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Mosquitoes which walked from the outside to the inside of the diaphragm were not counted, so as to eliminate the reaction due to the perception of non-directional receptors existing on other parts of the insect body which receive the stimuli when the insect is on or near the source of stimuli (ROTH, 1951 & RAHM, 1958).

#### IV. The Antennae of *Anopheles Maculipennis*.

It is a well-known fact that the antennae of males and females differ markedly in *Anopheles*. They can be distinguished with the naked eye by the very long fibrillae which exist on the different segments of the male antennae. The flagellar segments in the females are loosely articulated, while they are more closely attached to each other in the males. In both sexes the antenna is made up of 15 segments, comprising a scape, a pedicel and 13 flagellar segments.

##### 1. *The antenna of the female.*

The antenna of the female (Fig. 3) is about 1.6 mm long (average of twelve antennae, minimum of 1.4 mm and maximum of 1.7 mm). The scape is an irregular chitinous ring, connected with a rounded pedicel which measures about  $125\ \mu$  in diameter and carries a few scales and short articulated thick-walled sensilla (bristles or spines). Both the scape and the pedicel are darkly pigmented and carry many small, slender microtrichia. These are merely cuticular outgrowths and no innervation to them was seen in the histological preparations.

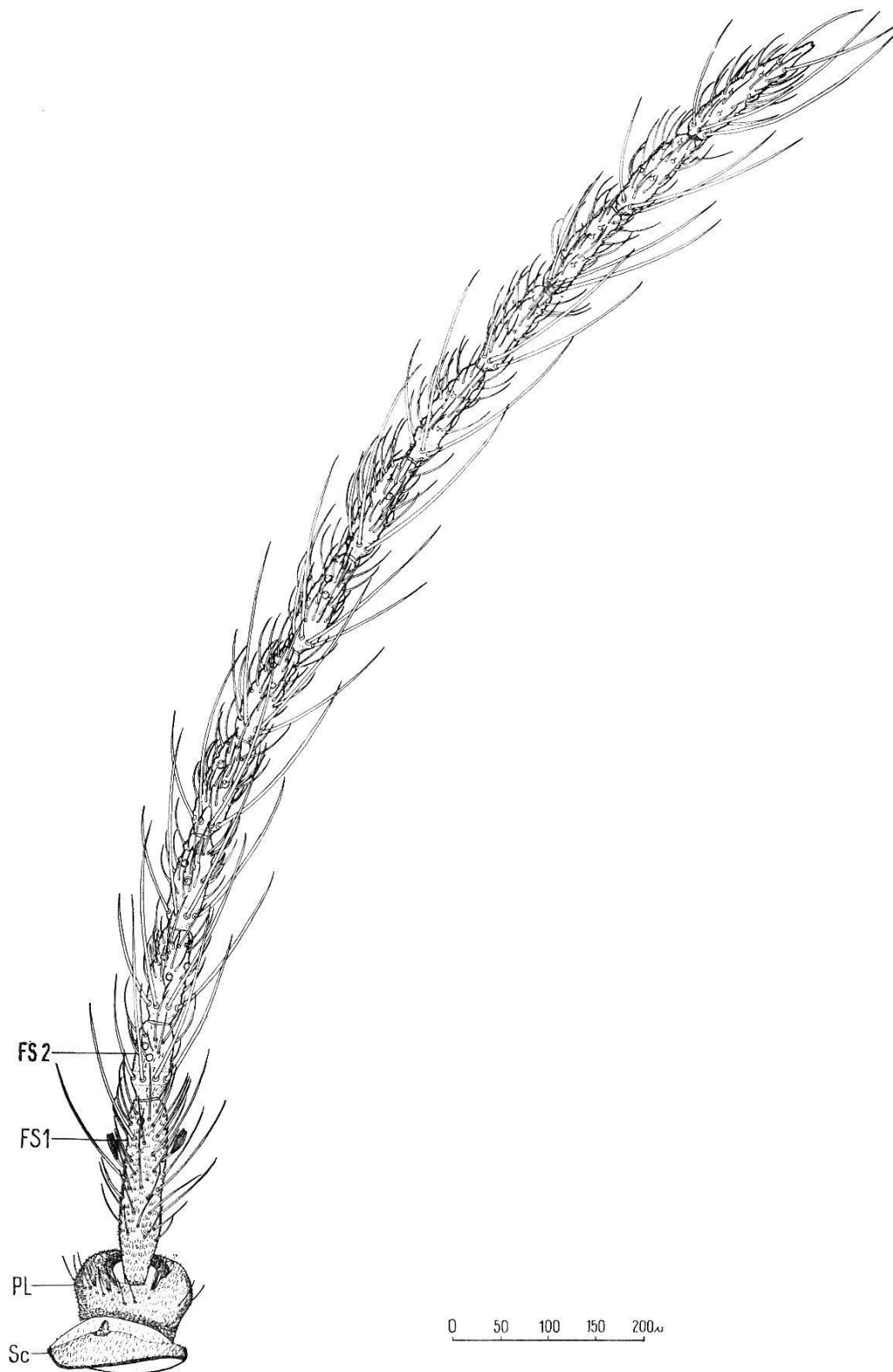
The first flagellar segment fits into the hollow of the pedicel. It is the longest segment of the antenna, measuring about  $200\ \mu$  in length and  $43\ \mu$  at its greatest diameter<sup>3</sup>. It bears scales and various lengths of articulated thick-walled sensilla (bristles or spines) on the whole segment except for a small portion at the base. Like the scape and the pedicel it is darkly pigmented and carries many microtrichia.

The second flagellar segment is the shortest of the flagellum, measuring about  $80\ \mu$  in length and  $40\ \mu$  in diameter. It carries several short bristles or spines, few thin-walled sensilla and very few microtrichia. It is also darkly pigmented except for a sub-basal colourless ring where long bristles are inserted.

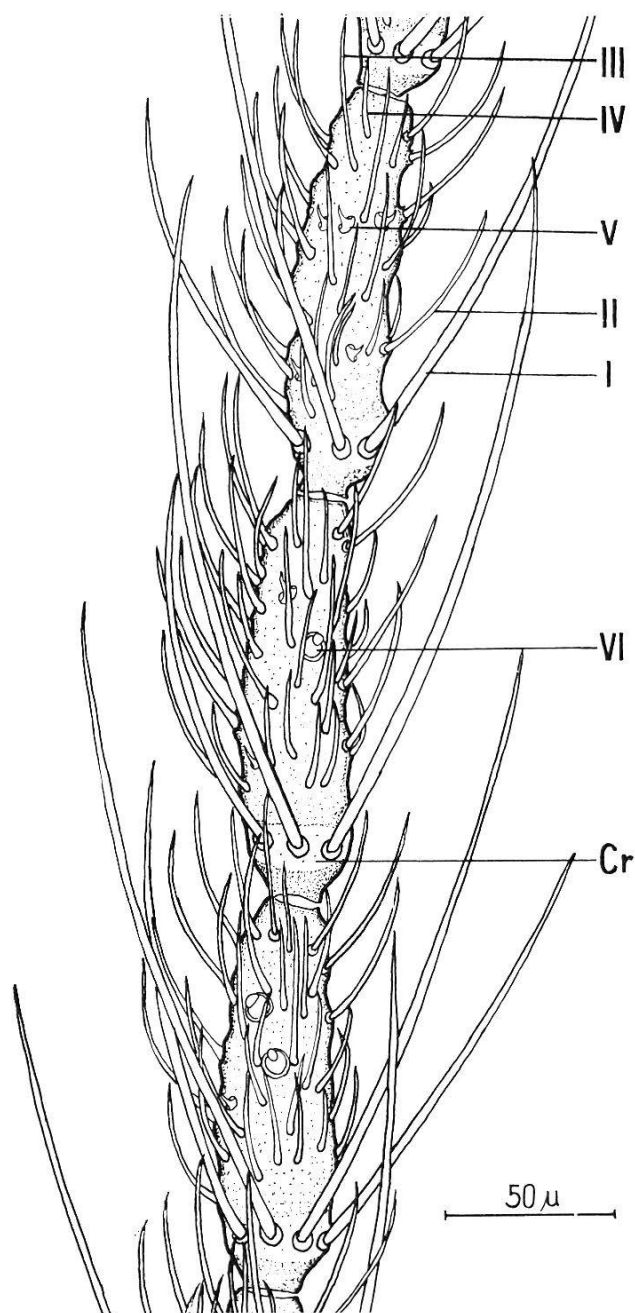
Flagellar segments 3 to 12 are more or less similar to each other, with the segments decreasing slightly in diameter towards

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<sup>3</sup> Measurements of all diameters were taken at the widest part of the segments.



*Fig. 3.* Antenna of the female *Anopheles maculipennis*. FS1 = first flagellar segment; FS2 = second flagellar segment; PL = pedicel; Sc = scape.



*Fig. 4 A.* Female flagellar segments 7-9, with the different types of sensilla. I = long bristles (or spines); II = short bristles (or spines); III & IV = trichoid sensilla; V = basiconic sensilla; VI = coeloconic sensilla; Cr = sub-basal colourless ring.

the apex of the antenna, measuring from  $40\ \mu$  to  $30\ \mu$ ; their lengths vary between  $100\ \mu$  and  $120\ \mu$ . They carry few small bristles and many thin-walled sensilla.

The last segment is shorter than the first flagellar segment, but longer than any other, measuring about  $165\ \mu$  in length and  $30\ \mu$  in diameter. It also carries few small bristles and many thin-walled sensilla. The apical end of the segment is branched into two small tips (Fig. 4 C). Near the apex there is a subapical circle of four large bristles.

Each of the segments 3 to 13 (Fig. 4 A) has a sub-basal colourless ring carrying large bristles; their pigmentation is lighter to-

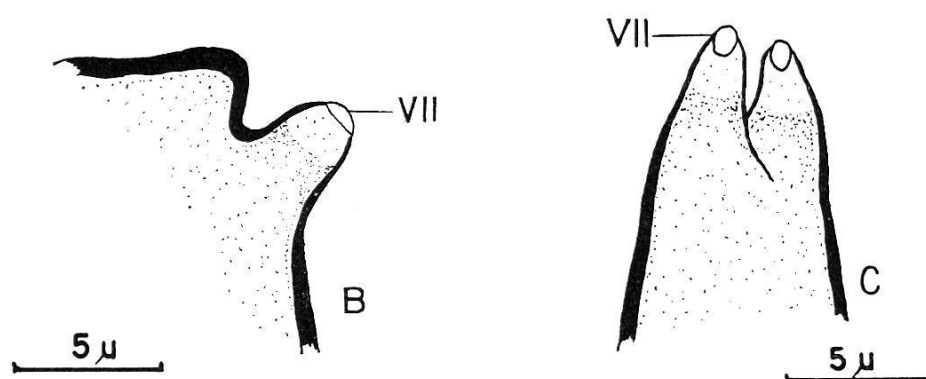


Fig. 4 B & C. B. Lateral view of sensillum type VII at the top of the female flagellar segment 12. C. The apex of the female antenna branches in two tips. Each tip ends with a sensillum type VII.

wards the apex. Occasionally there are articulated feathered bristles on the different antennal segments.

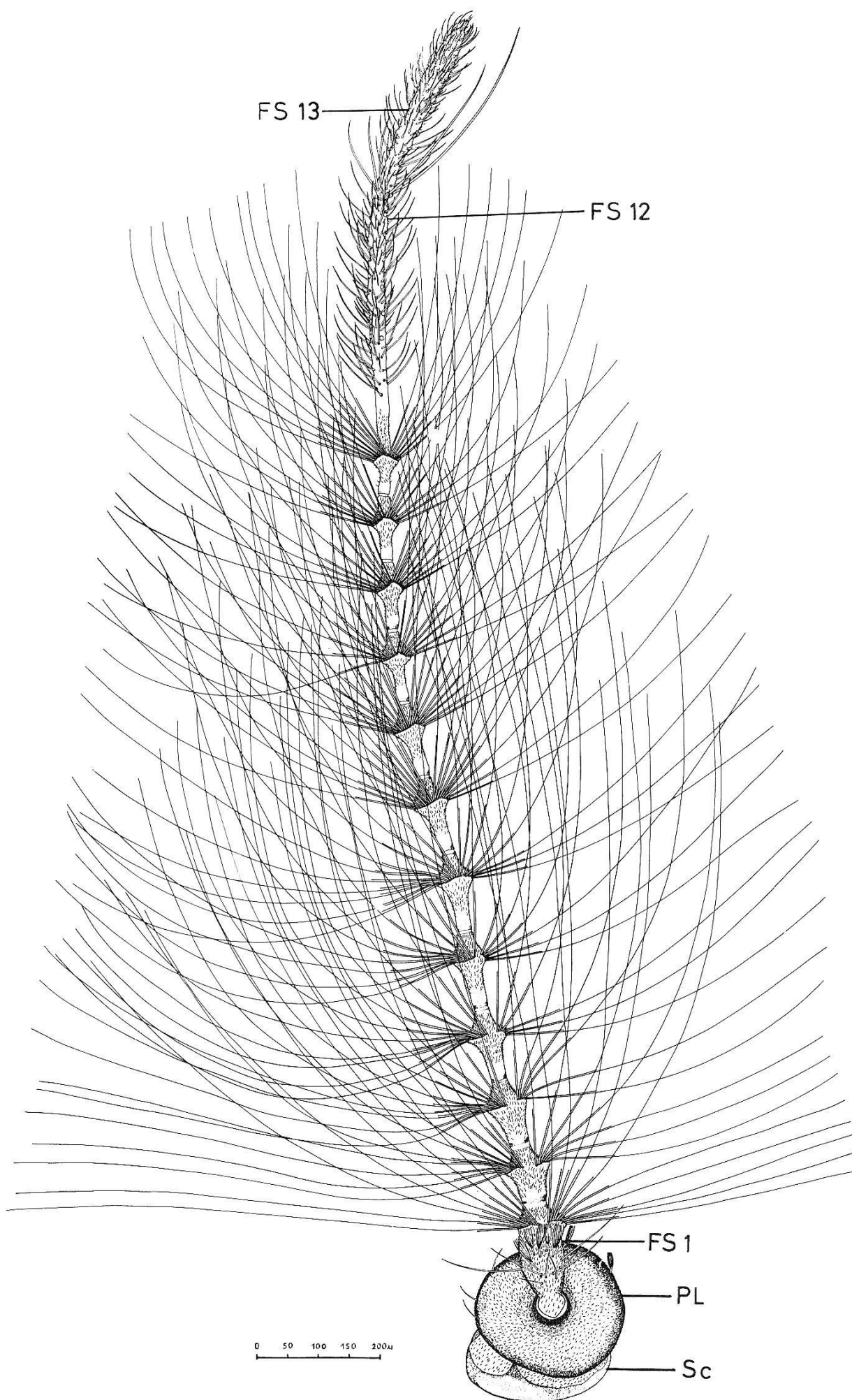
## 2. The antenna of the male.

The antenna of the male (Fig. 5) is longer than that of the female, measuring about 2 mm (average of twelve antennae, minimum of 1.8 mm and maximum of 2.1 mm). The scape is a narrow irregular ring attached to a greatly enlarged pedicel which measures about 240 μ in diameter. The scape and the pedicel are darkly pigmented and bear many minute microtrichia.

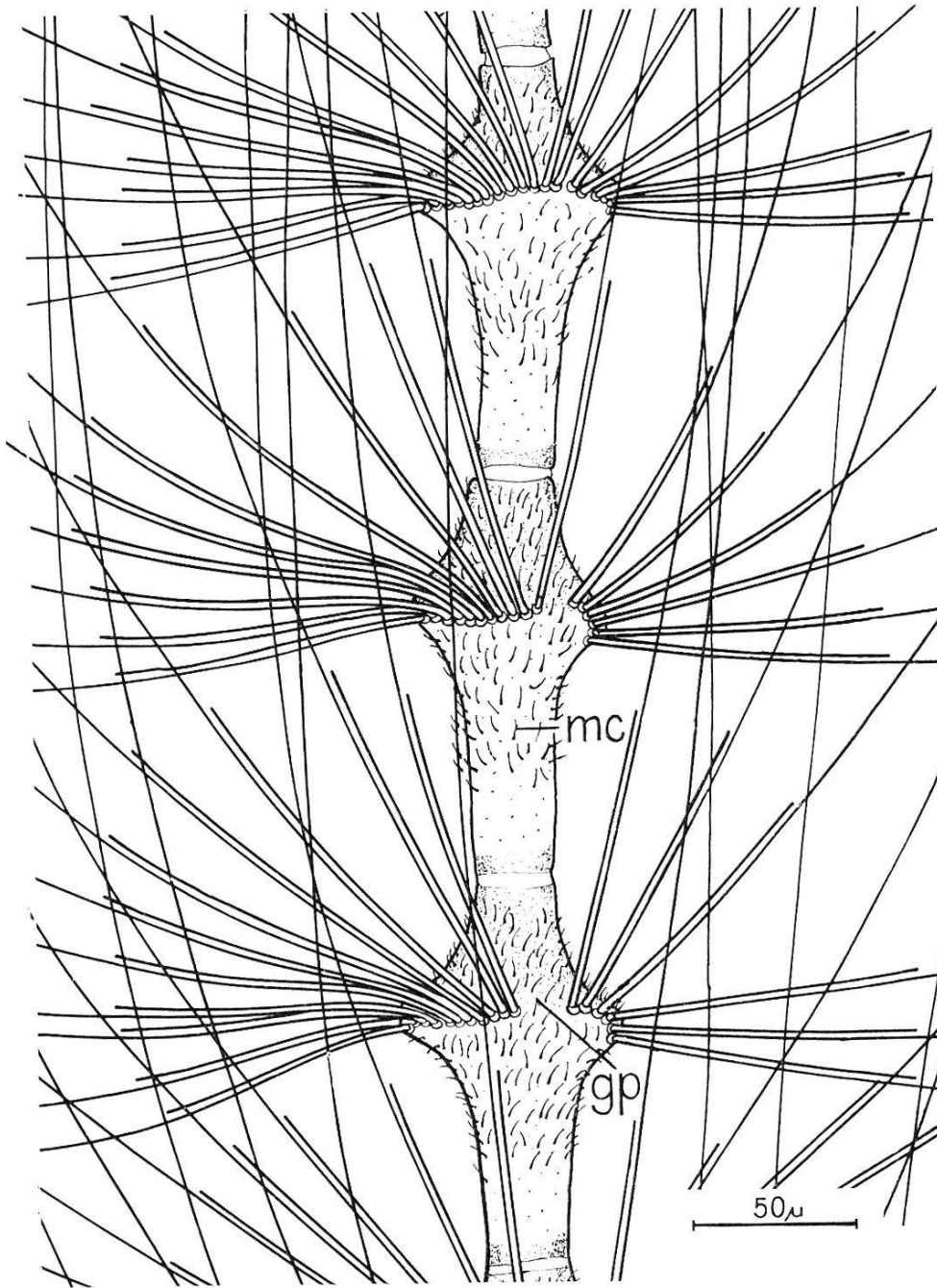
The large size of the pedicel of the male is due to the presence of a very well developed Johnston's organ. ROTH (1948) described this organ in the large pedicel of male *Aedes aegypti*. It is supposed that this well-developed organ in male culicids has an auditory function.

Each of the first 11 flagellar segments has a subapical or nearly medial whorl of numerous very long fibrillae. They differ in length and become shorter towards the apex of the antenna. The part of the segment where the whorl is inserted is somewhat enlarged. The fibrillae extend in all directions; they form a nearly complete ring with two gaps on both surfaces of the antenna. On the first five segments one gap is much wider than the other; both are very small on the subsequent segments. The function of the fibrillae has been investigated in the male mosquito *Aedes aegypti* by ROTH (1948). He says that the induction of male mating behaviour apparently is dependent upon the condition of the fibrillae. The male attempts to copulate when a sufficient number of its antennal fibrillae are extended, making possible the perception of the sound of the flying female.

The first flagellar segment is somewhat longer than the other



*Fig. 5.* Antenna of the male *Anopheles maculipennis*. Flagellar segments 1-12 with their whorls of fibrillae. The fibrillae show the same thickness (indicated at their bases in the figure) throughout their whole length. FS 1 = first flagellar segment; FS 12 = flagellar segment 12; FS 13 = flagellar segment 13; PL =

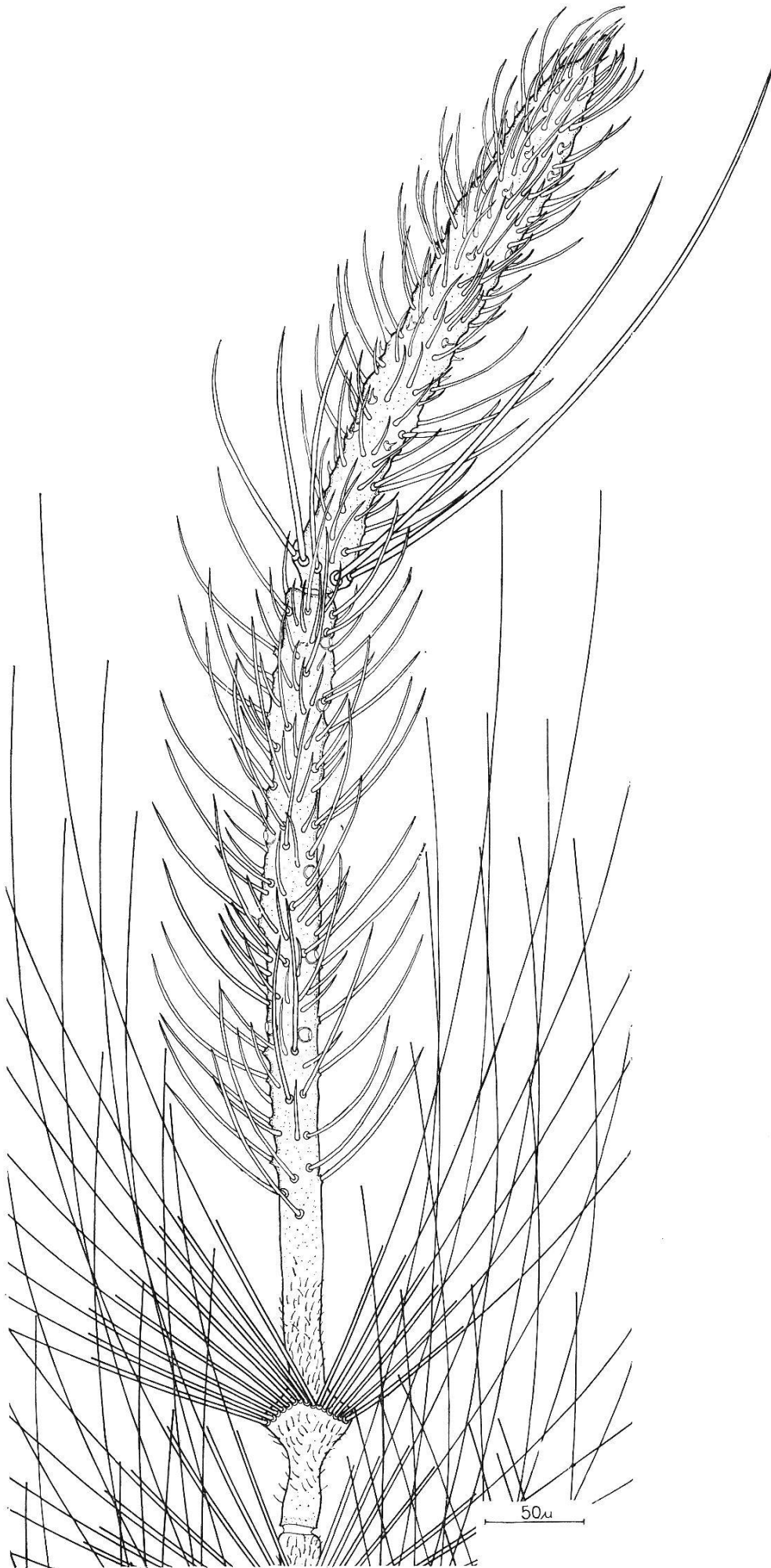


*Fig. 6 A.* Male flagellar segments 4-6 with their whorls of fibrillae. gp = large gap; mc = microtrichia.

following ten. It is nearly as long as the first of the female and twice as large in diameter. It fits into the hollow of the pedicel and is darkly pigmented except for a small irregular colourless area below the subapical whorl. The pigmented region below this area carries scales and several small and large bristles. The whole segment bears minute microtrichia.

Flagellar segments 2 to 11 (Fig. 6A) are more or less similar, measuring from  $95\ \mu$  to  $125\ \mu$  in length and decreasing slightly in diameter from  $75\ \mu$  to  $45\ \mu$  towards the apex of the antenna. They have a pigmented basal ring (very narrow compared with that of





*Fig. 6 B.* Last two segments in the male antenna with their different types of sensilla.



the first segment), a colourless area below the whorl and a pigmented region above the whorl. Each segment is covered with microtrichia except for a small portion at the base.

The flagellar segments 12 and 13 (Fig. 6 B) differ markedly from the rest. They are comparatively long, about  $470\ \mu$  and  $315\ \mu$  in length and  $30\ \mu$  and  $40\ \mu$  in diameter, respectively. Segment 12 has a whorl of fibrillae like segments 2 to 11, but as the apical part is greatly prolonged, the position of the whorl is much nearer to the base of the segment instead of being subapical or nearly medial as in the others. There is a narrow pigmented ring at the base of the segment; between it and the whorl is an unpigmented area with microtrichia. The prolonged region above the whorl is darkly pigmented; it carries many thin-walled sensilla, except for the portion immediately after the whorl which is bare of any kind of sensilla and carries only slender microtrichia. The terminal segment carries few small bristles and many thin-walled sensilla. Similar to the terminal segment of the antenna of the female, it is loosely articulated, darkly pigmented except for the irregular colourless ring near the base which carries large bristles, and ends in two small tips.

## **V. Morphology and Histology of the Different Types of Sensilla.**

Insects possess many different kinds of sense organs. They are defined by SNODGRASS (1935) as being literally "places on the periphery of the animal where forms of energy existing in the environment may activate the form of energy latent in the nerve tissue of the animal". IMMS (1942) wrote, in this connection, that the various and often minute forces acting on the organism need special mechanisms in order to differentiate between them. Such mechanisms are of various kinds and differ according to the nature of the stimuli which they are capable of appreciating. These structures are the sense organs or receptor organs. The simplest types of sense organs are the sensilla.

We found seven different types of sensilla distributed on the 13 flagellar segments of the female antenna (Figs 4 A and B, C). All these types are also found on the male antenna, where, however, they are restricted to the last two segments, except for one type (Type VII) which has two organs on the first segment. Since both sexes possess the same types of sensilla, sections were made only in the female antennae. The morphology and histology of each type are described below and a further chapter is devoted to their number and distribution.