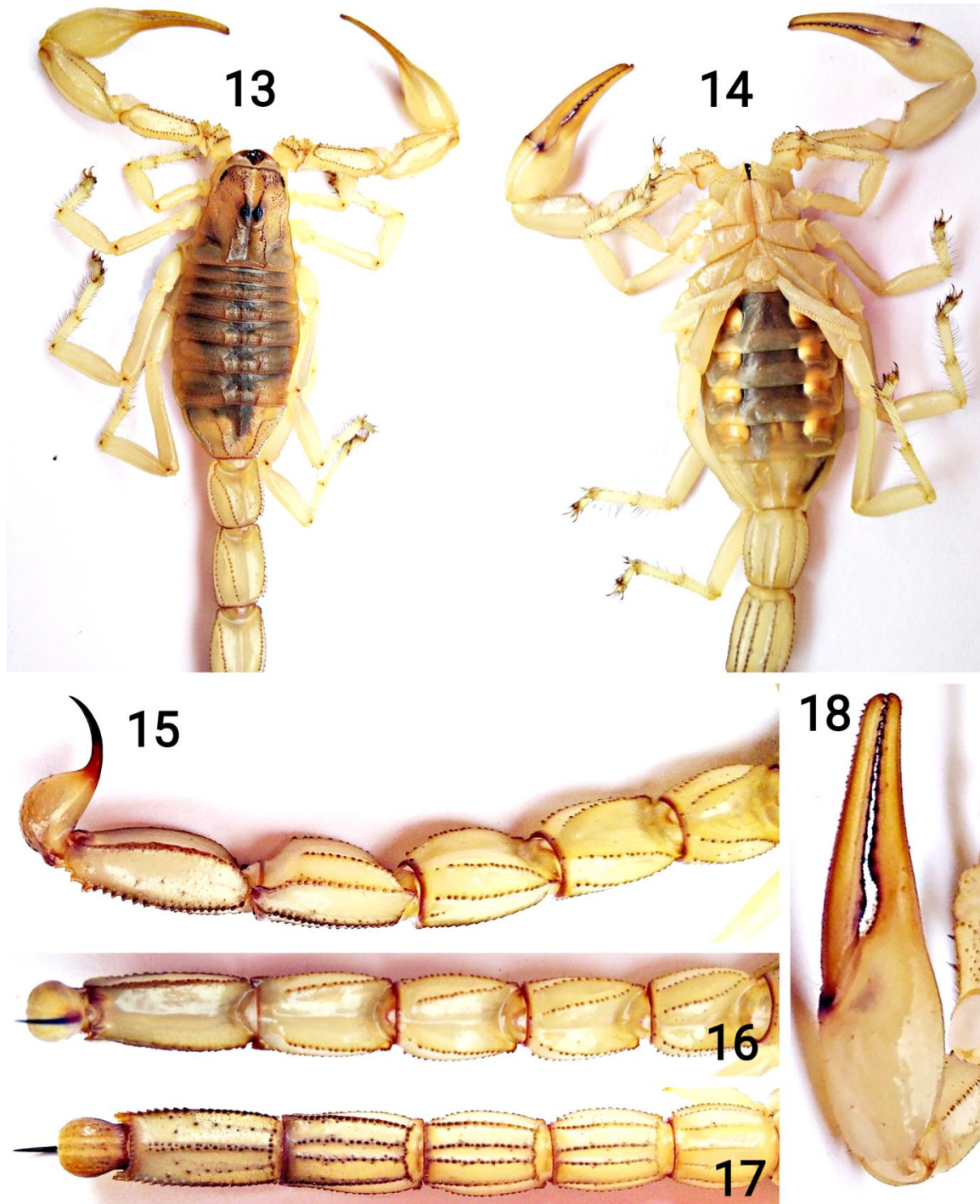
records of coordinates. A few authors have subsequently investigated this region, in an attempt to demystify the spread of the species further south. Touloun *et al.* (2014b: 18, fig. 2) reported three new localities in the rocky sandy region of Dakhla-Oued Ed Dahab: “Dar Amane” (22°38'43.2"N, 14°35'42.1"W; 284 m a.s.l.), “La Sebkha Imlily” (23°15'54.4"N, 15°54'08.5"W; 64 m a.s.l.; Touloun *et al.*, 2014b: fig. 1A-A'), and “Oued El Jena” (22°40'55.0"N, 14°29'44.4"W; 289 m a.s.l.). Touloun *et al.* (2016: table 1, fig. 1) further provided one record near Laayoune on the Atlantic coast (27°11'29.148"N, 13°19'50.808"W; 15 m a.s.l.). In conjunction with the report by Kovařík *et al.* (2016: 12) from Msied, these records are important observations regarding the dispersal of the species beyond its known southeastern distribution in Morocco. The documentation by Kovařík *et al.* (2016) extended its distribution area to Tan-Tan Province, which essentially bridged the record near Laayoune reported by Touloun *et al.* (2016).

Touloun *et al.* (2016: 880) also asserted that this species had been captured from the northeast Morocco near Oujda region, referencing to their paper in 2014. However, there was no report of this species from Oujda in Touloun *et al.* (2014a). Nevertheless, the same group of authors subsequently published a paper that included two maps with their cumulated records of *A. amoreuxi* across the entire Morocco (El Hidan *et al.*, 2017: figs. 1, 3). It is evident from their map that most records did not exceed the High-Atlas mountain range and constrained in the southeast area bordering Algeria, in concordance with most previous reports. The record from Oujda region was still not depicted in their map, but there is also one record that appeared to be located between the Middle-Atlas and High-Atlas mountain ranges, which remained enigmatic. However, Coelho *et al.* (2014: table 1) had mentioned a locality in the Jerada Province, which is just below the Oujda-Angad Province. More investigations are required to confirm this northern population.

Comparison with its congeners in Africa

Among its African congeners, *A. amoreuxi* appears to be most associated with *A. australis* (Linnaeus, 1758), *A. burkinensis*, *A. dekeyseri*, *A. eburneus* (Pallary, 1928), *A. maroccanus* Lourenço, Ythier & Leguin, 2009, *A. pallidus*, *A. tibesti* Lourenço & El-Hennawy, 2022 and *A. togolensis* Lourenço, 2008 in terms of the colouration and distribution. It can be confidently distinguished from *A. australis*, *A. dekeyseri* (cf. Lourenço, 2005: figs. 22-25), *A. maroccanus* (cf. MNHN-RS-RS8750, 8751), and *A. togolensis* (cf. MNHN-RS-RS8995) solely by its more slender metasoma. Type material of *A. eburneus* (a pair) are not observable to us, but Lourenço (2008: 39) suggested that this species is smaller (47.6 mm for male and 47.3 mm for female) than *A. amoreuxi* and possesses a higher PTC (male: 37-38 vs. 31-35; female: 22-24 vs. 21-25). However, it is uncertain if the type specimens of *A. eburneus* are immature, and the PTC discrepancy can be biased if the sample size is small. Geographically, the type locality of *A. eburneus* is located in the Tassili N'Ajjer National Park of Algeria, which is quite proximate to the asserted holotype of *A. amoreuxi* in Djanet. *A. burkinensis* was also differed from *A. amoreuxi* by a smaller size (holotype male 48.5 mm). One character that appeared to be reliable was the presence of an enlarged spinoid granule at the posterior end of the dorsosubmedian carinae of metasoma IV (cf. Ythier, 2021: fig. 3). This character was not observed in any of our examined specimens, as well as other individuals observed on iNaturalist (at least not as strong as what was illustrated for *A. burkinensis*). Moreover, the two species occupy distinct habitats and the distribution area of *A. burkinensis* is distant from the known area of *A. amoreuxi*. Another smaller species is *A. pallidus* (holotype male 67.5 mm), which appears to be more resemblant of *A. amoreuxi*. There is also one observation on iNaturalist seemingly conspecific with this species (obs. ID =

9897628). The more reliable character of those claimed by the authors appeared to be the lower DSC on the movable finger of chela (11 vs. 13; Lourenço, 2005: 158; Lourenço *et al.*, 2012: 312). However, problems are known to exist in the enumeration of denticle subrows, especially for the series near the proximity (Tang *et al.*, 2024: 11-12, 14). The assertion that “*chela without any scalloping of proximal dentate margin of fixed finger*”,



Figs. 13-18. A dead adult female from Achdad, Tinghir Province, observed by the first author and uploaded on iNaturalist (31°26'33.4"N, 5°26'17.8"W; 126853021). 13-14. Habitus. 13. dorsal view. 14. ventral view. 15-17. Metasoma. 15. lateral view. 16. dorsal view. 17. ventral view. 18. Left pedipalp chela, external view.

which is known to present in adult males of *A. amoreuxi*, could be subjectively biased by the degree of such feature (cf. Lourenço *et al.*, 2012: fig. 7). Nevertheless, we consider it as a valid species closely related to *A. amoreuxi* given its distribution. *A. tibesti* is a species occurring closely to both *A. amoreuxi* and *A. pallidus*, which was collected in the northeast of Tibesti Massif, Libya. According to the original description, although we are skeptical about the characters they proposed for distinguishing it from *A. pallidus*, this species can be differentiated from *A. amoreuxi* based on two characters shared respectively by *A. burkinensis* and *A. pallidus*, namely the strong spinoid granule at the posterior end of the dorsosubmedian carinae of metasoma IV, and a lower count of DSC on the movable finger of chela (11). It can be shown that this species does possess a pronounced spinoid granule (cf. MNHN-RS-RS9183) as opposed to *A. amoreuxi*.

Finally, we would like to share our doubts on the validity of another two congeners, namely *A. aleksandrplotkini* Lourenço & Qi, 2007 and *A. donairei* Rossi, 2015. However, before delving into this discussion, it is imperative to underscore the phylogenetic study conducted by Coelho *et al.* (2014), where *A. amoreuxi* was divided into three clades: clades AM1 and AM2 occurred in Morocco, clade AM2 also distributed in Tunisia and Algeria, and clade AM3 (based on specimens from local pet shops) was from Egypt. The genetic distance (mean *p*-distance) between AM1 and AM2 was 7.5%, while that between AM2 and AM3 was 8.9% (Coelho *et al.*, 2014: table 3). Those genetic distances were comparable with the genetic distance between *A. amoreuxi* and other undoubtedly distinct species (e.g., the genetic distance between AM1 clade and B2 clade of *A. bicolor* Ehrenberg, 1828 was 7.7%, and that between AM1 clade and B1 clade of *A. bicolor* was 8.8%). As stated by the authors, there were no significant morphological differences between the clades of *A. amoreuxi*. In fact, the type locality of this species was never specified as to which region in Egypt, not even in Audouin (1825: 173-174). The original diagnosis was also poor without useful information, and unfortunately, the holotype appeared to be lost. Thus, in a strict tone, due to the absence of a redescription based on the topotypes, none of the specimens in Morocco can be confidently assigned to the name *A. amoreuxi* considering the likelihood of this species being a complex comprising three cryptic clades as discovered by Coelho *et al.* (2014). Consequently, due to our limited knowledge constrained by the existing understanding of *A. amoreuxi*, we merely pose questions regarding those two species based on the prevailing consensus, refraining from suggesting any new synonyms, should any future study formally confirm the independence of those lineages.

The sole specimen of *A. aleksandrplotkini* (holotype female) was collected from Terjit, south of Atar town, in the north of Mauritania. Its overall habitus indicates that it is undoubtedly an immature female (cf. MNHN-RS-RS8980). The distinct colouration (cf. Lourenço & Qi, 2007: fig. 14) proposed by the authors as a diagnostic character, i.e., greyish yellow with dark brown stripes, is actually typical of the juvenile *A. amoreuxi* regardless of the locality (cf. Figs. 3, 11; also iNaturalist obs. IDs = 32950108, 53503746, 86226112, 109212317, 139034218, 156059597, 145131365, 164496747). Moreover, *A. amoreuxi* is sympatric with *A. aleksandrplotkini* in the region of Atar (Lourenço & Qi, 2007: fig. 15), which aligns with the known distribution of *A. amoreuxi* in Morocco. Both the DSC and PTC of the holotype female *A. aleksandrplotkini* (12 and 23-24) fall into a reasonable variation range of *A. amoreuxi*. Thus, there is a high likelihood that *A. aleksandrplotkini* represents a junior synonym of *A. amoreuxi*. A similar case concerns *A. donairei*: the holotype male, with a total length of 50 mm, possessed a DSC of 13 and a PTC of 32-34 (Rossi, 2015: 7). It is evident that this male was also immature (cf. Rossi, 2015: figs. 1-5). The morphological characters proposed by the author pertaining to the dark striped colouration, small size and lack of notch on pedipalp fingers were all again

in congruence with the characteristics of an immature *A. amoreuxi*. However, the type locality of this species falls into the distribution range of AM1 clade of *A. amoreuxi* (Zagora Province; 29°52'59.8"N, 6°07'09.2"W), distinct from the lineage in its type locality (i.e., AM3 clade in Egypt). The validity of this species can thus be only supported by a molecular study that did not introduce new taxa. More investigations are needed to confirm if these populations are completely non-overlapping. While the three lineages may represent valid, distinct species, the diagnosis proposed for *A. donairei* is nonetheless ineffective. Furthermore, if both *A. aleksandrplotkini* and *A. donairei* are distinct from *A. amoreuxi*, questions arise regarding the distinctness of *A. donairei* from *A. aleksandrplotkini*. If not, *A. aleksandrplotkini* would become the senior synonym of *A. donairei*.

Conclusion

The primary aim of this contribution is to unravel the mystery surrounding the distribution of *Androctonus amoreuxi* in Morocco. Based on our study on the past papers and field investigations, we reckon that this species occurs in a wider distribution than what it has been previously illustrated (Ythier & Lourenço, 2022: fig. 20). Our results show that this species mainly occupies a wide range along the border with Algeria and east to the Atlas mountain ranges, from Figuig Province in the north, through Errachidia, Tinghir, Zagora, and Tata provinces (probably Quarzazate as well), to Assa-Zag and Tantan provinces in the south, and finally entering the western Moroccan Sahara beyond which it meets with its Mauritanian populations (Fig. 1). In addition, we provide photos of live specimens in its wild habitat as a means to showcase its adaptations to the arid substrates. A brief rather than diagnostic description is provided, alongside an interspecific comparison with its African congeners, as a general guidance for the identification of this medically important species. Finally, we raise our questions concerning the true identity of *A. amoreuxi*, as well as the validity of several previously described species. We urge a comprehensive review of this species pertaining to its global populations, as well as a redescription and genetic analysis based on the study of its topotypes pending to be collected.

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