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Preliminary data on *Stegobium paniceum* (L.) larval head sensilla

Abstract - Sensory structures of *Stegobium paniceum* (L.) head have been investigated under Scanning and Transmission Electron Microscopes and described. Their possible function is hypothesized.

Key words: biscuit beetle, antennae, palpi, SEM, TEM.

INTRODUCTION

Stegobium paniceum (Linnaeus) was investigated in detail by several authors who especially concentrated on the study of its possible damages and its development cycle. Less numerous are the researches concerning morphology, particularly of preimaginal stages (Kashef, 1955; Toskina, 1999). In addition, these studies, conducted under optical microscope, do not allow a thorough investigation of sensilla present on the antennae and palpi.

The aim of the present study was to define the sensory structures of the larval head, focusing on the sensilla of the antennae and the palpi.

MATERIALS AND METHODS

The specimens used in this research were obtained from laboratory-breeding blocks maintained in a temperature-controlled room at 27 ± 2°C and 75 ± 5% R.H..

Some specimens were dehydrated through graded ethanol series, CO_2 critical-point dried, gold coated, and studied under a Hitachi S 2300 Scanning Electron Microscope.

Other larvae were anaesthetized with CO_2 and immediately immersed in a solution of glutharaldehyde and paraformaldehyde 2.5%, in cacodylate buffer 0.1M with 5% sucrose (pH 7.2-7.3). After rinsing overnight in cacodylate buffer, the specimens were post fixed in 1% osmium tetroxide for 1 hour, rinsed in the same buffer (two times, 15 min each), dehydrated in a graded ethanol series (50-99%), and embedded in Epon-Araldite with propylene oxide as bridging solvent. Thin sections (90-120 nm) were mounted on formvar coated 50 mesh grids, stained with uranyl acetate (15 min, room temperature), and lead citrate (5 min, room temperature), and investigated with a Philips® EM 208. Digital pictures were obtained using high resolution digital cameras connected to the SEM and TEM.

RESULTS AND DISCUSSION

On the head, globular in shape, differently from what described by Kashef (1955), we did not detect stemmata (Fig. 1, A), according to Ceruti *et al*. (2010) description of the larva of another anobiid beetle, *Tricorynus rudepunctatus* (Pic). Instead, lateral to the mouth apparatus, we recognized the antennae, consisting of a round plate with a rough surface, which Kashef (1955) defines "basal article", and a long, smooth piece that Kashef (1955) defines "apical article". At SEM observation, the latter showed a probably multiporous wall, indicating its possible sensory nature. TEM investigations confirmed this hypothesis, revealing the presence of many dendritic branches within the lumen and tiny pores opening on the cuticular wall of the sensillum (Fig. 3, A). This organization is typical of olfactory sensory structures.

On the basal plate, five sensilla are inserted: two chetica sensilla articulated in a socket, and therefore with a possible mechanical sensory function, a grooved sunken peg truncated at its distal apex, a very stocky and short basiconicum, and a rough placodeum sensillum situated in the middle of a round area bordered with irregular ridges (Fig. 1, B).

Preliminary TEM data were obtained for the latter two sensilla. Short basiconic sensillum presents a thin cuticular shaft pierced by numerous pores, with the sensillum lumen filled by dendrites (Fig. 3, B), thus indicating an olfactory function. The second sensillum, that at SEM appeared like a small plate, is actually a poreless, coeloconic sensillum innervated by three sensory neurons, one of them ending below the peg and forming typical lamellated dendritic branches. The peg presents two dendrites enclosed

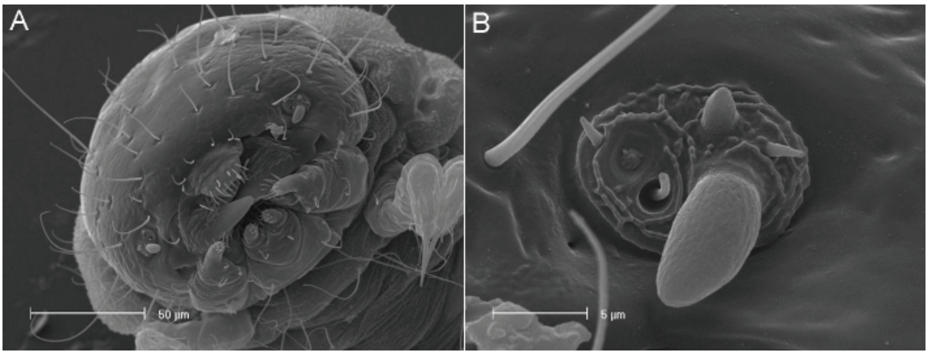

Fig. 1 - *Stegobium paniceum* larva. (A) The head in frontal view. The buccal apparatus and the antennae are visible (SEM). (B) Antenna. The rough round plate, the multiporous "apical article", the two short chetica, the stocky basiconicum, the sunken peg and the placodeum sensilla are visible (SEM).

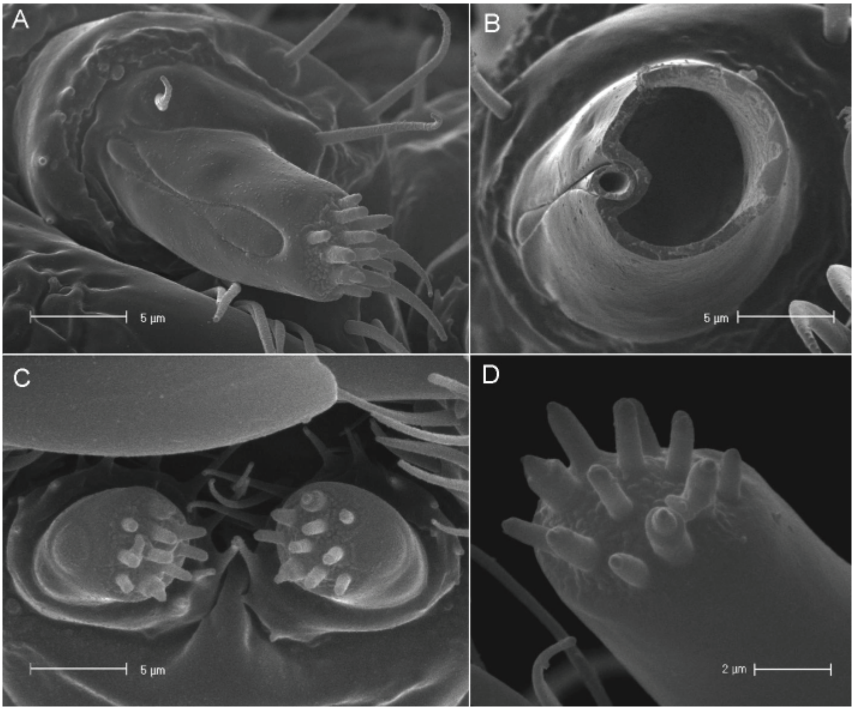

Fig. 2 - *Stegobium paniceum* larva. (A) Maxillary palpus in lateral view. The "furrow" in the form of an elongated eight indicating the digitiform sensillum is visible (SEM). (B). The same in section (SEM). (C) Labial palpi and (D) an enlargement of the apex of the palpus (SEM).

by the dendrite sheath (Fig. 3, C). This organization is typical of thermo-hygro receptors.

The mouth opening is surrounded by biting mouthparts as is typical of Coleoptera larvae. The labrum is provided with a series of bristles disposed on the distal half, which likely have a mechanical function, brushing wood chips inside the buccal cavity. In fact they are longer in the newly hatched larvae and slightly shorter and worn in the "old" ones.

The mandibles are sculptured on the outside and the medial edge has two teeth at the apex; there are bristles articulated into a "socket", located at the mandible base and in the middle of it.

The maxillae are formed by cardo and stipes, which shows a single medial lobe, accompanied by long distal bristles. They bring a three-segmented palpus.

The labium is formed by prementum and postmentum on which a two-segmented palpus is inserted.

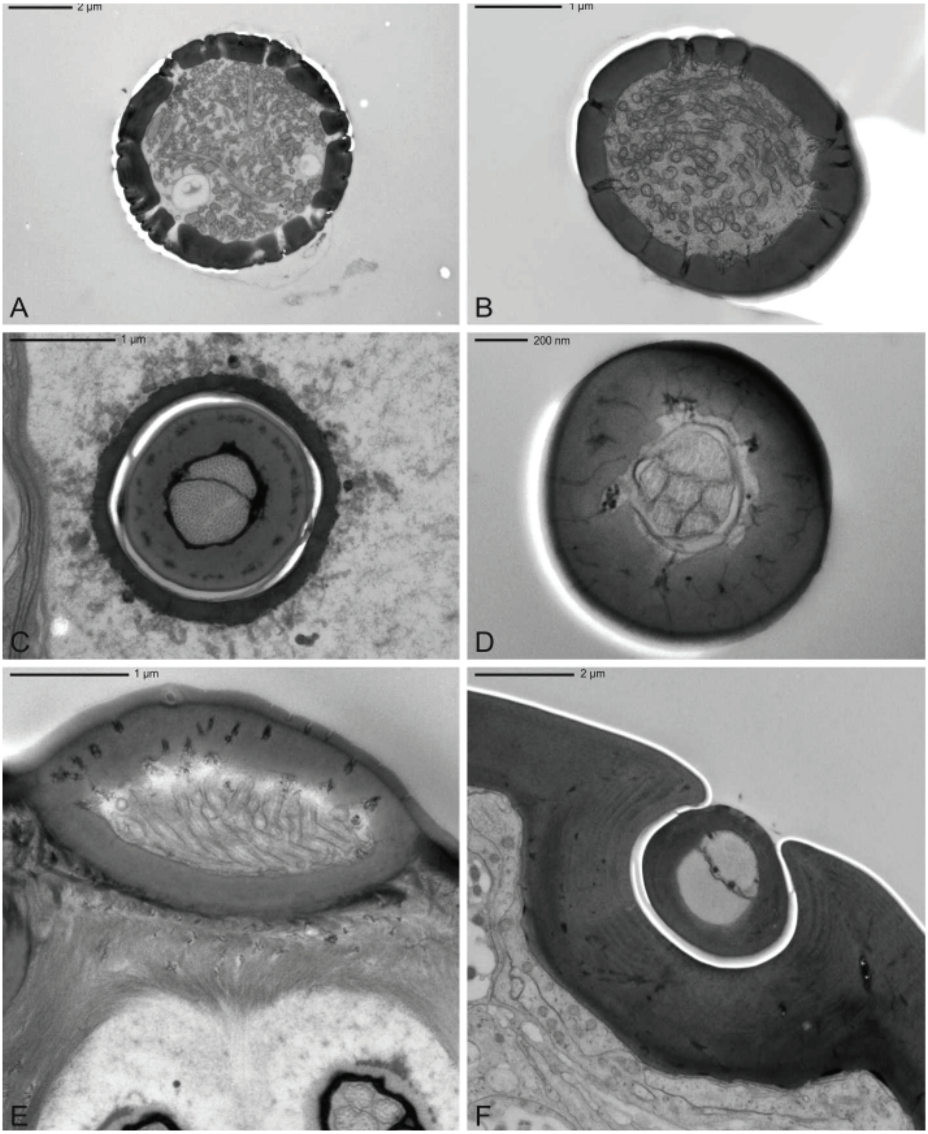

Fig. 3 - *Stegobium paniceum* larva. (A-C) TEM micrographs of antennal sensilla. (A) Cross section of the "apical article" showing dendritic branches and cuticular pores. (B) Cross section of the short basiconic sensillum. (C) Coeloconic sensillum. (D-F) TEM micrographs of maxillary palpus sensilla. (D) Basiconic sensillum. (E) Sensillum placodeum. (F) Digitiform sensillum.

The maxillary palpus is formed by a subcylindrical, wider than long, basal article, a very short median article, and a distal elongated one. On the lateral surface of the latter, a "furrow" in the form of an elongated, eight-like plate is present (Fig. 2, A). In section, it shows to be a separate structure, partially wrapped in the wall of the article (Fig. 2, B). Internally, this sensillum is innervated by a single sensory neuron (Fig. 3, F) that, in the distal part of the cuticular structure, is organised into several lamellated branches. This sensillum is known for Coleoptera and named digitiform sensillum (Honomichl & Guse, 1981; Alekseev *et al.*, 2005). It "responds electrophysiologically to contact and vibratory stimuli" (Zacharuk *et al.*, 1977).

At the distal end, just under the furrow, we found a sensillum placodeum that presents a porous external cuticle and numerous dendritic branches within the lumen (Fig. 3, E). The internal organization suggest an olfactory function of this sensillum.

There are also various sensilla basiconica (Fig. 2, A) that can be distinguished at least in three distinct types. There are finger-like sensilla, sensilla consisting of a cylindrical base and a conical tip, sensilla consisting of a digitiform base and a subspherical apex. So far TEM investigation revealed, for the finger-like sensilla, the presence of an aporous cuticle and a number of sensory neurons ranging from 5 to 6 (Fig. 3, D). The neurons run unbranched within the shaft up to the sensillum tip. At present, we can hypothesize for these sensilla a contact chemosensory function, possibly associated with a mechanosensitivity.

The labial palpus is formed by two articles, the basal one subequal to the distal one. At the distal end of the latter 10 basiconica sensilla are present together with a multiporous placodeum sensillum dome-like shaped, raised from the surrounding cuticle (Fig. 2, C). The sensilla basiconica strongly resemble those of the maxillary palpi (Fig. 2, D).

CONCLUSIONS

In this preliminary study we described the main sensory structures located on the antennae and maxillary palpi of *S. paniceum* larvae. We found that in this species there are no stemmata, this can be considered an obvious consequence linked to the peculiar micro habitat exploited by these larvae.

The presence of olfactory sensilla appears less obvious. We found olfactory sensilla at the level of the antennae, as well as the palpi, although the total number of sensilla is fair low (in total each larva has 6 putative olfactory sensilla). It will be interesting to look more in detail at the total number of sensory neurons associated with the sensilla, since we expect a very low number of sensory cells. This could explain the presence of olfactory receptor neurons, that could be specifically tuned to few volatile molecules of biological relevance for this species.

The poreless sensilla on the palpi are consistent with a possible thermo-hygroreceptive function. This function could apply also to the digitiform sensilla, because of the presence of a thick sensory neuron filled with densely packed microtubules, that runs within the poreless peg completely filling its lumen. In previous studies, a mechanosensory function for the digitiform sensilla was hypothesized, related to the possibility for the larva to monitor activity in the tunnels in which it lives, such as prey capture or predator evasion, but perhaps also to avoid to tunnel towards conspecifics. At present, we believe that this mechanosensory function could hardly be explained, based on the morphological features we observed.

Sensilla basiconica are good candidates for the role of gustatory chemosensilla, which could play an important role while the larva is tunnelling to assess the quality of the feeding substrate.

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