LETTERS TO THE EDITORS

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Ultra-structure of the Insect Ear

LIGHT microscope studies[1-4] have long established that the sensory unit (chordotonal sensillum or *stiftführendes Organ*) of the insect ear consists of three cells, namely, the bipolar neuron, the axon of which runs directly to the central nervous system, the sheath cell, which surrounds the dendrite of the neuron, and the attachment cell, which appears to anchor the whole assembly to the ear-drum. The approximate topographical arrangement of these cells and their inclusions are shown in Fig. 1. Examination of fresh material with the phase-contrast microscope by one of us (E. G. G.) has demonstrated that, though the vacuole (*v*) is a fixation artefact, the scolopale and the axial fibre are distinguishable *in vivo*. It is with the fine structure of the latter that this communication is principally concerned. All material has been taken from the auditory ganglia of adult female locusts (*Locusta migratoria migratorioides*) and fixed with 1 per cent osmium tetroxide buffered at *p*H 7·4 with veronal acetate. Each ganglion contains about eighty sensory units of the type described.

We confirm that the axial fibre enters the central end of the scolopale (Fig. 1) and reaches far up its axis, though we have not yet been able to trace it to contact with or passage through the cap. At the level indicated in Fig. 2 a transverse section discloses that the fibre (Fig. 2,*b*) consists of an outer ring of nine fibrillar elements and an inner group which may be two pairs of fibrils. At the level of the central end of the scolopale, this fibrillar structure is lost and the axial fibre becomes a single solid rod with cross-striations of dense lines (period 700 A.) with two wider and less dense bands between each pair of lines (Fig. 3). As this rod approaches the nucleus of the neuron it splits repeatedly into rootlets (Fig. 4). As many as forty rootlets have been counted in transverse section and each has a similar periodic structure to the parent rod.

The axial fibre therefore conforms closely, in the structure of both its distal and proximal parts, with what has been shown to be the fundamental structure of animal (and plant) cilia, and flagella[5,6]. Sjöstrand[7] has shown that the outer segment of the rod of the mammalian retina is connected with the inner by a cylinder of nine pairs of fibres with a striated root, and it is probably relevant that rods and cones are derived from the ciliated epithelium of the neurenteric canal. Wersäll[8] has found essentially the same structure (but without the striated root) in the kinocilia of the mammalian crista. Motility has been asserted of the kinocilia in the cristæ of lower vertebrates, but it has not been confirmed for mammals and it would in any event not necessarily exclude a sensory function. It seems that, when a ciliary effector is transformed into a receptor in the course of ontogeny, the fundamental structure of the cilium sometimes persists: and its retention in these cases suggests that, whatever role is ascribed to it in ciliary activity, it can play the same part but in a reversed sense in the receptor process.

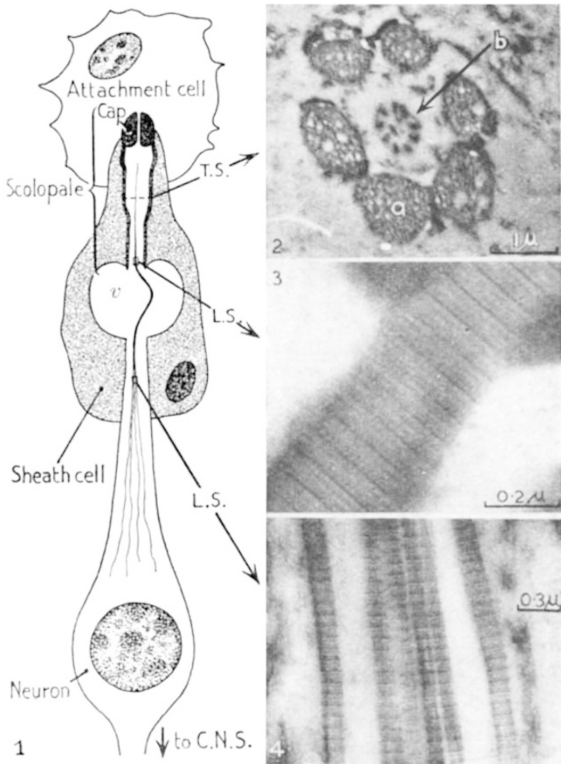

Fig. 1. (1) Diagram of light microscope preparation showing one sensory unit of the locust ear (Bouin fixed: hæmatoxylin and eosin stained). Figs. 2–4. Sections at various levels of Fig. 1 (electron microscope). Fig. 2,*a*, one of six or more pillars of finely vesiculated material forming the wall of scolopale

In insects, ciliary and flagellar effectors (except for the tails of spermatozoa in some genera) are wholly lacking in all members of the class and at every stage in the life-cycle. There is here no question of their transformation into receptors during the development of an individual. The occurrence in insects of the ciliary ultra-structure in what are unquestionably receptor cells of extremely high mechanical sensitivity is therefore of considerable interest.

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