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Description of a new species of *Heteroscorpion* Birula, 1903 (Scorpiones, Heteroscorpionidae) from 'Grande avasoa' in extreme southern Madagascar

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(with 9 figures)

Abstract

The endemic Malagasy genus *Heteroscorpion* Birula 1903 of the family Heteroscorpionidae was monotypic for a century with *H. opisthacanthoides* (Kraepelin, 1896) as the type species. Extensive field surveys conducted over the last 15 years in the different bioclimatic regions of Madagascar have resulted in the collection of numerous specimens belonging to the genus *Heteroscorpion*. These collections led to the description of four new species (see details in Lourenço & Goodman, 2006). In this paper, an additional new species to science is named from the extreme southeastern portion of the island and is presumed to be a local endemic. The number of species in the genus *Heteroscorpion* is now six, and its distribution covers numerous zones of the island, including humid and dry forests. Aspects of the biotope of the area from where the new species was collected is also discussed

Key words: Scorpiones, *Heteroscorpion*, new species, ecology, Lavasoa, Madagascar.

Introduction

The genus *Heteroscorpion* Birula, 1903 remained monotypic for century, represented by *H. opisthacanthoides* (Kraepelin, 1896), known from the northwest portion of the island, until Lourenço (1996) described a second species, *H. goodmani* from the Réserve Naturelle Intégrale d'Andohahela (now classified as a Parc National). Subsequent faunal inventories in previously unexplored or poorly known areas of the island led to the discovery of several new members of the genus *Heteroscorpion*. Perhaps one of the more spectacular new taxa came from the region of Daraina in the northeast, where the remaining natural habitat cover is composed of transitional dry and humid forests. Here a distinct population of *Heteroscorpion* was found in a humid forest block, and described as *H. magnus* by Lourenço & Goodman (2002). The most noteworthy aspect of this species is its overall size, with adult females reaching 144 mm and adult males 187 mm in total length (Lourenço et al. 2003), making it the largest scorpion known from the island.

Subsequently, *H. raselimanana* was described by Lourenço & Goodman (2004) from the region of Midongy-Sud in the southeastern portion of the eastern humid forest, followed by that of *H. kraepelini* Lourenço & Goodman (2006) from the dry forests of Montagne des Français in the extreme north. With the description of all these species, the geographical range of the genus *Heteroscorpion* included a considerable variety of different forest humid and dry forest habitats ranging across the complete north-south length of the island.

The new species of *Heteroscorpion* described herein is from the relict and transitional humid-dry forest in the extreme south-southeast quadrant of the island. Aspects of the biotype of the area where the new species was found are also discussed.

Methods

Illustrations and measurements were produced using a Wild M5 stereomicroscope with a drawing tube (camera lucida) and an ocular micrometer. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Vachon (1952) and Hjelle (1990).

Taxonomic account

Family Heteroscorpionidae Kraepelin, 1905*

Genus *Heteroscorpion* Birula, 1903

Heteroscorpion karii sp. n.

(Figs 1-8)

TYPE MATERIAL. Holotype ♀. Madagascar, Province of Toliara, Grande Lavasoa (= Forêt de Lavasoa), Tolagnaro, ca. 25.0833°S, 46.7417°E, under bark (coll. Kai Schütte, 29 November 2006). Deposited in the Zoologisches Museum Hamburg. (ZMH Acc. No. A11/09). No other specimen collected.

ETYMOLOGY: Patronym in honor of Kai Schütte, the Zoologisches Museum Hamburg, who collected the holotype specimen.

DIAGNOSIS: Scorpion of moderate size, with adult female reaching 75 mm in total length. Coloration, basically brownish-yellow to reddish-brown including the legs, although the tip of pedipalp fingers is paler than the body and approaching reddish-yellow. Carapace with two reddish spots just behind the lateral eyes. Body and pedipalps covered with a moderate

* The phylogenetic position and taxonomic rank of *Heteroscorpion* have been the subject of discussions amongst scorpion systematists in recent years (Prendini 2000; Soleglad & Fet 2003; Soleglad *et al.* 2005). In a more recent publication, Prendini & Wheeler (2005) re-established Heteroscorpionidae as a family, following Lourenço (1996) and Prendini (2000), after it was downgraded to the subfamily of Urodacidae Pocock, 1893 by Soleglad & Fet (2003) and the subfamily of Hemiscorpiidae Pocock, 1893 by Soleglad *et al.* (2005). The classification of Prendini & Wheeler (2005) is once again adopted here.



Fig 1. *Heteroscorpion kaih* sp. n.: female holotype, dorsal aspect.

setation. Trichobothriotaxy of type C, neobothriotaxic majorante (+); patella with 18 external trichobothria, and 10 ventral trichobothria; chela (chela + fixed finger) with 8 ventral trichobothria.

DESCRIPTION based on female holotype (measurements in Table 1).

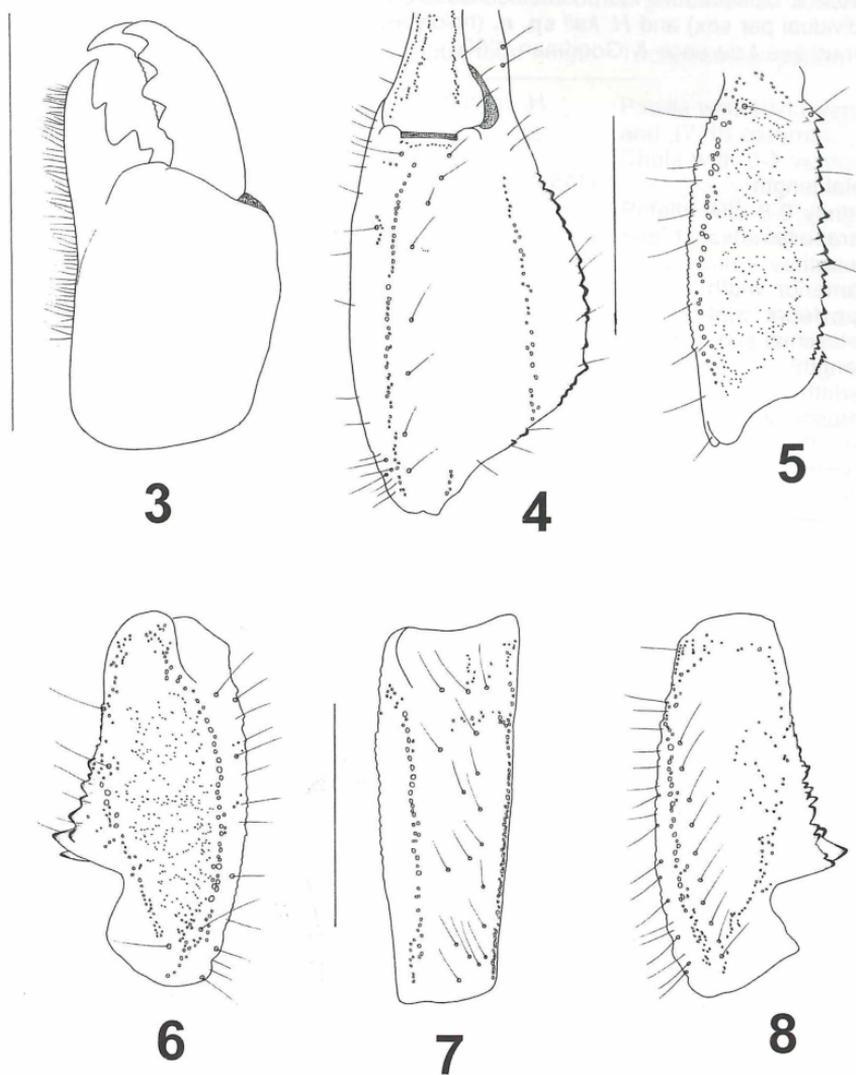
Coloration. Body basically brownish-yellow to reddish-brown. **Proso ma:** carapace reddish-brown, with two reddish spots just behind the eyes. **Meso ma:** Tergites reddish-brown; sternites III to VI reddish-yellow to reddish-brown with a conspicuous yellow spot on III; sternite VII darker than the others. Coxapophysis and sternum reddish-yellow to reddish-brown; genital operculum and pectines yellowish to reddish-yellow. **Meta ma.** All segments reddish-brown; dorsal and ventral carinae darker; vesicle reddish-brown to brown-yellowish; aculeus yellowish at the base and dark reddish at the tip. **Chelicerae** reddish-brown with variegated dark spots; fingers reddish-brown with reddish-yellow teeth. **Pedipalps.** Femur, patella, and chela reddish-



Fig 2. *Heteroscorpion kaili* sp. n.: female holotype, ventral aspect.

brown with the tip of the fingers reddish yellow. Legs reddish-yellow with tarsi yellowish.

MORPHOLOGY. *Prosomea.* Carapace with a rough tegument and moderately marked granules; anterior margin with a strongly pronounced concavity; carinae practically absent; posterior furrows strongly pronounced; median ocular tubercle anterior to the center of the carapace; two pairs of moderate to small lateral eyes; the first lateral eye almost twice the size of the second eye. Sternum pentagonal, wider than long. *Mesosoma.* tergites almost acarinate with only a very weak median carina and some weak granulations; tergite VII with a more intense granulation. *Venter:* Genital operculum formed by one heart-shaped plate. Pectines: Pectinal tooth count 11-11; fulcra conspicuous. Sternites smooth; presence of two longitudinal parallel furrows on III to VI; spiracles linear and conspicuous;



Figs 3-8. *Heteroscorpion kaih* sp. n., female holotype: **3.** chelicera, dorsal aspect; **4-8.** trichobothrial pattern: **4.** chela, ventro-internal aspect; **5.** femur, dorsal aspect; **6-8.** patella, dorsal, external and ventral aspects, respectively. (Scale bars: 3 = 5 mm; 4-8 = 6 mm).

sternite VII with two vestigial carinae. *Metasoma* with all segments flattened laterally; dorsal carinae with minute spinoid granules on segments III and IV; spinoid granulation more strongly marked on segment V; ventromedian and ventrolateral carinae vestigial on segments I to III, moderately marked on IV and intensely spinoid on V; all intercarinal surfaces sparsely granular to smooth. Telson elongated and

Table 1. Comparative morphometric values (in mm) of *H. goodmani* Lourenço (single individual per sex) and *H. kaii* sp. n. (holotype). For values on other members of this genus see Lourenço & Goodman (2006).

	<i>H. goodmani</i>		<i>H. kaii</i> sp. n.
	♂	♀	♀
Total length	115.0	63.0	74.9
Carapace:			
- length	10.2	11.4	11.5
- anterior width	6.2	7.0	6.8
- posterior width	9.3	10.0	11.2
Metasomal segment I:			
- length	10.0	5.4	6.2
- width	2.3	3.1	2.8
Metasomal segment V:			
- length	17.2	10.2	10.5
- width	1.8	2.4	2.0
- depth	2.4	2.6	2.3
Vesicle:			
- width	2.8	3.0	2.3
- depth	3.1	3.0	2.4
Pedipalp:			
- femur length	10.9	10.7	11.0
- femur width	3.4	3.6	4.0
- patella length	10.3	10.7	10.4
- patella width	4.5	4.7	4.4
- chela length	20.9	21.5	22.2
- chela width	6.0	7.5	6.4
- chela depth	5.0	5.3	4.4
Movable finger length	11.8	11.9	11.8

flattened laterally with moderately marked granules on ventral, lateral and dorsal surfaces; aculeus proportionally short and moderately curved; with a notable covering of setae on ventral and lateral faces. Cheliceral dentition characteristic of the Scorpionoidea (Vachon 1963); movable finger with one subdistal and one median tooth almost of the same size and a basal tooth slightly reduced. Pedipalps with moderately to strongly marked granulations; femur with dorsal external, dorsal internal, ventral external and ventral internal carinae, all complete; patella with dorsal internal, dorsal, dorsal lateral, external, ventral lateral and ventral internal carinae complete, and a very strong double apophysis on the internal aspect; chela with dorsal axial, dorsal accessory, median, dorsal external, ventral external and ventral internal carinae; weak to moderate; dentate margin on fingers with numerous granules not forming discrete rows on their basal two-thirds, and forming two vestigial parallel series of granules distally; presence of a few stronger accessory granules. Trichobothriotaxy of type C; neobothriotaxic (Vachon 1974); patella with 10 ventral and 18 external trichobothria; chela with 8 ventral trichobothria. Body and pedipalps covered with a moderate setation. Legs: tarsi of legs III and IV with three prolateral and two retrolateral spines.

Table 2. The differential characters of the six species of the genus *Heteroscorpion*.

Species	Color	Adult total length	Trichobothrial pattern
<i>H. opisthacanthoides</i>	brownish	110-142 mm	Patella with 10-11 ventral and 17-19 external. Chela with 8-9 ventral.
<i>H. goodmani</i>	blackish	60-115 mm	Patella with 8-9 ventral and 17 external. Chela with 9 ventral.
<i>H. magnus</i>	blackish	145-187 mm	Patella with 14-19 ventral and 31-40 external. Chela with 12-15 ventral.
<i>H. raselimanana</i>	blackish	70 mm	Patella with 8 ventral and 16 external. Chela with 6 ventral.
<i>H. kraepelini</i>	reddish-brown	100 mm	Patella with 13/15 ventral and 20 external. Chela with 11/12 ventral.
<i>H. karii</i> sp. n.	brownish -yellow	75 mm	Patella with 10 ventral and 18 external Chela with 8 ventral.

Distribution. Only known from the type locality.

REMARKS: *Heteroscorpion karii* sp. n. can be distinguished from other species in the genus *Heteroscorpion*, and in particular from *H. goodmani*, by the following characters: (i) a paler reddish-brown to brownish-yellow coloration over the body and appendages, with the tip of pedipalp fingers paler than the body; (ii) a bigger overall adult size, with distinct morphometric values (see Table 1); and (iii) a distinct trichobothrial pattern; patella with 10 ventral and 18 external trichobothria; chela with 8 ventral trichobothria (see Table 2). Internal trichobothria of both femur and patella very much displaced to the internal surface.

Ecology

According to notes made by the collector during fieldwork in 2005, several individuals of *Heteroscorpion karii* sp. n. were observed at night in the remnant forest parcel of "Grande Lavasoa" on the bark of trees, about 1.5 to 2 m from the ground. The holotype specimen was collected under bark and it is almost certain that the species is sheltered under loose bark during the day. These aspects are very similar to described ecology of *H. goodmani*, which is known from the humid forest "parcel 1" of the Parc national d'Andohahela (Lourenço 1996), located on the eastern side of the north-south aligned Anosyenne Mountains, while the type locality of

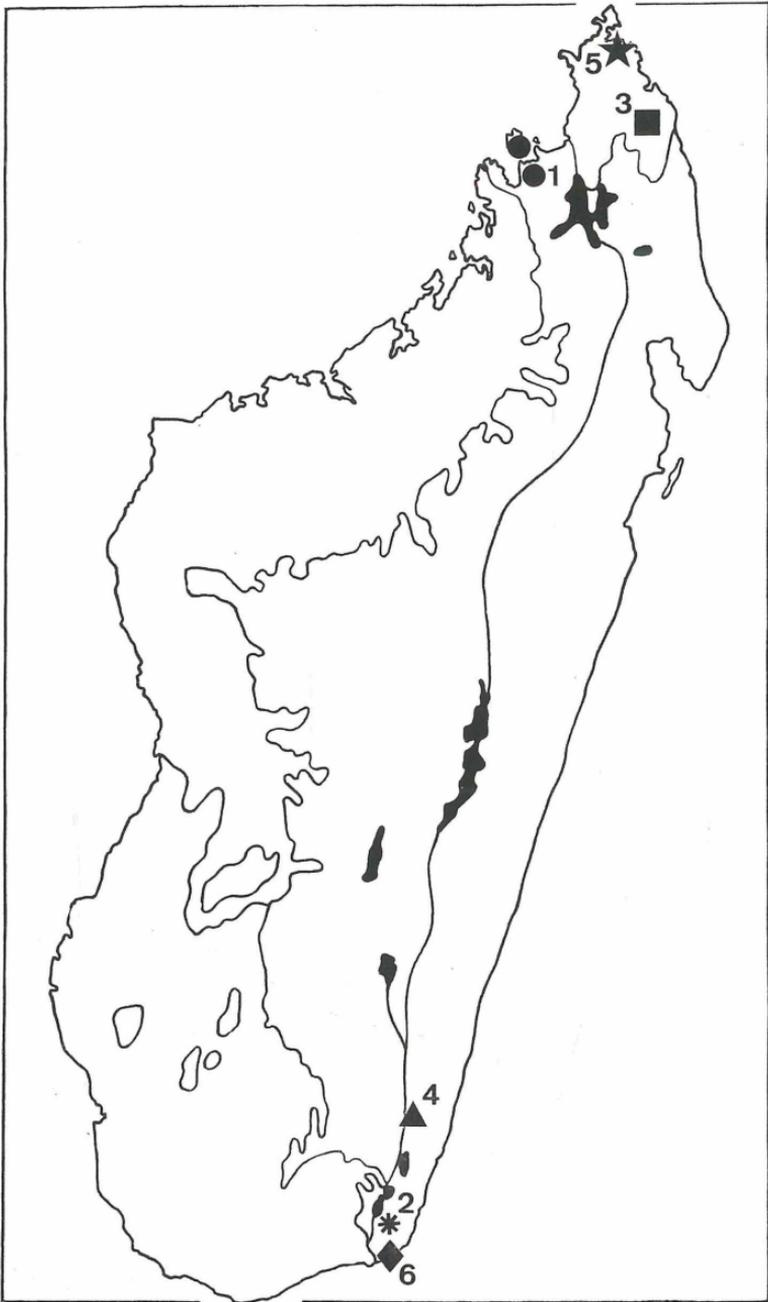


Fig. 9. Records of the species of the genus *Heteroscorpion* in Madagascar: 1. *H. opisthacanthoides* (Kraepelin)(black circles); 2. *H. goodmani* Lourenço (black asterisk); 3. *H. magnus* Lourenço & Goodman (black square); 4. *H. raselimanana* Lourenço & Goodman (black triangle); 5. *H. kraepelini* Lourenço & Goodman (black star); 6. *H. karii* sp. n. (black lozenge).

H. karii sp. n. is at the western foot of these mountains. For precise information on the ecology of the other species of *Heteroscorpion* refer to Lourenço & Goodman (2006).

The eastern portion of Madagascar receives moisture-laden air passing westward off the Indian Ocean and is notably more humid than more inland areas of the island. In extreme southeastern Madagascar, there is a very dramatic humid-dry forest ecotone between the eastern and western slopes of the Anosyenne Mountains, which acts as a rainfall barrier to systems moving from the east to the west (Goodman & Ramanamanjato 2007). The position and raised topography of the Grande Lavasoa Forest, which comprises about 50 ha of forest, and other nearby humid forest remnants, which include Ambatotsirongorongo (25 ha) and Vohisampa (30 ha), maintains notably more humid forest conditions as compared to other nearby zones, which are largely dry forest formations. On the basis of subfossil remains coming from Andrahomana Cave in close proximity to Grande Lavasoa, it is clear that during periods of Quaternary climatic change there were notable shifts in the local faunal composition of the zone between taxa adapted to humid (eastern) and dry (western) forest conditions (Burney et al. 2008, Goodman et al. 2007). These vicissitudes in turn have given rise to a modern biota in these remnant humid forest parcels with notably mixed eastern-western biogeographical affinities (Ramanamanjato et al. 2002, Hapke et al. 2005, Andrianarimisa et al., in press). Given that based on morphological characters, *H. karii* sp. n. is most similar to *H. goodmani* and they are presumed to be sister taxa, it is supposed that some vicariant event associated with their separation on opposite sides of the Anosyenne Mountains led to their separation and subsequent differentiation.

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