SOME OBSERVATIONS ON THE FINE STRUCTURE OF THE LATERAL LINE ORGAN OF THE JAPANESE SEA EEL *LYNCOZYMBA NYSTROMI*

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ABSTRACT

The fine structure of the lateral line organ of the Japanese sea eel *Lyncozymba nystromi* has been studied with the electron microscope. The sensory epithelium of the lateral line organ consists of a cluster of two major types of cells, the sensory hair cells and the supporting cells. The sensory cell is a slender element with a flat upper surface provided with sensory hairs, Two different types of synapses are distinguished on the basal surface of the receptor cell. The first type is an ending without vesicles and the second type is an ending with many vesicles. These are presumed to correspond to the afferent and the efferent innervations of the lateral line organ. The fine structure of the supporting cells and the morphological relationship between the supporting cells and the receptor cells were observed. The possible functions of the supporting cells are as follows: (*a*) mechanical and metabolic support for the receptor cell; (*b*) isolation of the individual receptor cell; (*c*) mucous secretion and probably cupula formation; (*d*) glial function for the intraepithelial nerve fibers. Both myelinated and unmyelinated fibers were found in the lateral line nerve. The mode of penetration of these fibers into the epithelium was observed.

INTRODUCTION

The lateral line organ is known to be sensitive to low frequency vibrations (Jielof, Spoor, and De Vries, 1952; Parker and van Heusen, 1917; Schulze, 1870; Suckling and Suckling, 1950), to liquid current (Dijkgraaf, 1934; Katsuki *et al.*, 1951 *b*; Lowenstein, 1957), or to the movement of the sound source (Harries and van Bergeijk, 1962); thus its function is somewhat similar to that of the labyrinth. Morphologically, the lateral line system and the labyrinth are derived from the common anlage, the lateral placode, and these two organ systems are very similar in basic structure. The end organs consist of sensory hair cells, the hair process of which are embedded in a more or less viscous gelatinous mass which is called the cupula (Dijkgraaf, 1963). Therefore, the analysis of the fine structure of the lateral line organ can be considered to contribute to a better understanding of the auditory and the vestibular mechanisms.

With the aid of the electron microscope, information on the fine structure of this important receptor organ is being accumulated. Flock and Wersäll (1962*b*) have beautifully demonstrated a correlation between fine structural and functional polarizations of the sensory cells in the organ. Some characteristic features of the synapses on the receptor hair cells of the lateral line organ have been observed by Trujillo-Cenóz (1961) and

Flock and Wersäll (1962*a*). Trujillo-Cenóz has reported that a calyx formation of the nerve terminal is found on the receptor cell base, and Flock and Wersäll have observed complicated infoldings of the receptor cell membrane at the synaptic site which they postulate as being typical features of the lateral line organ. Synaptic vesicles were found in the receptor cell cytoplasm by the former author and in the nerve terminal by the latter authors. To clarify these controversial points, a detailed observation with improved technique is required. Also, a comparison of the synaptic fine structure of the lateral line organ with that of the vestibular and auditory organ is expected to provide a datum for the elucidation of the synaptic mechanism at the junction between the receptor cell and the nerve terminal.

The receptor cells in the sensory epithelium are closely related to the supporting cells as the neuron is related to glial elements. Consequently, a careful examination of the fine structural relationship between the receptor cells and the supporting cells is also necessary for a more detailed study of the receptor mechanism. The present paper deals with the fine structural organization of the sensory epithelium and the lateral line nerve which innervates the neuromast of the Japanese sea eel, with special reference to the nerve terminals on the receptor cells.

MATERIALS AND METHODS

The Japanese sea eel *Lyncozymba nystromi* was selected as the specimen because it has a large lateral line canal in which the sensory hillock is situated, and because it lacks scales on the outer surface.

The specimens were fixed *in situ* by injecting a cold fixative consisting of equal parts of 5 per cent osmium tetroxide and *s*-collidine buffer (Bennett and Luft, 1959) into the lateral line canal. Dalton's bichromate-osmium solution (Dalton, 1958) and permanganate (Luft, 1956) were also employed.

The specimens were dehydrated through graded concentrations of acetone and embedded in Epon epxoy resin (Luft, 1961) without intermediate immersion in propylene oxide. The sections were cut

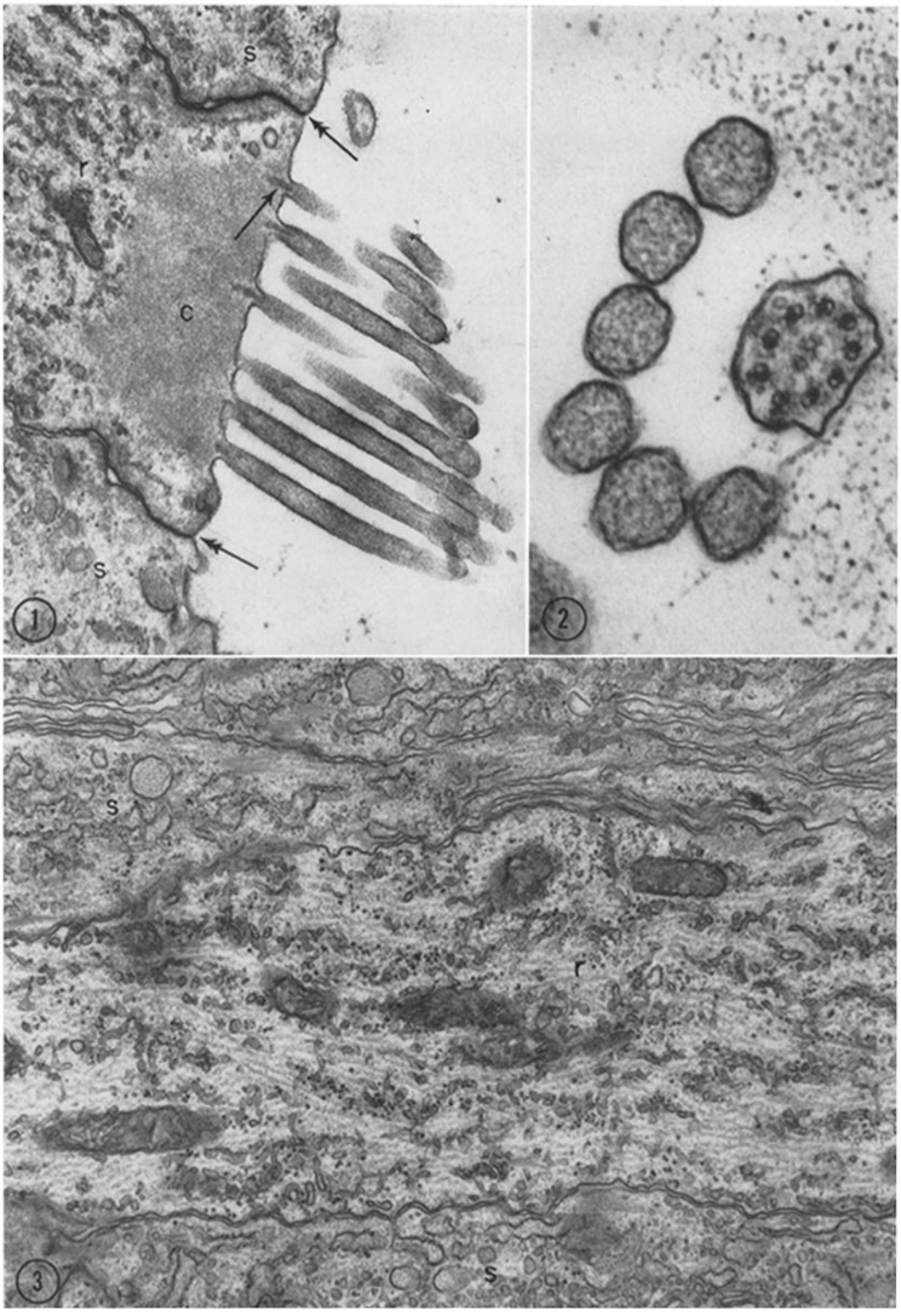
Abbreviations of Figures

a, glycogen granules	*m*, mitochondria
b, basement membrane	*n*, nerve fiber
c, cuticle	*o*, outer mesaxon
d, desmosome	*r*, receptor cell
e, rough surfaced endoplasmic reticulum	*s*, supporting cell
f, bundle of filaments	*t*, nerve terminal
g, Golgi apparatus	*v*, vesicles
i, inner mesaxon	*w*, Schwann cell
k, nucleus	*x*, myelin sheath

FIGURE 1 An electron micrograph showing the apical end of the receptor cell (*r*). Many microvilli are observed protruding from the surface into the canal lumen. The microvilli are covered by a layer limiting membrane which is continuous with the surface plasma membrane of the receptor cell. An electron-opaque process (arrow) which is continuous with the content of the microvilli is found to be embedded in the apical electron-opaque cytoplasm which is called cuticle (*c*). Near the free surface a junctional complex (double arrow) of Farquhar and Palade is found on the plasma membranes of the adjacent supporting cell (*s*) and receptor cell (*r*). × 23,000.

FIGURE 2 A cross-section of cilium is partially surrounded by a row of profiles of microvilli. The characteristic nine peripheral doublets and two central filaments are observed in the cilium. Each peripheral doublet consists of two units, one being electron opaque and the other having a less electron-opaque core. Granular material in the right half of the picture is cupula. × 87,000.

FIGURE 3 Many mitochondria, profiles of tubular endoplasmic reticulum, fine filaments about 200 A in diameter with a less electron-opaque core, and dense granules about 300 A in diameter are observed in the apical cytoplasm of the receptor cell (*r*). Rough surfaced endoplasmic reticulum and free ribosomes are also found in the cytoplasm. × 24,500.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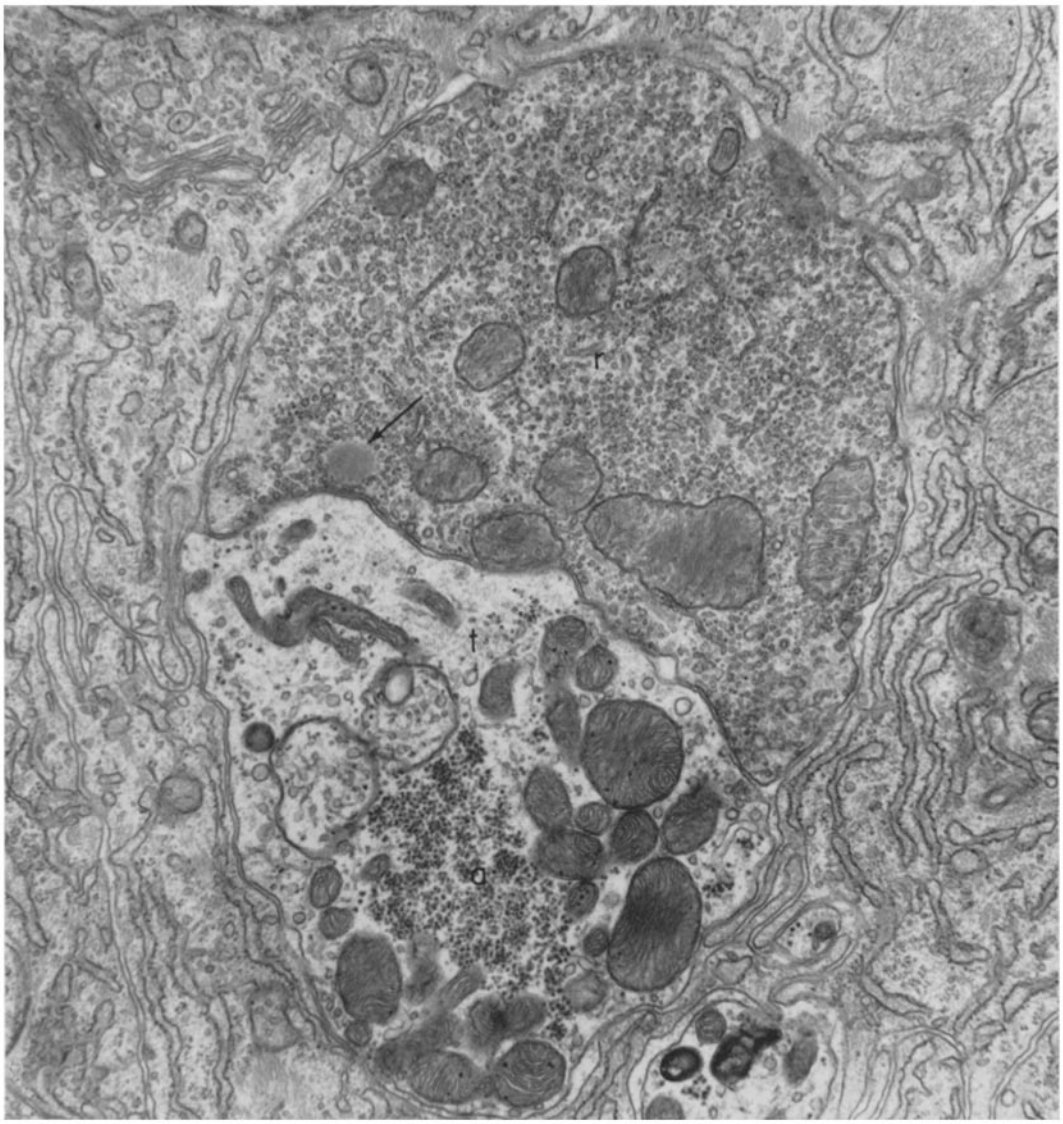


FIGURE 4 A low power electron micrograph showing a cross-section of a basal part of the receptor cell (*r*) and the associated first type of nerve terminal (*t*). The receptor cell cytoplasm is occupied by an accumulation of vesicles of various sizes. Some of these vesicles are associated with the synaptic membrane of the receptor cell. Many mitochondria are also found in the receptor cell cytoplasm. A homogeneous dense body (arrow) which is surrounded by vesicles is found in the receptor cell near the synaptic membrane. The nerve terminal contains mitochondria and dense granules (*a*) but few vesicles × 20,000.

with a Porter-Blum microtome, stained with lead subacetate (Dalton and Zeigel, 1960) or Millonig's lead hydroxide (Millonig, 1961) and examined in a Hitachi Hs-6 electron microscope.

RESULTS

The sensory epithelium (the "neuromast") of the lateral line organ is situated in each body segment in the lateral line canal, which is located beneath

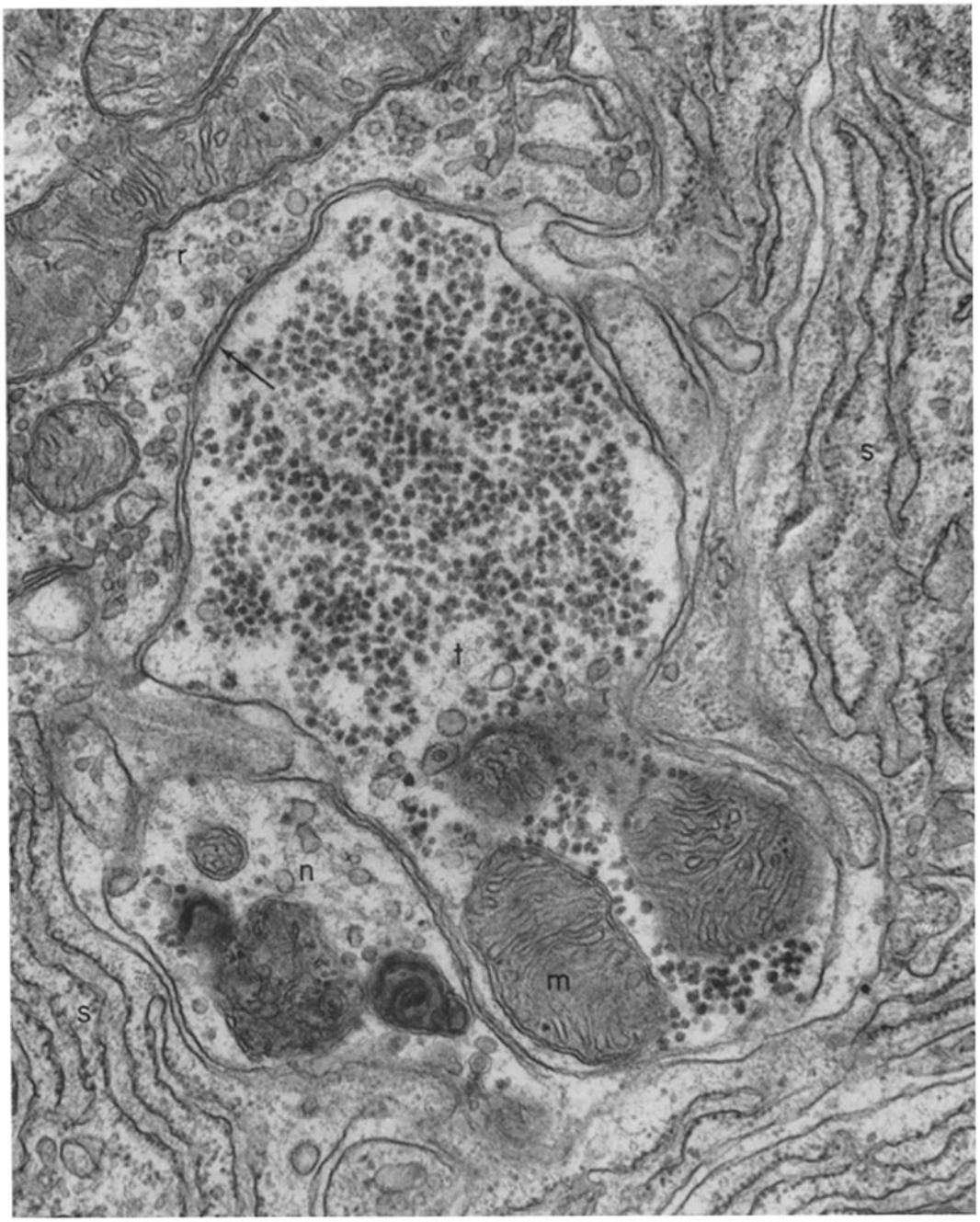


FIGURE 5 A high power electron micrograph showing a nerve terminal of the first type (*t*) which contains a cluster of glycogen granules and mitochondria (*m*), but few vesicles. The mitochondria are always found in the distal portion of the terminal. The receptor cell (*r*) contains mitochondria, tubular and vesicular structures, and dense granules. The opposing plasma membranes of receptor cell and nerve terminal show partial increase in electron density (arrow). × 49,500.

the body surface and runs along the body wall. The neuromast, which takes the form of a slightly flattened sphere, consists of a cluster of two major types of cells, the sensory hair cells and the supporting cells. The whole structure is embedded in the epidermis of the lateral line canal and has a slightly convex free surface at the canal lumen. The free surface is covered with a gelatinous mass, the cupula, which is triangular in shape with the broad base facing the sensory epithelium as seen in the longitudinal section of the canal. At the free surface, the epithelial cells are connected to each other by a junctional complex (Fig. 1) (Farquhar and Palade, 1963).

The Receptor Cells

The receptor cell is a slender element whose flat upper surface is provided with sensory hairs and whose rounded basal pole is studded with many nerve terminals. The basal pole sits on the nuclear level of the supporting cells and does not reach the basement membrane of the epithelium. The whole cell body of the receptor cell is surrounded by supporting cells (Fig. 8).

A cilium and 20 to 40 microvilli (stereocilia) are present on the outer surface of the cell (Figs. 1 and 2). The sensory hairs are arranged in a characteristic pattern, as described by Flock and Wersäll (1962*a*). The microvilli are oriented along straight lines displaying a hexagonal arrangement. The cilium is located at one end of the hexagonal disposition. The microvilli have filamentous cores which extend deep into the cytoplasm and are embedded in the dense material, the cuticle, which is located immediately beneath the surface plasma membrane (Fig. 1).

The cilium has nine peripheral double filaments and a pair of axial filaments. The peripheral set consists of two units, the plumbophilic and the plumbophobic filaments, reported by Nagano (1962) in the spermatid of domestic fowls (Fig. 2). The basal body of the cilium is located in the less dense apical area which is surrounded by cuticle.

In the supranuclear cytoplasm, fine structural elements such as the smooth-surfaced endoplasmic reticulum, dense granules about 200 to 300 A in diameter, filamentous mitochondria, and fine filaments about 200 A in diameter are observed (Fig. 3). The fine filaments are arranged roughly parallel to the long axis of the cell and extend from the cuticular region to the nuclear level. These filaments have a less dense core and display a tubular appearance; they resemble those found in the dendrites of neurons in higher vertebrates (Gray, 1959; Gray and Guillery, 1961). The nucleus, which has a small amount of chromatin substance, is ovoid in shape and frequently shows deep infoldings of the nuclear envelope.

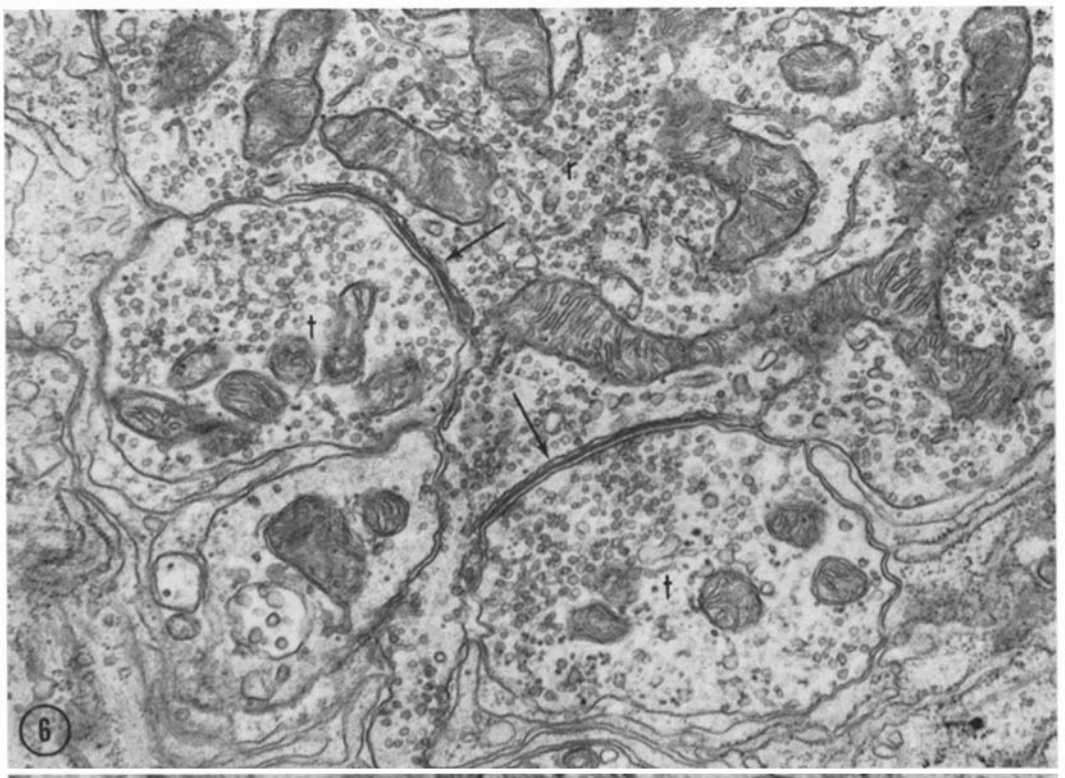
The most characteristic feature of the infranuclear cytoplasm is its large content of vesicles (Fig. 4). This cytoplasm is almost fully occupied by numerous vesicles of various sizes. Some of them are closely associated with the specialized area of the plasma membrane which makes a synaptic contact with the first type of nerve terminal which will be discussed later. It also contains multivesicular bodies, dense granules about 200 to 300 A in diameter, and many mitochondria.

The Nerve Terminals

Two different types of nerve terminals are distinguished on the basal surface of the receptor cell. The first type is an ending without vesicles (Figs. 4, 5, and 17), and the second type is an ending with many vesicles (Figs. 6 and 7). The

FIGURE 6 Two nerve terminals (*t*) of the second type are observed on the basal surface of the receptor cell (*r*). Vesicles are found accumulated both in the receptor cell and the nerve terminals. Subsurface cisternae are found closely associated with the synaptic membrane of the receptor cell (arrow). × 31,000.

FIGURE 7 A high power electron micrograph showing the second type of nerve terminal. Synaptic membranes are separated from each other by a constant space about 350 A wide. The synaptic cleft is occupied by a slightly electron-opaque material. In the nerve terminal (*t*) are seen vesicles (*v*) about 400 A in diameter which are closely associated with the synaptic membrane. The subsurface cisterns (arrows) are associated with the synaptic membrane of the receptor cell. The distal membrane of the cistern is parallel with the synaptic membrane and is separated from it by a constant narrow space about 80 A wide. × 104,000.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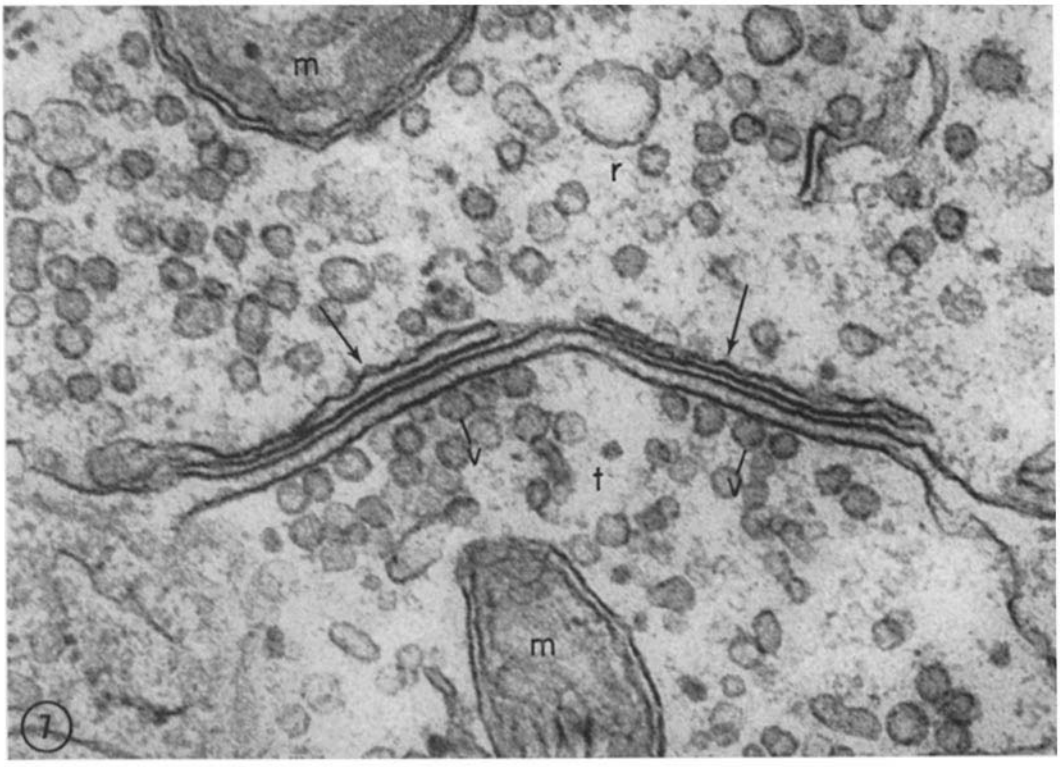
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first type of ending shows a considerable variation in size and shape. Frequently it ends as a spherical body and fits into a shallow depression of the receptor cell surface. Sometimes it extends as a rather flat leaf parallel to the side of the receptor cell, forming a broad contact area. However, in the present study the typical calyx formation which has been described in the vestibular sensory epithelium (Engström and Wersäll, 1958) and the lateral line of fishes (Trujillo-Cenóz, 1961) has not been observed. The nerve cytoplasm contains a cluster of small mitochondria and dense granules of irregular shape, about 200 to 300 A in diameter, but few vesicles. Although no precise histochemical evidence has been obtained in the present study, the dense granules are probably glycogen in nature (Yamamoto, 1963), from the standpoint of size, shape, and affinity for lead staining. The mitochondria always appear to occupy the distal position in the terminal. The synaptic membranes are not smooth and straight like those found in many other synaptic areas, and are separated from each other by an irregular space. However, they show a partial increase of electron opacity about 0.1 to 0.5 μ in extent. In these areas the membranes are parallel to each other and separated by a constant space of about 200 A in width (Fig. 5). In the receptor cell, vesicles about 400 A in diameter are found closely associated with the plasma membrane. A spherical body of homogeneous density, which is 0.1 to 0.5 μ in diameter, is frequently found in the receptor cell cytoplasm adjacent to the electron-opaque area of the synaptic membranes. These bodies are surrounded by a row of vesicles about 400 A in diameter (Fig. 4).

The second type of nerve terminal is bulbous in shape and 0.3 to 1.5 μ in diameter (Figs. 6 and 7). The synaptic membrane of this type of ending is smooth and separated from the opposed synaptic membrane of the receptor cell by a constant space 200 to 300 A in width. The cleft is occupied by a slightly electron-opaque material but does not show any specialization such as a bridge formation (Van Der Loos, 1963) or an intercellular contact layer (Odland, 1958; Hama, 1962). The nerve cytoplasm contains many small mitochondria and vesicles about 400 A in diameter. These vesicles are found closely associated with the synaptic membrane of the nerve terminal. At this type of synapse a pair of membranes, which fuse to each other at both ends to enclose a flattened space, is always found in the receptor cell cytoplasm adjacent to the synaptic membrane. The structure is considered to be analogous to the subsurface cistern described by Rosenbluth (1962) or to the accessory membrane pair described by Smith and Sjöstrand (1961). The distal membrane of the subsurface cistern is closely parallel to the synaptic membrane of the receptor cell, being separated by a constant narrow space about 50 to 80 A wide. Both surfaces of the cistern, the one facing the synaptic membrane and the other facing the cytoplasm, are free of Palade's granules and do not show any detectable morphological difference as described by Rosenbluth (1962) and Smith and Sjöstrand (1961).

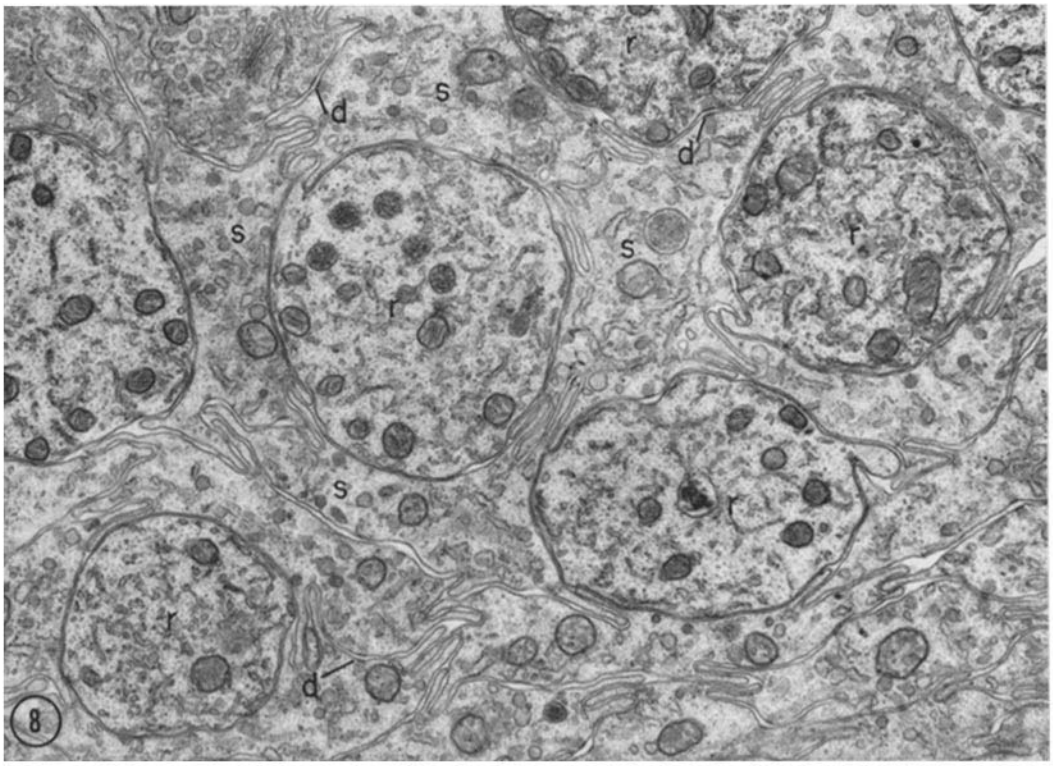
Sometimes these two types of nerve terminals are found existing on the same receptor cell. On the whole, the first type of nerve terminal is more frequently found than the second type of nerve terminal, though the number of terminals varies from section to section.

Supporting Cells

The supporting cell is also a slender element reaching from the basement membrane to the outer surface of the epithelium. The nucleus of the

FIGURE 8 An electron micrograph showing the relationship between the receptor cells (*r*) and the supporting cells (*s*) at the supranuclear level in a section parallel to the upper surface of the neuromast. The cross-section of the receptor cell (*r*) displays a round shape and is surrounded by supporting cells. Plasma membranes of adjacent supporting cells show complicated interdigitations and have many desmosomes (*d*). Desmosomes are also found on the surface of contact between the supporting cell and the receptor cell. × 96,500.

FIGURE 9 An electron micrograph of a part of the longitudinal section of the supporting cells at the supranuclear level, as in Fig. 8, shows four desmosomes (*d*) on the contact surface of adjacent supporting cells (*s*). A bundle of filaments (*f*) which connects the desmosomes is observed in each supporting cell beneath the plasma membrane at the surface of contact. × 26,000.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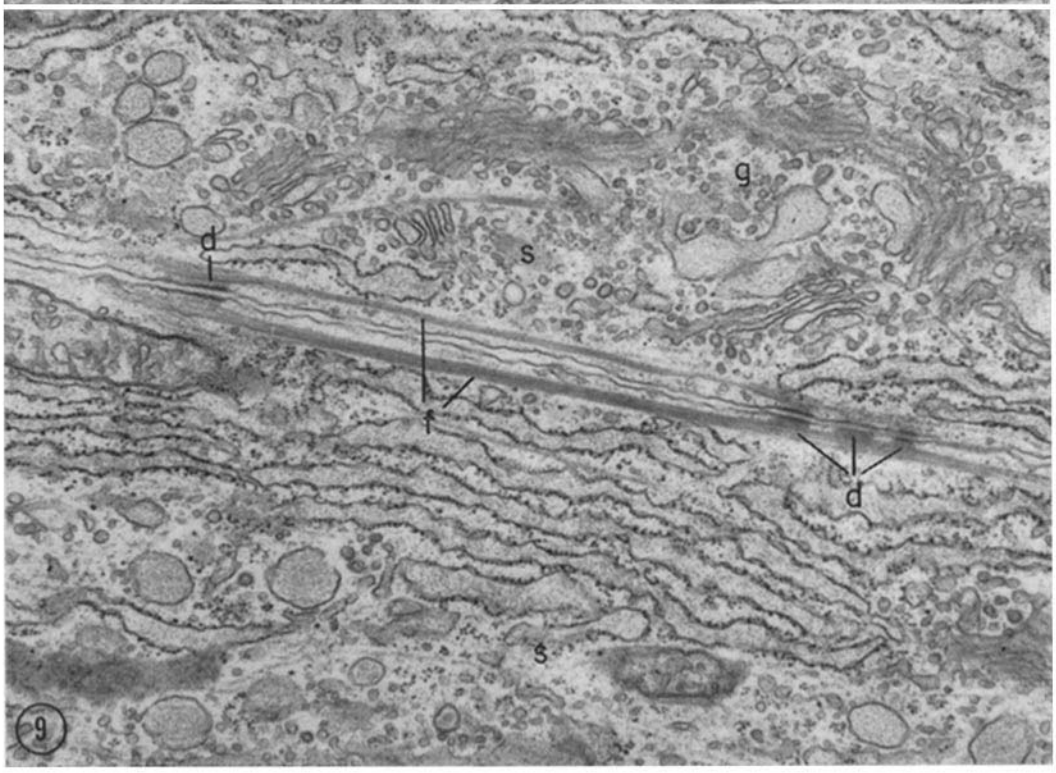
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cell is at a level between the basement membrane and the basal poles of the receptor cells. In the central part of the neuromast the supporting cell and the receptor cell are closely applied to each other (Fig. 8). The surface of contact between the receptor cell and the supporting cell is rather smooth, but that between two supporting cells is irregular and frequently shows interdigitations. Moreover, many desmosomes are observed on the contact surface between adjacent supporting cells. A bundle of fine filaments is observed to be arranged parallel to both the long axis of the cell and the outer cell surface and it connects with the desmosomes (Fig. 9). Thus, the supporting cells are strongly connected to each other by interdigitations and a specialized desmosome system forming a rigid cytoplasmic mesh in which the individual receptor cells are embraced. In the peripheral part of the neuromast the supporting cells form continuous cell layers without being intermixed with the receptor cells, and they encircle the central region of the neuromast. In the supporting cell cytoplasm, a well developed Golgi apparatus is found in the supranuclear region. The apparatus displays a ring form, as seen in the section parallel to the free surface of the epithelium (Fig. 11), and consists of parallel layers of vesicles and lamellae as seen in the section perpendicular to the epithelium (Fig. 10). From these observations, the Golgi apparatus of the supporting cells is considered to be cylindrical in form with the long axis parallel to the long axis of the cell. Near the apical end of the Golgi region, the inside of the cylinder is filled with vacuoles of various sizes and densities. Sometimes the apical cytoplasm is occupied by an accumulation of large secretory granules.

The rest of the cytoplasm is filled with a pile of flattened cisternae of the rough-surfaced endoplasmic reticulum which are arranged roughly parallel to the long axis of the cell (Fig. 12). The width of the cisternal cavity varies considerably. Continuity between the vesicular component of the Golgi apparatus and the rough-surfaced endoplasmic reticulum is observed at the periphery of the Golgi region (Fig. 10). Beneath the nuclear level of the receptor cell, the supporting cells are frequently found embracing the intraepithelial nerve fiber with mesaxon-like membrane infolding (Fig. 19).

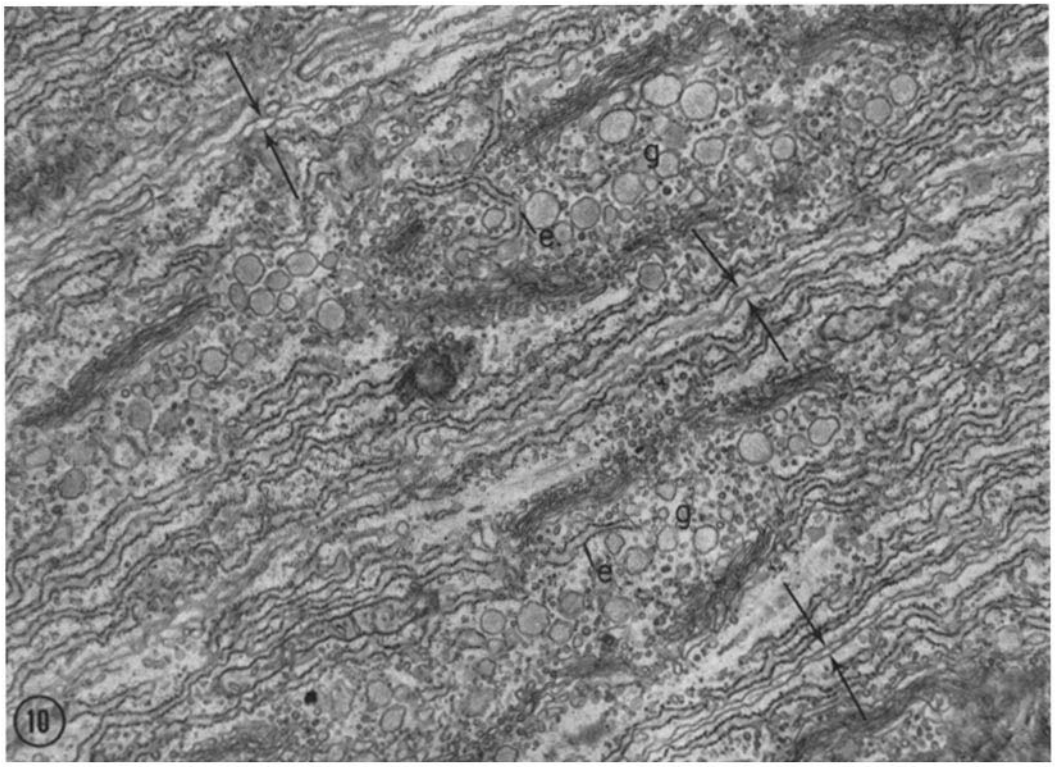
Lateral Line Nerve

Besides myelinated fibers of various sizes ranging from 1 to 5 μ found in the lateral line nerve, a bundle of unmyelinated fibers is also present (Figs. 13 and 16). Both types of fiber penetrate into the sensory epithelium (Figs. 14 and 15). In some cases, the myelinated fibers lose their myelin sheath in the subepithelial connective tissue (Fig. 14); however, they are frequently found penetrating into the epithelium with their myelin sheath (Fig. 18). In the latter case, the fiber is demyelinated in the epithelium. The mode of demyelination is the same in both cases and is analogous to the one which is observed in the case of the node of Ranvier (Robertson, 1959) (Fig. 17).

Filamentous mitochondria and two types of fine filaments, one about 200 A in diameter with a less electron-opaque core and the other about 70 A in diameter, are observed in both the myelinated and unmyelinated fibers (Figs. 13 to 16). Dense granules of irregular shape and about 300 A in diameter, probably glycogen in nature, are frequently found in the nerve fibers in the epithelium (Figs. 4 and 5). These fibers form an intraepithelial nerve plexus beneath the basal poles of the receptor cells and then make synaptic contact

FIGURE 10 An electron micrograph of a supranuclear region of the supporting cells, as seen in a section perpendicular to the upper surface of the sensory epithelium, shows the parallel arrangement of various membrane structures. The surface plasma membranes of adjacent supporting cells are indicated by opposing arrows. Layers of Golgi membranes run roughly parallel to each other and are separated by a space which is occupied by vesicles and vacuoles of various sizes and densities. Direct continuity between the rough surfaced endoplasmic reticulum (*e*) and the smooth surfaced membrane elements of the Golgi apparatus is found at many places. × 15,500.

FIGURE 11 Golgi apparatus (*g*) which is ring shape in a section parallel to the upper surface of the sensory epithelium at the same level as in Fig. 10. Both inside and outside of the Golgi ring are seen vesicles and vacuoles of various sizes and densities. × 19,000.



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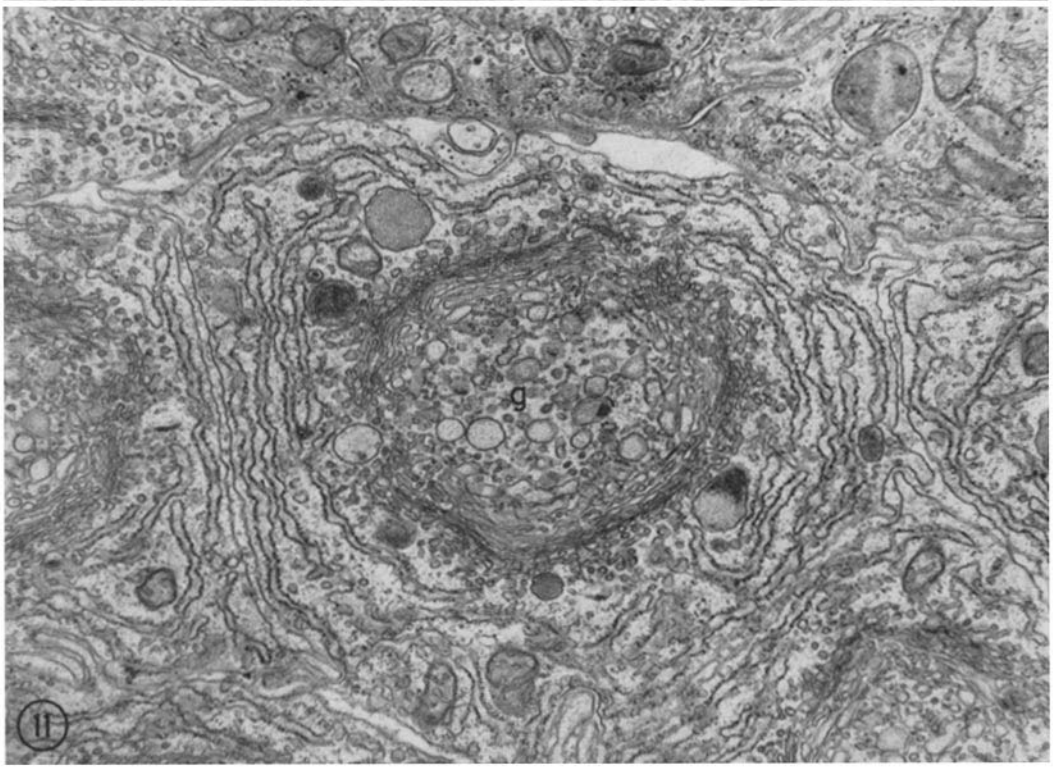

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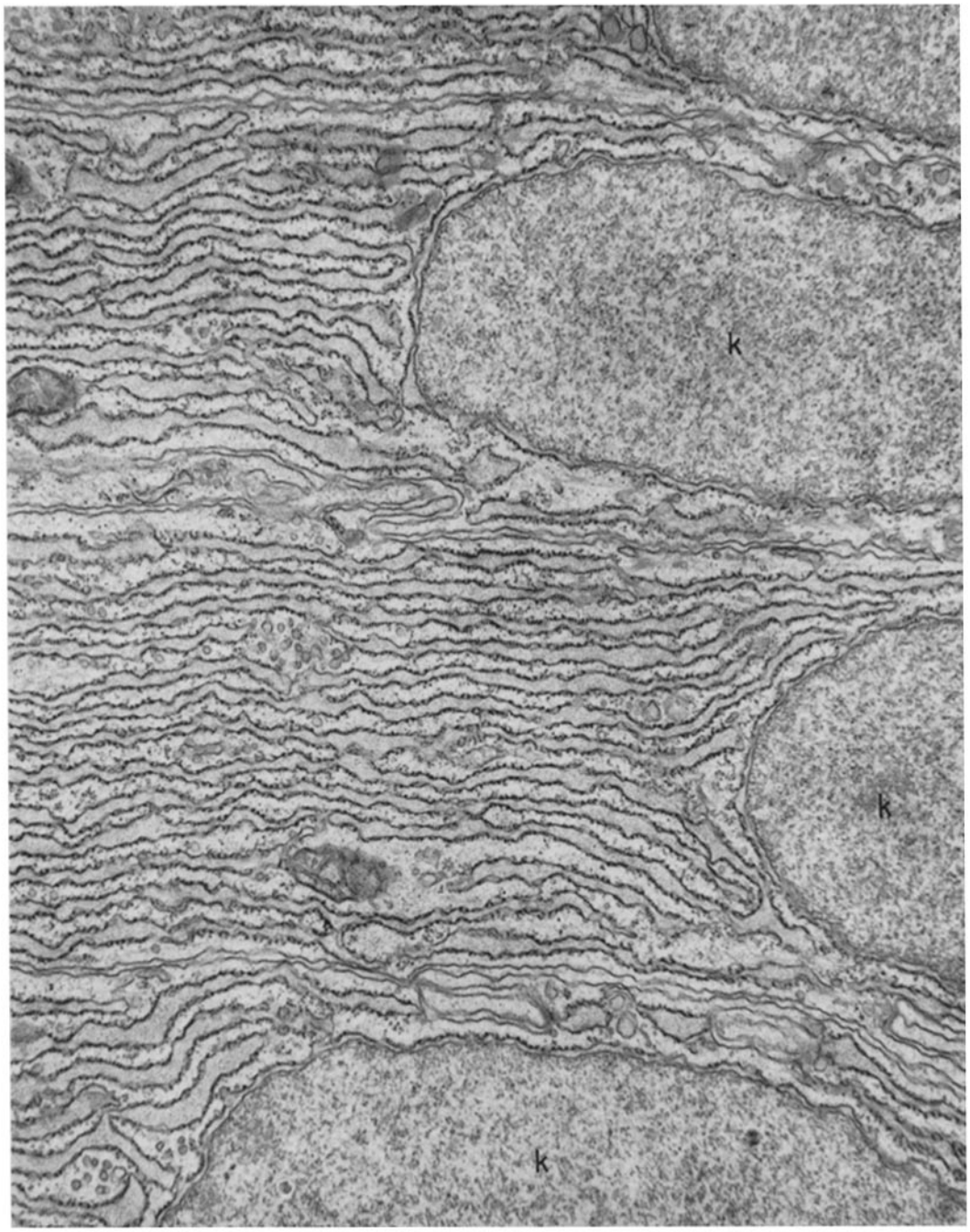

FIGURE 12 An electron micrograph showing the supranuclear region of the supporting cells. The cytoplasm is fully occupied by regularly arranged rough surfaced endoplasmic reticulum. The content of the cistern of the endoplasmic reticulum is slightly more electron opaque than the rest of the cytoplasm. × 23,000.

with the receptor cells. From the anatomical relationships mentioned above, it is difficult, if not impossible, to trace the whole intra-epithelial course and to determine the precise distribution of the terminal branches of the lateral line nerve.

DISCUSSION

It is interesting to note that the fine structure of the nerve terminals in the lateral line organ closely resemble those of the outer hair cell of the cochlea (Smith and Sjöstrand, 1961; Engström, 1958, 1960; Engström and Wersäll, 1958; Iurato, 1961, 1962). Besides the afferent innervation, the existence of efferent fibers in the cochlear nerve was suggested by Rasmussen (1946, 1960), Rasmussen and Gacek (1958) and Engström (1958). Their prevision has been beautifully confirmed by Fex (1962) who demonstrated the inhibitory nerve function of the crossed olivo-cochlear bundle. In morphological studies, Bairati and Iurato (1962) and Kimura and Wersäll (1962) found the degenerative change of "much granulated" nerve endings of the outer hair cells after the transection of both the crossed and the homolateral olivo-cochlear bundles. With respect to these findings, at least in the case of the outer hair cell of rat cochlea, it is well accepted that the less vesiculated terminal is afferent in function and that the much vesiculated terminal has an efferent nerve function.

From the morphological analogy mentioned above, it is conceivable that in the lateral line organ the first type of nerve terminal which contains few vesicles, and the second type of nerve terminal which contains many vesicles may correspond to the afferent and efferent innervations of the lateral line sensory epithelium, respectively, although no efferent nerve function has been observed in the lateral line nerve (Katsuki, Yoshino, and Chen, 1951 *a* and *b*). A homogeneous body with surrounding vesicles which is found in the receptor cell closely associated with the first type of synapse is presumed to be a structure corresponding to the synaptic ribbon in the outer hair cell of cochlea (Smith and Sjöstrand, 1961) or "ruban pre-synaptique" and "vesicles pre-synaptiques" in the sensory hair cell of "Ampoule de Lorenzini" (Barets and Szabo, 1962). The functional significance of these structures in the synaptic mechanism is not yet known. Complicated infoldings of the basal plasma membrane of the receptor cell which were reported by Flock and Wersäll (1962) have not been detected in the present study, even in permanganate-fixed material (Fig. 17). The basal cytoplasm of the receptor cell is always found to be occupied by an accumulation of vesicles. This point should be further clarified with respect to the problem of the membrane fragmentation caused by various fixing agents (Ito, 1961; Sedar, 1961, 1962; Rosenbluth, 1963).

Besides the high content of synaptic vesicles in nerve endings, the associated subsurface cistern in the receptor cell is the characteristic feature of the second type of nerve terminal. The functional significance of the subsurface cistern is not known; however, its constant association with a definite type of synapse suggests that it may play a role in synaptic transmission in a specific way.

The existence of the highly developed system of the rough-surfaced endoplasmic reticulum in the supporting cell cytoplasm strongly suggests a high rate of protein synthesis in the cell. The supporting cell also has the characteristics of a secretory cell: the well developed Golgi apparatus and the high content of the PAS-positive secretion granules in the apical cytoplasm. With respect to these facts, it can be considered that the supporting cells have a nutritive function for the receptor cell, and that they may also be responsible for the mucous secretion and for the cupula formation which is also polysaccharide in nature. As mentioned before, the supporting cells rigidly adhere to each other forming a cytoplasmic network in which each receptor cell is embedded. Thus, the individual receptor cells are separated from one another by a layer of supporting cell cytoplasm. In this respect, the supporting cells sustain the receptor cell and, at the same time, they may perform another important function as an insulator for the receptor cell. The basal part of the supporting cell shows the same morphological relationship to the nerve fiber as the Schwann cell does and thus may have the same functional significance as the Schwann cell.

The relation between the size of the myelinated fibers and the types of the nerve terminals is not yet known. The existence of the unmyelinated fibers in the lateral line nerve is clearly demon-

strated in the present study, but their final course in the epithelium and their terminals have not been detected. These two questions still remain to be clarified.

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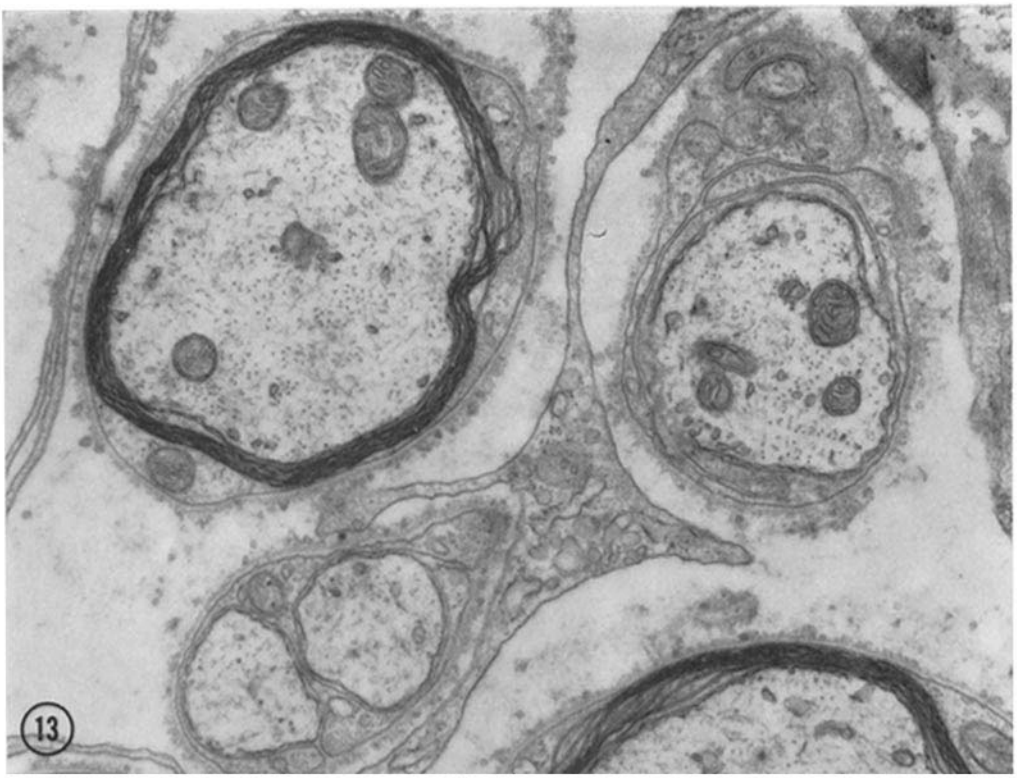
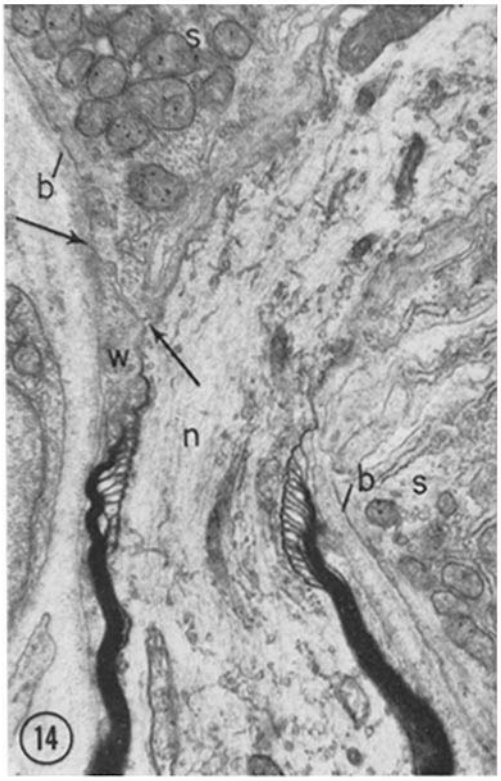
(*Bibliography Cont. on p. 210*)

FIGURE 13 Several unmyelinated fibers and two myelinated fibers are observed in the cross-section of the lateral line nerve. × 26,000.

FIGURE 14 An electron micrograph showing the penetration of a myelinated fiber (*n*) into the epithelium. The nerve fiber looses its myelin sheath beneath the epithelium. The basement membrane (*b*) of the epithelium continues to the basement membrane which surrounds the Schwann cell (*w*) of the nerve fiber. The supporting cell (*s*) and the Schwann cell are separated by a narrow gap (arrows) about 200 A wide, and no layer of basement membrane or connective tissue elements is intercalated between them. In the epithelium the nerve fiber is surrounded by the supporting cells (*s*). In the figure the epithelium is at the upper right and the connective tissue at the left. × 16,000.

FIGURE 15 An electron micrograph showing the penetration of an unmyelinated fiber into the epithelium. The nerve fiber (*n*) loses its Schwann sheath (*w*) immediately beneath the epithelium. In the epithelium the nerve fiber is surrounded by the supporting cells (*s*). Fine filaments about 200 and 70A in diameter are observed in the nerve fiber. The epithelium is shown in the upper half of the figure. × 22,000.


13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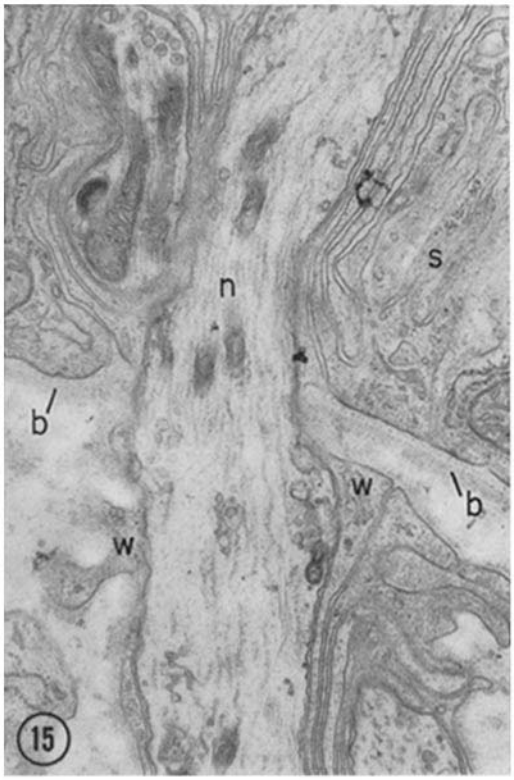
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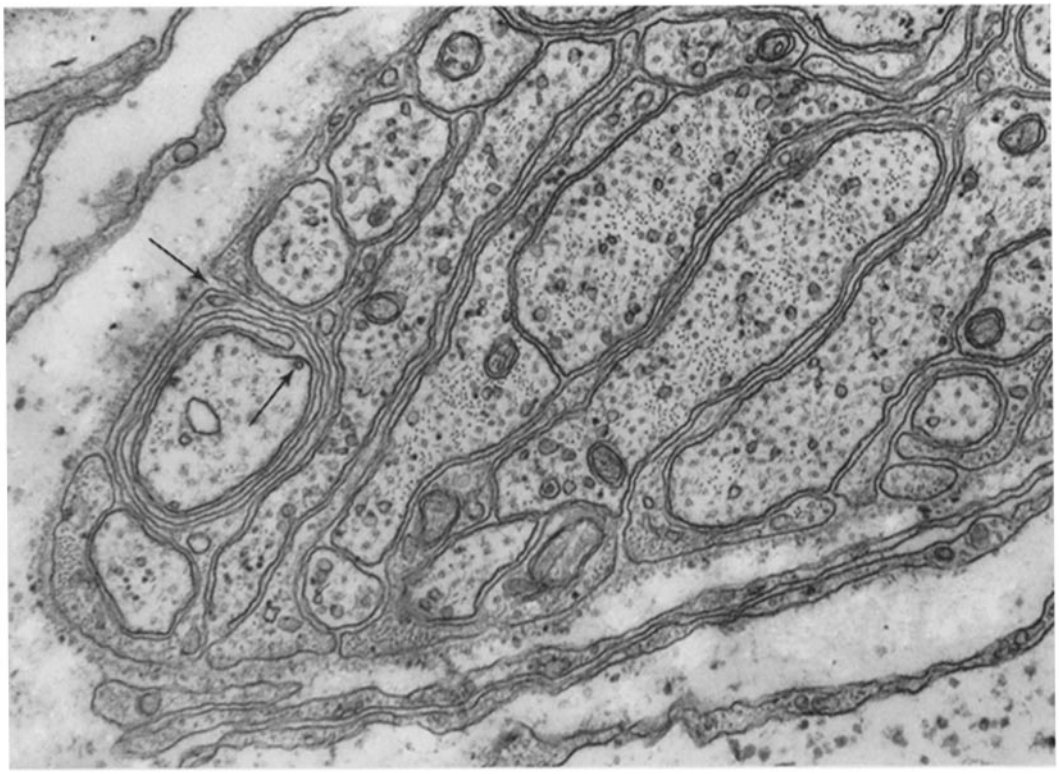
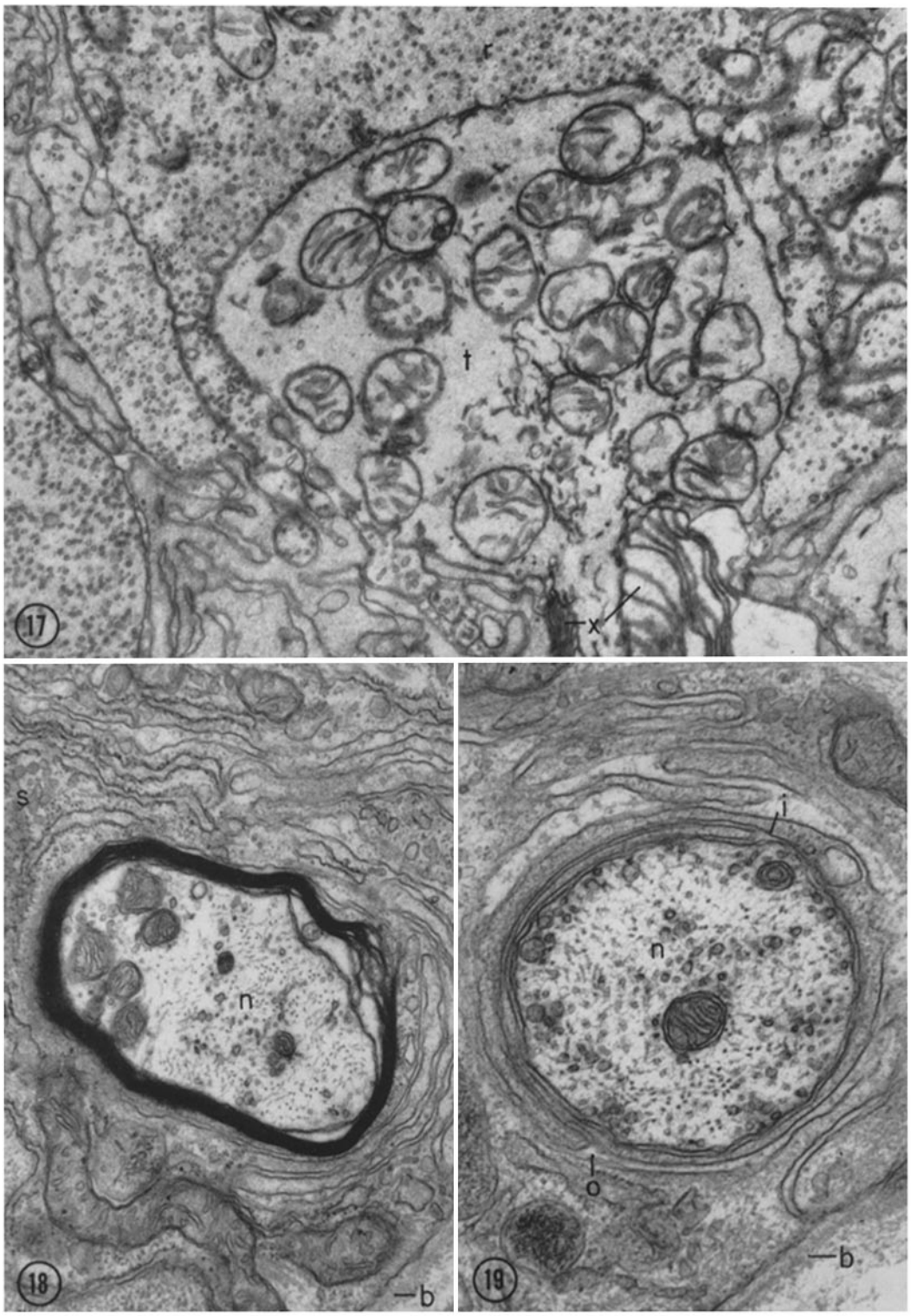


FIGURE 16 A high power electron micrograph showing a bundle of unmyelinated fibers in oblique section. Besides the mitochondria, the axon contains circular profiles of various sizes ranging from 300 to 1,000 A in diameter, circular profiles about 200 A in diameter, and dense dots less than 100 A in diameter. These correspond to cross-sections of the tubular endoplasmic reticulum, fine filaments about 200 A in diameter with a less dense core, and fine filaments about 70 A in diameter, respectively. Sometimes the nerve fiber has several turns of spiral mesaxon as indicated by the arrows. × 36,500.

FIGURE 17 A myelinated fiber loses its myelin sheath (*x*) before it ends as a bulbous terminal (*t*) to make synaptic contact with the receptor cell (*r*), which is occupied by an accumulation of small vesicles. The nerve terminal contains many mitochondria but few vesicles. Permanganate-fixed material. × 20,000.

FIGURE 18 Myelinated fiber (*n*) in the epithelium is surrounded by a supporting cell (*s*). Although no precise course can be traced, a complicated membrane infolding is observed around the nerve fibers. × 29,000.

FIGURE 19 A nerve fiber (*n*) in the epithelium is surrounded by a thin cell layer. The mesaxon can be traced from the outer cell surface (*o*) to the axon membrane (*i*). Various profiles as mentioned in Fig. 16 are observed in the axons. × 41,500.


r
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squid *Doryteuphis bleekeri*, *Z. Zellforsch.*, 1962, **56,** 437.

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