



ARTÍCULO:

Description of a new species of *Grosphus* Simon (Scorpiones, Buthidae) from the Ankarana Massif, Madagascar

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Revista Ibérica de Aracnología

ISSN: 1576 - 9518.
Dep. Legal: Z-2656-2000.
Vol. 7, 30-VI-2003
Sección: Artículos y Notas.
Pp: 19-28

Edita:

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ARTÍCULO:

**DESCRIPTION OF A NEW SPECIES OF
GROSPHUS SIMON (SCORPIONES, BUTHIDAE)
FROM THE ANKARANA MASSIF, MADAGASCAR**

Wilson R. Lourenço & Steven M. Goodman

Abstract

Some morphological characteristics of *Grosphus flavopiceus* Kraepelin, 1900 are revised. A new species, *Grosphus ankarana* sp. n., related to *G. flavopiceus*, is described from the Ankarana Massif in the province of Antsiranana (Diégo Suarez), Madagascar. The morphology of the basal middle lamellae of the pectines is illustrated by using scanning electron microscopy. A revised key to the 12 known species of this genus is presented.

Key words: Scorpions, *Grosphus*, new species, speciation, Madagascar, Ankarana Massif.

Taxonomy: *Grosphus ankarana* sp. n.

Descripción de una nueva especie de *Grosphus* Simon (Scorpiones, Buthidae) del Macizo Ankarana, Madagascar

Resumen

Se revisan los caracteres morfológicos de *Grosphus flavopiceus* Kraepelin, 1900. Se describe una nueva especie, *Grosphus ankarana* sp. n., próxima a *G. flavopiceus*, del Macizo de Ankarana, en la provincia de Antsiranana (Diégo Suarez), Madagascar. La morfología de la lamela basal media de las pectinas es ilustrada usando microscopio electrónico. Se presenta una clave revisada para las 12 especies conocidas del género.

Palabras clave: Escorpiones, *Grosphus*, nueva especie, especiación, Madagascar, Ankarana Massif.

Taxonomía: *Grosphus ankarana* sp. n.

Introduction

As discussed in recent papers (Lourenço, 1999, 2001, 2003), the first *Grosphus* species to be described was *Scorpio* (*Androctonus*) *madagascariensis* Gervais (1843/1844) [= *Grosphus madagascariensis*] (Gervais, 1843/1844). Kraepelin (1900) contributed to the study of the genus *Grosphus*, and described several new species. In his monograph on the scorpions of Madagascar, Fage (1929) described a new variety of *Grosphus limbatus*, which he named *annulata* and was subsequently raised to specific rank as *G. annulatus* (Lourenço, 1996). After Fage's (1929) monograph only four new species of this genus have been described (Lourenço, 1996, 1999, 2001, 2003).

The original descriptions of these *Grosphus* species were in most cases quite clear and the associated proposed distinguishing characters have been confirmed in subsequent diagnoses (Fage, 1929; Lourenço, 1996), although some features may require re-examination. The taxonomy of *Grosphus* is based mainly on two principal characters: the pattern of coloration, and the morphology of the basal middle lamellae of the female pectines. For some species, such as *G. flavopiceus*, recent studies (see Lourenço, 1996) were based on insufficient material. Moreover, the precise distributional range of this species was not properly understood. For the present study, freshly collected material was examined and the morphology of the basal middle lamella of the pectines studied using scanning electron microscopy. As already suspected by Fage (1929; see discussion), two species are in fact present over what was previously considered the distributional range of *G. flavopiceus*. A new species of *Grosphus*, related to *G. flavopiceus* is herein described from the Ankarana Massif.

Ecology and Biogeography of the Ankarana Massif

The Ankarana Massif is an outcrop of middle Jurassic limestone, oriented NE-SW with about 25 km long and 8 km large (Fig. 1). Quaternary earth movements (circa 1.5 MYA) resulted in the splitting of the massif and elevating its western wall

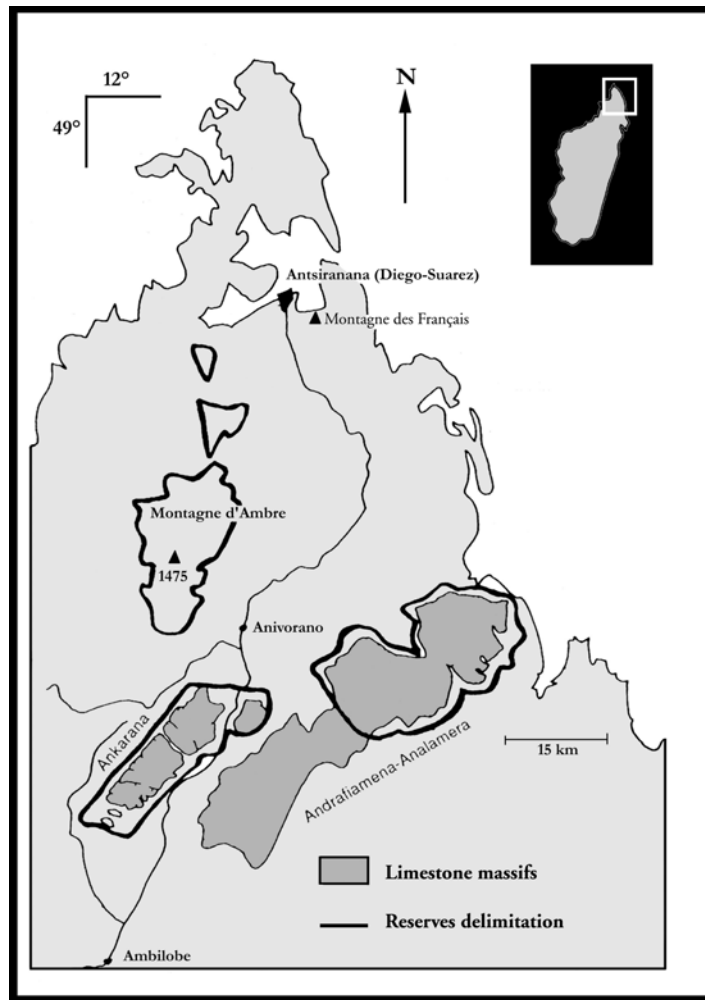


Fig. 1. Map showing the location of Ankarana Massif and Montagne des Français (Modified from Bardot-Vaucoulon, 1997).

(Wilson, 1987), which is now marked by vertical cliffs of 100 to 150 m high. A series of volcanic eruptions over the course of recent geological time have produced a series of lava flows in to the area, including to the east along the Besaboba River (2 MYA), to the west along the Analatelo Plain (1 MYA), and directly into the canyons of Ankarana (0.5 MYA). The vast majority of the massif is contained within the Réserve Spéciale (RS) d'Ankarana and the highest point in the reserve is at about 500 m.

The Ankarana Massif lies at the extreme northern end of Madagascar about 75 km south of Antsiranana (Diégo Suarez, 12°55'S, 49°06'E) and to the southwest of Montagne d'Ambre – this latter site is an isolated volcano and associated with orographic factors the upper slopes of which received considerable rainfall and hold humid forests. The Ankarana region is slightly drier and with slightly less than 2000 mm of rainfall each year (Hawkins *et al.*, 1990). Even with this relatively high annual precipitation the site has dry deciduous vegetation and this is due to an extended dry season (Lowry *et al.*, 1997), which lasts from May to November. The average daily temperature during this season is 26°C. The rainy season lasts from December to April, and accounts for 93% of the annual precipitation, and

with an average daily temperature of 27.5°C (Bardot-Vaucoulon, 1997).

The narrow and often deep canyons within the massif regularly have tall canopy semi-evergreen forests resting on slightly acidic soils of basaltic rock. These canyons provide a buffer against the relatively extreme dry conditions of this general region of Madagascar, in particular shelter against the sun and often-strong winds (Hawkins *et al.*, 1990). Further, an extensive subterranean aquifer passing under the Ankarana resurges in these canyons or is close to the surface level and helps to maintain mesic conditions even during the heart of the dry season. The forested habitat within the deep canyons of the Ankarana form an ecological island, isolated from the surrounding areas by dry deciduous forests or anthropogenic savannas. The biota of these canyons contain many endemic plant and animal species (Cardiff and Befourouack, in press), some with affinities of modern eastern humid forests and others to the western deciduous forests. On the basis of subfossil evidence it is clear that the massif supported more mesic conditions during the Quaternary (Godfrey *et al.*, 1996, 1999; Jungers *et al.*, 1995) and the remaining canyon forests hold some relict taxa of this more mesic period.



Fig. 2-5. *Grosphus ankarana* sp. n. 2-3: Male holotype, dorsal and ventral aspects. 4-5: Idem, Female paratype.

Taxonomic Treatment Description of a new species

Grosphus ankarana sp. n.

(Figs. 2-11, 16-24)

Grosphus flavopiceus; Fage, 1929: 649 (in part)

MATERIAL EXAMINED: Madagascar, Province d'Antsiranana, Réserve Spéciale d'Ankarana, 2.6 km E Andrafiabe, in forest near Andrafiabe Cave, 12° 55.9' S – 49° 03.4' E, 20621/I/2001, about 50 m, dry deciduous forest at base of *tsingy*, pitfall-traps (S. Goodman, leg), FMHD # 01-41. 1 male (holotype), 10 males and 3 females (paratypes). Campement des Anglais (Anilotra),

12° 54.5' S – 49° 06.6' E. (S. Goodman, leg.), 6 males and 8 females (paratypes). Holotype and paratypes deposited in the Field Museum of Natural History, Chicago, with the exception of one paratype deposited in the Muséum National d'Histoire Naturelle, Paris, and two paratypes deposited in the Natural History Museum, Geneva.

The new species was collected together with several specimens of *Grosphus madagascariensis*, also in the collections of the Field Museum of Natural History.

ETYMOLOGY: The name of the type locality (Ankarana Massif) is placed in apposition to the generic name.

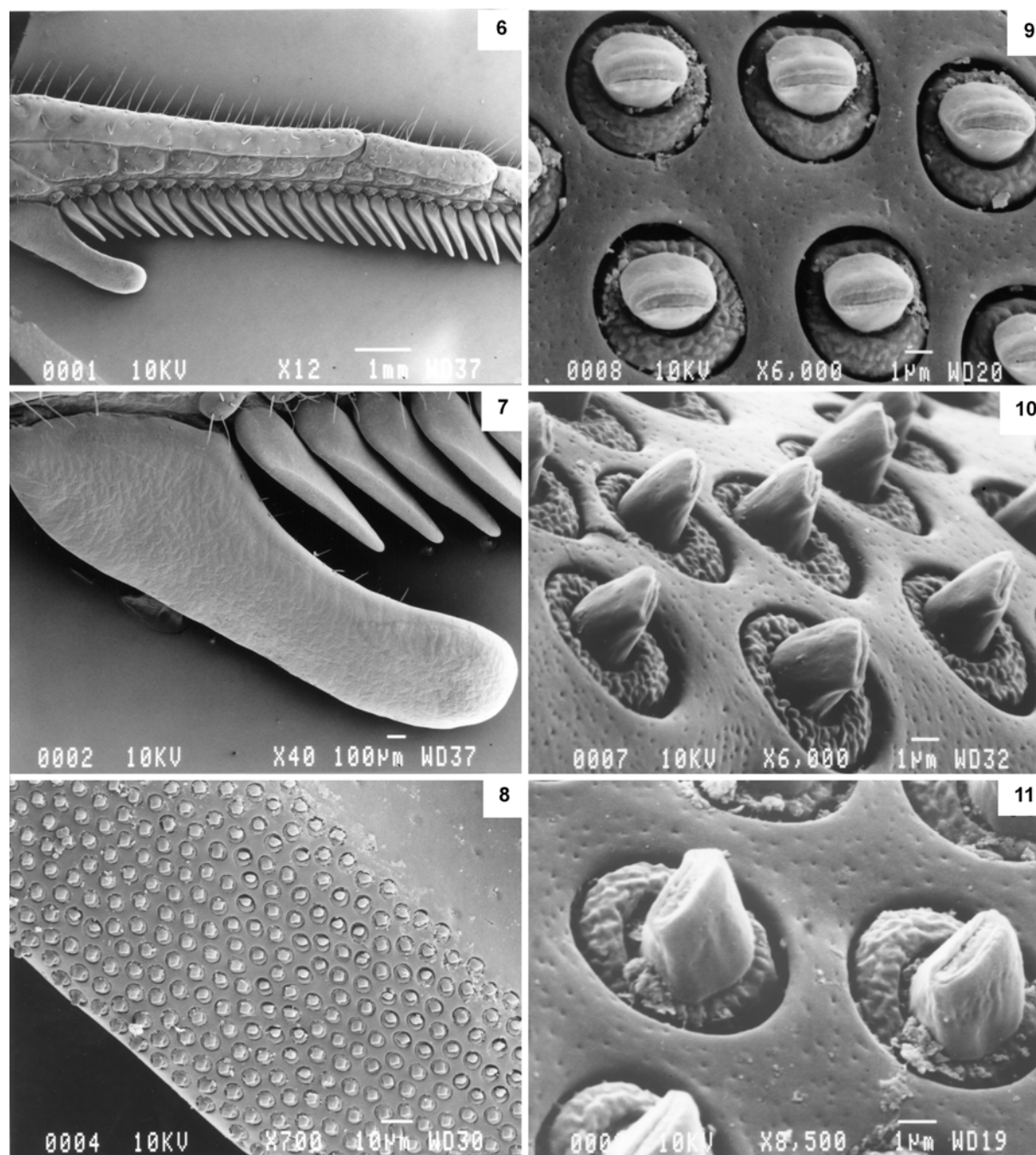


Fig. 6-11. *Grosphus ankarana* sp. n. (female paratype). **6:** Pecten showing the basal middle lamella. **7:** Basal middle lamellae, in detail. **8:** Microstructure of peg sensilla on one tooth. **9-11:** Peg sensilla in detail.

DIAGNOSIS: The morphology of the new species shows that it is close to *Grosphus flavopiceus* Kraepelin, but it can be readily distinguished from that species by the following characters: (i) overall larger size – see Table I; (ii) greater number of pectinial teeth in both males and females – see Table II; (iii) 14 to 15 rows of granules on the pedipalp tibia fingers; and (iv) more elongated and curved basal middle lamellae of the female pectines, covering the first 3 proximal teeth.

DESCRIPTION BASED ON MALE HOLOTYPE AND ONE FEMALE PARATYPE.

Measurements in Table I.

Coloration. Basically reddish-yellow to gray-yellowish or gray-reddish. Prosoma: carapace reddish-yellow; eyes surrounded by black pigment. Mesosoma: gray-yellowish. Metasoma: segment I gray-yellowish; segments II-IV reddish-yellow; segment V reddish.

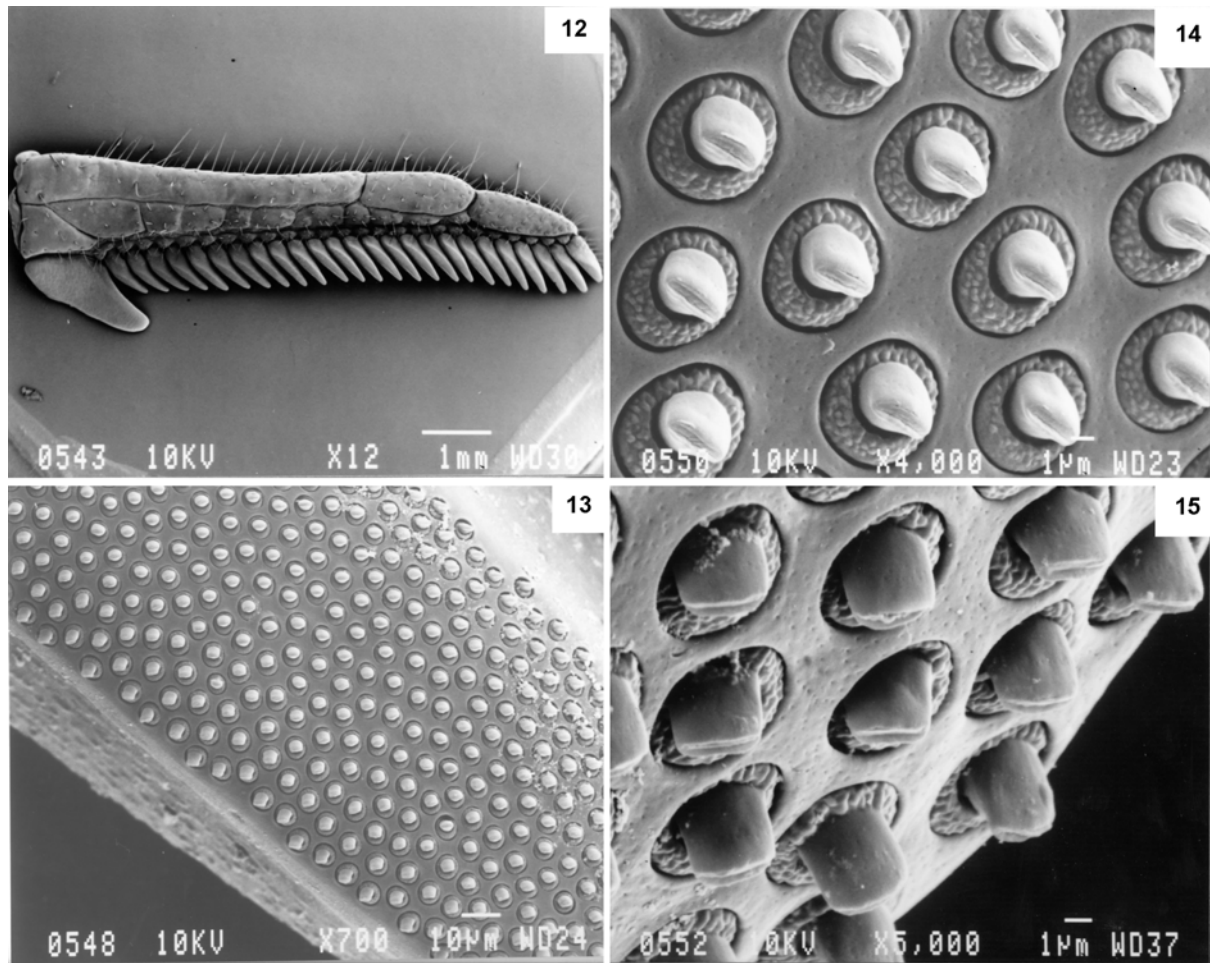


Fig. 12-15. *Grosphus flavopiceus*. **12:** Pecten showing the basal middle lamella. **13:** Microstructure of peg sensilla on one tooth. **14-15:** Peg sensilla in detail.

Vesicle dark reddish; aculeus with reddish base and blackish tip. Venter: coxapophysis, sternum and genital operculum gray-yellowish; pectines yellowish with some diffuse gray spots; sternites gray-yellowish. Chelicerae reddish-yellow without any dark variegated pigmentation along its entire surface; fingers reddish with teeth blackish. Pedipalps: femur yellowish, patella and tibia reddish with vestigial dark zones on patella and tibia; rows of granules on fingers blackish. Legs yellowish without spots.

Morphology. Carapace moderately to strongly granular; anterior margin almost straight, with a weak median concavity. All carinae weak; furrows moderately to strongly developed. Median ocular tubercle anterior to the center of carapace; median eyes separated by more than one ocular diameter. Three pairs of lateral eyes. Sternum between sub-triangular and sub-pentagonal in shape. Mesosoma: tergites with a weak to moderate granulation. Median carina moderately developed in all tergites. Tergite VII pentacarinat. Venter: genital operculum consisting of two subtriangular plates. Pectines: pectinal teeth count 40-41 (for variation see Table II); basal middle lamellae of each pecten not dilated in males; elongated and curved in females;

constant in wide from the base to the apex, covering the 3 proximal teeth. Sternites smooth, with elongated stigmata; III-VI with two longitudinal furrows; VII with four vestigial carinae. Metasoma: segments I and II with 10 carinae, moderately crenulate. Segments III and IV with 8 carinae, weakly crenulate. Segment V with 5 carinae. Dorsal carinae on segments I-IV with one or two posterior spinoid granules. Intercarinal spaces weakly granular to smooth. Telson smooth; aculeus strongly curved and slightly shorter than the vesicle; subaculear tooth absent. Cheliceral dentition characteristic of the family Buthidae (Vachon, 1963); two distinct basal teeth present on the movable finger, but very reduced; ventral aspect of both fingers and of manus with dense, long setae. Pedipalps: femur pentacarinat; patella with a dorsointernal carina and with several spinoid granules on the internal face; tibia smooth, without carinae, all faces weakly granular to smooth. Movable and fixed fingers with 14/15 oblique rows of granules in males and females. Trichobothriotaxy; orthobothriotaxy A- α (Vachon, 1974, 1975). Legs: tarsus with numerous short thin setae ventrally. Tibial spurs present on legs III and IV; pedal spurs present on legs I to IV; all spurs strong.

Table I

Morphometric values (in mm) of the male holotype and female paratype of *Grosphus ankarana* sp. n., and of male and female of *Grosphus flavopiceus* from the Montagne des Français area.

	<i>Grosphus ankarana</i> sp. n.		<i>Grosphus flavopiceus</i>	
	holotype	paratype	male	female
Total length	114.5	105.2	68.6	69.1
Carapace:				
length	10.9	11.4	7.4	8.2
anterior width	8.1	8.7	5.5	6.1
posterior width	11.8	12.9	8.0	9.3
Metasomal segment I:				
length	11.2	9.8	5.8	5.9
width	5.8	6.8	4.4	5.5
Metasomal segment V:				
length	15.3	13.2	9.4	8.8
width	5.2	5.5	4.2	5.0
depth	5.1	5.2	3.8	4.6
Vesicle:				
width	5.1	5.6	3.6	4.5
depth	5.1	5.6	3.6	4.3
Pedipalp:				
Femur length	12.2	11.3	7.5	7.5
Femur width	2.8	3.3	2.1	2.4
Patella length	12.9	12.7	8.4	8.9
Patella width	3.7	4.5	3.0	3.4
Chela length	20.7	20.9	13.9	14.7
Chela width	4.6	5.4	4.0	4.2
Chela depth	4.5	5.2	3.7	3.8
Movable finger:				
length	11.2	12.1	8.1	8.8

Table II

Variation in pectinal tooth count in *Grosphus ankarana* sp. n., and in *G. flavopiceus*.

Number of teeth	<i>G. ankarana</i>		<i>G. flavopiceus</i>	
	Males	Females	Males	Females
24	0	0	0	6
25	0	0	0	14
26	0	0	0	6
27	0	0	0	0
28	0	0	2	0
29	0	0	4	1
30	0	0	1	1
31	0	2	0	0
32	0	8	0	0
33	0	5	0	0
34	0	2	0	0
35	0	3	0	0
36	2	0	0	0
37	6	0	0	0
38	7	0	0	0
39	11	0	0	0
40	4	0	0	0
41	4	0	0	0

Remarks: Coloration in females is slightly paler. The body is bulkier but the total length is smaller than in males (see Table I for morphometric values).

Discussion

Fage (1929) in his monograph on the scorpions of Madagascar, noted the existence of two different forms within animals he referred to *Grosphus flavopiceus*. He remarked (pp. 648-650, translated from the French), “The description proposed here applies to the specimens deposited in the Muséum (Paris), and used by Kraepelin (1900) for the original description. These are from Diégo, Antsirana [sic] and Tamatave. There are, however, in the collections specimens from Ambilobe, collected by M. Waterlot which differ from the type material in several points. The females range from 50 to 107 mm, and the males from 68 to 75 mm. They show a greater number of pectinial teeth: 32-33 for females and 33-37 for males and the basal middle lamella is longer, not conic and rounded in its extremity (see also fig. 4, a-b in page 648).” [Some of the specimen material studied by Fage was not located in the Paris collections.]

Almost without a doubt, Fage had before him material of *Grosphus ankarana* and, probably given the size variation he presented, some of the individuals were juveniles. Although there appear to be characters to differentiate *G. flavopiceus* from the “Ambilobe” animal, Fage did not name the latter as a new species to science. This hesitation might be related to two different points concerning members of the genus *Grosphus*: a

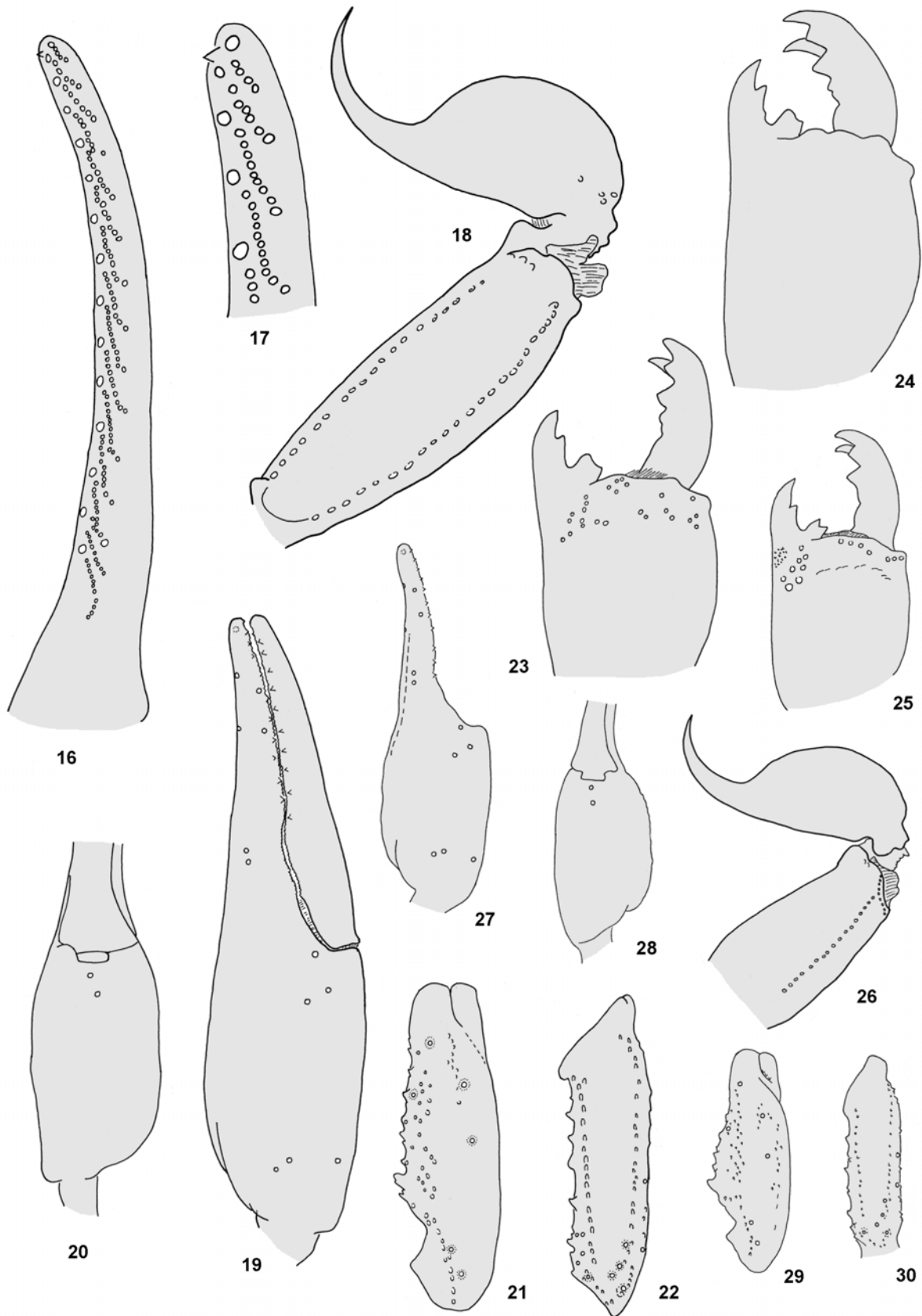


Fig. 16-24. *Grosphus ankarana* sp. n. **16-23:** Male holotype. **16:** Movable finger of tibia pedipalp. **17:** Detail of distal extremity of the same. **18:** Metasomal segment V and telson, lateral aspect. **19-22:** Trichobothrial pattern. **19:** Chela, dorso-external aspect. **20:** Chela, ventral aspect. **21:** Patella, dorsal aspect. **22:** Femur, dorsal aspect. **23:** Chelicera. **24:** Idem female paratype.

Fig. 25-30. *Grosphus flavopiceus* (Montagne des Français). **25:** Chelicera (female). **26:** Metasomal segment V and telson, lateral aspect. **27-30:** Trichobothrial pattern. **27:** Chela, dorso-external aspect. **28:** Chela, ventral aspect. **29:** Patella, dorsal aspect. **30:** Femur, dorsal aspect.

lack of information on the intraspecific variability of certain characters and an unclear view of the biogeographic patterns of the different names species (see also discussion in Lourenço, 2003). Given that at present this species is only known from the Ankarana Massif, the question remains if his specimens were indeed from Ambilobe, or this was simply the nearest town to the collection site.

The morphology of the basal middle lamellae of the female pectines proved to be a diagnostic character for *Grosphus* species (Lourenço, 1996, 2003). In fact, Fage (1946) himself emphasized this characteristic in regard to the species of the Sambirano and Ankarana. Moreover, *Grosphus* species show, almost without exception, very clear and discrete distributional patterns (Lourenço, 1996; Lourenço & Goodman, 1999). We suggest here that on the basis of current information the new species *G. ankarana* sp. n. is endemic to the Ankarana Massif.

Ecology of *Grosphus ankarana*

Grosphus ankarana is known to occur in several different habitats in the Ankarana. A considerable proportion of specimens were obtained in 121 pitfall buckets placed in lines on the forest floor. These lines were in intact forest and were located in areas of canyon forest with sufficient soil and humus to dig in the nearly

30 cm tall buckets. Clearly based on the placement of these devices, this scorpion moves on the forest floor. Further, a number of individuals were observed and collected at night climbing on exposed limestone rock forming the edge of the canyon walls or isolated outcrops within the canyon forest or on vertical tree trunks. During a night walk in the Andrafiabe Forest a very hard rain fell and an individual of *G. ankarana* sp. n. dropped from the tree canopy on to the head of one researcher. Thus, on the basis of current information this species is both terrestrial and arboreal.

At our campsites this scorpion was often found under personnel or research gear left in the open during the night. On one occasion a member of our research team was stung on the hand by an individual of *G. ankarana* sp. n. while removing it with a large forceps from a pitfall bucket. She experienced a painful swelling of the pain and stomach nausea that lasted for several hours. It is not certain that she received a full dose of this scorpion's venom. The number of tourists visiting the Réserve Spéciale d'Ankarana has been increasing in recent years (Cardiff and Befourouack, in press) and many of these visitors camp at several sites within the reserve. Given that *G. ankarana* sp. n. is notably common at some of these campsites they pose a potential threat to these visitors. However, on the basis of current information the sting of this animal is not particularly poisonous.

Key to the species of the genus *Grosphus*

- | | | |
|---|--|----------------------------|
| 1 | Pectines with a maximum of 21 teeth | 2 |
| – | Pectines with more than 22 teeth | 4 |
| 2 | Coloration yellowish to reddish yellow, with variegated brownish pigmentation;
body length about 30 mm | <i>G. garciai</i> |
| – | Coloration dark, from reddish brown to dark brown; body length about 50 mm | 3 |
| 3 | Coloration reddish brown to dark brown, without light spots; metasomal segment I
longer than wide; basal middle lamellae of female pectines oval in shape | <i>G. madagascariensis</i> |
| – | Coloration reddish brown with lighter spots; metasomal segment I wider than long;
basal middle lamellae of female pectines subquadragular in shape | <i>G. hirtus</i> |
| 4 | Coloration blackish or reddish brown to yellowish; pectines with 30 to 40 teeth;
body length more than 90 mm | 5 |
| – | Coloration reddish brown to yellowish, never blackish; body length less than 90 mm. | 6 |
| 5 | Coloration blackish throughout | <i>G. grandidieri</i> |
| – | Coloration reddish brown to yellowish | <i>G. ankarana</i> sp. n. |
| 6 | Mesosoma with homogenous coloration, reddish brown or yellowish | 7 |
| – | Mesosoma with a blackish median longitudinal band, or with two blackish lateral
longitudinal bands | 10 |
| 7 | Total length more than 65 mm; mesosoma reddish brown; basal middle lamellae of
female pectines two times longer than wide at their base | <i>G. flavopiceus</i> |
| – | Total length less than 60 mm; mesosoma yellowish; basal middle lamellae of female
pectines three times longer than wide at the base | 8 |

- 8 Metasomal segment V and telson pale yellowish *G. intertidalis*
 – Metasomal segment V and telson with blackish spots or blackish throughout 9
- 9 Metasomal segment V and telson with blackish spots *G. annulatus*
 – Metasomal segment V and telson blackish *G. feti*
- 10 Mesosoma with a wide blackish median longitudinal band; basal middle lamellae of female pectines three times longer than wide at their base and covering the 4 proximal teeth *G. limbatus*
 – Mesosoma with two narrow blackish lateral longitudinal bands 11
- 11 Carapace without a blackish triangular spot; basal middle lamellae of female pectines weakly curved, widening in proximal half and covering the two proximal teeth *G. bistriatus*
 – Carapace with a blackish triangular spot; basal middle lamellae of the female pectines curved and constantly narrowing from the base to apex covering the four proximal teeth *G. ankarafantsika*

Acknowledgements

We are very grateful to Laurent Albenga and Régis Cleve (Muséum National d'Histoire Naturelle, Paris) for technical help with the preparation of SEM and digital photos. For permission to work in the Ankarana we would like to thank the Association National pour la Gestion des Aires Protégées (ANGAP) based in Antananarivo and Ambilobe. Funds to conduct this fieldwork were provided by the National Geographic Society and the Volkswagen Foundation.

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