Smaller orders of Arachnida in Sudan: a literature review

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Abstract

Literature-based species lists for arachnids, excluding spiders and mites, found in the Republic of the Sudan are provided. We summarize records, references, and localities for 17 scorpions (Scorpiones), one harvestman (Opiliones), nine pseudoscorpions (Pseudoscorpiones), 21 camel spiders (Solifugae) and one whip spider (Amblypygi). There are no published records of palpigrades (Palpigradi), whip scorpions (Thelyphonida), schizomids (Schizomida) or ricinuleids (Ricinulei), although at least whip scorpions and ricinuleids would not be expected in East Africa based on their current distribution. Key literature for mites and ticks (Acari) is also mentioned. In general, the Sudanese arachnid fauna has not been documented in detail. Many more species, particularly among the harvestmen and pseudoscorpions, are to be expected, and we offer the data gathered here as a baseline for future work.

Keywords: checklist • East Africa • species diversity

Introduction

The Republic of the Sudan is one of the largest countries in East Africa and of considerable biogeographical interest for spanning a range of habitats from deserts in the north and west through to more tropical forests in the south, as well as a coastal region and the fertile Nile valley. Spiders (Araneae) from Sudan were reviewed from the literature by Dunlop & Siyam (2014), with additional records by Siyam, Dunlop & El-Hennawy (2015) and Siyam, Dunlop & Jäger (2017) bringing the total number of species to 122. This work involved matching records and localities to the relevant states as a first step towards producing distribution maps, as well as separating records from the Republic of the Sudan from the now politically independent South Sudan. Here, we continue this work by extending our survey to non-spider arachnids. Again, our goal is to document in the first instance which species have been recorded from The Republic of the Sudan and, if necessary, to clarify where these historical records came from. Studies of Sudanese arachnids are still at a very preliminary stage compared to, for example, the South African National Survey of Arachnida (Dippenaar-Schoeman *et al.* 2015) which recorded 2170 species of spider for that country. Our aim here is to offer a baseline compilation of Sudanese arachnids on which future records can build, together with a summary of the relevant primary literature.

Materials and methods

Previous overviews of Sudanese arachnids were published by Werner (1911) and Lewis (1958), but several new records have become available since this time. Data was gathered in the first instance from the primary literature, with the catalogues of Fet *et al.* (2000) and Harvey (2002, 2013a–c) proving valuable additional sources of citations, distribution data and correct taxonomic names. Scorpion distributions were also cross-referenced against Rein (2018). As in the spider lists prepared by Dunlop & Siyam (2014), we assigned localities to their current states (Table 1), while at the same time excluding records which now belong to the country of South Sudan. These are briefly mentioned below for completeness.

Results and discussion

For the Republic of the Sudan we could retrieve published records of 17 scorpions (Scorpiones), one harvestmen (Opiliones), nine pseudoscorpions (Pseudoscorpiones), 21 camel spiders (Solifugae), and one whip spider (Amblypygi) (Table 1). Similar to the situation with spiders (Dunlop & Siyam 2014), the diversity of the Sudanese arachnids belonging to these orders (49 in total) is almost certainly only a fraction of the total number of species present. This general situation reflects a lack of comprehensive studies or collecting trips, as well as local expertise for identifying these groups. Arachnids with medical or economic significance are somewhat better documented (e.g. Lewis 1958), and further notes on individual groups are provided below. What is also clear is that much of the data stems from a fairly limited set of localities, especially Wadi Halfa, Khartoum, and Port Sudan (Table 1). Future work should aim to sample other areas of the country to facilitate a more accurate picture of species distributions.

Acari

Species lists for mites and ticks are not presented here, as this would be more appropriate for an acarological publication, but some remarks and citations are included here for completeness. General overviews of the mite fauna in the Republic of the Sudan are lacking. Within the acariform branch of the mites, Lewis (1958) noted the presence of some parasitic taxa for Sudan such as mange or scabies mites; see also Abu-Samra, Imbabi & Mahgoub (1981). Several studies have focussed on crop pests like spider mites (Siddig & El-Bardy 1971; Yousof & Mahmoud 2013) or gall mites (Hammad & Yassin 2011). Water mites were

studied by Nordenskiöld (1905), while in arid regions large velvet mites in the genus *Dinothrombium* are notable for appearing in large numbers after rain (Cloudsley-Thompson 1962). Despite being ubiquitous in soil ecosystems, there are surprisingly few records (e.g. Aoki 1971) of oribatid mites. This is almost certainly a collecting artefact; neighbouring Ethiopia for example hosts 128 species (Ermilov, Sidorchuk & Rybalov 2012).

Among the parasitiform mite branch, neither Opilioacarida nor Holothyrida have been recorded from the Republic of Sudan. There are numerous records of Mesostigmata. Again, review papers for the entire Sudanese fauna have not been published, but some mesostigmatids are of medical or agricultural significance (e.g. Keegan 1956). Specific examples here would include the tropical fowl mite which can induce human dermatitis (Lewis 1958) or the *Varroa* mite which parasitizes honey bees (El-Niweiri, El-Sarrag & Satti 2008). Several ectoparastic species have recorded from rats (Fagir & El-Rayah 2009). Phytoseiid mites (e.g. El-Badry 1967, 1968) are also worth mentioning as potential agents of biological control feeding on phytophagous mites and insects in agricultural ecosystems. Ixodida (ticks) from Sudan were documented in considerable detail by Hoogstraal (1956), who recorded more than fifty species. A caveat here is that this, and other older works, does not discriminate between the Republic of the Sudan and South Sudan, thus it is necessary to compare localities and distributions for individual taxa with modern political boundaries. Given the economic significance of ticks as disease vectors both in humans and domestic livestock, the Sudanese fauna has continued to attract a considerable body of research. A comprehensive review of the ticks and their biology in the Republic of the Sudan is beyond the scope of the present paper, but for recent summaries of ticks and tick-borne infections see Salih *et al.* (2004), El Hussein, Abdel Majid & Shawgi (2004), El Ghali & Hassan (2012), and references therein.

Scorpiones

The oldest account of Sudanese scorpions is the famous study by Hemprich & Ehrenberg (1828). They recorded the buthids *Androctonus amoureuxi* (Audouin, 1826) (Fig. 1) as *A. citrinus* Ehrenberg in Hemprich & Ehrenberg, 1828 (synonymized by Caporiacco 1932), *Androctonus australis* (Linneaus, 1758) as *A. funestus* Ehrenberg in Hemprich & Ehrenberg, 1828 (synonymized by Thorell 1876), *Buthacus leptochelys* (Ehrenberg, 1829) (Fig. 5) as *Androctonus thebanus* Ehrenberg in Hemprich & Ehrenberg, 1828 (synonymized by Kraepelin 1891), and *Leiurus quinquestriatus* (Ehrenberg in Hemprich & Ehrenberg, 1828) (Fig. 4) from Dongola (as "Dongala Nubiae") in Northern State.

The next formal records come from Pocock (1895) who described material collected by the British zoologist John Anderson (1833–1900). Pocock again recorded *B. leptochelys*, as well as two new species: *Parabuthus hunteri* Pocock, 1895 and *Nanobuthus andersoni* Pocock, 1895. Note that *N. andersoni* was transferred by El-Hennawy (1992) and Kovařík (2004) to *Butheolus* Simon, 1882, but that Kovařík & Lowe (2012) subsequently redefined the taxonomic position of *Butheolus*, which they regarded as endemic to the Arabian Peninsula. The monotypic *Nanobuthus* Pocock, 1895 has not been studied recently, but for now (Table 1) we assume that it is a valid taxon. Both *Parabuthus hunteri* and *Nanobuthus andersoni* were cited as coming from "Duroor" (or "Dooroor"), north of Suakin in Red Sea State. We could not find a modern equivalent for this locality, which should lie about 100 km (60 miles) north of Suakin or 50 km north of Port Sudan. However, nineteenth century atlases reveal a "Mirsa Durrur" on the Red Sea coast, whereby mirsa (or mirza) is a transliteration of the Arabic word 'marsa' meaning port. Indeed, Guttmann (1908) referred to Mirsa Durrur as a small harbour noted for the unusual presence of fresh water, allowing vegetable cultivation. The original locality is probably in an area now more or less equivalent to the Sudan Red Sea Resort hotel north of Port Sudan.

Subsequently, Tullgren (1907) recorded species collected in 1901 by the Swedish Zoological Expedition to Egypt and the White Nile. He again found *A. australis* at Dongola, a species from South Sudan (see below), and *Buthus acutecarinatus* (now *Compsobuthus acutecarinatus* (Simon, 1882)) from Wadi Halfa in Northern State. The latter is now regarded as a misidentification of *C. werneri* Birula (1908), a species (Fig. 2) subsequently recognized by Birula (1908) based on Wadi Halfa material collected by the Austrian zoologist Franz Werner (1867–1939). In the same paper, Birula (1908) recorded *C. acutecarinatus* (a misidentification) and *A. amoureuxi* (Audouin, 1826) from Wadi Halfa, and *Hottentota minax* (L. Koch, 1875) (Fig. 3) from Khartoum, on the way from Khartoum to Duem, and also from South Sudan. We should stress here that *C. acutecarinatus sensu lato* was often incorrectly cited in older publications as coming from both Africa and Asia but is, in fact, restricted to Yemen and Oman on the Arabian Peninsula. Note that Tullgren's (1907) record of *Hottentotta hottentotta* (Fabricius, 1787) from Kaka in Upper Nile State, South Sudan, is almost certainly a misidentification as this species should only occur in western and central Africa. Birula (1908) recorded the related species *Hottentota minax* between Khor-Attar and Mongalla and in Mongalla itself, both in South Sudan.

Hirst (1911) documented six species from the Republic of the Sudan collected by military personnel, including *Androctonus amoureuxi* (as *A. citrinus*) and presumably *Compsobuthus werneri* (as *C. acutecarinatus*). He added several new localities for *Hottentotta minax* and a new record of *Parabuthus hunteri* from Omdurman in Khartoum State. Hirst (1911) also introduced the first non-buthid scorpion: *Pandinurus sudanicus* (Hirst, 1911) (Scorpionidae) from the Gebel Mountains south of Al-Ubayyid [as Obeid] in North Kordofan. Note that Kovařík (2012) listed the type locality as "South Sudan", but was not referring to the

Table 1: Published records of the 49 currently valid arachnid species (excluding spiders and mites) documented from the Republic of the Sudan. Abbreviations for states: NS = Northern State, KHS = Khartoum State, SS = Sennar State, RSS = Red Sea State, AQS = Al Qadarif State, RNS = River Nile State, WNS = White Nile State, BNS = Blue Nile State, AGS = Al Gezira State, NDS = Northern Darfur State, CDS = Central Darfur State, NKS = North Kordofan State, SKS = South Kordofan State.

Taxon	Locality	State	Reference
	SCORPIONES		
Buthidae (15)			
1. *Androctonus amoureuxi* (Audouin, 1826)	Dongola; Wadi Halfa	NS	Hemprich & Ehrenberg (1828); Birula (1908); Hirst (1911); Werner (1911); King (1925)
2. *Androctonus australis* (Linneaus, 1758)	Dongola	NS	Hemprich et Ehrenberg (1828); Tullgren (1907)
3. *Buthacus leptochelys* (Ehrenberg, 1829)	Dongola; "Duroor" N of Suakin; Port Sudan	NS, RSS	Hemprich & Ehrenberg (1828); Pocock (1895); Werner (1911); King (1925); Borelli (1929)
4. *Buthus brignolii* Lourenço, 2003	Jebel Meidob, Darfur	NDS	Lourenço (2003)
5. *Buthus duprei* Rossi & Tropea, 2016	Port Sudan	RSS	Rossi & Tropea (2016a)
6. *Buthus karoraensis* Rossi & Tropea, 2016	Karora	RSS	Rossi & Tropea (2016b)
7. *Compsobuthus werneri* (Birula, 1908) [often misidentified as *C. acutecarinatus* (Simon, 1882)]	Wadi Halfa; Khartoum; Atbara; Sennar; "Duroor" N of Suakin	NS, KHS, RNS, SS, RSS	Tullgren (1907); Birula (1908); Hirst (1911); Werner (1911); Borelli (1929); Pettet *et al.* (1964); Kovařík & Ojanguren Affilastro (2013)
8. *Compsobuthus seicherti* Kovařík, 2003	Khartoum	KHS	Kovařík (2003); Kovařík & Ojanguren Affilastro (2013)
9. *Hottentota minax* (L. Koch, 1875)	Khartoum; Duem; Sennar; Roseires; Kaduqli; [Wad] Madani	KHS, WNS, SS, BNS, SKS, AGS	Birula (1908); Hirst (1911); Werner (1911); King (1925); Borelli (1929); Kovařík & Ojanguren Affilastro (2013)
10. *Hottentotta niloticus* Birula, 1928	Nile River valley, Kordofan and Sennar regions	SS, NKS, SKS	Birula (1928); Kovařík & Ojanguren Affilastro (2013)
11. *Leiurus quinquestriatus* (Ehrenberg, 1828)	Dongola; Wadi Halfa; Khartoum; "Blue Nile"; Nekhaila	NS, KHS, BNS, NDS	Hemprich & Ehrenberg (1828); Birula (1908); Hirst (1911); Werner (1911); King (1925); Borelli (1929); Pettet *et al.* (1964)
12. *Nanobuthus andersoni* Pocock, 1895	"Duroor" N of Suakin	RSS	Pocock (1995); Werner (1911); King (1925)
13. *Orthochirus aristidis* (Simon, 1882)	Wadi Halfa	NS	Lourenço & Leguin (2011)
14. *Parabuthus hunteri* Pocock, 1895	Omdurman; "Duroor" N of Suakin; Suakin	KHS, RSS	Pocock (1895); Hirst (1911); Werner (1911)
15. ?*Parabuthus abyssinicus* Pocock, 1901 [as *P. liosoma*]	Khartoum; Erkowit	KHS, RSS	King (1925)
Scorpionidae (2)			
16. *Pandinurus sudanicus* (Hirst, 1911)	mountains S of Al-Ubayyid; Lagowa; Ingessana Hills, SW of Roseires	NKS, SKS, BNS	Hirst (1911); Werner (1911); Kovařík (2012); Prendini (2016)
17. *Scorpio sudanensis* Lourenço & Cloudsley-Thompson, 2009	Erkowit	RSS	Lourenço & Cloudsley-Thompson (2009)
	OPILIONES		
Phalangiidae (1)			
1. *Metaphalangium sudanum* Roewer, 1961	Sinkat	RSS	Roewer (1961); Staręga (2004)
	PSEUDOSCORPIONES		
Cheridiidae (1)			
1. *Cheiridium nubicum* Beier, 1962	Wadi Halfa	NS	Beier (1962)
Olpiidae (4)			
2. *Calocheirus atopos* Chamberlin, 1930	near Port Sudan	RSS	Chamberlin (1930)
3. *Minnizia sola* Chamberlin, 1930	Khartoum	KHS	Chamberlin (1930)
4. *Minnizia vermis* Simon, 1881	near Port Sudan	RSS	Chamberlin (1930)
5. *Olpium tenue* Chamberlin, 1930	Wadi Halfa; Faras	NS	Chamberlin (1930); Beier (1962)
Atemnidae (1)			
6. *Diplotemnus insolitus* Chamberlin, 1933	Al Fashir [as El Fasher]	NDS	Beier (1946)
7. *Lamprochernes savignyi* (Simon, 1881)	Wad Medani	AGS	Beier (1946)
Cheliferidae (2)			
8. *Dactylochelifer nubicus* Beier, 1962	Wadi Halfa	NS	Beier (1962)
9. *Rhacochelifer nubicus* Beier, 1962	Wadi Halfa	NS	Beier (1962)
	SOLIFUGAE		
Daesiidae (5)			
1. *Biton ehrenbergi* Karsch, 1880	Dongola; Koliat, Khartoum	NS, KHS	Werner (1911); Benoit (1964)
2. *Biton lividus* Simon, 1881	Sennar; Kordofan; El Obeid	SS, NKS	Roewer (1933); Benoit (1964)
3. *Biton ragazzii* (Kraepelin, 1899)	Port Sudan	RSS	Roewer (1933); Benoit (1964)
4. *Biton wicki* (Birula, 1915)	Khartoum; "Abu-Gat"; Wad Medani; Koshak; Kulme	KHS, RSS, AGS, CDS	Birula (1915); Roewer (1933); Lewis (1958); Benoit (1964)
5. *Blossia spinosa* Simon, 1880	Sennar	SS	Roewer (1933)
Galeodidae (7)			
6. *Galeodes arabs* C. L Koch, 1842	Wadi Halfa; Khartoum; Omdurman; "Hawa", Nabardi Mines; Shendi; Umm Badr	NS, KHS, RSS, RNS, NKS	Kraepelin (1901); Tullgren (1907); Birula (1908); Hirst (1911); Werner (1911); Lewis (1958); Benoit (1964)
7. *Galeodes barbarus* Lucas, 1849	"Tourah"; Suakin	NDS?, RSS	Tullgren (1907); Benoit (1964)
8. *Galeodes edentatus* Benoit, 1964	Khartoum	KHS	Benoit (1964)
9. *Galeodes granti* Pocock, 1903	Khartoum	KHS	Benoit (1964)
10. *Galeodes schendicus* Roewer, 1934	Shendi	RNS	Roewer (1934)
11. *Othoes floweri* Hirst, 1911	Wadi Halfa	NS	Hirst (1911)
12. *Paragaleodes scalaris* (C. L. Koch, 1842)	not specified	RSS?	Werner (1911)
Rhagodidae (6)			
13. *Rhagodalma melanocephala* Roewer, 1933	"Nubia" (Darfur?)	—	Roewer (1933); Benoit (1964)
14. *Rhagodeya nubia* Roewer, 1933	Kosha [as Kosheh]; Sennar	NS, SS	Roewer (1933)
15. *Rhagodessa cloudsleythompsoni* Benoit, 1964	Khartoum	KHS	Benoit (1964)
16. *Rhagodessa melanocephala* (Simon, 1879)	"Nubia"	—	Werner (1911)
17. *Rhagodessa sudanensis* Roewer, 1933	Sennar	SS	Roewer (1933); Benoit (1964)
18. *Rhagoduna nocturna* Roewer, 1933	Sennar	SS	Roewer (1933); Benoit (1964)
Solpugidae (3)			
19. *Zeria fordi* (Hirst, 1907)	Nuba Mountains	SKS	Roewer (1933)
20. *Zeria funksoni* (Birula, 1915)	Galegu/Galezu (Dinder Nat. Park)	SS	Birula (1915); Benoit (1964)
21. *Zeriassa sudanica* Roewer, 1933	Sennar	SS	Roewer (1933); Benoit (1964)
	AMBLYPYGI		
Phrynichidae (1)			
1. *Damon variegatus* (Perty, 1834) [questionable record]	Tekezé River [as Sedith]	AQS	Werner (1911), but see Prendini, Weygoldt & Wheeler (2005)

political entity which became independent in 2011. *Pandinurus sudanicus* is a bone fide species for the Republic of the Sudan (Kovařík 2012: fig. 64). Originally treated as a subspecies of *Pandinurus exitalis* (Pocock, 1888), it was later synonymized before being revalidated as a full species by Kovařík (2012); a treatment accepted by Prendini (2016). Both Kovařík (2012) and Prendini (2016) added new locality data for this species, which also occurs in South Sudan and Chad; see also Kovařík *et al.* (2017). A synonym of *P. sudanicus* allegedly from South Africa may be based on erroneous locality data; see Prendini (2016) for a discussion.

Werner (1911) summarized the presence of 11 species of scorpion for Sudan; with the caveat that some records are from South Sudan and some species are now under different names. He added new species records for the buthid *Buthus occitanus* (Amoreux, 1789) from "Duroor" and the scorpionid *Pandinurus pallidus* (Kraepelin, 1894) from "Kordofan", and expanded the distribution records of several other species (data incorporated into Table 1). *Buthus occitanus sensu lato* is best understood as a complex of species and was recently divided into many local taxa, such that the specimens cited by Werner (1911) as *Buthus occitanus* are probably members of one of the *Buthus* species described recently from Sudan (see below). *Buthus occitanus sensu stricto* is found in France and Spain, and is thus excluded here (Table 1) from the fauna of Sudan. Another problematic record is *Pandinurus pallidus*, which is now regarded as endemic to Somalia (Kovařík *et al.* 2017: fig. 396). Its types are juveniles, which were long considered to be adults, such that Kovařík (2012: 20) assumed that "records of this species from the other countries are based on incorrectly identified juvenile specimens". We also exclude this species from the Sudanese fauna (Table 1). Note that Werner (1911) also reported *Pandinus imperator* (C. L. Koch, 1841) from the Gour country in South Sudan, but this record of a West African scorpion is undoubtedly incorrect (Fet *et al.* 2000).

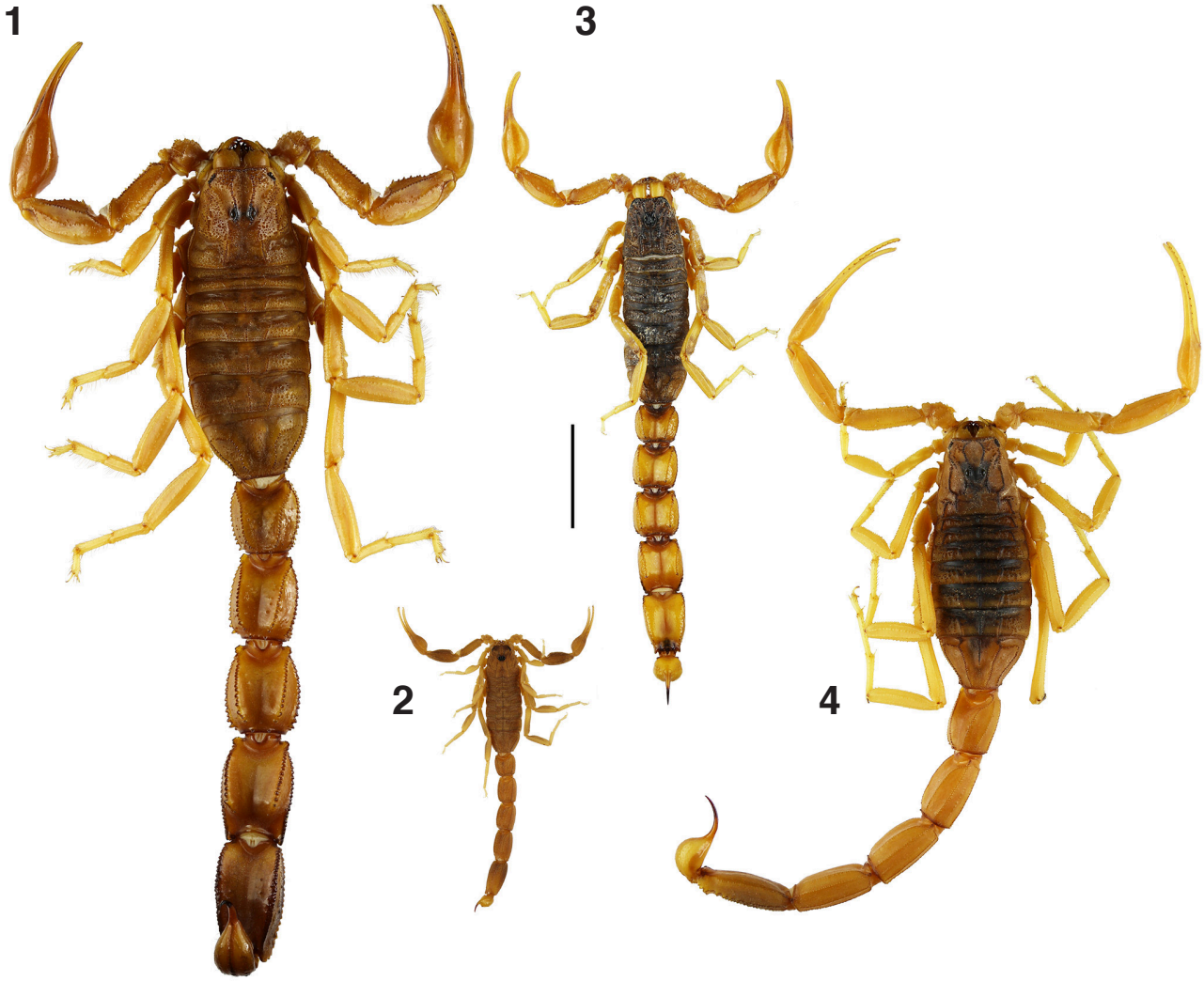
King (1925) added some new locality records for both South Sudan (see below) and the Republic of the Sudan, such as Kaduqliin in South Kordofan for *H. minax*, and Kosti in Western Nile State for *P. pallidus*, as well as a new species record for *Parabuthus liosoma* (Ehrenberg, 1828) collected north of Khartoum and at Erkowit near Sinkat in Red Sea State. The name *Parabuthus liosoma* was used by all authors between 1917 and 2016 for all populations of the *Parabuthus liosoma* complex. Subsequently, Kovařík *et al.* (2016b) split *Parabuthus liosoma sensu lato* into several species, of which *Parabuthus liosoma sensu stricto* occurs in Yemen and Saudi Arabia, while *P. abyssinicus* Pocock, 1901 occurs in Eritrea, Djibouti, and the central and northeastern parts of Ethiopia. Based on this distribution, the species which also occurs in Sudan is probably *P. abyssinicus*; thus, we tentatively list it as King's (1925) record in Table 1. He also recorded *Androctonus amoureuxi* from near Lake Turkana (as Lake Rudolf) and the same species (as *Buthus citrinus*) from Mongalla in South Sudan, and also added *Uroplectes fischeri* (Karsch, 1879) and *Parabuthus liosoma* (probably *P. abyssinicus*) from Lake Turkana from South Sudan. The occurrence of *U. fischeri* in South Sudan is to be expected (see Kovařík *et al.* 2016a: fig. 41).

Hottentotta niloticus Birula, 1928 was described from the Nile River valley, Kordofan, and Sennar regions. New species and records were added by Borelli (1929) including *Buthacus granosus* Borelli, 1929 from Port Sudan, which is now regarded as a synonym of *B. leptochelys*; see e.g. Kovařík (2005). In a preliminary note, Vachon (1955) reviewed the Sudanese scorpion genera, recognizing Saharan and Ethiopian faunal elements, and suggested that about twenty species in total should be present. Individual species were not listed. Lewis (1958) observed that the most commonly encountered scorpions were the buthids *Androctonus amoreuxi*, *Compsobuthus werneri*, *Hottentota minax* and *Leiurus quinqestriatus*. Cloudsley-Thompson (1961) made a detailed study of the biology of *L. quinquestriatus* (Fig. 4) based on Sudanese material. Pettet *et al.* (1964) recorded two scorpion species from Wadi Halfa, both previously known from this locality.

Recent additions to the buthid fauna, all currently endemic for the Republic of the Sudan, are *Buthus brignolii* Lourenço, 2003 from Northern Dafur State, *Compsobuthus seicherti* Kovařík, 2003 from Khartoum, and *Buthus duprei* Rossi & Tropea, 2016a and *Buthus karoraensis* Rossi &Tropea, 2016b from Port Sudan and the Karora enclave in Red Sea State respectively. Lourenço & Leguin (2011) added a record of the buthid *Orthochirus aristidis* (Simon, 1882) from Wadi Halfa. *Scorpio sudanensis* Lourenço & Cloudsley-Thompson, 2009 from Erkowit is another endemic which represents the first Sudanese record of the genus *Scorpio* (Scorpionidae). This brings the total species list (Table 1) up to seventeen species in two families for the Republic of the Sudan. Kinzelbach (1985) and El-Hennawy (1992) listed *Orthochirus innesi* Simon, 1910 as a Sudanese species, but this could not be confirmed by Lourenço & Leguin (2011), so the record is not included in Table 1.

A few scorpions were also described by Lourenço (2005) from what is now South Sudan and are noted here for completeness: *Babycurus solegladi* Lourenço, 2005, *Buthus jianxinae* Lourenço, 2005, and *Neobuthus sudanensis* Lourenço, 2005, all from Loka in the Bah El Jabal area; and *Butheoloides hirsti* Lourenço, 1996 from Mvolo. Prendini (2016) noted that a putative (South) Sudanese record of *Pandinoides militaris* (Pocock, 1900), is actually from Uganda.

Lewis (1958) claimed that scorpions are more common in the north of the country, although modern data (Table 1) suggests records throughout the Republic of the Sudan. He also included several references to the, sometimes lethal, clinical effects of scorpion venom. Scorpions thus represent a public health issue, and three species recorded from the Republic of the Sudan can be categorized as highly toxic: *Androctonus amoreuxi*, *A. australis*, and *Leiurus quinquestriatus* (popularly known as the 'deathstalker'). Pettet *et al.* (1964) mentioned that fatalities from *L. quinquestriatus* invariably affect children, while adults usually recover. Additional data, drawn from student interviews, on the prevalence, geographical distribution and effects of scorpion stings in Sudan can be found in Ali & Ali (2015).



Figs. 1–5: Comparative dorsal views of the most common representatives of scorpions from the Republic of the Sudan. **1** *Androctonus amoreuxi* (Audouin, 1826), male from Sabaloka Mt, *c*. 16°20′N 32°30′E, 24 October–14 November 2011, leg. Petr Pokorný; **2** *Compsobuthus werneri* (Birula, 1908), male from Sabaloka Mt, *c*. 16°20′N 32°30′E, 24 October–14 November 2011, leg. Petr Pokorný; **3** *Hottentotta minax* (L. Koch, 1875), male from New Halfa, Kassala State, 15°19′N 35°35′E, leg. M. Siyam 15 August 2014; **4** *Leiurus quinquestriatus* Ehrenberg, 1828, male from Sabaloka Mt, *c*. 16°20′N 32°30′E, 24 October–14 November 2011, leg. Petr Pokorný; **5** *Buthacus leptochelys* (Ehrenberg, 1829), male subadult from Khenifra, April 2015, leg. V. Trailin. Scale bar = 10 mm (1–4).

Opiliones

We could only trace a single record of a harvestman from the Republic of the Sudan. The suborder Eupnoi is represented here by *Metaphalangium sudanum* Roewer, 1961 from the family Phalangiidae. It was collected by John Cooke from Red Sea State (Roewer 1961), and later recorded from Egypt, Israel, and Saudi Arabia (Staręga 2004). This paucity of data for harvestmen is almost certainly an artefact of limited collecting opportunities. Whether the suborder Cyphopthalmi should be present in Sudan is difficult to say. The catalogue of Giribet (2000) does not show any species in neighbouring countries, but these are cryptic animals which are difficult to find without appropriate methods (e.g. sifting leaf litter). We found no published records of Dyspnoi, but it is also questionable whether the group should be here at all. There are some records of dyspnoids from North Africa (Schönhofer 2013), but the group appears to be generally absent in the Afrotropical region. The largely tropical Laniatores might have been expected in Sudan, and are certainly present in neighbouring Ethiopia and Chad for example (summarized by Staręga 1992).

Pseudoscorpiones

Pseudoscorpions are represented by nine species from five states. The oldest records stem from material collected by Stanley Hirst in the 1920s which was worked up by Chamberlin (1930). Note that, in this paper, the locality of Port Sudan in Red Sea State was erroneously assigned to Egypt. Beier (1962) studied Wadi Halfa material from Northern State and noted that the dry habitat here is not conducive to finding pseudoscorpions. Nevertheless, he was still able to describe three new species, all of which are currently listed (Harvey 2013a) as endemic for the Republic of the Sudan: *Cheiridium nubicum* Beier, 1962, *Dactylochelifer nubicus* Beier, 1962, and *Rhacochelifer nubicus* Beier, 1962. Other species records are for taxa also found in adjacent African or Middle Eastern countries. An exception is *Diplotemnus insolitus* Chamberlin, 1933, recorded from North Darfur in Sudan by Beier (1946) as the misidentification *D. piger*, which extends well into Asia. *Lamprochernes savignyi* (Simon, 1881) was recorded from Wad Medani in Al Gezira State by Beier (1946) and is otherwise found across several continents. A further species recorded by Beier (1946) comes from Lujulu in South Sudan.

Pseudoscorpions are actually quite ubiquitous, but tend to be overlooked because of their cryptic habitats. Searches of soil, leaf litter, bird nests, or cave ecosystems in Sudan would almost certainly reveal new records and probably new species. Note that *Atemnus letourneuxi* (Simon, 1881) reported by Tullgren (1907) comes from Kaka in Upper Nile State, South Sudan; it should be excluded from the fauna of the Republic of the Sudan.

Solifugae

Camel spiders are typically associated with arid habitats which are, of course, plentiful in the Republic of the Sudan. This is reflected in relatively rich records (21 species in four families: Table 1) and a fairly extensive literature. For example, observations of Sudanese species underlay many of Cloudsley-Thompson's (1961, 1977) important results about the behaviour and general biology of these animals. The oldest published record from Sudan we are aware of is Kraepelin (1901) who mentioned *Galeodes arabs* C. L. Koch, 1842 from Sudan, but without locality details. Tullgren (1907) identified three species. He recorded *G. arabs* from Omdurman and *G. barbarus* Lucas, 1849 from "Tourah". We were unable to place this locality in a modern context; some places with a similar name are found in western Dafur, but this is not on the White Nile where the relevant expedition took place. It could even be an alternative rendering of "Duroor" (see above). His third record, the predominantly Asian species *Galeodes araneoides* (Pallas, 1872) from Shendi (as Shendy), was regarded by Hirst (1911) as a probable misidentification. It is not included in Table 1. Birula (1908) also recorded *G. arabs* from Khartoum as part of Franz Werner's expedition to Sudan and Uganda. Several species collected by British military officers were added by Hirst (1911), including the endemic *Othoes floweri* Hirst, 1911 from Wadi Halfa.

Sudanese camel spiders were summarized for the first time by Werner (1911), who remarked that *Galeodes arabs* is the largest and most frequently encountered species (see also Table 1). It is still known locally as the 'karaba'. He also mentioned *Paragaleodes scalaris* (C. L. Koch, 1842) from an unspecified locality; possibly on the Red Sea coast, as the species is also known from Egypt and Saudi Arabia. This record was not picked up by Harvey (2013c) in his distribution data. Birula (1915) added two species collected by the Russian collector S. N. von Wick. One is from "Abu Gat" (as Abu-Gas) which could be the coastal locality labelled in nineteenth century atlases as "Scherm Abu Gat" in the northern part of Red Sea State, close to the Egyptian border. In this context "scherm" may refer to a (temporary) shelter, which would explain why the locality is no longer seen on modern maps. The other von Wick record is from Galegu, which is in Sennar State as part of the Dinder National Park. The daesiid *Biton wicki* (Birula, 1915) was later found in neighbouring parts of East Africa (Benoit 1964; Delle Cave & Simonetta 1971), but the solpugid *Zeria funksoni* (Birula, 1915) is currently endemic to the Republic of the Sudan.

Six species were added by Roewer (1933, 1934) from Kosha (as Kosheh) in Northern State, Sennar in Sennar State, Shendi (as Schendi) in River Nile State and an unspecified part of "Nubia". All are currently regarded (cf. Harvey 2013c) as endemic for the Republic of the Sudan: *Galeodes schendicus* Roewer, 1934 in the Galeodidae, and *Rhagodalma melanocephala* Roewer, 1933, *Rhagodes sasudanensis* Roewer, 1933, *Rhaogodeya nubia* Roewer, 1933, *Rhagoduna nocturna* Roewer, 1933 and *Zeriassa sudanica* Roewer, 1933 in Rhagodidae. It is worth noting (see also comments in Harvey 2003) that there are several shortcomings with Roewer's approach to camel spider systematics and we would caution that his Sudanese genera and species have not been revised since the original descriptions. Lewis (1958) also noted that *G. arabs* is the largest and most common species and added several new localities for it. He remarked that while it is locally feared, it is actually quite

harmless. Benoit (1964) summarized previous records of Sudanese camel spiders (data incorporated into Table 1) as well as describing two additional species from Khartoum, both of which are currently endemic: *Galeodes edentatus* Benoit, 1964 (Galeodidae) and *Rhagodesa cloudsleythompsoni* Benoit, 1964 (Rhagodidae).

We are not aware of any more recent taxonomic publications on Sudanese camel spiders. Two records from South Sudan, noted under Sudan in general by Werner (1911), have already been separated out in the online catalogue of Harvey (2013c): *Solpugas sadentatidens* (Simon, 1879) comes from the White Nile region and *Zeria schweinfurthi* (Karsch, 1880) from the Jur River. The ubiquitous *G. arabs* has also been recorded from Mongalla in South Sudan (Benoit 1964).

Amblypygi

Whip spiders are represented by a single species, originally assigned to *Damon variegatus* (Perty, 1834). This record by Werner (1911) lacks locality details, but may be based on a specimen from the Vienna museum which Prendini, Weygoldt & Wheeler (2005) listed as coming from the "River Sedith" [sic: Setit]; now better known as the River Tekezé which flows from Eritrea into Sudan. Note that they treated this as a dubious record of *D. variegatus* outside its typical range and possibly belonging to another, as yet unidentified, species. The catalogue of Harvey (2003, 2013b) records several other species of Amblypygi from East Africa up into Egypt (see also El-Hennawy 2002) or on the other side of the Red Sea. More Sudanese whip spider species might thus be expected.

Other arachnids

There are no published reports of palpigrades (Palpigradi), ricinuleids (Ricinulei), whip scorpions (Thelyphonida) or schizomids (Schizomida) from the Republic of the Sudan. It is possible that palpigrades could be present, as they have been listed by Harvey (2003) from North Africa (Algeria) and East Africa (Kenya), as well as Saudi Arabia across the Red Sea. However, they are typically found in specialized, usually subterranean, ecosystems which have not been extensively sampled in Sudan. Similarly, schizomids have been listed from East Africa (Somalia, Tanzania) and could thus be present in Sudan, but again these tend to be cryptic arachnids which are less commonly recorded. Finally, ricinuleids and whip scorpions would not be expected in Sudan as the only known African species have a distinctly West African distribution.

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