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Research Article / Araştırma Makalesi

External Morphology of *Pyza taurica* Gruber, 1979 (Arachnida: Opiliones)

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Abstract: The harvestmen species *Pyza taurica* Gruber, 1979 (Opilionida, Nemastomatidae) is endemic to Anatolia. In this study, external morphology of *P. taurica* was investigated in detail by using scanning electron microscope (SEM). Cuticular structures and sense organs on the segments of legs, pedipalps, chelicerae, and the dorsal integument of male specimens of *P. taurica* are investigated and depicted, in particular, characters of taxonomic and systematic importance. Such studies are needed especially for understanding the functional anatomy and morphology of opilionids.

Keywords: *Pyza taurica, Nemastomatidae,* Opiliones, harvestmen, external morphology, scanning electron microscopy, endemic.

Pyza taurica'nın Gruber, 1979 Dış Morfolojisi (Arachnida: Opiliones)

Özet: *Pyza taurica* Gruber, 1979 (Opilionida, Nemastomatidae) otbiçen türü Anadolu'ya özgüdür. Bu çalışmada, *P. taurica*'nın dış morfolojisi ayrıntılı olarak taramalı elektron mikroskopu (SEM) kullanılarak araştırılmıştır. Özellikle taksonomik ve sistematik önem taşıyan karakterde, bacaklar, pedipalp, chelicerae ve *P. taurica* erkek örneklerinin dorsal üzerindeki kesici yapılar ve duyu organları incelenmekte ve tasvir edilmektedir. Bu gibi çalışmalar, özellikle otbiçenlerin fonksiyonel anatomisini ve morfolojisini anlamak için gereklidir.

Anahtar kelimeler: *Pyza taurica, Nemastomatidae,* Opiliones, otbiçen, dış morfoloji, taramalı electron mikroskop, endemik.

1. Introduction

The harvestmen or harvest spiders belong to arthropods; their cuticle, like other arthropods, is the substrate to cuticular structures and sense organs are of great importance for obtaining environmental information (Spicer, 1987; Willemart & Gnapsini, 2003; Willemart, Chelini, Andrade, and Gnaspini, 2007; Willemart & Giribet, 2010; Rodriguez, Townsend, & Pround, 2014). Many scanning electron microscopic and light microscopic studies on the integument of arachnids have been carried out in the world (Pittard & Mitchell, 1972; Barth & Stagl, 1976; Igelmund, 1987; Spicer, 1987; Willemart & Gnaspini, 2003; Willemart et al., 2007; Yigit, Bayram, Çorak, & Danışman, 2007; Willemart & Giribet, 2010). Because harvestmen are often characterized by prominent protuberances, ornamented cuticles, cephalothoracic and abdominal setae and spines, the detailed electron microscopic studies gained importance.

Recently, morphological stasis and convergent evolution in some groups and the fast-paced evolution of supposedly complex characters require validation of systematics and morphology by additional means such as molecular data (Hedin, Tsurusaki, Macías-Ordóñez, & Shultz, 2012). This does not only apply for the understudied areas of harvestmen fauna but also for several groups in supposedly well-researched areas. But the detailed morphological studies by using SEM and other imaging techniques are still important in not well studied areas such as in Turkey.

A number of morphological studies on arachnids such as scorpions, spiders and harvestmen have used SEM (Lourenço, 2007; Pittard & Mitchell, 1972; Barth & Stagl, 1976; Martens, 1979; Igelmund, 1987; Spiger, 1987; Willemart & Gnapsini, 2003; Willemart et al., 2007; Yigit et al., 2007; Willemart & Giribet, 2010). Many of these studies with special sense organs and structures remained limited. Recently, most species description of harvestmen is based on morphological characters such as coloration of body, total body length, and measurements of body segments. The most important characters such as reproductive morphology and microanatomical structures are generally absent from most taxonomic works. For this reason, to identify novel characters, scanning electron microscopic studies are important (Rodriguez et al., 2014).

For the present study, *Pyza taurica* Gruber, 1979 was selected as the study material. Four species in the genus of *Pyza* are known in the world. These species are *Pyza anatolica* (Roewer, 1959), *Pyza bosnica* (Roewer, 1917), *Pyza navarrense* (Roewer, 1951), and *Pyza taurica* Gruber, 1979. In Turkey, *P. taurica* and *P. anatolica* are known (Bayram, Çorak, Danışman, Sancak, & Yiğit, 2010). *P. taurica* is an endemic species for Turkey. This species was recorded from Antalya, Isparta, Burdur, Mersin, and Niğde. Systematic and taxonomic characters of *P. taurica* that are important in the diagnosis are needed to be defined by the SEM. In this study, morphological characters of *P. taurica* were studied in detail by using scanning electron microscopy.

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2. Materials and Methods

In the course of this study, four male specimens of *Pyza taurica* were examined. They were collected from different localities in Antalya, Turkey (around Serik Zeytintaşı Cave, Serik, Olympos Mountain) between 2005 and 2009. The specimens were collected with pens, aspirators, and hand pots. The parts, which were taken from fresh specimens, were preserved in ethanol before they were prepared for SEM. Samples were prepared according to our standard methods. The surfaces of the samples were cleaned with steam and dehydrated with a series of 70, 80, 90 and 100% ethanol, respectively, for 10 min each. They were transferred sequentially to a mixture of ethanol/acetone (3:1, 1:1, and 1:3) followed by 100% acetone for 15 min each. Finally, the materials were allowed to air dry. After dehydration, they were mounted onto copper stubs by using double-stick carbon adhesive, and they were coated with a thin layer of gold by a sputter coater (Polaron SC 500, Polaron plc, Watford, United Kingdom) in the electron microscopy unit of the University of Kırıkkale (Kırıkkale, Turkey). The materials were examined at an accelerating voltage of 20 kV on a scanning electron microscope (JSM 5600, JEOL, Tokyo, Japan), and electron micrographs were taken in the same laboratory. The stereomicroscopic examination was carried out under a stereomicroscope (SMZ 800, Nikon, Tokyo, Japan), and micrographs were obtained by a camera attachment (FDX 35, Nikon). All materials from this investigation are on deposit in the Zoological Research Laboratory (University of Çankırı Karatekin).

3. Results

In the present study, morphological characters of the dorsal integument structure, chelicerae, pedipalpus, legs, and the penis of *P. taurica,* belonging to the family Nemastomatidae, may be important in the diagnosis of the species that has been tried to be revealed in detail by using SEM.

4. Description

As the general morphology of *P. taurica* is examined by using a stereo microscope, it is seen that the body is yellowish brown in color while the coxa, chelicerae, and pedipalp are seen to be yellowish in color. The body of *P. taurica* seems to be covered with sand in stereo microscope. The exoskeleton that is called the scutum is hard-shelled and oval shape. Scutum is laterally extensive. The eyes are close to the front of prosoma and its color is brown. When ocular area is compared with whole body, it has smaller area. Its dorsum has two rows of eight total hillock and the distance between them is almost equal. The color of these hillocks is more brownish than the body color (Fig. 1).

When the scutum was investigated by SEM in detail at higher magnification, it is seen that overall it has coarse granular structure including eight hillocks and ocular area (Fig. 2). The ocularium is longer than wide and bears a pair of simple eyes directed sideways. The cornea and retina are conspicuous (Fig. 2 A, B). At high magnification, the surface of the dorsal integument tubercles bears resemblance to mushroom (Fig. 2 C, D).

Figure 1: The habitus of *P. taurica* (stereo microscope, 3X).

4. 1. Chelicerae

In *P. taurica,* the chelicerae are robust and each chelicera consists of basal and distal segment with movable and fixed finger (Fig. 3 A). The movable finger works against the fixed digit of the distal segment to form a cutting or grasping device. There are no hairs on fingers and its cuticle is smooth (Fig. 3 B). The distal segment of chelicerae is slightly convex structure. Also, a few sparse falciform hairs found on the dorsal of distal segment and on the ventral of it the short hairs (average 25-35 micrometers in length) are located (Fig. 3 A-C). A fairly large mushroom-shaped apophyse takes place on the dorsal of the basal segments of chelicerae. The numerous falciform hairs were found on the apophyse (Fig. 3 D). In addition, on the ventral of basal segment has a semicircular ventral spur. When the lateral sides of basal segments were examined at the higher magnification this area has a unique cuticular pattern that attracts attention (Fig. 3 E).

4. 2. Pedipalps

The pedipalps are long, slender, and delicate. The tarsus of the pedipalp is tapered to the joint (Fig. 4 A). Almost all segments of the palp compared with the leg segments are decorated with more intense hairs and the longest part of the palp is femoral segment (Fig. 4 A). In *P. taurica*, we present for the first time SEM micrographs of the hairs with swollen tip on the palp. We called these hairs as the hairs with apical process (Fig. 4 B-E). They occur on all segments of palp; however, they do not occur on the other appendages of *P. taurica*. Many of these hairs have a smooth apical process whereas a few of them have rough texture. The length of these hairs varies from 70-100 μm.

4. 3. Legs

As in all opilionids, the second leg of *P. taurica* is the longest. The femur, patella, and tibia have rounded structure. Trochanter, femur, patella, and tibia are very poor in terms of sense hairs that are called setae. Sensory hairs are densely decorated on the tarsus of legs. When the patella of the second leg of *P. taurica* was examined at higher magnification, coarse granular structure of cuticle and acute tubercles attracted attention. These acute tubercles are 10-20 micrometers in length.

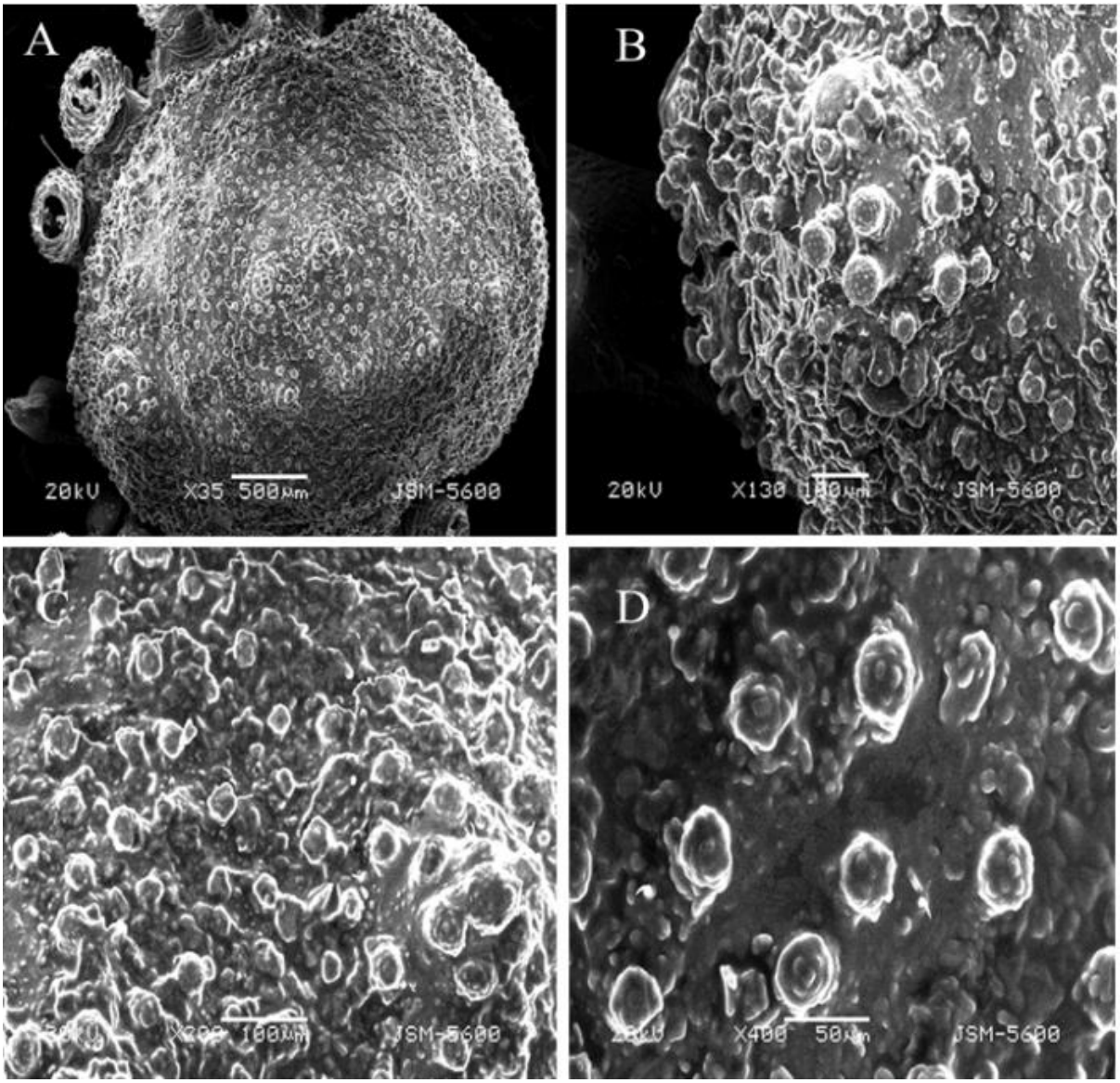

Figure 2: The scutum of *P. taurica*: A. General dorsal view, B. Ocular area, C. A hillock, D. Coarse granular structures at higher magnification

Basal membranes of these tubercles are pronounced (Fig. 5). Also, there are denticles in rows.

Metatarsus has a morphology that is similar to the other segments of the leg such as patella and tibia. The cuticle has granular structure and the denticles are observed (Fig. 7 A-C).

Tarsus is the last segment of the leg that is quite different from the other leg segments. Tarsus is composed of a large number of pseudo-segments (Fig. 8 A, D, E). The sense hairs densely decorate on the tarsus (Fig. 8 B). There are two different kinds of sense hairs on the tarsus. One type is trichomes that are quite commonly distributed on the tarsal segments. The tip of these are pointed, their shafts insert directly in cuticle and form acute angle of the leg's cuticle. Basal membrane is not observed (Fig. 8 B, C). The other type is sensilla chaetica, they only occur on the retrolateral side of tarsus segments, arrangement is two rows (Fig. 8 B, E). The length of them is longer than other hairs, their proximal part is curved, and they are formed nearly right angle. They are easily distinguished within trichomes. Tarsus claw is located at the tip, and the claw bears no tooth (Fig. 8 D, F).

4. 4. Penis

The penis corpus consists of glans and stylus. The glans penis adorned with a long slender or tubular shape stylus at the tip of penis (Fig. 9 A-D). On the glans, there are many setae. These are approximately similar in shape and size. However, some of the setae located towards the bottom of the glans can be curved less or more at base, and these are parallel to glans (Fig. 9 B). Both side of the base of glans have structures like a leaf-shape (Fig. 9 A, D). The penis is an important character in all harvestmen.

5. Discussion

The several structures such as sense hairs, setae, spine, and denticle were determined on the different appendages of several groups of opilinoids. The shape, size, and number of these structures that are researched varied in different species and even different sexes. Consequently, these variations can have a large taxonomic value for identification of species (Willemart & Giribet, 2010).

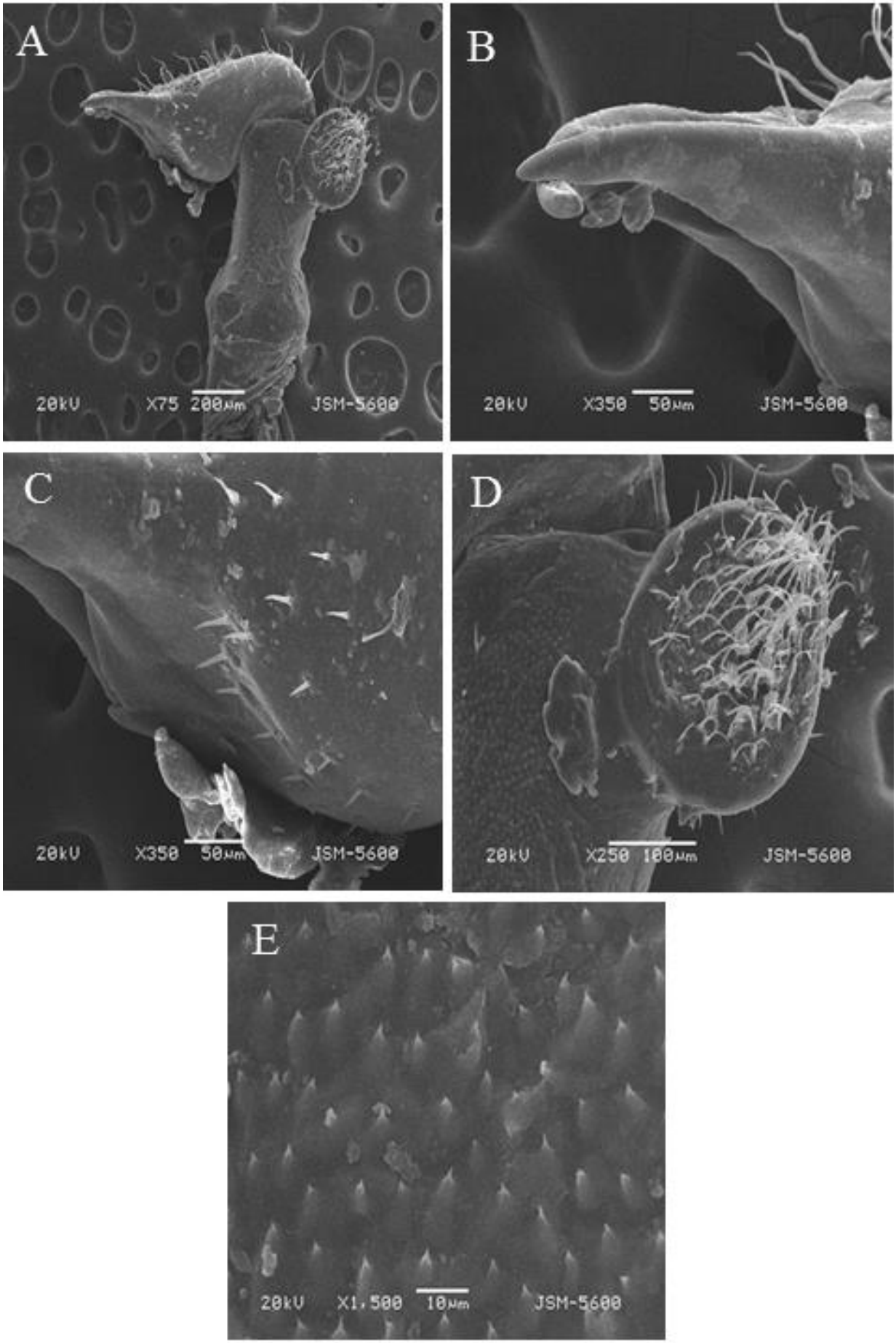

Figure 3: The chelicerae of *P. taurica*: A. General view of a chelicera, B. The fixed finger of chelicera, C. A few hairs on the basal segment, D. Apophyse at higher magnification, E. The lateral view of basal segment and cuticular patterns.

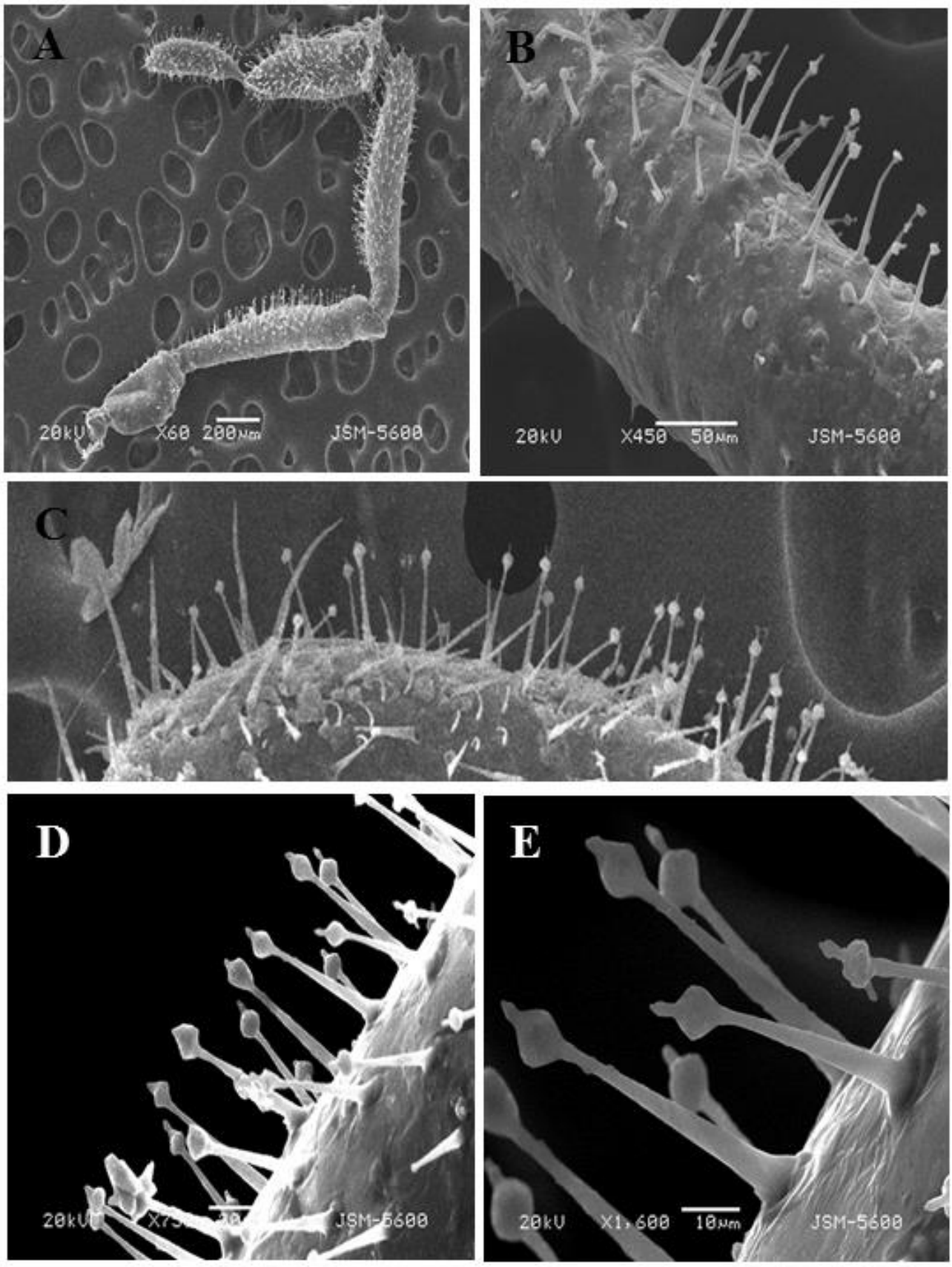

Figure 4: The pedipalp: A. Lateral view of the palp, B. Femur of the palp, C. Tarsus of the palp, D, E. Hairs with apical processes at higher magnification.

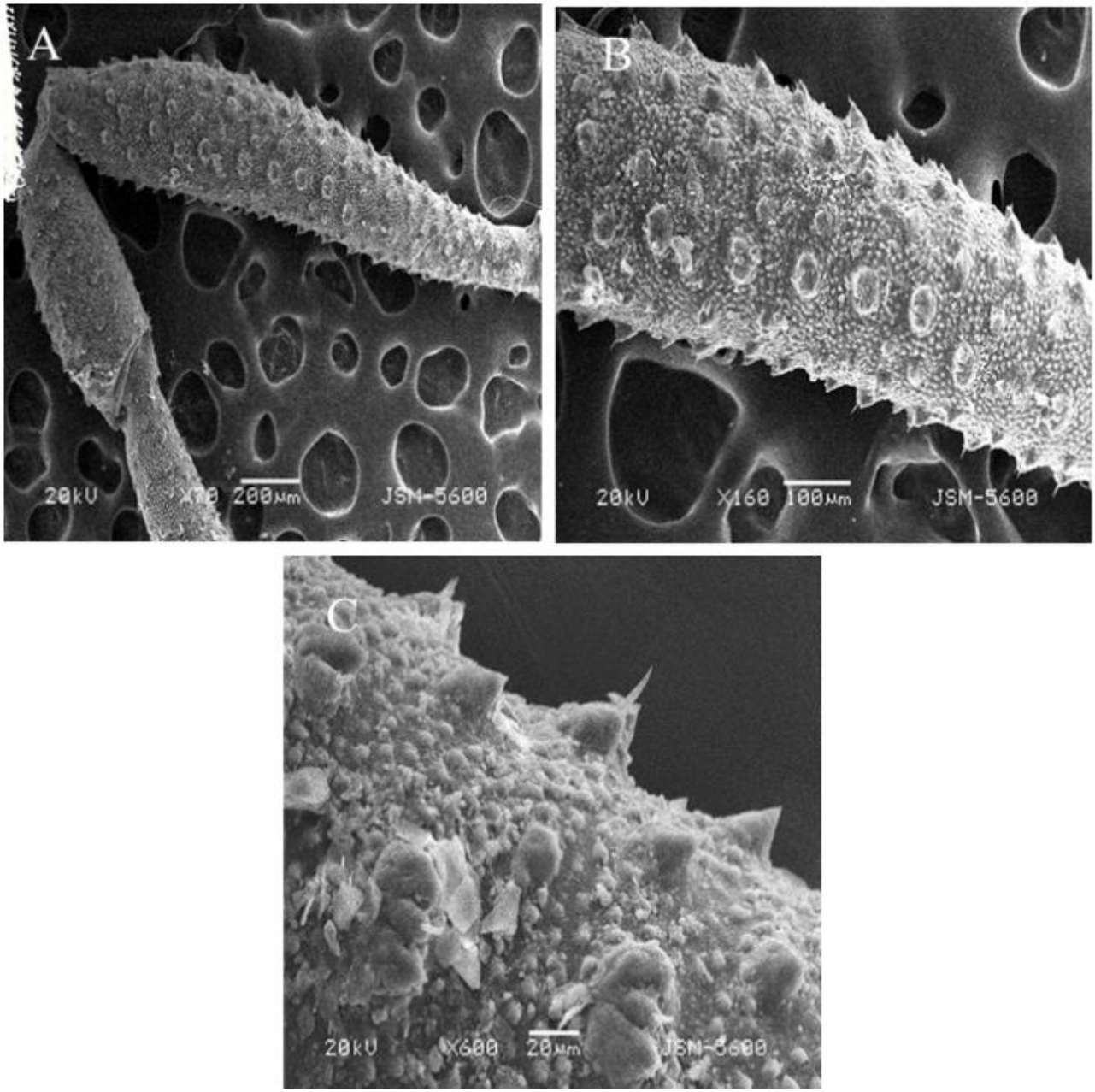

Figure 5: The leg: A. General view of the patella, B, C. Cuticular structure of the patella, acute tubercles, and denticles.

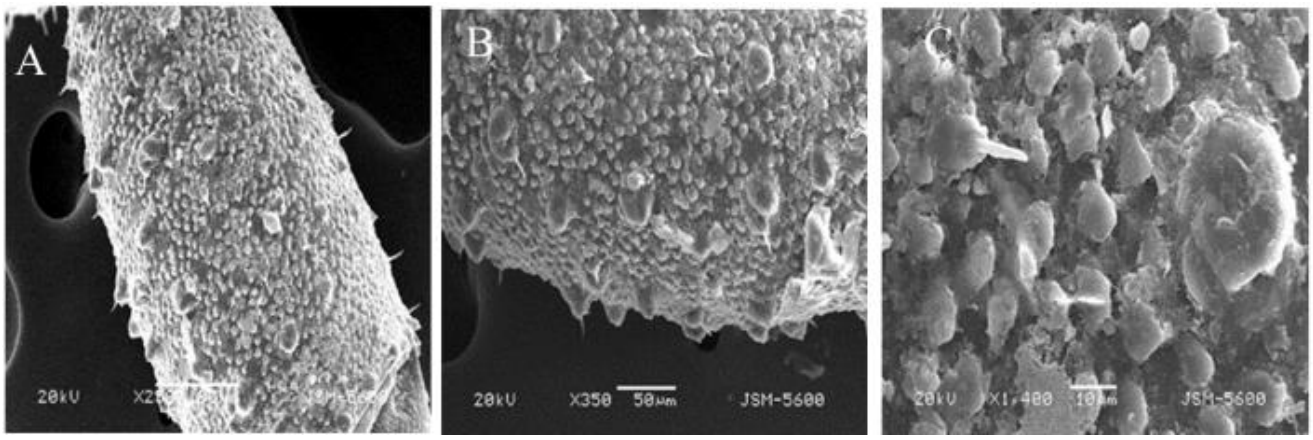

Figure 6: The leg: A. General cuticle structure of the tibia, B, C. Coarse granules and tubercles on the tibia at higher magnifications.

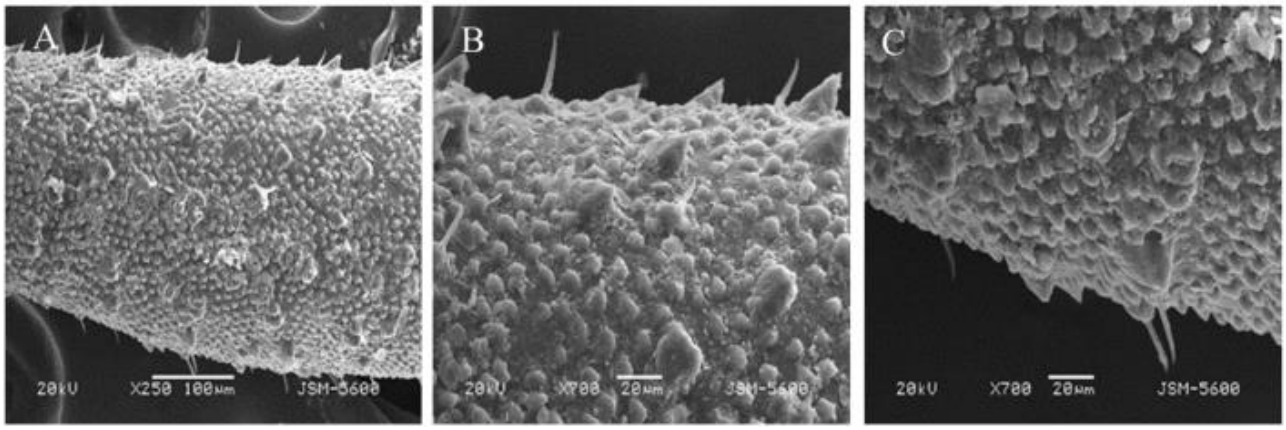

Figure 7: The leg: A. Metatarsus, B, C. Metatarsus at higher magnifications.

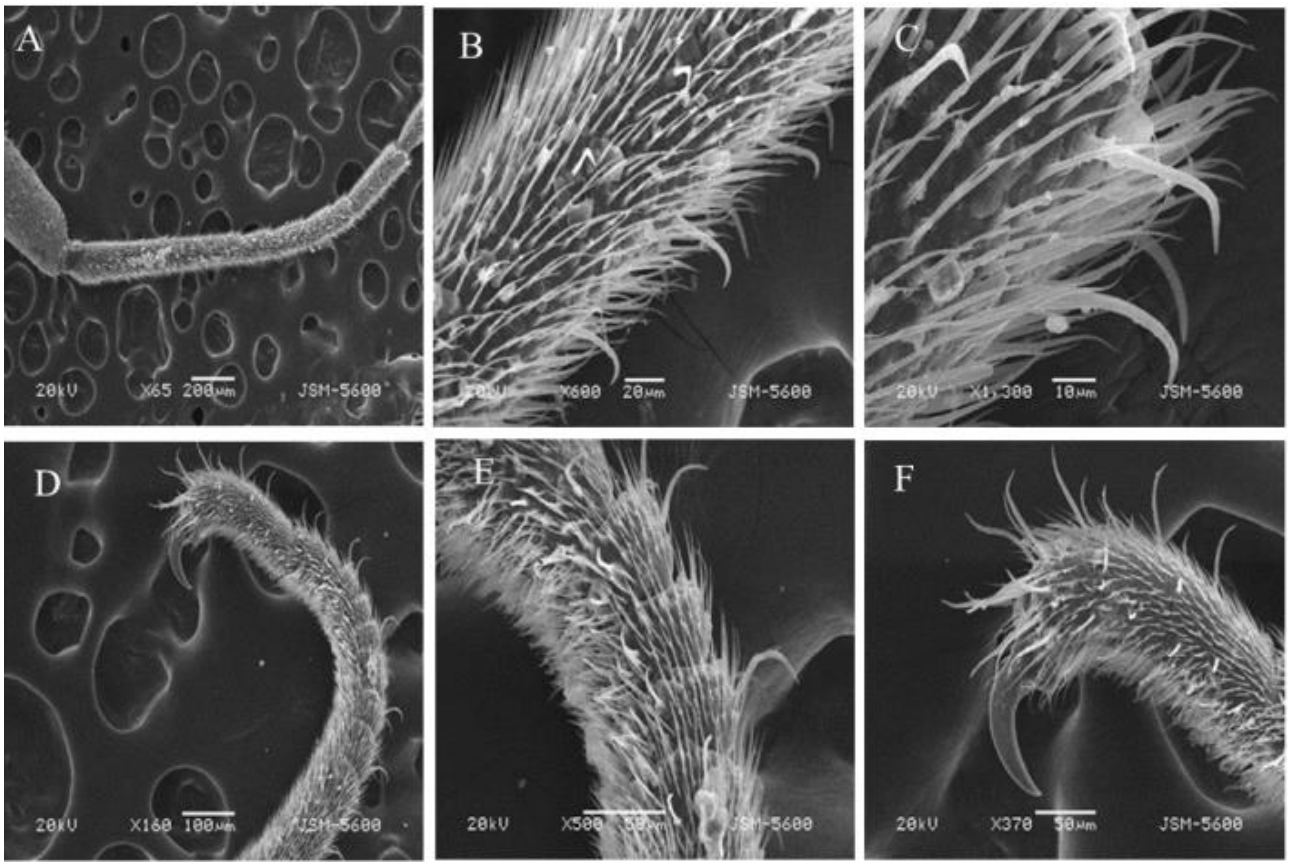

Figure 8: The leg. A. General view of the tarsus, B. Two types of sense hairs, C. The higher magnification of Fig. B, D. Retrolateral view of the tarsus, E. Two types of sense hairs, F. Claw with no teeth.

The different pairs of legs of opillionids have different functions. Therefore, the number and kind of sense hairs and structures varies according to the function. In fact, even in different side (dorsal, lateral, ventral) pair of same legs vary. Willemart & Gnaspini (2003) found out that two abundant hair sensilla were *sensilla chaetica* and *sensilla trichodea* on the legs of opilionids. In the same study, the ventral side of leg tarsus had more dense sensilla than dorsal and lateral sides of tarsus. This shows us the close relationship of structure and function. In *P. taurica*, we found out that the sense hairs are densely located on the tips of appendages, such as the tarsal segments of both palps and legs.

Willemart et al. (2007) studied two Neotropical harvestmen and they found and identified several kinds of sense structures such as *trichomes*, *sensilla chaetica*, *falciform hairs*, *sensilla basiconica,* and *spines*. As they did not find the trichobothria on the studied species, we did not find trichobotria in *P. taurica* either.

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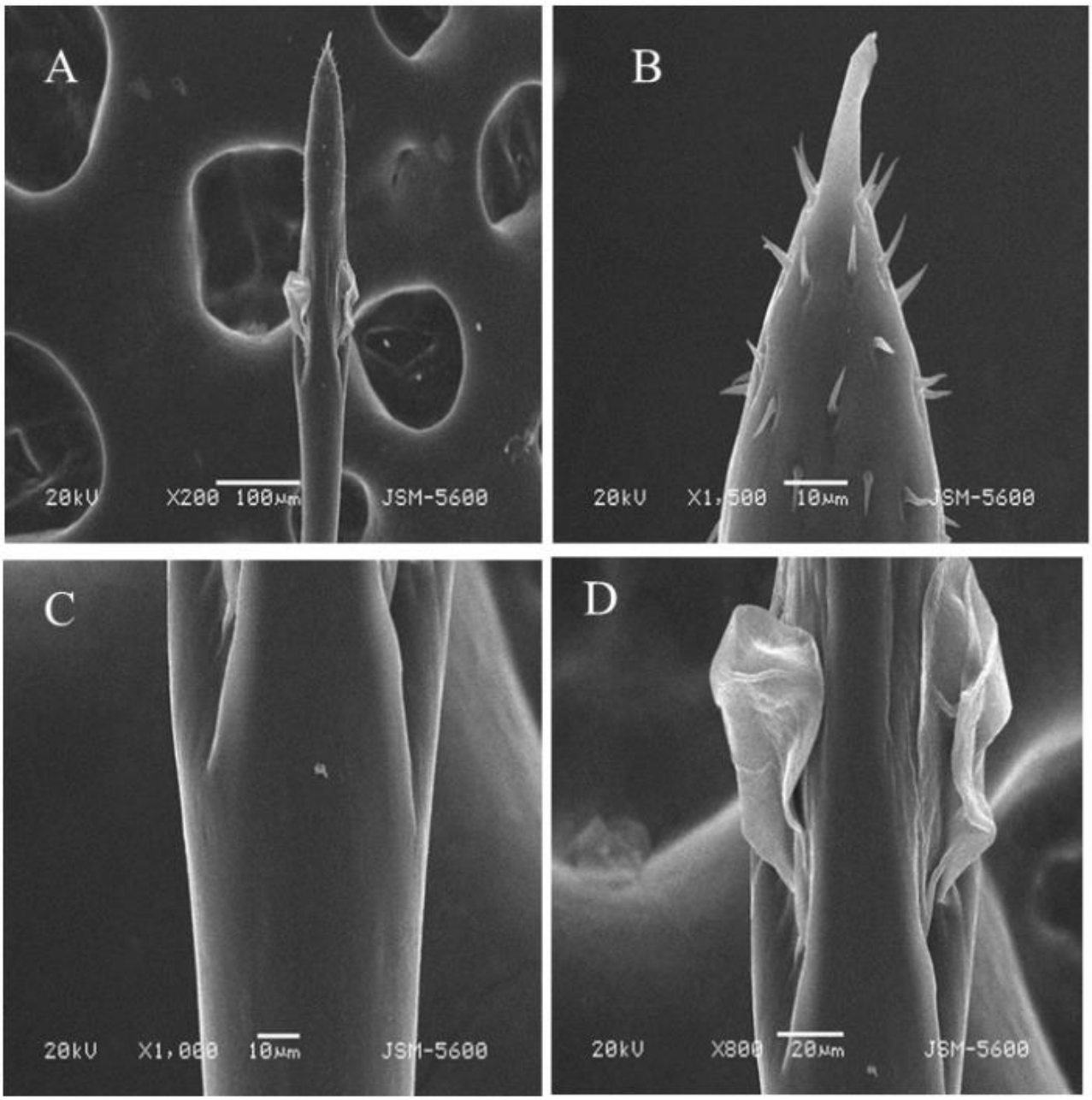

Figure 9: The penis: A. General view of the penis, B. Tip of the penis, C. Base of penis, D. Leaf-shape structures on base of the glans.

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