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Artikel: Sense organs in the antennae of "Anopheles Maculipennis Atroparvus" (v. Thiel), and their possible function in relation to the attraction of female mosquito to man
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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 μ and 315 μ in length and 30 μ and 40 μ 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.

Type I (Long bristles or spines).

Consist of large, rigid thick-walled bristles from 110 to 230 μ long, arising from a distinct socket and ending at the apex in a sharp point. Figs 7 A & B show two cells lying at the base of the bristle; one of these is large, nearly rounded and vacuolated; the other is smaller with no vacuole. They are presumably the trichogen and the tormogen cells respectively. A filament comes from the base of the bristle, swells somewhat and leads to a presumably bipolar sense cell, then the cell narrows again to form the proximal process which runs to the main nerve.

Type II (Short bristles or spines).

Like Type I in structure, having a thick wall, a sharp tip and the same cellular elements. But they differ in being smaller, about 60 μ long, more curved and articulated in a small socket.

Type III (Sensilla trichodea).

Vary in length from 45 to 55 μ, not articulated at the base, curved, having a sharp tip and relatively thin-walled sensilla. At the base (Fig. 8) there is one large cell (presumably the trichogen cell) which extends into the cavity of the seta. This latter is connected by two sense cells through their distal processes which run through the trichogen cell into the cavity. In this type no tormogen cell could be detected at the base.

Type IV (Sensilla trichodea).

They are smaller than the previous type (from 20 to 30 μ long). They are thin-walled structures and lie close to the surface of the antenna. Fig. 9 shows a large cell (trichogen cell), extending in the same manner as in the previous type into the cavity of the seta. A fusiform of about five sense cells gives off very delicate filaments in the form of a cylindrical bundle running into the cavity.

Type V (Sensilla basiconica).

Exceedingly thin-walled, transparent sensilla, small and peg-like (peg organs), about 7 μ long. At the attachment of the peg to the surface of the antenna there is a clear, colourless area in the shape of a ring surrounding the peg. Figs 10 A & B show two large cells at the base of the peg. The tormogen cell appears to embrace the distal end of the trichogen cell. A group of about 7 sense cells is seen to have distal processes as in the last type, forming a cylindrical bundle ending in the cavity of the peg.

At about the middle of the bundle a group of minute, dark-stained bodies (e) is seen. Only two of these bodies were observed in Types III and IV. These bodies have been studied in the wasp by VOGEL (1923), who calls them "olfactory rods" (Riechstäbchen). But SNODGRASS (1935) says that they are so extremely minute that nothing satisfactory can be determined as to their nature or structure. He adds that while they appear to belong to the sense cell processes, it is perhaps possible that the terminal filaments beyond them are cuticular processes to which the cell processes are attached, and that the bodies in question might therefore be cuticular structures themselves.

Type VI (Sensilla coeloconica).

Peg organs sunken into depressions of the antennal wall. The coeloconic sensilla are seen on the surface of the antennae as dark chitinous rings with a nearly rounded aperture inside. Figs 11 A & B show this type of sensilla which has very short pegs, about 5.5 μ long with very thin walls. The pit measures about 5 μ (without the thickness of the walls) and contains only one peg organ. A thick chitinous wall surrounds the pit from the lateral sides and appears on the surface of the antenna as a dark ring; a thin wall forms the floor of the pit. The abrupt change from the thick to the thin wall is very clearly marked. The wall forming the floor is not on one level parallel to the surface of the antenna, as one half lies deeper than the other; the peg projects between them. There are two cells; one is very large at the base of the pit and darkly stained; the other is smaller, not stained so dark and ending at the base of the peg. These two cells are presumably the tormogen and the trichogen cells respectively. A compact group of about six relatively large cells is seen, their distal processes forming a cylindrical bundle thicker than that of the last type, ending in a terminal strand attached distally by a scolopale to the apex of the peg (Pg). A group of minute bodies (e) lies in about the middle of the distal processes.

This type of sensilla is found on the antennae of many dipterous insects, usually as groups of pegs lying in large pits. SMITH (1919) described a typical sense-pit in the antennae of some dipterous insects: "There is first a somewhat large opening in the chitin leading down into the pit itself; in *Sarcophaga carnaria* this opening is wide and leads abruptly to the sensory processes, but in some species, e.g. certain Muscidae, this opening leads into a long channel lined by chitin which sometimes exhibits spiral or convoluted folds or even a series of communicating ridges like basket-work *(Musca domestica)*. The floor of the pit consists of a very thin

chitinous membrane which is produced into the sensory processes much in the same fashion that fingers arise from a glove". SMITH found a mass of radiating cells beneath the floor of the pit; each one is connected with a sense process. In agreement with many scientists, he says that these cells are themselves nervous elements, although BERLESE and others assert that this is a mistaken view and that they are glandular, while the nerve fibres run between them and the cells secrete a fluid which fills the sensory processes; passes through the chitin to the exterior and bathes the whole surface of the pit. PACHARD also says that these sensory processes are filled with a serous fluid and are definitely olfactory in function, but SMITH has never been able to find any trace of this fluid. HSÜ (1938) also found pits in the antennae of the fly *Calliphora erythrocephala,* either in the form of simple cavities or divided into several compartments. In each cavity or compartment there are numerous sensory processes, concentrated in the centre. He says that the number of sense cells seems to be variable as he sometimes found three and at other times five, but four was the usual number.

Type VII (Sensilla campaniformia).

The sense organs of this type are similar to sensilla campaniformia described by SNODGRASS (1926, 1935), which were also called organs of Hicks, papillae, cupola organs, dome organs, umbrella organs, bell organs, and sense pores. Externally (Fig. 4 B), they appear (laterally) as very small swellings on the surface, which measure about 4 μ in length and 3 μ in diameter. Great care was needed to find these organs as at the beginning it was difficult to distinguish them from the bristle sockets. MCINDOO (1918) faced the same difficulty when he searched for these organs, which he called "olfactory pores", in the tibiae of various species of Diptera.

The basal half of the external part of the organ is pigmented in the same manner as the surface of the antenna, while the upper half is less pigmented. The apex has the shape of a bell and lies totally above the surrounding chitin. It consists (Fig. 12 B) of a very thin outer lamella of the cuticula (a) and of an inner layer of clear, soft chitin (b). A cuticular structure in the form of a cylinder (c) is present in the middle of the organ, with a small aperture at the top and closed at the bottom except for a small portion, penetrated by a scolopale. The scolopale (Sp) is darkly stained, cylindrical, somewhat expanded towards the distal end and tapering to an acute point which lies within the opening of the cylinder in the layer (b) of the bell. The sense process (Fig. 12 A) runs out from the cylinder through the distal end of a very long, large cell; it is

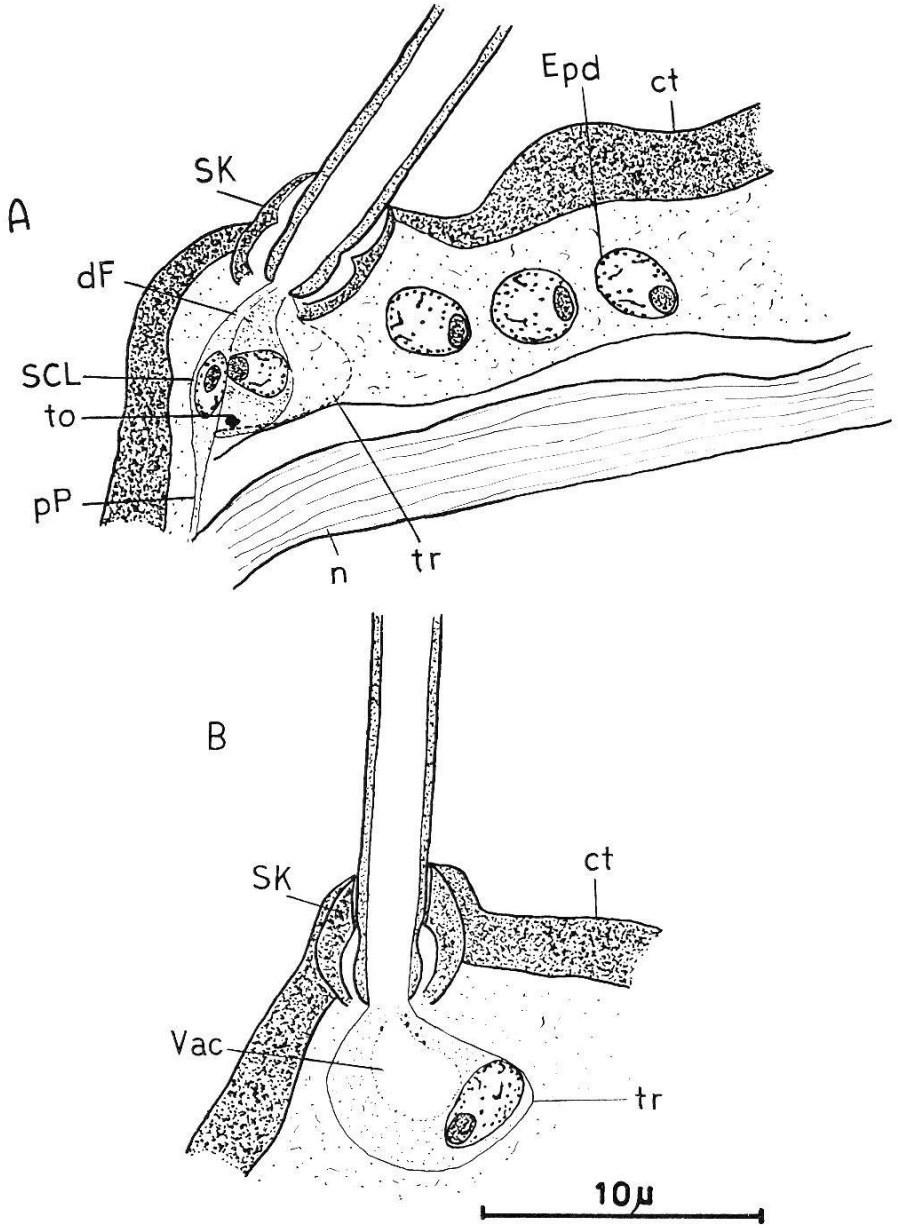

Fig. 7. Sensillum type I (long bristles or spines). A. Section of a sensillum with the sense, tormogen and trichogen cells, the latter drawn in dots to show the tormogen cell below. B. Section with only the trichogen cell.

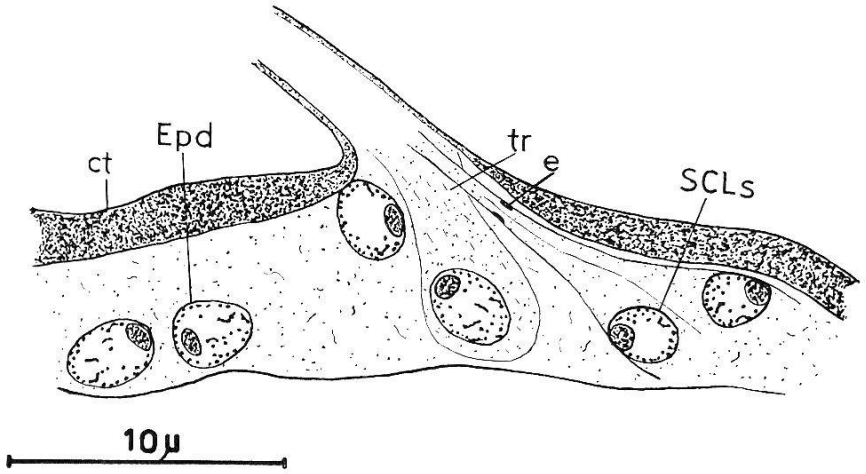

Fig. 8. Section of a sensillum type III (trichodea).

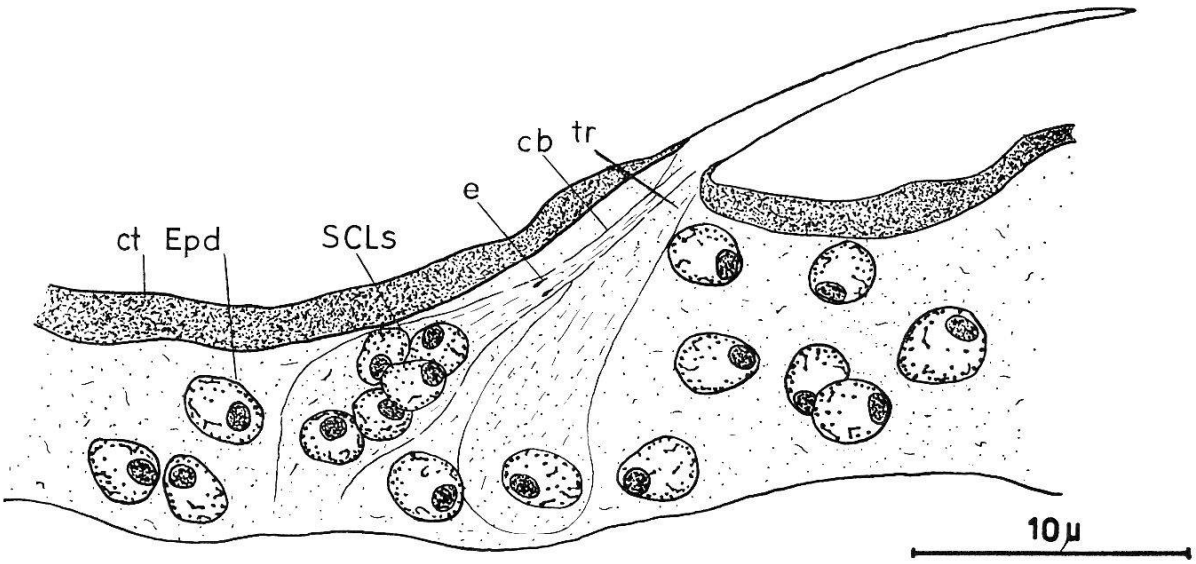

Fig. 9. Section of a sensillum type IV (trichodea).

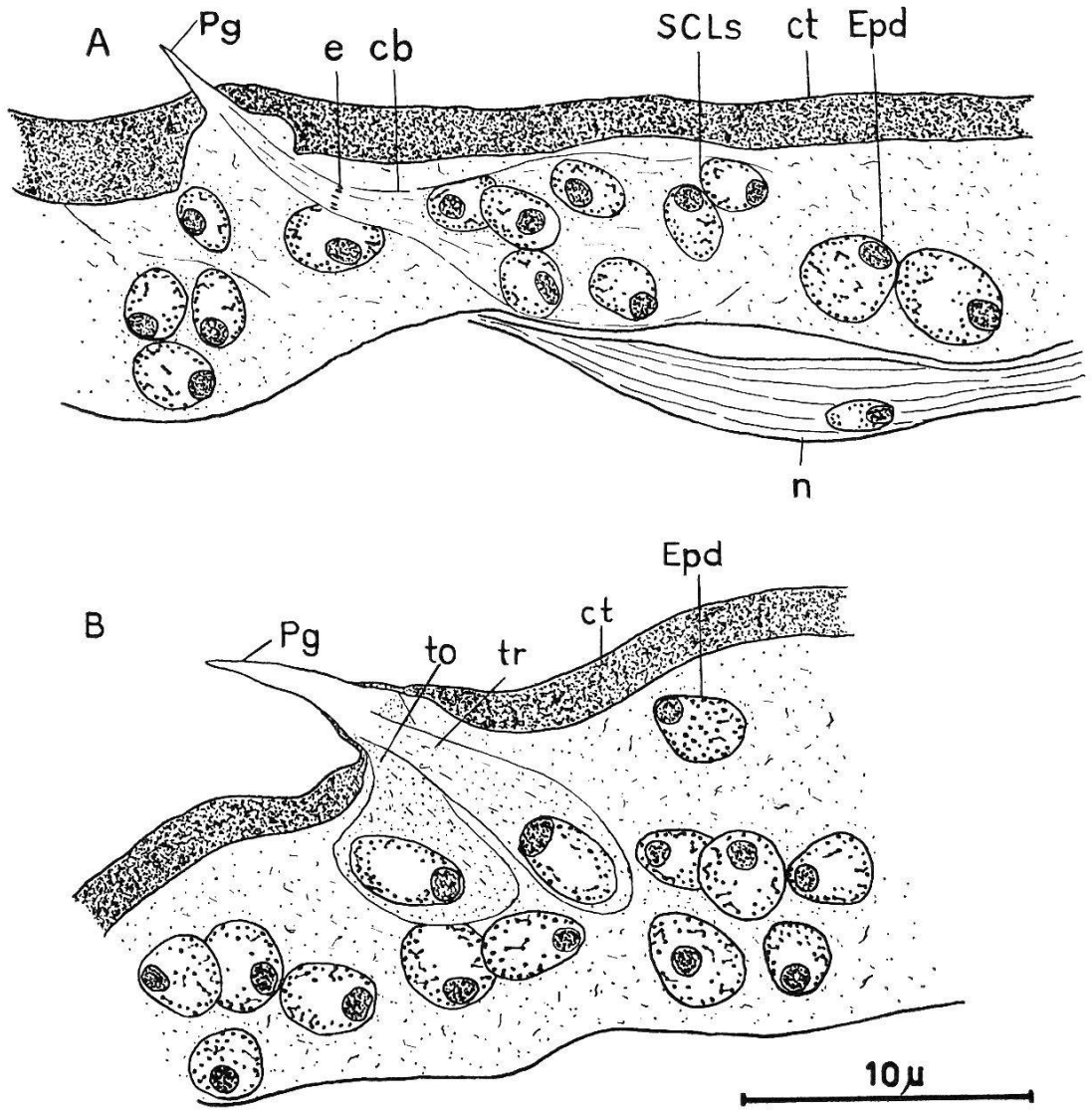

Fig. 10. Sensillum type V (basiconica). A. Section with the sense cells and a part of the peg. B. Section with the tormogen and trichogen cells.

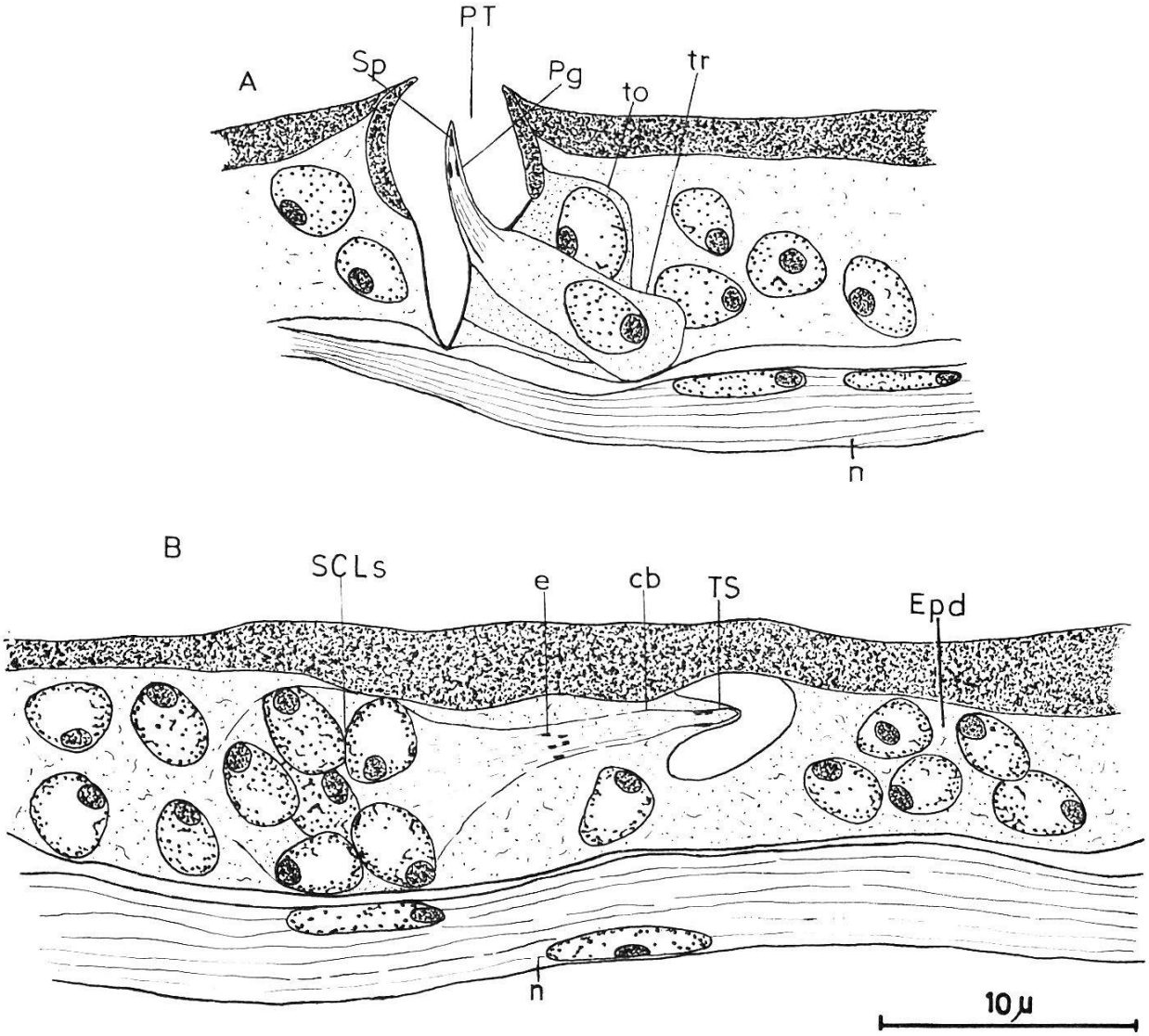

Fig. 11. Sensillum type VI (coeloconica). A. Section showing the pit, tormogen, trichogen cells and the terminal strand of the sense processes with the scolopale. B. Section with the sense cells.

not clear where it leads to. Minute bodies (e) are seen in two places on the sense process and a large body apparently of the same structure (ee) is found beyond the second group. Traces of three cells comparatively larger than the surrounding epidermal cells are seen close to the large cell. Whether one or more of these three cells, or the large cell, is the reception cell, was not possible to determine. In spite of the numerous sections which were made, they could not show clearly the cellular elements of this type. These cellular elements were seen in the organs which lie in the tips of the antenna but it was even impossible to see such parts in organs which lie in the other parts of the antenna.

NEWTON (1931) suggested that the large cell in such a type of sensilla is chitinogenous and receptive in function, although according to SNODGRASS (1926, 1935) various investigators have

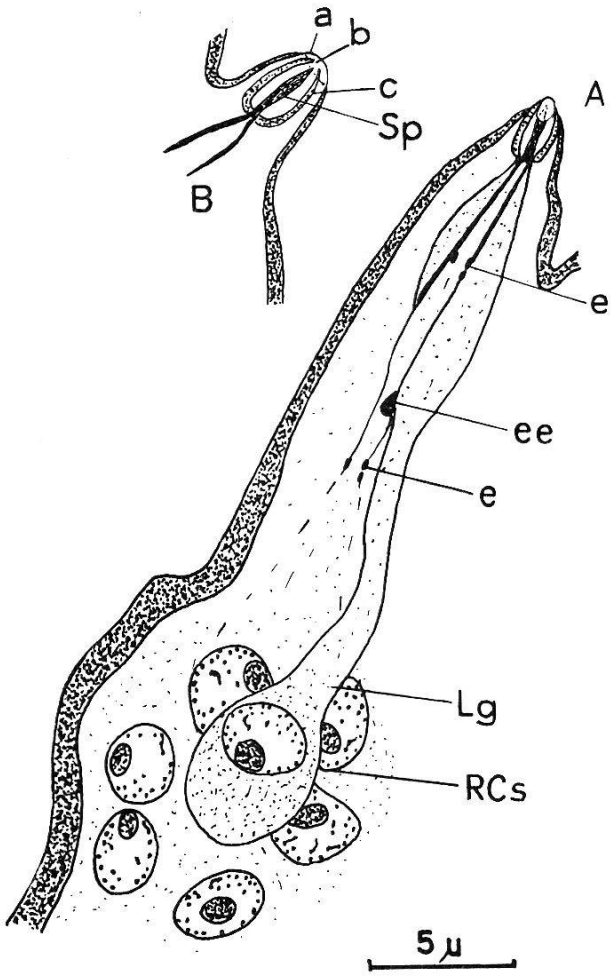

Fig. 12 A & B. A = Section of a sensillum type VII (campaniformia) in one of the tips of the female antenna. B = Section of the external part of type VII in the female flagellar segment 12. a = outer lamella; b = inner layer; c = cuticular cylinder; ee = large body apparently of the same structure as the minute bodies; Lg = large long cell; RCs = three large cells.

Abbreviations: cb = cylindrical bundle; ct = cuticula; dF = distal filament; e = minute bodies; Epd = epidermis; n = antennal nerve; Pg = peg-like structure; pP = proximal process; PT = pit; SCL = sense cell; SCLs = sense cells; SK = socket; Sp = scolopale; to = tormogen cell; tr = trichogen cell; TS = terminal strand; Vac = vacuole.

found traces of other cells. He mentioned SIHLER, who describes in Periplaneta a large cell ending in the canal of the cuticula, which is transversed by the distal process of the sense cell. HSÜ (1938) mentions one sense cell in this type and a large vacuolated cell; he calls it a membranous cell. A third cell lies between the first two and envelops the distal process of the nerve cell and the scolopale which he calls the accessory cell. SNODGRASS (1926) says that the other cells beside the sense cell have not been definitely identified with those of the hair-bearing sensilla.