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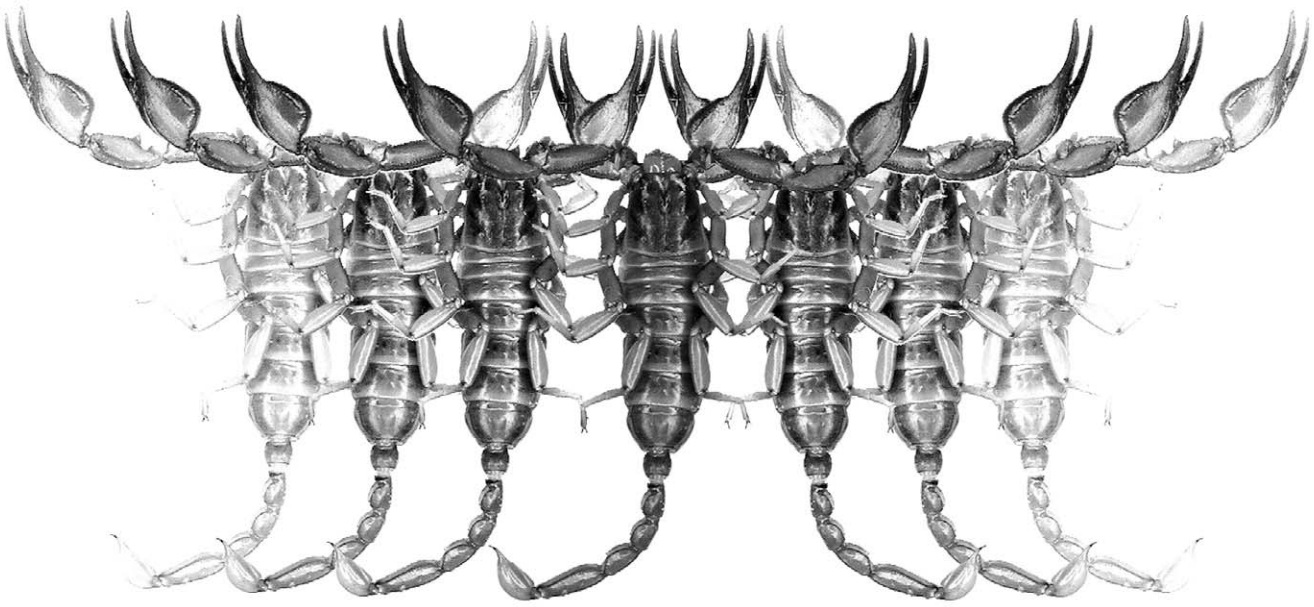

First Report of *Lissothus occidentalis* Vachon, 1950 (Scorpiones: Buthidae) from Morocco and Western Sahara, with Notes on Ecology and Captive Breeding

Mark Stockmann, Carlos Turiel, Felix Althoff, Graeme Lowe & František Kovařík

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EDITOR: **Victor Fet**, Marshall University, **'fet@marshall.edu'**
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Euscorpius — Occasional Publications in Scorpiology. 2016, No. 235

First report of *Lissothus occidentalis* Vachon, 1950 (Scorpiones: Buthidae) from Morocco and Western Sahara, with notes on ecology and captive breeding

Mark Stockmann [1], Carlos Turiel [2], Felix Althoff [3], Graeme Lowe [4] & František Kovařík [5]

[1] Poststraße 69, D-49477 Ibbenbüren, Germany, skorpionzuchtstockmann@gmail.com
[2] Niederrheinstraße 49, D-41472 Neuss, Germany, centruroides@gmx.de
[3] Natruper Str. 99, D-49076 Osnabrück, Germany, botaniker@t-online.de
[4] Monell Chemical Senses Center, 3500 Market St., Philadelphia, PA 19104-3308, USA
[5] P. O. Box 27, CZ-145 01 Praha 45, Czech Republic; www.scorpio.cz

http://www.zoobank.org/urn:lsid:zoobank.org:pub:ACF5E82B-C960-42A4-A21B-E0A0EF32877C

Summary

Genus *Lissothus* Vachon, 1948 represented by *L. occidentalis* Vachon, 1950 is reported for the first time from four localities in Morocco and the Western Sahara. We provide a revised diagnosis of *L. occidentalis*, fully complemented with color photos of live and preserved specimens. Hemispermatophore is also illustrated and described in detail. Furthermore, we describe aspects of the ecology of this species, and provide photos of collection sites and habitats. We also report on the reproductive biology of this species based on captive breeding and rearing. and provide the first envenomation report for the species.

Introduction

The scorpion fauna of Morocco and the Western Sahara was recently surveyed in some detail (Touloun & Boumezzough, 2011; Touloun et al., 2016a, 2016b), several new species were described (Lourenço & Geniez, 2005; Lourenço & Leguin, 2011a, 2011b; Lourenço et al., 2011; Turiel, 2014), cryptic species were revealed based on genetic analysis (Sousa et al., 2011; Turiel, 2014), and new distributions were documented (Touloun & Boumezzough, 2011; Touloun et al., 2016a, 2016b).

The North African genus *Lissothus* Vachon, 1948 includes three species. Vachon described *L. bernardi* Vachon, 1948 from Libya and *L. occidentalis* Vachon, 1950 from Mauritania, and recently a third species *L. chaambi* Lourenço & Sadine, 2014 was described from Algeria. Distributions of this genus are rarely recorded, and the few known localities are restricted to arid zones of the Sahara Desert (Lourenço, 2001; Lourenço & Sadine, 2014). All previously known records for this genus are from Algeria, Libya and Mauritania (Lourenço, 2001; Lourenço & Sadine, 2014). However, we now report new records for *L. occidentalis* from Akka (Souss-Massa region, Morocco), Zag and Targa Wassay (Guelmim-Qued Noun region, Morocco), and Smara (Es Semara Province, Western Sahara). The fauna of Morocco and the Western Sahara harbors the highest biodiversity of scorpions in Northern Africa, but the genus *Lissothus* has never been reported in these countries until now. Here we report new records that are more than 1,000 km from the type locality in Akjoujt, Mauritania (Vachon, 1952a).

Methods, Material & Abbreviations

Nomenclature and measurements follow Stahnke (1971), Kovařík (2009), and Kovařík & Ojanguren Affilastro (2013), except for trichobothriotaxy (Vachon, 1974). Hemispermatophore terminology follows Kovařík et al. (2016).

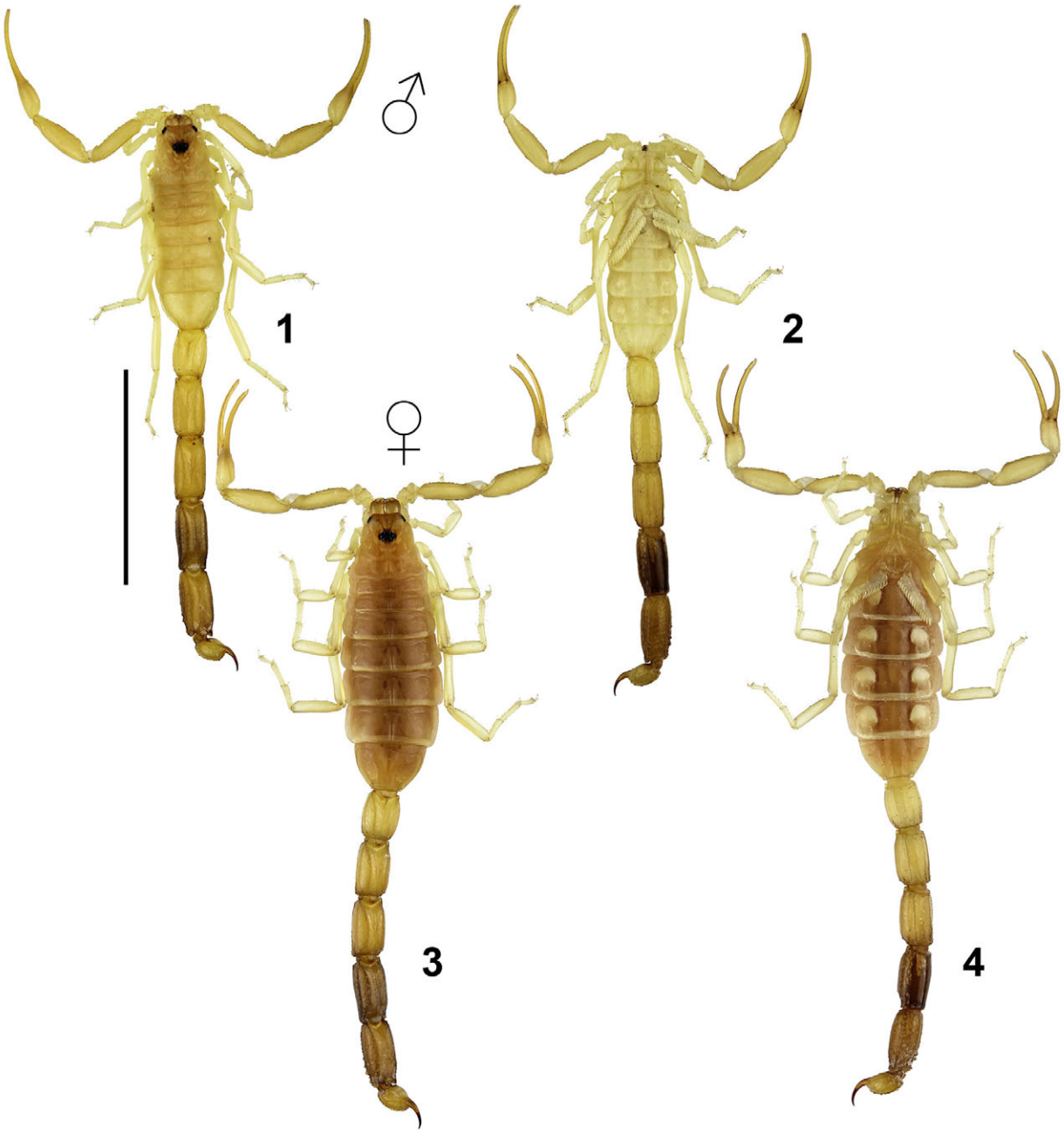
Specimen Depositories: CIBIO (Centro de Investigação em Biodiversidade e Recursos Genéticos, Vairão, Portugal); FKCP (František Kovařík, private collection, Prague, Czech Republic); MSGC (Mark Stockmann, private collection, Germany). The specimens are preserved in 80 % (FKCP) and 98 % (CIBIO) ethanol. *Morphometrics*: D, depth; L, length; W, width.

Systematics

Lissothus occidentalis Vachon, 1950

(Figs. 1–45, Table 1)

Lissothus occidentalis Vachon, 1950: 406 (1952a: 412): Vachon, 1952b: 172–177, figs. 1–7; Vachon, 1953: 1021, fig. 11; Vachon, 1974: 909, fig. 41; Fet & Lowe, 2000: 158 (complete reference list until

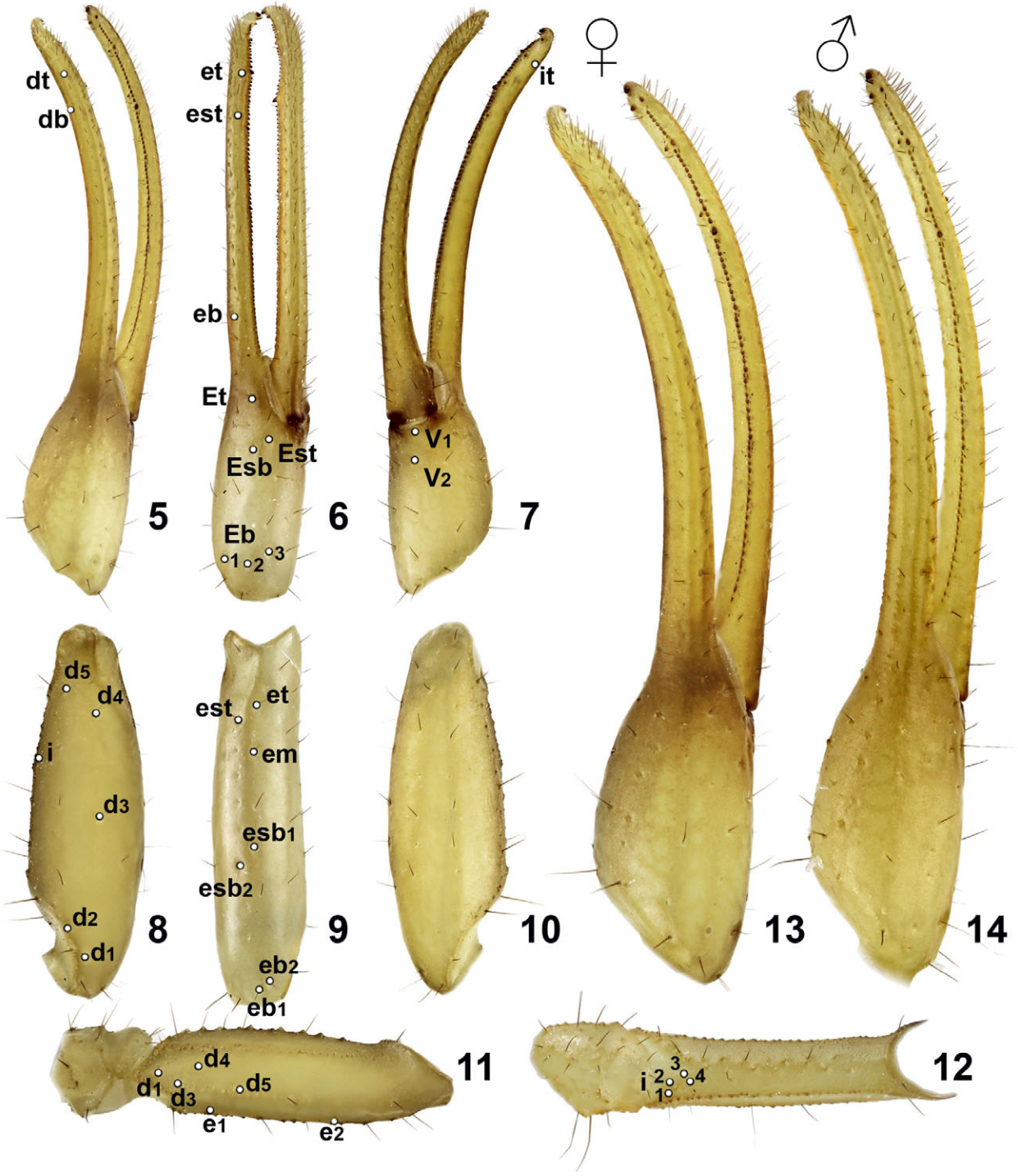


Figures 1–4: *Lissothus occidentalis*, Morocco, Akka. **Figures 1–2**. Male in dorsal (1) and ventral (2) views. **Figures 3–4:** Female in dorsal (3) and ventral (4) aspects. Scale bar: 10 mm.

2000); Lourenço, 2001: 52–54, figs. 1, 3; Lourenço & Sadine, 2014: 417, fig. 1.

TYPE LOCALITY AND TYPE DEPOSITORY. Mauritania, Akjoujt, MNHN.

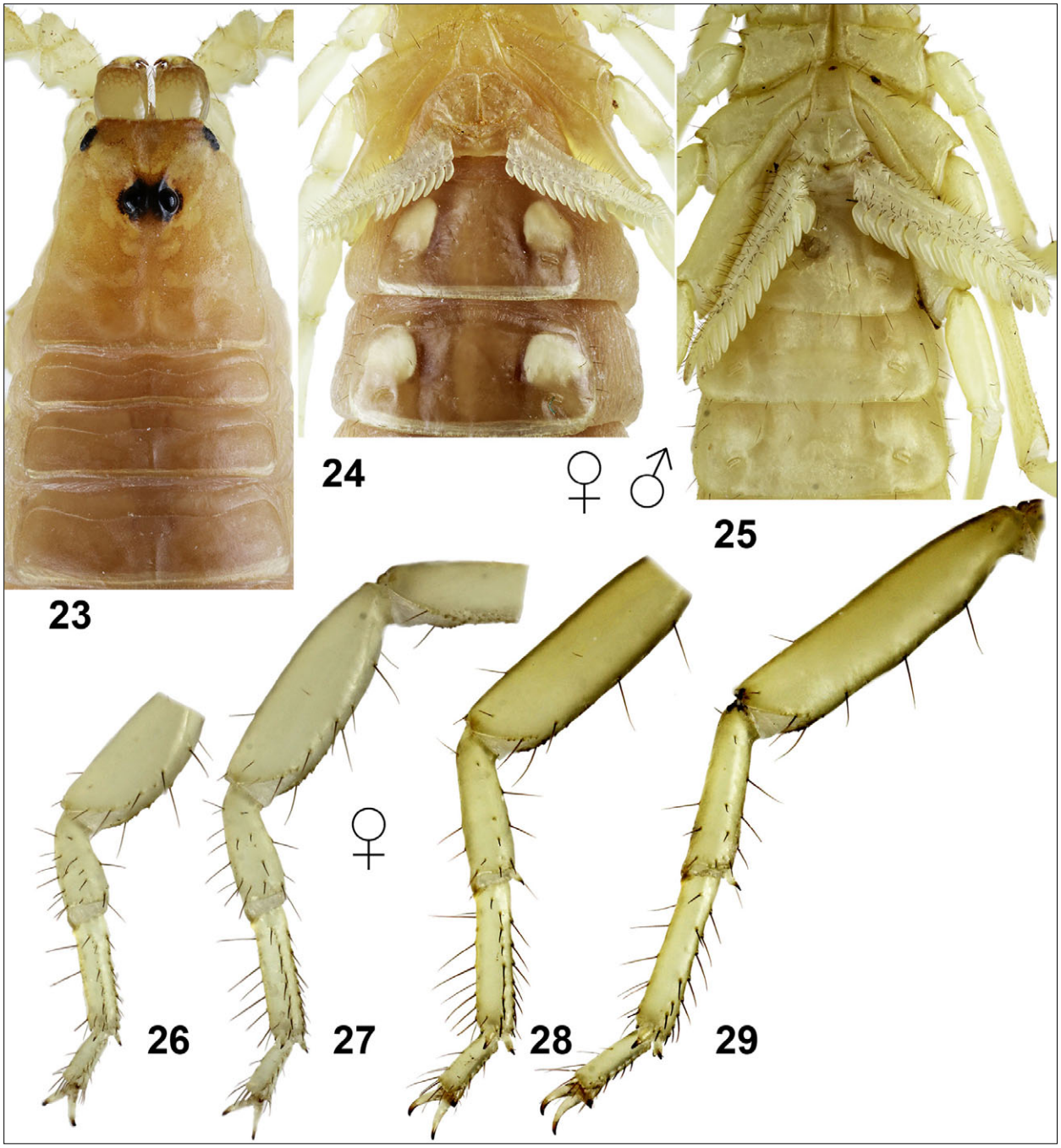
MATERIAL EXAMINED. **Morocco**, Souss-Massa region, Akka, 29°23'03"N 8°16'04"W (Figs. 35–37), 20.IX.–1.X.2013, 1♂2♀ (Figs. 1–34), FKCP, V.2015–XI.2016, 10♂3♀5♀ims., still alive, MSGC, leg. Omar Hassan, at sandy plains close to oasis, UV detection per night and under stones per day; Guelmim-Qued Noun region, North of Zag, 28°14'55.4"N 9°19'58.5"W (Fig. 39), 4. –14.X.2016, 2♂1♂im., FKCP, leg. Omar Hassan, under stones at a sandy plain; Guelmim-Qued Noun region, Targa Wassay, 29°4'6.3"N 10°14'54.3"W, 152 m a.s.l, V.2009, 1♀, UV detection, CIBIO SC529. **Western Sahara**, Es Semara Province, Smara, 26°57'22.1"N 11°39'47.7"W, V.2013, 1♂im., UV detection, CIBIO SC2396.



Figures 5–14: *Lissothus occidentalis*, Morocco, Akka, pedipalp segments. **Figures 5–13**. Female, chela dorsal (5, 13), external (6), and ventral (7). Patella dorsal (8), external (9) and ventral (10). Femur dorsal (11), and internal (12). Movable Trichobothrial pattern is indicated in Figures 5–9 and 11–12. **Figure 14**. Male, chela dorsal.

Figures 15–22: *Lissothus occidentalis*, Morocco, Akka, metasoma and telson. **Figures 15, 17–19**. Male, telson lateral (15), metasoma and telson lateral (17), ventral (18), and dorsal (19) views. **Figures 16, 20–22**. Female, telson lateral (16), metasoma and telson lateral (20), ventral (21), and dorsal (22) views.

DIAGNOSIS. Total length 24–37 mm; coloration basically yellow to light brown with darker fuscous areas on metasomal segments IV–V and anterior part of interocular triangle of carapace; carapace trapezoidal, in lateral view preocular area not distinctly inclined towards anterior margin; surface of carapace finely granular, without carinae; tergites only with single median carina; pectines with fulcra, hirsute; pectine teeth 15–18 in male, 14–16 in female; sternites III–VI lacking carinae; sternum subtriangular; metasoma II as wide as other metasomal segments; metasoma I–III with 10 smooth carinae indicated or absent; metasoma IV smooth without obviously developed carinae; metasoma V with enlarged "lobate" dentition on ventrolateral carinae; telson tuberculate without subaculear tubercle, with short aculeus, shorter than vesicle; segments of metasoma I–III sparsely hirsute, IV–V with solitary seta only; dentate margin of movable finger of pedipalp with linear row of granules, divided into three non-imbricated rows by two slightly enlarged denticles; 2 internal accessory granules, 2 terminal, and 1 basal terminal granules present; trichobothrial pattern orthobothriotaxic type A; dorsal trichobothria of femur arranged in β-configuration; pedipalp patella with 7 external trichobothria; pedipalp chela with trichobothrium *esb* missing; pedipalp femur with trichobothrium d_2 missing; d_2 of pedipalp patella pre-

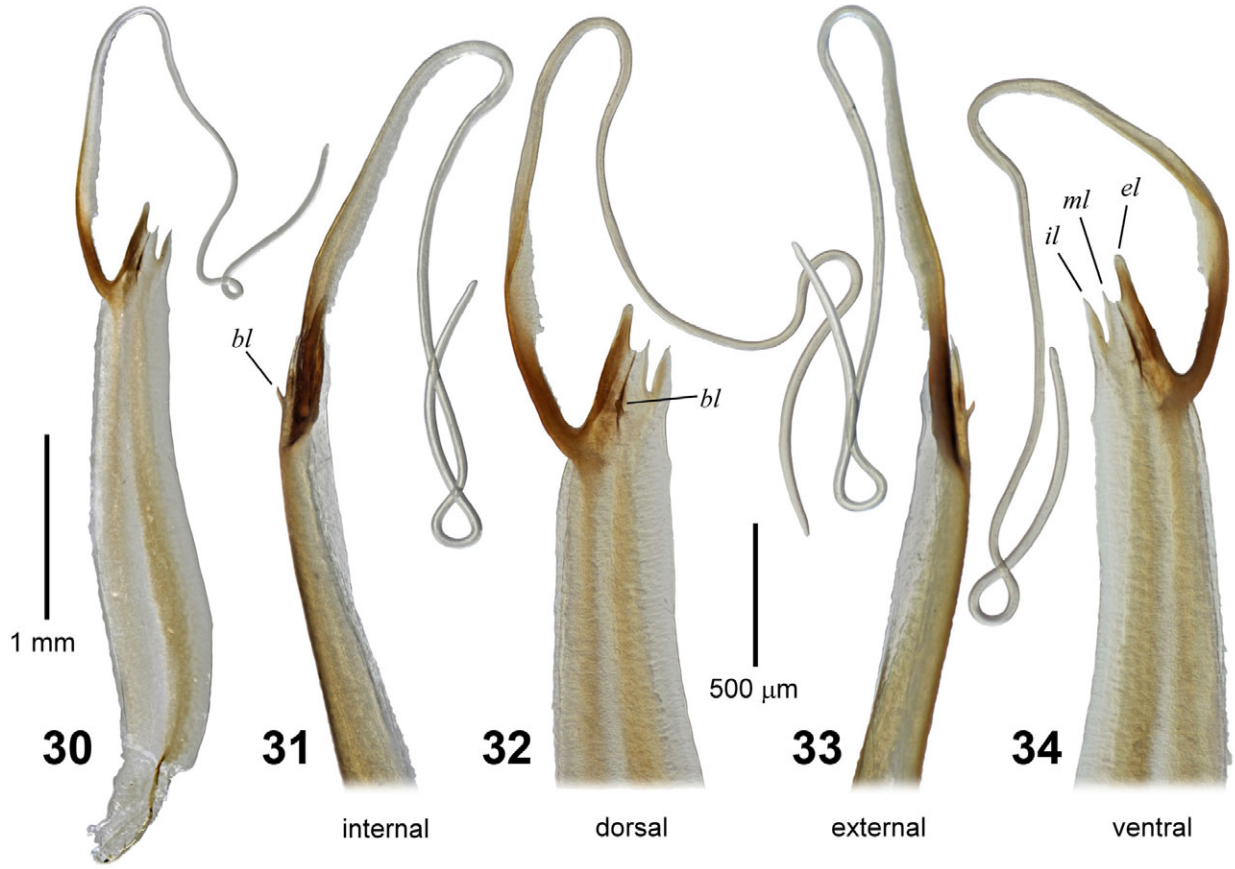


Figures 23–29: *Lissothus occidentalis*, Morocco, Akka. **Figures 23–24, 26–29**. Female, carapace and tergites I–III (23), coxosternal area and sternites III–IV (24), left legs I–IV, retrolateral aspect (26–29). **Figure 25**. Male, coxosternal area and sternites III–V (25).

sent; tibial spurs present on legs III–IV; shape of pedipalp and metasoma without sexual dimorphism.

Measurements. Male from Morocco, Akka (FKCP). Carapace L/Wp 2.6/2.6; pedipalp L 11.4; chela L 5.2; hand W 0.9; movable finger L 3.7 patella L/W 3.4/1; femur L/W 2.8/0.7; metasoma L 16; I.segment L/W/D 2.1/1.5/1.2; II.segment L/W/D 2.6/1.4/1.2; III.segment L/W/D 2.8/1.4/1.2; IV.segment L/W/D 3/1.4/1.2; V.segment L/W/D 3.1/1.4/1.2; telson L 2.4; vesicle L/W 1.5/1.2; aculeus L 0.9; total length L 28.8. Measurements in mm (L = length, W = width, Wp = posterior width, D = depth).

Hemispermatophore (Figs. 30–34). Flagelliform, relatively stout, trunk 4.65 times length of capsule region. Flagellum well separated from capsule lobes, pars



Figures 30–34: *Lissothus occidentalis*, Morocco, Akka, right hemispermatophore. **Figure 30.** Whole hemispermatophore, dorsal view. **Figures 31–34.** Capsule region and flagellum: internal (31), dorsal (32), external (33) and ventral (34) views. Abbreviations: *bl*, basal lobe; *el*, external lobe; *il*, internal lobe; *ml*, median lobe. Scale bars: 1 mm (30), 500 μm (31–34).

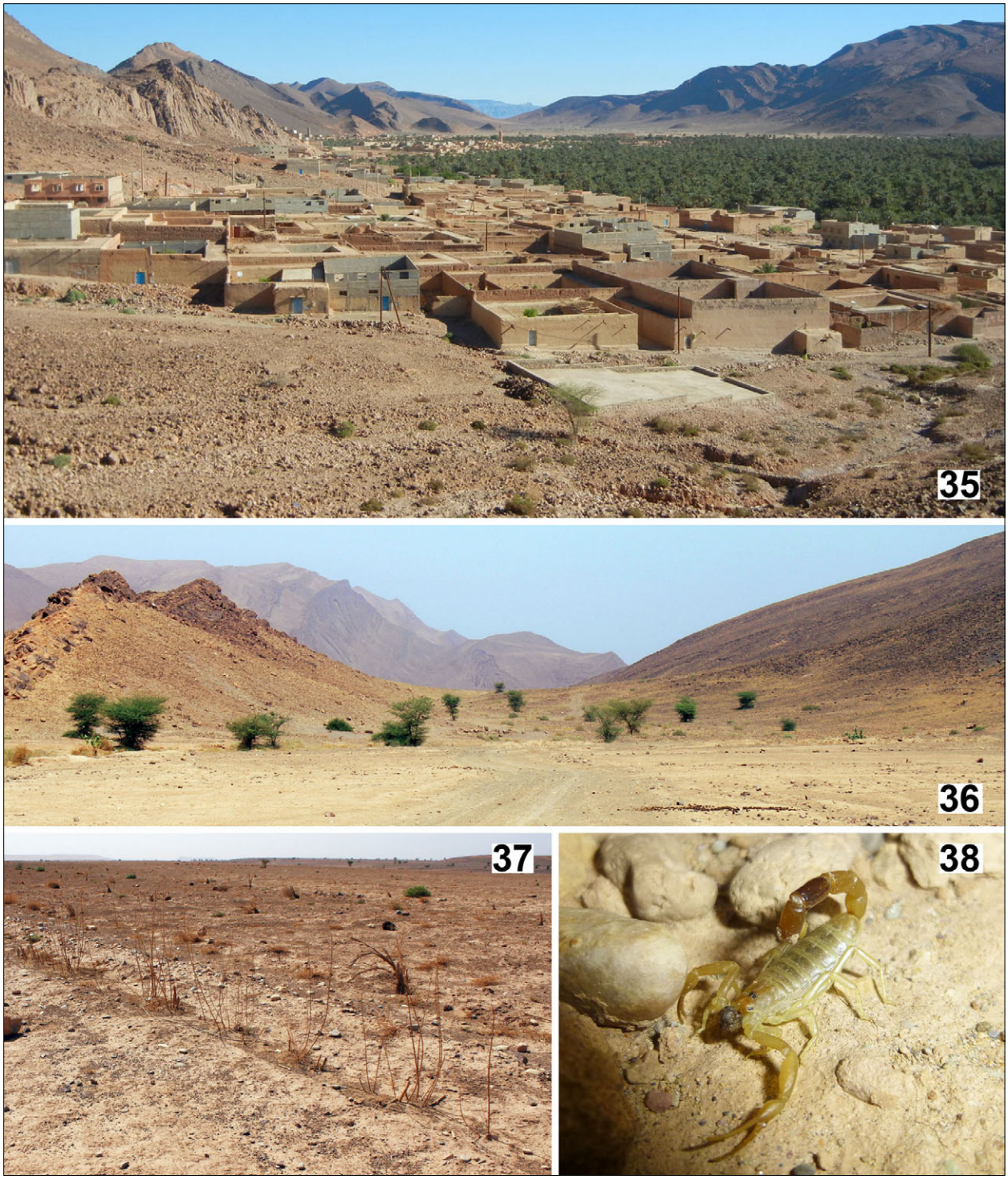
recta long, 0.65 times length of trunk, with gradually tapering fin along internal margin; pars reflecta long, narrow, hyaline, 1.17 times length of trunk. Capsule region with 4 lobes arranged in 3 + 1 configuration typical of the "Buthus" group (Fet et al., 2005; Kovařík et al., 2016): external lobe largest, a gently tapered lamina with rounded apex; median lobe smallest, sharply acuminate, with weak carina on internal margin; external and median lobes partially fused along a dark suture line or fine carina; internal lobe intermediate in size, laminate, gently tapered with pointed apex; internal and median lobes well separated by deep incision; basal lobe a small, distally projecting, hook-like process. Right and left hemispermatophores from the dissected male were similar in structure.

Vachon (1952b, fig. 6) showed the capsule lobes of the holotype male of *L. occidentalis* from Mauritania in a crude line drawing. That illustration differs from the hemispermatophores that we examined as follows: (i) the external lobe (= internal lobe of Vachon) is not distally rounded but terminates in a pointed apex; (ii) the median lobe is not as finely acuminate; (iii) the basal portions of external and median lobes are shown as overlapped but separate, not fused. We could not confirm whether these are genuine differences in the hemispermatophore of the holotype, which was unavailable for loan to the authors, but suspect that they may reflect errors or inaccuracies in illustration.

Notes on Ecology

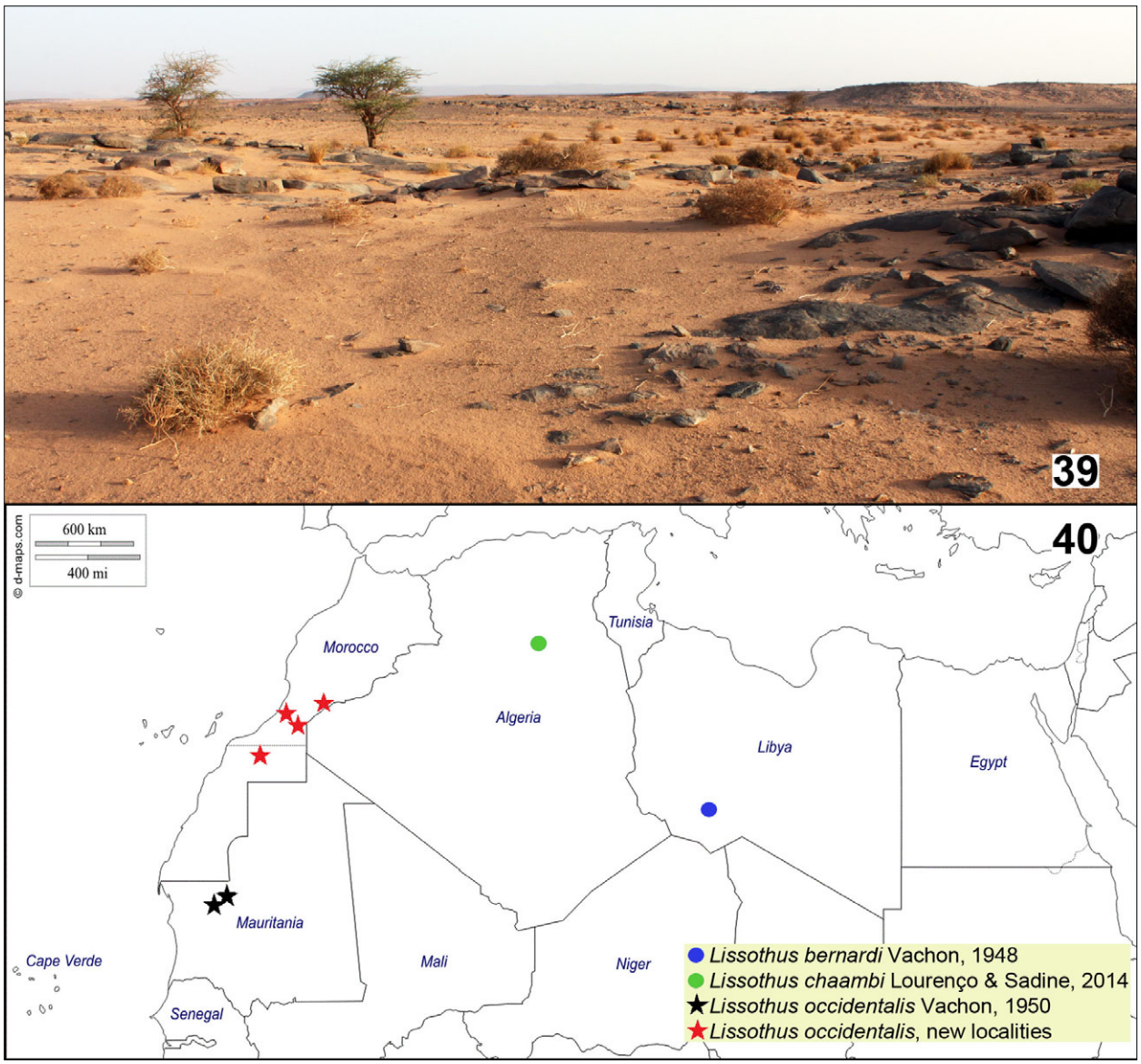
L. occidentalis seems to be locally rare, but has a widespread distribution. Populations are small and dispersed. Their distribution is mostly limited to typical reg–desert formations. However, the record for Targa Wassay (Morocco), does not correspond to the typical distribution and habitat, as this a loamy flat area surrounded by vegetated mountains close to the coast. Unfortunately we were not able to observe the habitat in Smara (Western Sahara) and our own efforts to locate *L. occidentalis* in Targa Wassay were not successful.

Akka (Figs. 35–37) is located in the south-eastern part of Morocco. The village and the small sand desert south of Akka is surrounded by mountains (Fig. 35). Climatic conditions in the summer have temperatures close to 40 °C by day and ca. 22 °C at night with nearly



Figures 35–38: *Lissothus occidentalis*, Morocco, Akka. **Figure 35**. Oasis Akka. **Figure 36**. Plain east of Akka. **Figure 37**. Fields west of Akka. **Figure 38**. Female at the locality.

no precipitation. Only the oasis and the riverbed (Arabic: Qued or Wadi) provide water and humidity in the dry summer season. In winter, temperatures rarely drop below 20 °C by day and 5 °C at night. Most precipitation occurs in the winter, with an average rainfall of 23–24 mm in November and December. Qued Akka and Oasis Akka are fertile with many date-palms and acacias. The Oasis is surrounded by farmland, and the small area in



Figures 39–40: Figure 39. *Lissothus occidentalis*, locality Morocco, Guelmim-Qued Noun region, North of Zag. **Figure 40**. Map showing confirmed distribution of *Lissothus*.

the south is typical sand desert. Rock cover is sparse on the plains, but the bases of the mountains provide more rocky habitat. Small, thorny shrubs occur widely but the area is not heavily vegetated. A female of *L. occidentalis* was found during the day under a larger rock on relatively loose sand one side of a street. The other side of the street was farmland (Fig. 37). Two males and a female were found in the rocky and shrubby area between the mountains and the oasis (Fig. 35) by UV detection. The female was feeding on a termite late at night (Fig. 38). Termites seem to be the primary food source, because of infrequent occurrence of other suitable prey species. In addition, at this sandy plain near Akka, *Compsobuthus* sp. and *Androctonus amoreuxi* (Audouin, 1825) were recorded. Inside the oasis, *Hottentotta gentili* (Pallary, 1924) was observed on the date palms.

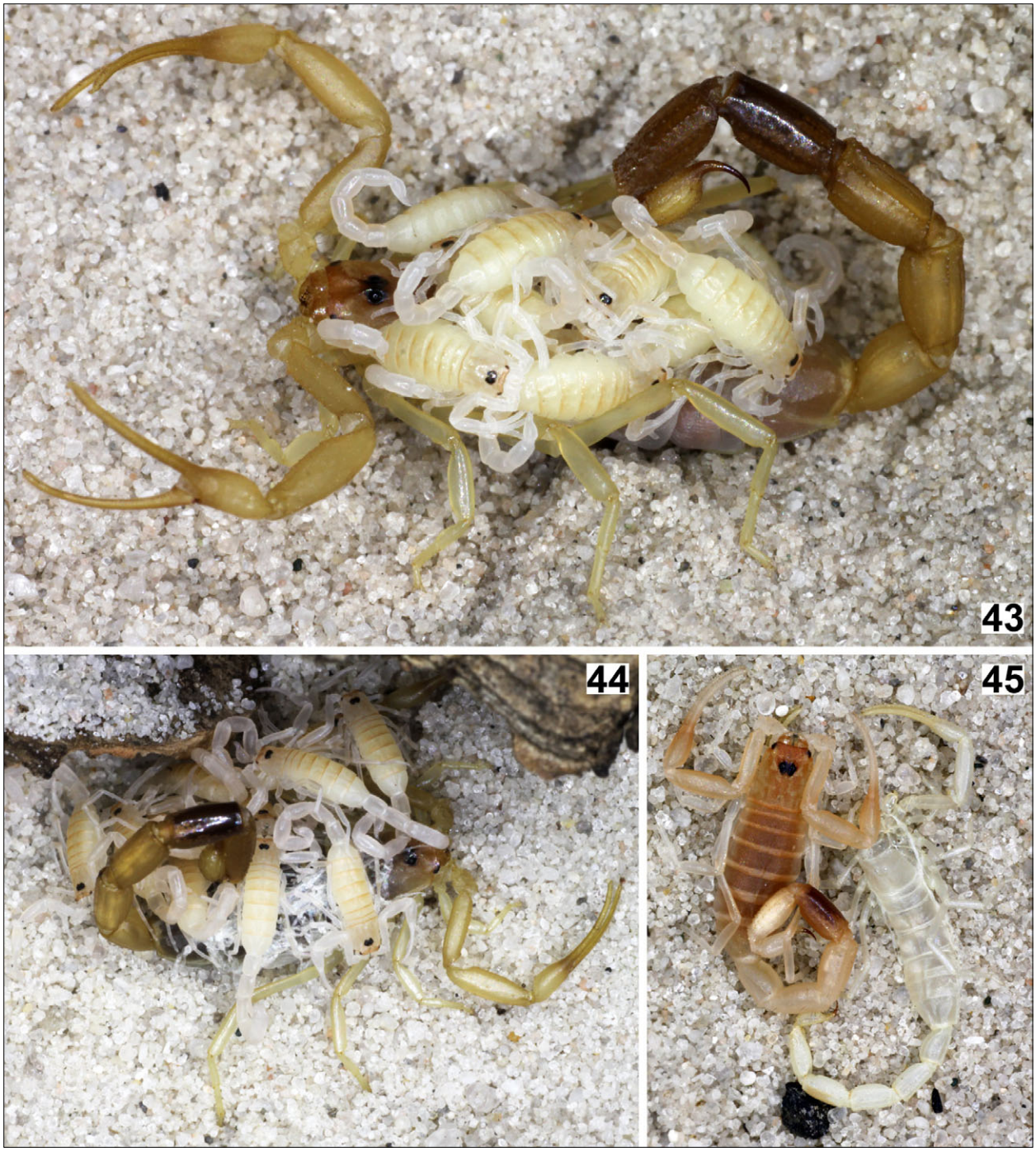
Zag is a village in the far south-east of Morocco, close to the borders of Algeria and the Western Sahara. The described habitat is located 25 km north of Zag. Climatic conditions are similar to those at Akka, but the environment is slightly different. Sandy flat areas are partially covered with large black rocks. Some of these rock areas are loamier than the surrounding environment and provide a substrate for scorpions to excavate burrows. The habitat is sparsely but consistently covered with small shrubs and some solitary trees (Fig. 39). Three males of *L. occidentalis* were found under rocks, but none were found by UV detection at night. In ad-

Figures 41–42: *Lissothus occidentalis*, in vivo habitus, male (41) and female (42) from locality Morocco, Akka.

dition, in this habitat *Androctonus amoreuxi*, *Compsobuthus berlandi* Vachon, 1950 and *Buthacus* sp. were recorded. *Buthus mariefrancae* Lourenço, 2003 was also observed here, but was mostly limited to the loamy rock areas.

Notes on Envenomation

During a field trip in the evening, the first author was stung on the left thumb by an adult male of *Lissothus occidentalis*. Slight local pain occurred im-



Figures 43–45: *Lissothus occidentalis*, in vivo, female from locality Morocco, Akka with newborns, instar 1 (43), with juveniles after the first ecdysis, instar 2 (44), juvenile shortly after third ecdysis, instar 4, and its exuvia (45).

mediately around the sting site, comparable with a honeybee sting. The pain faded after a few hours, leaving the thumb touch sensitive until the next morning. No further symptoms were observed, suggesting that the venom of this species probably only has mild clinical effects.

Notes on Captive Breeding and Rearing

Two adult pairs were each maintained in 20 x 20 x 10 (cm) (length x width x height) plastic boxes. Temperatures during the summer were ca. 30–32 °C (day) and ca. 22–24 °C (night). Hibernation conditions were

	1st brood (*n*)	2nd brood (*n*)	3d brood (*n*)
female 1	05/14 (10)	07/14 (14)	06/15 (2)
female 2	08/14 (6)	05/15 (12)	08/15 (13)

Table 1: Gestation and number of offspring of two *L. occidentalis* females in captivity. Dates of birth are indicated as month and year. Numbers in brackets represent the size of litters.

simulated in the winter at ca. 22 °C (day) and 14–15 °C (night). To provide drinking water, a corner of the box was slightly moistened by spraying water once a week. The water completely evaporated during the next day. Three broods of two females were observed in captivity under these conditions during months 11 and 12. Numbers of offspring varied from 2 – 14 (Tab.1).

Gestation of both females was about 2–3 months during the active phase in the summer. Hibernation was simulated for about 4 months and prolonged the gestation to 9–11 months. Spermatophores were absent and mating activity was not observed between broods. This indicates the ability to store sperm and produce several broods after mating. This hypothesis is further supported by the extremely short gestation period of ca, 2 months during the summer.

After leaving the mother, instar 2 individuals were separated into 11 x 11 x 6 (cm) plastic boxes with two perforated sides. The first three litters from 2014 were reared under the same temperature conditions as the adults. However, moisture conditions were different: one third of the box was kept mainly moist, to prevent dehydration of the small juveniles. The substrate dried out for a maximum of one day. Under these conditions most juveniles did not molt to instar 3, and died before or right after their hibernation period. Only 3 specimens molted to instar 3 and instar 4 after hibernation, but died in 2015.

The three litters from 2015 were reared under different conditions. The temperature was decreased to 27–28 °C during the summer and less water was provided. A quarter of the substrate was moist for 3 days, and dry for the rest of the week. About 50 % of the juveniles molted to instar 3 in Autumn of 2015.

A mild hibernation was simulated from November 2015 to March 2016. The growth rate of the juveniles seemed too low for a small, fast reproducing (i.e. opportunistic, or r-selected) buthid scorpion. To induce molting and faster growth, conditions were further modified after hibernation. The temperature was elevated to 30–31 °C by day and ca. 22–23 °C at night during the summer. Moisture was further reduced. The substrate was mostly dry, similar to the conditions of the adult specimens. When juveniles rejected food and seemed to molt soon, more humidity was provided by keeping one third of the substrate moist for 4–5 days. In parallel, the temperature was elevated to 36 °C on one side of the box. Under these warmer and more humid conditions, juveniles molted within 1–2 two weeks. After molting, the conditions were switched back to the previous standard temperature and humidity. It seemed important to provide food shortly after the hardening of the exoskeleton, for water and nutrient supplementation. Small-sized *Thermobia domestica* were constantly present in the boxes as a food source. On average, males attained maturity at instars 5–6, and females at instar 6.

Acknowledgments

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