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## On the African Whip Scorpion, *Etiennesus africanus* (Hentschel, 1899) (Thelyphonida: Thelyphonidae), with a Redescription Based on New Material from Guinea-Bissau and Senegal

JEREMY C. HUFF<sup>1</sup> AND LORENZO PRENDINI<sup>1</sup>

### ABSTRACT

An illustrated redescription of the monotypic African whip scorpion, *Etiennesus africanus* (Hentschel, 1899), is provided based on examination of material newly collected in Guinea-Bissau and Senegal, as well as material from the Gambia, Guinea and Senegal studied by previous workers. The species is reported for the first time from Guinea-Bissau. Several character systems are documented in this species for the first time, new characters that appear to be autapomorphic are described, and notes on its natural history provided. The phylogenetic position of *E. africanus* is discussed, supporting the opinion that it is a Gondwana relict, most closely related to the Neotropical hypoctonine genera, *Thelyphonellus* Pocock, 1894 and *Ravilops* Viquez and Armas, 2005.

### INTRODUCTION

The arachnid order Thelyphonida, commonly known as whip scorpions or vinegaroons (vinegarones or *vinagrillos*), comprises 106 described species and 5 subspecies, in 18 genera (8 of which are monotypic) and a single family (Haupt, 1996, 2004; Harvey, 2002, 2003, 2007; Viquez and Armas, 2005, 2006, 2007; Ballesteros and Francke 2006;

Armas and Viquez, 2007; Giupponi and Vasconcelos, 2008). Whip scorpions have been poorly studied. Most whip scorpion taxonomy was conducted in the late 1800s and early 1900s; only three genera and 16 species were described in the past 50 years (Haupt, 1996, 2004; Harvey, 2002, 2003, 2007; Viquez and Armas, 2005, 2006, 2007; Ballesteros and Francke, 2006; Armas and Viquez, 2007; Giupponi and Vasconcelos,

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2008). Even less is known about their biology. Most research has focused on the composition and function of their defensive spray, consisting largely of acetic acid and caprylic acid (Eisner et al., 1961; Haupt et al., 1988; Schmidt et al., 2000; Haupt and Müller, 2004), which is a strong deterrent to various potential predators (Schmidt et al., 2000). Reproductive behavior and development have also been studied in a few species (Klingel, 1963; Weygoldt, 1970, 1971, 1972, 1988; Schmidt et al., 2000).

Whip scorpions have a disjunct distribution in Africa, Asia, and the New World (Harvey, 2002, 2003). Approximately 80% of the species occur in Asia, extending from India and Sri Lanka to Samoa. Nearly 50% of these are recorded from Myanmar and Indonesia. Although common in New Guinea and the Solomon Islands, whip scorpions are absent from Australia. In the New World, whip scorpions occur in North America, South America, and the Caribbean. Their distribution ranges from the southern United States to Brazil, but they have not been recorded in Panama, Ecuador, or Peru. In the Caribbean, they occur on the islands of Cuba, Hispaniola, and Martinique. A single species, *Etiennesus africanus* (Hentschel, 1899), occurs in Africa (figs. 1, 2).

*Etiennesus africanus* is currently placed in subfamily Hypoconinae because it lacks a carina between the lateral and median ocelli. It was previously suggested that no indigenous whip scorpions exist in Africa, and that this species was probably introduced to the Gambia region, 130–150 years ago, in shipments of agricultural material from Burma (Myanmar) or Thailand (Millot, 1949; Cooke and Shadab, 1973). At the time of its discovery, there were two Old World genera of Hypoconinae, *Hypoconus* Thorell, 1888, and *Labochirus* Pocock, 1894, sharing elaborate modifications of the male pedipalp patellar apophysis, but separated by the presence of an accessory tooth on the internal margin of the pedipalp coxal apophysis in *Labochirus* that is absent in *Hypoconus* (Pocock, 1894, 1900; Kraepelin, 1897, 1899). The African species was originally placed under *Hypoconus* because it lacks the accessory tooth; the male, and hence the state of the male pedipalp patellar apophysis, were unknown. Gravely (1916) considered the acces-

sory tooth less important than the tibial spur of leg III, redefined the composition of *Hypoconus* and *Labochirus*, and transferred *Hypoconus africanus* Hentschel, 1899, to *Labochirus* based on the absence of a tibial spur on leg III. Gravely's (1916) classification of *Hypoconus* and *Labochirus*, based on the tibial spur of leg III, was adopted by Mello-Leitão (1931), whereas Werner (1935) and Rowland and Cooke (1973) followed the original classification based on the accessory tooth of the pedipalp coxal apophysis (Pocock, 1894, 1900; Kraepelin, 1897, 1899). Rowland and Cooke (1973) argued that tibial spurs are not reliable characters because they can vary within a species (e.g., *H. africanus*) and that defining *Hypoconus* and *Labochirus* based on the tibial spur of leg III made little sense biogeographically.

A second African species, *Hypoconus clarki* Cooke and Shadab, 1973, morphologically distinct from *H. africanus*, was subsequently described, and *H. africanus* redescribed (Cooke and Shadab, 1973). In the early 1980s, the Muséum National d'Histoire Naturelle, Paris, obtained several adult male and female whip scorpions from Senegal and a male specimen from Guinea. Hentschel's (1899) type series of *H. africanus* was rediscovered and examined. Heurtault (1984) compared the new material with the holotypes of *H. africanus* and *H. clarki*, and discovered that *H. clarki* was in fact the adult male of *H. africanus* and not the female of another species. *Hypoconus clarki* was therefore synonymized with *H. africanus*. The genus *Etiennesus* Heurtault, 1984 was created to accommodate the lone African species, based on the fact that the male lacks any modification of the pedipalp patellar apophysis, which separates it from both *Hypoconus* and *Labochirus*. Heurtault (1984) suggested that *E. africanus* is a Gondwana relict and is more closely related phylogenetically to the Neotropical whip scorpion genus *Thelyphonellus* Pocock, 1894, also a member of the Hypoconinae, than to the Asian hypoconine genera.

No further investigations of this unique African whip scorpion were conducted after Heurtault (1984). Its relationship to other whip scorpion genera remains unclear. As part of ongoing investigations into the systematics of Thelyphonida and their relationship to other arachnid orders, the first author travelled to

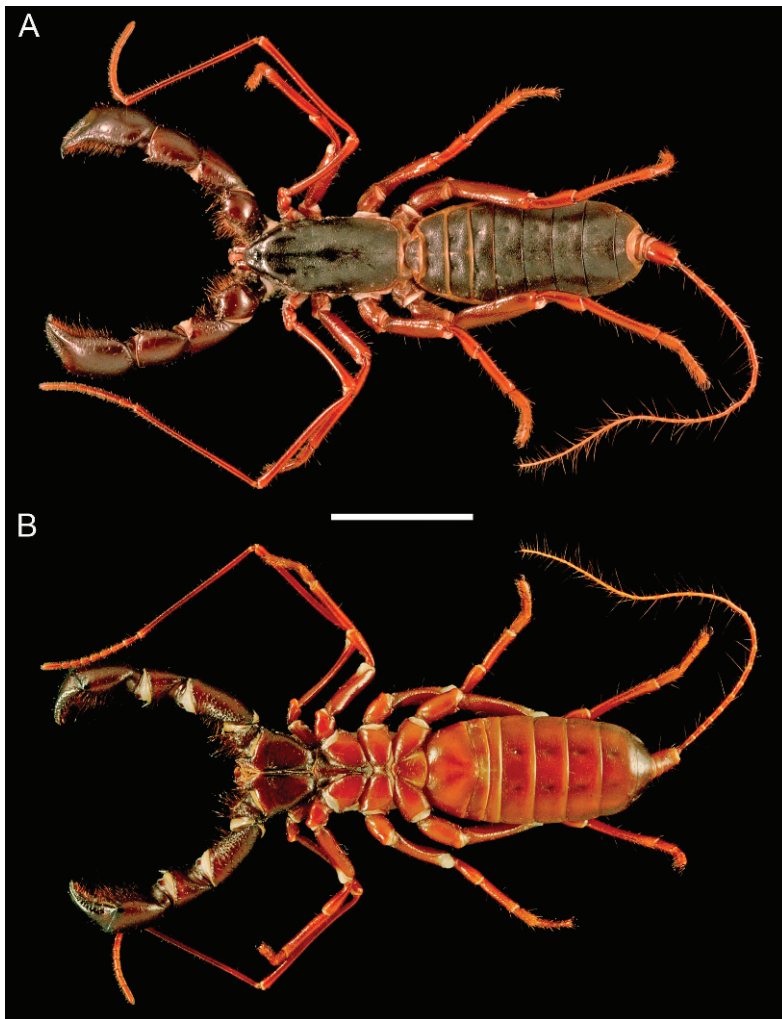


Fig. 1. *Etienneus africanus* (Hentschel, 1899), ♂ (AMNH), habitus. **A.** dorsal aspect. **B.** ventral aspect. Scale bar = 10 mm.

West Africa in the summer of 2005, to collect fresh material of *E. africanus* for a reinvestigation of its morphology. Several specimens were collected from Senegal, within 30 km of the border with Guinea and 100 km of the border with Mali, and also from Guinea-Bissau, the first record of the species from this country (fig. 3).

In the present contribution, we provide an illustrated redescription of this unique whip scorpion, based on examination of the newly collected material as well as material studied by previous workers. We document several character systems in this species for the first time, describe new characters that appear to

be autapomorphic, and provide notes on its natural history. Based on our observations, we agree with Heurtault's (1984) hypothesis that *E. africanus* is a Gondwana relict, most closely related to *Thelyphonellus* and another recently described Neotropical whip scorpion genus, *Ravilops* Viquez and Armas, 2005.

#### MATERIALS AND METHODS

Material is deposited in the American Museum of Natural History, New York (AMNH), Natural History Museum, London (BMNH), Muséum National d'Histoire Na-

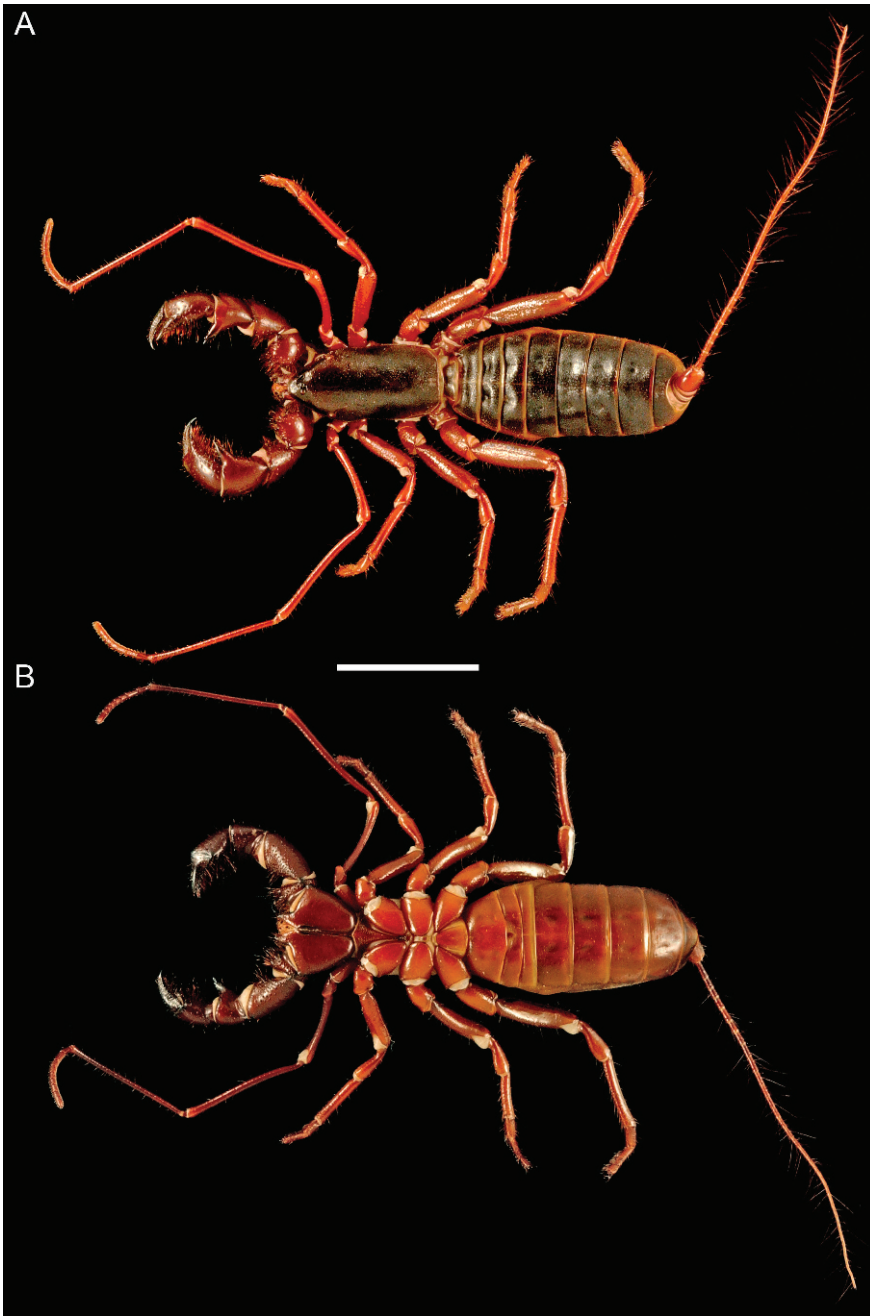


Fig. 2. *Etienneus africanus* (Hentschel, 1899), ♀ (AMNH), habitus. **A.** ♀, dorsal aspect. **B.** ♀, ventral aspect. Scale bar = 10 mm.

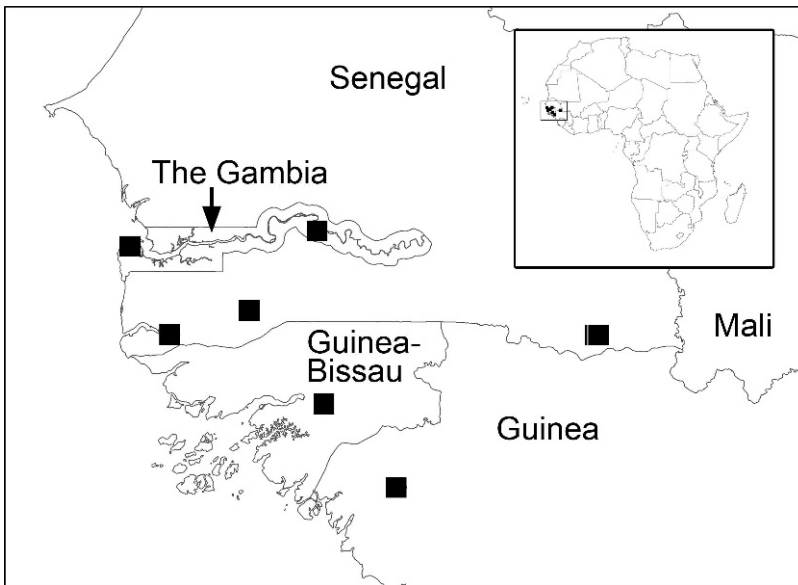


Fig. 3. Map of West Africa, plotting the known locality records of *Etienneus africanus* (Hentschel, 1899).

turelle, Paris (MNHN) and Musée Zoologique de l'Université Louis Pasteur, Strasbourg (MZS). Female genitalia were studied following methods described by Viquez and Armas (2005). Hemispermatoaphore morphology follows Weygoldt (1971, 1988). General morphological terminology follows Werner (1935) and Millot (1949), except for pedipalp segmentation, which follows Snodgrass (1948). Measurements (mm) were taken with Mitutoyo® digital calipers. Photographs were taken using a Microptics® ML-1000 digital imaging system. Scanning electron micrographs were prepared using a Hitachi® S-4700 scanning electron microscope. Genitalia and hemispermatoaphores were dissected and cleared using KOH, following Viquez and Armas (2005), and further clearing and photography was done in clove oil and Purell® sanitizer.

## TAXONOMY

FAMILY THELYPHONIDAE LUCAS, 1835

SUBFAMILY HYPOCTONINAE POCKOCK, 1899

GENUS *ETIENNEUS* HEURTAULT, 1984

*Etienneus* Heurtault, 1984: 115–123, figs. 1–11.

TYPE SPECIES: *Hypoctonus africanus* Hentschel, 1899, by original designation.

DIAGNOSIS: *Etienneus* differs from all other whip scorpions on the basis of the following combination of characters. Carapace without carina between median and lateral ocelli; median ocelli not separated by superciliary carina; three pairs of lateral ocelli. Leg I, tarsomere IX (♀) terminating in dorsally curved, subconical projection; IV, tibia with single ventrodiscal spur. Tergites I–IV divided by median longitudinal suture; V–VII (♂) or V–IX (♀) partially suturiform; XII (anal) with pair of large, oval, laterally compressed ommatoids. Sternum divided by median longitudinal suture. The median longitudinal suture of the sternum and dorsally curved, subconical projection of leg I, tarsomere IX (♀) appear to be autapomorphic for *Etienneus*.

DISTRIBUTION: *Etienneus* is endemic to West Africa (fig. 3) and has thus far been recorded from the Gambia, Guinea, Guinea-Bissau, and Senegal. No records are known from north of the Gambia River. The record from Guinea-Bissau provided below is the first from this country. We suspect that *Etienneus* may also occur in western Mali, where the habitat is very similar, with rolling hills and

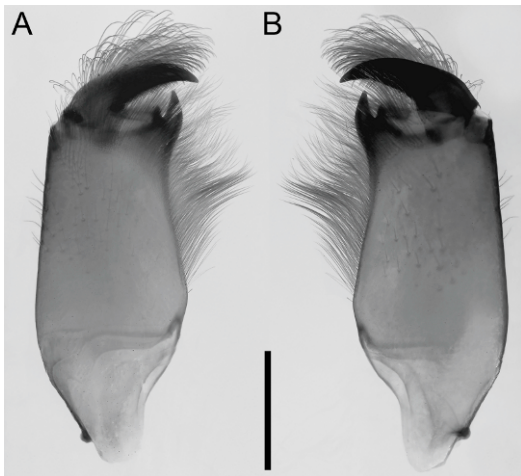


Fig. 4. *Etiennus africanus* (Hentschel, 1899), ♀ (AMNH), dextral chelicera. **A.** Ental aspect. **B.** Ectal aspect. Scale bar = 1 mm.

forest patches, and perhaps also to the south of Guinea, in Sierra Leone and Liberia.

*Etiennus africanus* (Hentschel, 1899)

Figures 1–10; table 1

*Hypoctonus africanus* Hentschel, 1899: 430, 431; Werner, 1935: 479; Cooke and Shadab, 1973: 1–6, figs 1, 2, 7, 10; Rowland and Cooke, 1973: 65.

*Labochirus africanus* (Hentschel, 1899): Gravely, 1916: 64; Mello-Leitão, 1931: 21.

*Hypoctonus clarki* Cooke and Shadab, 1973: 1–3, 6–11, figs. 3, 4, 8, 12; Rowland and Cooke, 1973: 65 (synonymized by Heurtault, 1984: 122).

*Etiennus africanus* (Hentschel, 1899): Heurtault, 1984: 115–122, figs. 1–11; Haupt and Song, 1996: 43; Harvey, 2002: 363, 2003: 61; Giupponi and Vasconcelos, 2008: 18.

**TYPE MATERIAL:** *Hypoctonus africanus* Hentschel, 1899: **SENEGAL:** 1843, E. Ehrmann, 4 ♀ syntypes (MZS). According to the original description, two of the syntypes were collected in Senegal and two in Algeria (erroneous). It is also unclear whether E. Ehrmann was the original collector. *Hypoctonus clarki* Cooke and Shadab, 1973: **THE GAMBIA:** *Western Division:* Yundum [13°24'N 16°42'W], 1.ix.1956, C.R. Wallace, holotype ♂ (BMNH), 1951, M.H. Roth, 2 ♂ paratypes (BMNH).

**DIAGNOSIS:** As for genus.

**DESCRIPTION:** The following description is based on 2 ♂ and 6 ♀ deposited in the AMNH (figs. 1, 2, 4–10; table 1).

**Total length:** Maximum adult length, measured from anterior margin of carapace to posterior edge of pygidium (segment XII), 30.42 mm (♂), 35.35 mm (♀) (table 1).

**Color:** Carapace and tergites, dorsal surfaces, brown to dark reddish brown (figs. 1, 2). Sternites I–VII, ventral surfaces, orange-brown, lateral edges, brown; VIII, surfaces, uniformly brown. Pygidium, dorsal and ventral surfaces, reddish brown. Flagellum, dorsal, lateral and ventral surfaces, reddish brown, covered with reddish macrosetae. Pedipalp trochanter, femur, patella and tibia, dorsal and ventral surfaces, reddish brown; internal surfaces with reddish macrosetae. Pedipalp basitarsus, dorsal and ventral surfaces, dark brown proximally, black distally. Leg I, segments, reddish brown; II–IV, coxa and trochanter, orange-brown, other segments reddish brown.

**Chelicerae:** Movable finger longer than fixed finger, hinged along dorsal edge, with dense brush of reddish macrosetae on ental and ectal surfaces (fig. 4); manus with fewer, anteriorly directed, short, stout macrosetae on internal and external surfaces; fixed finger with short tooth basally. Chelicera of female larger than male.

**Prosoma:** Carapace, dorsal surface, finely and densely granular, granulation coarser below and immediately posterior to lateral ocelli (fig. 5A); posterior fovea obsolete; epistoma present; without carina between median and lateral ocelli; median ocular tubercle situated 1.12 mm from anterior carapace margin (table 1), distance between ocelli 0.78 times ocular diameter; lateral ocelli, anterior ocellus nearly twice diameter of median and posterior ocelli. Sternum with median longitudinal suture (fig. 5B).

**Pedipalps:** Surfaces very smooth, shiny, finely punctate, covered with short macrosetae internally (fig. 6). Coxa, external surface with vertical wrinkles, ventral surface smooth; apophysis with one tooth distally, covered in long macrosetae. Trochanter smooth, as long as (♀) or longer than (♂) wide; dorsointernal surface with five teeth, fourth from terminal twice length of remaining four (♀), or with

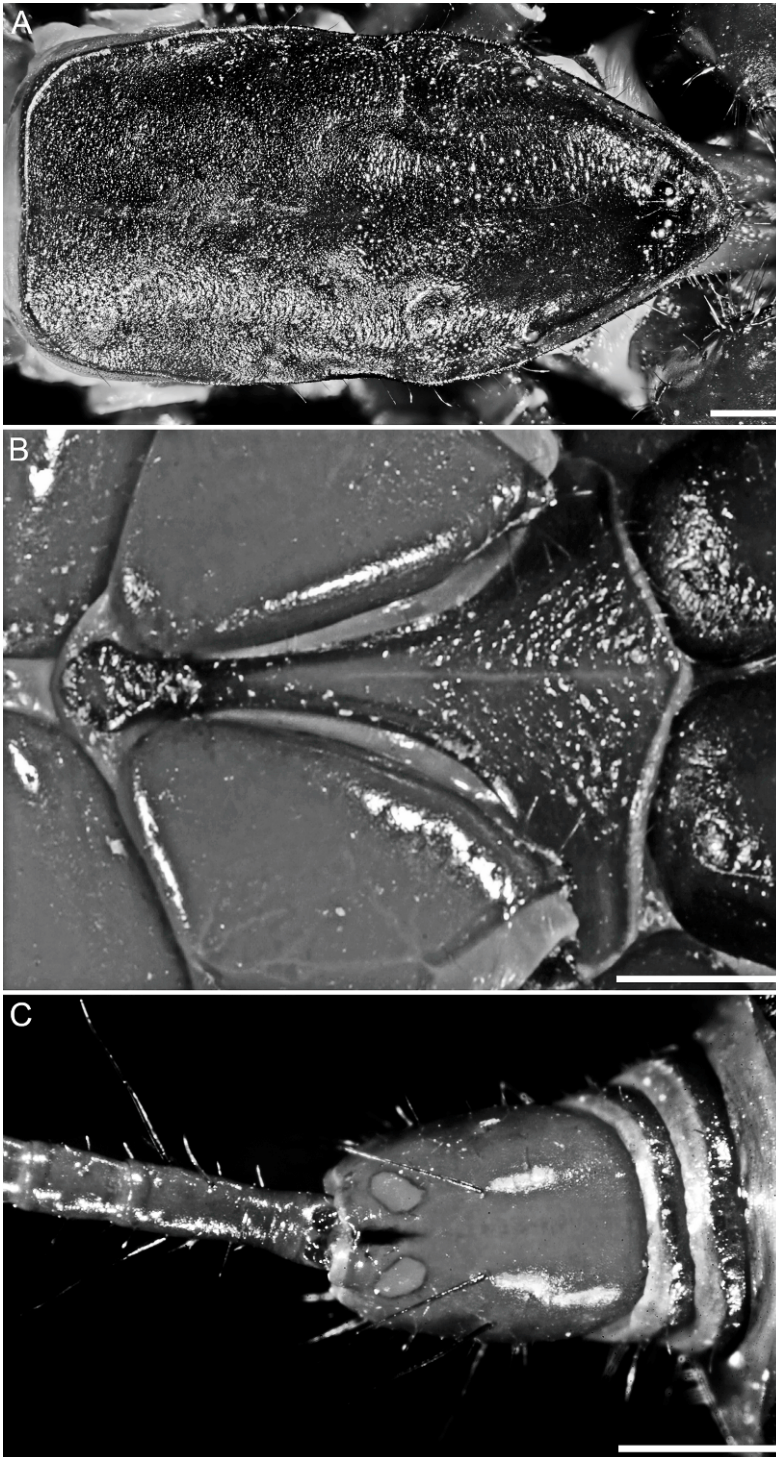


Fig. 5. *Etienneus africanus* (Hentschel, 1899), ♀ (AMNH). **A.** Carapace, dorsal aspect. **B.** Sternum, ventral aspect, showing median longitudinal suture. **C.** Pygidium, dorsal aspect, showing ommatoids. Scale bars = 1 mm.



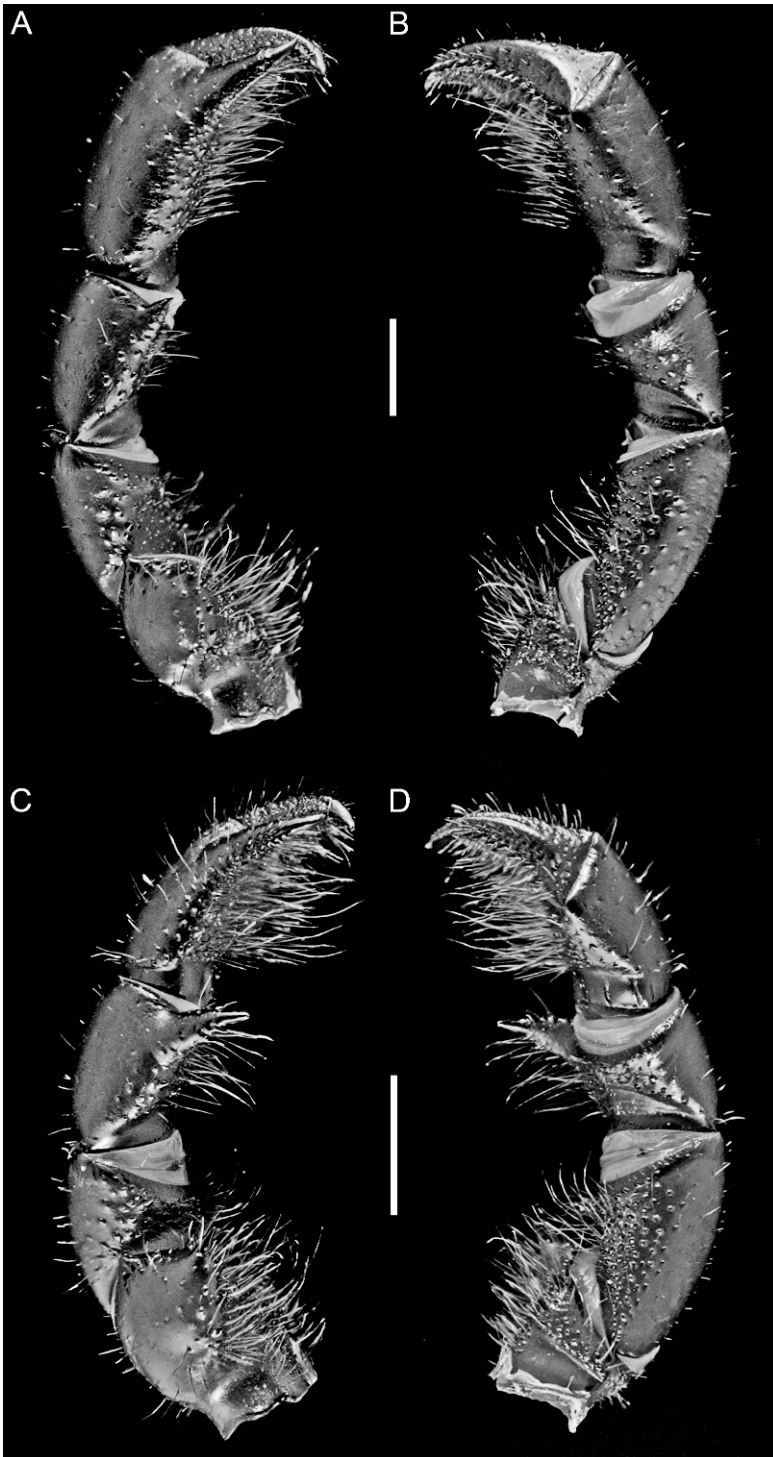


Fig. 6. *Etienneus africanus* (Hentschel, 1899), ♂ and ♀ (AMNH), pedipalps. **A.** ♂, dorsal aspect. **B.** ♂, ventral aspect. **C.** ♀, dorsal aspect. **D.** ♀, ventral aspect. Scale bars = 2.5 mm.

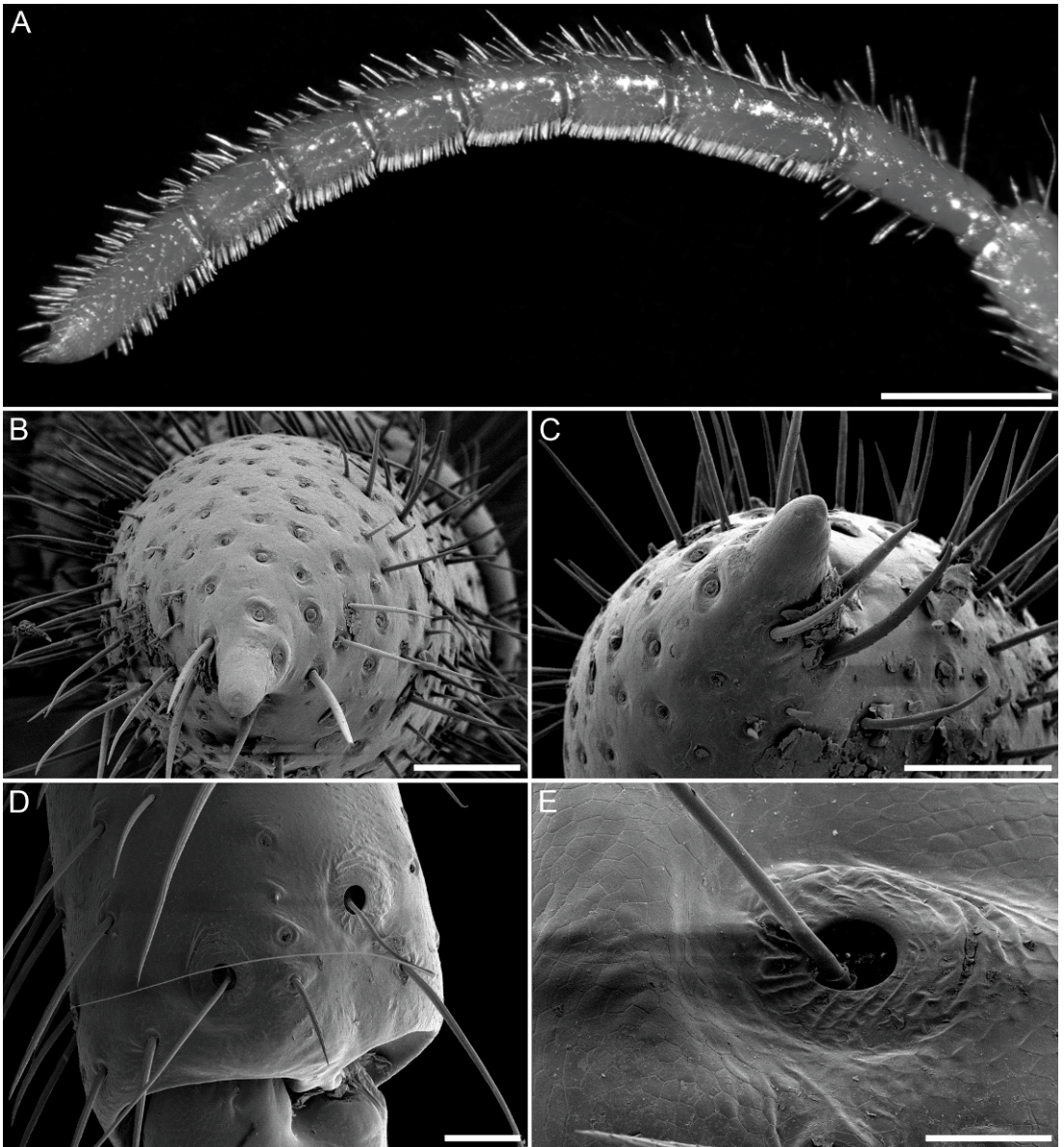


Fig. 7. *Etienneus africanus* (Hentschel, 1899), ♀ (AMNH), leg I. **A.** Basitarsus and telotarsus, lateral aspect, showing uniformly short setae along ventral surface. Scale bar = 1 mm. **B.** **C.** Telotarsus, terminal segment, anterior aspect, showing curved, subconical projection. Scale bars = 100  $\mu$ m. **D.** Tibia, distal end, lateral aspect, showing relative positions of two trichobothria. Scale bar = 100  $\mu$ m. **E.** Tibial trichobothrium, dorsal aspect. Scale bar = 50  $\mu$ m.

only one pronounced tooth, others greatly reduced or granular ( $\delta$ ); internal surface with granules and reduced teeth ( $\delta$ ) or few, sparse granules ( $\delta$ ); ventrointernal surface with three teeth, proximal tooth greatly reduced. Femur

one and a half times longer than ( $\delta$ ) to almost twice ( $\delta$ ) length of trochanter; external surface smooth; dorsal, internal, and ventral surfaces sparsely to densely granular; dorsointernal surface with ( $\delta$ ) or without ( $\delta$ ) tooth;

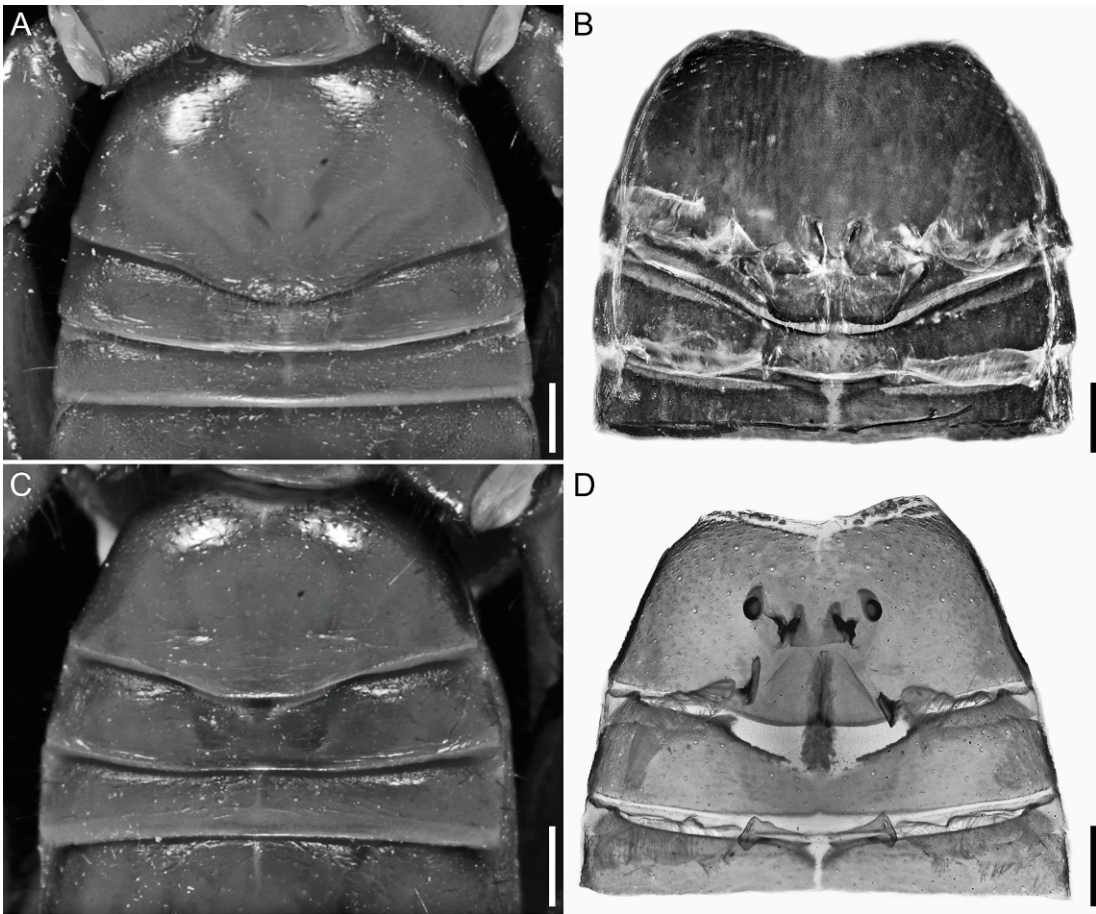


Fig. 8. *Etienneus africanus* (Hentschel, 1899), ♂ and ♀ (AMNH), sternites II–IV, showing genital opercula. A. ♂, ventral aspect. B. ♂, dissected and cleared, dorsal aspect. C. ♀, ventral aspect. D. ♀, dissected and cleared, dorsal aspect. Scale bars = 1 mm.

ventrointernal surface with tooth. Patella almost as long as femur; dorsal and external surfaces smooth; external surface with median longitudinal indentation; dorsointernal surface with granules and with (♀) or without (♂) short tooth proximal to apophysis; internal and ventral surfaces sparsely granular; ventrointernal edge with one prominent (♀) or vestigial (♂) tooth distally. Patellar apophysis twice as long as (♀) or slightly longer than (♂) basal width; internal edge with serrate row of teeth; external edge with (♀) or without two teeth (♂). Tibia as long as femur, swollen (♂) or unmodified (♀); dorsal, external, and ventral surfaces smooth; internal surface smooth proximally, densely granular

distally with macrosetae situated at base of most granules; dorsointernal edge with row of prominent (♀) or vestigial (♂) teeth; ventrointernal surface with one tooth distally. Fixed finger, dorsal edge smooth (♂) or with row of teeth (♀); ventral edge with serrate row of denticles. Basitarsus (movable finger), dorsal margin with serrate row of denticles; ventral margin with serrate row of teeth.

*Legs:* Leg I, basitarsus and telotarsus, tarsomeres II and III equal in length; IV slightly longer than V; V, VI, and VIII equal in length; VII shorter than VIII; IX longest, terminating in dorsally curved, subconical projection (♀) (fig. 7A–C); III–IX, ventral surfaces each covered with dense, uniformly

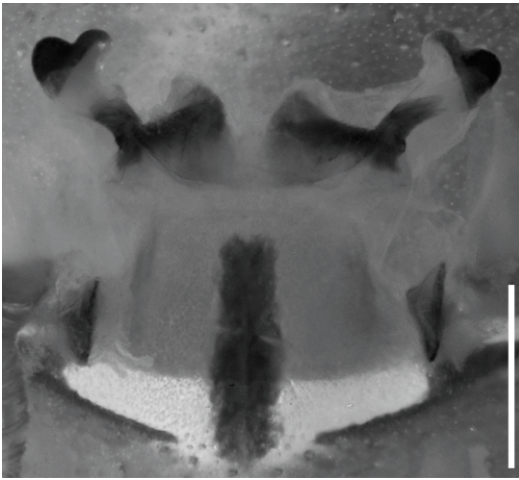


Fig. 9. *Etienneus africanus* (Hentschel, 1899), ♀ (AMNH), spermatheca and operculum showing the two seminal receptacles. Scale bar = 1 mm.

short macrosetae (fig. 7A). Legs II–IV, basitarsus with two ventrodistal spurs. Leg IV, tibia with one ventrodistal spur. Leg I with two trichobothria (fig. 7D, E); II–IV with one; trichobothria situated distally on tibia.

*Opisthosoma*: Tergites, surfaces, finely granular; I–IV divided by median longitudinal suture; V–VII (♂) or V–IX (♀) partially suturiform; X not divided laterally by suture (pleuron); XII (anal) with pair of large, oval, laterally compressed ommatoids angled anteromedially in dorsal aspect (fig. 5C). Sternite II (genital) (fig. 8A, C) smooth, with two shallow lateral depressions (♀) or shallow folds along posterior edge (♂), posterior median margin lobate (♂) or sublinear (♀) (fig. 8A, C); III and IV (♂) or IV (♀) divided by median longitudinal suture; V partially suturiform (♀ only). Pygidial flagellum without flagellar organs; each segment with two to

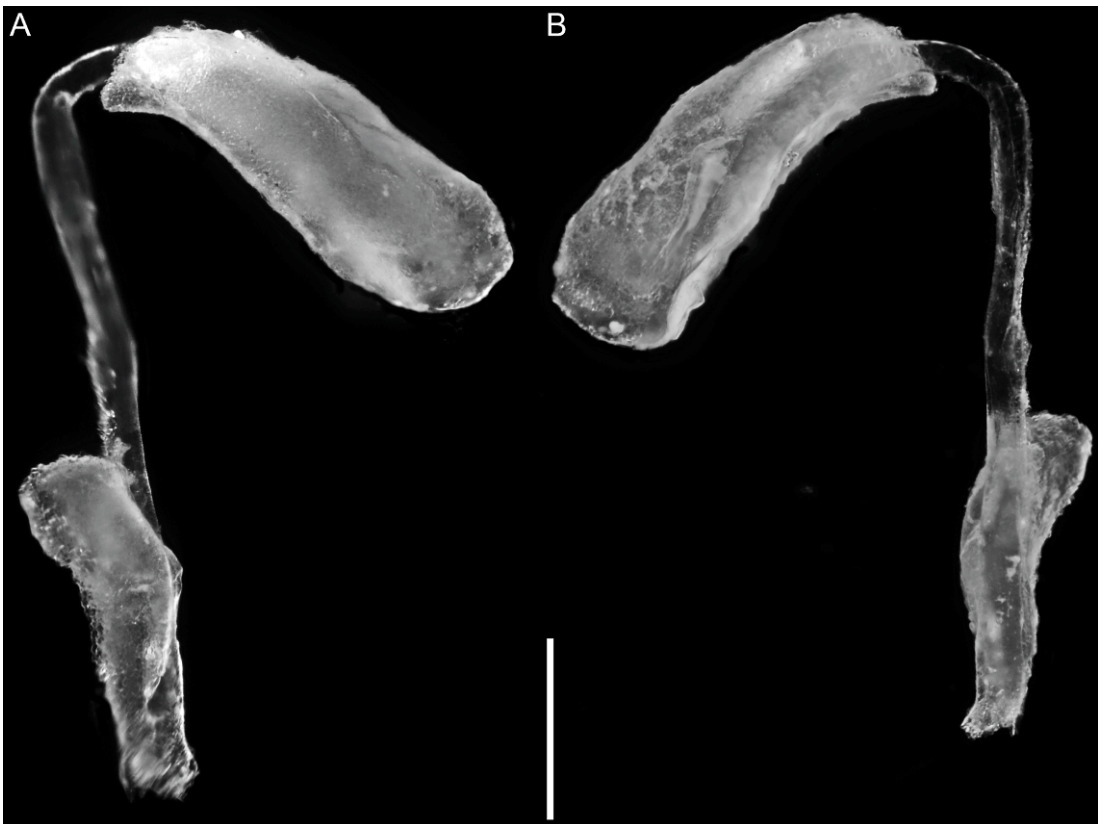


Fig. 10. *Etienneus africanus* (Hentschel, 1899), ♂ (AMNH), hemispermaphore. A. Ental aspect. B. Ectal aspect. Scale bar = 1 mm.

TABLE 1  
*Etiennus africanus* (Hentschel, 1899), selected measurements (mm) of seven specimens from Senegal (AMNH)

Sex		♂	♂	♀	♀	♀	♀	♀
Carapace	Length	10.81	11.06	11.28	12.21	12.26	10.86	12.21
	Width at lateral ocelli	4.52	4.77	4.74	5.00	5.32	4.93	5.24
	Width at fovea	5.43	5.52	5.68	5.99	6.36	5.39	6.09
	Median ocular tubercle distance <sup>1</sup>	1.08	1.09	1.14	1.16	1.22	0.91	1.23
	Ocular width	0.34	0.36	0.37	0.41	0.37	0.33	0.35
	Distance between median ocelli	0.24	0.27	0.29	0.31	0.26	0.30	0.32
Leg I	Coxa length	2.30	2.93	2.50	2.91	2.69	2.21	2.50
	Trochanter length	1.70	2.04	2.19	2.1	2.07	1.69	2.15
	Femur length	5.77	6.49	6.58	6.56	6.50	6.45	6.96
	Patella length	9.42	9.86	9.79	10.04	10.73	9.00	9.03
	Tibia length	10.45	10.53	9.85	10.61	11.45	10.11	10.16
	Basitarsus-tarsus length	7.33	7.18	6.40	6.70	6.51	5.63	6.53
Leg IV	Coxa length	3.15	3.12	3.34	3.88	3.61	3.35	3.50
	Trochanter length	3.55	3.86	3.85	4.07	4.16	3.12	3.91
	Femur length	7.12	6.58	7.26	8.21	7.80	6.47	7.33
	Patella length	2.93	3.36	3.65	4.45	4.21	3.12	4.14
	Tibia length	5.89	5.87	5.24	6.08	6.31	5.64	5.85
	Basitarsus length	1.79	1.99	2.08	1.94	1.77	1.75	2.52
Tarsus length	3.15	3.55	3.15	3.27	3.99	2.94	3.18	
Total length <sup>2</sup>		30.25	30.58	36.52	37.23	36.81	29.18	36.99

<sup>1</sup>Measured from anterior carapace margin.

<sup>2</sup>Measured from anterior carapace margin to posterior edge of pygidium.

four very long macrosetae. Seminal receptacles spherical, directed posteriorly (fig. 9).

*Hemispermaphore*: Sperm package J-shaped with enlarged tip and reservoir; elongated jointlike stem connecting tip with hooked end (fig. 10).

*Sexual dimorphism*: The adult male and female differ in several characters. The spination and granulation of the pedipalps are more pronounced in the female; the pedipalp patellar apophysis is greatly reduced in the male; the dorsally curved, subconical projection of leg I, tarsomere IX of the female is absent in the male; the paired shallow lateral depressions on sternite II of the female are absent in the male; sternites II and III are separated medially by a subcutaneous sclerotized surface in the female but unmodified in the male (fig. 8B, D).

ADDITIONAL MATERIAL: **THE GAMBIA**: *Central River*: Sapu Agricultural Station, 180 mi. up river [13°33'N 14°54'W], 1968, G.C.H. Smith, 1 ♀ (BMNH), 1 ♀ tritonymph (AMNH). **GUINEA**: Dr. Mallaud, 1 ♂

(MNHN). **GUINEA-BISSAU**: *Bafata*: Bamba-dinca, 19 km S, 11°53'03.9"N 14°50'08.5"W, 38 m, 30.vi-1.vii.2005, J. Huff and V. Vignoli, 1 ♀, 1 ♂ tetranymph, 1 ♂, 2 ♀ tritonymphs. **SENEGAL**: *Région de Casamance*: Djibelor [12°33'10"N 16°19'20"W], J. Etienne 15.vii.1982, 1 ♀ (MNHN); Djibelor, Centre de recherches agronomiques Zuiginchor [12°33'10"N 16°19'20"W], J. Etienne and Dr. Mallaud, 3.viii.1982, 11 ♂ (1 dissected) (MNHN). *Région de Kolda*: Sefa [12°47'09"N 15°33'02"W], A. Diop, 1 ♂ (MNHN), J. Etienne, 15.ii.1981, 4 ♀, 5 juv. (2 dissected) (MNHN). *Région de Tambacounda*: Kedougou [12°33'N 12°11'W], P. de Miré and D. Pluot-Sigwalt, x.1981, dans litière de forêt, 4 juv. (MNHN); Kedougou, 3 km W on road to Salemata, 12°33'10.6"N 12°13'39.4"W, 126 m, 4.vii.2005, J. Huff and V. Vignoli, 2 ♂, 5 ♀, 3 ♂ tetranymphs, 2 ♂, 1 ♀ tritonymphs, 4 ♂, 3 ♀ deutonymphs, 1 protonymph (AMNH).

**NATURAL HISTORY**: Newly collected specimens were taken from under rocks or logs in small forest fragments (fig. 11). The soil under

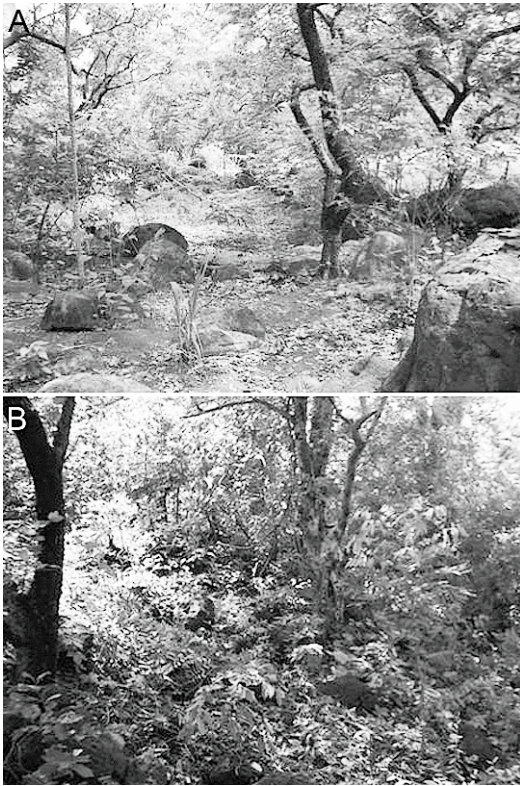


Fig. 11. Subtropical forest habitat of *Etiennesus africanus* (Hentschel, 1899). **A.** Guinea-Bissau: 19 km S of Bambadinca. **B.** Senegal: 3 km W of Kedougou on road to Salemata.

the rocks or logs where specimens were found was more humid and less compacted than that under rocks or logs in direct sunlight, where specimens were not found. The behavior of *E. africanus* appears to be similar to that of other whip scorpion species that inhabit regions with distinct wet and dry seasons. During the dry season, individuals burrow to reach moisture and remain dormant below the surface until arrival of the first rains, whereupon they reemerge to the surface. In the summer of 2005, the rains in Guinea-Bissau were over a month late, and the substrate, even under logs and in the leaf litter, was extremely dry. No specimens were collected in five days of intense searching by several individuals in a forest where, according to local collectors and photographs, specimens are commonly found in the rainy season. Approximately 20 km south, however, in a

forest bordered by a flood savanna, and thus considerably more humid than other forests in the region, five specimens were located under rocks and logs in approximately four hours of searching (fig. 11A). During this period, Senegal experienced heavy rains. One day after returning to Senegal from Guinea-Bissau, 21 specimens, including adults and juveniles, were collected under rocks in just two hours, in a small, humid patch of forest (fig. 11B). The forest in which these specimens were collected was only about 100 m<sup>2</sup> in area, and surrounded by dry grassland with no tree canopy, suggesting that *E. africanus* was concentrated in the forest because it was the only suitable habitat in the immediate area.

## DISCUSSION

Some previous authors suggested that no indigenous whip scorpions exist in Africa, and that *E. africanus* was probably introduced to the Gambia region, 130–150 years ago, in shipments of agricultural material from Burma (Myanmar) or Thailand (Millot, 1949; Cooke and Shadab, 1973). Our observations refute these hypotheses. Besides the fact that 150 years would be insufficient time to allow the species to achieve its present distribution in four West African countries, morphology suggests that it is more closely related to the whip scorpions of the New World than it is to those of Asia.

Although placed in the Asian genera *Hypoctonus* and *Labochirus* by previous workers (Hentschel, 1899; Gravely, 1916; Werner, 1935; Cooke and Shadab, 1973; Rowland and Cooke, 1973) for reasons discussed above, *Etiennesus* is readily distinguished from both of them on the basis of several characters. The pedipalp patellar apophysis of the male is greatly modified and enlarged, relative to that of the female, in *Hypoctonus* and *Labochirus*, as is also the case in the Asian genus *Typopeltis* Pocock, 1894. In *Etiennesus*, however, the pedipalp patellar apophysis of the male is greatly reduced, relative to that of the female. The genital operculum of female *Etiennesus* is not markedly sexually dimorphic, unlike that of *Hypoctonus* and *Labochirus*, in

which sternite II of the female is lobate, heavily sclerotized, and flattened medially. *Etiennus* may be further distinguished from *Labochirus* by the absence of an accessory tooth on the internal edge of the pedipalp coxal apophysis.

*Etiennus* appears to be more closely related to the New World genera, *Thelyphonellus* and *Ravilops*, than to the above-mentioned Asian genera. *Etiennus* shares the following characters with *Thelyphonellus* and *Ravilops*: the male pedipalp patellar apophysis is unmodified; the genital operculum is not markedly sexually dimorphic; the carapace is narrow and elongated.

The hypothesis that *Etiennus* might be more closely related phylogenetically to the hypoctonine genera of the New World than to those of the Old World was first proposed by Heurtault (1984). Rowland and Cooke (1973) had earlier suggested that the sole New World hypoctonine species known at the time, *Thelyphonellus amazonicus* (Butler, 1872), might also be an introduction from Southeast Asia. This has since been refuted, however, by the discovery of additional hypoctonine species in the New World, including *Thelyphonellus ruschii* Weygoldt, 1979, from Guyana, *Thelyphonellus vanegasae* Giupponi and Vasconcelos, 2008, from Colombia, *Ravilops wetherbeeii* (Armas, 2002) from the Dominican Republic, and two undescribed hypoctonine taxa from Surinam and Venezuela (Rowland, 2002; Giupponi and Vasconcelos, 2008; J. Huff, unpublished data).

Heurtault's (1984) hypothesis of a Gondwana connection between the whip scorpions of Africa and the Neotropics is plausible, given the many biogeographical connections between these areas. Among arachnids, for example, the order Ricinulei Thorell, 1876, the pseudoscorpion genus *Pseudochthonius* Balzan, 1892, and the scorpion genera, *Ananteris* Thorell, 1891 and *Opisthacanthus* Peters, 1861 (subgenus *Opisthacanthus*) are restricted to tropical western and central Africa and the New World (Newlands, 1973; Francke, 1974; Lourenço, 1985, 1987, 1993; Harvey, 1996, 2003; Prendini, 2005).

In addition to confirming Heurtault's (1984) hypothesis of a phylogenetic relationship between the hypoctonine whip scorpions of

Africa and the New World, our observations support the creation of a monotypic genus for the African species. *Etiennus* differs from *Thelyphonellus* and *Ravilops*, and indeed from all other whip scorpions, on the basis of two potential autapomorphies described here for the first time: the presence of a median longitudinal suture on the sternum and a dorsally curved, subconical projection of leg I, tarsomere IX in the female.

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