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ARTÍCULO:

**New considerations on the genus *Tityobuthus* Pocock (Scorpiones, Buthidae), and description of a new species from the Ankarana in northern Madagascar**

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# NEW CONSIDERATIONS ON THE GENUS *TITYOBUTHUS* POCOCK (SCORPIONES, BUTHIDAE), AND DESCRIPTION OF A NEW SPECIES FROM THE ANKARANA IN NORTHERN MADAGASCAR

Wilson R. Lourenço & Steven M. Goodman

**Abstract:**
New taxonomic considerations on the genus *Tityobuthus* Pocock are proposed. *T. dastychi* Lourenço, 1997 of western Madagascar is redescribed and its range notably expanded on the basis of new specimen material. One new species, *T. rakotondravonyi* sp. n., is described from the Réserve Spéciale d'Ankarana in northern Madagascar. A revised key is given for the species of the genus *Tityobuthus*.
**Key words:** Scorpiones, Buthidae, *Tityobuthus*, new species, taxonomy, Madagascar.
**Taxonomy:** *Tityobuthus rakotondravonyi* sp. n.

**Nuevas consideraciones sobre el género *Tityobuthus* Pocock (Scorpiones, Buthidae) y descripción de una nueva especie de Ankarana (Norte de Madagascar)**

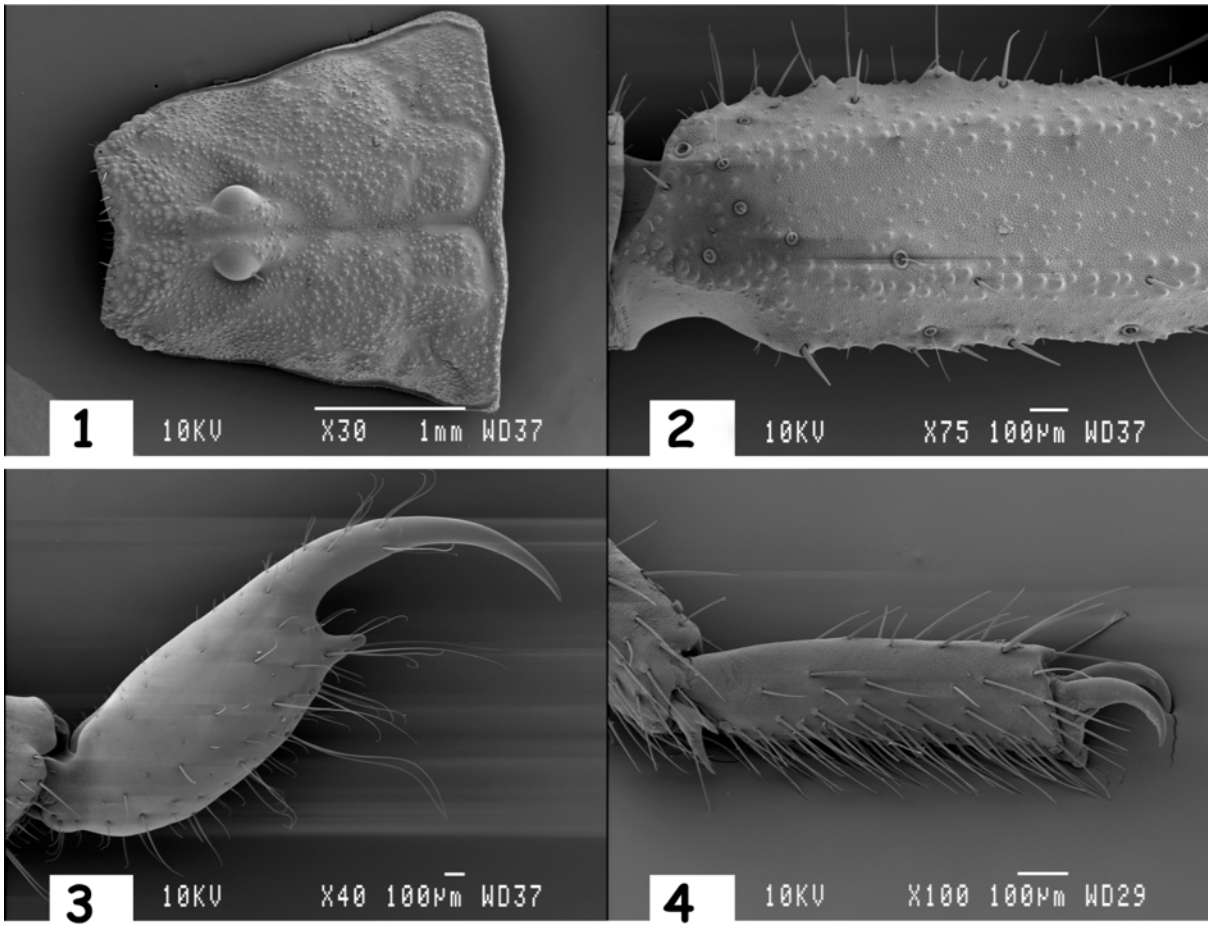
**Resumen:**
Se proponen nuevas consideraciones taxonómicas sobre el género *Tityobuthus* Pocock. Se redescribe *T. dastychi* Lourenço, 1997 del oeste de Madagascar y se amplía notablemente su área de distribución conocida en base a nuevos registros. Se describe una nueva especie, *T. rakotondravonyi* sp. n., de la Reserva Especial de Ankarana en el norte de Madagascar. Se presenta una clave de identificación revisada para las especies del género *Tityobuthus*.
**Palabras clave:** Scorpiones, Buthidae, *Tityobuthus*, nueva especie, taxonomía, Madagascar.
**Taxonomy:** *Tityobuthus rakotondravonyi* sp. n.

## Introduction

When Vachon (1979) published his analysis of the genus *Tityobuthus* Pocock, only two species were regarded as valid: *T. baroni* (Pocock, 1890) and *T. gracilis* (Fage, 1946). The situation remained unchanged until Lourenço (1995) named two new species in this genus: *T. guillaumeti* and *T. pococki*. In more recent publications (Lourenço, 1996a,b, 1997; Lourenço & Goodman, 1999) several other new species were described. Finally, Lourenço (2000) revised the taxonomic position of the Buthoidea of Madagascar with particular reference to *Tityobuthus*, in which a revised diagnosis of this genus was given and three more new species were described from the eastern portion of the island. Moreover, for two species previously placed within *Tityobuthus*, two new genera were established -- *Troglotityobuthus* Lourenço for *Tityobuthus gracilis* (Fage) (described as *Babycurus gracilis*) and *Palaeogrosphus* Lourenço for *T. copalensis* Lourenço.

As suggested by Lourenço (2000), the increasing number of new taxa within the genus *Tityobuthus,* which can be considered among the genera of microscorpions, indicates that this genus may be very rich in species. A similar phenomenon has already been observed in other micro-scorpion genera such as *Ananteris* Thorell of the New World tropics, in which over the course of twenty years the number of new species increased from 5 to 24 (Lourenço, 1993, 2001; Lourenço & Goodman, 2002).

In this paper, some new considerations are proposed for the genus *Tityobuthus*. *T. dastychi* Lourenço, 1997 is redescribed, and two new collection localities are indicated for this scorpion. One new species, new to science, *T. rakotondravonyi*, is described from the Réserve Spéciale d'Ankarana in the north of Madagascar. Finally, a revised key to the known species of the genus *Tityobuthus* is also provided.




**Figs. 1-4:** *Tityobuthus dastychi*. Male from Province de Mahajanga, Ampijoroa. **1.** Carapace, dorsal aspect. **2.** Femur, dorsal aspect, showing trichobothria. **3.** Telson, lateral aspect. **4.** Tarsus of leg IV, lateral aspect.

## Redescription of *Tityobuthus dastychi* Lourenço, 1997

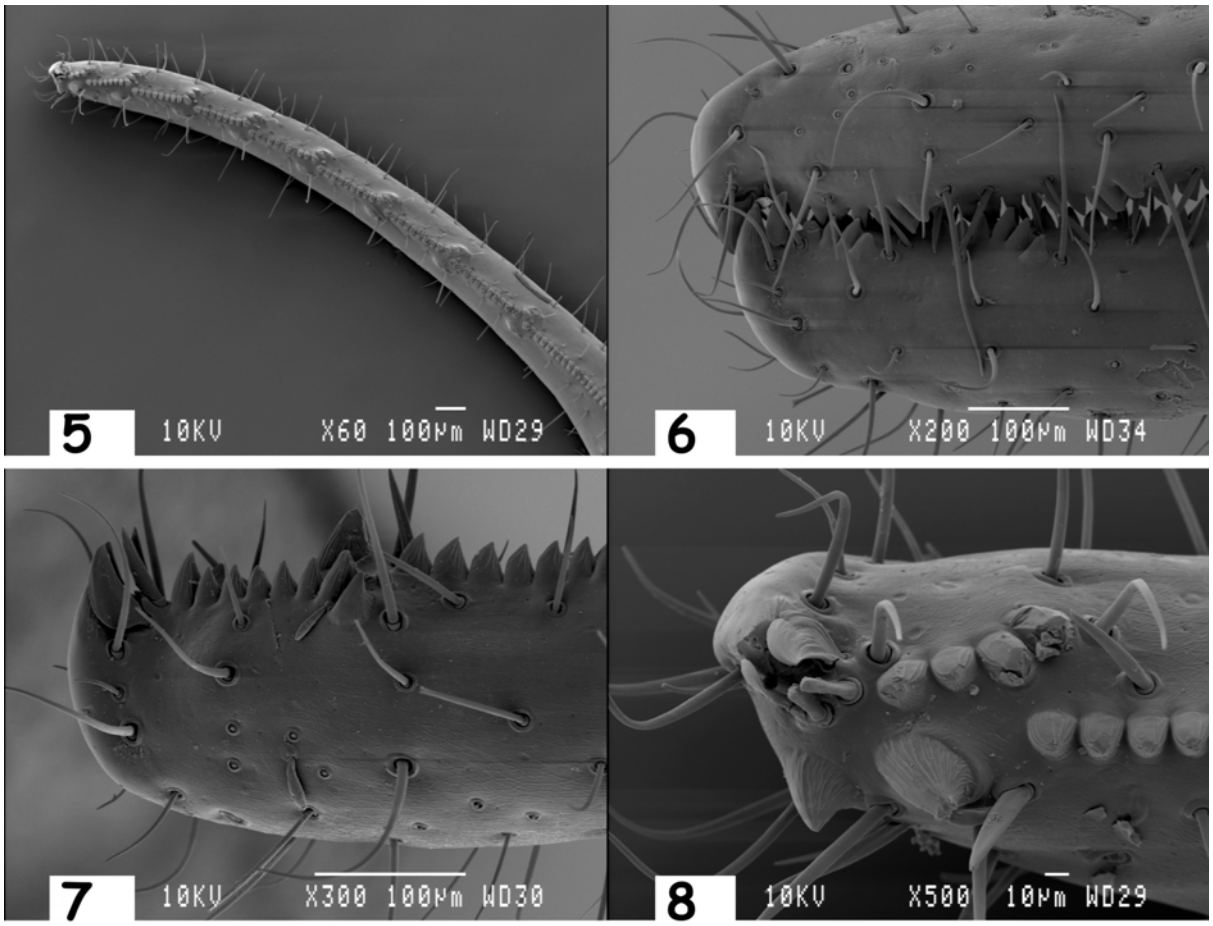
Figs. 1-12
*Tityobuthus dastychi* Lourenço, 1997: 147.

**MATERIEL EXAMINED.** N.W. Madagascar, Province de Mahajanga, Ampijoroa, III/1996 (S. M. Goodman, leg.), 1 male holotype and 1 female allotype; 1 male II/2001 (G. Garcia leg.) (specimen used for SEM photos). Prov. Toliara, Parc National de Kirindy Mite, 13 km W. Marofihitsa, 20°47.4'S – 44°08.8'E (slightly disturbed transitional dry deciduous-spiny forest, 30 m), 11/XI/2002 (S. M. Goodman leg. – SMG 13272), 1 male. Province de Mahajanga, Parc National de Bemaraha, south bank Manambolo River, near Tombeau Vazimba, 3.5 km Bekopaka, 19°08.4'S, 44°49.7'E (disturbed tsingy forest, 100 m) (A. Raselimanana leg. – SMG 12587), 1 female.

**REDESCRIPTION** based on type material and on the three new specimens. Measurements presented in Table I.

**Coloration.** Basically yellowish, symmetrically marbled with dark brown pigment, producing an overall spotted appearance. Prosoma: carapace yellowish heavily spotted; eyes surrounded by black pigment. Mesosoma: yellowish with three longitudinal brown stripes; the median one divided by a longitudinal yellow strip. Metasoma: segments I to V yellowish; vesicle yellowish but lighter than segment V. Venter yellow with a number of spots on sternites IV to VII. Sternite V of male with a bright white zone in the posterior region. Chelicera yellowish with dark spots interiorly and laterally; fingers reddish. Pedipalps yellowish with several spots on femur and patella; chela less densely spotted; fingers much darker than chela, reddish-brown. Legs yellowish with diffuse fuscous spots.

**Morphology.** Carapace moderately to weakly granular; anterior margin with a weak median concavity. Anterior median superciliary and posterior median carinae moderate to weak. All furrows moderate to weak. Median ocular tubercle distinctly anterior to the center of carapace; median eyes separated by one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular to pentagonal. Mesosoma: tergites weakly granular. Median carina moderate in all tergites. Tergite VII pentacarinate. Venter: genital operculum divided longitudinally. Pectines: pectinal tooth count 18 to 19 in both males and females; basal middle lamella of the pectines not dilated; presence of fulcra. Sternites smooth with moderately elongate stigmata; VII without carinae. Metasoma: segments I to IV with 10 carinae,



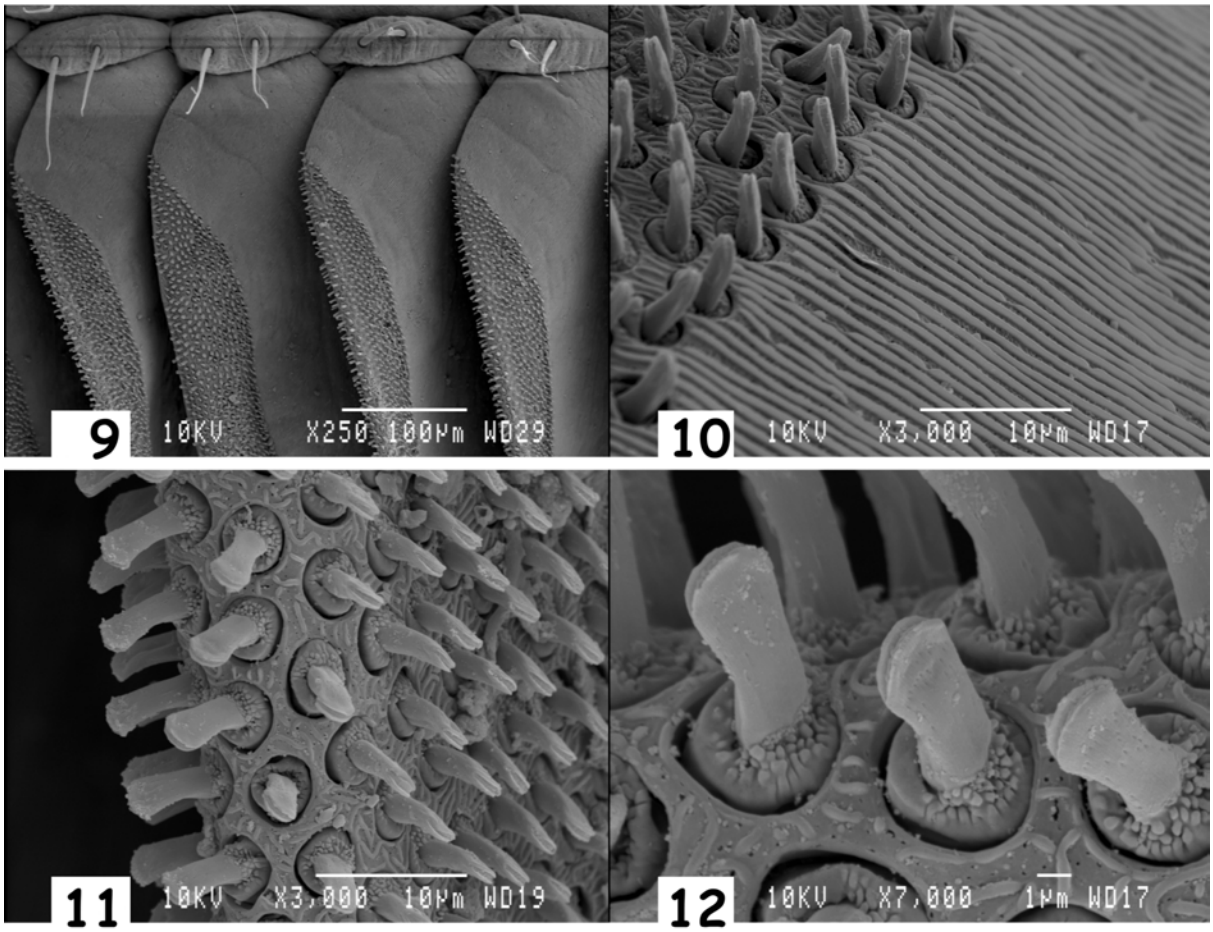

**Figs. 5-8:** *Tityobuthus dastychi*. Male from Province de Mahajanga, Ampijoroa. **5.** Movable finger of pedipalp chela. **6.** Detail of distal extremity of pedipalp chela fixed and movable fingers, lateral aspect. **7-8.** Idem for movable finger, lateral and dorsal aspects.

crenulate. Intercarinal spaces weakly granular. Segment V smooth and rounded, especially in males. Telson smooth with a long and moderately curved aculeus; subaculear tooth strong and slightly spinoid. Cheliceral dentition characteristic of the family Buthidae (see Vachon, 1963); basal teeth of movable fingers reduced and of same size; ventral aspect of both finger and manus with dense, long setae. Pedipalps: femur pentacarinate; patella and chela with some carinae but moderately crenulate; internal face of Patella with 4/5 spinoid granules; all faces moderate to weakly granular. Movable fingers with 8/9 almost oblique rows of granules; internal and external accessory granules present. Trichobothriotaxy; orthobothriotaxy A-α (Vachon, 1974, 1975). Legs: tarsus with very numerous median fine setae ventrally. Tibial spurs present on legs III and IV.

**Differences presented by females**: Coloration and pigmentation similar to that of the male, but slightly darker. Morphology: the same as for the male, but slightly more bulky-built. Morphometric differences presented in Table I. Smaller pectines; tooth count 18-19 as for males; basal middle lamellae not dilated.

**Ecology**. *Tityobuthus dastychi* is currently known from three separate forest blocks, the Ampijoroa region to the east of Mahajanga, Kirindy Mite to the south of Belo-sur-Mer, and the limestone region of Bemaraha. At all three sites and in the specific zones the specimens were collected the natural habitat is dry deciduous forest resting on light colored sands. In all cases these very friable soils contain little leaf litter or organic material. The physiognomy of the forests at the first two sites is notably similar, while that Bemaraha has a higher percentage of woody taxa with spines and drought adaptations associated with the local limestone pinnacle formations, also known as *tsingy* (Rajoelison *et al*., 2002; Goodman, unpub. obs.).

In the forests of Ampijoroa considerable information is available about the scorpion fauna (Lourenço, 2002) and *Tityobuthus dastychi* is known to occur in the same general area as four species of the genus *Gros-phus* (Buthidae: *G. madagascariensis* (Gervais) *G. hirtus* Kraepelin, *G. garciai* Lourenço, and *G. ankarafantsika* Lourenço), and a single species of *Opisthacanthus* (Ischnuridae: *O. madagascariensis*). In total six species of scorpion are known to occur at this site. In contrast, the known scorpion fauna of the Kirindy Mitea forest comprises only one species: *Tityobuthus dastychi* and that of Bemaraha four species: *T. dastychi*, *Grosphus*




**Figs. 9-12:** *Tityobuthus dastychi*. Male from Province de Mahajanga, Ampijoroa. **9.** Proximal extremity of pecten. **10.** Microstructure of peg sensilla and tegument on teeth. **11-12.** Peg sensilla in detail.

*madagascariensis*, *G. flavopiceus*, and *Opisthacanthus madagascariensis*. However, it should be noted that Ampijoroa has been more extensively inventoried for scorpions than the other two sites (Lourenço, 2003).

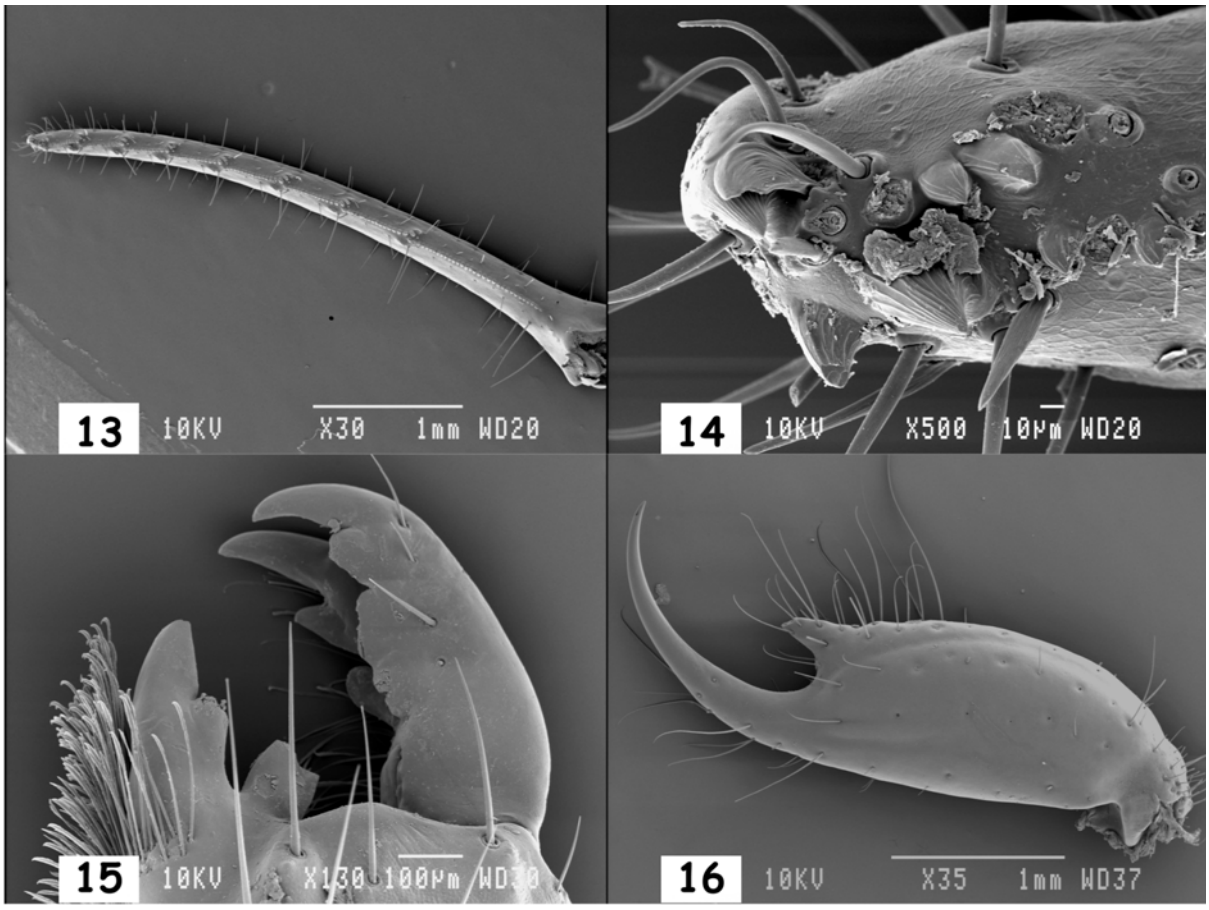
## Ecology and Biogeography of the Ankarana Massif

The Ankarana Massif lies at the extreme northern end of Madagascar about 75 km south of the city of Antsiranana (Diégo Suarez, 12°55'S, 49°06'E) The massif is an outcrop of middle Jurassic limestone, oriented along a NE-SW axis and measuring about 25 km long and 8 km large. The vast majority of this karstic complex is contained with the Réserve Spéciale d'Ankarana and the highest point in the reserve is at about 500 m.

The Ankarana region receives about 2000 m of rainfall each year (Hawkins *et al*., 1990) of which 93% falls between the months of December and April (Bardot-Vaucoulon, 1997). The presence of deciduous forest vegetation in portions of the massif is associated with the extended period of little to no rainfall (Lowry *et al*., 1997). The average daily temperature during the dry season is 26°C and during the rainy season 27.5°C.

The narrow and often deep canyons within the massif regularly have tall canopy semi-evergreen forests resting on slightly acidic soils. These canyons provide a buffer against the relatively extreme dry, windy, and strong solar radiation conditions of this general region of northern Madagascar. Leaf litter and organic material in the upper portion of the soil is extremely limited in most forested areas of the massif.

An extensive subterranean aquifer passing under the Ankarana Massif resurges in some of these canyons or is close to the surface level and helps to maintain mesic conditions even during the dry season. The forested habitat within the deep canyons of the Ankarana form ecological islands, isolated from the surrounding areas by dry deciduous forests or anthropogenic savannas and other canyons in the massif by non-vegetated rock formations. These canyons contain many endemic plant and animal species (Cardiff and Befourouack, 2003), several with biogeographic affinities to eastern humid forests and others to 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*., 1999; Jungers *et al*., 1995) and the remaining canyon forests hold some relict taxa associated with this moister period.




**Figs. 13-16:** *Tityobuthus rakotondravonyi* sp. n. Male paratype. **13.** Movable finger of pedipalp chela. **14.** Detail of distal extremity of the same. **15.** Chelicera. **16.** Telson, lateral aspect.

## Taxonomic Treatment
## Description of a new species: *Tityobuthus rakotondravonyi* sp. n.

Figs. 13-28

**TYPE MATERIAL.** Madagascar, Province d'Antsiranana, Réserve Spéciale d'Ankarana, Encampment des Anglais (Anilotra), 7.5 km NW Mahamasina, 12°54.5'S, 49° 06.6'E (125 m), (S. M. Goodman). **Holotype** (12736) and 13 **paratypes** (12827, 12869, 12843, 12838, 12731, 12837, 12753, 12730, 12750, 12831, 12836, 12738, 12737, 12872 and 02-137). Holotype and 10 paratypes deposited in the Field Museum of Natural History, Chicago; one paratype deposited in the Muséum d'Histoire Naturelle, Geneva and two paratypes deposited in the Muséum national d'histoire naturelle, Paris.

**ETYMOLOGY:** The specific name is in honor of Prof. Daniel Rakotondravony, Département de Biologie Animale, Université d'Antananarivo, for the important contribution he has made to our work, as well as for other national and foreign researchers working on Madagascar. Further, Prof. Rakotondravony has played a paramount role in the advancement of young Malagasy field scientists.

**DIAGNOSIS**: Scorpion of moderate to large size (with respect to the genus) and with 24-27 mm in total length. Carapace with a moderately pronounced concavity, forming a weak angle. Cheliceral dentition with basal teeth of movable fingers reduced. Pectines with 14-16 teeth and the presence of fulcra. Sternites smooth; sternite V of males with a bright zone on posterior edge. Telson with a long but moderately curved aculeus; subaculear tooth strong and spinoid without basal granules. Tibial spurs very reduced or absent. Pedipalp fixed and movable fingers with 8/9 slightly oblique, almost straight rows of granules. Trichobothrial pattern of type A-α - orthobothriotaxic.

**RELATIONSHIPS**: From general morphology *Tityobuthus rakotondravonyi* sp. n. appears to be most closely related to *T. baroni* (Pocock) and *T. darainensis* Lourenço & Goodman. The new species can be readily distinguished from the other two by the following features: (i) a distinct pigmentation pattern. *T. rakotondravonyi* has dark spots covering the anterior margin of the chelicerae at the base of fingers; the carapace and

tergites are weakly spotted, and metasomal segments IV-V are very dark almost blackish. In *T. baroni* dark spots envelop almost the total chelicerae surface; carapace and tergites are heavily spotted and metasomal segments IV-V are only partially spotted; (ii) female pectines of *T. rakotondravonyi* have 14-16 teeth whereas those of *T. darainensis* have 17-18 teeth.

**DESCRIPTION** based on male holotype and male and female paratypes

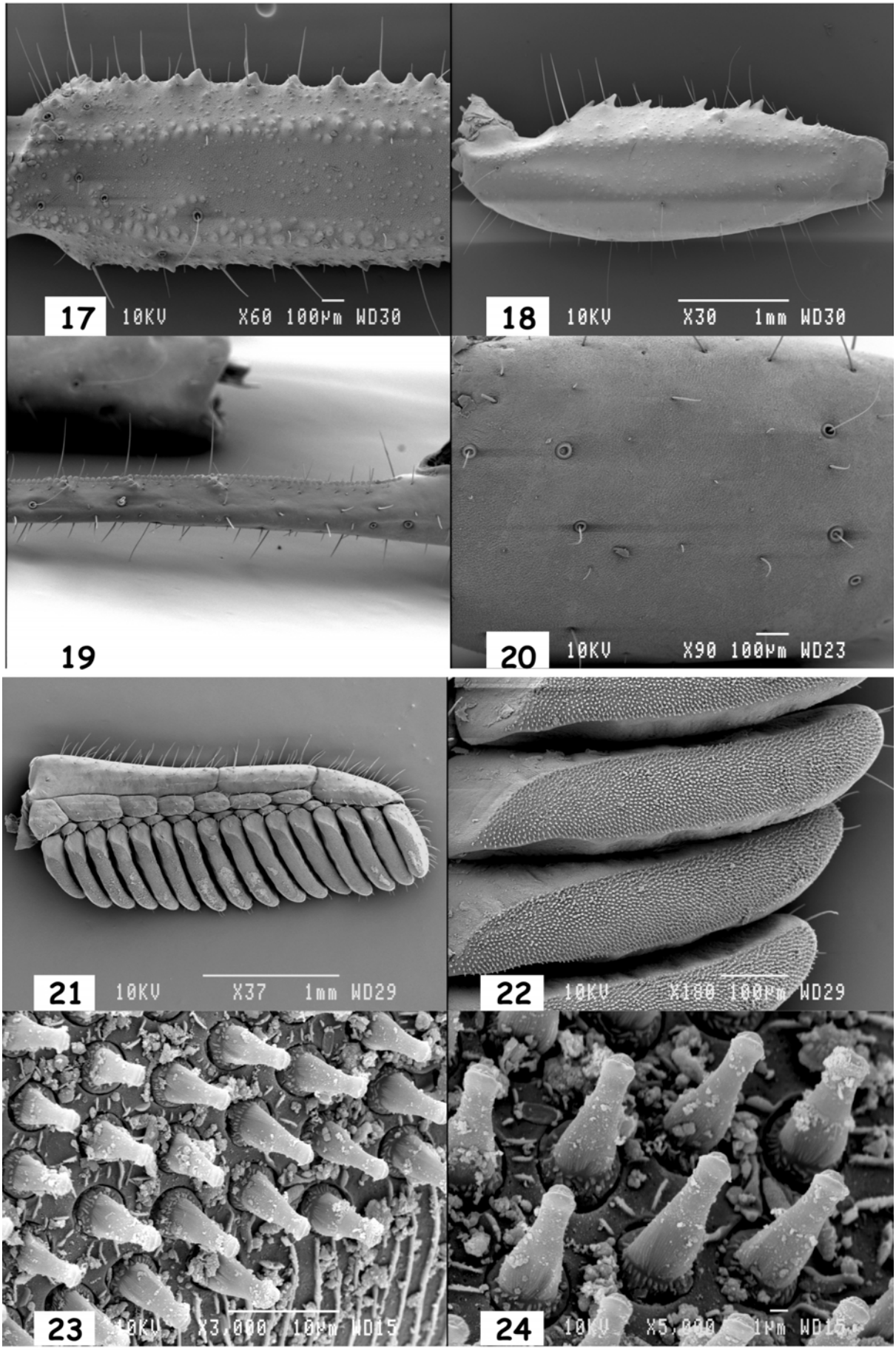
**Coloration.** Ground color yellowish, symmetrically marbled with a dark reddish brown, giving an overall spotted appearance. Prosoma: carapace yellowish, moderately spotted, more intensely on the anterior margin; eyes surrounded by black pigment. Mesosoma: yellowish, with four longitudinal brown stripes, i.e. two central and two lateral ones; the central are separated by a yellow band. Metasoma: segments I to III yellowish; IV-V brown to blackish. Vesicle yellowish or reddish yellow. Venter yellowish, with spots on sternite VII. Chelicerae yellowish, with dark spots on the anterior margin at the base of fingers; fingers reddish-yellow. Pedipalps: yellowish, with several dark spots on femur and patella; chela yellowish with some diffuse dark spots; fingers brown to blackish with darker zones on their base. Legs yellowish, with diffuse dark spots.

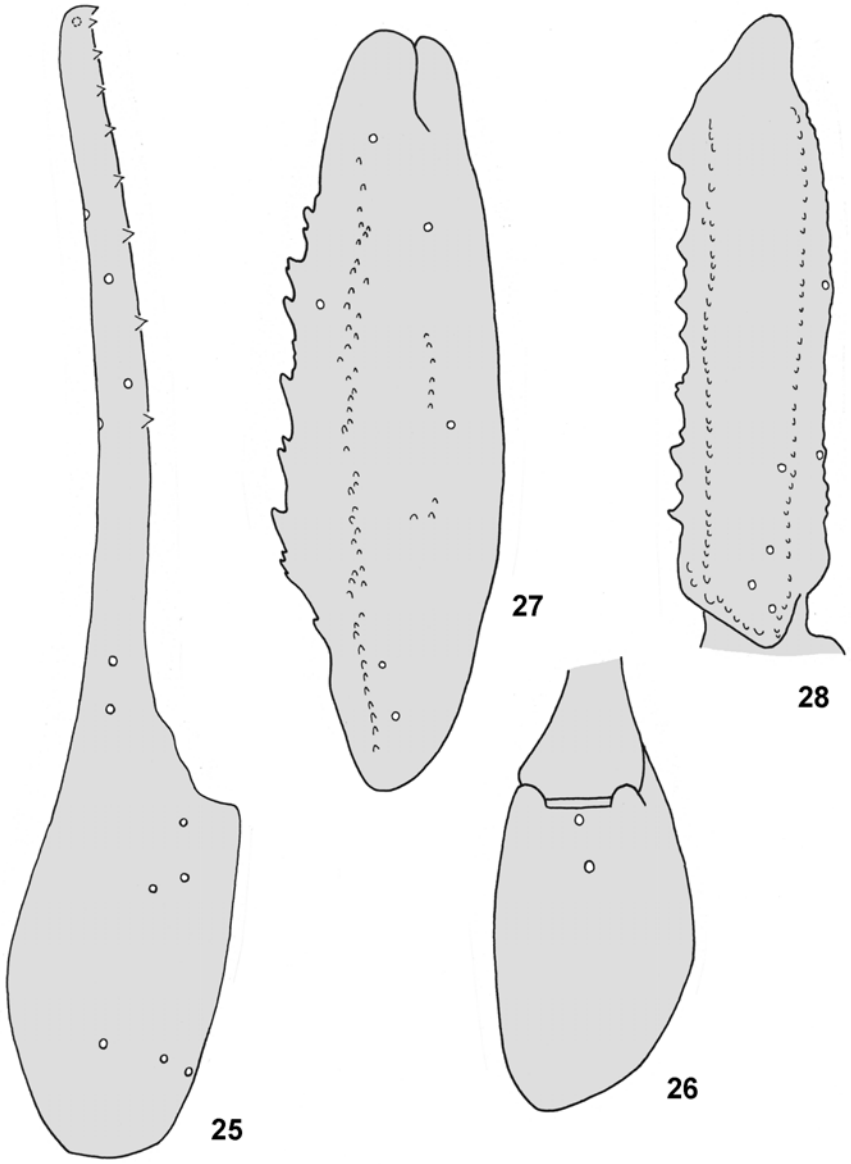
**Morphology.** Carapace moderately to weakly granular; anterior margin with a moderately pronounced median concavity, forming a weak angle. Anterior median superciliary, posterior median carinae weak; furrows moderate. Median ocular tubercle distinctly anterior to the center of the carapace; median eyes separated by one ocular diameter. Three pairs of lateral eyes. Sternum subtriangular to subpentagonal. Mesosoma: tergites weakly granular. Median carina weak on all tergites; absence of other carinae. Tergite VII pentacarinate. Venter: genital operculum longitudinally divided, each half being oval-shape. Pectines: pectinal tooth count 14-16 (see Table II for variability); basal middle lamellae not dilated; fulcra present. Sternites smooth with small, elongate stigmata; VII without carinae. Sternite V of males with a smooth or bright zone on posterior edge. Metasoma: segments I-II with 10 carinae, crenulate. Segments III-IV with 8 carinae, crenulate. Intercarinal spaces weakly to moderately granular. Segment V with five carinae, rounded and weakly granular. Telson smooth, without punctuations, with a long but moderately curved aculeus; subaculear tooth strong and spinoid without basal granules. Cheliceral dentition characteristic of the family Buthidae (see Vachon, 1963); basal teeth of movable fingers reduced and of same size; ventral surfaces of finger and manus with setae. Pedipalps: femur pentacarinate; patella and chela with some carinae, moderately crenulate; internal face of patella with 8/9 spinoid granules; all faces weakly granular; fixed and movable fingers with 8/9 almost oblique rows of granules. Trichobothriotaxy; orthobothriotaxy A-α (cf. Vachon, 1974, 1975). Legs: tarsus with numerous fine median setae ventrally. Pedal spurs moderate and tibial spurs reduced or absent.

**ECOLOGY**. The type series of *T. rakotondravonyi* was taken in the dry deciduous forests of Ankarana, and in the general vicinity of the Encampment des Anglais, which is also known as Anilotra. This forest is in the central portion of the limestone complex, and grows in the lower lying areas resting on sandy-clay substrates and nestled between rock outcrops and deep canyons. Two soil samples collected within forested zones were composed of between 32-33% sand and 58.5-59.6% different types of clays. The vast majority of individuals were captured in pit-fall traps, dug into the ground until rim level, and set out principally for small mammals. These devices were checked at dawn and in the late afternoon for captured animals. The vast majority of the trapped *T. rakotondravonyi* were found during the early morning check, which indicates that they are nocturnal in their activities and at least partly terrestrial.

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**Figs. 17-24:** *Tityobuthus rakotondravonyi* sp. n. Male paratype. **17-20:** Details of trichobothriotaxy. **17.** Femur, dorsal aspect. **18.** Patella, dorsal aspect. **19.** Fixed finger, dorso-external aspect. **20.** Chela, dorso-external aspect. **21.** Left pecten. **22.** Microstructure of peg sensilla and tegument on teeth. **23-24.** Peg sensilla in detail.


17 10KV X60 100µm WD30
18 10KV X30 1mm WD30
19
20 10KV X90 100µm WD23
21 10KV X37 1mm WD29
22 10KV X180 100µm WD29
23
24




**Figs. 25-28:** *Tityobuthus rakotondravonyi* sp. n. Male holotype. Details of trichobothriotaxy. **25.** Chela, dorso-external aspect. **26.** Chela, ventral aspect. **27.** Patella, dorsal aspect. **28.** Femur, dorsal aspect.

## Key to the species of *Tityobuthus*

**1.** Pectines with fulcra vestigial or absent . . . . . **2**
– Pectines with well developed fulcra . . . . . **3**

**2.** Fulcra vestigial . . . . . ***T. monodi***
– Fulcra absent . . . . . ***T. guillaumeti***

**3.** Tibial spurs reduced or absent . . . . . **4**
– Tibial spurs present . . . . . **5**

**4.** Pectines with 19-20 teeth . . . . . ***T. baroni***
– Pectines with 14-16 teeth . . . . . ***T. rakotondravonyi* sp. n.**

**5.** Chelicerae without spots or pigmentation . . . . . ***T. judsoni***
– Chelicerae with dark spots and pigmentation . . . . . **6**

**6.** Pectines with 20 or more teeth . . . . . **7**
– Pectines with less than 20 teeth . . . . . **9**

**7.** A conspicuous smooth, white and bright central zone on sternite V . . . . . ***T. manonae***
– No such zone on sternite V . . . . . **8**

**Table I. Morphometric values in mm.**
**A**. Male holotype of *Tityobuthus dastychi*, and male FMNH-13272. **B-C**. Male holotype (12736) and female paratype (12750) of *T. rakotondravonyi* sp. n. **D**. Female holotype of *T. darainensis* (Data in Lourenço & Goodman, 2002)

| Character | A | B | C | D |
|---|---|---|---|---|
| Total length | 19.8/20.7 | 27.1 | 25.9 | 35.1 |
| Carapace: | | | | |
| - length | 2.4/2.6 | 3.1 | 2.8 | 4.0 |
| - anterior width | 1.8/1.7 | 2.3 | 2.0 | 2.9 |
| - posterior width | 2.6/2.7 | 3.2 | 3.0 | 4.4 |
| Metasomal segment I: | | | | |
| - length | 1.5/1.6 | 2.2 | 1.8 | 2.3 |
| - width | 1.4/1.4 | 1.7 | 1.6 | 2.2 |
| Metasomal segment V: | | | | |
| - length | 3.2/3.2 | 4.3 | 3.8 | 4.9 |
| - width | 1.2/1.2 | 1.4 | 1.2 | 1.9 |
| - depth | 1.0/1.0 | 1.3 | 1.2 | 1.7 |
| Vesicle: | | | | |
| - width | 0.8/0.8 | 1.0 | 0.9 | 1.2 |
| - depth | 0.8/0.8 | 1.0 | 0.9 | 1.3 |
| Pedipalp: | | | | |
| - Femur length | 2.0/2.1 | 3.6 | 2.9 | 4.0 |
| - Femur width | 0.6/0.6 | 0.9 | 0.8 | 1.0 |
| - Patella length | 2.4/2.5 | 4.4 | 3.7 | 5.0 |
| - Patella width | 0.9/0.9 | 1.3 | 1.1 | 1.6 |
| - Chela length | 4.0/4.0 | 6.7 | 5.4 | 7.7 |
| - Chela width | 0.8/0.9 | 1.0 | 0.8 | 1.2 |
| - Chela depth | 0.8/0.9 | 1.0 | 0.8 | 1.1 |
| Movable finger: | | | | |
| - length | 2.8/2.7 | 4.8 | 3.9 | 5.5 |

**Table II. Variation in pectinal tooth count in *Tityobythus rakotondravonyi* sp. n.**

| Number of teeth | Males | Females |
|---|---|---|
| 14 | 0 | 6 |
| 15 | 7 | 12 |
| 16 | 7 | 2 |

**8.** Body, pedipalps and legs heavily spotted; pedipalpal chela short and robust; internal face of patella with four spinoid granules . . . . . ***T. lucileae***
– Body, pedipalps and legs with only vestigial spots; pedipalpal chela long and slender; internal face of patella with 5 or 6 spinoid granules . . . . . ***T. pococki***

**9.** Pectines with 11 teeth . . . . . ***T. ivohibe***
– Pectines with 12 to 19 teeth . . . . . **10**

**10.** Pectines with 12 to 14 teeth . . . . . **11**
– Pectines with 15 to 19 teeth . . . . . **12**

**11.** A smooth with a white central zone on sternite V and two small rounded smooth white zones laterally . . . . . ***T. griswoldi***
– Sternite V without any smooth white zone . . . . . ***T. parrilloi***

**12.** Sternite V with a reduced or conspicuous smooth white zone; total length averaging 20 mm . . . . . **13**
– Sternite V without any smooth white zone; total length averaging 35 mm . . . . . ***T. darainensis***

**13.** Sternite V centrally with a single conspicuous smooth white zone . . . . . ***T. dastychi***
– Sternite V with a reduced smooth white central zone associated with two small rounded smooth white zones laterally . . . . . ***T. petrae***

## Acknowledgements

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