Biomorphometric characteristics of different types of sensilla detected on the antenna of *Helicoverpa armigera* by scanning electron microscopy

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A B S T R A C T
A morphometric study on *H. armigera* antenna showed four styles of sensilla, i.e., styloconica, chaetica, coeloconica, and trichodea, and their numbers were estimated. Sensilla trichodea detect inter and intraspecific communication signals and was the most numerous. They were divided into three types: type I, the longest, with a length of 34.04±3.16 μm and about 2.16 to 2.42 μm in diameter at its base; 2) type II, intermediate, with a length of 22.58±0.77 μm and basal diameter of 1.8–2.52 μm; 3) type III, the shorter sensilla trichodea, with a length of 7.62±0.4 μm and a range in diameter similar to that of type II. The length of the female sensilla trichodea was longer than that of the male. The total number of sensilla trichodea was estimated to be 7520 on the antenna of the female, and 6831 on the male antenna. The lengths of the sensilla trichodea type I and type III were significantly different on male ($t=4.6881, P=0.0034$) and female antenna ($t=18.9852, P=0.0001$). An estimation of the predicted surface area of the most numerous type I on sampled segments between the 12th and 20th segments from a female of *H. armigera* showed a surface area of $5\times10^7$ μm² and a sensillar density of 38 sensilla/10² μm². The fraction of sensilla-occupied surface area was 0.4 μm².

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Introduction

Chemical composition of the environment is one of the most dominant cues for most animals to orient space. Volatile or dissolved molecules in the air lead to food sources, oviposition sites, and warn of enemies or toxic conditions. These molecules represent a sophisticated means of interspecific communication (Stocker, 1994). Mate identification or selection, food source detection or choice, and navigation toward suitable oviposition substratum depend on olfaction (Vosshall, 2000). Olfaction is a crucial sensory modality for controlling many aspects of behavior and might be defined as the detection of volatile chemostimulants, but a more appropriate definition relates to the unique neuroanatomy of olfaction. Despite their small size, insects have olfactory systems of surprising sensitivity. Many volatile chemicals are perceived by the olfactory receptor neurons (ORNs) located inside the antenna. ORNs have the ability to sense volatile chemicals with remarkable sensitivity and specificity (Huotari, 2004). However, before any volatile chemical can be decoded by the ORN, it must be detected by the surface sensilla, which must carry it through the sensillar lymph to the ORN. The sensilla play a central role prior to the olfactory process but not all sensilla present on insect antennae have similar sensory ability. Odors are detected by specific olfactory sensilla in insects and show a variety of shapes, including long and short hairlike or plate-like structures, which may have single or double cuticular walls. Zhang et al. (2001) reported that pheromone receptor cells in noctuid moths are found in the long sensilla trichodea standing out on lateral rows on the antenna. These sensilla are generally multiporous, and the many small holes penetrating the cuticle provide odor molecules access to the chemosensory neurons (Steinbrecht, 1973, 1987). However, Mayer et al. (1981) reported that the modern concepts of olfactory transduction and olfactory thresholds in insects are based on exact measurements of the number, dimensions, and proportions of the different olfactory sensilla on the antenna, as well as the number and distribution of pores on the sensillar surface. Therefore, many investigators have classified three or four types of trichoid sensilla according to size, shape of hair and hair tip, and the angle at which these sensilla stand out from the antennal surface (Jefferson et al., 1970; Lavoie and Mcneil, 1987; Mochizuki et al., 1992). In the case of the noctuid family, Zhang et al. (2001) described the presence of multimodal sensory organs carrying not only olfactory sensilla but also thermos-/hygroresponsive sensilla styloconica, mecano-sensitive sensilla chaetica and sensilla campaniformia, and sensilla chaetica with mechanosensitive and gustatory neurons. In this study, we observed the antennal surface of one of the most damaging noctuid moths in the tropics, *Helicoverpa armigera*, under scanning electron microscopy to obtain estimates of morphological sensilla. We used...