

## NEW CONSIDERATIONS ON THE TAXONOMIC STATUS OF THE GENUS *PHYSOCTONUS* MELLO-LEITÃO, 1934 (SCORPIONES, BUTHIDAE)

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**Abstract:** The study of new specimens of the rare species *Rhopalurus debilis* (C. L. Koch, 1840), confirms that this species should not be included in the genus *Rhopalurus* Thorell, 1876. Detailed investigation with the aid of an SEM, in particular of the morphological characteristics of the pectines of *R. debilis*, demonstrates that this species does not possess a stridulatory apparatus as all other species of the genus *Rhopalurus*. Accordingly, *R. debilis* is transferred to the available genus *Physoctonus* Mello-Leitão, 1934, and thus placed in a new combination, *Physoctonus debilis* (C. L. Koch, 1840), **comb. n.**

**Key words:** Scorpiones, Buthidae, *Physoctonus*, *Rhopalurus*, taxonomy, stridulatory apparatus.

**Nuevas consideraciones sobre el estatus taxonómico del género *Physoctonus* Mello-Leitão, 1934 (Scorpiones, Buthidae)**

**Resumen:** El estudio de nuevos especímenes de la infrecuente especie *Rhopalurus debilis* (C. L. Koch, 1840), confirma que esta especie no debería estar incluida en el género *Rhopalurus* Thorell, 1876. El examen detenido a través de un microscopio electrónico (SEM), en particular de la morfología de los peines de *R. debilis*, demuestra que esta especie no tiene aparato estridulatorio como todos los demás *Rhopalurus*. Por consiguiente, *R. debilis* se transfiere al género disponible *Physoctonus* Mello-Leitão, 1934, dando lugar a una nueva combinación, *Physoctonus debilis* (C. L. Koch, 1840), **comb. n.**

**Palabras clave:** Scorpiones, Buthidae, *Physoctonus*, *Rhopalurus*, taxonomía, aparato estridulatorio.

### Introduction

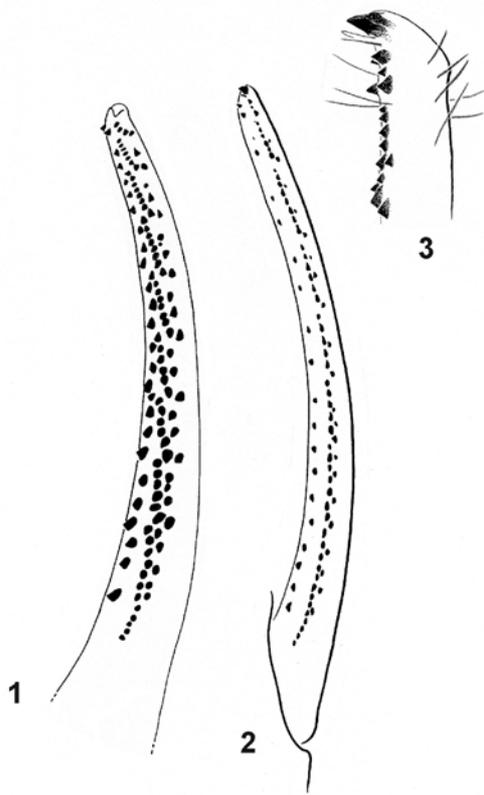
The genus *Rhopalurus* was described by Thorell (1876) based on *Rhopalurus laticauda* Thorell, 1876 from Colombia. After its description the genus *Rhopalurus* was considered by some authors to be valid, but was regarded as a junior synonym of the genus *Centruroides* Marx, 1890 (nec *Centrus*) by others (e.g. Pocock, 1890; Kraepelin, 1899; Werner, 1939; Mello-Leitão, 1945). This controversial situation persisted until the end of the 1970s, when Vachon (1977) and Lourenço (1979) finally separated *Rhopalurus* from the other genera of Buthidae.

Lourenço (1982) proposed a full revision of the genus *Rhopalurus* and reduced the number of species and subspecies from 19 to 8. Since this revision, however, several new species have been added: in South America, *Rhopalurus amazonicus* Lourenço, 1986, *Rhopalurus lacrau* Lourenço & Pinto-da-Rocha, 1997, *Rhopalurus piceus* Lourenço & Pinto-da-Rocha, 1997 and *Rhopalurus guanambiensis* Lenarducci, Pinto-da-Rocha & Lucas, 2005 all from Brazil (Lenarducci *et al.* 2005). New species have also been described from the Caribbean region, and at a greater rate than from South America. The Caribbean species were exclusively from the Dominican Republic and Cuba. For details see Teruel (2006), Teruel & Armas (2006).

The genus *Rhopalurus* can be defined by a number of characters, the most conspicuous of which being the presence of stridulatory surfaces on the pectines. During the 1990s, several species were studied in detail with the aid of SEM or light microscopy. All of them were found to possess stridulatory apparatus (Lourenço & Cloudsley-Thompson, 1995; Lourenço *et al.*, 2000). For the species described in recent years, the presence of a stridulatory apparatus has not yet been investigated. In the case of other

species, described long ago, studies using SEM, were impossible on account of the scarcity of available material. This is the case in *Rhopalurus debilis* (C. L. Koch, 1840), a very rare species found only in the Northeast region of Brazil. *R. debilis* has been the subject of taxonomic confusion for a long time. The species was originally described in the genus *Vaejovis*, but was later included in the family Buthidae by Kraepelin (1899) (as *incertae sedis*). It was subsequently transferred to the genus *Rhopalurus* by Borelli (1910) who was able to examine a single specimen. Mello-Leitão (1934) later proposed a new genus *Physoctonus* to accommodate a new species *Physoctonus physurus* from Brazil. In this study Mello-Leitão (1934) apparently ignored *Vaejovis debilis*.

In an amendment, Francke (1977) discussed the status of *Physoctonus physurus*. He clearly demonstrated that this is a junior synonym of *Rhopalurus debilis*, and attributed the taxonomic errors cited above to the scarcity of the known material belonging to the species *R. debilis*. The decision taken by Francke (1977) appeared to be justified and has not again been discussed since his publication. SEM studies, however, were not provided to confirm the presence or absence of stridulatory apparatus in *R. debilis*. Recently, I have recently been able to examine four new specimens belonging to the species *R. debilis*, and to proceed with SEM examination of the pectines of one of the males. The results were surprising, because this species was found to lack any stridulatory apparatus - which should exclude it from the genus *Rhopalurus*. Furthermore, the distribution of the rows of granulations on the pedipalp chela fingers shows a different disposition from those in the known species of *Rhopalurus* (Figs. 1-2). In the light of these new



**Fig. 1-3.** Cutting edge of movable fingers with characteristic rows of granulations. **1.** *Rhopalurus rochai* (male). **2.** *Physoctonus debilis* (male). **3.** Detail of the extremity of finger of *P. debilis*.

observations, revalidation of the genus *Physoctonus* Mello-Leitão, 1934, described for the single species *P. physurus* (a junior synonym of *R. debilis*) appears to be the correct solution. The species described by Koch is therefore now placed in a new combination, *Physoctonus debilis* (C. L. Koch, 1840).

### Materials and methods

Specimens of *Physoctonus debilis* (Koch) have been examined and a detailed study made using Scanning Electron Microscope (SEM) photography. The stridulatory surfaces were exposed by removing the pectines from a freshly fixed specimen. These were then coated with gold, according to standard procedure, and photographed with the SEM of the Muséum national d'Histoire naturelle, Paris.

Illustrations and measurements were obtained using a Wild M5 stereo-microscope with a drawing tube and ocular micrometer. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Hjelle (1990).

The material of *Physoctonus debilis* (C. L. Koch, 1840) studied was from Brazil, Pernambuco, Tacaratu (Faz. Paquiú), 15/VII/2005 (G. Freitas leg.), 2 males (UFPE – MNHN); Maranhão, Caxias, 2/X/2004 (F. Limeira-de-Oliveira), 2 females (MNHN).

### Revised diagnose for the genus *Physoctonus* Mello-Leitão, 1940

Medium to small sized scorpions, measuring 21 to 30 mm in total length. Pedipalp fixed and movable fingers with 7/8 linear rows of granules, and inconspicuous internal and external accessory granules (Figs. 2-3). Sternum between subtriangular and subpentagonal. Pectines small with 12 to 16 teeth; no stridulatory apparatus; fulcra moderately marked; basal middle lamellae not dilated in females. Trichobothrial pattern of type A- $\alpha$  (alpha) – orthobothriotaxic (Vachon, 1974, 1975) Tibial spurs absent; pedal spurs reduced.

Type species of the genus, *Physoctonus debilis* (C. L. Koch, 1840)

### Revised diagnose for *Physoctonus debilis* (C. L. Koch, 1840)

Medium to small sized scorpions, measuring 21 to 30 mm in total length. General coloration yellowish with a brownish inverted triangle covering the anterior margin of carapace; diffused brownish spots over tergites, ventral aspect of metasomal segments II to V and appendages. Median ocular tubercle anterior to centre of carapace; three pairs of lateral eyes. Chelicerae with dentition according to the buthid pattern (Vachon, 1963). Pedipalp fixed and movable fingers with 7/8 linear rows of granules, and inconspicuous internal and external accessory granules (Figs. 2-3). Sternum between subtriangular and subpentagonal. Pectines small with 12 to 16 teeth; no stridulatory apparatus; fulcra moderately marked; basal middle lamellae not dilated in females. Sternites with short linear spiracles. Telson with a globular vesicle; aculeus long and strongly curved, with a reduced spinoid subaculear tooth. Trichobothrial pattern of type A- $\alpha$  (alpha) – orthobothriotaxic (Vachon, 1974, 1975) Tibial spurs absent; pedal spurs reduced.

### Description of the stridulatory apparatus in *Rhopalurus* species with the use of SEM

Stridulation has long been known to occur in scorpions of the genus *Rhopalurus*. It was first noted by W. J. Burchell during a field trip to Brazil in 1828. Several decades later, Pocock (1904) described the phenomenon using more scientific terminology, but the detailed structure of the stridulatory apparatus has only recently been observed with the use of SEM. In the case of two species, *Rhopalurus agamemnon* (Koch) and *Rhopalurus rochai* Borelli, which have stridulatory apparatus of the pecten-sternite type, sonograms (spectrograms) of the stridulations have also been registered (Lourenço & Cloudsley-Thompson, 1995; Lourenço *et al.*, 2000).

Pocock (1904) mentioned peculiarities in the structure of the stridulatory apparatus of different species. His initial observations concerned the size and shape of pectines. *Rhopalurus* species possess pectines which are quite broad in their proximal half. Pocock (1904) noted this as follows “**No doubt the expansion of the shaft of the pecten in its proximal half is correlated with an increase in the size of its muscles and of the surfaces to which they are attached to add force to the sweep of the organ**”. In fact,

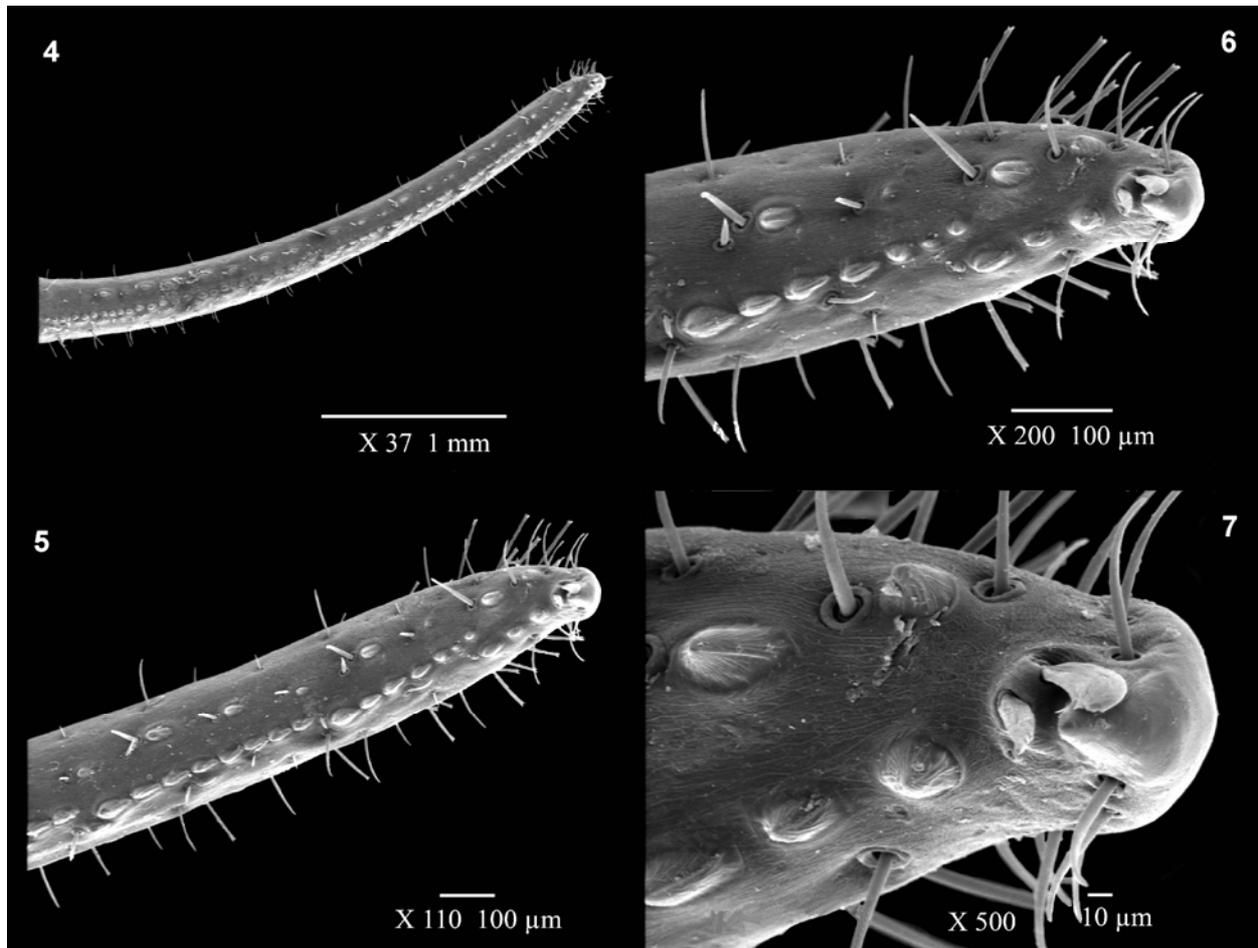


Fig. 4-7. Scanning electron micrographs of the movable finger of *P. debilis* (male). 4. Finger with rows of granules. 5-7. Extremity of the finger showing details of the granulation.

this aspect of pectine structure has been observed in all known species of the genus with the exception of *Rhopalurus debilis* (= *Physoctonus debilis*).

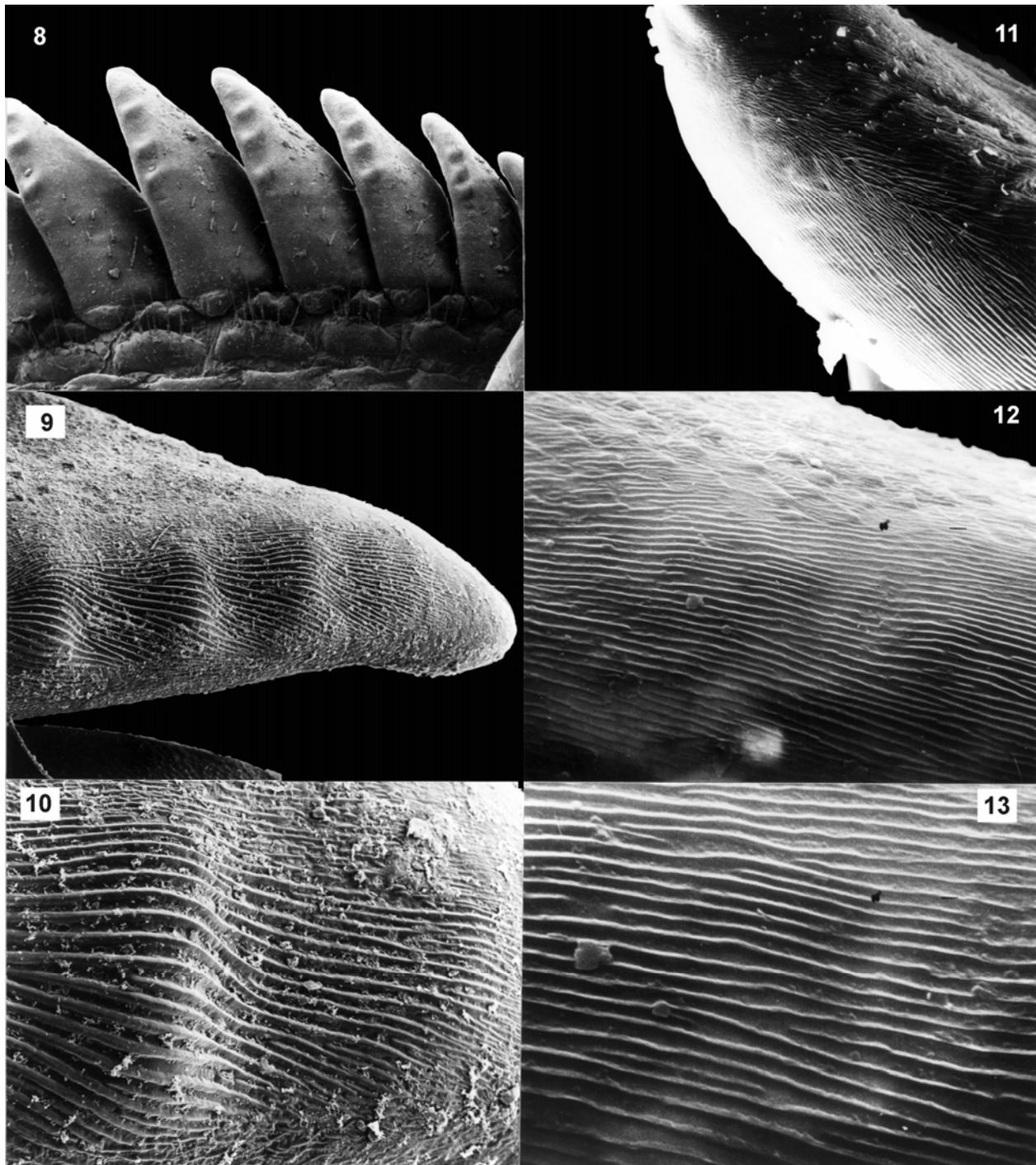
The previous SEM studies carried out on *Rhopalurus princeps* (Karsch) and *Rhopalurus abudi* Armas & Marcano Fondeur<sup>(1)</sup> from Hispaniola (Lourenço & Cloudsley-Thompson, 1995; Lourenço *et al.*, 2000) confirmed many of Pocock's observations concerning the structure of the internal surface of the teeth. Pocock (1904) described this in *Rhopalurus borellii* Pocock (= *Rhopalurus agamemnon* [Koch]) as follows: "When examined under a half-inch objective, or even a lower power, practically the entire face of the tooth, and especially the bulging area, is seen to be covered with a multitude of fine striæ lying parallel to the longitudinal axis of the tooth (PL. IV fig. 3)". He also affirmed that differences could be observed in the structure of the teeth of *Rhopalurus junceus* (Herbst) from Cuba, when compared with those of *R. borellii* (= *R. agamemnon*). He described these differences as follows: "The pectines in *R. junceus* are expanded exactly as in *R. borellii*, and the distal edges of the teeth bulge in almost precisely the same way, but the differentiation of the striæ is carried to a greater extreme. Along the edge of each tooth there is a distinct series of small tubercular elevations, which are largest where they cross the thickened bulging area, becoming smaller both above and

below it. These elevations are very distinctly striated, and the striæ appear to be practically restricted to them (PL. IV. fig. 4)" (Pocock, 1904).

The SEM studies carried out with both *R. princeps* and *R. abudi*, confirm the presence of these two different patterns in the structure of the striated areas of the internal surface of the teeth which form the stridulatory apparatus. What Pocock defined as "tubercular elevations", correspond in fact to the expanded zones observed at the inner edge of each tooth. This pattern was reported by Pocock (1904) only in the case of *R. junceus*. Our observations show that a similar structure is present in *R. abudi* (Figs. 8-10), but absent from *R. princeps* (Figs. 11-13) which likewise is distributed throughout the island of Hispaniola. Pocock made reference only to the pattern in *R. borellii* (= *R. agamemnon*) from which expanded zones are absent. Observations carried out for other species of *Rhopalurus* distributed in South America reveal that this pattern is the usual one.

**Note:**

<sup>(1)</sup> Specimens collected in 1982 and identified as *R. abudi*. According to L. F. Armas (in litt.) this species could maybe correspond to *Rhopalurus bonettii* Armas, 1999.



**Fig. 8-13.** Scanning electron micrographs of the pecten of *Rhopalurus* species. **8-10.** *Rhopalurus abudi*. **8.** Pecten, internal aspect (x 37). **9.** Tooth, internal aspect (x 180) showing three expanded zones over the stridulatory lyriform files. **10.** Expanded zone in one particular tooth (x 500). **11-13.** *Rhopalurus princeps*. **11.** Tooth, internal aspect (x 600) showing the absence of expanded zones. **12-13.** Detail of the internal aspect showing stridulatory lyriform files (x 1200 and x 2500, respectively).

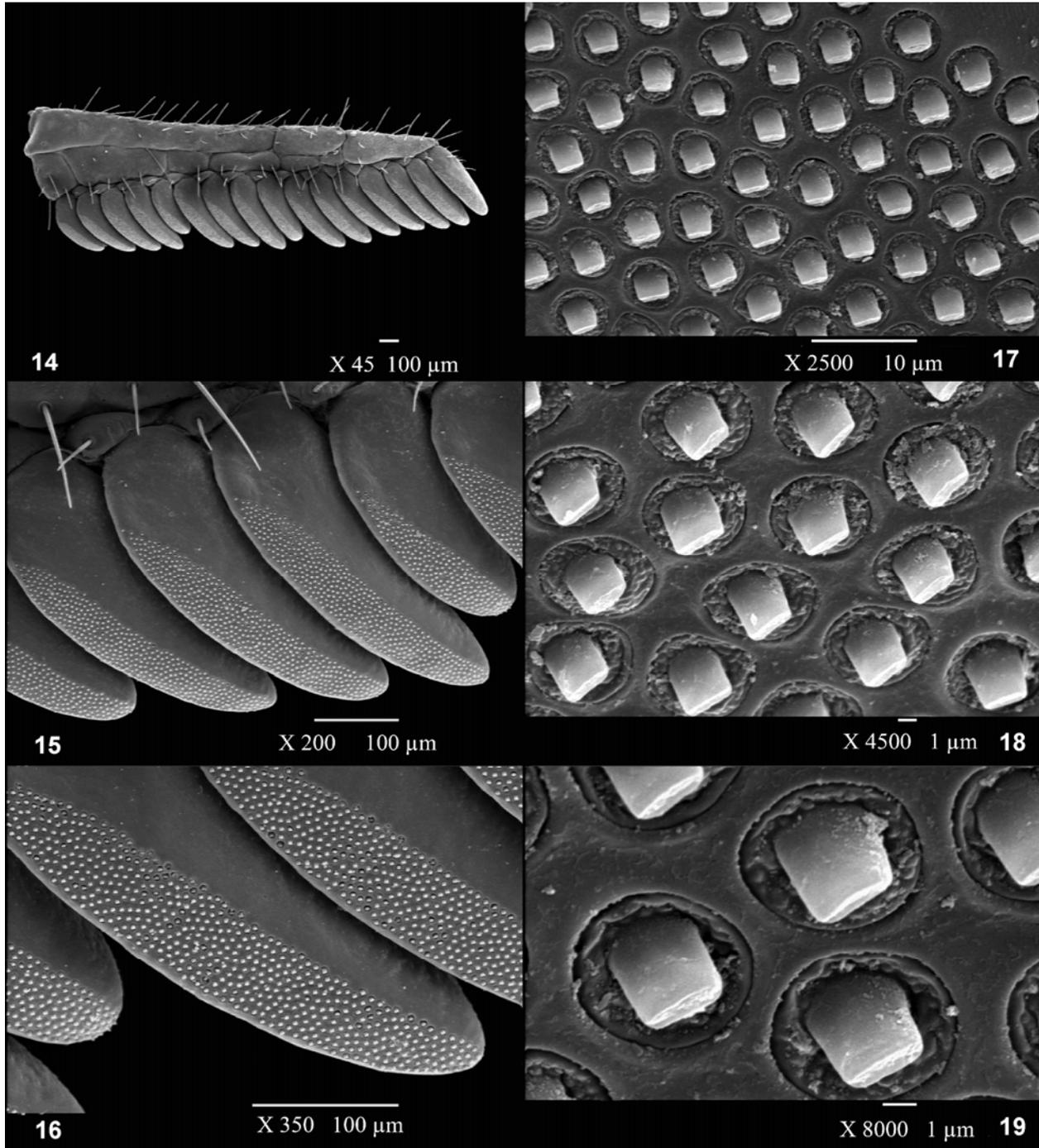
### Description of the pectines of *Physoctonus debilis*

As shown in figures 14 and 20 the size and shape of the pectines of *P. debilis* do not follow the general morphology observed in the species of *Rhopalurus*. The pecten is not particularly broad in its proximal half and the size of the muscles and of the attached surface is weak.

SEM observations on the external surface of the pectines (Figs. 15-16) reveal that the surface covered with the peg sensillae on each tooth, is moderate and similar to

what is observed in other species of buthids. The density, as well as the individual size and shape (spatular) of the peg sensillae (Figs. 17-19) is also similar to what has been observed in previously investigated species of Buthidae (Lourenço & Pézier, 2002; Lourenço, 2003).

SEM observations on the internal surface of the pectines reveal that the tegument is almost smooth, and presents only the relief left by the matrix which produced

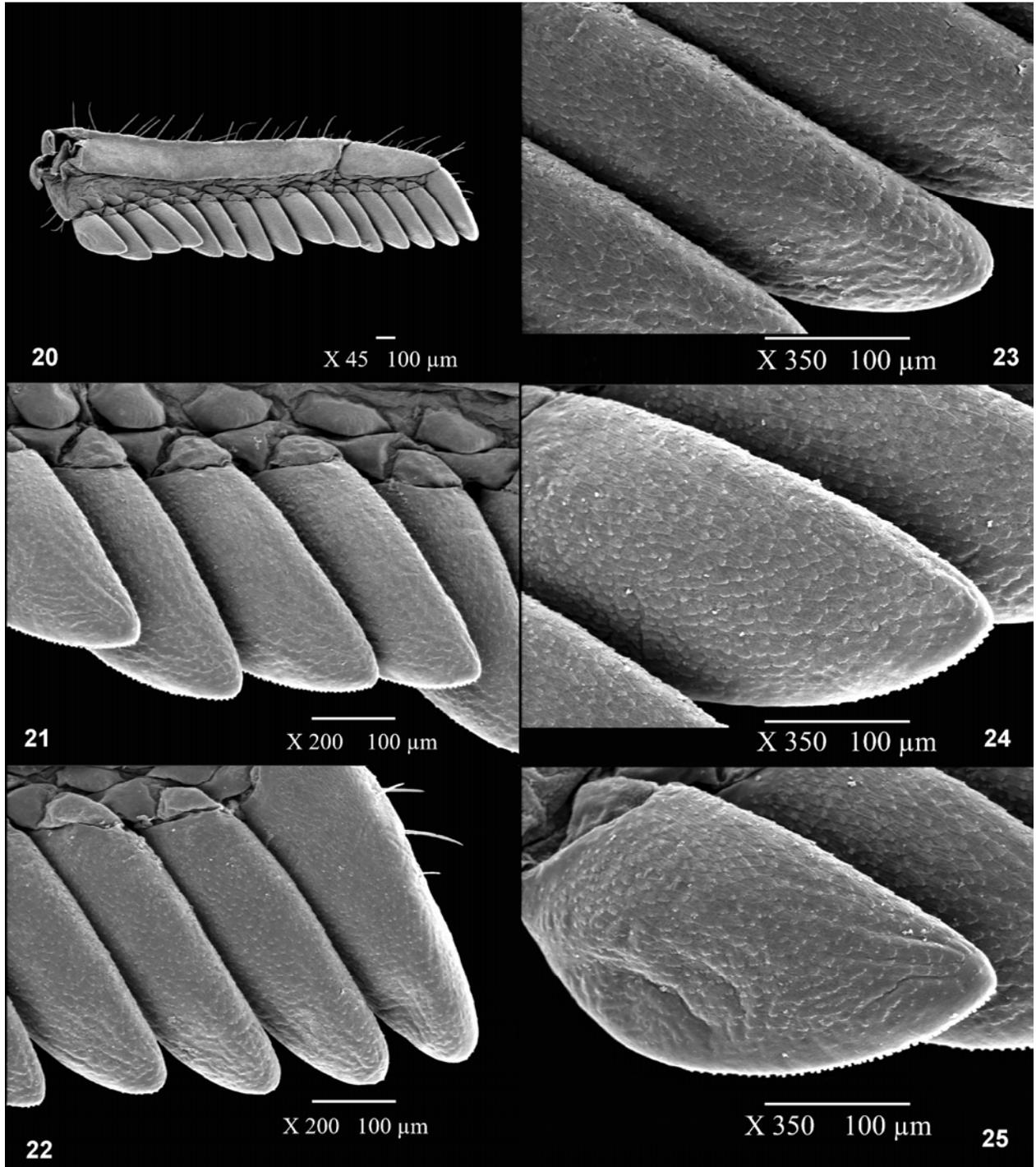


**Fig. 14-19.** Scanning electron micrographs of the pecten of *Physoctonus debilis*. **14.** Left pecten. **15-16.** Microstructure of peg sensilla and tegument on teeth. **17-19.** Peg sensilla in detail.

the tegument itself (Figs. 21-22). This observation is valid for all the teeth, from the most proximal to the most distal, and even when observations are produced with higher magnification (Figs. 23-25), the total absence of any striated areas on the internal surfaces of the teeth is confirmed. These results attest to the absence of stridulatory apparatus in *P. debilis*.

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**Fig. 20-25.** Scanning electron micrographs of the pecten of *Physoctonus debilis*. **20.** Right pecten. **21.** Detail of proximal teeth. **22.** Detail of distal teeth (x 200). **23-25.** Idem, in a higher magnification; to notice the absence of any stridulatory lyriform files (x 350).

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