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RESEARCH ARTICLE

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New collection records for Theraphosidae (Araneae, Mygalomorphae) in Angola, with the description of a remarkable new species of *Ceratogyrus*

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Abstract

During 2015 and 2016 several baboon spider specimens (Araneae: Theraphosidae) were collected in central Angola during surveys undertaken for the Okavango Wilderness Project. These collections represent range and habitat extensions for *Pterinochilus* Pocock, 1897, *Ceratogyrus* Pocock, 1897 and *Phoneyusa* Karsch, 1884. The new species *Ceratogyrus attonitifer* **sp. n.** is described from female specimens and the distribution of genera mapped. Central and eastern Angola is severely under sampled for theraphosid spiders, with every species collected during the survey either being potentially new to science or representing a significant range extension for the genus.

Keywords

Arachnida, *Pterinochilus*, *Ceratogyrus*, *Phoneyusa*, Theraphosidae, biodiversity, survey, taxonomy

Introduction

The National Geographic Okavango Wilderness Project (OWP) was initiated in 2015 to investigate biodiversity in the entire Okavango catchment of Angola, Namibia and Botswana, and to introduce sustainable conservation in the area. Previous assessments of the Okavango system have focussed on the delta in Botswana only, due in part to civil war in Angola, where the majority of the catchment is located. Access to central Angola is also logistically difficult, resulting in a sampling gap where high potential for biodiversity exploration exists.

Published records of Theraphosidae from Angola are rare, compared to other southern African countries (Smith 1990, Gallon 2002, 2008, Gallon and Engelbrecht 2011, van Noort and Ranwashe 2017, Denver Museum of Nature & Science 2018, Grant and Maier 2018, iNaturalist.org 2018, Lyle and Ranwashe 2018, Senckenberg 2018, Tarantupedia 2018), with only nine species in five genera currently known from the country (Figure 1, Table 1). Many Afrotropical ecoregions converge in Angola, resulting in high biodiversity and endemism of other taxa (Myers et al. 2000). When the low diversity of theraphosids and high diversity of other taxa are considered together, it suggests a lack of knowledge of Angolan Theraphosidae, making any new collections potentially important.

The genus *Ceratogyrus* Pocock, 1897 currently includes nine species, with most confined to southern Africa. These are *C. brachycephalus* Hewitt, 1919, *C. darlingi* Pocock, 1897, *C. dolichocephalus* Hewitt, 1919, *C. hillyardi* (Smith, 1990), *C. marshalli* Pocock, 1897, *C. meridionalis* (Hirst, 1907), *C. paulseni* Gallon, 2005, *C. pillansi* (Purcell, 1902) and *C. sanderi* Strand, 1906 (World Spider Catalog 2018). Those species which occur outside of southern Africa, as traditionally defined as the area south of the northern borders of Namibia, Zimbabwe, and the Zambezi river in Mozambique, are *C. sanderi* which extends into Zambia and Malawi, and *C. meridionalis* which occurs in Malawi and Mozambique north of the Zambezi River. We describe a remarkable new species collected from the Okavango catchment in Angola and also report on new records for other theraphosid genera collected from the OWP survey region and their implications for the current understanding of the diversity, distribution and ecology of this family in the country.

Materials and methods

Specimens were collected during the 2015 and 2016 OWP field trips in central Angola. Sampling areas fell within miombo (*Brachystegia*) woodland with associated dambos (seasonal wetlands, Figure 2A). Spider burrows were located during the day and excavated at night when conditions were more conducive to collecting. Wandering male theraphosid spiders were collected in pitfall traps and by active searching under logs and other surface cover. Sampling took place throughout the landscape, but female theraphosids were only collected from the dambos and marginal miombo.

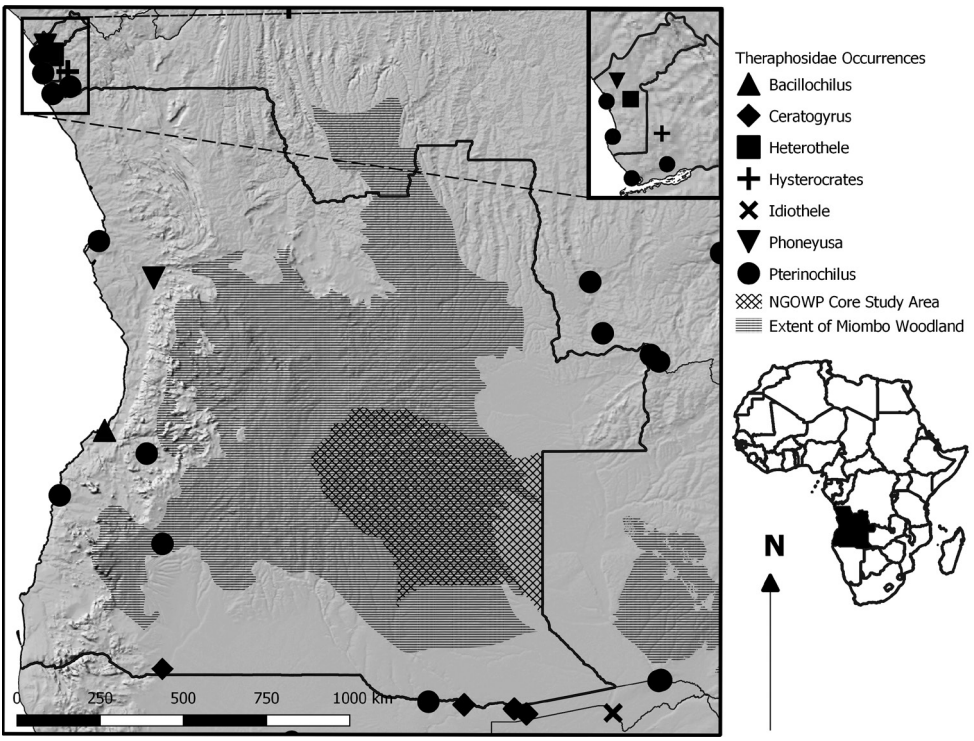

Figure 1. Map of the Okavango Wilderness Project study region in south-eastern Angola, known records of baboon spiders (Araneae: Theraphosidae) for Angola and adjacent parts of neighbouring countries, and extent of miombo woodland. Inset shows Cabinda Province. Prepared in QGIS V3.2 using publicly available spatial layers from the World Wildlife Foundation (Olson et al. 2001), www.naturalearthdata.com and www.mapcruzin.com. Background is shaded relief.

Table 1. Species of baboon spiders (Araneae: Theraphosidae) currently known from Angola, based on the primary taxonomic literature. Species with a dash (–) for Year Collected do not have collection event data associated with the specimen record.

Species	Year first recorded	No. records	Source	Reference
Bacillochilus xenostridulans Gallon, 2010	1905	1	Primary literature	Gallon 2010
Ceratogyrus sanderi Strand, 1906	1983	1	Published distribution records	van Noort and Ranwashe 2017
Pterinochilus cryptus Gallon, 2008	1956	1	Primary literature	Gallon 2008
Pterinochilus murinus Pocock, 1897	1973	1	Primary literature	Gallon 2002
Heterothele honesta Karsch, 1879	–	1	Primary literature	Karsch 1879
Pterinochilus simoni Berland, 1917	1876	2	Primary literature	Gallon 2002
Pterinochilus vorax Pocock, 1897	1900	1	Primary literature	Gallon 2002
Phoneyusa westi Smith, 1990	1900	1	Primary literature	Smith 1990
Phoneyusa gracilipes (Simon, 1889)	–	1	Primary literature	Simon 1889

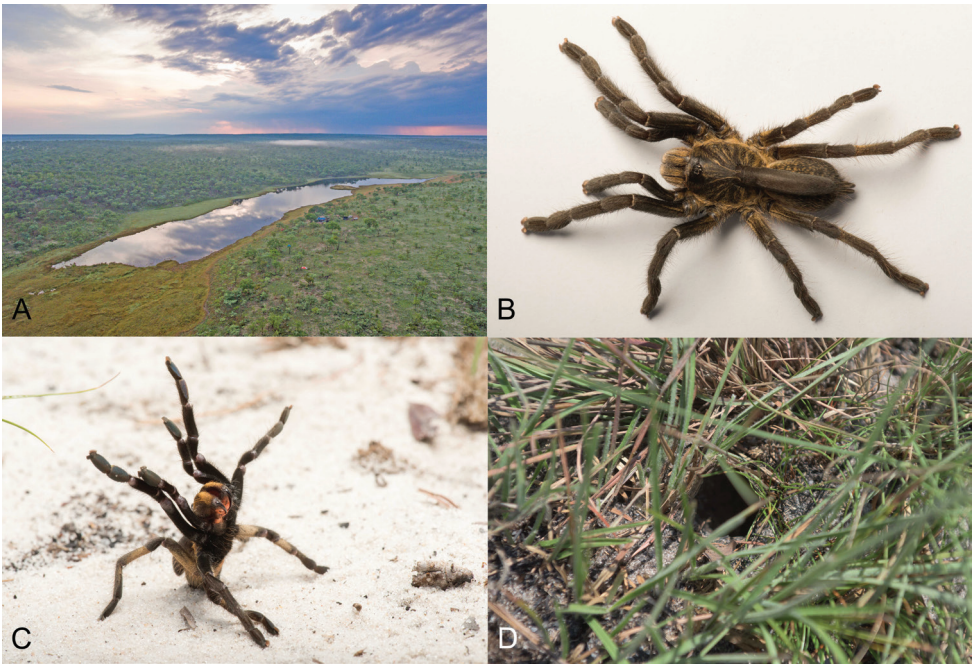

Figure 2. Habitat, burrow and live habitus of *Ceratogyrus attonitifer* sp. n. in south-eastern Angola. **A** Aerial view of habitat at the type locality showing a dambo (wetland) amongst miombo (*Brachystegia*) woodland. The expedition campsite is to the right of the dambo. Specimens were collected primarily along the margins of the wetland area **B** live habitus, dorsal, showing full size of the foveal protuberance in life **C** specimen in defensive posture typical for baboon spiders; background is white sand at the type locality **D** burrow entrance amongst grass tussocks; entrance approximately 2cm wide.

Specimens were photographed in the wild and then killed humanely and preserved in 80% ethanol. Digital images of the cephalothorax were taken using a Canon 5D Mark II camera with a Tamron 90mm macro lens. Images of ocular tubercle and spermathecae were taken using a high resolution AxioCam MRc5 camera mounted on a Zeiss Axio Zoom V16 microscope. Measurements of the carapace, palps, and legs were taken using Vernier callipers accurate to 0.5mm. Ocular measurements were taken on the same Zeiss Axio Zoom V16 microscope. Counts of cuspules on the labium and maxilla were taken from images using the Count Tool in Adobe Photoshop CC. Clavate trichobothria on the tarsi were counted directly under the microscope. Counts for cuspules and clavate trichobothria were taken from four specimens and ranges are presented. Terminology for the description follows that of Gallon and Engelbrecht (2011). Abbreviations are AER: anterior eye row; ALE: anterior lateral eyes; AME: anterior median eyes; DPD: distal prodorsal; DPV: distal proventral; DRD: distal retrodorsal; DRV: distal retroventral; PER: posterior eye row; PLE: posterior lateral eyes; PME: posterior median eyes. Specimens are deposited in the Albany Museum, Grahamstown (AMGS), National Collection of Arachnida, Pretoria (NCA), the Kwa-

Zulu-Natal Museum, Pietermaritzburg (NMSA), and the Museum für Naturkunde, Berlin (ZMB). Maps of the survey area were prepared in QGIS 3.2 using publicly available spatial layers from the World Wildlife Foundation (Olson et al. 2001), www.naturalearthdata.com and www.mapcruzin.com.

Known locality records for theraphosids were extracted from the Tarantupedia (www.tarantupedia.com) and the Global Biodiversity Information Facility (van Noort and Ranwashe 2017, Denver Museum of Nature & Science 2018, Grant and Maier 2018, Lyle and Ranwashe 2018, Senckenberg 2018), the largest available databases of Theraphosidae locality records, and include published records from the primary taxonomic literature. These served as the basis for assessment of the new records collected during the survey. The specific locality details of the new records are redacted from this publication due to concerns that they may facilitate illegal collecting for the pet trade (see Lindenmayer and Scheele 2017). Researchers and conservation officials interested in those records may obtain them directly from the institutions where the specimens are deposited.

Results

Taxonomy

Family THERAPHOSIDAE Thorell, 1869
Subfamily Harpactirinae Pocock, 1897
Genus *Ceratogyrus* Pocock, 1897

***Ceratogyrus attonitifer* Engelbrecht, 2019, sp. n.**
http://zoobank.org/3aed634b-961f-471c-9bbf-fea83a06a94d
Figures 2B, C, 3A–C, 4A, B

Type material. Holotype ♀: NCA 2018/334. Angola, Moxico Province. Locality data redacted. 2016/10/31 to 2016/11/04. J.M. Midgley. Excavated from burrows.

Paratypes: 1 ♀: NCA 2018/335. Label data as for holotype. 2 ♀: NMSA 29340 (Type No: 2335). Label data as for holotype. 2 ♀ ZMB/arach 49121, ZMB/arach 49122. Label data as for holotype.

Diagnosis. *Ceratogyrus attonitifer* sp. n. can be diagnosed from its congeners, and all other species of Theraphosidae, by the presence of a large, elongate protuberance which extends out of the fovea and over the spider's abdomen (Figure 2).

Etymology. The specific epithet is derived from the Latin root attonit–, meaning astonishment or fascination, and the suffix –fer, bearer of or carrier, and refers to the astonishment felt by the authors at the discovery of this remarkable species.

Generic placement. The presence of distinct scopulae made up of plumose setae on the retrolateral surfaces of the chelicerae support the inclusion of this species in the Harpactirinae. The new species is placed in the genus *Ceratogyrus* on the basis of the presence of a foveal protuberance. While not all *Ceratogyrus* species possess a foveal

Figure 3. *Ceratogyrus attonitifer* sp. n. paratype, cephalothorax. **A** retrolateral view **B** dorsal view **C** ventral view. Scale bar: 10mm (**A**).

horn or protuberance, all known species of the theraphosid subfamily Harpactirinae which do possess such a structure are placed within this genus. A diagnosis for the genus *Ceratogyrus* is provided in Gallon (2001).

Description. Measurements are presented in Table 2.

Carapace (Figure 3A, B): Golden brown with paler coloration distally; ovate, hirsute with fringe of longer, pale setae on lateral and posterior margins. Cephalic region flat in lateral profile, not distinct from thoracic region. Ocular tubercle distinct with eye pattern as in Figure 4A. Eye sizes (mm): AME: 0.3 (0.27–0.32), ALE: 0.46 (0.36–0.51), PME: 0.22 (0.18–0.25), PLE: 0.41 (0.38–0.44). ALE larger than all other eyes, ca. 1.5x diameter of AME; PLE larger than PME, AME and PLE similar in size. Clypeus relatively wide, straight, with fringe of short, anteriorly oriented setae on anterior margin. Fovea strongly procurved with prominent, elongate protuberance extending over dorsal aspect of abdomen, as long as or longer than carapace length, anterior part extending from carapace sclerotized, remainder soft and membranous, bag-like in living specimens, becoming shrivelled when preserved, dark in colour.

Chelicerae: Golden brown, hirsute on dorsal, prodorsal and anterior surfaces. Retrolateral surface concave, more so ventrally, with distinct, well developed scopula of plumose setae. Prolateral surface with fine, sparse setae, no plumose setae; ventral surface with single row of seven large teeth along promargin and single, small depression anterior to first tooth; >10 smaller teeth or denticles on proximal ventral surface external to larger teeth. Promargin with long, slender, grey setae; retromargin with long, red, wooly setae corresponding to those on maxilla.

Sternum, labium and maxillae (Figure 3C): sternum densely hirsute with short black setae, longer setae marginally and anteriorly. Sigilla not apparent. Labium sparsely hirsute with elongate, slender setae and ca. 60–85 cuspules. Maxillae densely covered in 250–320 cuspules on proximal region of ventral surface; ventral surface also with sparse medium to long, slender setae, becoming shorter on retrolateral surface. Prolateral surface with sparse, elongate setae; proventral margin with elongate, red, woolly setae, no spiniform setae present.

Legs and pedipalps: all femora golden brown dorsally; palps and legs I and II dark brown for remainder of dorsal and retrolateral surfaces; legs III and IV golden brown for remainder of dorsal surface. Palps and legs I and II dark brown to black ventrally and prolaterally as is typical for the genera *Ceratogyrus* and *Augacephalus* (Gallon 2005). Legs III and IV with alternating broad, pale and narrow dark brown bands as follows: majority of femora yellow-brown but with proximal and distal margins dark brown, patella dark brown, tibia yellow-brown. Palp and leg tarsi scopulate for entire ventral surface; all leg tarsi with paired claw tufts concealing paired tarsal claws, third claw absent, but a small triangular patch of longer scopular setae is present in its place. Metatarsi scopulate, scopulae entire for legs I-III, divided by longitudinal row of setae on leg IV. Scopulae broad and covering almost entire non-articulating surfaces of metatarsi I and II, approximately distal ¾ of metatarsus III, narrow and tapering for metatarsus IV covering distal 2/3 of non-articulating surface. Dorsal surface of palp and leg tarsi with

Table 2. Measurements of female specimens of the type series and two additional specimens.

	Specimen Number								Mean (range)
	1	2	3	4	5	6	7	8	
Total length	33.5	30.0	37.0	29.5	40.5	37.0	28.0	36.5	34.0 (28.0–40.5)
Carapace length	15.5	16.0	16.5	13.0	19.0	15.5	15.0	18.0	16.0 (13.0–19.0)
Carapace width	12.0	12.0	12.5	9.5	15.0	11.5	12.0	13.5	12.0 (9.5–15.0)
Palp femur length	8.0	7.5	7.5	6.5	8.5	7.0	6.5	8.5	7.5 (6.5–8.5)
Palp patella length	5.5	4.5	5.5	4.5	6.0	5.0	6.5	5.5	5.5 (4.5–6.5)
Palp tibia length	5.5	4.5	5.0	4.5	5.5	5.0	5.0	4.5	5.0 (4.5–5.5)
Palp tarsus length	5.0	6.0	5.5	5.0	7.0	5.5	5.5	6.0	5.5 (5.0–7.0)
Femur I length	9.0	10.0	10.0	9.0	8.0	9.5	9.0	11.0	9.5 (8.0–11.0)
Patella I length	6.5	6.5	7.0	6.0	5.5	6.5	6.5	8.0	6.5 (5.5–8.0)
Tibia I length	7.0	6.5	7.0	6.0	7.0	6.5	6.5	8.0	7.0 (6.0–8.0)
Metatarsus I length	6.0	6.5	6.5	5.5	6.5	6.0	6.0	7.0	6.5 (5.5–7.0)
Tarsus I length	5.0	4.5	5.0	4.5	5.0	5.0	4.5	5.0	5.0 (4.5–5.0)
Femur II length	9.5	8.5	9.5	7.0	10.0	8.5	8.5	10.0	9.0 (7.0–10.0)
Patella II length	6.5	5.5	6.0	5.5	7.0	5.0	5.5	7.0	6.0 (5.0–7.0)
Tibia II length	6.5	5.5	5.5	5.0	6.5	5.5	5.5	6.5	6.0 (5.0–6.5)
Metatarsus II length	7.0	6.0	7.0	5.5	7.0	5.5	5.5	7.0	6.0 (5.5–7.0)
Tarsus II length	5.0	9.5	4.5	4.5	4.5	4.5	5.5	4.5	5.5 (4.5–9.5)
Femur III length	7.5	8.0	8.5	7.0	9.5	7.5	7.0	8.5	8.0 (7.0–9.5)
Patella III length	5.0	5.0	5.5	5.5	6.0	5.0	5.0	6.0	5.5 (5.0–6.0)
Tibia III length	6.0	5.0	5.0	4.5	6.0	4.5	4.5	5.5	5.0 (4.5–6.0)
Metatarsus III length	6.5	6.5	7.0	6.0	7.5	6.5	5.0	7.5	6.5 (5.0–7.5)
Tarsus III length	4.5	4.5	5.0	4.5	5.0	4.5	5.0	5.0	5.0 (5.4–5.0)
Femur IV length	10.0	10.5	10.5	9.5	12.0	10.0	9.5	11.0	10.5 (9.5–12.0)
Patella IV length	5.5	5.5	5.5	5.0	6.5	5.5	5.5	6.5	5.5 (5.0–6.5)
Tibia IV length	5.5	7.0	7.5	7.0	8.5	7.5	7.5	8.0	7.5 (5.5–8.5)
Metatarsus IV length	9.5	9.5	10.0	8.0	11.0	8.0	9.5	11.0	9.5 (8.0–11.00)
Tarsus IV length	5.5	5.5	6.0	5.0	5.5	5.0	5.5	5.5	5.5 (5.0–6.0)

long, scattered setiform trichobothria and two distal submedian rows of short, clavate trichobothria. For palps and legs I, II, III, and IV counts of clavate trichobothria as follows: 6–21, 12–27, 13–30, 16–29, 15–29. Spination: all leg tibia with 1DPV, 1DRV; metatarsi III and IV with 1DPD, 1DRD; remaining segments without spines.

Abdomen: densely hirsute with short setae and more sparse, elongate setae; dorsal and lateral surfaces brown with golden speckles. Ventrally, book lungs covered with pale, yellow-brown transverse bands, separated by narrow, black band of setae, remainder of ventral surface posterior to book lungs, and spinnerets, black. Distal segment of posterior spinnerets digitiform, but not markedly elongate.

Spermathecae (Figure 4B): Simple, paired, unlobed, flattened in cross section; relatively broad, widening at their base, no swollen terminus. Not diagnostic within the genus.

Additional material. NCA2018/328: 1 imm. Angola, Moxico Province. Locality data redacted. 2016/11/20. W. Conradie. Pitfall traps.

Ecology. *Ceratogyrus attonitifer* sp. n. occurs in miombo woodland in south-eastern Angola. All specimens were collected from open burrows in sandy soil in

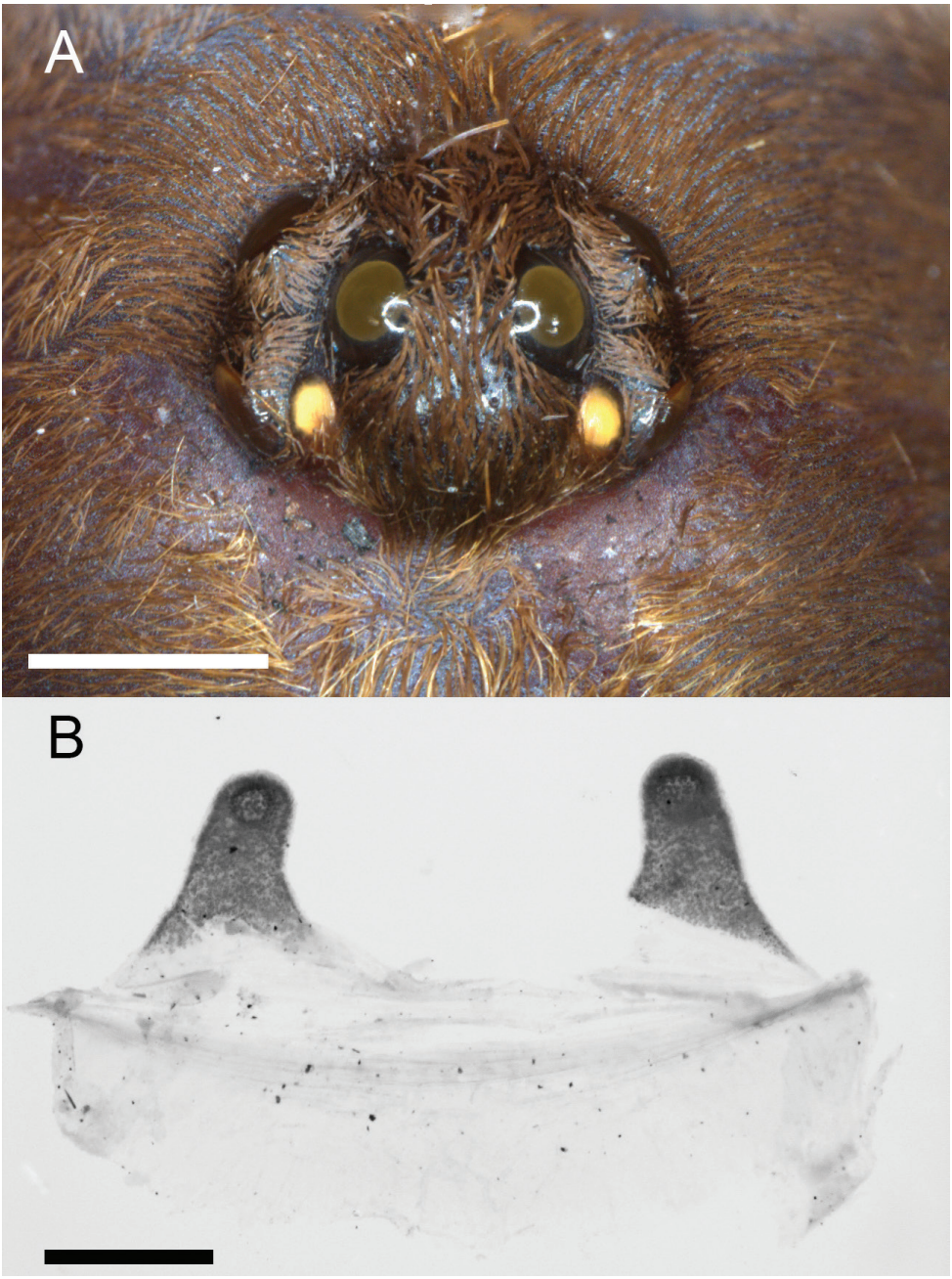

Figure 4. *Ceratogyrus attonitifer* sp. n. paratype. **A** ocular tubercle showing eye pattern **B** spermathecae. Scale bars: 1 mm (**A**); 0.5 mm (**B**).

dambos, between the high-water flood line and the miombo woodland edge (Figure 2A). Burrows (Figure 2D) were approximately 40 cm deep, and near vertical with a horizontal chamber at the bottom. Burrow entrances have a low collar made of silk

and incorporate surrounding grass and twigs, but the collar is not as large and distinctive as in some other species of *Ceratogyrus*. The entrances are often hidden among grass tufts, but may also be found in open sand. Any object inserted into the burrow was attacked enthusiastically.

Indigenous knowledge. This species is known as "Chandachuly" in the Luchazi language. It was reported that they prey mainly on insects. The venom is not considered to be dangerous, though bites may result in infections which can be fatal due to poor medical access. It is claimed that the females enlarge existing burrows rather than digging their own burrows, though this needs to be verified as both behaviours are known in harpactirines.

Distribution records

Notable new locality records were found for all theraphosid genera collected. Apart from the new species *Ceratogyrus attonitifer* sp. n., the collections were the first records of *Phoneyusa* Karsch, 1884 and *Pterinochilus* Pocock, 1897 from miombo woodland in Angola. They also represent a range extension and first record for *P. lugardi* Pocock, 1900 in Angola (AMGS 99714 – 99717, NCA 2018/325, NCA 2018/333). In addition to the new species described here, the survey produced specimens of two other potentially undescribed species, one in the genus *Ceratogyrus* (AMGS 99712, NCA 2018/326, 2018/327, 2018/332), and the other in *Pterinochilus* (AMGS 99713). Descriptions of these species require additional material to assess variation and for proper diagnoses from congeners.

Discussion

The new species of *Ceratogyrus* described here is remarkable. No other spider in the world possesses a similar foveal protuberance. The function of the foveal protuberance, or 'horn', in *Ceratogyrus* is uncertain. Members of other theraphosid genera from the Neotropics, namely *Cyrtopholis* Simon, 1892, *Sphaerobothria* Karsch, 1879 and *Umbyquyra* Gargiulo, Brescovit & Lucas, 2018, also possess similar foveal structures, as do some species of the ctenizid genus *Stasimopus* in South Africa, and several aganippine idiopid genera from Australia (M. Rix pers. comm.). The protuberance of *C. attonitifer* is unique in its length, as well as being soft, whereas this structure is fully sclerotized in all other genera where it is known to occur.

Prior to, and even including, this work, very little was known about Angolan Theraphosidae, as is the case for Angolan biodiversity in general. Despite being a minor contribution, the new records presented here and the synopsis of historical records represents, to the best of our knowledge, the most complete assessment of the Angolan theraphosid fauna to date. Previous records are limited to the western quarter of the country, highlighting the paucity of biodiversity data for central and eastern Angola

(Figure 1). Biodiversity exploration in Angola still offers many potential new scientific discoveries, particularly in the eastern provinces.

The occurrence of the genus *Ceratogyrus* in central Angola represents a substantial range extension for the genus. *Ceratogyrus* is known primarily from southern Africa, south of the Cunene and Zambezi Rivers, and is most diverse in Zimbabwe with six of the nine previously described species occurring there. One species, *C. sanderi* Strand, 1906, has also been recorded in the southern parts of Angola (Table 1, van Noort and Ranwashe 2017), and several records have been obtained from Zambia and Mozambique through an atlas project driven primarily by citizen scientists (Campbell and Engelbrecht 2018). The collection of *Ceratogyrus attonitifer* sp. n. and another potentially undescribed *Ceratogyrus* in Angola represents a range extension of approximately 400 km for the genus. Its occurrence in miombo woodland suggests that the genus may be more widely distributed in central Africa. The miombo woodland ecoregion extends from the southern parts of the Democratic Republic of Congo (DRC) through central and eastern Angola, most of Zambia and Zimbabwe, and into Tanzania and Mozambique. Extensive collecting effort will be required to establish the true distribution of this genus in the country.

The genus *Pterinochilus* is known from four species in Angola, *P. cryptus* Gallon, 2008, *P. murinus* Pocock, 1897, *P. simoni* Berland, 1917 and *P. vorax* Pocock, 1897. *Pterinochilus murinus* is a widespread species in east and central Africa, occurring from southern Kenya through Tanzania, Mozambique, the southern DRC, Zambia and Zimbabwe. There is a single published locality record from southwestern Angola, although the lack of records from elsewhere in the country is likely a result of lack of collecting rather than absence of the species. *Pterinochilus cryptus* is described from the arid south western part of the country (Gallon 2008), and appears to be widely distributed in that arid ecoregion (M. Sakko, pers. comm.). *Pterinochilus simoni* is known from the enclave of Cabinda in the north of Angola, and occurs throughout the central and northern parts of the DRC. *Pterinochilus vorax* is known from a two records in the north west of the country, and also occurs in the southern DRC and northern Zambia Gallon 2002). The discovery of *P. lugardi* during the Okavango Wilderness Project surveys increases the total number of species known for Angola to five. Together with the potentially undescribed species recorded during the survey, these records extend the distribution range of the genus in Angola by almost 600km. The single record of *P. murinus* is from within the miombo woodland ecoregion, and the new records from this survey again indicate the wider distribution of the genus in miombo.

The genus *Phoneyusa* is represented by two species in Angola, *P. gracilipes* (Simon, 1889) and *P. westi* Smith, 1990. Both are known from single records from the northwestern parts of the country, *P. gracilipes* from Landana, Cabinda and *P. westi* from Dondo (Smith 1990). The locality "Dondo" is somewhat uncertain, as multiple settlements in Angola have this name (in the provinces Huambo, Huila, Cuanza Norte and Uige), or similar names (e.g. Dundo, Lunda Norte). As the collection date predates the founding of Dundo, we have considered the spelling to be correct. We have assumed the largest settlement, in Cuanza Norte, to be correct. Access from Luanda was possible in the early 1900s, after the construction of the Luanda Railway in 1889. All Dondo

localities are in western Angola and so, despite some uncertainty, do not diminish the importance of the new locality. The collection of the unidentified female specimen of *Phoneyusa* in central Angola (NCA 2018/331) during this survey represents a range extension for the genus of over 600 km and the first record for the country from miombo woodland. Currently the genus is poorly known taxonomically and requires revision (Smith 1990). Collection of adult males should be a priority for revisionary work. Only on completion of a revision would it be possible to determine if this new locality record represents a broader ecological niche width of a known species or a new species which may have evolved independently in miombo woodland.

Despite only presenting data for twelve specimens, this study has shown significant range expansions for three genera. The general paucity of biodiversity data for Angola is clearly illustrated by this example with theraphosid spiders, highlighting the importance of collecting specimens in biodiversity frontiers.

Acknowledgments

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