

## SCORPIONS OF SOUTH-WEST MADAGASCAR. II. THE SPECIES OF *GROSPHUS* SIMON (SCORPIONES, BUTHIDAE)

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**Abstract:** The south-western portion of Madagascar appears to have one of the highest levels of scorpion diversity on the island, and herein we present an analysis of the known species of *Grosphus* from this region. Information on ecological aspects of the locally occurring species is also given, including a brief description of the female of *Grosphus mahafaliensis* Lourenço, Goodman & Ramilijaona, 2004.

**Key words:** Scorpiones, Buthidae, *Grosphus*, taxonomy, ecology, south-western Madagascar.

### Escorpiones del sudoeste de Madagascar. II. Las especies del género *Grosphus* Simon (Scorpiones, Buthidae)

**Resumen:** La porción suroccidental de Madagascar parece tener uno de los niveles más altos de diversidad de escorpiones de la isla. Se presenta un análisis de las especies conocidas del género *Grosphus* de esta región, así como información sobre aspectos ecológicos de las especies presentes en la zona, incluyendo una breve descripción de la hembra de *Grosphus mahafaliensis* Lourenço, Goodman & Ramilijaona, 2004.

**Palabras clave:** Scorpiones, Buthidae, *Grosphus*, taxonomía, ecología, suroeste de Madagascar.

### Introduction

As already discussed in previous publications (Lourenço *et al.*, 2007), the southwestern portion of Madagascar has a rich scorpion fauna as compared to other portions of the island. Recent detailed inventory work in the southwest has revealed several new species to science (Lourenço & Goodman, 2006a, b) and in particular species belonging to the genus *Grosphus* (Lourenço, 2004; Lourenço *et al.*, 2004, 2007). These new insights into the regional scorpion fauna provides further support that southwestern Madagascar holds a rich and complex scorpion fauna.

The taxonomy of the genus *Grosphus* (Family Buthidae), endemic to Madagascar, is based mainly on two characters: external coloration patterns and in females the pectine morphology of the basal middle lamellae. This last character has been considered by scorpion taxonomists to show species-specific features, with little intraspecific variation (Fage, 1929). However, recent detailed investigations have shown that in some cases closely related species have similar basal middle lamellae morphology (Lourenço, 2003; Lourenço & Goodman, 2003, 2006c; Lourenço *et al.*, 2004, 2007).

In the present note, we present an analysis of the known species of *Grosphus* distributed in southwestern Madagascar. Considerable collections have been made over the past few years during biological inventories. The vast majority of scorpions in these new collections were obtained with the use of pit-fall trapping devices, put in place principally for the capture of small mammals and reptiles (Raxworthy & Nussbaum, 1994). Further, ecological infor-

mation about the collection sites and possible patterns of distribution of the species are also discussed.

### Material and methods

Illustrations and measurements were produced using a Wild M5 stereo-microscope with a drawing tube 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). Abbreviations: SMG = Steven M. Goodman VS = Voahangy Soarimalala

### Taxonomy

Family BUTHIDAE C. L. Koch, 1837

Genus *Grosphus* Simon, 1880

#### [ *Grosphus hirtus* Kraepelin, 1900 ]

*Grosphus hirtus* was described by Kraepelin in 1900 from Makaraingo, in the central region of Madagascar. It was first suggested that this species was broadly distributed in the island (Lourenço, 1996). However, more precise inspection of specimens previously allocated to *G. hirtus* indicates that several previous records attributed to this taxon were misidentifications of morphologically similar species, which were subsequently described as new to science (Lourenço, 2005). After a reexamination of available material, there is no evidence for the occurrence of *G. hirtus* in southwestern Madagascar (Lourenço *et al.*, 2007).

**Table I. Comparative morphometric values (in mm) some of the *Grosphus* species treated in this paper: H=holotype, P=paratype, L=lectotype, Par=paralectotype, S=standard. Values represent single specimen measurements**

	<i>G. mahafaliensis</i>			<i>G. annulatus</i>		<i>G. olgae</i>		<i>G. intertidalis</i>		<i>G. polskyi</i>
	♂-H	♂-S	♀-S	♂-L	♀-Par	♂-H	♀-Pa	♂-S	♀-H	♂-H
Total length	43.9	56.7	55.1	35.9	45.9	36.2	37.2	44.1	57.2	32.6
Carapace:										
- Length	5.2	6.3	6.2	4.1	4.8	3.9	4.2	5.2	5.5	3.9
- Anterior width	3.8	4.8	5.2	3.0	3.7	2.8	3.3	3.8	4.3	2.7
- Posterior width	5.3	7.0	7.4	4.6	5.7	4.2	4.8	5.4	6.7	4.4
Metasomal segment I:										
- Length	4.0	5.1	4.6	3.1	3.4	3.1	3.0	3.9	4.0	2.3
- Width	3.3	4.1	4.5	2.5	3.1	2.2	2.6	3.2	3.2	2.3
Metasomal segment V:										
- Length	6.4	8.3	7.6	5.4	6.0	4.9	4.8	6.3	6.2	4.3
- Width	3.2	4.0	4.3	2.5	2.7	1.9	2.0	3.3	3.2	2.2
- Depth	2.9	3.3	3.5	2.3	2.6	1.8	1.9	2.8	2.7	2.2
Vesicle:										
- Width	2.4	3.0	3.6	2.1	2.7	1.4	1.6	2.6	2.4	2.0
- Depth	2.2	2.7	2.9	2.0	2.8	1.4	1.5	2.3	2.5	1.9
Pedipalp:										
- Femur length	4.8	5.7	5.5	3.7	3.9	3.9	3.6	4.7	4.8	3.5
- Femur width	1.4	1.7	1.7	1.3	1.5	1.1	1.3	1.6	1.4	1.2
- Patella length	5.2	6.3	6.1	4.3	4.8	4.6	4.6	5.5	5.7	4.3
- Patella width	1.9	2.4	2.5	1.8	2.0	1.6	1.8	1.8	2.3	1.8
- Chela length	9.0	10.3	10.1	7.0	7.8	7.3	7.3	8.9	9.1	7.2
- Chela width	2.6	3.2	2.6	2.2	2.2	1.8	1.5	2.5	2.4	2.3
- Chela depth	2.5	3.1	2.6	2.2	1.9	1.7	1.4	2.5	2.4	2.0
Movable finger:										
- Length	4.9	5.9	6.2	4.0	4.8	4.5	5.0	5.1	5.8	3.8

### ***Grosphus grandidieri* Kraepelin, 1900**

*Grosphus grandidieri* was originally collected by G. Grandidier at an unspecified locality on 23 May 1898 and described by Kraepelin (1900). This species is distributed across portions of southwestern Madagascar (see Lourenço, 1996). It is one of the most conspicuous species of *Grosphus*, with its very large size, adults ranging from 85 to 90 mm in total length; an intense blackish coloration, almost unique among the species of *Grosphus*; and a large number of pectine teeth, 30 to 34 in females and 34 to 40 in males. On the basis of recent collections made with pit-fall traps, *G. grandidieri* does not appear to be particularly common in southwestern Madagascar, as compared to some other members of this genus.

### ***Grosphus annulatus* Fage, 1929**

*Grosphus annulatus* was originally described by Fage (1929) only as a variety of *G. limbatus annulata*. More detailed studies indicated that it was necessary to elevate this form to the rank of species (Lourenço, 1996). *Grosphus annulatus* is an animal of small to moderate size, with males and females 36 and 46 mm in total length (see Table I). It can be easily distinguished from *G. limbatus* Kraepelin by a characteristic pigmentation pattern -- the carapace and tergites are extensively yellowish, but the metasomal segments IV and V are markedly blackish. *Grosphus limbatus* and *G. annulatus* show notable shape differences in the basal middle lamellae of the female pectines (Figs. 11-12).

Based on pigmentation patterns, *G. annulatus* is probably closely related to *G. olgae* Lourenço, 2004 described from southwestern Madagascar (see below). These species can, however, be distinguished from one another based on the shape of basal middle lamellae of the female pectines, and distinct shape differences in the telson. In *G. annulatus*, the vesicle is strongly globular and longer than the aculeus, while in *G. olgae*, the vesicle is weakly globular and shorter than the aculeus (Figs. 1-2, 3-4). Given all of the fieldwork

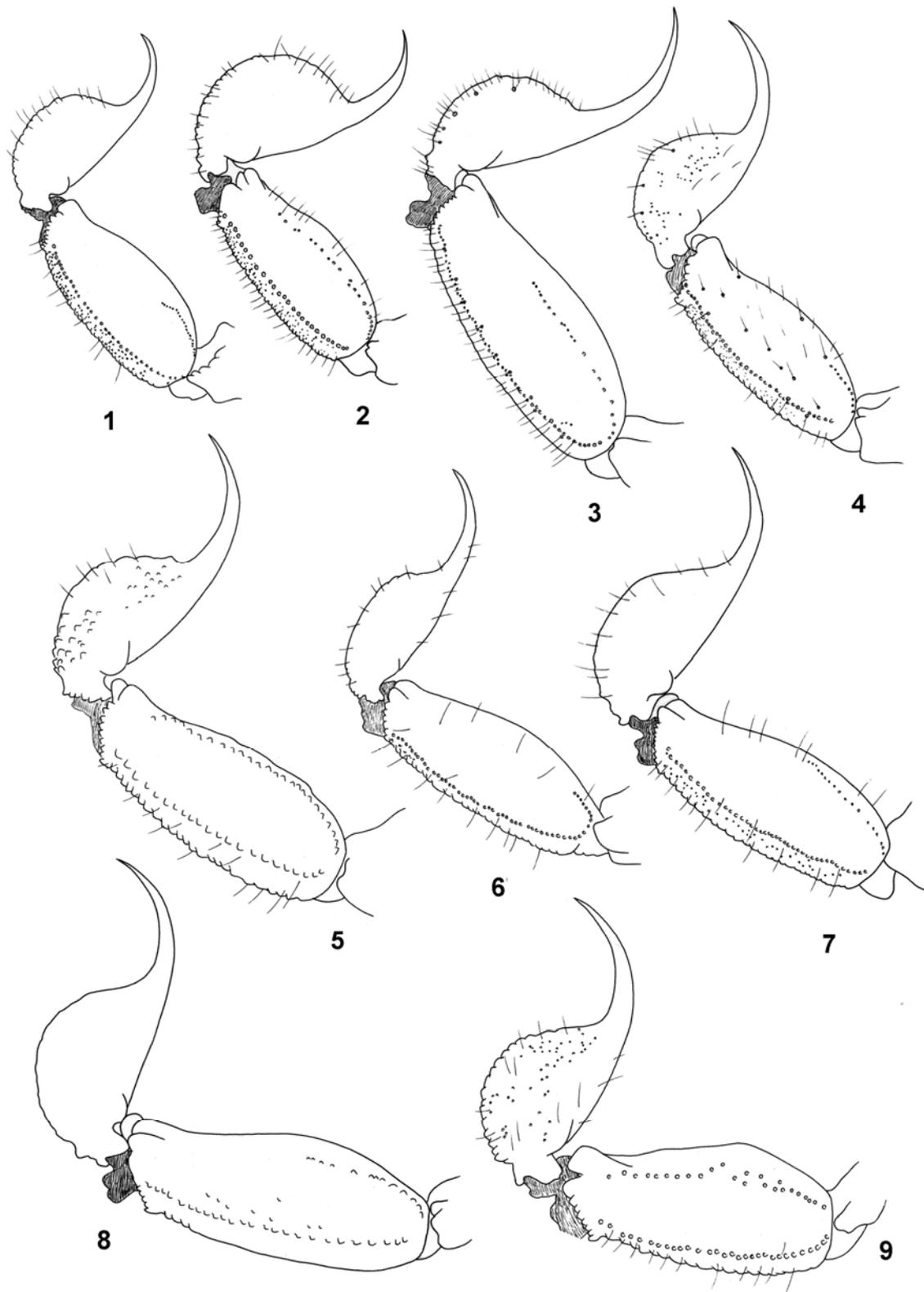
conducted in southwestern Madagascar, it is rather remarkable that *G. annulatus* is only known from the original type locality of 'Province Tuléar [=Toliara], Sarodrano' (Fage, 1929). The coastal sand dune habitat surrounding the Sarodrano area has not been the subject of a recent inventory using pit-fall traps and perhaps this taxon has very specific ecological requirements. Fresh material will be needed for molecular studies to resolve the relationships of this species.

### ***Grosphus feti* Lourenço, 1996**

*Grosphus feti* was collected by S. M. Goodman in October 1995 from the extreme southern portion of Madagascar, Province de Toliara, Tanjon' I Vohimena (=Cap Sainte Marie), and described by Lourenço (1996). The holotype comes from the stunted coastal forest formation of the Réserve Spéciale de Cap Sainte Marie. The original diagnosis of this species was based on its unique pigmentation pattern, including a general yellowish coloration with an inverted blackish triangle on the front of the carapace (as for *G. limbatus*), and the presence of five longitudinal stripes over the tergites. These stripes are arranged as one thin line over the central carinae, two large latero-internal lines, and two rather thin latero-external lines. Metasomal segment V and telson are blackish. These coloration patterns are more similar to *G. limbatus* than to *G. annulatus* or *G. olgae*. However, *G. feti* is only known by two male specimens and as long as the female remains unknown further precise comparisons between these species remains impossible. *Grosphus feti* is only known from the type locality, which has a very particular habitat and vegetational community (Nicoll & Langrand, 1989).

### ***Grosphus intertidalis* Lourenço, 1999**

*Grosphus intertidalis* was described by Lourenço (1999) based on a single specimen collected in the Province of Toliara, in the coastal zone 3.5 km to the north of Tulear



**Fig. 1-9.** Metasomal segment V and telson, lateral aspect. **1-2.** *Grosphus annulatus*. **1.** Male paralectotype. **2.** Female lectotype. **3-4.** *Grosphus olgae*. Male and female paratypes. **5.** *Grosphus feti*. Male holotype. **6-7.** *Grosphus intertidalis*. Male and female. **8-9.** *Grosphus mahafaliensis*. Male and female.

(=Toliara). More recently, Lourenço (2004) described a male specimen collected in the Province of Toliara, Parc National de Tsimanampetsotsa, 21.5 km NE d'Efoetse (24°0.5'S, 43°53.9'E). The specimen was found at 100 m of altitude under a stone, in a slightly disturbed zone of spiny bush. This species remains poorly known and was not

represented in most recent samples coming from field inventories.

*Grosphus intertidalis* is characterized by a very pale general yellow coloration, without darker pigmentation on the body and appendages. Pectinal tooth counts in females range from 28-30 and in males from 32-34. Basal middle

lamellae of the female pectines is, however, very inconspicuous, covering only the most internal tooth of the pecten (Fig. 14). The telson vesicle is not globular in shape, but rather pear-like, particularly in males (Fig. 6-7).

### *Grosphus olgae* Lourenço, 2004

In contrast to the descriptions of the vast majority of *Grosphus* spp., based on single specimens, *G. olgae* was named from a series of almost 20 specimens, allowing a good assessment of character variability.

*Grosphus olgae* is a small to moderately sized scorpion, 35 to 37 mm in total length. The general coloration is pale yellow with the exception of metasomal segment V and telson, which are dark. This coloration pattern shows some similarities to *G. annulatus* and *G. feti*. Pectinal tooth counts in *G. olgae* are 23 to 28 teeth in females and 28 to 33 in males (see Table II). On the basis of the basal middle lamellae shape of the female pectines, *G. olgae* shows notable similarity to *G. limbatus* (Figs. 11, 13). However, it differs from *G. limbatus* by the general color pattern (absence of spots on carapace and tergites).

This species appears to be very common, both in the Forêt de Mikea, its type locality, but also on and at the base of the Plateau Mahafaly, where new collections document its sympatric occurrence with *Grosphus mahafaliensis* (see next section).

**Table II. Variation of the number of Pectinal teeth *Grosphus olgae***

Number of teeth	Male pectines	Female pectines
23	0	3
24	0	2
25	0	5
26	0	4
27	0	13
28	4	6
29	11	0
30	25	0
31	27	0
32	18	0
33	5	0

TYPE MATERIAL: Madagascar: Province de Toliara, Forêt des Mikea, 7.5 km NE Tsifota, 22°48.0'S, 43°26.0'E, 60 m (in spiny bush forest with some dry deciduous forest elements on light-colored sands), 21 to 25/II/2003 (S.M. Goodman & V. Soarimalala leg.): 1 male holotype (13518), 4 males paratypes (13503, 13526, 13527), and 3 females paratypes (13503, 13520). Province de Toliara, Forêt de Mikea, 9.5 km W. Ankiloloaka, 22°46.7'S, 43°31.4'E, 80 m (in partially disturbed dry deciduous forest on red sand), 14 to 19/II/2003 (S.M. Goodman & V. Soarimalala leg.): 9 males paratypes (13449, 13450, 13458, 13459, 13465, 13466, 13467, 13478, 13491). Parc National de Tsimanampetsotsa, 6.5 km NE Efoetse, 24°3.0'S, 43°45.0'E (forest along Mitoho Cave, pitfall), 28/II to 5/III/2002 (S.M. Goodman leg.): 1 male paratype.

#### NEW MATERIAL STUDIED:

Province de Toliara, 10.5 km SE Itampolo (village), 24°44.2'S, 44°1.79'E, 120 m. – in disturbed spiny bush on Mahafaly Plateau, pitfall traps  
 SMG-14539 – 1 male (with 4 males *G. mahafaliensis*)  
 SMG-14541 – 2 males (with 6 males *G. mahafaliensis*)  
 SMG-14545 – 2 males  
 SMG-14547 – 2 males (with 6 males, 1 female *G. mahafaliensis*)  
 SMG-14548 – 2 males (with 5 males, 1 female *G. mahafaliensis* and 1 male *Neogrosphus griveaudi*).

Province de Toliara, 10.5 km SE Itampolo (village), 24°44.2'S, 44°1.79'E, 120 m. – in disturbed spiny bush on Mahafaly Plateau, pitfall traps

VS-518 – 1 female (with 9 males *G. mahafaliensis*)  
 VS-520 – 1 female (with 8 males, 1 female *G. mahafaliensis*)  
 VS-525 – 2 males, 2 females (with 1 male *N. griveaudi*)  
 VS-524 – 1 male (with 4 males, 5 females *G. mahafaliensis*). Province de Toliara, 4 km NE of Vohombe Village, 24°23.9'S, 43°50.8'E, 80 m. – in spiny bush on Mahafaly Plateau, pitfall traps  
 VS-533 – 4 males, 3 females (with 3 males *G. mahafaliensis*)  
 VS-534 – 3 males  
 VS-543 – 1 male (with 11 males *G. mahafaliensis*)  
 VS-544 – 8 males, 2 females  
 VS-545 – 7 males, 3 females (with 10 males, 1 female, *G. mahafaliensis*)  
 VS-553 – 8 males, 2 females.  
 Province de Toliara, 13.5 km SSE Efoetse, 2 km E Soarano, 24°11.3'S, 43°46.7'E, 15 m – in spiny bush on sandy substrate  
 VS-612 – 7 males.

ECOLOGY: Based on this new material, *Grosphus olgae* occurs in a variety of habitats that include both limestone and sandy soil substrates, although it was notably more common on the former substrate. Animals registered under a single field collection number were all collected during the same dawn pitfall trap check and were presumed to have been active the previous night. These new data indicate that *G. olgae* occurs in sympatry with *G. mahafaliensis*, at most sites this latter species outnumbers the former. Further, there are several cases of *Neogrosphus griveaudi* being captured in the same pitfalls as *G. olgae*. Thus, these three species show broad geographical overlap in portions of southwestern Madagascar.

### *Grosphus mahafaliensis* Lourenço, Goodman & Ramilijaona, 2004

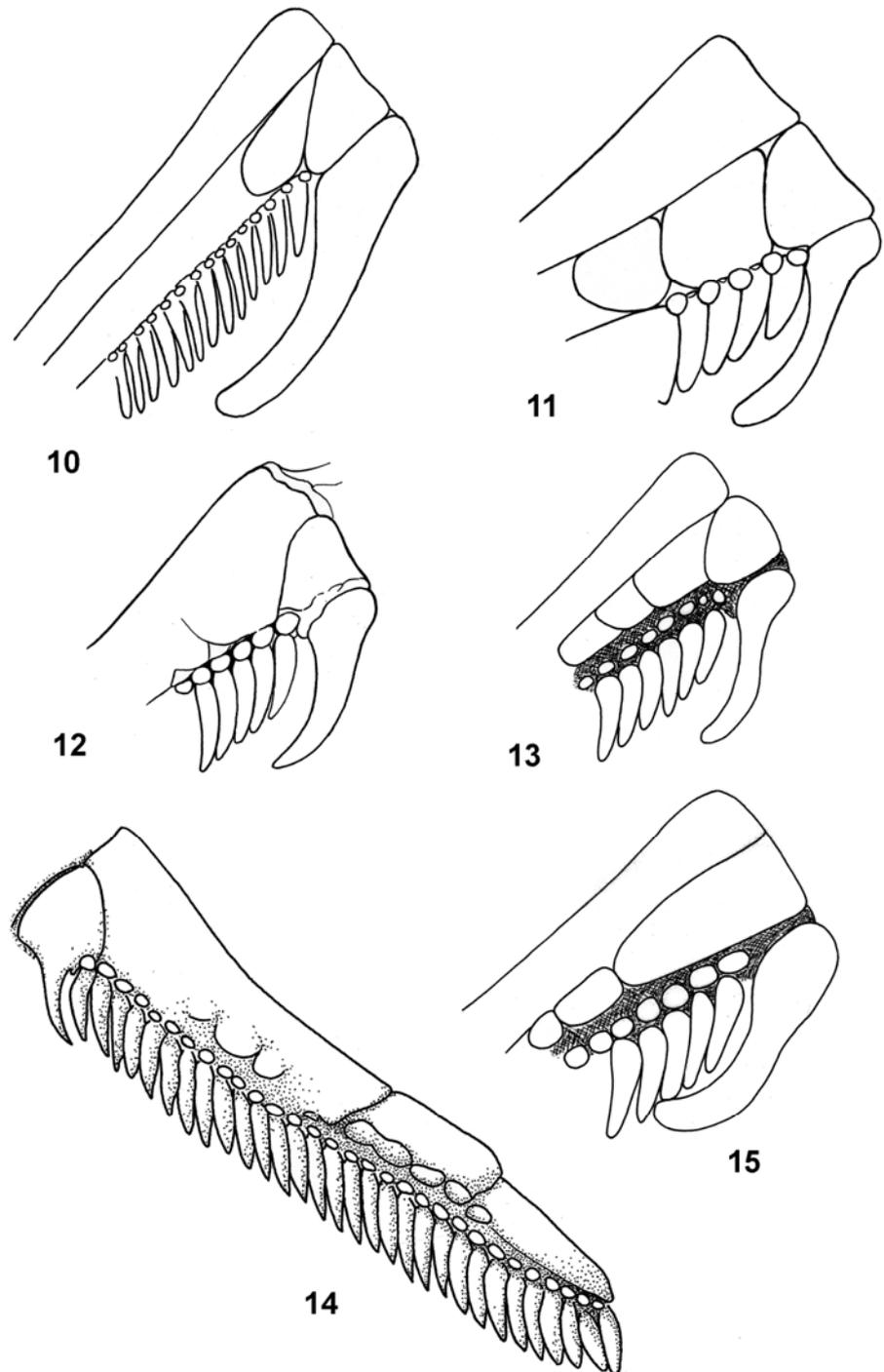
*Grosphus mahafaliensis* was described based on a single male specimen collected in the Province de Toliara, Parc National de Tsimanampetsotsa, N of Efoetse, in coastal *Euphorbia* scrub. Recent collections however, indicate that this species is very common in the region of the Plateau Mahafaly. Almost 150 new specimens have been obtained by the use of pit fall traps, including females which were previously unknown. Using this new material, we present a revised diagnosis for this taxon.

Scorpion of medium size with a total length in females and males of 55 to 57 mm. General coloration reddish yellow. Metasomal segments IV and V and telson intensely reddish in males, and reddish-yellow in females. The general shape of the basal middle lamellae of the female pectines is similar to *G. limbatus* (Figs. 11, 15), however the basal middle lamellae of *G. mahafaliensis* is broader than that of *G. limbatus* and covers the four most proximal teeth. Further, these two species show notable differences in color patterns: *G. mahafaliensis* being reddish-yellow without any spots over the body or appendages. Moreover, pectinal tooth counts in *G. mahafaliensis* are notably greater (see Table III). For more details on *G. mahafaliensis* see the original description by Lourenço *et al.* (2004).

#### NEW MATERIAL EXAMINED

Province de Toliara, 10.5 km SE Itampolo (village), 24°44.2'S, 44°1.79'E, 120 m. – in disturbed spiny bush on Mahafaly Plateau, pitfall traps

**Fig. 10-15.** Female pectines, showing the morphology of the basal middle lamellae. **10.** *Grosphus grandidieri*. **11.** *Grosphus limbatus*. **12.** *Grosphus annulatus*. **13.** *Grosphus olgae*. **14.** *Grosphus intertidalis*. **15.** *Grosphus mahafaliensis*.



**Table III. Variation of the number of pectinal teeth *Grosphus mahafaliensis***

Number of teeth	Male pectines	Female pectines
31	0	16
32	0	14
33	0	12
34	0	0
35	6	0
36	50	0
37	52	0
38	16	0
39	10	0
40	4	

Note: For *Grosphus limbatus* pectinal tooth counts for males had 30 to 32 teeth and for females 24 to 29.

SMG-14539 – 4 males (together with 1 male *G. olgae*)  
 SMG-14540 – 1 male, 3 females  
 SMG-14541 – 6 males (together with 2 males *G. olgae*)  
 SMG-14545 – 10 males, 1 female (together with 2 males *G. olgae*)  
 SMG-14546 – 11 males, 1 female  
 SMG-14547 – 6 males, 1 female (together with 2 males *G. olgae*)  
 SMG-14548 – 5 males, 1 female (together with 2 males *G. olgae*)  
 SMG-14551 – 4 males  
 SMG-14558 – 3 males, 2 females  
 SMG-14559 – 7 males (together with 1 male *Neogrosphus griveaudi*)  
 SMG-14562 – 2 males, 2 females  
 VS-518 – 9 males (together with 1 female *G. olgae*)  
 VS-519 – 9 males, 1 female

VS-520 – 8 males, 1 female (together with 1 female *G. olgae*)  
 VS-521 – 10 males  
 VS-522 – 9 males, 1 female  
 VS-523 – 9 males  
 VS-524 – 4 males, 5 females (together with 1 male *G. olgae*).  
 Province de Toliara, 4 km NE of Vohombe Village, 24°23.9'S,  
 43°50.8'E, 80 m, – in spiny bush on Mahafaly Plateau, pitfall  
 traps  
 VS-533 – 3 males (together with 4 males, 3 females *G. olgae*)  
 VS-543 – 11 males (together with 1 male *G. olgae*)  
 VS-552 – 1 male, 1 female.

**ECOLOGY:** Using this new material, it can be inferred that *Grosphus mahafaliensis* has a broad distribution across the inventory sites on the limestone substrate of the Mahafaly Plateau. These new specimen data indicate that this species occurs in sympatry with *G. olgae*, and based on pitfall trap captures it is the more abundant of the two scorpions. There is one case of *G. mahafaliensis* occurring in sympatry with *Neogrosphus griveaudi*. Thus, these three species show broad geographical overlap in portions of southwestern Madagascar. Based on pitfall captures male *G. mahafaliensis* greatly outnumber females.

Other species of scorpions known to occur specifically in the Tsimanampetsotsa area or elsewhere on the Mahafaly Plateau include: *Grosphus annulatus* Fage from the region of Sarodrano close to sea-level; *G. olgae* Lourenço from near Mitoho Cave within the Parc National de Tsimanampetsotsa; *Pseudouroplectes betschi* Lourenço from the Mahafaly Plateau to the north of Itampolo (Lourenço, 2004); and *Palaeocheloctonus pauliani* Lourenço from Efoetse (Lourenço, unpublished).

### ***Grosphus polskyi* Lourenço, Qi, Goodman, 2007**

*Grosphus polskyi* was recently described from the Province de Toliara, Ifaty, 23°10'80"S, 43°37'00"E, from a "dry spiny bush forest, dominated by baobabs (*Adansonia za*) resting on red sand soil," at 30 m above sea-level (Lourenço *et al.*, 2007).

This species is of small size with a total length of 32.6 mm. The general coloration is reddish-yellow with some diffused brownish variegated pigmentation on the carapace and tergites. Certain morphological characters (overall size, carination pattern, and pectinal tooth count) indicate that *G. polskyi* is similar in certain regards to *G. hirtus*, however, distinct from this last species by a much paler overall coloration with some diffused brownish pigmentation, a metasomal segment I with a length equal to its width, and a subaculear tooth moderately marked. This species remains known only from its type locality. For more details, see the original description in Lourenço *et al.* (2007).

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### Addenda

Revised key to the species of the genus *Grosphus* distributed in the southwest of Madagascar (*G. limbatus* is included for comparative purposes, although this species lives in the central region of the island – see Lourenço, 2003)

1. Pectines with a maximum of 20 teeth; coloration yellowish to reddish-yellow, with pale brownish variegated pigmentation present ..... *G. polskyi*
- 1'. Pectines with more than 23 teeth ..... **2**
2. Coloration pale yellow to reddish-yellow; brownish to blackish pigmentation may be present or not ..... **3**
- 2'. Coloration blackish throughout; pectines with 30 to 40 teeth; female basal middle lamellae covering up to 8 internal teeth ..... *G. grandidieri*
3. Coloration from yellowish to reddish, without any brownish to blackish pigmentation ..... **4**
- 3'. Coloration yellowish with brownish to blackish pigmentation present ..... **5**
4. Coloration pale yellow; pectines with 28 to 34 teeth; female basal middle lamellae covering the first internal tooth ...  
..... *G. intertidalis*
- 4'. Coloration reddish-yellow to reddish; pectines with 31 to 40 teeth; female basal middle lamellae covering the first four internal teeth ..... *G. mahafaliensis*
5. Carapace with an inverted blackish triangle; tergites with brownish to blackish longitudinal stripes ..... **6**
- 5'. Carapace without any blackish triangle; tergites without brownish or blackish stripes ..... **7**
6. Metasomal segment V and telson yellowish ..... *G. limbatus*
- 6'. Metasomal segment V and telson blackish ..... *G. feti*
7. Vesicle strongly globular; aculeus shorter than vesicle ..... *G. annulatus*
- 7'. Vesicle pear-like shaped; aculeus longer than the vesicle ..... *G. olgae*