Denervated Taste Buds. I. General Ultrastructural Observations

The cut of the taste nerves brings about the disintegration and the disappearance of the taste buds[1]. The present report examines the general ultrastructural features of such a degenerative process.

Materials and methods. The foliate papillae of adult rabbits were removed at subsequent times, and precisely on the 2nd, 5th, 10th, 15th and 20th day after the transection of the homolateral glossopharyngeal nerve. The pieces were fixed in 3% glutaraldehyde, post-fixed in osmium, dehydrated in ethanol and embedded in Epon.

Results and discussion. After the denervation, the taste buds degenerate rapidly and disappear within a period of some 15 days, according to the findings of light microscopy[1-3].

The earliest alterations occur in the apical region of the cells which converge towards the taste pore and consist in the disorientation of the microvilli which mingle with each other in a disordered way and are variably dislocated due to the strangling of the taste pore (Figure 1). Furthermore, the cells tend to lose their spindle shape, becoming coarsely polyhedric. The 'mucoid substance' of RANVIER[1] often has the aspect of elongated longitudinal masses with a dusty look.

As regards the medio-basal region of the cell, this is characterized in the first days after the denervation by the presence of cytosegregosomes[4] – also called autophagic vacuoles – in the slightly differentiated cells of the taste buds, that is to say in the basal and in the peripheral cells and, characteristically, in similar cells scattered here and there in the taste bud[5]. They are very voluminous formations, limited by a simple or double membrane and containing cytoplasmic organules in various stages of break-up (Figure 2).

In the type I cells which are considered by some authors the typical mature taste cells[6], classical lysosomes are observed[7] with the presence of numerous membranes which have been brought close together and which have a myeloid type aspect and frequent ferritin-like granules (Figure 3). Subsequently the massive degeneration of the type II cells prevails. This brings about the deformation and progressive disappearance of lipid droplets normally present in such cell type and the swelling of the tubulo-vesicular cytoplasmic profiles (Figure 4). Finally, the whole cytoplasmic organization is rapidly overwhelmed.

In the degeneration of the denervated taste bud, it is therefore possible to distinguish 2 types of lesions. To the focal lesions of the first type the cells answer through the

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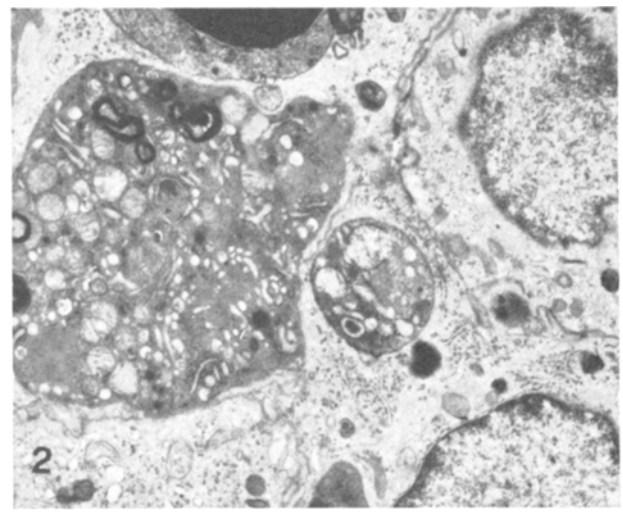

Fig. 2. Denervated taste bud. Big cytosegregosoma containing many swollen mitochondria, myeloid figures, cisternae of the rough endoplasmic reticulum and scattered tubulo-vesicular spaces. Close to the big cytosegregosoma there is a small one. × 9900.

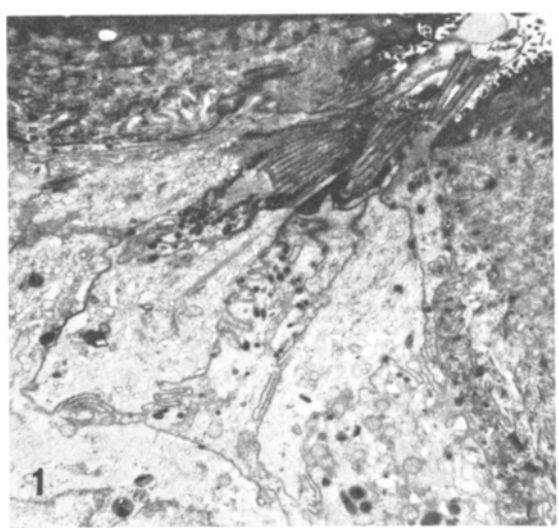

Fig. 1. Denervated taste bud. The apical region is shown. Note the altered direction of the reciprocally interweaving microvilli and the strangling of the taste pore. × 12,500.

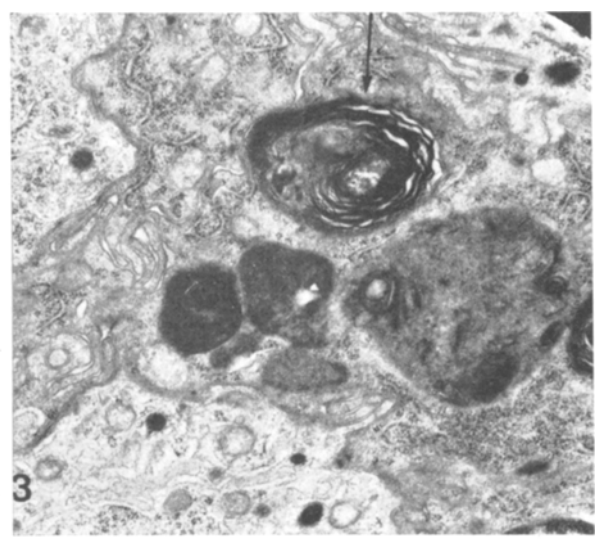

Fig. 3. Denervated taste bud. Some typical lysosomes are observed within a type I cell. One of them (arrow) exhibits many membranous layers condensed at the periphery. × 16,250.

sequestration and subsequent enzymatic degradation of the cytoplasmic areas involved within membrane-bound formations. Consequently the production of cytosegregosomes is, within certain limits, the expression of a residual self-defensive capacity of the cell directed to circumscribing the degree and the range of the damage caused by the denervation. This is confirmed by the extreme scarcity of the alterations observed in the residual cytoplasm.

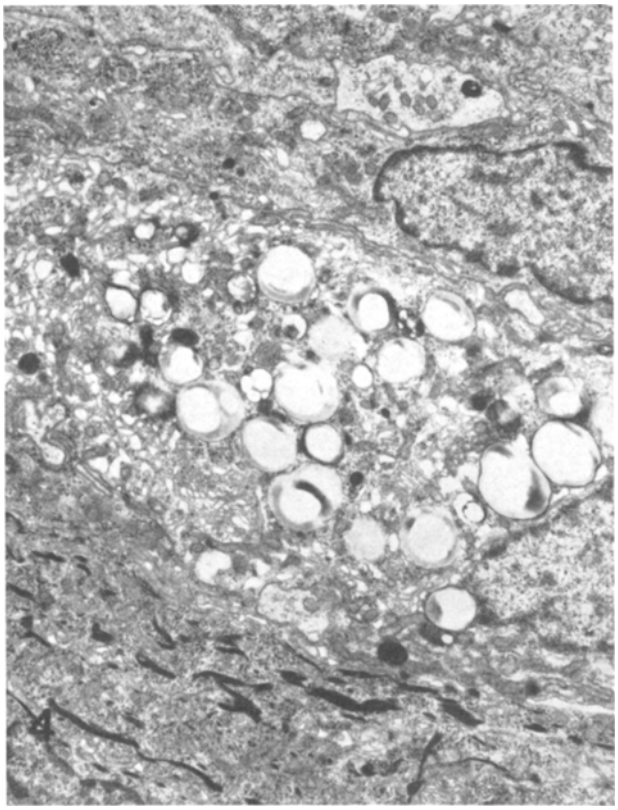

Fig. 4. Denervated taste bud. The cytoplasm of a type II cell is observed. Many lipid droplets are visible, some showing vacuolization, others thickening or deformation of the edge. The swelling of the tubulo-vesicular cytoplasmic spaces has already begun. × 8850.

The second group of lesions causes the total degeneration of the type II cells.

The sub-microscopic alterations just described provide further proof of the validity of the trophic theory of nerves[8–10]. In our case, sensory nerves are involved. In this connection it must be emphasized that the trophic function exercised by the taste nerve fibres on the cells of the taste bud is – in respect of other sensory fibres – particularly complex, not only as regards maintenance but also the development and the differentiation of the cells themselves which are subject to a continuous physiological turnover.

Riassunto. La denervazione dei calici gustativi provoca due tipi fondamentali di alterazioni cellulari: il primo è rappresentato da lisosomi e citosegregosomi che colpiscono le cellule scarsamente differenziate, il secondo è invece rappresentato da lesioni che sconvolgono l'intera organizzazione citoplasmatica delle cellule di II tipo.

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Einfluss von Augenstielextrakt auf Trehalose, Fructose und Glucose in der Hämolymphe von *Orconectes limosus*

Hyperglykämische Wirkung von Augenstielextrakten ist bei dekapoden Crustaceen mehrfach beschrieben worden[1–3]. In den meisten Untersuchungen wurden Veränderungen des «Gesamtzuckers» gemessen, so dass nicht klar ist, ob nur einer oder ob mehrere Zucker unter dem Einfluss des hyperglykämischen Hormons vermehrt werden. Bei den Wirbeltieren, deren normaler Blutzucker die Glukose ist, ist eine Hyperglykämie wohl stets eine Hyperglukosämie, bei den Insekten, deren Hauptblutzucker Trehalose ist, eine Hypertrehalosämie. Bei den Crustaceen sind die freien Kohlenhydrate in der Hämolymphe vielfältig zusammengesetzt und es kann nicht vom eindeutigen Überwiegen eines Zuckers gesprochen werden[4]. Die bisherigen Befunde sprechen dafür, dass unter Hormoneinfluss oder stress vor allem die Glukose erhöht wird[2,3,5]. Über Konzentrationsveränderungen weiterer Zucker ist nichts Näheres bekannt. Insbesondere wurde bisher der Trehalose bei dekapoden Crustaceen eine nebensächliche Rolle zugeschrieben. Unsere Versuche ergaben jedoch, dass gerade die Trehalose zu bestimmten Zeiten unter Hormoneinfluss bemerkenswert hohe Konzentrationen erreichen kann.

Methode. Den Versuchstieren, die im Mittel 20 g wogen, wurde die einem halben Augenstiel entsprechende Extraktmenge (ca. 0,4 mg Augenstielprotein) in van Harreveldlösung, den Kontrollen van Harreveldlösung allein injiziert. Hämolymphe wurde aus dem Coxalgelenk entnommen. In der Hämolymphe wurden Protein und Polysaccharid durch Fällung mit Methanol, Lipide durch Ausschütteln mit Chloroform entfernt. Weitere Reinigung erfolgte an Dowex 21K und Dowex 50WX4, Auftrennung der Zucker auf borsäureimprägnierten Kieselgelplatten

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