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Preliminary Report on the Fine Structure of the Receptor Cells of the Small Pit Organ of the Catfish, *Parasilurus asotus*

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Abstract The present observations revealed the ultrastructural differences between the receptor cell of the lateral-line canal organ and that of the small pit organ. The chief differences are as follows: 1. While the sensory hairs protruding from the top of the receptor cell of the former organ are composed of a few number of stereocilia and one kinocilium, those of the receptor cell of the latter organ are made up of a number of microvilli (stereocilia) only, and apical part of the cell lacks the dense material, cuticle. 2. Nerve endings on the basal surface of the receptor cell of the former organ are separated into two different types, viz., non-granulated and granulated. However, nothing but the non-granulated type of the nerve ending is discernible in the latter organ.

Introduction

In the skin of the catfish, *Parasilurus asotus*, lateral-line canal organs, large pit organs and small pit organs are found. According to Dijkgraaf (1963), the first and the second belong to "ordinary lateral-line organ" system which seems to act as distant touch receptor, and the last belongs to "ampullary lateral-line organ" system which is sensitive to weak local electrical potential changes. If there are such differences in the function of these two systems, it might be conjectured that there are differences in also the ultrastructure of the lateral-line canal organs and the small pit organs. While the fine structure of the canal organ has been studied by several authors such as Trujillo-Cenóz (1961), Flock (1965) and Hama (1965), that of the small pit organ has not yet been ascertained. The writers have undertaken electron-microscopical observations of the small pit organ in order to confirm the differences in the ultrastructures of these two organs. The present paper is a preliminary report of the fine structure of the receptor cell of the small pit organ. The detailed report will appear elsewhere.

Material and methods

Catfishes measuring 11–14 cm in total length were obtained from an irrigation pond called by the name of Mawarizeki, Aomori Prefecture and were used as the material for this study. The head skin was excised from the anesthetized catfish and was cut into small blocks of roughly 1 mm^3 and then fixed for 2 hours in 1% osmium tetroxide buffered at pH 7.3 with Sörensen's phosphate or for 30 minutes in 2.5% glutaraldehyde followed by postosmication using the above-mentioned osmium tetroxide fixative for 2 hours. Dalton's bichromate osmium was also employed. After dehydration in an ethanol series, the blocks were embedded in Epon 812 according to Luft's method, sectioned on a Porter-Blum MT-1 ultramicrotome using glass knives, and stained with a saturated aqueous solution of uranylacetate for 5–45 minutes or with Millonig's lead solution for 3–30 minutes. In some cases the sections were stained with the uranyl acetate followed by the lead. Electron microscopy was performed with a Hitachi HS-7D electron microscope.

Results

Receptor cells. Each small pit organ contains several oval or pear-shaped receptor cells, measuring about 17–22 μ in height and about 13–15 μ in width. The whole cell body of the receptor cell is surrounded by supporting cells, but apical end of the former projects slightly over the apical level of the latter. The receptor cells occupy the upper half of the small pit organ and never reach the basement membrane of the epithelium. On their exposed apical ends each receptor cell bears a number of sensory hairs. They cannot be divided into two kinds of stereocilium and kinocilium, differing from the receptor cell of the lateral-line canal organ, but fall into one category, namely, microvilli (stereocilia) (Figs. 1 and 2, A). The apical portion of the receptor cell is similar electron opaque to the rest of the cell (Fig. 2, A). Accordingly, it is very difficult to distinguish the cuticular plate in this portion. This portion is occupied

Fig. 1. A low power electron micrograph showing a vertical section of two receptor cells. ×7,650. ly, lysosome; m. mitochondrion; mv, microvilli; n, nucleus; ne, nerve ending; rc, receptor cell; sc, supporting cell.

by ribosome rosettes, rough-surfaced endoplasmic reticula and multivesicular bodies. Mitochondria are widely distributed throughout the cytoplasm of the receptor cell, but, they are especially very abundant in the supra-nuclear region. The nucleus is located in the middle or proximal part of the cell, and has one or two nucleolus and small amount of chromatin. Lysosomes, rough-surfaced endoplasmic reticula, free ribosomes, vesicles of various sizes and microtubules are found in the supra-nuclear cytoplasm. Nu-

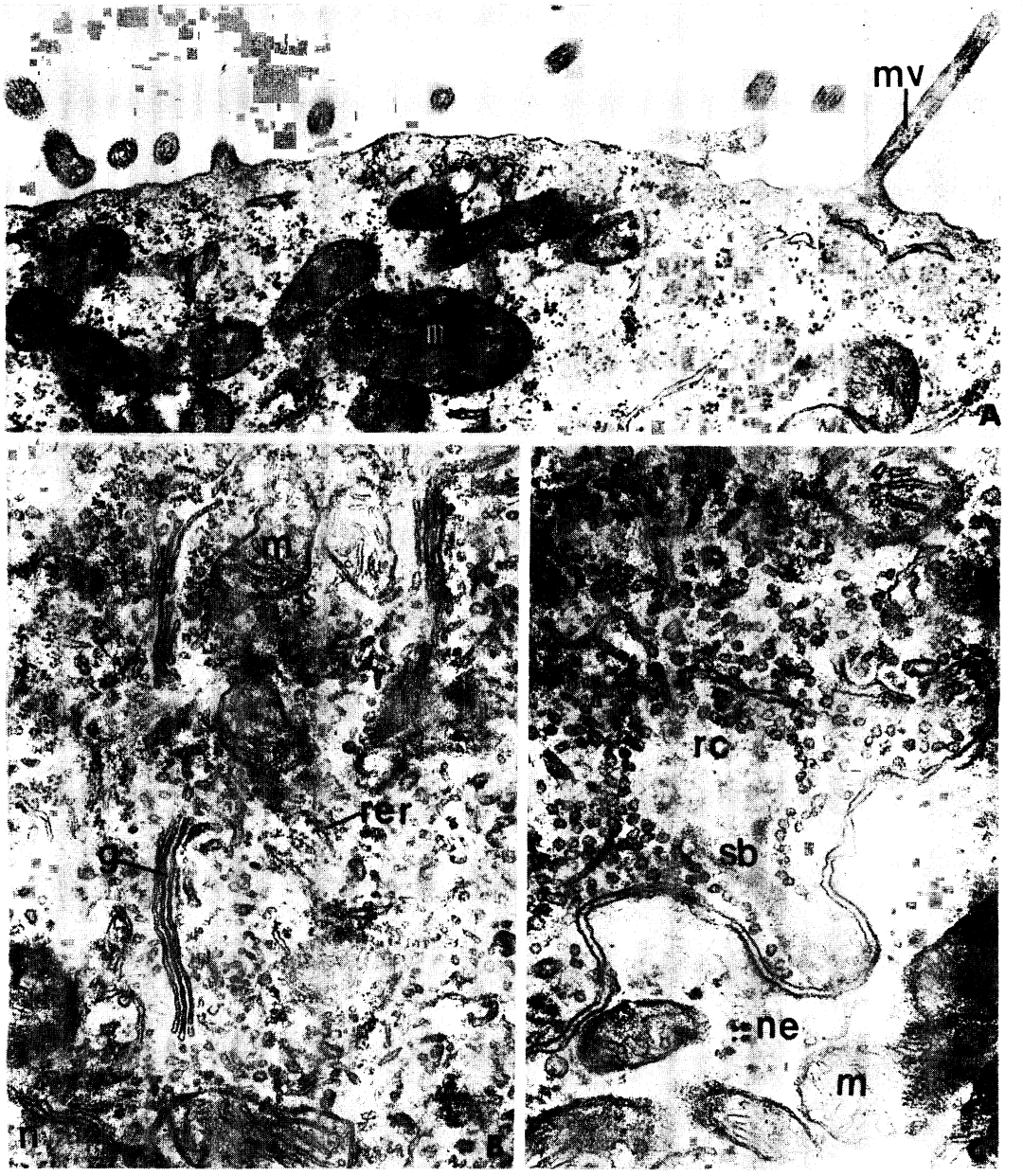

Fig. 2. Electron micrographs showing fine structures of the receptor cells. A. Apical region. ×30,000. B. Supra-nuclear region. ×25,000. C. Infra-nuclear region of the receptor cell and associated nerve ending. ×40,000. g, Golgi complex; rer, rough-surfaced endoplasmic reticulum; sb, synaptic body. For other letters, see Fig. 1.

merous Golgi complex are also found in this region (Fig. 2, B). The infra-nuclear cytoplasm is almost fully occupied by numerous vesicles of about 300–400 Å in diameter and microtubules (Fig. 3, C). Rough-surfaced endoplasmic reticula are also scattered there.

Nerve endings. Each receptor cell is innervated by several nerve endings which make contact with latero-proximal surface or bottom of the cell. The nerve endings show considerable variations in size and shape. They frequently end in a deep invagination at the receptor cell (Fig. 1), or they sometimes form a broad contact area with the basal part of the receptor cell only slightly impinging on it. However, all the nerve endings have similar structure and cannot be distinguished into two types, differing from the lateral-line canal organ. Flock (1965) and Hama (1965) described two different types of the nerve endings in the receptor cells of the canal organ of *Lota vulgaris* and *Lyncozymba* (mis-spelling for *Rhynchocymba*) *nystromi*, respectively: one type is granulated and the other is non-granulated. In the receptor cells of the small pit organ, all of the nerve endings, as far as the writer's observations go, may be designated as the non-granulated type which is presumably of afferent sensory. According to Barets and

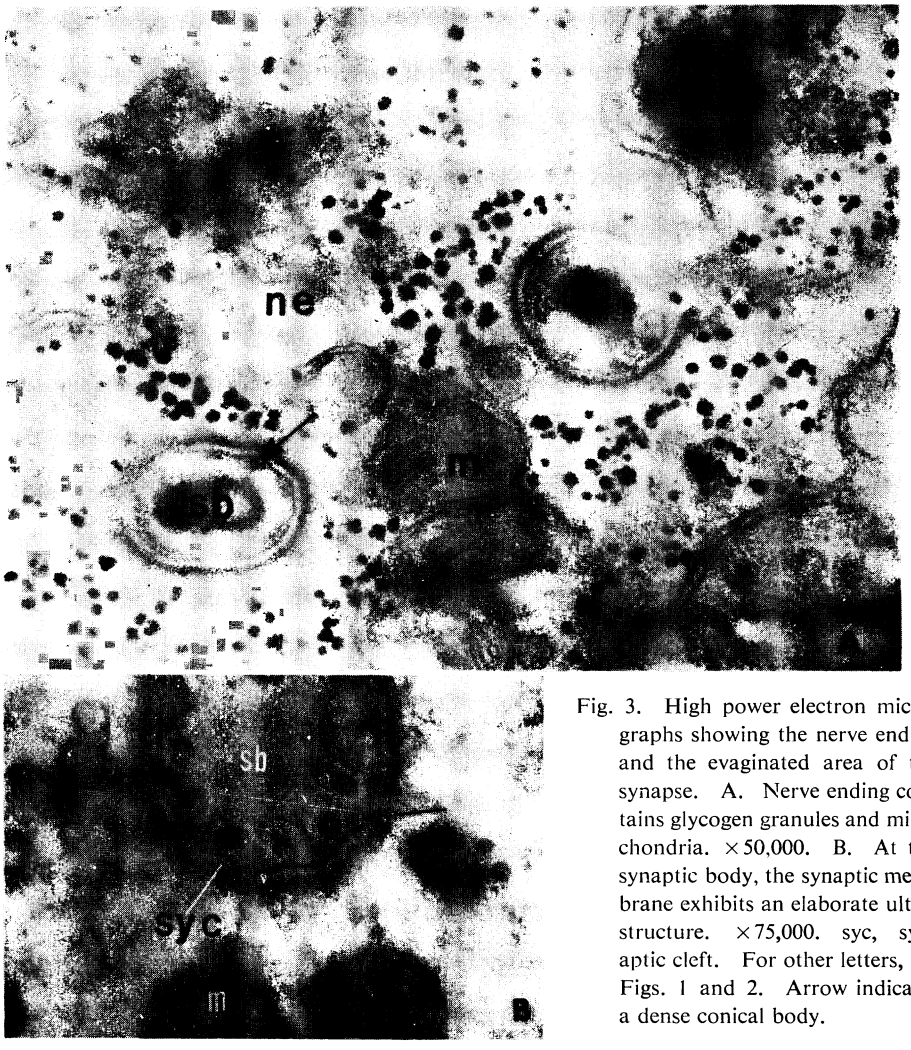

Fig. 3. High power electron micrographs showing the nerve ending and the evaginated area of the synapse. A. Nerve ending contains glycogen granules and mitochondria. ×50,000. B. At the synaptic body, the synaptic membrane exhibits an elaborate ultrastructure. ×75,000. syc, synaptic cleft. For other letters, see Figs. 1 and 2. Arrow indicates a dense conical body.

Szabo (1962), nothing but afferent nerve terminals have been demonstrated in the receptor cells of the ampulla of Lorenzini of *Torpedo*. The nerve ending of the receptor cell of the small pit organ contains mitochondria and dense granules of roughly circular shape and of about 200–400 Å in diameter, but few vesicles (Fig. 3, A). Judging from the size, shape, affinity for lead staining and PAS-positive reaction which corresponds to distribution of the granules, the dense granules seem to be glycogen in nature. Similar granules to these mentioned above are reported by Hama (1965) in the non-granulated nerve endings of the lateral-line canal organ.

The synaptic structures exist in junction of the receptor cell and the nerve ending. At the synapse, the basal part of the receptor cell evaginates and fills gutter-shaped depressions of the nerve ending, as in the synapse of the receptor cell of the ampulla of Lorenzini which is a member of the ampullary lateral-line organ system. In the evaginated area of the receptor cell of the small pit organ, a dense body surrounded by a row of vesicles with a diameter of about 400 Å are found (Fig. 2, C). The dense body may be given the name of the synaptic body. Typical synaptic body is shuttlecock-shaped, and is separated by about 900 Å from the synaptic membrane of the receptor cell. At the synaptic body the synaptic membranes of the receptor cell and nerve ending follow a wavy but parallel course, separated from each other by about 200 Å wide synaptic cleft, and in each of several valleys which appear at a period of about 600 Å, dense conical bodies are located (Fig. 3, B). Such dense bodies are also described by Flock (1965) to be in the synaptic area of the receptor cell of the lateral-line canal organ. The synaptic membranes except those of the evaginated area are separated from each other by an irregular space. The synaptic body seems to originate at a distance from the synaptic area of the receptor cell and migrate into the evaginated area of the synapse. The processes of the formation of the synaptic body will be described elsewhere in detail.

The receptor cell of the small pit organ is similar, in the type of the nerve endings and the evagination of the synaptic area, to that of the ampulla of Lorenzini.

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ナマズの small pit organ の receptor cells の微細構造
(予報)

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small pit organ は壜形側線系に属する器官で，通常形側線系の側線管器とは機能を異にしており，従ってその微細構造においても，これら両者はかなり相違することが予測される．今回の観察結果から，これら両器官の受容細胞の微細構造上の主な相違点をあげると，次のようになる．1. 側線管器の受容細胞遊離面には不動毛と運動毛の2種の感覚毛がみられるのに，small pit organ のそれには微細絨毛(不動毛)のみ認められ，この絨毛直下にクチクラ部も識別しがたい．2. 管器受容細胞に分布する神経の終末には，non-granulated type と granulated type の2つを区別できるが，small pit organ の受容細胞においては，すべての神経終末は non-granulated type である．

なお，small pit organ の受容細胞は，神経終末の型およびシナプス部における膨出構造において，Lorenzini 壜の受容細胞と類似しているといいうる．

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