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Distribution of sensory structures on antennae of female Culex mosquito: A SEM study

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Abstract
Female mosquitoes are blood feeders and vectors of many diseases. They search their hosts easily with the help of their sensory structures found on the surface of antennae and mouth parts. They use these structures to sense the chemical cues from the potential hosts. The structure distribution of sensory structures is an area of study since centuries. In the present study the distribution of sensory structures on the mouth parts of *Culex quinquefasciatus* mosquito has been studied using (SEM) Scanning Electron Microscope. The flagellomeres of antennae showed the hair like sensory structures on them. The sensory structures were of various lengths, some seem to be very long and some seem to be short. There were small pit like structures seen on the flagellomeres and the sensory structures were found to be sensilla coeloconica, sensilla chaetica, sensilla trichoidea, sensilla basiconia, sensilla ampullacea on the maxillary palp and antenna of the *C. quinquefasciatus*.

Keywords: *Culex quinquefasciatus* mosquito, sensory structures, scanning electron microscope

1. Introduction

Mosquitoes are small, midge-like flies which comprise the family culicidae [8]. Females are ectoparasites, whose tube-like mouth parts are called proboscis. A proboscis is used to pierce the skin to consume blood. The main role of some species of mosquitoes as vectors of diseases, few transmit extremely harmful infections such as malaria, yellow fever, dengue, filariasis [14]. Antennae are the primary olfactory sensors of mosquitoes and are accordingly well equipped with a wide variety of sensilla [2].Mosquitoes are attracted by host odours, CO_2 , warmth, humidity, optical stimuli and chemo-attractants are the functions of various receptors on the antennae of the mosquitoes [6]. Antennal sensory organs are important for the interaction of insects with their environment [9]. There are about 174 sense organs are present in antennal flagellum of mosquito. The antennal sensilla of medically important species of anopheline and culicine female mosquitoes are intensively investigated [10]. The investigation of the sensilla of culicoides is necessary to reveal their importance in taxonomic analysis and better understand their role in the behavior of these insects [20]. The sensilla are sensory receivers with peculiar locations at the mosquito body being placed at antennas, maxillary palps, proboscis, etc., the sensilla exist in several forms. Each is specialized to receive a well-defined stimulus such as mechanical effects, temperature (or) humidity changes [13]. The complex diversity of sensillar structures on mosquito antennae has puzzled scientists since the 19th century.

Mosquitoes often walk around soon after landing on a suitable host and probably detect the acceptability of the host using the chemoreceptors located on the tarsi of the prothoracic legs and mesothoracic legs. Tarsi of the metathoracic legs may not be important in host discrimination, as the hind legs are often raised when the mosquito is walking around [5, 15]. Female mosquitoes hunt their blood host by detecting organic substances such as Carbon dioxide (CO_2) and 1-octen-3-ol produced from the host and through optical recognition [4]. Mosquito prefer some people over others, the victim's sweat simply smells better than others because of the proportions of the carbon dioxide, octenol and other compounds that make up body odor [19]. The most powerful semi chemical that triggers the keen sense of smell of *C quiquefasciatus* [7]. Another compound identified in human blood that attracts mosquitoes is Sulcatone (or) 6-methyl, 5-hepten, 2-one. A large part of the mosquitos' sense of smell (or) olfactory system is devoted to sniffing out blood sources. Of 72 types of odor receptors on its antennae, atleast 27 are tuned to detect chemicals found in perspiration [16].

2. Materials and Methods

Specimens of female Culex mosquitoes were collected from breeding sites at Bahour, (11.80° N, 79.74° E) Pondicherry in the month of February, 2016. The adults caught were killed with ethyl acetate and preserved in bottles for further investigation. They were identified with the help of the following keys. The mosquito was brown in color and the abdomen was bent like that of culicine group. The head was light brown in color with shorter maxillary palp. The antennae and the proboscis were about the same length. The characteristic features are the absence of a pale band on the proboscis and the presence of basal pale bands on the terga [17]. The specimens were fixed in 5% formalin. The head was amputated and preserved for SEM study. The head was dehydrated through a graded series of ethanol, cleared in xylene, air, dried on a glass slide, coated with gold by gold sputtering. Head was observed for various types of sense organs on the antennae under Scanning Electron Microscope (JSM, 5610)

3. Results

In present study, we observed some types of sensilla like sensilla coeloconica, sensilla chaetica, sensilla trichoidea, sensilla basiconia, sensilla ampullacea on the maxillary palp and antenna of *C. quinquefasciatus*. Similar types of senisilla were described earlier in other species of aedinine, culicine, and anopheline mosquitoes.

The head portion of the mosquito is shown in Plate 1. It clearly shows the flagellomeres of the antennae, maxillary palps, and proboscis. The flagellomeres of antennae are shown in Plate 2 and showed the hair like sensory structures on them. The sensory structures were of various lengths, some seem to be very long and some seem to be short. There were small pit like structures seen on the flagellomeres and the sensory structures found are described below.

3.1 sensilla chaetica: The sensilla chaetica (Plate 3) were long articulated bristles arising from a socket and presenting thick walls and sharp points. These sensilla are also called verticals'. The surface of sensilla chaetica presented longitudinal grooves as revealed by scanning electron microscopy. The sensilla chaetica were of two distinct subtypes. The large sensilla chaetica and small sensilla chaetica

3.2 sensilla trichoidea: The sensilla trichoidea (Plate 4) were thin walled tapering and not articulated setae which arise from clear areas on the cuticle. They are lightly pigmented. The sharp, tipped trichoidea appear most tapered. These hairs were also apparently more uniform in length than the sharp trichoidea.

3.3 sensilla basiconica: The sensilla basiconica (Plate 5) are thin-walled, peg-shaped structures with slightly curved tips which have been referred to as sensory pegs (or) cones. The sensilla basiconica can be found sparsely distributed between the sharp, tipped trichoidea of these segments.

3.4 sensilla coeloconica: The sensilla coeloconica (Plate 6) are small, thin, walled peg organs sunken into depressions of the antennal wall. These sensilla are also known as olfactory pits and sensory tufts.

3.5 Sensilla ampullacea: These sensilla (Plate 7) consist of a peg organ located in a deep flask like pit with a narrow opening. Sensilla ampullacea is present on the opposite side of the sensilla coeloconica. The sensilla ampullacea are small, thick, walled peg sensilla set at the bottom of a tube. The external opening of which appears as a very small aperture on the cuticular surface.

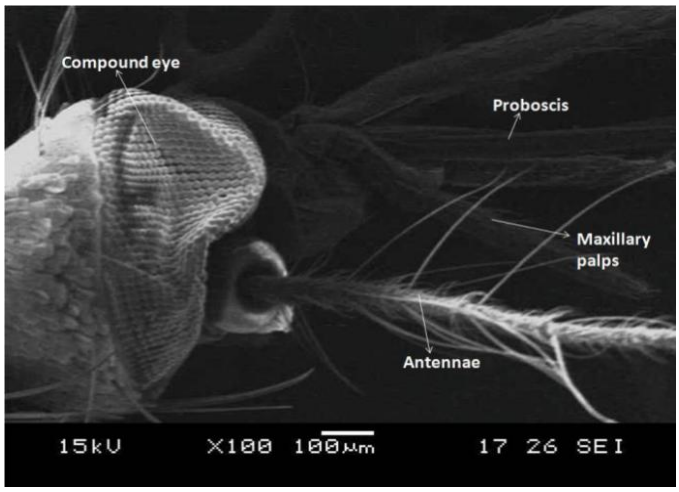

Plate 1: Close view of *C. quinquefasciatus* head portion

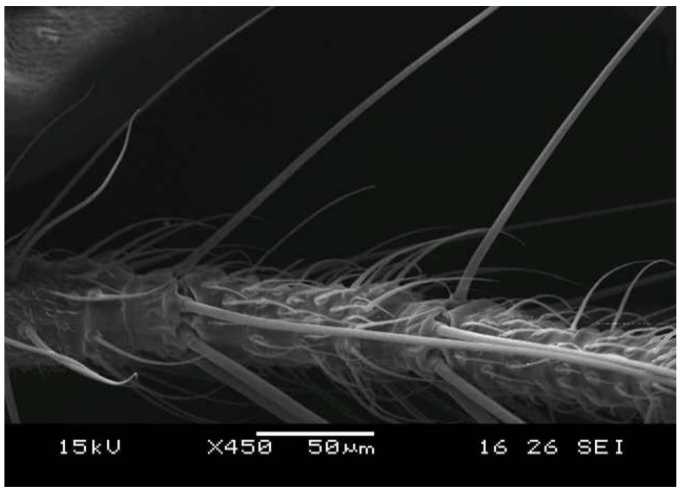

Plate 2: Close view of Antennae

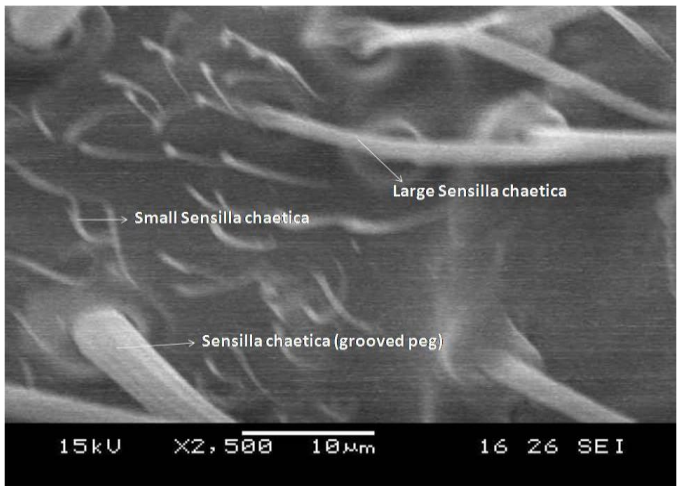

Plate 3: Sensilla chaetica

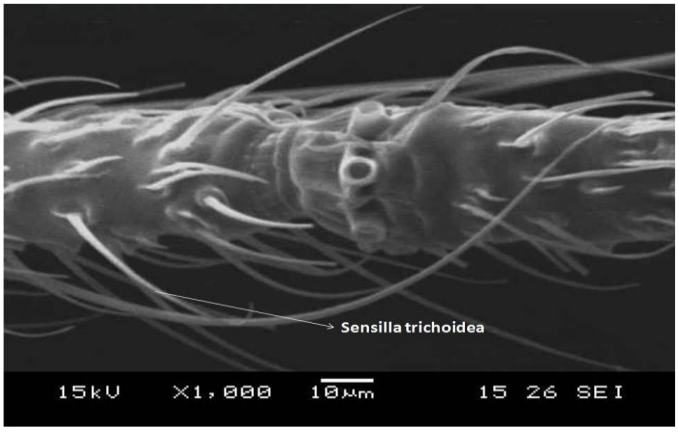

Plate 4: Sensilla trichoidea

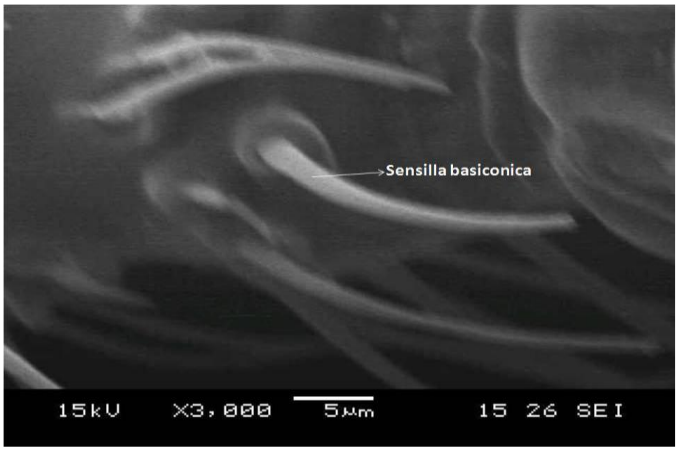

Plate 5: Sensilla basiconica

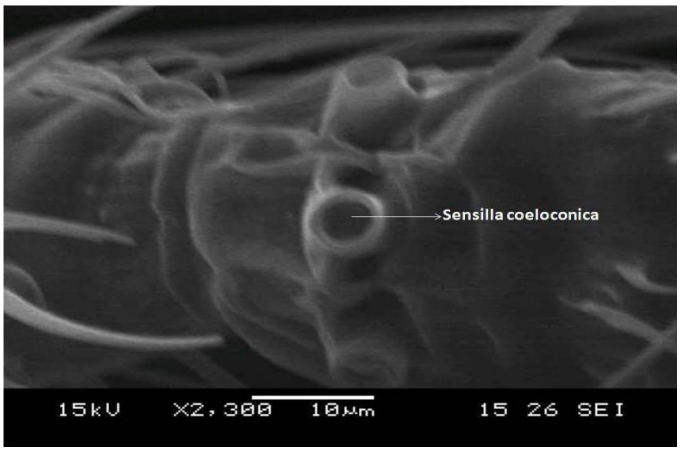

Plate 6: Sensilla coeloconica

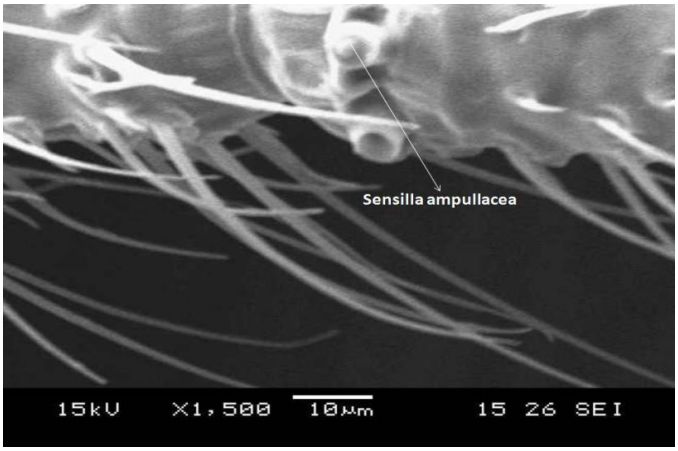

Plate 7: Sensilla ampullacea

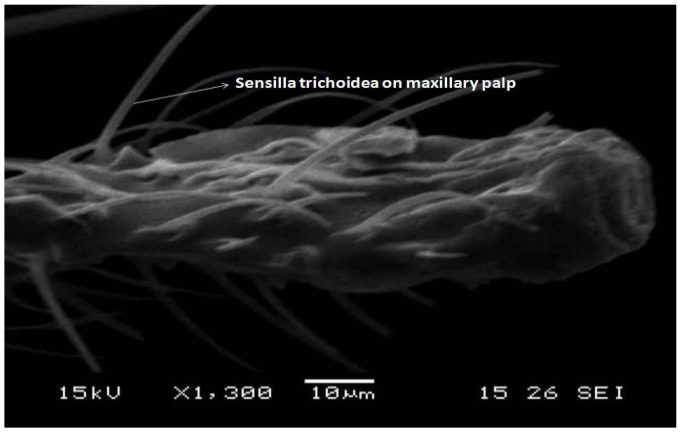

Plate 8: Sensilla trichoidea on Maxillary palp

4. Discussion

C. quinquefasciatus emerged as a smart vector because of the adaptive fitness, ecological plasticity, invasive behavior, host specificity and high reproductive potential along with expanded immune gene repertoire property at the genetic level. This mosquito possesses the necessary potential to initiate and facilitate the disease transmission by establishing an effective vector-host transmission cycle for diverse pathogens in different environments [18]. In general five types of stimuli are used by mosquitoes to locate hosts, namely visual cues, water vapour, heat, carbon dioxide and body odour. The respective sensilla responding to these stimuli would be the compound eyes, grooved pegs, sensilla coeloconica, capitate pegs and sensilla trichoidea [12]. Two subtypes of sensilla chaetica were identified in Aedes and anopheles [1]. The grooved pegs sense sweat components, including ammonia and lactic acid [3]. Small sensilla chaetica were generally found on the dorsal surface and near the distal edge of flagellomeres. These were not clearly seen on the flagellomeres [1]. In the previous studies, two subtypes of grooved peg sensilla were mentioned, (i.e.) long and short grooved peg sensilla in some Aedes and Culex species, however, They had found not only the difference in length but also in tip structure (one is pointed and the other is blunt tipped) The highly significant difference in the length of these two types of grooved peg sensilla would indicate a possible difference in the perception mechanism of odour molecules Sensilla trichoidea have been proved to sense carboxylic acid of skin of the host animals. They act as olfactory receptors for sensing the various chemicals produced by the host. In Aedes mosquito the Sensilla trichoidea are the most abundant sensilla when compared to culex [21]. The sensillum coeloconicum on the tarsi of mosquito might be playing the role of short-range olfaction in addition to thermo and hygroreception. The early studies, reported that the two sensilla coeloconica protruding from the terminal tip of antennal flagella of *Aedes albopictus* in a tubular structure whereas in *Aedes aegypti* and Anopheles mosquitoes these sensilla coeloconica were observed at tip of the flagellum but any protrusion was not observed [10]. The ampullacea appear as light points or as pigmented rods depending on the angle of observation, scanning electron microscopy demonstrated the narrow opening of these sensilla in *C.paraensis* [11]. Once a female mosquito has landed the texture and perhaps taste of the host's surface would be perceived first by the tactile setae and contact chemosensilla on the tarsi and subsequently labellum sensilla. Labial sensilla probably respond to cues in the blood during probing [21].

5. Conclusion

Mosquito find their hosts using odors released by them. The odor sensing is an interesting field of research since 1900. Continuous attempts are being made by researchers to understand about them. In this humble study an effort has been made to study the types and distribution of various sensory structures on the flagellomeres of antennae. Sensory structures were identified such as sensilla cheatica, sensilla trichoidea, sensilla basiconica, sensilla coeloconica and sensilla ampullacea on antennae of female culex mosquito. This study will be useful in explaining the types and distribution of various sensory structures on the flagellomeres of antennae and could possibly help in assessing the vectorial capacity of female mosquito. A future study is required for understanding the responses of these sensory structures against various chemical cues.

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